INSTALLATION

AND

OPERATION MANUAL

FOR

DYNACON MODEL 2600
ELECTRO-HYDRAULIC CORING WINCH

MANUFACTURED FOR

UNIVERSITY OF TEXAS
MARINE SCIENCE INSTITUTE

MANUFACTURED BY:

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SECTION 1
INTRODUCTION

GENERAL

This manual is written to support the experienced technician/operator during maintenance, repair and operation of the DYNACON, Inc. Model 2600 Electro-Hydraulic Coring Winch System.

SYSTEM DESCRIPTION

The Coring Winch System is a self-contained winch system which can be installed on the open deck of a ship. The system is electrically powered, hydraulically operated and is capable of operating in prolonged exposure to marine conditions.

SAFETY

Under normal operating conditions, the winch system poses no electrical or mechanical hazards to personnel. The system does utilize voltages, however, which are potentially lethal or hazardous to personnel. Further, the winch system itself could present a hazard to shipboard personnel if safety precautions are not observed. The purpose of this subsection is to establish a means to identify those potential hazards to the operator or technician and to describe precautionary procedures to limit those hazards.

Throughout this manual there are three categories of safety information provided.

WARNING !!!

WARNINGS identify situations which are potentially lethal or hazardous to personnel.

CAUTION !!!

CAUTIONS identify situations which are potentially hazardous to equipment or material.

NOTE !!!

NOTES are used to amplify or emphasize information provided in text or procedures.

TABLE 1-1, QUICK REFERENCE DATA

POWER:	
▸ Primary	- 208 VAC, 3 phase, 60 Hz
▸ Prime Mover	- 40 HP, 208-230VAC, 3 Phase, 60 Hz, Marine Duty Electric Motor
HYDRAULIC FLUID:	- Mobil DTE15M ISO VG-46 (Or Equivalent)
RATINGS :	
▸ Drum Capacity	- 8,000 Ft. of 0.68 inch electro-mechanical cable or 10,000 Ft. of 0.5 inch wire rope.
PERFORMANCE:	
▸ Dynamic	- 10,000 lbs. continuous @ 0-100 fpm @ full drum. - 4,000 lbs. continuous @ 0-250 fpm @ full drum
▸ Static (Braking)	- 20,000 pounds @ mid-drum
WEIGHT (NO CABLE):	- 6200 pounds — with Cable - 11,000 pds
DRUM SIZE:	
▸ Core Diameter	- 30 inches
▸ Flange Diameter	- 52 inches
▸ Core Width	- 36 inches
FRAME FOOTPRINT:	
▸ Width	- 58 inches (76 1/8 inches overall)
▸ Length	- 72 inches ()82 3/4 inches overall)
▸ Height	- 81 3/4 inches

OTHER FEATURES:

- DYNACON, Inc. Electro-Active Levelwind System
- Lebus Bolt-on Grooved Drum Liner
- Air/Oil Heat Exchanger
- Local and Remote Control
- Installation of Customer Supplied Slipring
- Line Count and Speed @ Local and Remote Control

NOTES

SECTION 2
DESCRIPTION

GENERAL

The information in this section provides the technician/operator with both a physical and a functional description of the Model 2600 Coring Winch System.

The physical description is presented in three categories: structural, electrical and hydraulic. The functional description describes theory of operation and covers system operation for shipboard use.

PHYSICAL DESCRIPTION

STRUCTURAL

The Coring Winch System is comprised of the following functional sub-assemblies: electro-hydraulic power unit, winch drum, and electro-active levelwind. All three sub-assemblies are mounted on a common structural steel tubing frame that can be bolted or welded to the deck plates of a vessel in the required orientation.

The winch frame is constructed of structural steel tubing. The frame is totally seal welded to prevent moisture from entering the tubing.

The winch drum is supported on one end by a DODGE SAF-XT 3 15/16 inch pillow block bearing assembly. The drum shaft extends through the entire length of the drum.

The drum is directly driven on one end by a VOAC FD-28 planetary gearbox having a 115.6:1 ratio. The VOAC gearbox has an integral spring applied-hydraulically released failsafe brake and V-12 60 CC hydraulic motor.

Insert Blueprint Here

SYM	DATE	REVISION	BY
D	16OCT97	AS BUILT	LVE

K1 LOCAL BRAKE RELEASE
A-BRAKE SIGNAL
B-I/L BRAKE > START
C-I/L BRAKE > REMOTE ENABLE

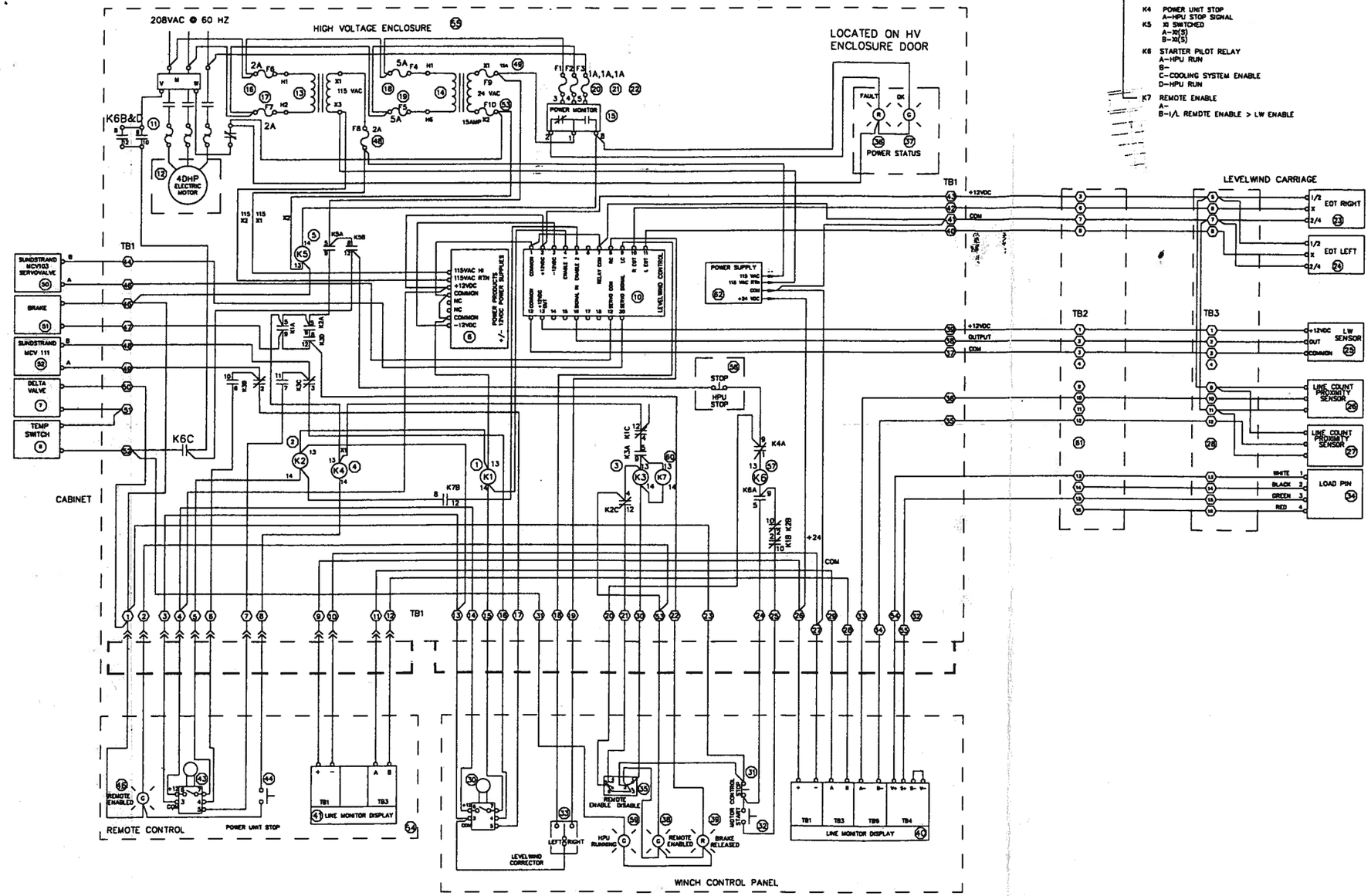
K2 REMOTE BRAKE RELEASE
A-BRAKE SIGNAL
B-I/ > REMOTE BRAKE > START

K3 REMOTE ENABLE
A-LATCH
B-SELECT REMOTE CONTROL > LOCAL
C-
D-I/L > REMOTE BRAKE RELEASE

K4 POWER UNIT STOP
K5 A-HPU STOP SIGNAL
X1 SWITCHED
A-X1(S)
B-X1(S)

K6 STARTER PILOT RELAY
A-HPU RUN
B-
C-COOLING SYSTEM ENABLE
D-HPU RUN

K7 REMOTE ENABLE
A-
B-I/L REMOTE ENABLE > LW ENABLE



ITEM	QTY	DESCRIPTION	PART NUMBER	MANUFACTURER	CAGE NO.
1	1	RELAY	RH3B-UL-DC12V/SH3B-05	IDEC	
2	1	RELAY	RH3B-UL-DC12V/SH3B-08	IDEC	
3	1	RELAY	RH4B-UL-AC24V/SH4B-05	IDEC	
4	1	RELAY	RH4B-UL-AC24V/SH4B-05	IDEC	
5	1	RELAY	RH2B-UL-AC12V/SH3B-05	IDEC	
6	1	POWER SUPPLY	PM536 & HE583 / MSI49	COMPUTER PRODUCTS	
7	1	SOLENOID VALVE	SEE HYDRAULICS		
8	1	TEMPERATURE SWITCH	SEE HYDRAULICS		
9		NOT USED			
10	1	LEVELWIND PCB	DY96000-312-02	DYNACON	
11	1	MAGNETIC STARTER	CAT1602415	SPRECHER & SCHUH	
12	1	ELECTRIC MOTOR	CM41110TB	BALDOR	
13	1	TRANSFORMER	TA-2-B1304	ACME	
14	1	TRANSFORMER	TA-2-B1325	ACME	
15	1	MOTOR PROTECTOR	257B	TIME MARK	
16	1	FUSE	KTKR-2A F6	BUSSMAN	
17	1	FUSE	KTKR-2A F7	BUSSMAN	
18	1	FUSE	KTKR-5A F4	BUSSMAN	
19	1	FUSE	KTKR-5A F5	BUSSMAN	
20	1	FUSE	KTKR-1 AMP F1	BUSSMAN	
21	1	FUSE	DTKR-1 AMP F2	BUSSMAN	
22	1	FUSE	KTKR-1 AMP F3	BUSSMAN	
23	1	PROXIMITY SENSOR	IME3015FNOG	EFECTOR	
24	1	PROXIMITY SENSOR	IME3015FNOG	EFECTOR	
25	1	LW SENSOR	DYN97000-036-01	DYNACON	
26	1	PROXIMITY SENSOR	IW3008BPOG	EFECTOR	
27	1	PROXIMITY SENSOR	IW3008BPOG	EFECTOR	
28	1	J-BOX	580B	PAULUHN	
29		NOT USED			
30	1	CONTROL HANDLE	MCH51AB1174	SUNDSTRAND	
31	1	PUSHBUTTON	52PAB/52BAJ/51AABA	FURNAS	
32	1	PUSHBUTTON	52PAB/52BAK/52AABA		
33	1	SWITCH,TOGGLE	1TL1-7	MICROSWITCH	
34	1	NOT USED			
35	1	TOGGLE SWITCH	2TL1-70	MICROSWITCH	
36	1	INDICATOR LAMP	177-8430-09-503&177-0931-003	DIALIGHT	
37	1	INDICATOR LAMP	177-8430-09-503&177-0932-003	DIALIGHT	
38	1	INDICATOR LAMP	177-8430-09-503&177-0932-003	DIALIGHT	
39	1	INDICATOR LAMP	177-8430-09-503&177-0931-003	DIALIGHT	
40	1	DISPLAY	LM2-14-0003-Z	M/D TOTCO	
41	1	DISPLAY	LM2-14-0003-Z	M/D TOTCO	
42		NOT USED			
43	1	CONTROL HANDLE	MCH51AB1174	SUNDSTRAND	
44	1	PUSHBUTTON	52PAB/52BAK/52AABA	FURNAS	
45		NOT USED			
46	1	INDICATOR LAMP	177-8430-09-503&177-0932-003	DIALIGHT	
47		NOT USED			
48	1	FUSE	KTKR-2A F8	BUSSMAN	
49	1	FUSE	3AG-15A F9	LITTELFUSE	
50	1	SERVO VALVE	SEE HYDRAULICS		
51	1	SOLENOID VALVE	SEE HYDRAULICS		
52	1	SERVO VALVE	SEE HYDRAULICS		
53	1	FUSE	3AG-15A F10	LITTELFUSE	
54	1	ENCLOSURE	A-1212CHNFSS	TEJAS	
55	1	ENCLOSURE	A-30H2008SS	TEJAS	
56	1	PUSHBUTTON	52PAB/52BAJ/52AABA	FURNAS	
57	1	RELAY	RH4B-UL-AC24V/SH4B-05	IDEC	
58		NOT USED			
59	1	INDICATOR LAMP	177-8430-09-503&177-0932-003	DIALIGHT	
60	1	RELAY	RH2B-UL-AC24V/SH2B-05	IDEC	
61	1	J-BOX	58DB	PAULUHN	
62	1	POWER SUPPLY	NFS 110-7602 P	COMPUTER PROD	

TOLERANCES
FRACTIONAL ±
DECIMAL
X.XX ± .02
X.XXX ± .005
X.XXXX ± .001
ANGULAR ± 1/2°
BREAK CORNERS 1/64 X 45°
MIN RADIUS 1/16
FINISH 125
TOLERANCES OUTSIDE THOSE INDICATED MAY BE SUBSTITUTED AS INDICATED BY EXPERIENCE AND/OR RECOGNIZED COMMERCIAL PRACTICE

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DRAWN BY –
REVISED BY –
REVISION DATE –
WORK ORDER ATTACHED

DYNACON, INC.
631 INDUSTRIAL BLVD.
BRYAN, TEXAS 77803

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PLOT DATE 10/17/97 PLOT TIME 13:14

TITLE
MODEL 2600
CORING WINCH
ELECTRICAL

DRAWING NO. 347-9001-01

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Levelwind

The DYNACON Electro-Active Levelwind is bolted to the structural tubing frame and is located above the winch drum on the power unit side of the drum. The frame is an integral part of the total system assembly.

The DYNACON, Inc. levelwind consists of the framework, two nickel plated guide bars, levelwind carriage, sheave, hydraulic motor, ACME Screw/ACME Nut drive system, levelwind sensor assembly, and various mounting brackets and hardware.

The 2"-4 RH ACME Screw/ACME Nut drive converts rotary motion of the hydraulic motor to linear motion of the levelwind carriage. There are two ACME Nuts in the assembly; the primary nut and the secondary nut. The primary nut is intended for normal operation and the secondary nut is used to indicate the amount of wear in the primary nut and to provide for a "limp-home" mode of operation in the event of primary nut failure.

The levelwind sheave is made of steel and has a tread diameter of 20 inches. Deep groove ball bearings provide frictionless rotation of the sheave. The bearings are sealed from contamination by fully encapsulated lip seals.

The levelwind sensor senses the fleet angle from the levelwind to the drum and provides an error signal to the levelwind control.

Prime Mover

The 40 HP electric motor and pump assembly is bolted to mounting plates welded to the floor plate. The hydraulic reservoir is mounted in a bolt-on frame mounted above the pump-motor assemblies.

Pressure gauges are mounted in a small gauge panel adjacent to the control enclosure. These gauges allow operators to check pump pressures at the power unit.

Motor starter, transformers, relays, levelwind control electronics, and speed controls, and related circuitry is installed in a common enclosure mounted to the frame next to the gauge panel. The enclosure is a NEMA 4X watertight and dustight stainless steel.

HYDRAULIC

The hydraulic system of the Model 2600 Coring Winch System consists of one closed loop circuit and one open loop circuit.

The prime mover 40 horsepower electric motor is coupled to a Sundstrand 90 Series 42CC closed-loop variable displacement pump. Output developed by the pump is controlled by a Sundstrand electric-displacement controller mounted on the pump. A signal generated by the operator is transformed into linear motion of the internal swashplate of the pump supply flow to the winch drive motor. As the swashplate moves speed and direction of the pump discharge flow are proportionally controlled.

A fixed displacement charge pump is an integral part of the variable pump. The purpose of this pump is to, 1) provide a flow of oil through the pump motor circuit for cooling purposes, 2) supply oil under pressure to maintain a positive pressure on the low side of the pump/motor circuits, 3) supply sufficient oil under pressure for control purposes , and 4) provide makeup oil for internal leakage. Hydraulic oil supplied to the pump from the reservoir is filtered through a 200 mesh suction strainer mounted in the reservoir as well as a DONALDSON charge pump filter mounted on the side of the charge pump. The pressure developed by this charge pump is called Charge Pressure and can be monitored on the 0-600 PSI gauge located on the power unit gauge panel.

Working pressure and flow from the variable displacement pump is plumbed to the VOAC gearbox variable displacement winch drive motor. Oil is circulated from one side of the closed-loop pump into one side of the motor and is returned to the opposite side of the pump forming a closed-loop system. Tilting the swashplate in the pump the opposite direction reverses the flow of oil, therefore reversing the rotation of the VOAC V-12 winch drive hydraulic motor. The variable displacement winch drive motor utilizes an automatic control to shift motor displacement from minimum to maximum with increasing system pressure in an approximate constant horsepower function, where there is a demand for additional torque.

The pressure required to rotate the motor is called System Pressure and is monitored at the gauge panel by a 0-5000 PSI pressure gauge.

A REXROTH A10VSO16 Series 30 pressure compensated open-loop hydraulic pump, piggybacked to the winch closed-loop pump, provides pressure and flow required to operate the Electro-Active Levelwind System. The pressure compensator control automatically adjusts pump delivery to maintain pressure to the levelwind system at a pre-set operating pressure. Pressure is factory set at 1200 PSI. Any deviations from this pressure will change levelwind response characteristics.

Pressure and flow required by the Electro-Active Levelwind, provided by the open-loop circuit, is plumbed through a DONALDSON non-bypass high pressure filter via hydraulic hoses to a Sundstrand servovalve. A signal generated by the Electro- Active Levelwind Control PCB# DY96000-312-02 proportionally controls the direction and flow rate of oil to the DANFOSS OMP-100 levelwind drive motor in response to the signal generated by the levelwind cable sensor. Levelwind system pressure can be monitored by a 0-3000 PSI pressure gauge mounted in the gauge panel.

Failsafe Brakes

A spring-applied hydraulically released failsafe brake is integral to the VOAC FD28 gearbox and is located inline between the winch drive motor and the input of the final drive gear reducer. Hydraulic pressure required to release the brake is supplied by the charge pump of the winch closed-loop circuit variable displacement pump. Actuation of the brake is controlled by a solenoid operated hydraulic brake valve, which switches charge pressure to the brake releasing it. Actuation of the solenoid operated brake valve is accomplished by relay K1 in the winch drive control, when the operator control lever is moved from the Neutral position.

Heat Exchanger

Hydraulic oil returning from the pump case drain of the winch closed-loop pump and open-loop return lines is plumbed to a common return header and routed through a HAYDEN forced air/oil heat exchanger. The hydraulically driven heat exchanger fan motor is actuated by a BARKSDALE thermal switch mounted on the return header. When the temperature exceeds the limit setting, a DELTA solenoid valve is actuated which in turn activates the motor driven cooling fan installed behind the cooling coils. When the temperature again drops below the threshold limit, the thermostatically controlled system automatically shuts the fan off.

Motor Control

The motor contactor for the electric motor uses a 24 VAC latched coil to hold the contactor on. Any loss of power will cause the contactor to drop out and thus require restarting of the electric motor.

The start circuit is interlocked to prevent start-up if the control operator lever is not in the neutral position.

A TIME MARK Model 257B power monitor will prevent start-up if incoming voltage is low, phase is reversed, or

phase imbalance due to loss of leg.

The solenoid operated brake valve and fan motor valve are actuated by 24 VAC.

DYNACON, INC. Electro-Active Levelwind System

The DYNACON, INC. Electro-Active Levelwind Control System is designed to operate with a single coil hydraulic displacement control and appropriate sensor to control a hydraulic motor driven levelwind. The system is housed in a NEMA 4 stainless steel enclosure. Sensors are installed on the levelwind itself.

ADJUSTMENTS AND OPERATION

The magnet in the sense assembly is mounted such that the center of the magnet is over the levelwind sensor target when the cable is perpendicular to the drum. The flux intensity of the north and south poles cancel each other out. When the sense assembly is moved by the increasing fleet angle of the cable going on the drum, an error signal is generated by the levelwind sensor and processed by the DY96000-312-02 control board.

The null setting of the sense assembly can be adjusted by loosening the bolt over the slotted hole holding the sensor block plate and repositioning the sensor block.

End-of-Travel sensors stop the levelwind carriage when the cable is approximately one cable diameter from the end of the drum flange. If the cable is not wrapping close enough to the flange, the trigger bars that pass over the sensors can be moved out to allow the carriage to move closer to the drum flange. If the cable is stacking against the flange, the trigger bars can be moved inward. The End-of-Travel sensors are proximity devices that respond to the presence of metal within the target sensor range. The End-of-Travel sensors also prevent the carriage from manually being moved beyond the normal travel range.

Levelwind Control Circuit Theory of Operation

Amplifier U1A level-shifts the input signal to zero volts at test point A. With the magnet removed and no flux signal present, zero potentiometer R4 is adjusted to indicate 0 volts at TP-A.

When an error signal is present at TP-A, the output of U1B will swing to $\pm$12 volts. This signal is clamped to 4.0 volts and a part of this signal is added to the error signal

at U1C to reduce the deadband in the hydraulic servocontrol.

The amount of deadband reduction is controlled by R30. Turning R30 clockwise increases the amount of deadband. In general, the closer the levelwind carriage is to the drum, the less deadband can be tolerated. The amount of time the levelwind has to react to a fleet angle is reduced with the distance and system must respond faster by reducing deadband effects.

Overall gain is controlled by fixed resistor R14 and potentiometer R13. Turning R13 counterclockwise will increase gain of amplifier U1C. The final adjustment of R13 will depend on the characteristics of the overall system. Q1 and Q2 are current boost transistors for the output amplifier. Diodes D3 through D8 and resistors R16 and R17 form a current limiting circuit and are preset according to the servovalve coil requirements. The DY96000-312-02 control board is preset to current limit at between 40-50 mA.

Relay K1 is energized by an external signal to enable drive signal to the servovalve. This feature prevents the levelwind from "hunting" when the winch drum is not in motion.

Relays K2 and K3 are energized by self-centering toggle switches to inject a signal to the servovalve for manual positioning. These relays override the control board signal. Potentiometers R19 and R21 determine the rate of manual movement. These can be set by the operator to any safe speed.

Relays K4 and K5 are energized by the end-of-travel sensors. These sensors are located such that they are energized when the levelwind carriage reaches its maximum excursion. The carriage should stop when the cable is one cable diameter from the flange. This will allow the cable to wrap to the flange but keep the cable from stacking up on itself. Potentiometers R23 and R25 provide an opposite polarity signal when the carriage is driven to the maximum excursion.

Line Count

EFFECTOR sensors installed on the levelwind sheave bracket assembly sense targets on the sheave. Line count is output to a display unit on the Local Control Station. A RED LION slave message center displays this continuous line count information at the Remote Control Station. This line counter is programmed to read in feet.

Line Speed

Line count information is integrated with a speed switch located in the electrical enclosure to calculate line speed. This information is output to display units on the Local and Remote Control units. Readings provide a continuous indication of line speed in meters or feet per minute.

NOTE !!!

An initial scale factor was factory set in feet with a reading of 1.309. The metric equivalent, if later required is approximately .3991.

NOTES:

1) Both line speed and line count use the same scaling factors.

2) Count is currently set up so that:

   a) "A" Channel is in meters.
   b) "B" Channel is in feet.

3) Speed is set up in meters per minute. Only 1 channel allowed for rate. By changing scale factor, speed can be set in feet per minute.

4) SEE ENCLOSED RED LION LITERATURE FOR INSTRUCTIONS ON SETTING SCALING FACTOR.

NOTES

NOTES

SECTION 3
INSTALLATION

GENERAL

The purpose of this section is to outline the procedures required to install and prepare for operation of the Model 2600 Coring Winch.

STRUCTURAL

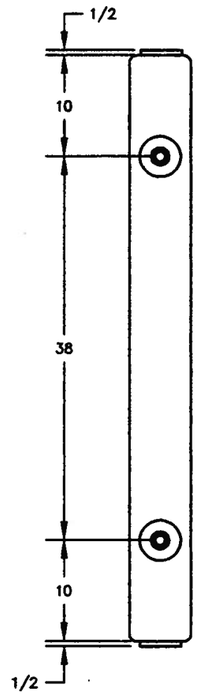
Winch

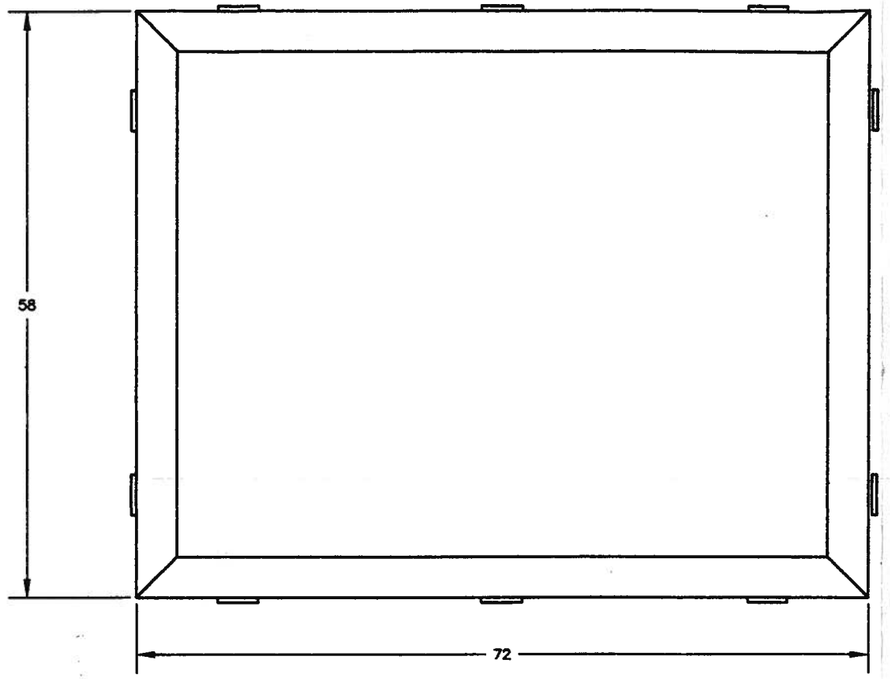
The winch frame is bolted to the deck. Twelve 1"-8 NC threaded inserts are welded into the base frame to facilitate attachment to the deck with mounting plates. These plates may be welded to the deck or to doubler plates which are bolted to the deck. This allows the winch to be easily mounted and detached from the deck of the ship without structural damage to the base frame of the winch. Twelve Grade 5 or stronger 1"-8 bolts with, flatwashers and lockwashers are recommended fasteners for bolting the winch down. Bolts should be of sufficient length to accommodate the full thread length of the nuts. The blind side of the nuts are capped to prevent salt spray and water from entering the tubing base frame.

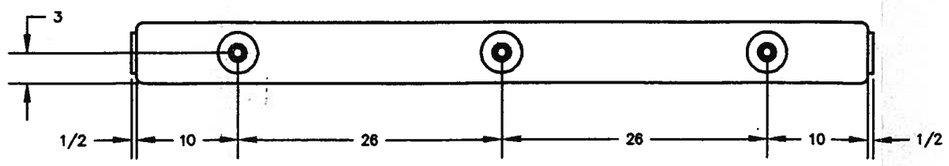
CAUTION !!!

EXCESSIVE BOLT LENGTH WILL CAUSE THE BOLTS TO HIT THE BACK OF THE CAP AND NOT SECURELY CLAMP THE MOUNTING PLATE

SYM	DATE	REVISION	BY







NOTE: ALL MOUNTING HOLES
ARE 1"–8 UNC LOCATED AS SHOWN

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			X.XXX ± .005		REVISION DATE –	FILE NAME J:\347\34710102	
			X.XXXX ± .001	THIS DRAWING IS THE PROPERTY OF DYNACON INC., ANY REPRODUCTION OR USE OF THIS DESIGN IS EXPRESSLY FORBIDDEN UNLESS AUTHORIZED IN WRITING BY DYNACON INC., BRYAN, TEXAS	WORK ORDER ATTACHED	PLOT DATE 23-FEB-93	PLOT TIME 13:02
			ANGULAR ± 1/2°				
			BREAK CORNERS 1/64 X 45°			TITLE	UT WINCH BASE DESCRIPTION – –
			MIN RADIUS 1/16				
			FINISH 125				
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HYDRAULIC INITIAL START-UP PROCEDURES

CAUTION !!!

The winch system shipped from DYNACON, Inc. with the oil reservoir filled and Items 1-4 accomplished. If oil has been removed for shipping, the following Items 1-4 must be performed before proceeding.

1. Fill pump and motor cases through the upper case drain openings with recommended hydraulic fluid. It is recommended that all fluid be passed through a 10 micron filter.

2. Check all fittings to be sure they are tight.

3. Loosen the suction lines to the reservoir and/or filters at the inlet of the pumps.

4. Fill reservoir using a 10 micron filter cart until it reaches the loosened hoses at the pump inlets. Tighten the hoses and continue to fill the reservoir. Ensure that reservoir level is above the critical mark on the sight level gauge.

NOTE !!!

The remaining steps require that the system be electrically operational. Notify proper personnel to ensure that electrical installation procedures have been completed before continuing beyond this point!!

Line Counter Calibration

The counter counts targets on the levelwind sheave. A calibration factor must be entered into the counter in order to obtain an accurate line count. The line count may be in feet or meters, depending upon the calibration factor used.

A calibration factor in feet of 1.309 has been entered into the counter at the factory and should not require changing. Should a change be required, refer to enclosed literature for instructions.

Line speed indicator receives its input from same sensors as for line count and is factory programmed. Readings for line speed are in feet or meters per minute.

Electrical Installation and Initial Start-up

Power is connected to the three terminals, L1-L3, on top of the SPRECHER & SCHUH motor starter located in the electrical enclosure.

CAUTION !!!

A TIME MARK power monitor is mounted in the power unit enclosure to protect the electrical system from low voltage, loss of phase, and phase reversal. Proper phase has been set at DYNACON, Inc. prior to shipping. If for any reason, the power monitor is removed or rewired, the following Items 1-3 must be performed before proceeding.

1. With the reservoir filled with hydraulic oil, direction of rotation of the of the hydraulic pump must be checked. The hydraulic pump must rotate clockwise as viewed from the shaft end of the pump or fan side of the electric motor.

2. To visually check rotation, remove the cover on the pump mount adaptor. Jog the electric motor while viewing the chain coupling. The chain should move clockwise looking at the front of the pump if the pump is turning the proper direction.

3. If the electric motor is turning the wrong direction, disconnect the electric power and reverse any two incoming power leads and recheck rotation.

Once proper rotation is determined, jog the electric motor on for two to three seconds and watch for the charge pressure gage to rise. When the gage needle starts to move upward allow the motor to run and note that the pressure rises to 320-350 PSI. If pressure does not appear recheck motor rotation and oil level. DO NOT RUN SYSTEM IF CHARGE PRESSURE IS BELOW APPROXIMATELY 290 PSI.

The failsafe brake must be bled to remove all air. Disconnect the cable connecter on the pump controller. With the winch running, loosen fitting to the brake at the gearbox. Attach rubber hose to fitting and place open end in a catch pan. Move the control handle from neutral. Allow fluid to flow until no air or bubbles in the fluid are present. Tighten fitting, remove hose, and reconnect the pump control cable.

Local Control Cable Interconnection

Control cable interconnection between the Power Unit electrical enclosure and Local Control Station are terminated with terminal strips at both ends. The interconnect cable enters the control console enclosure and the power unit electrical enclosure through stuffing tubes.

Remote Control Cable Interconnection

Control cable interconnection between the Local Control unit and the Remote unit is made via permanent wiring at both ends. The cable enters both control boxes through stuffing tubes.

NOTE !!!

System is now ready for operation.
See Section 5 for scheduled
maintenance requirements.

NOTES

NOTES

SECTION 4
OPERATION

GENERAL

The purpose of this section is to familiarize personnel with the controls, indicators, and operating procedures of the Model 2600 Coring Winch.

Controls and Indicators

The controls and indicators on the control panels and electrical enclosures are shown in Figures 4.1 to 4.3 and are described in Tables 4-1 to 4-3.

Although there is, from an electrical and electro-hydraulic standpoint, only one set of controls, they have been split into a "fixed" and "moveable" configuration for operational ease and flexibility. The fixed position section is on the Local control panel and the moveable section is in a separate Remote control panel, which is tied to the fixed position location by an electrical umbilical linkage.

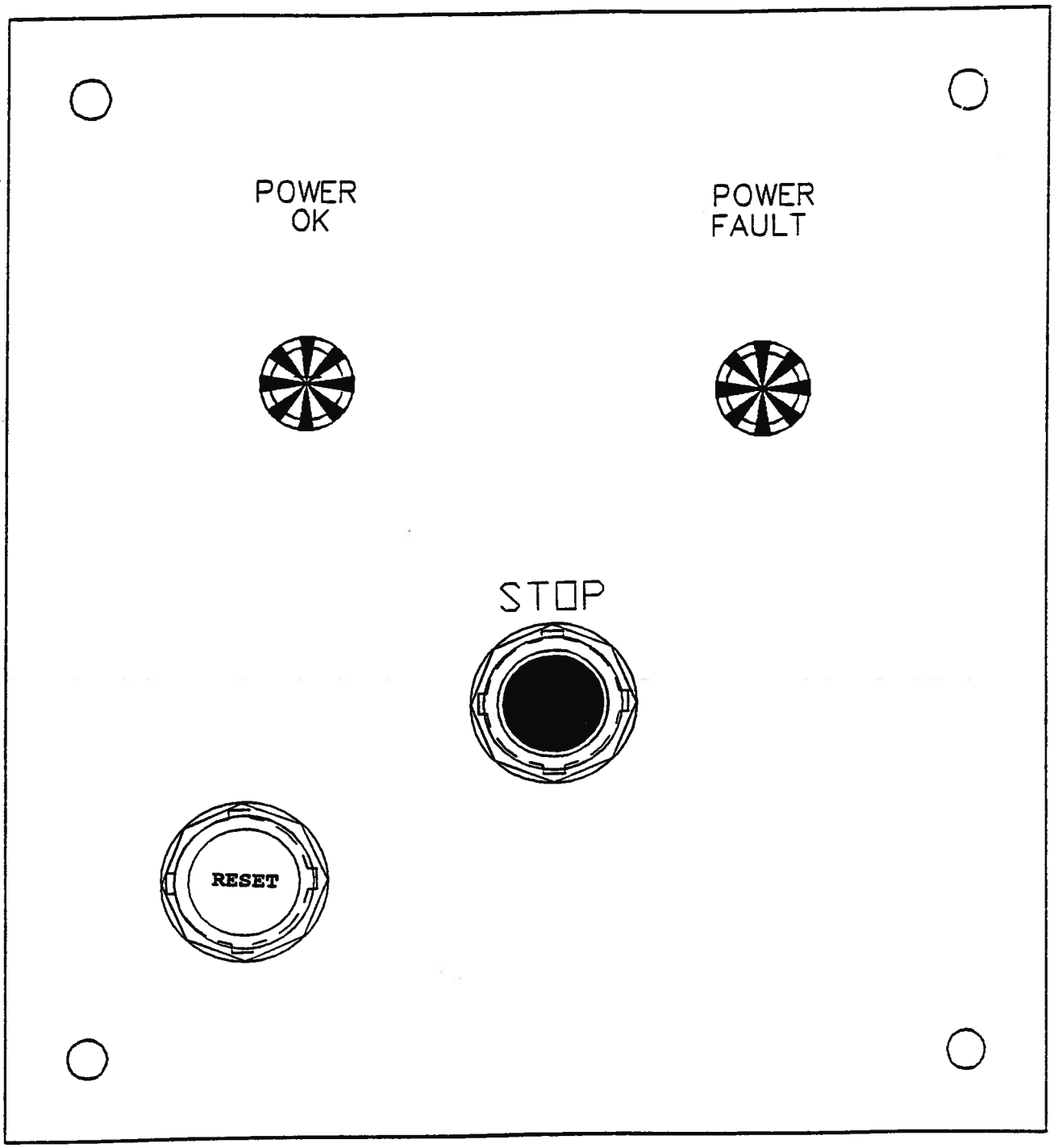


Figure 4.1 - High Voltage Enclosure Controls and Indicators

TABLE 4-1
HIGH VOLTAGE CONTROL ENCLOSURE, CONTROLS AND INDICATORS

NOMENCLATURE	FUNCTION
POWER UNIT STOP (Button)	When DEPRESSED, removes 24VAC from the motor starter contactor of the 40 HP electric motor, and stops the power unit.
POWER OKAY (Light)	When LIT, indicates power unit is running and proper power is being applied. Power fault (red) light will be on for a few seconds after power is first applied.
POWER FAULT (Light)	When LIT, indicates improper voltage, loss of phase, or phase imbalance is occurring. This light will be lit for several seconds after power is first applied.
MOTOR RESET (Button)	When motor is automatically shut down due to improper power conditions, RESET button must be pushed to reset motor starter circuitry.

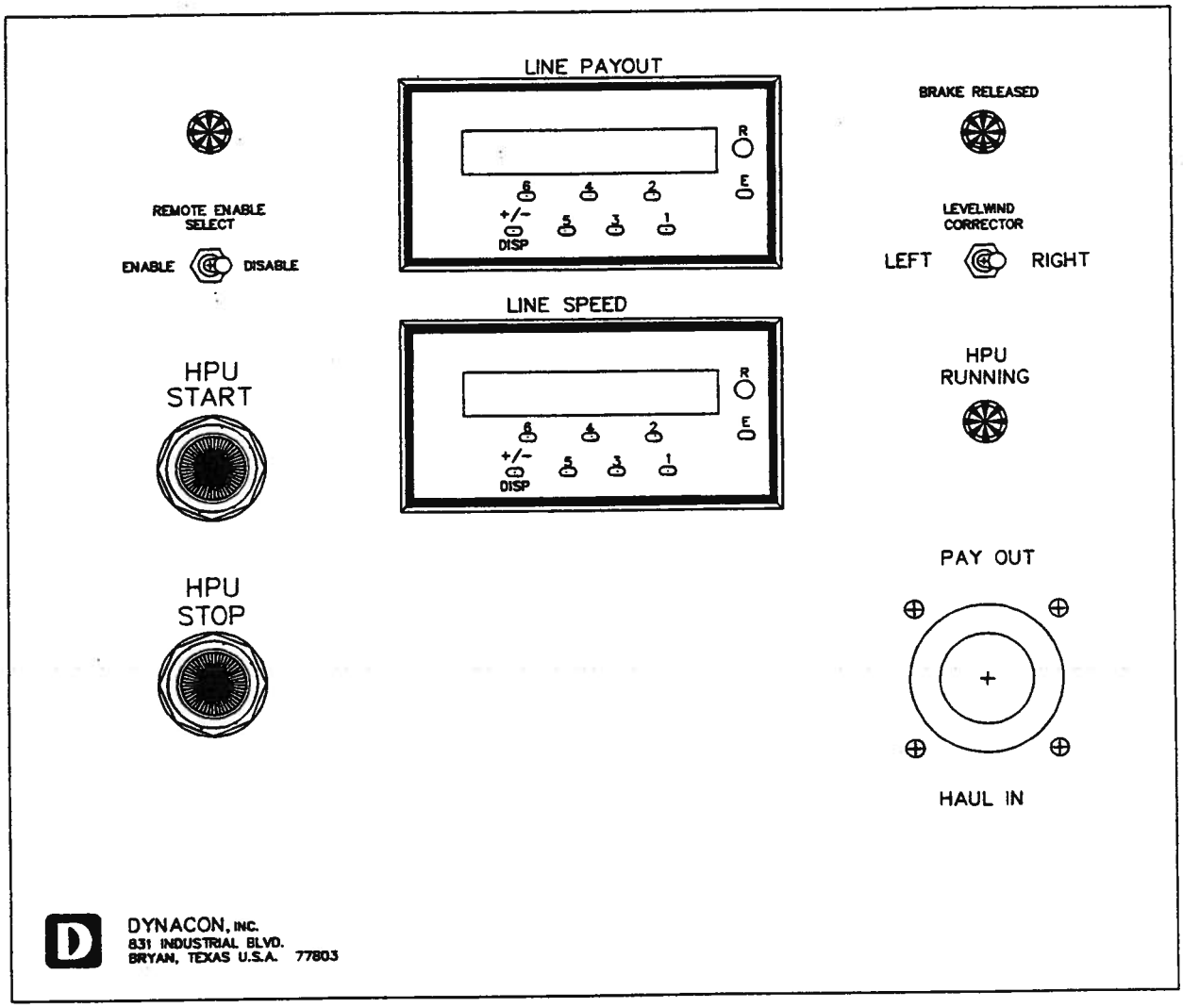


FIG. 4.2 - LOCAL CONTROL PANEL

TABLE 4-2
LOCAL CONTROL PANEL, CONTROLS AND INDICATORS

NOMENCLATURE	FUNCTION
CONTROL HANDLE (Lever)	When moved out of neutral toward top of panel, PAYS OUT cable. When moved out of neutral toward bottom of panel HAULS IN cable. Brake sets in neutral position.
LEVELWIND CORRECTOR LEFT/RIGHT (Toggle Switch)	When Toggled LEFT, over rides automatic levelwinding and drives the levelwind carriage to the LEFT. When Toggled RIGHT, over rides automatic levelwinding and drives levelwind carriage to the RIGHT.
HPU RUNNING (Light)	When LIT, indicates power unit is running.
REMOTE CONTROL ENABLE/DISABLE (Toggle Switch)	When Toggled LEFT, ENABLES Remote Control Unit. When Toggled RIGHT, DISABLES Remote. Remote is automatically disabled when Local Control Handle is moved from neutral.
REMOTE ENABLED (Light)	When LIT, indicates Remote Control Unit is selected.
HPU START (Button)	When DEPRESSED, starts power unit.
HPU UNIT STOP (Button)	Provides emergency power unit shut down from the Local Control Unit.
BRAKE RELEASED (Light)	When LIT, indicates failsafe brakes are released. Normally occurs when control handle is moved from neutral.
DIGITAL LINE COUNT (Meter)	Provides continuous line count in feet (or meters).
DIGITAL LINE SPEED (Meter)	Provides continuous reading of line speed in feet or meters-per minute. Initial setting is in meters.

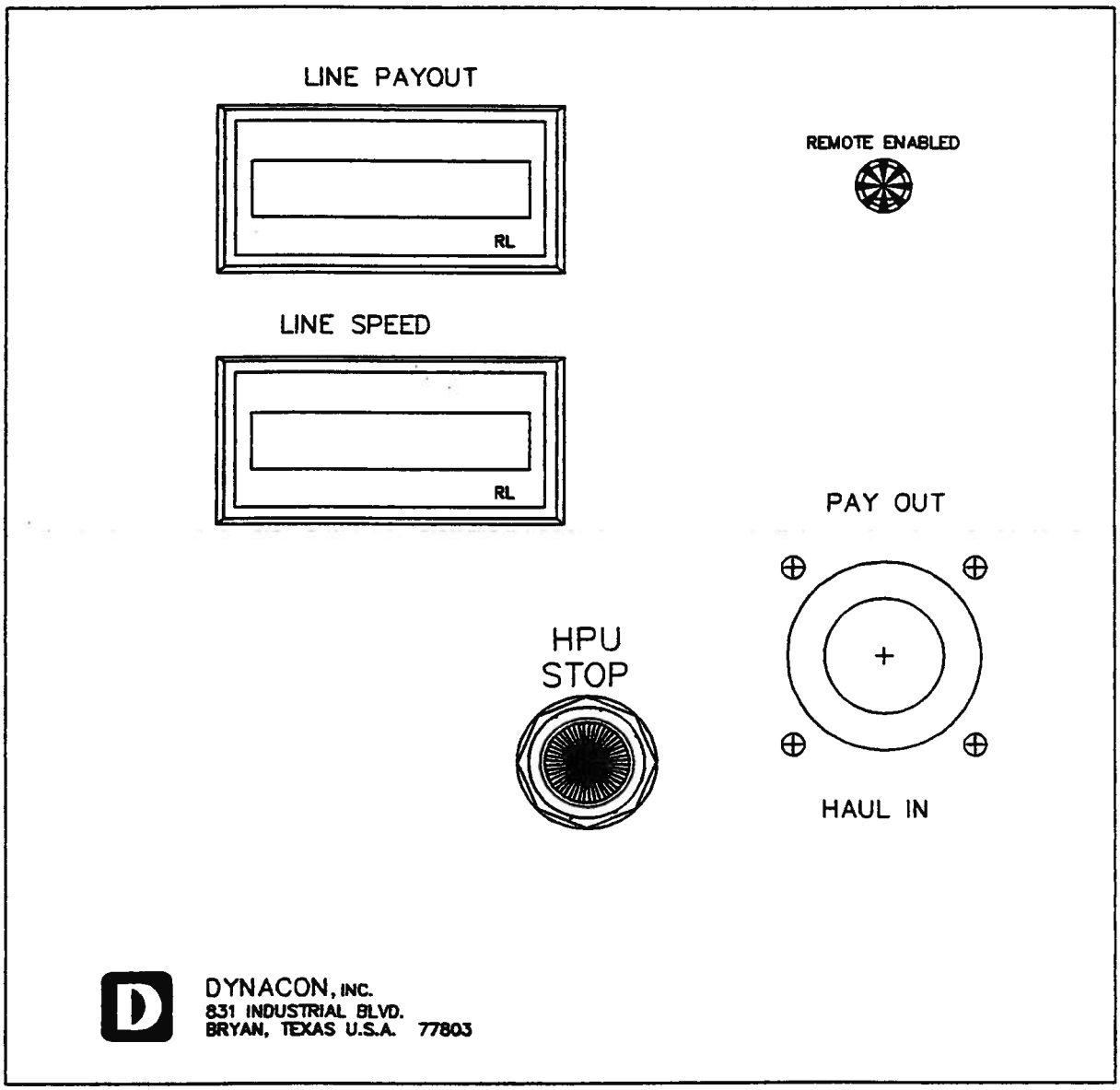


FIG. 4.3, REMOTE CONTROL PANEL

TABLE 4-3
REMOTE CONTROL PANEL, CONTROLS AND INDICATORS

NOMENCLATURE	FUNCTION
CONTROL HANDLE (Lever)	When moved out of neutral toward top of panel, PAYS OUT cable. When moved out of neutral toward bottom of panel HAULS IN cable. Brake sets in neutral position.
REMOTE ENABLED (Light)	When LIT, indicates Remote Control Unit is selected.
HPU UNIT STOP (Button)	Provides emergency power unit shut down from the Remote Control Unit.
DIGITAL LINE COUNT (Meter)	Provides continuous line count in feet (or meters).
DIGITAL LINE SPEED (Meter)	Provides continuous reading of line speed in feet or meters-per minute. Initial setting is in meters.

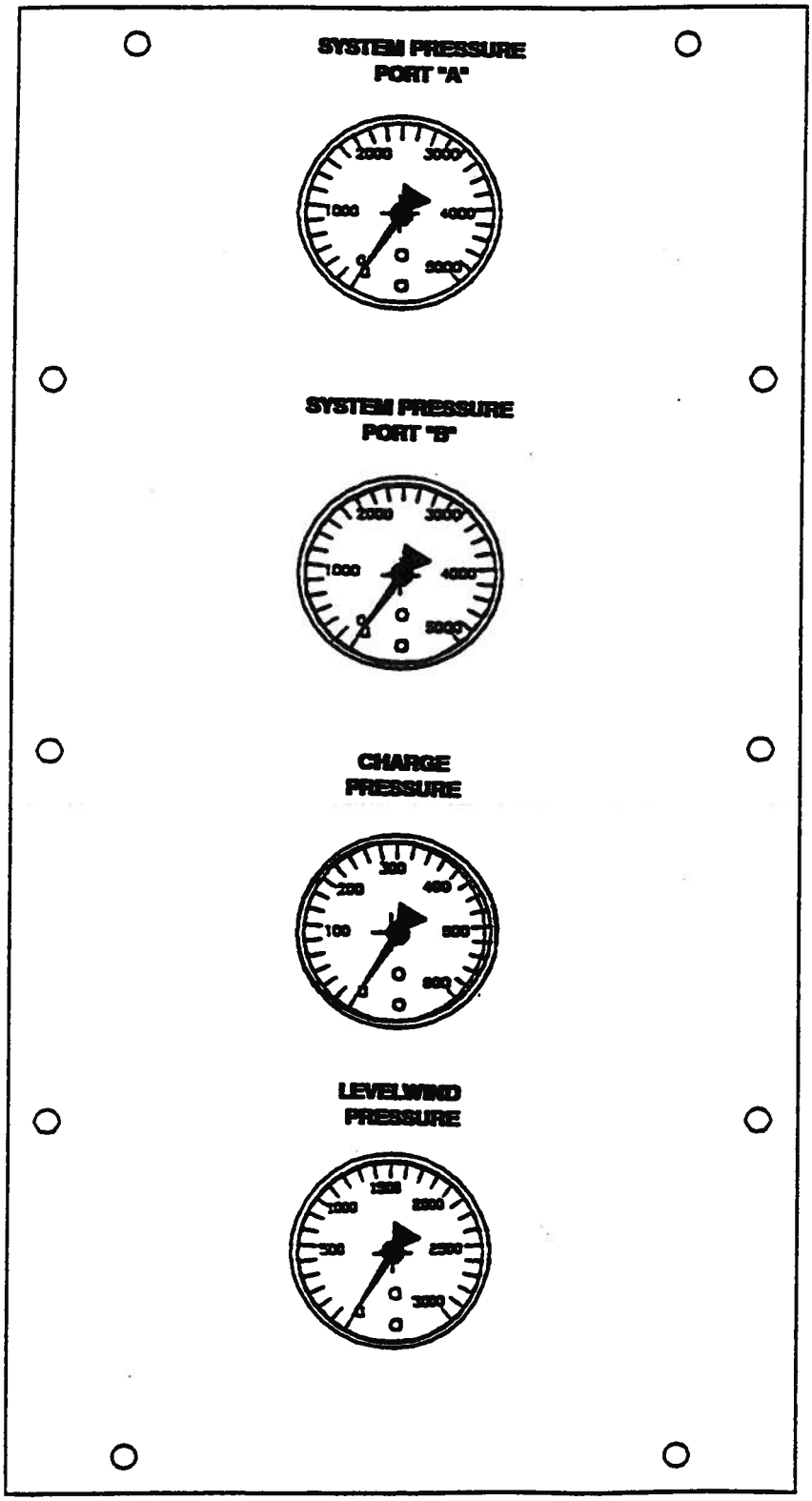


FIG. 4.4, GAUGE PANEL

TABLE 4-4
POWER UNIT GAUGE PANEL INDICATORS

NOMENCLATURE	FUNCTION
WINCH SYSTEM PRESSURE PORT "A" (0-5000 PSI Gauge)	Indicates system pressure of the winch drive variable displacement pump at Port "A" in P.S.I.
WINCH SYSTEM PRESSURE PORT "B" (0-5000 PSI Gauge)	Indicates system pressure of the winch drive variable displacement pump at Port "B" in P.S.I.
CHARGE PUMP PRESSURE (0-600 PSI Gauge)	Indicates pressure at charge pump of the main winch drive variable displacement pump.
LEVELWIND SYSTEM PRESSURE (0-3000 PSI Gauge)	Indicates levelwind system pressure of the levelwind pressure compensated open loop pump.

OPERATING PROCEDURES

Start-up Procedure

The start-up procedure presented in Table 4-4 assumes that the initial posture of the Model 2600 Coring Winch is as follows:

1. The cable has been loaded onto the winch drum and properly attached to the tow point of the vehicle.

2. Proper voltage is available to the power unit control enclosure and winch is properly wired.

3. The hydraulic reservoir is filled to the proper level.

4. The winch is properly attached to the deck.

Follow the steps in Table 4-5 to start-up the winch system.

TABLE 4-5, STARTUP PROCEDURE - LOCAL CONTROL PANEL	
ITEM	**PROCEDURE**

1. Verify that control lever is in the neutral position.

WARNING !!!

Check and verify that all personnel are cleared to safe zones !!

2. Observe the POWER STATUS indicator lights on the Power Panel for OK indicator light is lit. (Fault light will be on momentarily.)

3. Depress the START switch and observe:

   a. CHARGE PRESSURE gauge reading is okay (320-340 PSI). Minimum 290 PSI.

   b. SYSTEM PRESSURE gauge reading is equal to CHARGE PRESSURE reading.

4. If Remote Control operation is required, select from LOCAL Control console.

NOTE !!!

REMOTE IS DISABLED WHEN THE CONTROL HANDLE ON THE LOCAL CONTROLS IS ENGAGED.

NOTE !!!

The Model 2600 Coring Winch is Now ready for Launch and Recovery Operations.

Launch and Recovery Procedures

It is not within the scope of this manual to outline the procedures for launching or recovering the payload. Therefore, order of operation of the system during this activity must be established by the customer.

NOTES

95
96

A → push
B → start Button
and should
24 V

X2 X1

NOTES

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SECTION 5
MAINTENANCE

GENERAL

This section is intended for the use of maintenance personnel and contains procedures for scheduled maintenance. The procedures are written to the component level and include manufacturer recommendations for off-the-shelf items. For maintenance data not covered in this section refer to Section 8, Manufacturer's Literature.

SCHEDULED MAINTENANCE

Included in scheduled maintenance is lubrication, cleaning, and inspection. Table 5-1 outlines the periodicity of those task. Table 5-2 provides a list of recommended lubricants.

WARNING !!!

Unless otherwise stated, 208 VAC to the Coring Winch will be secured while performing maintenance tasks.

TABLE 5-1.
SCHEDULED MAINTENANCE CHART

MAINTENANCE DESCRIPTION	PERIODICITY						
STORAGE WINCH	**D**	**W**	**M**	**Q**	**S**	**A**	**AR**
Grease Drum Support Bearings					X		
Inspect Bolt Tightness on Winch Frame Deck Plates			X				
LEVELWIND	**D**	**W**	**M**	**Q**	**S**	**A**	**AR**
Grease Levelwind Guide Tubes	X						
Grease Levelwind ACME Screw	X						
Inspect Levelwind Sheave Bearings		X					
Grease Sheave Pivot Pin		X					
Grease ACME Screw Support Bearing			X				
Inspect Levelwind Follower Arm for Wear			X				
Inspect Bolt Tightness on Levelwind Frame			X				
ELECTRO-HYDRAULIC POWER UNIT	**D**	**W**	**M**	**Q**	**S**	**A**	**AR**
Check Hydraulic Fluid Level & Filter Indicators	X						
Clean/Change Hydraulic Filters					X		X
Check for Hydraulic Leaks	X						
Change Hydraulic Oil and Suction Strainers							X

D = Daily, W = Weekly, M = Monthly, Q = Q'trly., S = Semi-Ann., A = Annual, AR=As Reqd.

TABLE 5-2 RECOMMENDED LUBRICANTS		
LUBRICANT	**USE**	**TYPE**
Grease	Grease Fittings	MYSTIK JT-6 or equivalent.
Hydraulic Fluid	Hydraulic System	Mobil DTE15M ISO VG-46 (Or Equivalent)
Gear Oil	Gearbox	SAE 80W-90

Lubrication

Grease fittings are installed for those bearings requiring periodic lubrication. Primarily, periodic greasing is required to remove dirt, dust, splash water and condensation. The grease packing will seal the bearing, reduce friction and protect against corrosion. Refer to Table 5-1 for greasing periodicity. Table 5-2 lists a selection of lubricants which can be used for the bearing races and gears.

Levelwind Guide Tubes

To grease the guide tubes(2), attach a grease gun nozzle to the grease fitting located on the levelwind carriage. Pump grease into fitting until a surplus can be seen extruding from the carriage.

Levelwind ACME Screw

To grease the ACME screw apply a thin coat of grease to the outside diameter along the entire length of the screw.

Levelwind Sheave Bearing

To grease the levelwind sheave bearings, attach a grease gun nozzle to the grease fitting located on the levelwind sheave axle. Pump grease into fitting until a surplus can be seen extruding from the sheave axle retaining plates.

Hydraulic Fluid Level

The level of the hydraulic fluid in the reservoir must be checked to ensure proper fluid level. To check the level locate the sight level gauge located on the reservoir. The level of the oil must never be below the red line located on the internal marker in the gauge. If low fill reservoir with appropriate fluid. See Table 5-2.

Hydraulic Oil Strainers and Filter

Suction Strainers

200 mesh suction strainer strains the oil being supplied to the winch pump, and a 100 mesh suction strainer strains the oil being supplied to the levelwind pump. Both are in the hydraulic reservoir. The element is the cleanable type. Cleaning the strainer is accomplished by draining the reservoir, unscrewing the element from the inside, remove the filter, clean the filter with a clean solvent (naptha or trichlorethylene), blow dry with dry air from inside out, replace strainer, and refill reservoir with new hydraulic oil.

Charge System Filter

The winch variable displacement pump is equipped with an integral Donaldson disposable canister charge system filter (600 PSI rating). This filter filters the charge system oil generated by the charge pump. Replacement of the filter element is accomplished by unscrewing the element from the filter head. A strap wrench is recommended for loosing the element. Remove the old sealing gasket. Replace the gasket and filter element with new ones by inserting the new gasket and screwing on the replacement element. Care should be taken not to overtighten the element.

When to change Charge System Filter

Charge pressure is prime factor for determining when the charge system filter should be changed. If the Charge Pressure readings are below approximately 290 PSI the strainer and filter must be replaced. It is recommended that all strainer and filter elements be changed at the same time.

CAUTION !!!

Low charge pressure due to dirty filters can cause loss of control and damage to hydraulic pumps !!

High Pressure Filter

The high pressure filter is inline, located just before the levelwind servovalve, and filters the oil being supplied to the levelwind servovalve manifold. To check the condition of the filter check pressure gauge.

Replacement Strainer and Filter Element Part Numbers

Table 5-3 lists the part numbers for the replacement elements for the strainers and filters utilized on the Model 2600 Coring Winch System.

TABLE 5-3
STRAINER AND FILTER ELEMENT PART NUMBERS

DESCRIPTION	MANUFACTURER	PART NUMBER	NO. REQ'D.
WINCH PUMP SUCTION STRAINER	FLOW EZY	50-1.5-0-200	1
LEVELWIND PUMP SUCTION STRAINER	FLOW EZY	50-1.5-0-100	1
MAIN WINCH CHARGE PUMP FILTER	DONALDSON	P16-3542	1
LEVELWIND HIGH PRESSURE FILTER	DONALDSON	P16-7183 HIGH COLLAPSE TYPE	1
FILLER BREATHER	FLOW EZY	AB1010-3	1

Inspect ACME Nut for Wear

The levelwind system has two ACME Nuts. The primary ACME nut drives the carriage assembly and the secondary ACME Nut essentially rides free without being under a load.

During the assembly stage the primary ACME nut assembly is firmly attached to the carriage. Slack needs to be removed by pushing or pulling carriage to the primary nut. The secondary nut is moved to the carriage then backed off until the first bolt hole position lines up, then secured. There is space on both sides of the secondary Nut, which allows it to ride free during the operation.

The best way to monitor wear on the primary ACME Nut is to measure the distance between the secondary ACME Nut and the carriage assembly before any wear occurs on the primary ACME nut and to record this measured value. Wear on the threads on the primary nut will cause this distance between the secondary nut and the carriage assembly to increase. When the measured gap reaches the initial measured value plus approximately 1/16 inch, and certainly when it reaches initial value plus 3/32 inch, the primary nut should be replaced.

In the event no initial measurement between the secondary ACME nut and the carriage assembly has been recorded, an alternate approach is indicated.

The alternate approach calls for loosening the bolts holding the primary nut to the carriage assembly and shove the nut away from the carriage assembly. Measure the gap when it reaches its maximum distance. Then, shove the nut back toward the carriage assembly and measure the gap again. Normal tolerance between the nut and the screw is approximately 1-2 thousandths. When the difference between the two measurements exceeds 1/16 to 3/32nds of an inch, excessive wear has occurred and the nut should be replaced.

Should this alternate test result in replacement of the primary ACME nut or a determination be made that the nut has no significant wear, the gap between the secondary nut and the carriage should be measured and recorded as a new reference value for later checks.

NOTES

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SECTION 6
TROUBLESHOOTING

This section is intended for use by technicians qualified to perform electrical and hydraulic troubleshooting of the winch system.

WARNING !!!

Many of the following troubleshooting procedures require that the system be electrically operational. Ensure that technician is properly qualified in electrical safety procedures before proceeding beyond this point !

A. WINCH WILL NOT START -

1. POWER STATUS FAULT (LIGHT) LIT

- Check incoming power at the top of the MAIN DISCONNECT.

a. Check for loss of phase.
b. Check for phase reversal.
c. Check for LOW incoming voltage.

2. POWER STATUS OK (LIGHT) LIT

- Check control handle in neutral position

- Press RESET button on electrical enclosure. This resets motor overload. Insure 208 VAC power is locked "on" before pressing RESET button.

- Check output terminals of 24VAC control transformer. If 24VAC is not present, turn off input power and check primary and secondary input fuses.

- Turn off power to the winch and check for continuity through the normally closed STOP contact and normally open RUN contact when the RUN button is depressed.

B. NO CHARGE PRESSURE ON GAUGE -

1. Check oil level in reservoir.

2. Check for proper motor rotation.

C. LOW CHARGE PRESSURE

1. Check charge pressure filter for low reading 320 PSI minimum. If gage is showing less than minimum allowable, change filter and check that proper viscosity oil is being used.

D. DRUM WILL NOT TURN, NO CHANGE IN PUMP NOISE WHEN HANDLE IS MOVED. BRAKE RELEASED LIGHT NOT LIT.

1. Loss of +12 VDC power.

2. Check the 12 volt DC power supply for proper output. This is an indication of loss of control signal. If power is okay, check for +/- 2-3 volts across the leads going to the transmission electronic displacement control when the control handle is moved to full speed. If voltage is present, check the connector and wires on the transmission displacement control.

E. DRUM WILL NOT TURN, NOISE INCREASES FROM THE PUMP WHEN HANDLE IS MOVED FROM CENTER.

1. **BRAKE RELEASED LIGHT - ON**

   - Failsafe brake is not releasing. Check for minimum 200 PSI charge pressure. If charge pressure is zero go to symptom A. If charge pressure is low go to symptom B.

   - Check brake release solenoid for actuation when control handle is moved from neutral. If valve is not switching, brake will not release.

   - If charge pressure drops under load, brake will set.

   - The motor or pump may be worn and flow is being diverted internally in the pump or motor when the system is under load. When the control handle is moved from neutral, the system pressure should rise to 4,500 PSI on the System Pressure Gauge. If pressure is okay, problem is probably in brake or gearbox.

- To determine if the brake is releasing, it may be necessary to remove the hydraulic motor from the gearbox. With hands clear, move the control handle from neutral and observe the motor shaft for movement. If the brake is free and the motor runs, try turning the drum by hand. If the drum cannot be turned, either brake or gearbox is jammed. Brake is internal to the gearbox.

WARNING !!!

Do not attempt to disable brake without first having cable onboard or secured.

2. **BRAKE RELEASED LIGHT - OFF**

- Check for 24 VAC across terminals when control handle is moved from neutral.

ELECTRO-ACTIVE LEVELWIND SYSTEM

A. LEVELWIND TOTALLY INOPERATIVE

- Check levelwind correctors, left and right.
- Check fuses F1, F2, and F3 on printed circuit card DY96000-312-02.
- If fuses OK, connect voltmeter across T19 and T20 and press Corrector switch on main control panel of winch Check for approximately 1 V.
- If voltage OK, check levelwind hydraulics.
- If no voltage, problem is in circuit card, refer to electrical schematic # DY96000-860716.

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SECTION 7

DRAWINGS AND PARTS LIST

CONTENTS

(1) Hydraulic Schematic, Drawing# 347-8001-01

a. Hydraulic Parts List

b. Hydraulic Hose List

C. Mechanical Parts List

(2) Electrical Schematic, Drawing# 347-9001-01

a. Electrical Parts List

(3) Electro-Active Levelwind PC Board Schematic, Drawing# DY96000-860716

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HYDRAULIC PARTS LIST HYDRAULIC SCHEMATIC NO. 347-8001-01			
ITEM	PART NUMBER	MANUFACTURER	DESCRIPTION
1	50-1 1/2-200	FLOW EZY	SUCTION STRAINER
2	90R042EA1A8P4C3B 03NNN262624	SUNDSTRAND	MAIN PUMP
3	63-1008SL-02B (0-600 PSI)	ASHCROFT	PRESSURE GAUGE
4	DF S3A 00HC 25N	DELTA	BRAKE VALVE
5	MF-250B	REGO	FLOW CONTROL VALVE
6	8800485-24-00	SUNDSTRAND	HOT OIL SHUTTLE VALVE
7	63-1008SL-02B (0-5000 PSI)	ASHCROFT	PRESSURE GAUGE
8	63-1008SL-02B (0-5000 PSI)	ASHCROFT	PRESSURE GAUGE
9	50-1 1/2-100	FLOW EZY	SUCTION STRAINER
10	A10VS016DFR/ 30RPSC62N00	REXROTH	OPEN LOOP PUMP
11	63-1008SL-02B (0-3000 PSI)	ASHCROFT	PRESSURE GAUGE
12	HPK02K00B0807X NON-BYPASS	DONALDSON	HIGH PRESSURE FILTER
12A	P167183	DONALDSON	HIGH COLLAPSE ELEMENT
13	MCV113A-5206	SUNDSTRAND	SERVO VALVE
13A	KK030509	SUNDSTRAND	SUB PLATE

MECHANICAL PARTS LIST			
ITEM	PART NUMBER	MANUFACTURER	DESCRIPTION
1	03320043	HUB CITY	SPLINE
2	042024	DODGE	3 15/16 PILLOW BLOCK BEARING

HYDRAULIC HOSE LIST HYDRAULIC SCHEMATIC NO. 347-8001-01			
ITEM	HOSE ASSEMBLY	PART NUMBER	LENGTH
1	347-HA-001	12HT6-BW-12FJ-12FJ	89"
2	347-HA-002	12HT6-BW-12FJ-12FJ	75"
3	347-HA-003	16C-SH-16FJ-16FJ	47"
4	347-HA-004	16C-SH-16FJ-16FJ	61"
5	347-HA-005	12MX-SB-12FJ-12FJ	44"
6	347-HA-006	12MX-SB-12FJ-12FJ	22 1/2"
7	347-HA-007	8BX-SB-8FJ-8FJ	97"
8	347-HA-008	6MX-SB-6FJ-6FJ	50 3/4"
9	347-HA-009	4BX-SB-4FJ-4FJ	51"
10	347-HA-010	6BX-SB-6FJ-6FJ	29 3/4"
11	347-HA-011	4BX-SB-4FJ-4FJ	46"
12	347-HA-012	4BX-SB-4FJ-4FJ	120"
13	347-HA-013	6BX-SB-6FJ-6FJ	22 3/4"
14	347-HA-014	6MX-SB-6FJ-6FJ	34 3/4"
15	347-HA-015	4BX-SB-4FJ-4FJ	34 3/4"
16	347-HA-016	4BX-SB-4FJ-4FJ	53 3/4"
17	347-HA-017	4BX-SB-4FJ-4FJ	58 3/4"
18	347-HA-018	8BX-SB-8FJ-8FJ	37 3/4"
19	347-HA-019	6BX-SB-6FJ-6FJ	67 3/4"

HYDRAULIC HOSE LIST HYDRAULIC SCHEMATIC NO. 347-8001-01			
ITEM	HOSE ASSEMBLY	PART NUMBER	LENGTH
20	347-HA-020	6BX-SB-6FJ-6FJ	146 1/2"
21	347-HA-021	6BX-SB-6FJ-6FJ	146 1/2"
22	347-HA-022	4BX-SB-4FJ-4FJ	49 1/2"
23	347-HA-023	12MX-SB-12FJ-12FJ	19 3/4"
24	347-HA-024	4BX-SB-4FJ-4FJ	29 1/4"
25	347-HA-025	4BX-SB-4FJ-4FJ	32 1/4"
26	347-HA-026	4BX-SB-4FJ-4FJ	46 3/4"
27	347-HA-027	4BX-SB-4FJ-4FJ	58 3/4"
28	347-HA-028	6MX-SB-6FJ-6FJ	41 1/4"

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NOTES

SECTION 8

MANUFACTURER'S LITERATURE

The purpose of this section is to provide maintenance personnel specific maintenance and ordering information for the hydraulic and electrical components utilized in the Coring Winch System.

The literature is arranged in numerical order by the Item Numbers assigned to each component on the hydraulic and electrical schematics.

REFERENCE: HYDRAULIC PART NO.(S) 1, 9, 23
HYDRAULIC SCHEMATIC NO. 347-8001-01



FLOW EZY FILTERS

SUMP STRAINERS

Sump strainers are used in hydraulic fluids, coolants, lubricants, and many process fluids. Flow Ezy offers them in many different constructions to better match a variety of applications. All have strong perforated metal support tubes under the straining elements. All are available with optional, built-in bypass relief valves to avoid starving the pump should the strainer become dirt-clogged.

ALL-METAL CONSTRUCTION

The traditional all-metal sump strainer has stainless steel pleated elements, in mesh sizes 30 to 200. Continuous epoxy-bonded joints will not leak fluid around the element. They may be cleaned and used indefinitely.

ALL-STEEL CONSTRUCTION

All-steel sump strainers (Style AS) provide greater strength. Otherwise they are the same as the standard unit. (Not a stocked item.)

HOW TO ORDER

Select the desired specifications from the ordering table and build an ordering code number, as shown in this example:

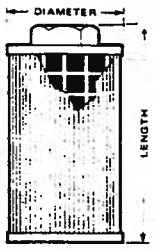
AS	-	**75**	-	**2-1/2**	-	**NIPPLE**	-	**100**	-	**RV-3**
STYLE	-	GPM	-	NPT	-	CONNECTION (spell out NIPPLE if wanted)	-	MESH	-	VALVE (omit if not wanted)

STYLE	GPM (Flow Capability)	NPT (Pipe size)	CONNECTION (Nut or Nipple)	MESH (Screen size)	VALVE (Optional)
no symbol (all-metal)	5 5 10 20 30 50	3/4 1 1 1-1/4 1-1/2 1-1/2&2	no symbol (nut) (nipple N/A)	30 (.022-in.) 60 (.010-in.) 100 (.005-in.) 200 (.0029-in.)	RV-3 (3-psi bypass) RV-5 (5-psi bypass)
AS (all-steel)	75 100	2-1/2 3	nut or nipple		

(Pressure drop through a clean element will not exceed 0.2 psi (0.4-in. Hg) at rated flow of 150 SUS viscosity fluid.)

NUT STYLE

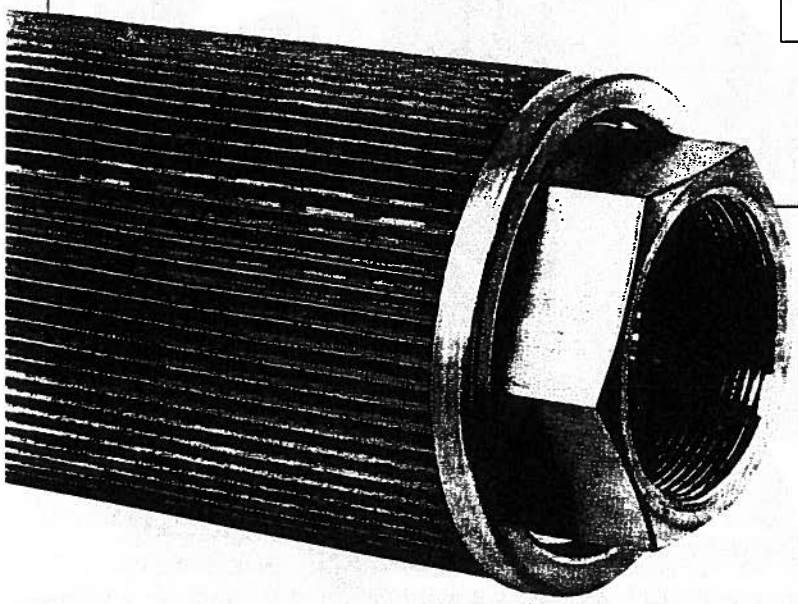
GPM RATING	SCREEN AREA (Sq. Inches)	NPT (Pipe Size)	OVERALL DIMENSIONS Diameter	Length
5	62	3/4	3-1/16	3-1/16
10	125	1	3-1/16	5-5/16
20	162	1-1/4	3-1/16	7-1/8
30	310	1-1/2	4	8-3/4
50	340	1-1/2 & 2	4	9-5/8
75	400	2-1/2	5-1/16	12-5/8
100	500	3	5-1/16	12-5/8



NIPPLE STYLE

GPM RATING	SCREEN AREA (Sq. Inches)	NPT (Pipe Size)	OVERALL DIMENSIONS Diameter	Length
75	400	2-1/2	5-1/16	12-5/8
100	500	3	5-1/16	12-5/8





HOW TO ORDER

Select the desired specifications from the ordering table and build an ordering code number, as shown in this example:

P	-	50	-	2	-	NIPPLE	-	100	-	RV-3
STYLE	-	GPM	-	NPT	-	CONNECTION- (spell out NIPPLE if wanted)		MESH	-	VALVE (omit if not wanted)

STYLE	GPM (Flow Capacity)	NPT (Pipe size)	CONNECTION (Nut or Nipple)	MESH (Screen size)	VALVE (Optional)
P (std. Nyl-End)	3 3 3	3/8 1/2 3/4	Nipple (nut N/A)	30 (.022-in.) 60 (.010-in.) 100 (.005-in.) 200 (.0029-in.)	RV-3 (3-psi bypass) RV-5 (5-psi bypass)
PASS (S.S. Nyl-End)	5 5 10 20 30 50	3/4 1 1 1-1/4 1-1/2 1-1/2	no symbol (nut) (nipple N/A)		
	50	2-1/2	Nipple Only		
	30 50 75 100	2 2 2-1/2 3	Nut or Nipple (to get nipple you must specify it)		

(Pressure drop through a clean element will not exceed 0.2 psi (0.4-in. Hg) at rated flow of 150 SUS viscosity fluid.)

NYLON CONNECTOR TYPE

"Nyl-End" sump strainers (Style P) are made with the same selection of stainless steel elements as the standard all-metal units. They differ in that the connector end pieces are molded in a single piece of glass-reinforced nylon resin. Pleated stainless elements are epoxy-bonded in place.

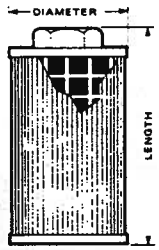
They're as serviceable as all-metal units, but they cost 12 to 50 percent less, depending on size.

ALL-STAINLESS CONSTRUCTION

All-stainless-steel sump strainers with nylon connectors (Style PASS) are available in the same wide variety of sizes and element mesh sizes as the standard Nyl-End units. For excellent resistance to oxidation and corrosion. (Not a stocked item.)

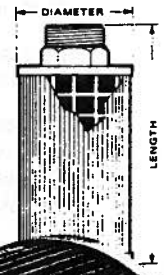
NUT STYLE

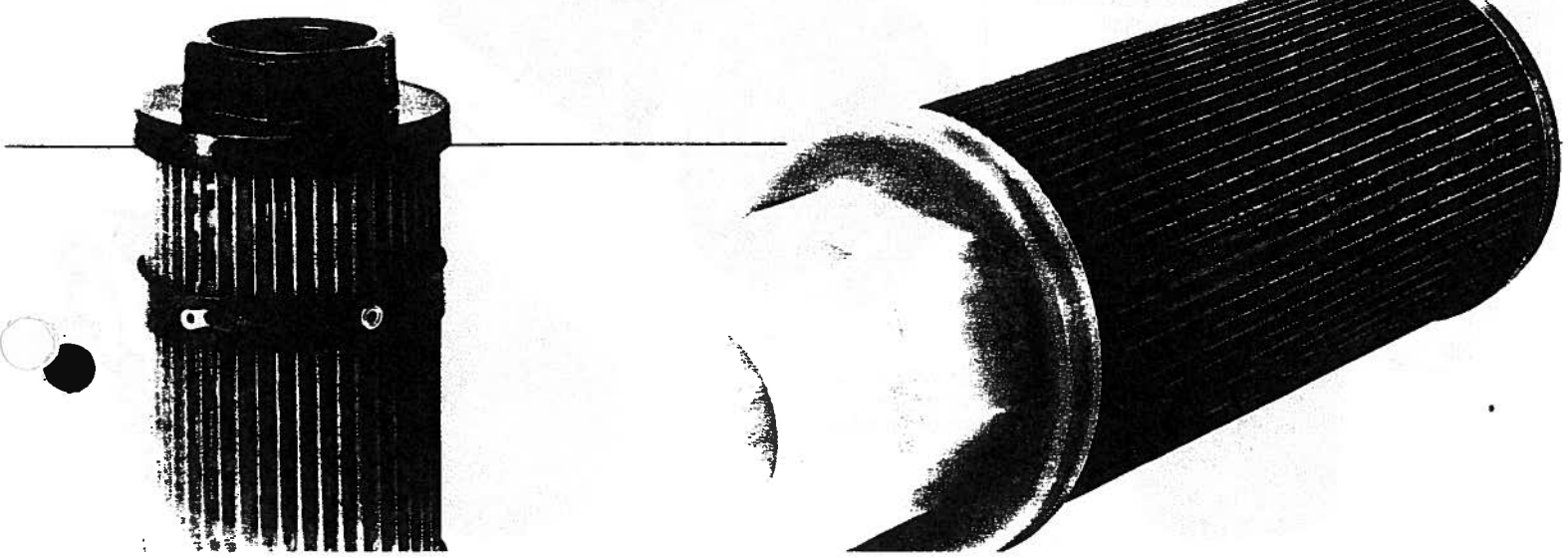
GPM RATING	SCREEN AREA (Sq. Inches)	NPT (Pipe Size)	OVERALL DIMENSIONS	
			Diameter	Length
5	62	3/4	3-3/16	3-1/2
10	125	1	3-3/16	5-3/4
20	162	1-1/4	3-3/16	7-3/8
30	310	1-1/2 &2	4-3/16	9-1/8
50	340	1-1/2 & 2	4-3/16	9-3/4
75	400	2-1/2	5-1/16	12-1/2
100	500	3	5-1/16	12-1/2



NIPPLE STYLE

GPM RATING	SCREEN AREA (Sq. Inches)	NPT (Pipe Size)	OVERALL DIMENSIONS	
			Diameter	Length
3	40	1/2,3/8,3/4	2-1/8	3-3/4
30	310	2	4-3/16	10-5/8
50	340	2 & 2-1/2	4-3/16	11-1/4
75	400	2-1/2	5-3/16	13-3/4
100	500	2-1/2	5-3/16	13-3/4





TANK FILLER-BREATHERS

These provide filler ports for hydraulic power unit tanks or other liquid reservoirs. Liquids are strained as they are added to the tank and it lets the tank breathe filtered air.

The 30-mesh filler screen removes dirt and debris from liquids as they enter the systems. The breather cap filters the air, trapping airborne dirt down to 40- or 10-micron levels. It permits air passage at up to 25 scfm. Mounting hardware, gaskets, and templates are supplied.

ACCESSORIES

PERFORATED INNER GUARD: Protects strainer basket against puncture. Four sizes (3", 6", 8" and 13") to match basket depths.

MAGNET AND POST: Attaches to bottom of basket, removes tiny iron particles which can sift through the screen. Impervious to hydraulic fluid. Three sizes (3", 6", and 8").

DIPSTICK: Attaches to cap. Can be marked to order: FULL, ADD, etc. Supplied in lengths (3", 6", 8" and 13"). Eliminates safety chain. If chain is wanted, it must be ordered. Minimum order: 50.

The standard filler cap can be ordered with these modifications:

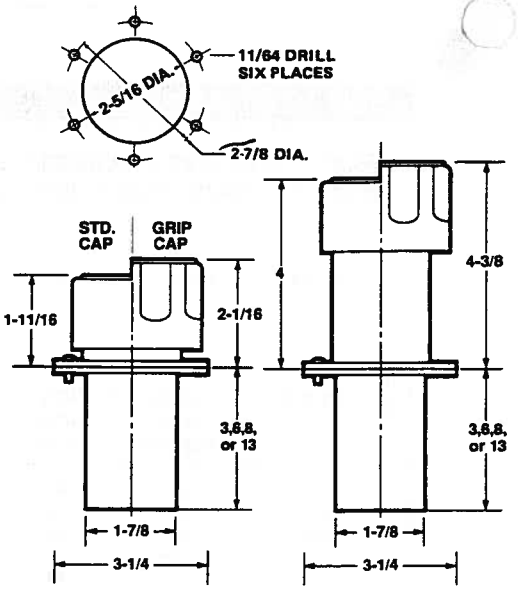
Padlock adapted. To help prevent tampering the cap and mount can have welded lugs to allow use of a padlock. Specify "padlocka dapted".

Stainless steel. Stainless caps and all-stainless units are available. Specify "stainless cap" or "all stainless".

STEEL TOP-MOUNTING UNITS

If funnels are used for filling, it is recommended that the screen basket be ordered at least 6-inches deep, to prevent accidental puncturing. Perforated metal inner guards may be ordered also, to prevent damage to the screen.

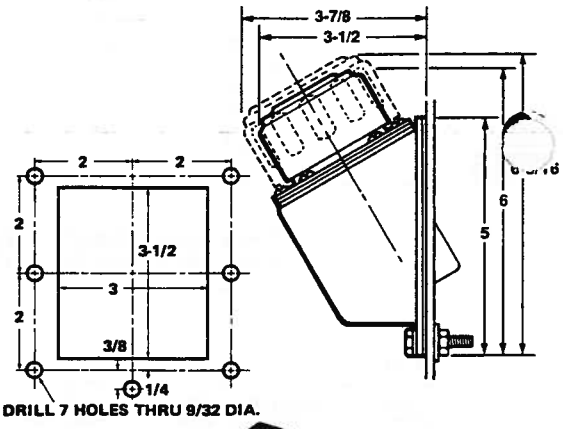
To help prevent tank-top dirt from plugging up the air filter you can order a 'high-neck' model. It puts the air filter 3 inches above the tank top. A 'grip' cap is another option: it is a larger, nickel-plated filler cup with curved indentations to provide a better gripping surface. Ideal for outdoor or oily environments.



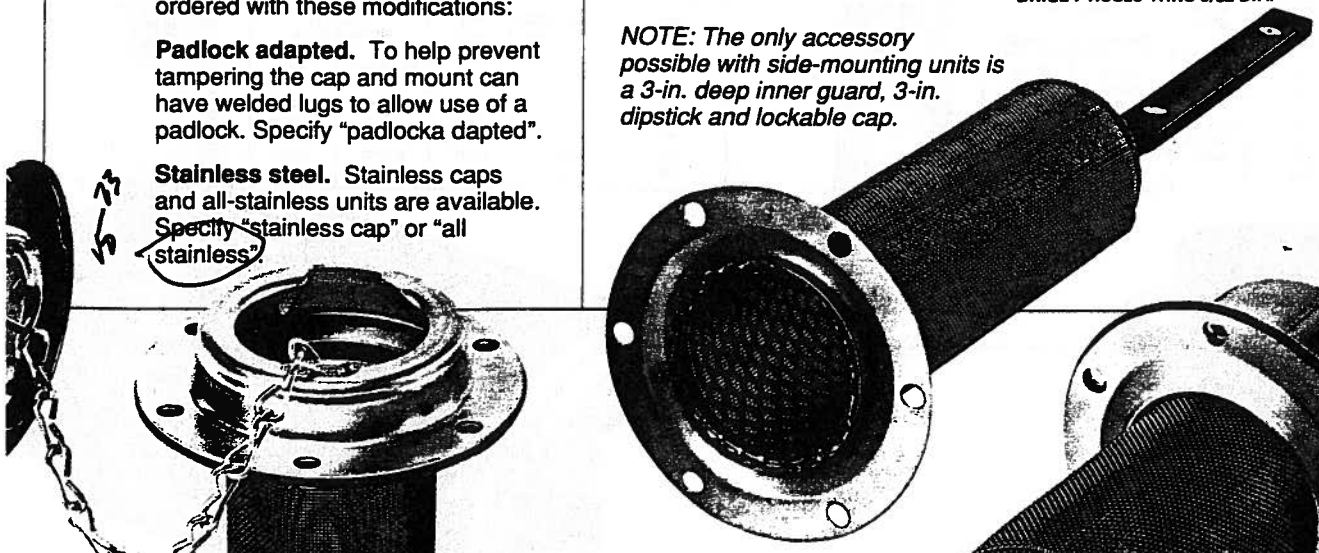
Standard *High-Neck*

SIDE-MOUNTING UNITS

Where top surfaces are not available for locating a filler port, this unit mounts on vertical tank walls. The housing is tough glass-reinforced nylon. It's only available with a 3-in.-deep basket (and optional inner guard).



NOTE: The only accessory possible with side-mounting units is a 3-in. deep inner guard, 3-in. dipstick and lockable cap.



Lockable cap



Filler-breathers with standard neck heights come with safety chains unless ordered without.

HOW TO ORDER TOP-MOUNTED UNITS

Select the desired specifications from the ordering table and build an ordering code number, as shown in this example:

AB - 1000 - 6 - HN - G - DS-6 - M8
CAP - ELEMENT - BASKET - NECK - GUARD - DIP - MAGNET
(omit if not wanted)

CAP Type	ELEMENT (Micron)	BASKET Depth(In.)	NECK Height	Inner GUARD	DIP Stick	MAGNET and Post
AB* (std)	1000 (40)	3	no symbol (std)	no symbol (no guard)	no symbol (no stick)	no symbol (no magnet)
ABG (grip type)	1010 (10)	6 8 13	HN (high neck) (no safety chain unless ordered)	G (guard)	DS-3 (3-in.) DS-6 (6-in.) DS-8 (8-in.) DS-13 (13-in.)	M3 (3-in. post) M6 (6-in. post) M8 (8-in. post)

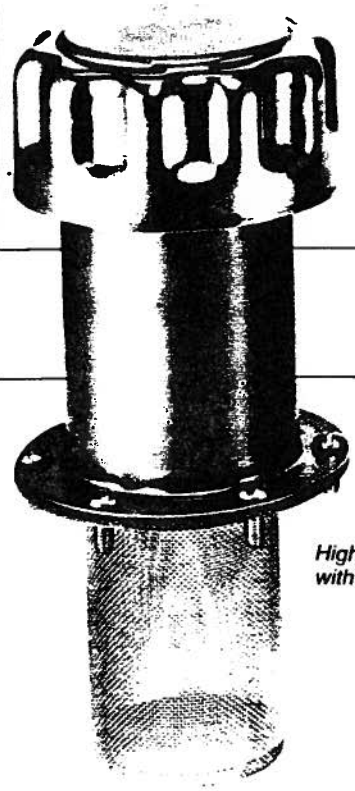
*Available in stainless steel also.

HOW TO ORDER SIDE-MOUNTED UNITS

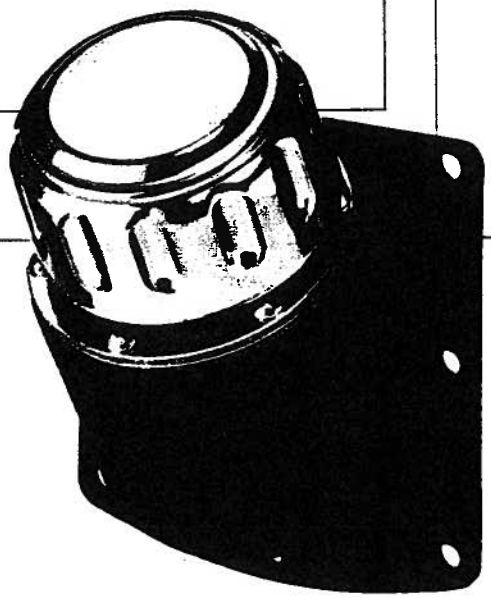
Select the desired specifications from the ordering table and build an ordering code number, as shown in this example:

AM - 1100 - 3 - G
CAP - ELEMENT - BASKET - GUARD
(omit if not wanted)

CAP Type	ELEMENT (Micron)	BASKET Depth (In.)	Inner GUARD
AM (std)	1100 (40)	3	no symbol (no guard)
AMG (grip type)	1110 (10)		G (guard)



High-neck unit with "grip" cap.

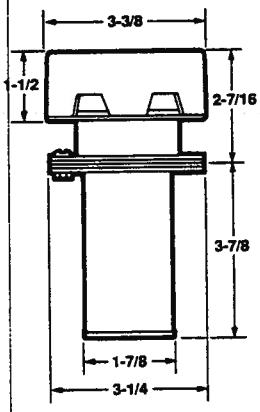


ALL-NYLON TOP-MOUNTING UNITS

This is an alternative to the traditional metal tank filler. It is made entirely of injection-molded, glass-filled nylon, which provides an attractive, tough, non-rusting product. A strainer basket with 30-mesh equivalent openings is provided.

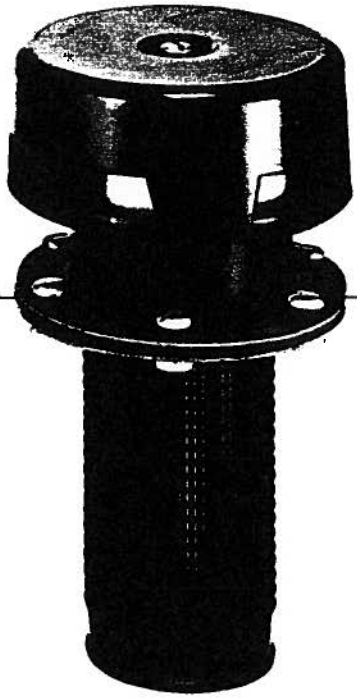
It will fit into the same size hole as the metal units, and they share the same screw-hole pattern.

Nylon breathers are offered only with a 10-micron rated air filter, and in only one basket depth. Mounting hardware supplied. (Stainless steel screws and dipsticks are available.)



To order specify **Model No. NAB-1010-4.**

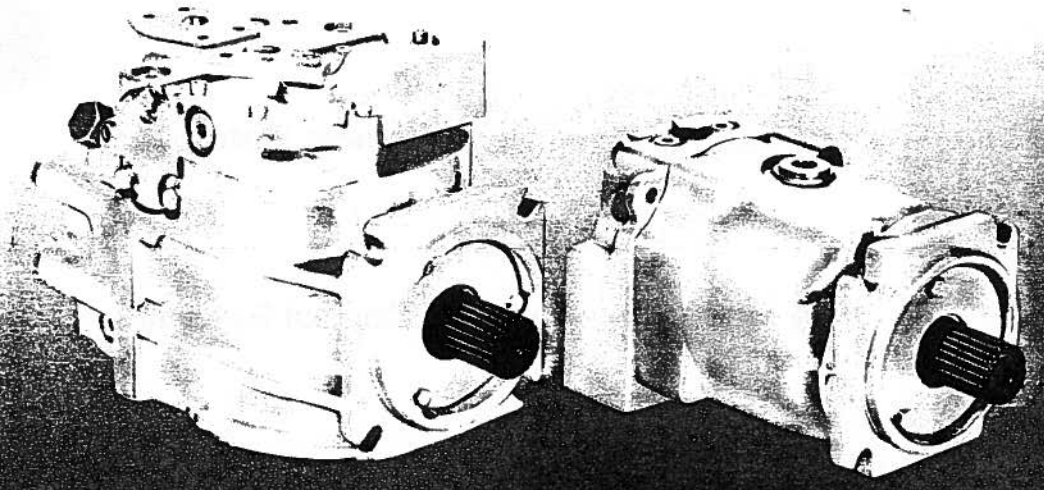
For molded nylon parts made to your specs, call Flow Ezy. Baskets also available separately.



REFERENCE: HYDRAULIC PART NO.(S) 2
HYDRAULIC SCHEMATIC NO. 347-8001-01

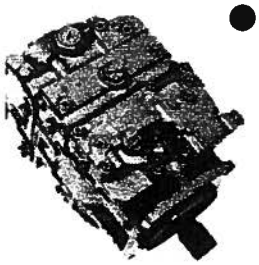
SAUER SUNDSTRAND

Series 90

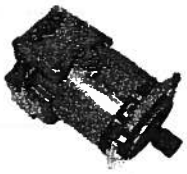


Axial Piston Pumps and Motors Service Manual

Series 90 Pumps and Motors



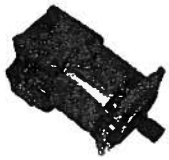
- The Series 90 — Advanced Technology Today



- The Most Technically Advanced Hydraulic Units in the Industry



- 8 Sizes of Variable Displacement Pumps



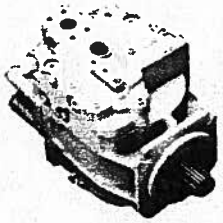
- 6 Sizes of Fixed Displacement Motors



- Complete Family of Control Systems



- Proven Reliability and Performance



- Optimum Product Configurations



- Compact, Lightweight



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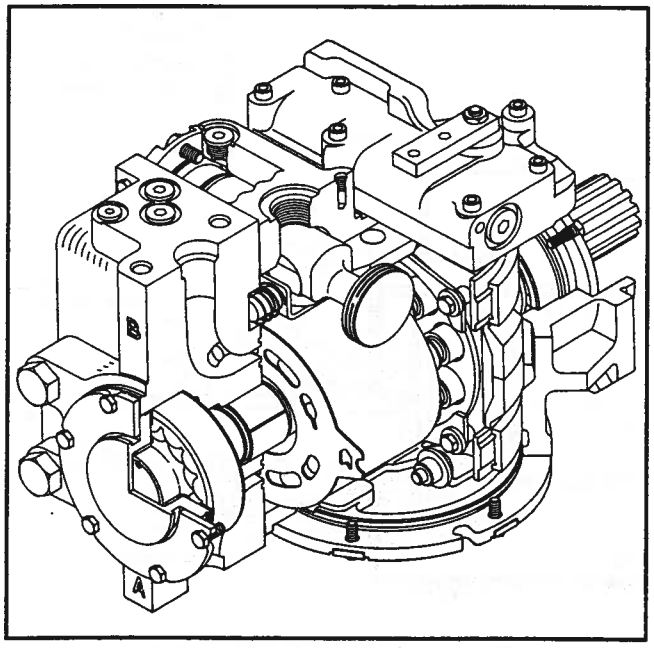
Introduction

The purpose of this manual is to provide information necessary for the normal servicing of the Series 90 family of hydrostatic pumps and motors. This manual includes unit and component description, troubleshooting, adjustments, and minor repair procedures. Following the procedures in this manual, the minor repairs may be performed without affecting the unit warranty.

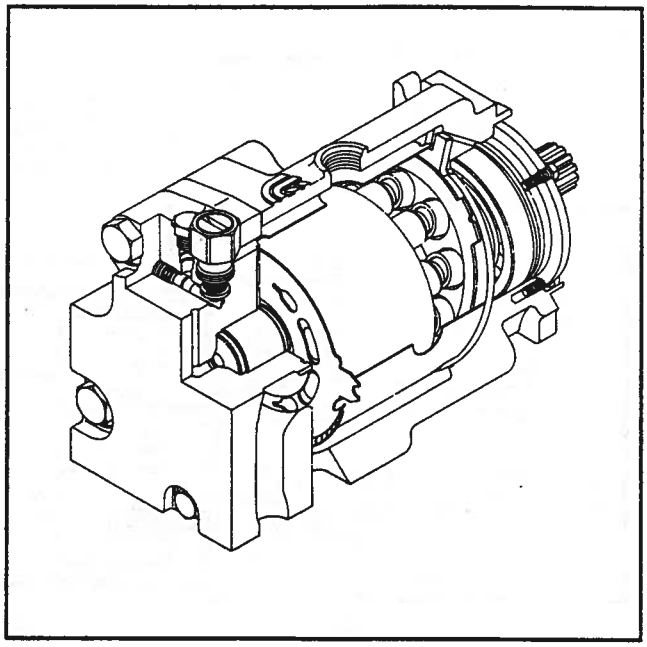
A Series 90 transmission does occasionally require servicing and the transmission has been designed with this in mind. Many of the parts on these transmissions are interchangeable among certain frame sizes within the Series 90 family. This includes such items as the controls, charge system, multi-function valves, loop flushing valves and auxiliary mounting pads. In addition, many repairs or adjustments can be accomplished without the necessity of removing the unit from the vehicle provided the unit is accessible and can be thoroughly cleaned before beginning any procedures. Since dirt or contamination is the greatest enemy of any type of hydraulics, the greatest possible cleanliness is necessary.

Sauer-Sundstrand provides a complete repair service for its products. Contact any Sauer-Sundstrand Authorized Service Center for details.

The torque values, pressure settings and dimensions used throughout this manual are given in English and metric measurements.



Variable Displacement Pump



Fixed Displacement Motor

General Description of the Series 90 Hydrostatic Transmission

The Series 90 hydrostatic pumps and motors can be applied separately or combined in a system to transfer and control power.

The Series 90 pump and motor combined in a system provide an infinitely variable speed range between zero and maximum in both forward and reverse modes of operation.

Series 90 variable displacement pumps are a compact, high power density unit with state-of-the-art design, using the parallel axial piston/slipper design in conjunction with a tiltable cradle swashplate to vary the pump's displacement. Reversing the direction of tilt of the swashplate reverses the flow of oil from the pump and thus reverses the direction of rotation of the motor output.

The variable displacement pump is controlled by a compact, responsive hydro-mechanical, closed loop control system which can be controlled by either a mechanical, hydraulic, or electric input signal.

Two (2) unique multi-function valves are designed in the pump to provide the check valve, pressure limiter, high pressure relief valve, and bypass functions.

The pump includes the charge pump and associated valving to provide the necessary flow for makeup oil, to operate the control system, and provide cooling for the system. It also features a range of auxiliary mounting pads to accept an auxiliary hydraulic pump for use with complementary hydraulic systems.

The fixed displacement motors also use the parallel-axial piston/slipper design in conjunction with a fixed displacement swashplate. Valving options are included in the motor to provide cooling and flushing functions.

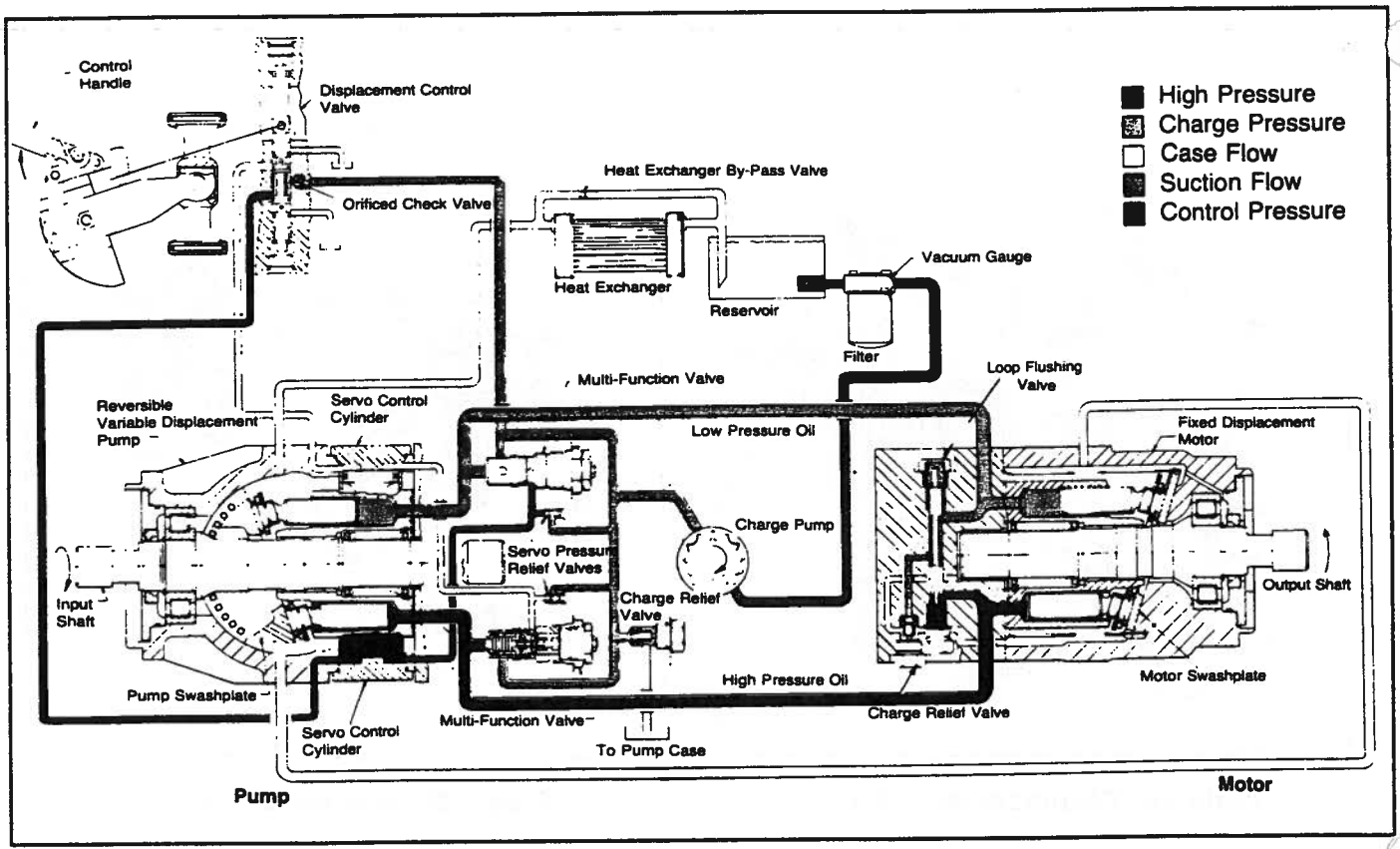


Fig. 1 - Typical Series 90 Variable Pump — Fixed Motor Transmission Schematic

Transmission Hydraulic Support System

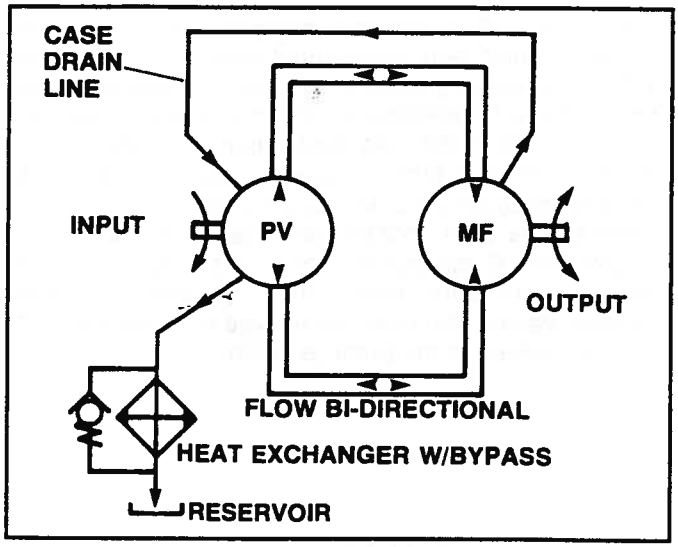


Fig. 2 - Basic Closed Circuit

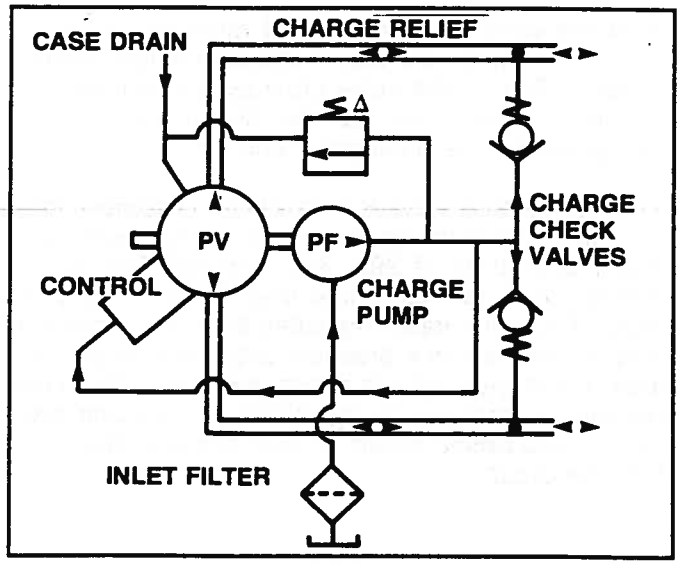


Fig. 3 - Charge System

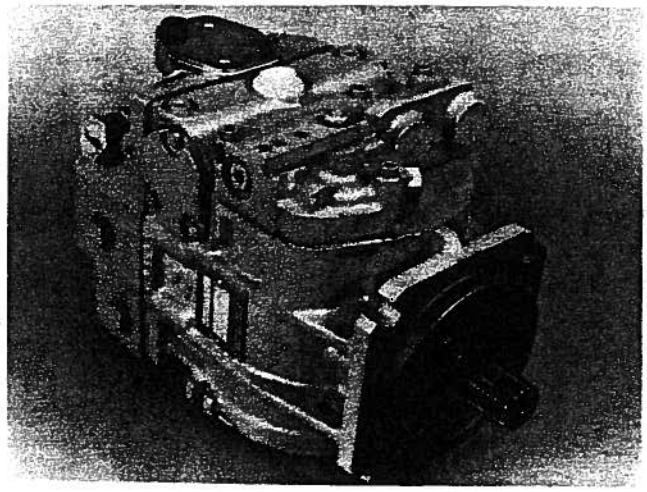


Fig. 4 - Variable Displacement Pump

The Series 90 Pumps and Motors are easy to install, requiring no adjustments and few auxiliary components. They have their own hydraulic support system which is discussed in this section.

Basic Closed Circuit

The main ports of the pump are connected by hydraulic lines to the main ports of the motor. Fluid flows, in either direction, from the pump to the motor then back to the pump in this closed circuit. Either of the hydraulic lines can be under high pressure. The position of the pump swashplate determines which line is high pressure as well as the direction of fluid flow.

Case Drain and Heat Exchanger

The pump and motor require case drain lines to remove hot fluid from the system. The motor should be drained from its topmost drain port to insure the case remains full of fluid. The motor case drain is then connected to the lower drain port on the pump housing and out the top most port. A heat exchanger, with a bypass valve, is required to cool the case drain fluid before it returns to the reservoir.

CAUTION

Continuous case pressure should not exceed 40 PSI (3 BAR).

Charge System and Inlet Filter

A fixed displacement (gerotor type) charge pump is installed in the variable displacement pump and driven off the main pump shaft. The charge pump supplies cool fluid to the system, keeps the system charged, and supplies fluid to operate the control system. Charge pressure, with the pump in neutral (zero flow), is limited by a relief valve (nominal settings of 290, 350, and 405 PSI [20, 24, and 28 BAR] above case pressure at 1800 RPM, are available).

Since either of the main hydraulic lines can be high pressure, two (2) charge check valves are used to direct the charge supply into the low pressure lines. The check valves are contained in the multi-function valves located in the pump end cap.

The charge pump draws the fluid from the reservoir. An inlet filter is required to insure that only clean fluid enters the system.

CAUTION

The inlet vacuum, measured at the charge pump inlet should not exceed 10 in. Hg (0.7 BAR, absolute) except during cold starts.

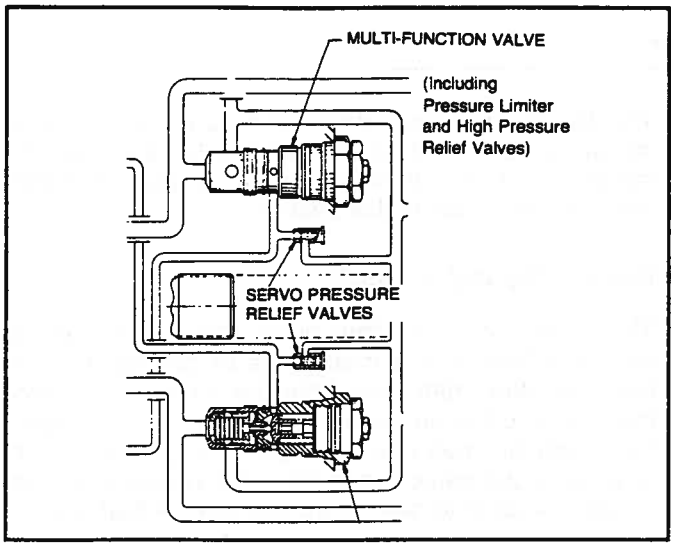


Fig. 5 - Pressure Limiter and High Pressure Relief Valve

Pressure Limiter and High Pressure Relief Valve

The Series 90 pumps are designed with a pressure limiter system and sequenced system relief valves. When the preset pressure is reached in the main loop, the pump will destroke to limit the system pressure. For unusually rapid load application, the relief valve is available to also limit pressure. The pressure limiter sensing poppets also act as pilot valves for the relief valve spools, such that the relief valves are sequenced to operate at pressures above the pressure limiter destroke pressure level. Both the pressure limiter sensing valves and relief valves are built into the multi-function valves in the pump end cap.

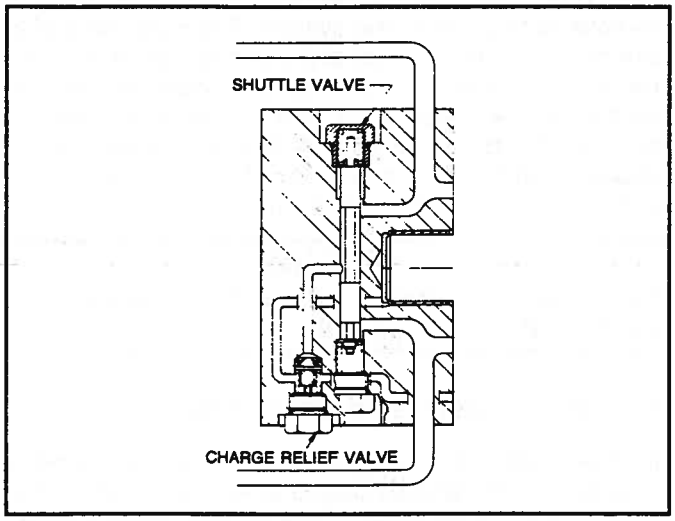


Fig. 6 - Loop Flushing Valve

Loop Flushing Valve

A shuttle valve and charge relief valve can be assembled in the motor end cap to provide the loop flushing function. The shuttle valve provides a circuit between the low pressure side of the closed loop and the charge relief valve in the motor end cap.

This charge relief valve is normally set at approximately the same pressure as the pump charge relief valve (nominal settings of 290, 350, and 405 PSI [20, 24, and 28 BAR], at 1 GPM flow over the valve are available). This relief valve regulates the charge pressure level when there is a pressure differential in the main loop. The shuttle valve is spring centered to the closed position so that during transition of reversing pressures in the closed circuit, no high pressure fluid is lost from the circuit.

Safety Precautions

● When Series 90 units are used in vehicular hydrostatic drive systems, the loss of hydrostatic drive line power in any mode of operation may cause a loss of hydrostatic braking capacity. A braking system, redundant to the hydrostatic transmission must, therefore, be provided which is adequate to stop and/or hold the system should the condition develop.

● Certain service procedures may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing them in order to prevent injury to the technician and bystanders.

● Use caution when dealing with hydraulic fluid under pressure. Escaping hydraulic fluid under pressure can have sufficient force to penetrate your skin causing serious injury. This fluid may also be hot enough to burn. Serious infection or reactions can develop if proper medical treatment is not administered immediately.

● Some cleaning solvents are flammable. To avoid possible fire, do not use cleaning solvents in an area where a source of ignition may be present.

Technical Data - Variable Displacement Pump

Frame Size		030	042	055	075	100	130	180	250
Product Status									
Available			X	X	X	X	X		
In Development*		X						X	X
Displacement (Maximum)									
in^3/Rev		1.83	2.56	3.35	4.57	6.10	7.93	10.98	15.25
cc/Rev		30	42	55	75	100	130	180	250
Input Speed									
Maximum - RPM		5000	5000	4700	4300	4000	3700	3500	3100
Continuous - RPM		4200	4200	3900	3600	3300	3100	2900	2600
Minimum - RPM		500	500	500	500	500	500	500	500
Pressure									
Maximum	PSI	7000	} ALL SERIES 90 PUMPS →						
	BAR	480							
Continuous	PSI	6000							
	BAR	420							
Case Pressure									
Continuous	PSI	40	} ALL SERIES 90 PUMPS →						
	BAR	3							
Maximum	PSI	75							
(Cold Start)	BAR	5							
Input Mounting Flange									
(per SAE J744)		SAE B	SAE B	SAE C	SAE C	SAE C	SAE D	SAE D	SAE D
Input Shaft (Std. Spline)									
Number of Teeth and Pitch		15T 16/32P	15T 16/32P	14T 12/24P	14T 12/24P	13T 8/16P	13T 8/16P	13T 8/16P	13T 8/16P
Weight									
	lbs	62	75	88	108	150	195	260	300
	kg	28	34	40	49	68	88	118	136
Mass Moment of Inertia of the internal rotating parts									
	lb.ft. - Sec^2	0.0017	0.0029	0.0044	0.0071	0.0111	0.0170	0.0280	0.0470
	Nm - Sec^2	0.0023	0.0039	0.0060	0.0096	0.0150	0.0230	0.0380	0.0640
Charge Inlet Vacuum at Sea Level									
Normal	in. Hg	10	} ALL SERIES 90 PUMPS →						
	BAR (abs.)	.7							
Cold Start	in. Hg	25							
	BAR (abs.)	.2							

* Specifications for products in development are projected.

Technical Data - Fixed Displacement Motor

Frame Size		055	075	100	130	180	250
Product Status							
Available		X	X	X	X		
In Development*						X	X
Displacement							
in³/Rev		3.35	4.57	6.10	7.93	10.98	15.25
cc/Rev		55	75	100	130	180	250
Output Speed							
Maximum - RPM		5300	4800	4400	4000	3800	3400
Continuous - RPM		4200	3800	3500	3200	2900	2600
Pressure							
Maximum	PSI	7000	} ALL SERIES 90 MOTORS →				
	BAR	480					
Continuous	PSI	6000					
	BAR	420					
Case Pressure							
Continuous	PSI	40	} ALL SERIES 90 MOTORS →				
	BAR	3					
Maximum	PSI	75					
(Cold Start)	BAR	5					
Output Mounting Flange							
(per SAE J744)		SAE C	SAE C	SAE C	SAE D	SAE D	SAE D
Output Shaft (Std. Spline)							
Number of Teeth and Pitch		14T 12/24P	14T 12/24P	13T 8/16P	13T 8/16P	13T 8/16P	13T 8/16P
Weight							
	lbs	48	57	74	99	137	190
	kg	22	26	34	45	62	86
Mass Moment of Inertia of the Internal Rotating Parts							
	lb.ft. - Sec²	0.0044	0.0071	0.0111	0.0170	0.0280	0.0470
	Nm - Sec²	0.0060	0.0096	0.0150	0.0230	0.0380	0.0640

* Specifications for products in development are projected.

Technical Data - All Series 90 Pumps and Motors

Temperature at Hottest Point in Transmission (normally at case drain)		
Maximum	°F	240
	°C	115
Continuous	°F	220
	°C	104

Fluid Viscosity Limits — SUS (CST)	
Optimum	70 (13)
Minimum Continuous	47 (6.4)
Minimum Intermittent	42 (5.0)
Maximum Continuous	500 (110)
Maximum Cold Start	7500 (1600)

Fluid Contamination Levels — ISO Code	
Recommended Limit - Continuous Operation	18/13
Limit for Machine Assembly (at roll off)	21/15

Suggested Filtration	
Dedicated Reservoir (Beta 10)	1.5 to 2.0
Common Reservoir (Beta 10)	10 to 20

Controls and Options

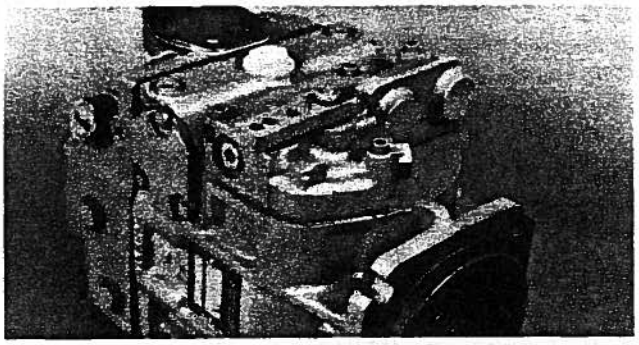


Fig. 7 - Variable Displacement Pump with Manual Displacement Control

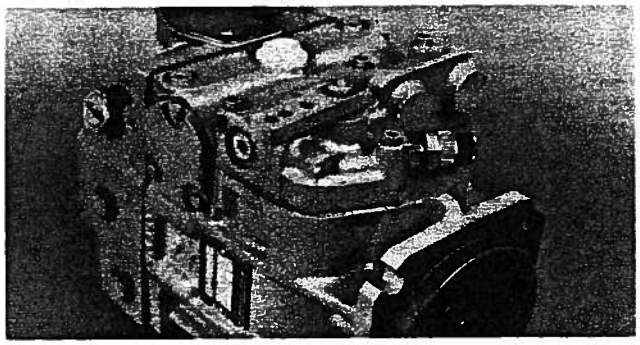


Fig. 8 - Variable Displacement Pump with Manual Displacement Control and Neutral Start Switch

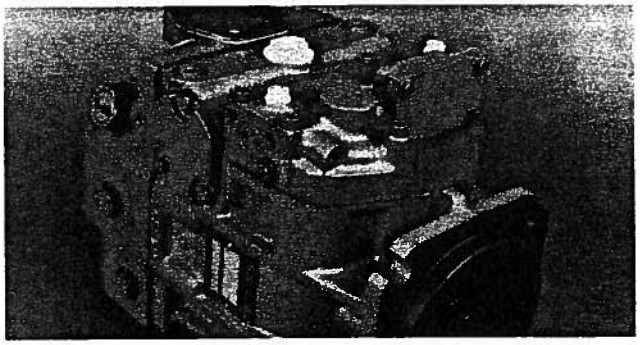


Fig. 9 - Variable Displacement Pump with Hydraulic Displacement Control

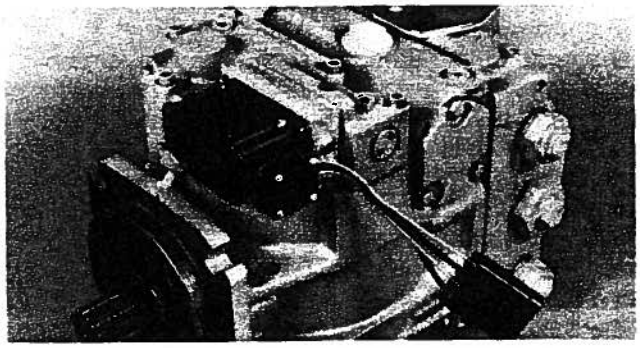


Fig. 10 - Variable Displacement Pump with Electric Displacement Control

Manual Displacement Control (MDC)

The manual displacement control converts a mechanical input signal to a hydraulic signal using a spring centered 4-way servo valve which ports hydraulic pressure to either side of a double acting servo piston. The servo piston rotates the cradle swashplate through an angular rotation of ±17°, thus varying the pump's displacement from full displacement in one direction to full displacement in the opposite direction.

A solenoid override option is available for the manual displacement control. This option consists of a DC solenoid operated valve which connects the sides of the servo piston to each other when no current is supplied to the solenoid. This maintains the pump in a zero displacement condition. When current is supplied to activate the solenoid, the control acts as a standard manual displacement control.

Manual Displacement Control with Neutral Start Switch

The neutral start switch is a feature available with the manual displacement control. When connected properly with the vehicle's electrical system, the neutral start switch assures that the prime mover can be started only when the control is in a neutral position.

Hydraulic Displacement Control

The hydraulic displacement control uses a hydraulic input signal to operate a spring centered 4-way servo valve, which ports hydraulic pressure to either side of a double acting servo piston. The servo piston rotates the cradle swashplate through an angular rotation of ±17°, thus varying the pump's displacement from full displacement in one direction to full displacement in the opposite direction.

Electric Displacement Control (EDC)

The electrical displacement control is similar to the hydraulic displacement control with the input signal pressure controlled by a 12 volt D.C. pressure control pilot (PCP) valve. The PCP valve converts an electrical input signal to a hydraulic signal to operate a spring centered 4-way servo valve which ports hydraulic pressure to either side of a double acting servo piston. The servo piston rotates the cradle swashplate through an angular rotation of ±17°, thus varying the pump's displacement from full displacement in one direction to full displacement in the opposite direction.

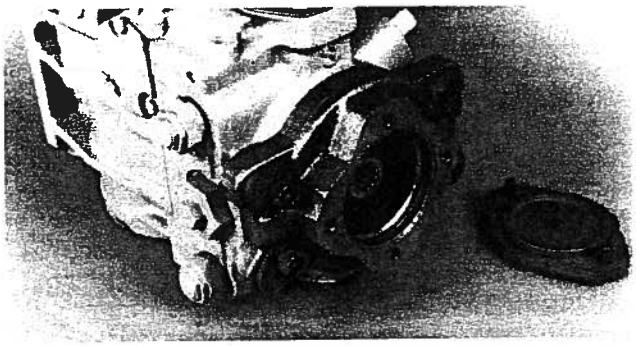


Fig. 11 - Variable Displacement Pump with Auxiliary Mounting Pad

Auxiliary Mounting Pads

Auxiliary mounting pads are available on all Series 90 pumps. This pad is used for mounting auxiliary hydraulic pumps and for mounting other Series 90 pumps to make tandem pumps.

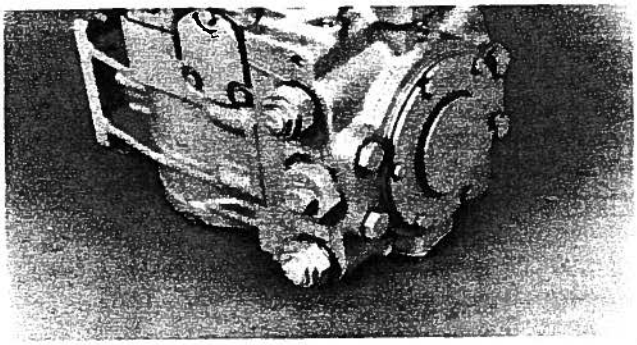


Fig. 12 - Variable Displacement Pump showing location of Multi-Function Valves

Multi-Function Valve

All Series 90 pumps are designed with multi-function valves. The multi-function valve incorporates the main loop check valve, the pressure limiter valve, the high pressure relief valve, and the bypass valve in a replaceable cartridge. There are (2) multi-function valve cartridges in each Series 90 pump.

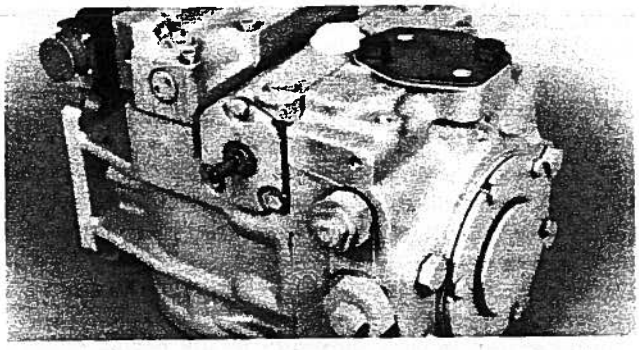


Fig. 13 - Variable Displacement Pump showing location of Displacement Limiters

Displacement Limiters (Option)

All Series 90 pumps are designed for optional mechanical displacement (stroke) limiters. The displacement of the pump can be adjusted to any displacement to zero displacement.

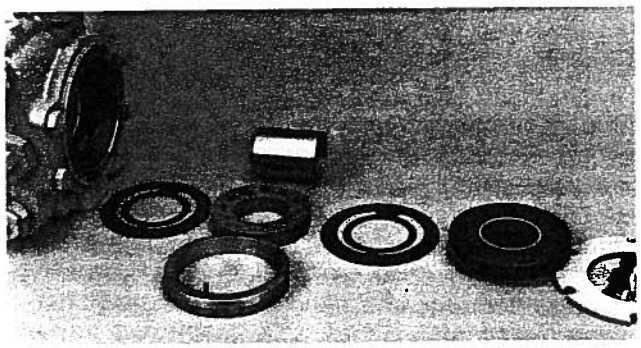


Fig. 14 - Variable Displacement Pump with Charge Pump

Charge Pumps

The charge pump is necessary to provide for cooling, to maintain positive pressure in main circuit, to provide control pressure and to make-up internal leakage. Charge pressure must be at its specified pressure under all conditions of driving and braking to prevent damage to the transmission. The standard charge pumps will be satisfactory for most applications: however if the charge pump sizes available for this size pump are not adequate, a gear pump may be mounted to the auxiliary pad and supply the required additional charge flow.

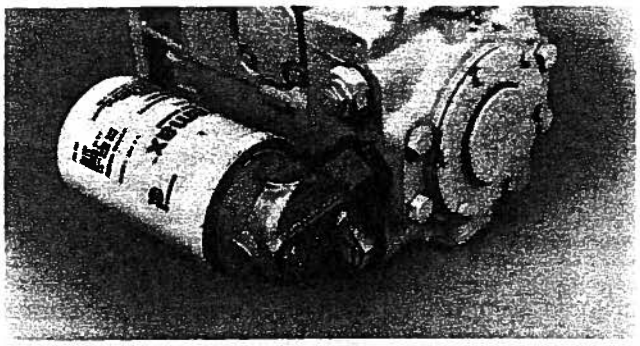


Fig. 15 - Variable Displacement Pump with Integral Charge Pressure Filtration

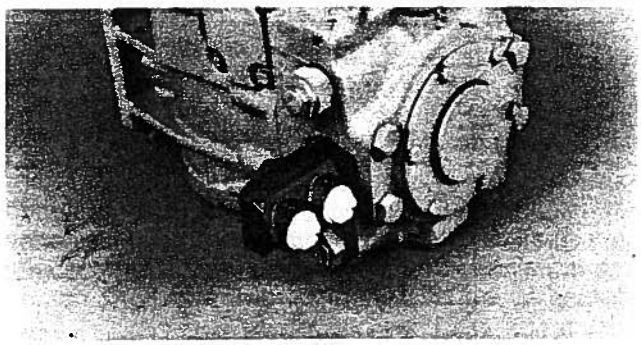


Fig. 16 - Variable Displacement Pump with Remote Charge Pressure Filtration

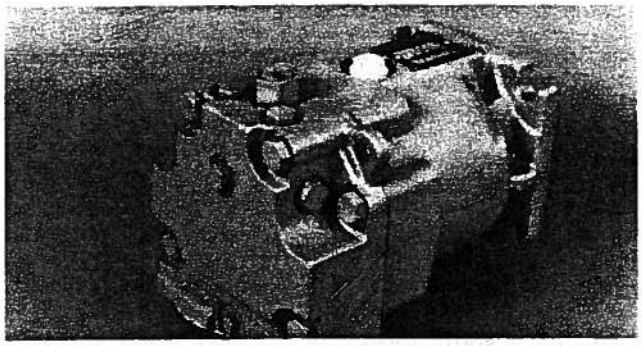


Fig. 17 - Fixed Displacement Motor showing location of Loop Flushing Valve

Filtration

All Series 90 pumps are available with provisions for either suction or charge pressure filtration (integral or remote mounted) to filter the fluid entering the charge circuit.

The suction filter is placed in the circuit between the reservoir and the inlet to the charge pump.

The pressure filter may be integrally mounted directly on the pump or a filter may be remotely mounted for ease of servicing.

A non-bypass filter is preferred on all types of filtration.

Loop Flushing Valve

All Series 90 motors are designed to accept a loop flushing valve. The loop flushing valve is used in installations which require additional fluid to be removed from the main hydraulic circuit because of transmission cooling requirements, or unusual circuits requiring additional loop flushing to remove excessive contamination in the high pressure circuit.

Start-Up & Maintenance

Fluids

Hydraulic fluids used with Sauer-Sundstrand products should be carefully selected with assistance from a reputable supplier, following the guidelines presented in the "Fluid Quality Requirements" bulletin, BLN-9887.

Start-Up Procedure

The following start-up procedure should always be followed when starting-up a new Series 90 installation or when restarting an installation in which either the pump or motor had been removed from the system.

WARNING

The following procedure may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing the procedure in order to prevent injury to the technician and bystanders. Take necessary safety precautions before moving the vehicle/machine.

Prior to installing the pump and/or motor, inspect the units for damage incurred during shipping and handling. Make certain all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean prior to filling with fluid.

Fill the reservoir with recommended hydraulic fluid which should be passed through a 10 micron (nominal, no bypass) filter prior to entering the reservoir. The use of contaminated fluid will cause damage to the components, which may result in unexpected vehicle/machine movement.

The inlet line leading from the reservoir to the pump must be filled prior to start up. Check inlet line for properly tightened fittings and make sure it is free of restrictions and air leaks.

Be certain to fill the pump and/or motor housing with clean hydraulic fluid prior to start up. Fill the housing by pouring filtered oil into the upper case drain port.

Install a 0 to 500 PSI (35 BAR) pressure gauge in the charge pressure gauge port to monitor the charge pressure during start-up.

It is recommended that the external control input signal (linkage for MDC, hydraulic lines for HDC, or electrical connections for EDC) be disconnected at the pump control until after initial start-up. This will allow the pump to remain in its neutral position.

"Jog" or slowly rotate prime mover until charge pressure starts to rise. Start the prime mover and run at the lowest possible RPM until charge pressure has been established. Excess air may be bled from the high pressure lines through the high pressure gauge ports.

WARNING

Do not start prime mover unless pump is in neutral position (0° swashplate angle). Take precautions to prevent machine movement in case pump is actuated during initial start up.

Once charge pressure has been established, increase speed to normal operating RPM. Charge pressure should be 320 PSI (23 BAR) minimum. If charge pressure is incorrect, shut down and determine cause for improper pressure.

WARNING

Inadequate charge pressure will affect the operator's ability to control the vehicle/machine.

Shut down prime mover and connect external control input signal. Start prime mover, checking to be certain pump remains in neutral. With prime mover at normal operating speed, slowly check for forward and reverse machine operation.

Charge pressure should remain at 320 to 340 PSI (23 to 24 BAR) minimum during forward or reverse operation. Continue to cycle slowly between forward and reverse for at least five (5) minutes.

Shut down prime mover, remove gauges, and plug ports. Check reservoir level and add fluid if necessary.

The transmission is now ready for operation.

Maintenance

To insure optimum service life on Series 90 products, regular maintenance of the fluid and filter must be performed.

Check the reservoir daily for proper fluid level, the presence of water (noted by a cloudy to milky appearance, or free water in bottom of reservoir), and rancid fluid odor (indicating excessive heat).

It is recommended that the fluid and filter be changed per the vehicle/machine manufacturer's recommendations or at the following intervals:

- System with a sealed type reservoir - 2000 hrs.
- System with a breathing type reservoir - 500 hrs.

It may be necessary to change the fluid more frequently than the above intervals if the fluid becomes contaminated with foreign matter (dirt, water, grease, etc.) or if the fluid has been subjected to temperature levels greater than the maximum recommended. Never reuse fluid.

The filter should be changed whenever the fluid is changed or whenever the filter indicator shows that it is necessary to change the filter.

Troubleshooting

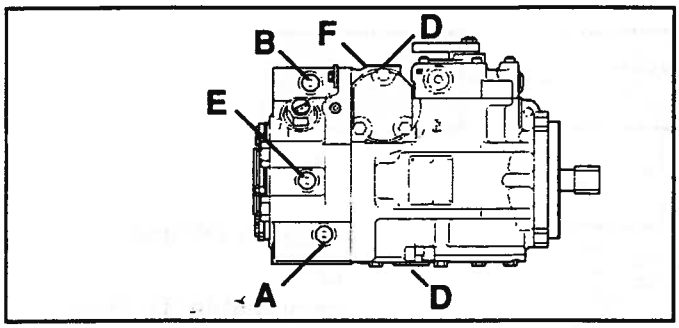


Fig. 18 - Gauge Connections -- Variable Pump with Radial Port End Cap

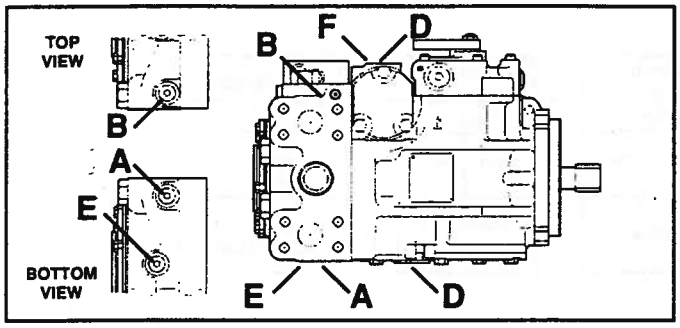


Fig. 19 - Gauge Connections -- Variable Pump with Twin Port End Cap

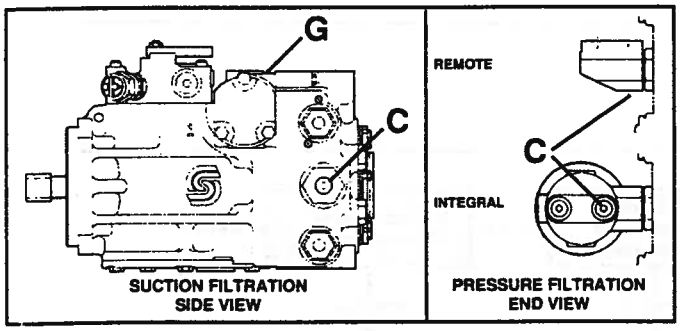


Fig. 20 - Gauge Connections -- Variable Pump

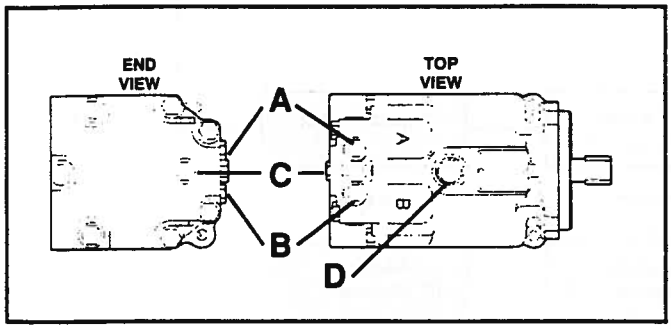


Fig. 21 - Gauge Connections -- Fixed Motor

Gauge Installation

Various pressure and vacuum gauge readings can be a great asset in troubleshooting problems with the Series 90 transmission or support system.

It will be necessary to install a high pressure gauge into the system pressure gauge ports to check the high pressure setting of the multi-function valves.

Measuring the charge pump inlet vacuum will help locate restrictions in the inlet lines, filter, etc.

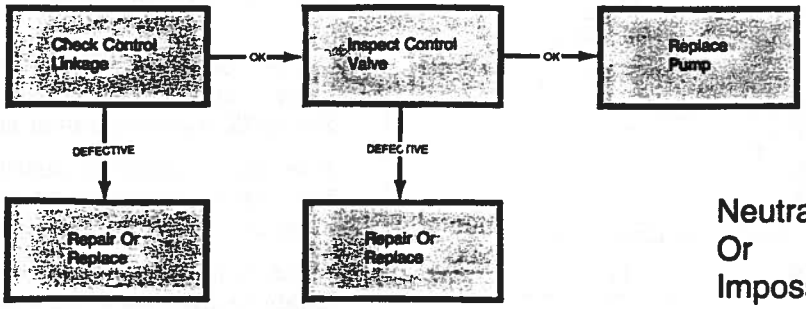
Case pressure readings can help locate restrictions in the return lines, oil cooler, and return filter.

Gauge Information		
A	System Pressure Port "A"	10,000 PSI (690 BAR) - Gauge 9/16 - 18 O-Ring Fitting
B	System Pressure Port "B"	10,000 PSI (690 BAR) - Gauge 9/16 - 18 O-Ring Fitting
C	Charge Pressure	500 PSI (35 BAR) - Gauge 9/16 - 18 O-Ring Fitting or Tee into Charge Pressure Filter Outlet Line
D	Case Pressure	500 PSI (35 BAR) - Gauge See Chart Below
E	Charge Pump Inlet Vacuum	Vacuum Gauge 9/16 - 18 O-Ring Fitting or Tee into Charge Pump Inlet Line
F	Servo Pressure	500 PSI (35 BAR) - Gauge 9/16 - 18 O-Ring Fitting or 7/16 - 20 O-Ring Fitting
G	Servo Pressure	500 PSI (35 BAR) - Gauge 9/16 - 18 O-Ring Fitting or 7/16 - 20 O-Ring Fitting

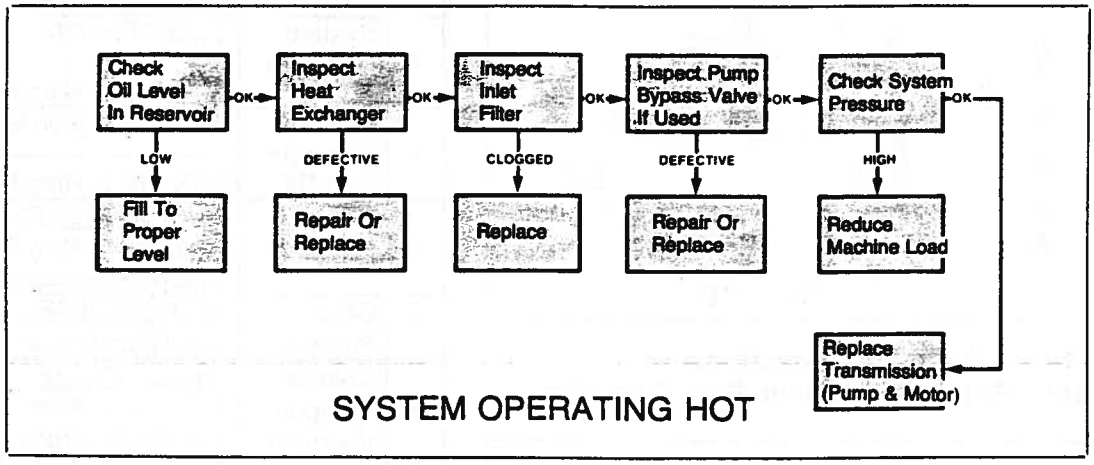
Case Drain Port Sizes		
Frame Size	Pump	Motor
030	7/8 - 14 O-Ring Fitting	———
042	7/8 - 14 O-Ring Fitting	———
055	1-1/16 - 12 O-Ring Fitting	7/8 - 14 O-Ring Fitting
075	1-1/16 - 12 O-Ring Fitting	1-1/16 - 12 O-Ring Fitting
100	1-1/16 - 12 O-Ring Fitting	1-1/16 - 12 O-Ring Fitting
130	1-5/16 - 12 O-Ring Fitting	1-5/16 - 12 O-Ring Fitting

Snubbers are recommended to protect pressure gauges. Frequent gauge calibration is necessary to insure accuracy.

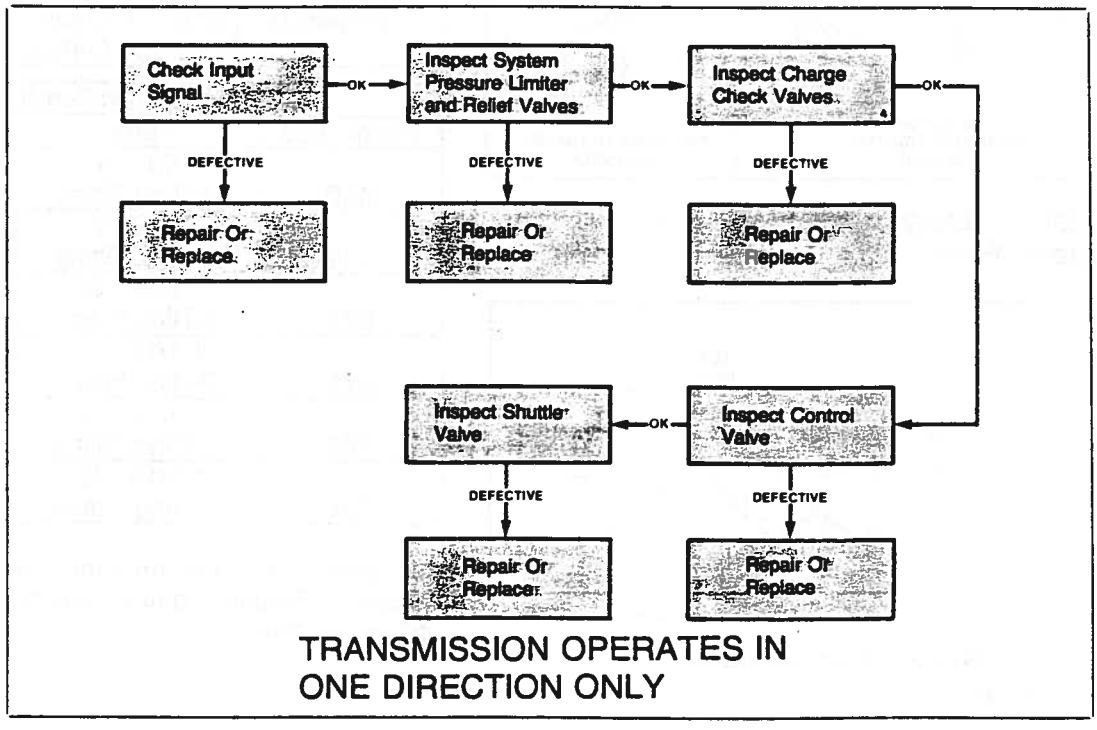
Fault Logic Diagrams



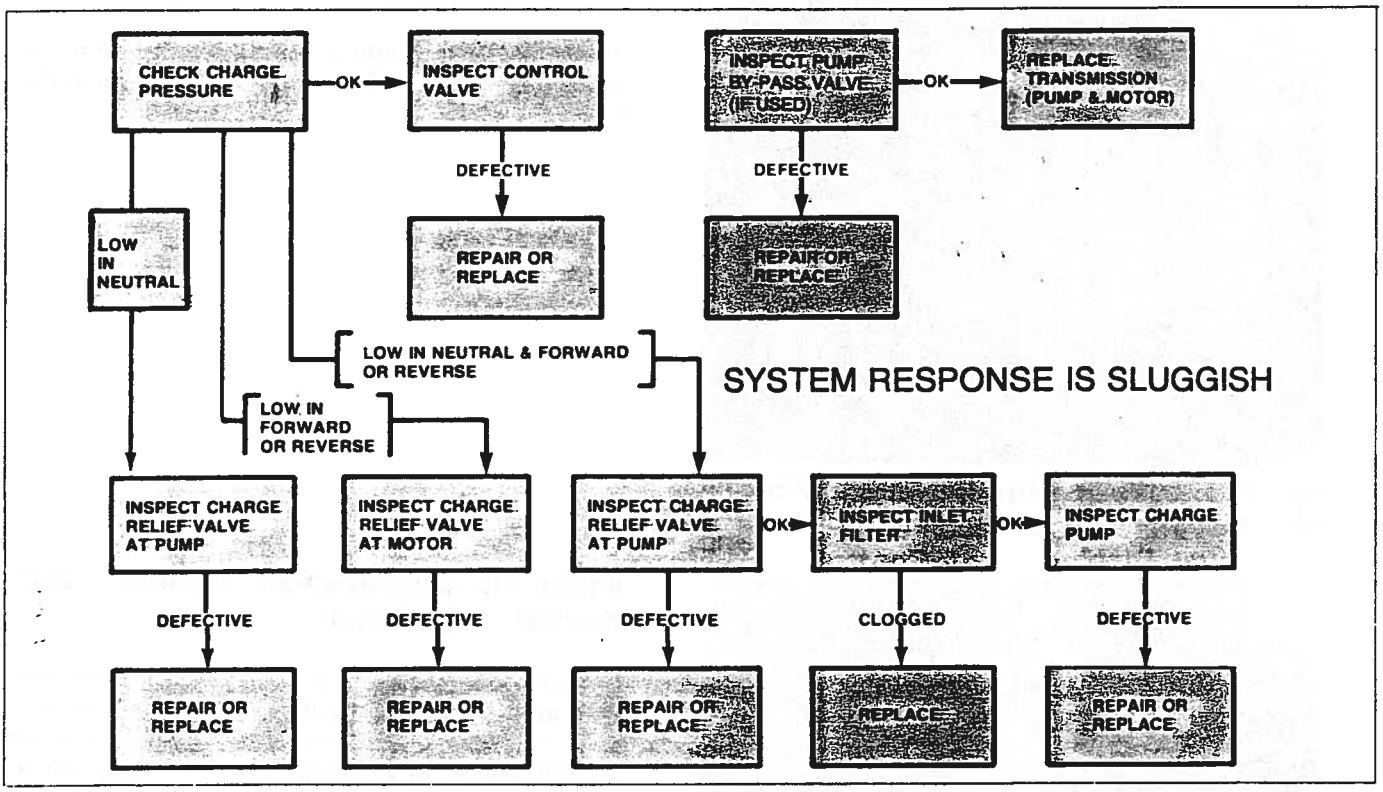
Neutral Difficult
Or
Impossible To Find

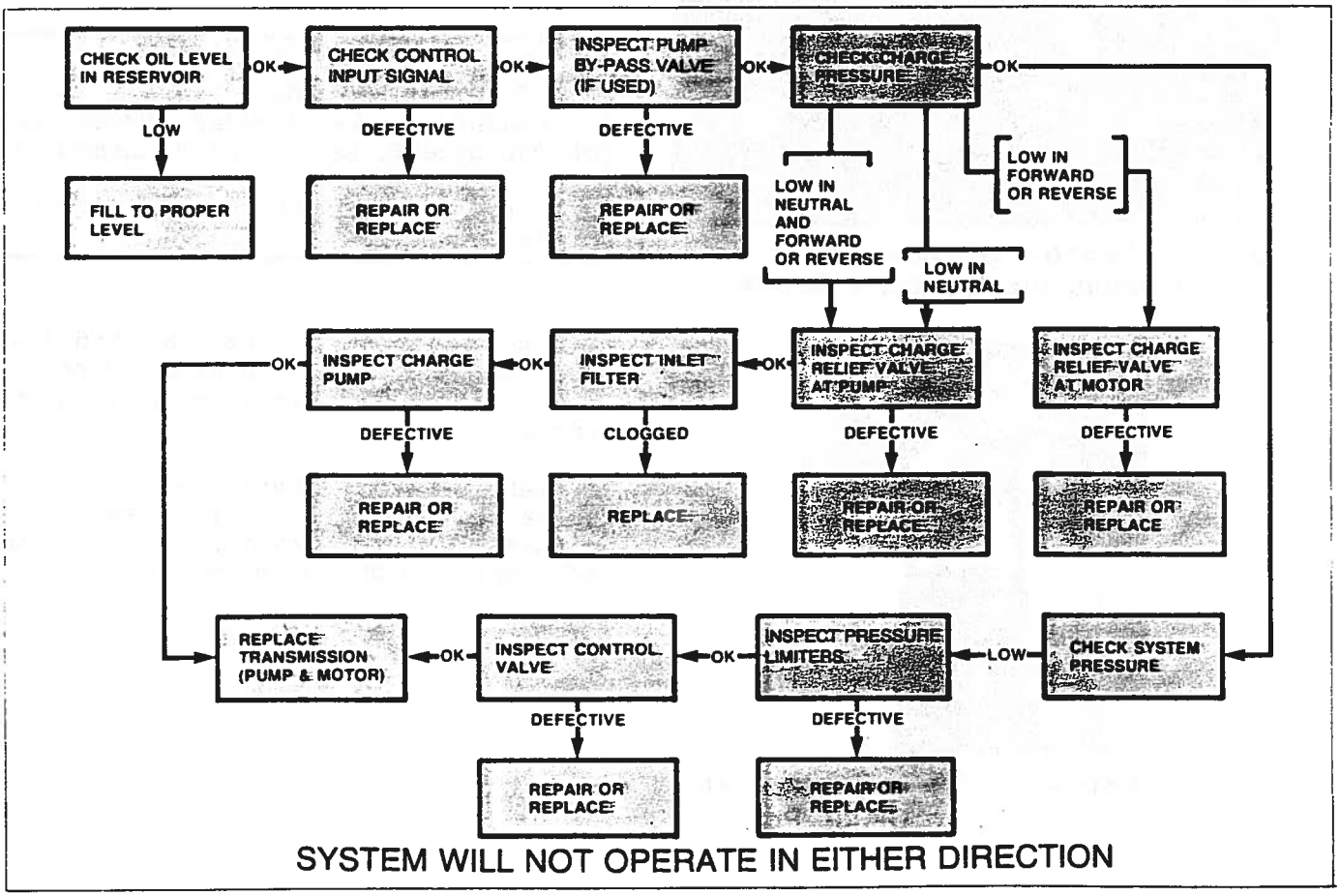


SYSTEM OPERATING HOT



TRANSMISSION OPERATES IN
ONE DIRECTION ONLY


CHECK CHARGE PRESSURE
OK
INSPECT CONTROL VALVE
DEFECTIVE
REPAIR OR REPLACE
INSPECT PUMP BY-PASS VALVE (IF USED)
OK
REPLACE TRANSMISSION (PUMP & MOTOR)
DEFECTIVE
REPAIR OR REPLACE
LOW IN NEUTRAL
LOW IN NEUTRAL & FORWARD OR REVERSE
LOW IN FORWARD OR REVERSE
SYSTEM RESPONSE IS SLUGGISH
INSPECT CHARGE RELIEF VALVE AT PUMP
INSPECT CHARGE RELIEF VALVE AT MOTOR
INSPECT CHARGE RELIEF VALVE AT PUMP
OK
INSPECT INLET FILTER
OK
INSPECT CHARGE PUMP
DEFECTIVE
REPAIR OR REPLACE
DEFECTIVE
REPAIR OR REPLACE
DEFECTIVE
REPAIR OR REPLACE
CLOGGED
REPLACE
DEFECTIVE
REPAIR OR REPLACE


CHECK OIL LEVEL IN RESERVOIR
OK
CHECK CONTROL INPUT SIGNAL
OK
INSPECT PUMP BY-PASS VALVE (IF USED)
OK
CHECK CHARGE PRESSURE
OK
LOW
FILL TO PROPER LEVEL
DEFECTIVE
REPAIR OR REPLACE
DEFECTIVE
REPAIR OR REPLACE
LOW IN NEUTRAL AND FORWARD OR REVERSE
LOW IN NEUTRAL
LOW IN FORWARD OR REVERSE
OK
INSPECT CHARGE PUMP
OK
INSPECT INLET FILTER
OK
INSPECT CHARGE RELIEF VALVE AT PUMP
INSPECT CHARGE RELIEF VALVE AT MOTOR
DEFECTIVE
REPAIR OR REPLACE
CLOGGED
REPLACE
DEFECTIVE
REPAIR OR REPLACE
DEFECTIVE
REPAIR OR REPLACE
REPLACE TRANSMISSION (PUMP & MOTOR)
OK
INSPECT CONTROL VALVE
OK
INSPECT PRESSURE LIMITERS
LOW
CHECK SYSTEM PRESSURE
DEFECTIVE
REPAIR OR REPLACE
DEFECTIVE
REPAIR OR REPLACE
SYSTEM WILL NOT OPERATE IN EITHER DIRECTION

Inspections and Adjustments

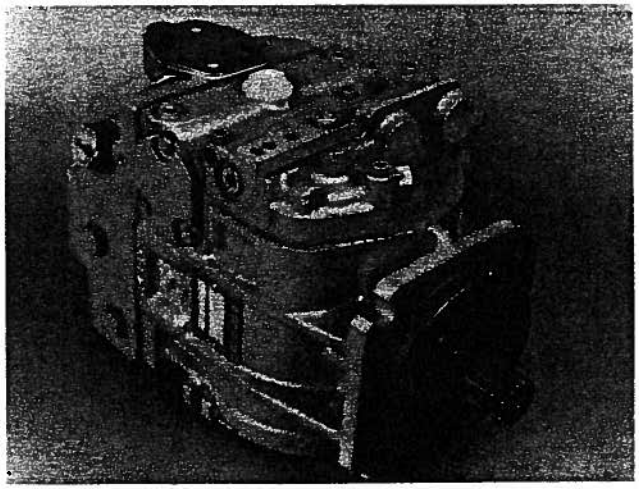


Fig. 22 - Variable Displacement Pump with Manual Displacement Control

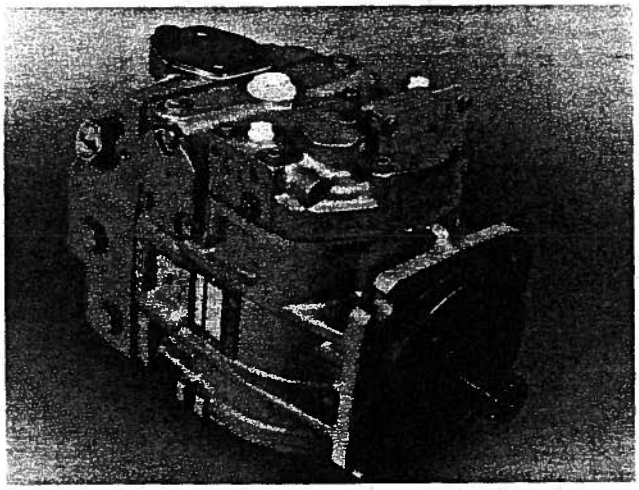


Fig. 23 - Variable Displacement Pump with Hydraulic Displacement Control



Fig. 24 - Gauges in Servo Gauge Ports

Manual Displacement Control (MDC)

There are no adjustable elements in the manual displacement control. All functions are pre-set at the factory.

Hydraulic Displacement Control (HDC) Neutral Adjustment

The neutral adjustment is the only adjustment that can be made on the hydraulic displacement control, all other functions are pre-set at the factory. The neutral adjustment of this control must be made on a test stand or on the vehicle with the prime mover operating.

WARNING

The following procedure requires the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing the procedure in order to prevent injury to the technician and bystanders.

Disable vehicle or machine. Install two (2) 500 psi (35 BAR) gauges in the servo gauge ports (one in each side). Start the prime mover and operate at normal speed.

For earlier production controls, loosen the lock nut on the neutral shaft with a 17 mm hex wrench. For later production controls, loosen the lock nut on the neutral adjusting screw with a 10 mm hex wrench.



Fig. 25 - Rotating Neutral Adjustment Shaft (Early Production Control)



Fig. 26 - Rotating Neutral Adjustment Screw (Later Production Control)

Use a 5 mm internal hex wrench to turn the neutral shaft on earlier production controls, or a 3 mm internal hex wrench to turn the neutral adjusting screw on later production controls.

Rotate the neutral shaft or neutral adjusting screw clockwise until the pressure increases in one of the two (2) pressure gauges. Note the location "A" (angular position) of the internal hex wrench.

Without removing the internal hex wrench, rotate the neutral shaft or adjusting screw counter-clockwise until the pressure increases in the other gauge. Note the location "B" (angular position) of the internal hex wrench.

Rotate the neutral shaft or adjusting screw clockwise half the distance between location "A" & "B". The control should now be in a neutral position. In this position the gauges should read the same pressure (case pressure).



Fig. 27 - Tightening Neutral Shaft Locking Nut (Early Production Control)



Fig. 28 - Tightening Neutral Screw Locking Nut (Later Production Control)

While holding the shaft or screw stationary with the internal hex wrench, tighten the neutral shaft lock nut (earlier production controls) to 16 ft.lbsf. (22 Nm) or the neutral adjusting screw lock nut (later production controls) to 60 in.lbsf. (7 Nm). Do not overtorque the lock nut.

If the pump does not consistently return to neutral, stop the prime mover and refer to the trouble shooting procedure in the Troubleshooting Section. With the neutral position set, stop the prime mover, remove the two (2) gauges, and install the gauge port plugs.

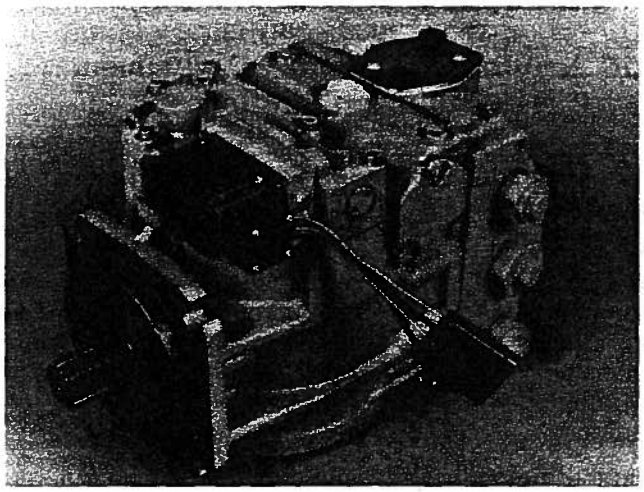


Fig. 29 - Variable Displacement Pump with Electric Displacement Control

Electric Displacement Control (EDC) Neutral Adjustment

The adjustment procedures for the Electric Displacement Control are the same as the procedures for adjusting the hydraulic displacement control listed above.

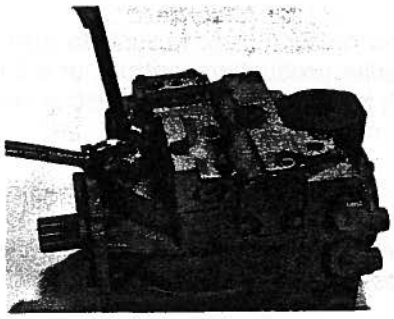


Fig. 30 - Loosen Neutral Start Switch Lock Nut

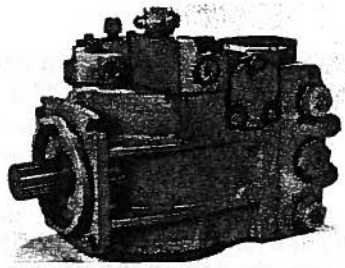


Fig. 31 - Neutral Start Switch Removed

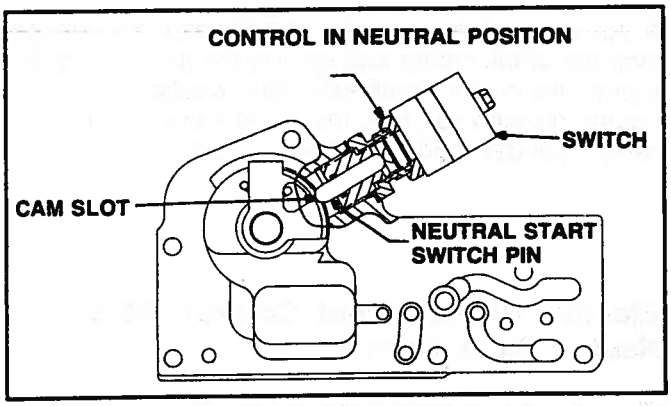


Fig. 32 - Cam Slot and Neutral Start Switch Pin



Fig. 33 - Checking Continuity of Neutral Start Switch

MDC Neutral Start Switch Removal and Installation

Replacement of the neutral start switch may be accomplished with the control on the machine providing a space of .38 in. (9.85 mm) is available for switch removal.

WARNING

Do not disturb any locknuts or adjustments on the Neutral Start Switch other than those described in these procedures. Disturbing other components may result in the prime mover starting in other than the neutral (0 flow) position. If other adjustments are disturbed during replacement, perform the "Neutral Start Switch Check" procedure on the following page.

Using two (2) 1-1/8 inch wrenches, hold the switch from turning and loosen the locknut.

CAUTION

Do not allow the special locknut on the eccentric plug to turn when loosening the switch locknut. Turning these parts may change other critical switch adjustments.

After the locknut is loose, remove the switch.

NOTE: An assist spring and disc were installed between the earlier production neutral start switch and the eccentric plug. If the current production switch is installed, the spring and disc are not required.

Install the new switch into the special lock nut, finger tight. Leave the switch lock nut loose. Perform the Neutral Start Switch Adjustment as outlined in the following section

MDC Neutral Start Switch Adjustment

Make certain the control is in the neutral position. If the switch is being replaced with the control removed from the unit, neutral can be verified by rotating the control link assembly until the neutral start switch pin is engaged in the slot on the cam.

Attach a continuity checker to the two screws on the end of the switch. With the control in the neutral position, turn the switch counter-clockwise until electrical continuity is obtained. Turn switch counter-clockwise an additional 1/4 turn after continuity has been obtained.

Hold the switch in place and tighten the locknut to 20 ft.lbsf. (27 Nm) torque.

With the continuity checker attached to the switch, rotate the control lever (or the control link) in each direction to assure continuity is broken when the control is not in the neutral position.

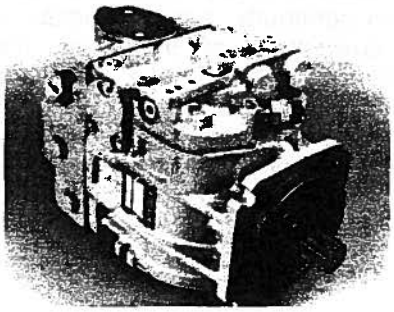


Fig. 34 - Variable Displacement Pump with Neutral Start Switch

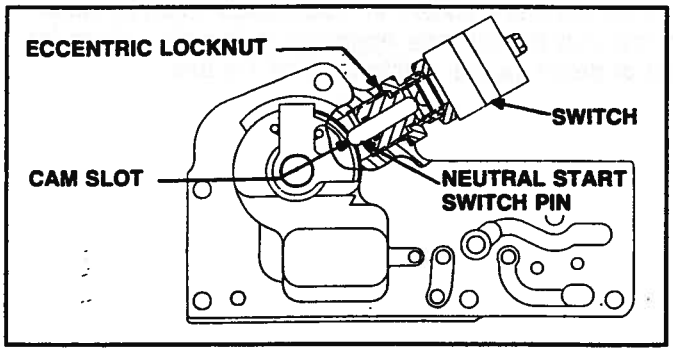


Fig. 35 - Neutral Start Switch Showing Special Lock Nut for Eccentric Plug

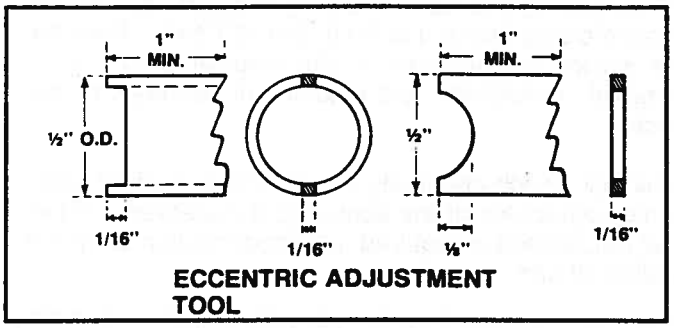


Fig. 36 - Eccentric Plug Adjustment Tools

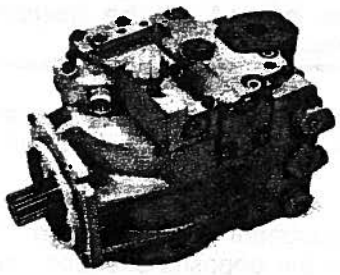


Fig. 37 - Neutral Start Switch Removed

MDC Neutral Start Switch Check and Eccentric Plug Adjustment

Proper switch operation must be verified prior to installing the external control linkage and starting the prime mover.

Connect a continuity checker to the screws on the end of the neutral start switch.

Make certain the control is in neutral (zero flow) position. Electrical continuity should now be obtained; verify by observing the continuity checker.

For the switch to operate properly and continuity to be established, the pin located in the eccentric plug must engage in a slot on a cam in the internal control mechanism. When the control handle is moved in either direction, the pin is forced out of the slot and actuates the switch to interrupt the circuit. The continuity should be interrupted with an equal amount of handle rotation in both directions. If the continuity is obtained in neutral and satisfactorily interrupted in each direction, proceed to check the switch with the prime mover running.

If continuity can not be verified in neutral, determine the direction of handle rotation (clockwise or counterclockwise) necessary to establish continuity.

The pin which engages the cam slot is mounted in an eccentric plug which allows for adjustment. The accompanying drawing provides dimensions for alternate designs for an eccentric plug adjustment tool.

While holding the switch from turning, loosen the switch lock nut and remove the neutral start switch. Note the slots on the eccentric plug for the adjustment tool. Loosen the special eccentric plug lock nut while holding the eccentric in place with the adjustment tool.

WARNING
Do not start the prime mover while the neutral start switch is removed from the control. Damage to the control will result.

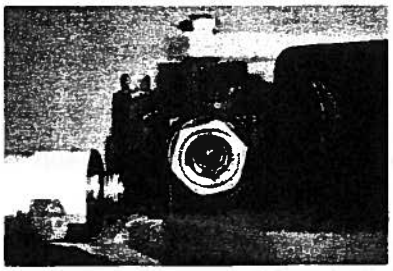


Fig. 38 - Neutral Start Switch Removed - Showing Start Switch Pin

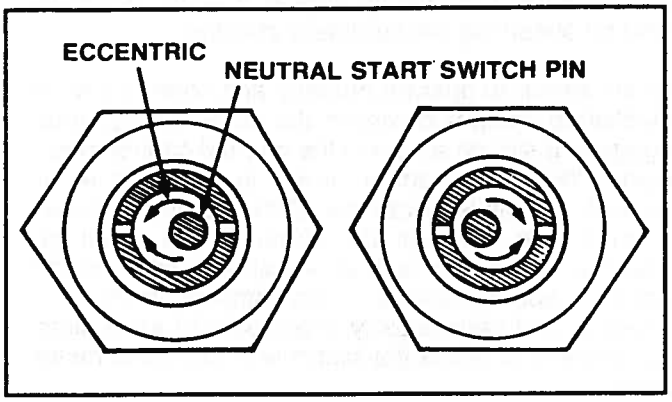


Fig. 39 - Adjust Eccentric Plug to move pin toward pump or away from pump as required

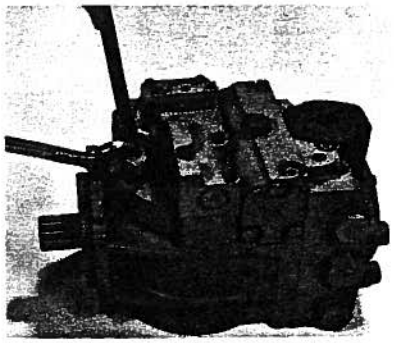


Fig. 40 - Tighten Lock Nut

If it was necessary to rotate the control handle clockwise to obtain continuity, turn the eccentric plug to move the pin down (or toward the pump). If a counterclockwise rotation of the handle was necessary to obtain continuity, rotate the eccentric plug to move the pin up (or away from the pump). Only a small amount of adjustment in either direction is needed to center the pin in the internal mechanism cam slot.

Turn the eccentric plug a maximum of 1/4 of a turn while frequently stopping to check maximum pin depth into the eccentric collar. In most cases it can be determined that the pin has engaged in the slot, either by feel or depth gauge, within the first 1/4 turn.

While holding the eccentric plug in place, tighten the eccentric plug lock nut to 20 ft. lbsf. (27 Nm). Reinstall the switch as outlined in the neutral start switch removal / installation and adjustment headings of this section.

Recheck switch continuity to determine whether additional adjustment of the eccentric is necessary. If further adjustment is required, continue rotation up to 1/4 additional turn.

CAUTION

Do not exceed 1/2 turn total or 180° from the initial pin position. Doing so will turn the eccentric into or out of the housing beyond specifications.

NOTE: The eccentric plug is normally installed into the control housing between 5-1/2 and 6-1/2 turns.

If too much adjustment was made, turn the eccentric plug 1/8 turn in the opposite direction. Again, install the switch and check for continuity.

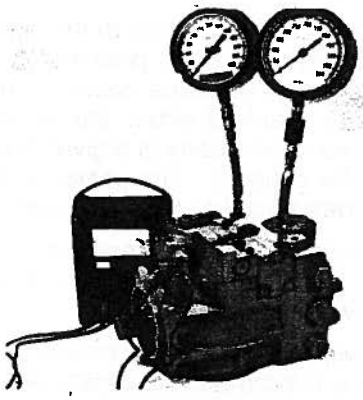


Fig. 41 - Checking Continuity of Neutral Start Switch (Gauges Installed in Servo Gauge Ports)

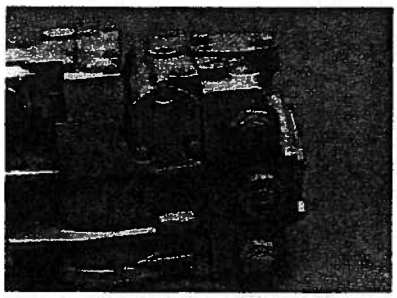


Fig. 42 - Multi-Function Valves

WARNING

The following procedure requires the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) in the event the pump should go into stroke during this adjustment.

Install two (2) 500 psi (35 BAR) gauges in the servo gauge ports (one in each side). Energize the starter circuit, and start the prime mover.

While operating at normal speed and with the pump in the neutral (zero flow) position, note the pressure reading on the gauges. This reading should be noted as the base pressure.

Slowly move the control handle in one direction while observing the pressure gauges and the continuity checker. Continuity must be broken before the pressure on either gauge increases more than 12 PSI (0.9 BAR) from the base pressure obtained at neutral.

Slowly move the control handle in the opposite direction. Again, continuity must be broken before the gauge pressure increases more than 12 PSI (0.9 BAR) from base pressure.

Continuity must again be verified when the control is returned to neutral.

If continuity is not broken at base pressure plus 0 to 12 PSI (0 to 0.9 BAR) in either direction, stop the prime mover and readjust the eccentric plug as described previously. If the pressure difference is equal in each direction but greater than 12 PSI (0.9 BAR), loosen the switch locknut and turn the switch clockwise 1/16 of a turn to increase the sensitivity. Retighten the locknut and recheck pressure differences and continuity.

After verifying proper control and switch operation, stop the prime mover. Remove the continuity checker and pressure gauges. Reinstall the servo pressure port plugs and reconnect the electrical leads from the machine starter circuit to the neutral start switch. Install and adjust, if necessary, the external control linkage.

Multi-Function Valve Pressure Adjustment

Adjustment of the pressure limiter and high pressure relief valve pressure setting is accomplished by the same procedure.

In order to set the pressure setting on the pressure limiter or high pressure relief valve, the motor output shaft must be locked so it does not rotate. This may be accomplished by locking the vehicle's brakes or rigidly fixing the work function so it cannot rotate.

WARNING

Take necessary precautions that the motor shaft remains locked during the adjusting procedure.

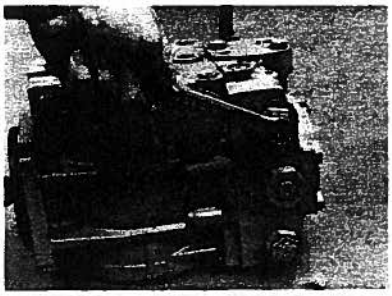


Fig. 43 - Loosen Pressure Adjusting Screw Lock Nut

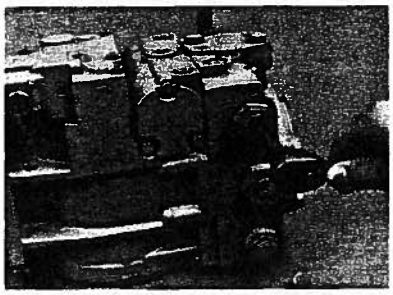


Fig. 44 - Rotate Pressure Adjusting Screw

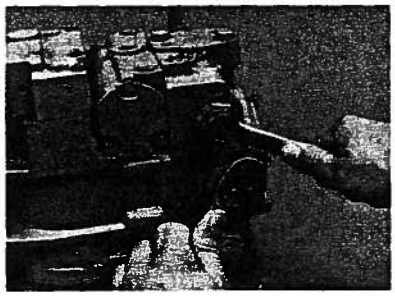


Fig. 45 - Tighten Lock Nut

Install two (2) 10,000 PSI (690 BAR) pressure gauges in the high pressure gauge ports. Install a 500 PSI (35 BAR) pressure gauge in the pump charge pressure gauge port.

Start the prime mover and operate at normal speeds.

Loosen locking nut (smallest hex on multi-function valve) with a 10 mm wrench for earlier 042 through 100 frame size units, a 19 mm wrench for later 042 through 100 frame size units, or a 13 mm wrench for 130 frame size units.

Insert a 3 mm (earlier 042 through 100 units), 5 mm (later 042 through 100 units), or 4 mm (130 units) internal hex wrench into the pressure adjusting screw.

NOTE: A plastic dust plug is installed in the adjusting screw on later 042 through 100 units.

Activate or move the input signal to the control so that pressure increases in the high pressure closed circuit to the pressure limiter pressure setting. The pressure limiter setting is reached when the pressure stops increasing and remains steady at a given pressure level (as shown on the gauges). The pressure limiter pressure setting is referenced to charge pressure.

Rotate the pressure adjusting screw with the internal hex wrench, until the desired pressure level is established (as shown on the gauges).

NOTE: Clockwise rotation of the pressure adjustment screw will increase the pressure setting, and counterclockwise rotation will decrease the pressure setting. Each complete rotation of the pressure adjusting screw changes the pressure setting by 1200 PSI (83 BAR) on earlier 042 through 100 units, or by 1350 PSI (93 BAR) on later 042 through 100 units.

While holding the internal hex wrench and pressure adjusting screw in the same position, tighten the pressure adjusting screw lock nut to 26 in.lbsf. (3 Nm) on earlier 042 through 100 and all 130 units, or 12 ft.lbsf. (16 Nm) on later 042 through 100 units. **Do not over-torque.**

Activate or move the input signal so pump returns to the neutral position. The pressure in the high pressure circuit should return to the charge pressure setting. To verify the actual pressure setting, actuate or move the input signal to the control such that the pump again develops pressure in the high pressure circuit to the newly adjusted pressure limiter pressure setting. Then allow the pump to return to its neutral position.

The same procedure is used for setting the pressure of the other multi-function valve, but the input control signal must be activated or moved in the opposite direction so that the pressure develops in the opposite high pressure side of the closed circuit.

Shut down the prime mover and remove the gauges and install the gauge port plugs. Replace the plastic dust plugs (if used).

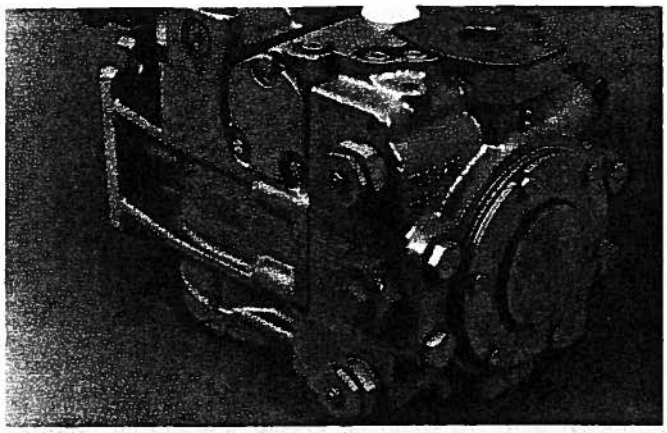


Fig. 46 - Charge Pressure Gauge Port (Variable Displacement Pump with Suction Filtration)

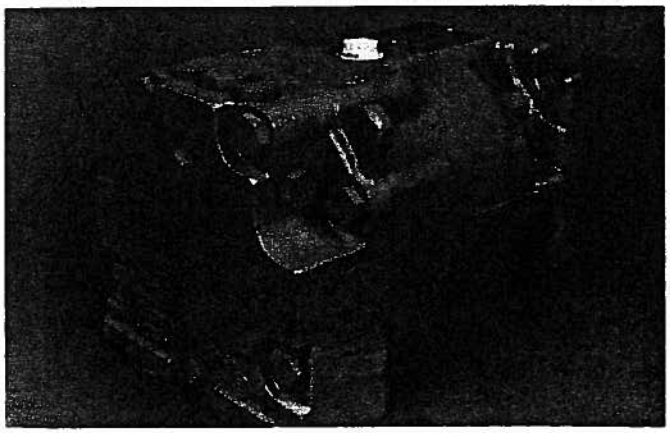


Fig. 47 - Charge Pressure Gauge Port (Fixed Displacement Motor)

Charge Pressure Relief Valve Adjustment

WARNING

The following procedure may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing the procedure in order to prevent injury to the technician and bystanders.

To measure pump charge pressure, install a 500 PSI (35 BAR) pressure gauge in the pump charge pressure gauge port. Install a gauge to measure case pressure. Operate the system with the pump in neutral (zero angle) when measuring pump charge pressure.

The following table shows the acceptable pump charge pressure range for the nominal charge relief valve settings. These pressures assume 1775 pump RPM and a reservoir temperature of 120°F (49°C), and are referenced to case pressure. Smaller displacement charge pumps will produce charge pressure readings in the lower portion of the range, while larger charge pumps will produce readings in the higher portion of the range.

CAUTION

The following pressure settings assume a pump speed of 1775 RPM. At higher pump input speeds (with higher charge flows) the charge pressure will rise over the rated setting.

Model Code Setting	Pump Charge Pressure (Acceptable Range) (±25 PSI [1.7 BAR])
"20 BAR"	291 to 308 PSI (20.1 to 21.2 BAR)
"24 BAR"	348 to 365 PSI (24.0 to 25.2 BAR)
"28 BAR"	403 to 420 PSI (27.8 to 29.0 BAR)

To measure motor charge pressure, install a 500 PSI (35 BAR) pressure gauge in the motor charge pressure gauge port. Install a gauge to measure case pressure. Operate the system with the pump in stroke (forward or reverse) when measuring motor charge pressure.

The following table shows acceptable motor charge pressures for the nominal charge relief valve settings. These pressures assume a reservoir temperature of 120°F (49°C), and are referenced to case pressure.

Model Code Setting	Motor Charge Pressure (Acceptable) (±20 PSI [1.4 BAR])
"20 BAR"	262 PSI (18.1 BAR)
"24 BAR"	320 PSI (22.1 BAR)
"28 BAR"	378 PSI (26.1 BAR)



Fig. 48 - Shim Adjustable Charge Pressure Relief Valve (Pump)



Fig. 49 - Shim Adjustable Charge Pressure Relief Valve (Motor)

Earlier production Series 90 pumps and motors are equipped with a shim adjustable charge pressure relief valve. Adjustment of the charge pressure is accomplished by changing the shim thickness behind the spring. The plug for this type charge relief should be torqued to 50 ft.lbsf. (68 Nm).

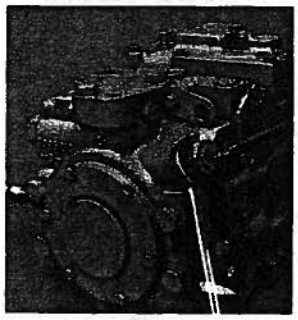


Fig. 50 - Screw Adjustable Charge Pressure Relief Valve (Pump)



Fig. 51 - Screw Adjustable Charge Pressure Relief Valve (Motor)

Later production Series 90 pumps and motors are equipped with an external screw adjustable charge pressure relief valve. Adjustment of the charge pressure is accomplished by loosening the lock nut (with a 1-1/16" hex wrench for 042 through 100 units, or a 1-5/8" hex wrench for 130 units), and turning the adjustment plug with a large screwdriver. Clockwise rotation of the plug increases the setting, and counterclockwise rotation decreases the setting (at a rate of approximately 50 PSI [3.4 BAR] per turn). The lock nut for this type charge relief should be torqued to 38 ft.lbsf. (52 Nm).

Once the desired charge pressure setting is achieved, remove the gauges.

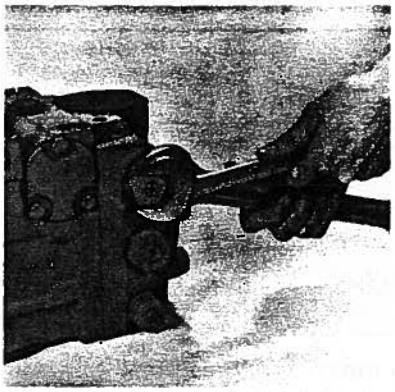


Fig. 52 - Loosening and Rotating Bypass Hex on Multi-Function Valve

Bypass Valve

The bypass function is performed by the multi-function valve cartridges. The prime mover should be shut down when opening or closing the bypass valves.

Using a 1-1/16" (042 through 100) or 1-3/8" (130) wrench on the middle size hex of the multi-function valve cartridge, and a 1-1/4" (042 through 100) or 1-5/8" (130) wrench on the large hex to prevent rotation of the cartridge assembly, rotate the middle hex three (3) revolutions counterclockwise to open the bypass valve. Do not rotate more than 3-1/2 revolutions, as additional rotation will permit external leakage.

Prior to moving the vehicle or otherwise causing the motor shaft to turn, move the control handle of the manual displacement control on the pump to the maximum full forward position. Hold the handle in this position during bypass valve operation.

To close the bypass valve, rotate the middle hex clockwise until it is seated. Then torque the middle hex to 30 ft.lbsf. (41 Nm.).

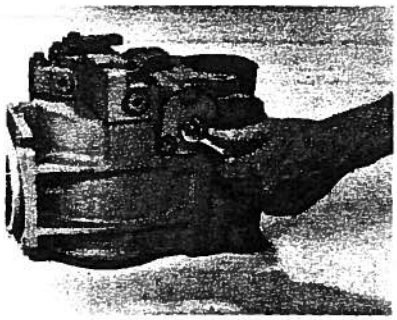


Fig. 53 - Loosen Displacement Limiter Lock Nut

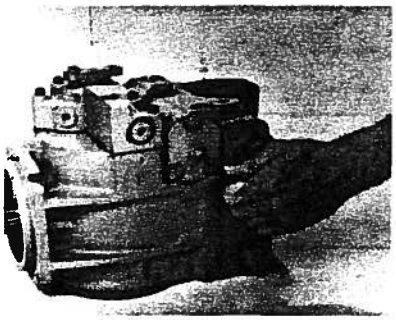


Fig. 54 - Rotate Adjusting Screw

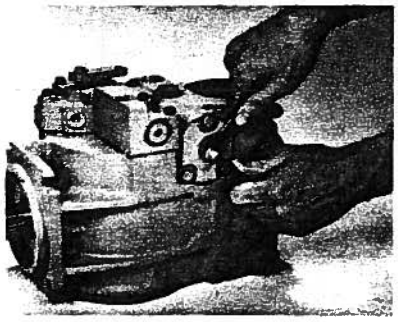


Fig. 55 - Tighten Lock Nut

Displacement Limiter Adjustment (Option)

Using a 13 mm wrench for 042 through 100 frame size pumps or a 17 mm wrench for 130 frame size pumps, loosen the lock nut retaining the displacement limiter adjusting screw.

Using a 4 mm internal hex wrench for 042 through 100 frame size pumps or a 5 mm internal hex wrench for 130 frame size pumps, rotate the adjusting screw to limit the displacement of the pump.

NOTE: Rotating the adjusting screw clockwise will decrease the maximum displacement of the pump while rotating the adjusting screw counterclockwise will increase its max. displacement up to the max. designed displacement of the pump.

After establishing the desired maximum displacement setting, tighten the lock nut on the adjusting screw to 18 ft.lbsf. (24 Nm) for 042 through 100 frame size pumps, and 35 ft.lbsf. (48 Nm) for 130 frame size pumps.

The maximum displacement can be limited in either direction. Use the above procedure to set either or both displacement limiters.

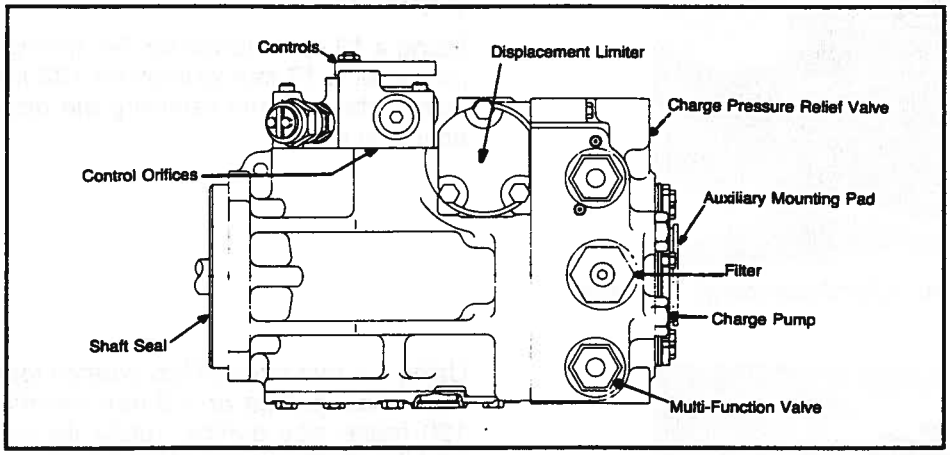
For each full revolution, of the adjusting screw, the displacement will change according to the following chart.

Frame Size	Approximate Change in Displacement Per Revolution of Adjusting Screw
042	.21 in^3/Rev (3.4 cc/Rev)
055	.25 in^3/Rev (4.0 cc/Rev)
075	.31 in^3/Rev (5.0 cc/Rev)
100	.37 in^3/Rev (6.0 cc/Rev)
130	.55 in^3/Rev (9.0 cc/Rev)

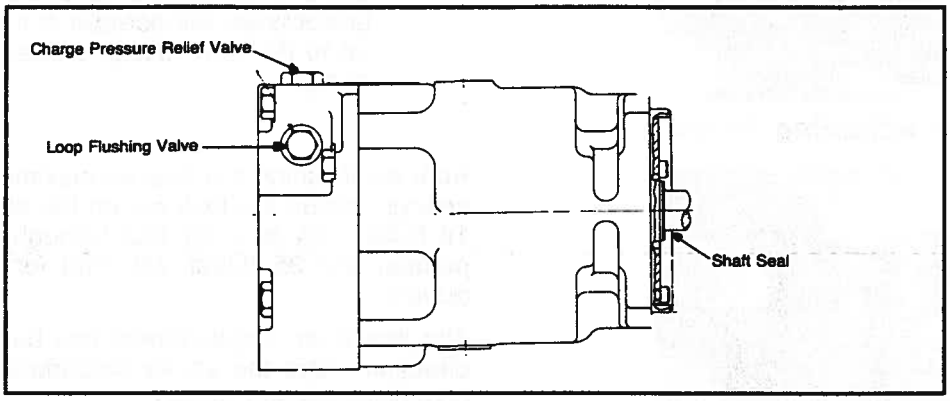
WARNING

Care should be taken in adjusting displacement limiters to avoid undesirable flow or speed conditions. The sealing lock nut must be retorqued after every adjustment to prevent an unexpected change in operating conditions and to prevent external leakage during unit operation.

Minor Repair and Replacement



Variable Displacement Pump



Fixed Displacement Motor

Fig. 56 - Minor Repairs

Minor Repairs may be performed, following the procedures in this section, without voiding the unit warranty. Although specific products are illustrated, these procedures apply to all series and types of units in the Series 90 Family.

General

Cleanliness is a primary means of insuring satisfactory transmission life, on either new or repaired units. Cleaning parts by using a solvent wash and air drying is adequate, providing clean solvent is used. As with any precision equipment, the internal mechanism and related items must be kept free of foreign materials and chemicals.

Protect all exposed sealing surfaces and open cavities from damage and foreign material.

It is recommended that all gaskets and O-rings be replaced. All gasket sealing surfaces must be cleaned prior to installing new gasket. Lightly lubricate all O-rings with clean petroleum jelly prior to assembly.



Fig. 57 - Remove Screws Holding Retainer Plate and Seal Carrier



Fig. 58 - Remove Seal Carrier



Fig. 59 - Press Out Old Seal



Fig. 60 - New Seal Installed in Carrier



Fig. 61 - Install Seal Carrier



Fig. 62 - Torque Retainer Screws

Shaft Seal

Lip type shaft seals are used on the Series 90 pumps and motors. These seals can be replaced without major disassembly of the unit. However, replacement of the shaft seal usually requires removal of the pump or motor from the machine.

Remove the screws holding the retainer plate and seal carrier to the housing, using a 10 mm hex wrench (042 pumps), a 5 mm internal hex wrench (055 through 100 units), or a 6 mm internal hex wrench (130 units). Remove the retainer plate.

NOTE: Certain units use a one piece retainer plate and seal carrier.

After removing the screws, the seal carrier may move out of its bore by approximately 1/4 in. (6 mm). An outward spring force on the shaft will tend to overcome the friction from the O-ring on the seal carrier O.D. If the seal carrier does not move from its bore upon removal of the screws, pry it from its bore as shown and/or lightly tap the end of the shaft with a soft mallet.

NOTE: After the seal carrier is removed, the shaft and bearing assembly may be free in the housing. Do not remove shaft unless unit is positioned with the mounting flange UP. If the unit is positioned horizontally when the shaft is removed, the cylinder block could move out of place, making shaft installation difficult.

Place seal carrier and seal in arbor press and press out old seal.

Inspect the seal carrier, the new seal and the O-ring for any damage or nicks.

Using the arbor press, press the new seal into seal carrier. Be careful not to damage seal.

NOTE: The outside diameter of the seal may be lightly coated with a sealant (such as Loctite High Performance Sealant #59231)prior to installation. This will aid in preventing leaks caused by damage to the seal bore in the seal carrier.

Inspect the sealing area on the shaft for rust, wear, or contamination.

Wrap spline or key end of shaft with plastic film to prevent damage to the sealing lip on the seal during installation.

Prior to assembly, lubricate the O-ring on the O.D. of the seal carrier and the I.D. of the seal with petroleum jelly.

Assemble the seal carrier and seal over the shaft and into the housing bore. Install the retainer plate (if used).

Install the screws and torque to 10 ft.lbsf. (13.5 Nm) for 042 through 100 pumps, 24 ft.lbsf. (32 Nm) for 130 pumps, 7 ft.lbsf. (9.5 Nm) for 055 through 100 motors, and 16.6 ft.lbsf. (22.5 Nm) for 130 motors.

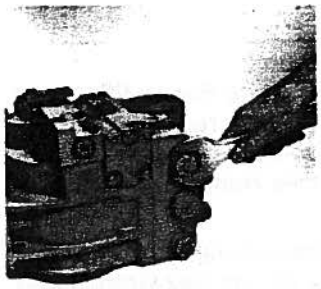


Fig. 63 - Remove Multi-Function Valve Cartridge

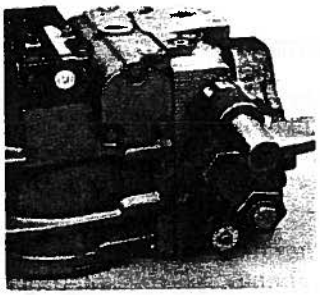


Fig. 64 - Install and Torque Cartridge

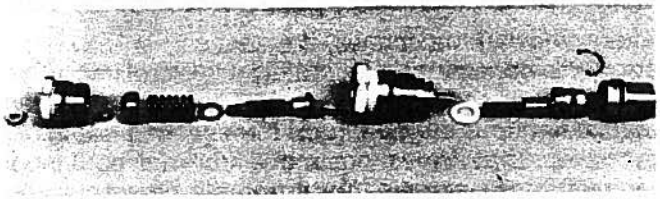


Fig. 65 - Multi-Function Valve Cartridge Components (Earlier Production)

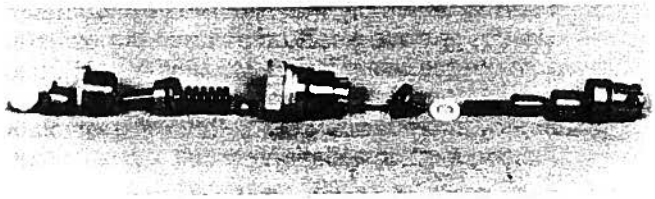


Fig. 66 - Multi-Function Valve Cartridge Components (Later Production)

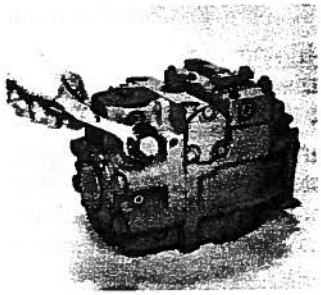


Fig. 67 - Remove Charge Relief Valve (Shim Adjust)

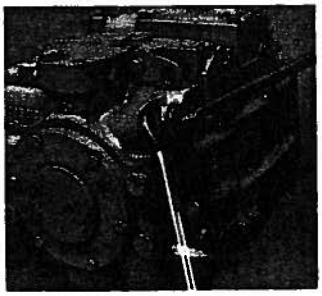


Fig. 68 - Remove Charge Relief Valve (Screw Adjust)



Fig. 69 - Shim Adjustable Charge Relief Valve

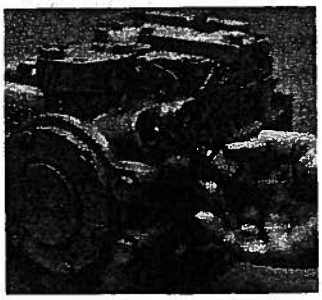


Fig. 70 - Screw Adjustable Charge Relief Valve

Multi-Function Valve Cartridges

The multi-function valve cartridge is removed with a 1-1/4" (042 through 100 pumps) or a 1-5/8" (130 pumps) hex wrench on the largest hex on the cartridge.

Inspect cartridge for damage to parts and O-rings.

Install cartridge in multi-function valve cavity and torque to 66 ft.lbsf. (89 Nm) for 042 through 100 pumps and 206 ft.lbsf. (279 Nm) for 130 pumps.

CAUTION
Do not over-torque the Multi-Function Valve Cartridge.

Charge Pressure Relief Valve (Variable Pump)

Remove the shim adjustable charge relief valve plug with a 1" hex wrench.

Before removing the screw adjustable relief valve plug, mark the plug, lock nut, and housing so as to approximately maintain the original adjustment when assembling. Remove the screw adjustable charge relief valve plug by loosening the lock nut with a 1-1/16" wrench and unscrewing the plug with a large screwdriver.

Remove the spring and relief valve poppet.

Inspect the poppet and mating seat in the end cap for damage or foreign material. When inspecting shim adjustable valves, do not alter the shims or interchange parts with another valve.

Install the poppet and spring. For shim adjustable valves, install the plug and torque to 50 ft.lbsf. (68 Nm). For screw adjustable valves, install the plug with its lock nut, aligning the marks made at disassembly, and torque the lock nut to 38 ft.lbsf. (52 Nm).

Check and adjust, if necessary, the charge pressure.



Fig. 71 - Remove Auxiliary Pad

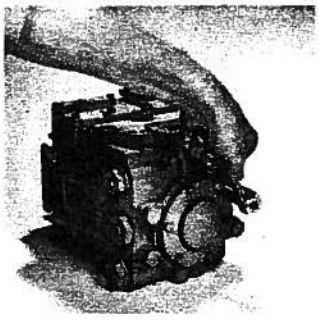


Fig. 72 - Remove Retainer Screws



Fig. 73 - Remove Cover Retainer

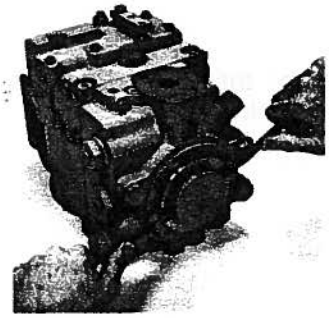


Fig. 74 - Remove Charge Pump Cover

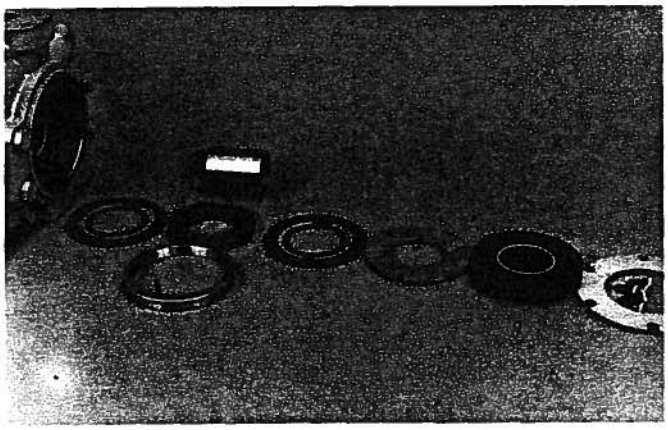


Fig. 75 - Charge Pump Components

Charge Pump

For pumps with an auxiliary mounting pad, remove the four (4) screws holding the auxiliary mounting pad to the end cap and remove auxiliary mounting pad.

Using a 10 mm (042 through 100 pumps) or a 13 mm (130 pumps) hex wrench, remove the six (6) screws holding the charge pump cover retainer.

Remove the retainer and the charge pump cover. For pumps with an auxiliary mounting pad, remove the auxiliary drive coupling.

Remove the charge pump shaft and charge pump drive key.

Remove the spacer plate(s) (which may be present in later production pumps).

Remove the charge pump outer port plate.

Remove the charge pump gerotor assembly.

Remove the outer eccentric ring and alignment pin.

Remove the inner port plate.

Inspect the port plates, gerotor assembly, bushings, and charge pump shaft, for abnormal wear, damage or foreign material.

NOTE: If a different displacement charge pump is being installed, the gerotor assembly, gerotor outer eccentric ring, and inner port plate (earlier production pumps) or outer spacer plate(s) (later production pumps) must be replaced together. If different thickness port plates are included in an earlier production charge pump assembly, the thicker plate is the inner port plate (installed next to the pump end cap).

Prior to installation, apply a small quantity of petroleum jelly to the I.D., O.D., and side faces of the gerotor assembly.

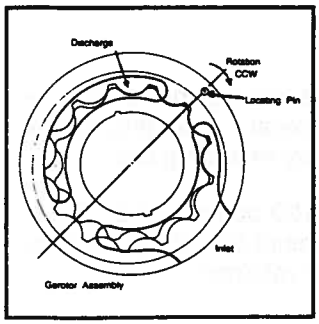


Fig. 76 - Orienting Gerotor Outer Ring and Alignment Pin (CCW Rotation)

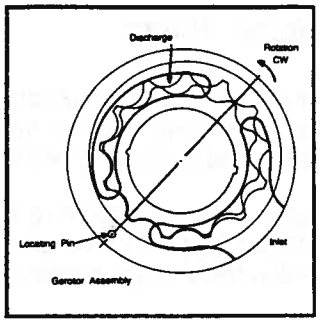


Fig. 77 - Orienting Gerotor Outer Ring and Alignment Pin (CW Rotation)

Note: The charge pump rotation is determined by the orientation of the gerotor assembly outer eccentric ring and the location of the alignment pin in the end cap.

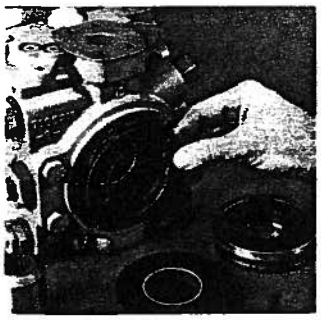


Fig. 78 - Install Inner Port Plate



Fig. 79 - Install Gerotor Assembly Outer Ring

Install the inner port plate and the gerotor assembly outer ring.

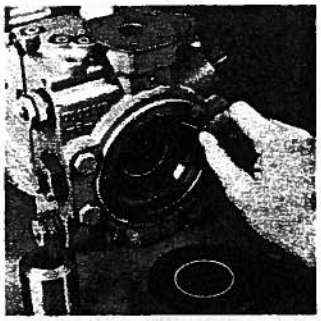


Fig. 80 - Install Alignment Pin

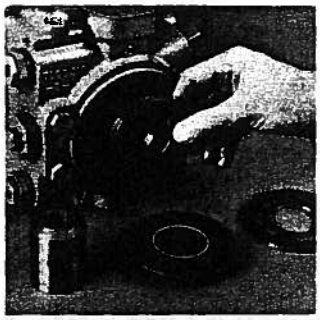


Fig. 81 - Install Gerotor Assembly

Install the alignment pin to properly orientate the port plates and outer eccentric ring for correct pump rotation.

Install the gerotor assembly.

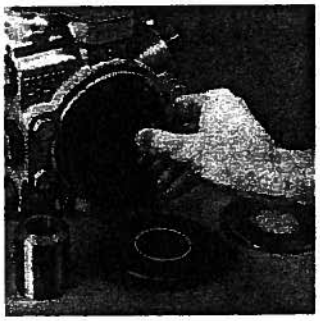


Fig. 82 - Install Outer Port Plate

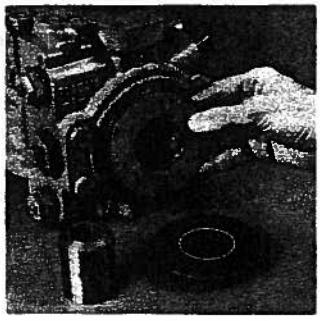


Fig. 83 - Install Spacer Plate

Install the outer port plate.

Install the spacer plate (if used).

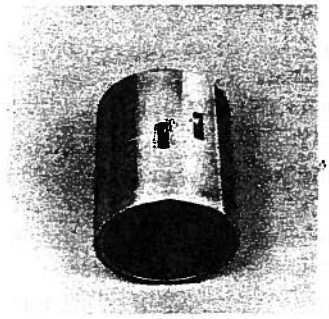


Fig. 84 - Keyway Locations in Charge Pump Shaft (075 and 100)



Fig. 85 - Install Charge Pump Shaft

Install the charge pump drive key into the charge pump shaft.

NOTE: The 75 cc and 100 cc pumps use the same charge pump drive shaft. Two (2) keyways are provided in the drive shaft for the later production charge pumps used in these units. The rear keyway (with identifier groove) is used in 75 cc pumps. The front keyway (closest to the internally splined end of the shaft) is used in 100 cc pumps.

Install the charge pump shaft. The internally splined end of the shaft is installed next to the end cap.

NOTE: The outer diameter of the front (internally splined) end of the earlier production charge pump shafts is chamfered. Earlier production pump end caps may not be machined to accept the current (non-chamfered) shaft. Always use a chamfered end shaft in units with the earlier end cap.

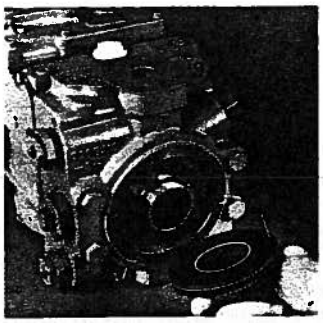


Fig. 86 - Install Aligning Pin in Charge Pump Cover



Fig. 87 - Install Charge Pump Cover

For pumps with an auxiliary mounting pad, install the auxiliary drive coupling.

Carefully remove alignment pin from cavity without disturbing aligned parts. Using petroleum jelly place pin in charge pump cover.

Install charge pump cover with aligning pin into the aligned parts in the cavity, taking caution not to damage the cover O-ring during assembly.

CAUTION

For pumps with an auxiliary mounting pad, the charge pump cover can be installed two (2) ways. Always install cover with small thru hole oriented towards the charge inlet port. Failure to do so will result in loss of charge pressure. Refer to the Auxiliary Pad Installation Instructions for details.

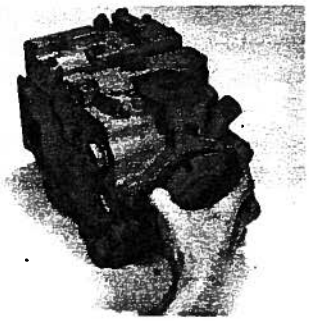


Fig. 88 - Install Cover Retainer

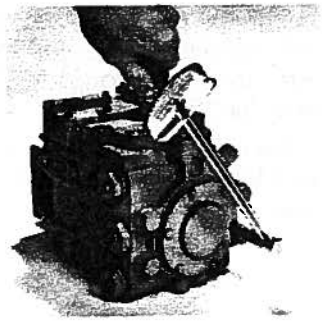


Fig. 89 - Torque Retainer Screws

Install the charge pump cover retainer and the six (6) hex screws and torque the screws to 10 ft.lbsf. (13.5 Nm) for 042 through 100 pumps, and 24 ft.lbsf. (32 Nm) for 130 pumps.

For pumps with auxiliary mounting pads, install the O-ring and auxiliary mounting pad adaptor onto the end cap. Refer to the Auxiliary Pad Installation instructions for details.

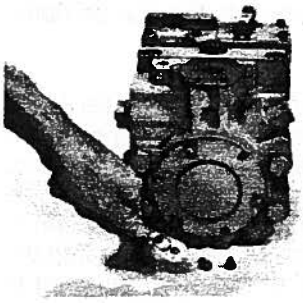


Fig. 90 - Remove Screws and Retainer

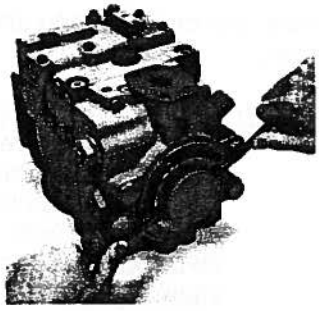


Fig. 91 - Remove Charge Pump Cover

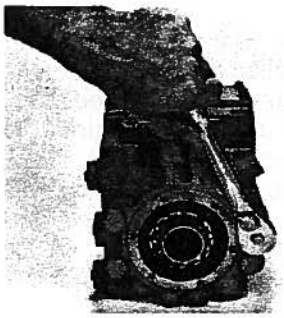


Fig. 92 - Remove Large Screws



Fig. 93 - Install Coupling

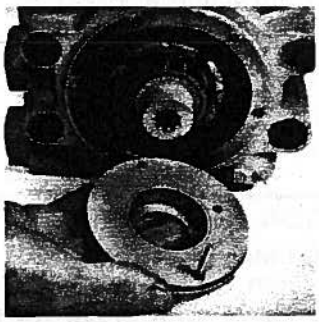


Fig. 94 - Install Alignment Pin in Charge Pump Cover (shown for CCW Rotation)

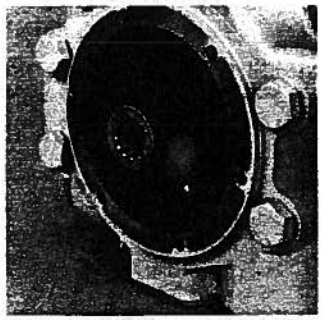


Fig. 95 - Install New Charge Pump Cover



Fig. 96 - Install Screws and Cover Retainer

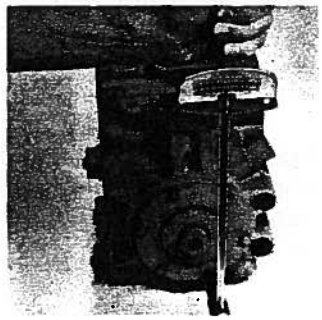


Fig. 97 - Torque Retainer Screws

Auxiliary Pad Installation

The following procedure should be followed when converting a pump which has no auxiliary mounting pad to a pump with an auxiliary mounting pad.

Using a 8 mm internal hex wrench for 042 pumps, a 19 mm hex wrench for 055 pumps, a 24 mm hex wrench for 075 and 100 pumps, or a 14 mm internal hex wrench for 130 pumps, remove the four (4) large screws which fasten the end cap to pump housing.

Using a 10 mm (042 through 100 pumps) or a 13 mm (130 pumps) hex wrench, remove the six (6) screws holding the charge pump cover retainer. Remove the retainer.

Remove the charge pump cover.

Note: The original charge pump cover will not be used when installing the auxiliary pad.

Install the auxiliary drive coupling onto the pump drive shaft spline (small outer diameter of coupling must be toward rear of pump).

Remove alignment pin from valve plate in cavity. Place pin in correct hole in the new charge pump cover. Use petroleum jelly to hold pin in place.

CAUTION

The charge pump cover can be installed two (2) ways. Always install cover with small thru hole oriented towards the charge inlet port. Failure to do so will result in loss of charge pressure.

Install new charge pump cover (with hole for auxiliary shaft) and O-ring in end cap cavity, aligning pin to hole in valve plate.

Install the charge pump cover retainer and the six (6) hex screws and torque the screws to 10 ft.lbsf. (13.5 Nm) for 042 through 100 pumps, and 24 ft.lbsf. (32 Nm) for 130 pumps.

Take care to assure the surfaces are clean and free of any foreign material prior to assembly of the mounting pad.

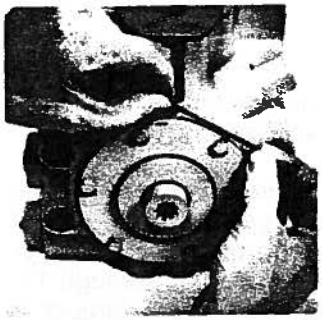


Fig. 98 - Install O-Ring on End Cap Pilot



Fig. 99 - Install Auxiliary Pad Adapter

Install O-ring on end cap pilot.

Install the auxiliary mounting pad adaptor on external pilot on rear of end cap.



Fig. 100 - Install Auxiliary Pad Adapter Screws



Fig. 101 - Torque Pad Adapter Screws

Position mounting pad and install four (4) new large screws (and washers, if used) through mounting pad adaptor and end cap into the housing. Torque per table below.

Frame Size	Wrench Size (Internal Hex)	Installation Torque ft.lbsf.	Nm
042	8 mm	55	75
055	10 mm	90	122
075	14 mm	189	256
100	14 mm	220	298
130	14 mm	220	298

Install the O-ring and flange cover or auxiliary pump.



Fig. 102 - Pump with Auxiliary Mounting Pad



Fig. 103 - Install Pad Cover O-Ring



Fig. 104 - Install Auxiliary Pad Cover



Fig. 105 - Auxiliary Mounting Pad Parts

Auxiliary Pad Conversion

To convert an auxiliary mounting pad to a different size mounting pad, use the above procedure with the following additions:

In addition to removing the charge pump cover retainer and the charge pump cover, remove the old auxiliary drive coupling.

In addition to removing the four (4) large end cap retaining screws, remove the old auxiliary mounting pad adapter.

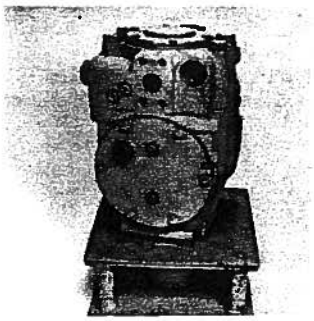


Fig. 106 - Charge Pump Inlet



Fig. 107 - Fitting with Gauge Port (Suction Filtration)

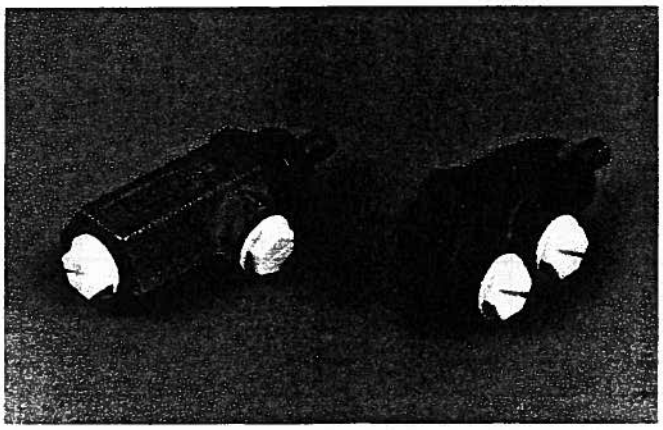


Fig. 108 - Remote Pressure Filtration Manifolds

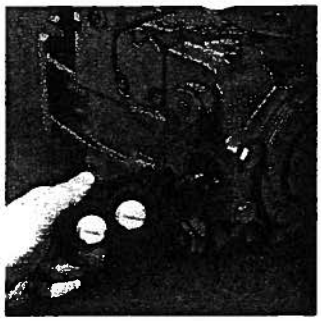


Fig. 109 - Install Remote Pressure Filter Manifold into End Cap



Fig. 110 - Tighten Remote Pressure Filter Manifold Lock Nut

Filtration Options

Suction Filtration

Install the hydraulic fitting to connect the external suction filter to the charge pump inlet port.

The reducer fitting (with charge pressure gauge port) is torqued to 120 ft.lbsf. (165 Nm) using a 1-1/4" wrench on 042 frame size pumps, or torqued to 140 ft.lbsf. (190 Nm) using a 1-1/2" wrench on 055 through 130 frame size pumps. The gauge port plug is torqued to 20 ft.lbsf. (27 Nm).

Remote Charge Pressure Filtration (Option)

The following procedures are required to install the remote charge pressure filter manifold.

Remove the reducer fitting, located at charge pressure gauge port, from pump end cap. (This part will not be used with the remote charge pressure filter option).

Install the filter manifold into the port on the side of the housing. The hydraulic tube should enter its mating bore in the pump end cap with a low force.

Rotate filter manifold clockwise between 6 and 7 revolutions after the filter manifold threads engage the threads in the end cap.

Note: Failure to install the filter manifold to a sufficient depth in the end cap will result in insufficient engagement of the tube in the end cap bore. This may allow unfiltered oil to bypass the filter and enter the charge system.

After the filter manifold is installed to the proper depth, rotate the manifold to the desired position.

While holding the filter manifold in the desired position, use a 1-3/8" open end wrench to tighten the swivel lock nut to 52 ft.lbsf. (70 Nm) on 042 frame size pumps, or a 1-5/8" open end wrench to tighten the swivel lock nut to 90 ft.lbsf. (122 Nm) on 055 through 130 frame size pumps.

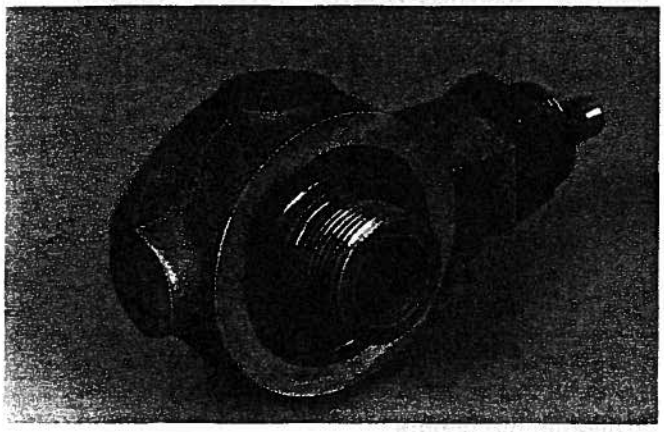


Fig. 111 - Integral Pressure Filter Head Assembly

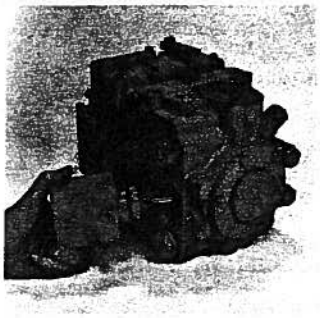


Fig. 112 - Install Integral Pressure Filter Head into End Cap

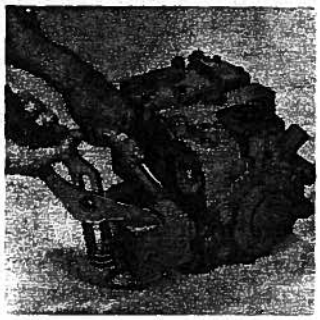


Fig. 113 - Tighten Integral Pressure Filter Head Lock Nut

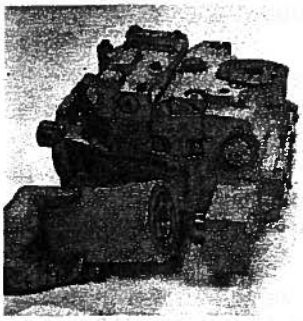


Fig. 114 - Install Filter Canister



Fig. 115 - Pump with Pressure Filter Installed

Integral Charge Pressure Filtration (Option)

The following procedures are required to install the integral charge pressure filter assembly.

Remove the reducer fitting, located at the charge pressure gauge port, from pump end cap. (This part will not be used with the integral charge pressure filter assembly).

Install the filter assembly into the port on the side of the housing. The hydraulic tube should enter its mating bore in the pump end cap with a low force.

Rotate filter head clockwise between 6 and 7 revolutions after the filter head threads engage the threads in the end cap.

Note: Failure to install the filter head to a sufficient depth in the end cap will result in insufficient engagement of the tube in the end cap bore. This may allow unfiltered oil to bypass the filter and enter the charge system.

After the filter head assembly is installed to the proper depth, rotate the assembly to the desired position.

While holding the filter head in the desired position, use a 1-3/8" open end wrench to tighten the swivel lock nut to 52 ft.lbsf. (70 Nm) on 042 frame size pumps, or a 1-5/8" open end wrench to tighten the swivel lock nut to 90 ft.lbsf. (122 Nm) on 055 through 130 frame size pumps.

After installing the filter head assembly, install the filter canister per the instructions on filter canister.

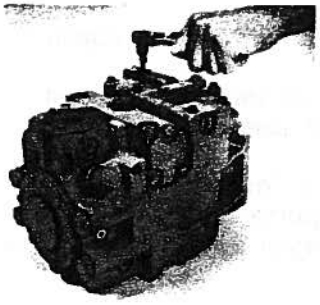


Fig. 116 - Remove Mounting Screws



Fig. 117 - Remove Control



Fig. 118 - Inner Face of Control

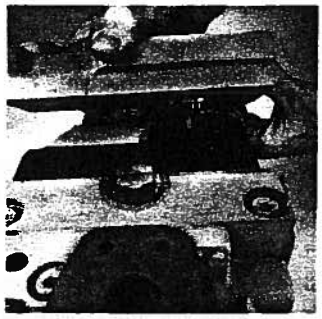


Fig. 119 - Assemble Control to Linkage

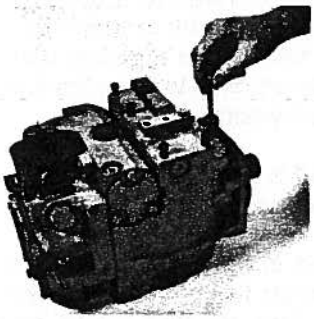


Fig. 120 - Assemble Control to Pump



Fig. 121 - Torque Mounting Screws

Manual Displacement Control (MDC)

Thoroughly clean external surfaces prior to removal of control.

Using a 5 mm internal hex wrench, remove the eight (8) control mounting screws. Remove the control and gasket from housing.

CAUTION
Protect exposed surfaces and cavities from damage and foreign material.

In preparation for installing the control, place a new gasket on the housing. Inspect to assure that the control orifice check valve and spring are in their proper position in the control.

Engage the pin on the control linkage in the mating hole in the link attached to the swashplate.

Set control into place and move control lever both directions to check proper engagement of control linkage pin. Proper engagement will be indicated by centering torque as the lever is moved from center. Non-engagement of control linkage pin is indicated by lack of centering torque as the lever is moved. In case of non-engagement remove the control and repeat the above procedure.

Move the control into place against the pump housing, align the gasket, and install the screws.

NOTE: For 042 pumps, the rear / center control mounting screw installs into a "thru" hole, and has a sealing washer installed under its head.

Torque the screws to 12 ft.lbsf. (16 Nm).

NOTE: If the control being removed or replaced is equipped with a neutral start switch, refer to the "Neutral Start Switch Removal and Installation" instructions in the Component Adjustment section.

Solenoid Override Valve for MDC (Option)

Thoroughly clean external surfaces prior to removal of valve.

Using a 5 mm internal hex wrench, remove the two (2) screws and remove solenoid manifold from housing. Remove the old gasket.

The solenoid may be removed from the valve by removing the nut with a 3/4" hex wrench. The solenoid valve may be removed from the manifold with a 7/8" hex wrench.

When installing the solenoid valve into the manifold, the valve should be torqued to 13.8 ft.lbsf. (18.6 Nm). When installing the solenoid onto the valve, torque the nut to 25 in.lbsf. (2.8 Nm).

In preparation for installing the solenoid manifold, place a new gasket on the control housing. Install the manifold onto the control housing, align the gasket, and install the screws. Torque screws to 10 ft.lbsf. (13.5 Nm).



Fig. 122 - Remove Mounting Screws

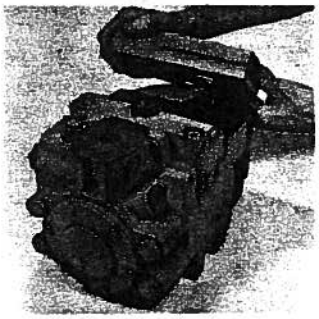


Fig. 123 - Remove Control



Fig. 124 - Inner Face of Control

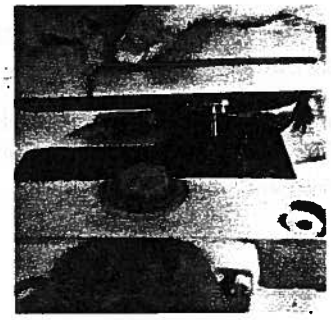


Fig. 125 - Assemble Control to Linkage



Fig. 126 - Assemble Control to Pump



Fig. 127 - Torque Mounting Screws

Hydraulic and Electric Displacement Control (HDC and EDC)

Thoroughly clean external surfaces prior to removal of control.

Using a 5 mm internal hex wrench, remove screws and lift control away from housing.

CAUTION
Protect exposed surfaces and cavities from damage and foreign material.

In preparation for installing the control, place new gasket on the housing. Inspect to assure that the control orifice and spring are in the proper position in the control.

Engage the pin on the control linkage in the mating hole in the link attached to the swashplate.

Move control back and forth to check engagement of pin in the link. Proper engagement will be indicated by an increasing spring force as the control is moved away from center position. Non-engagement of pin will be indicated by lack of spring force. In case of non-engagement, remove control and repeat the above procedure.

Position the control in place on the pump housing, align the gasket, and install the screws.

NOTE: For 042 pumps, the rear / center control mounting screw installs into a "thru" hole, and has a sealing washer installed under its head.

Torque the screws to 12 ft.lbsf. (16 Nm).

Displacement Control Filter Screens

If the pump is equipped with control filter screens in the pump housing, they should be pressed into position (with the rounded edge of the filter screens facing the control) until they are flush to 0.08 in. (2.0 mm) below the surface of the housing.

Displacement Control Adapter Plate (130 Pumps Only)

The screws retaining the control adapter plate to the housing may be removed with a 6 mm internal hex wrench.

When installing the adapter plate, ensure the O-rings are in the proper position and torque the screws to 24 ft.lbsf. (32 Nm).

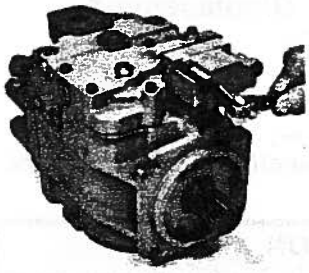


Fig. 128 - Remove PCP Mounting Screws

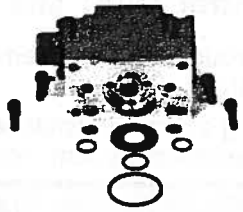


Fig. 129 - PCP Components

Electric Displacement Control PCP (Pressure Control Pilot)

Thoroughly clean external surfaces of control.

Using a 4 mm internal hex wrench, remove the four (4) screws and remove the PCP.

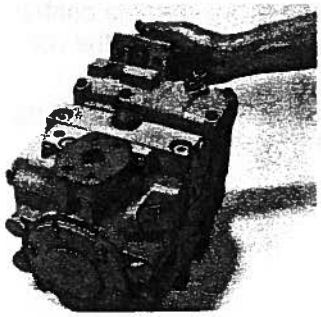


Fig. 130 - Install PCP onto Control



Fig. 131 - Torque PCP Valve Screws

Check surfaces for nicks or damage. Clean internal screens.

Install new O-rings in PCP Housing. Place PCP against EDC housing and install the screws. Torque to 48 in.lbsf. (5.4 Nm).



Fig. 132 - Remove Spring Retainer

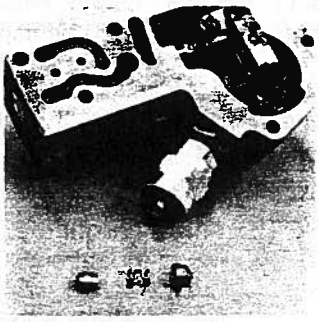


Fig. 133 - Orifice Check Valve Components

Orifice Check Valve

Remove the control assembly as described in the instructions for the specific control.

The orifice check valve is located at the surface of the pump housing face, in the control assembly. Remove the spring retainer and spring from the orifice check valve cavity and then remove the orifice check valve.



Fig. 134 - Orifice Check Valve Installed

Install the desired orifice check valve in the cavity and then install the spring and spring retainer to hold orifice check valve in position.

Assemble the control onto the pump. Refer to the instructions for the specific control.

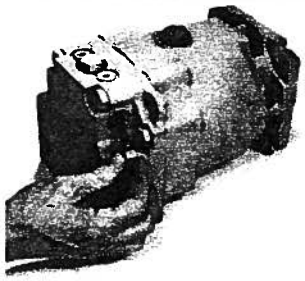


Fig. 135 - Remove Plugs, Springs and Washers



Fig. 136 - Remove Shuttle Spool

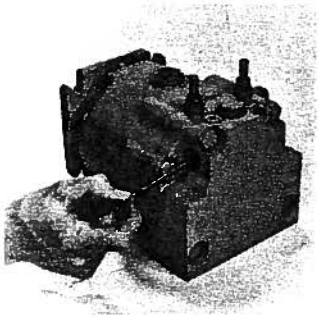


Fig. 137 - Install Flushing Valve Shuttle Spool



Fig. 138 - Install Washers, Springs, and Plugs, and Torque Plugs



Fig. 139 - Remove Charge Relief Valve (Shim Adjust)

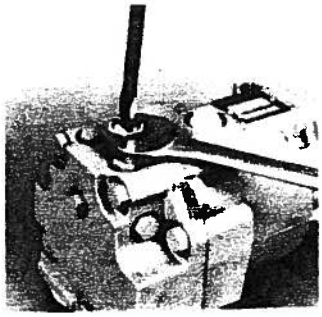


Fig. 140 - Remove Charge Relief Valve (Screw Adjust)

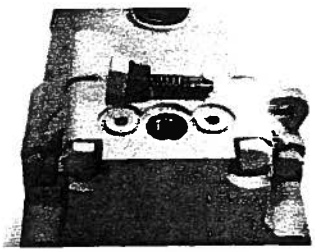


Fig. 141 - Shim Adjustable Charge Relief Valve

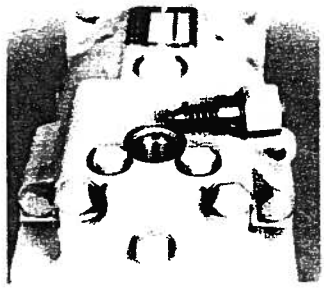


Fig. 142 - Screw Adjustable Charge Relief Valve

Loop Flushing Valve (Fixed Motors)

Using an 11/16" wrench, remove hex plugs from both sides of valve.

Remove springs, washers, and flushing valve shuttle spool. Note orientation of washers.

Remove flushing valve spool.

Inspect parts for damage or foreign material.

NOTE: Earlier production motors used a 1/4" (6.4 mm) nominal diameter shuttle valve spool. Later motors use a 3/8" (9.5 mm) diameter spool.

Install flushing valve spool in end cap, then install the washers (the step on the washers should face out, toward the springs) and springs on each end of the spool. Install the hex plugs and torque to 30 ft.lbsf. (41 Nm) on 055 through 100 motors, or 50 ft.lbsf. (68 Nm) on 130 motors.

Defeating Loop Flushing Valve

Remove loop flushing valve per above instructions (these parts will not be used).

Install defeating spool into spool bore in end cap. Install hex plugs provided and torque to 30 ft.lbsf. (41 Nm) on 055 through 100 motors, or 50 ft.lbsf. (68 Nm) on 130 motors.

Remove charge relief valve (these parts are not necessary). Replace with hex plug provided and torque to 30 ft.lbsf. (41 Nm) on 055 through 100 motors, or 50 ft.lbsf. (68 Nm) on 130 motors.

Charge Pressure Relief Valve (Fixed Motor)

Remove the shim adjustable charge relief valve plug with a 7/8" hex wrench.

Before removing the screw adjustable relief valve plug, mark the plug, lock nut, and housing so as to approximately maintain the original adjustment when assembling. Remove the screw adjustable charge relief valve plug by loosening the lock nut (with a 1-1/16" hex wrench for 042 through 100 units, or a 1-5/8" hex wrench for 130 units), and unscrewing the plug with a large screwdriver.

Remove the spring and relief valve poppet.

Inspect the poppet and mating seat in the end cap for damage or foreign material. When inspecting shim adjustable valves, do not alter the shims or interchange parts with another valve.

Install the poppet and spring. For shim adjustable valves, install the plug and torque to 50 ft.lbsf. (68 Nm). For screw adjustable valves, install the plug with its lock nut, aligning the marks made at disassembly, and torque the lock nut to 38 ft.lbsf. (52 Nm).

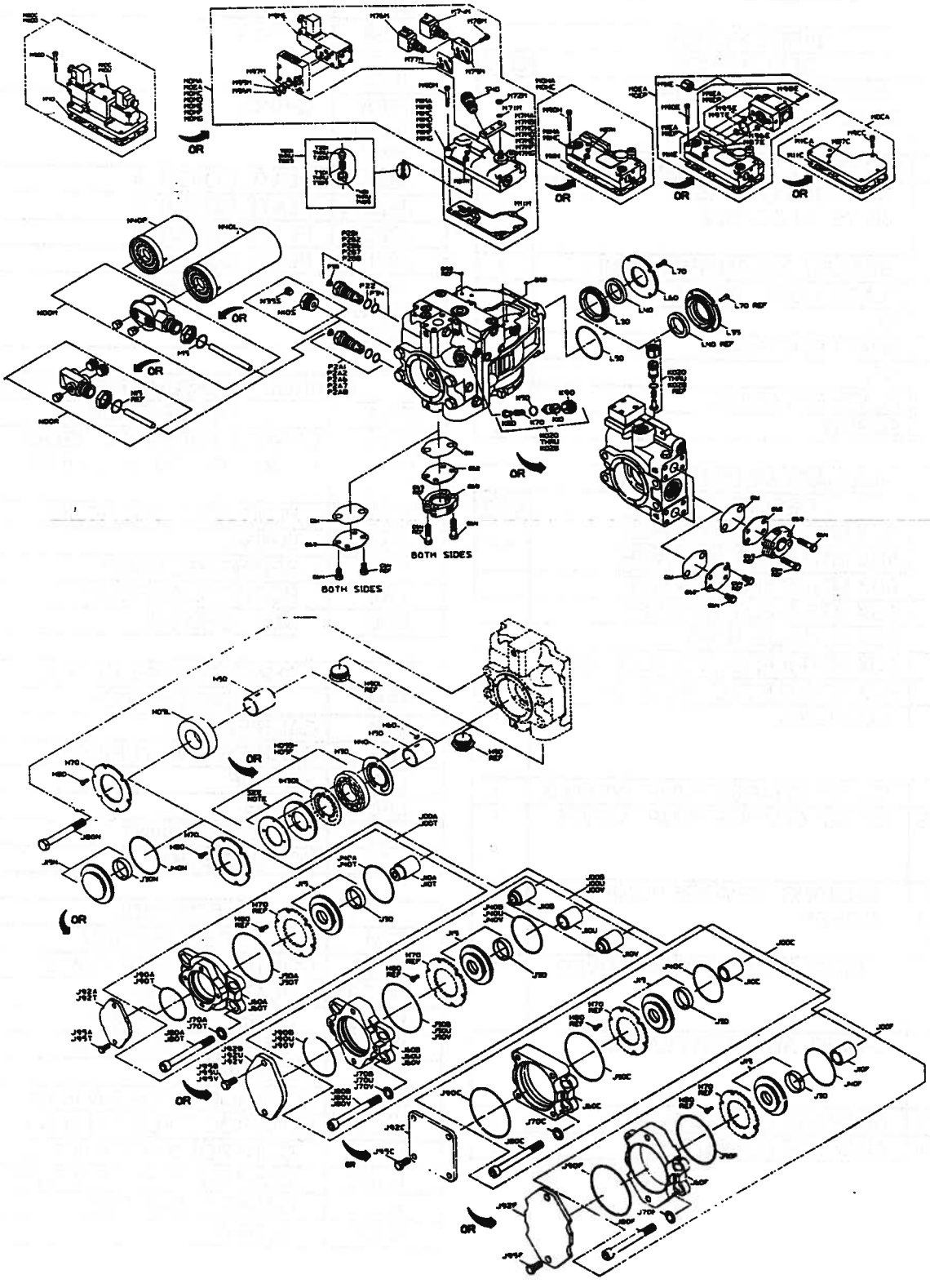
Check and adjust, if necessary, the charge pressure.

Notes

General Parts Identification

The following information is for general parts identification ONLY. Refer to the applicable Service Parts List when ordering service parts.

Series 90 Variable Displacement Pump (Minor Repair)



Series 90 Variable Displacement Pump (Minor Repair)

END CAP (PORT COVERS)		
ITEM	DESCRIPTION	QTY
G61	GASKET - SHIPPING	2
G62	COVER, PORT - SHIPPING	2
G63	CLAMP, SPLIT 1" (CODE 61)	4
G64	SCREW, HEX HEAD (SHIPPING)	4

CHARGE SYSTEM		
ITEM	DESCRIPTION	QTY
H00B THRU H00G	CHARGE PUMP - 11, 14, 17, 20, 26, 34 CC/REV	
H00L	EXTERNAL (NO CHARGE PUMP)	
H05B THRU H05G	CHARGE PUMP ASSY - 11, 14, 17, 20, 26, 34 CC/REV	1
H05L	SPACER (NO CHARGE PUMP)	1
H30	PLATE, PORT - INNER (THIN)	1
H40	PIN	1
H50	SHAFT CHG PUMP	1
H60	KEY	1
H70	PLATE RETAINING	1
H80	SCREW	6

AUXILIARY MOUNTING PAD		
ITEM	DESCRIPTION	QTY
J00A	AUX MTG A FLG, W/COVER	
J00B	AUX MTG B FLG, W/COVER	
J00C	AUX MTG C FLG, W/COVER	
J00D	AUX MTG D FLG, W/COVER	
J00N	AUX MTG FLG- NONE	
J00T	AUX MTG A FLG (11T), W/COVER	
J00V	AUX MTG B-B FLG, W/COVER	
J10A THRU J10V	COUPLING	1
J15N	COVER CHARGE PUMP- W/O AUX	1
J15A/B /C/D /T/V	COVER CHARGE PUMP - W/AUX	1
J30A THRU J30V	BUSHING - CHARGE PUMP COVER	1
J40A THRU J40V	O-RING, CHARGE PUMP COVER	1
J50A THRU J50V	O-RING, ADAPTOR FLANGE	1
J60A/T	ADAPTOR FLANGE A	1
J60B/V	ADAPTOR FLANGE B	1

AUXILIARY MOUNTING PAD (CON'T)		
ITEM	DESCRIPTION	QTY
J60C	ADAPTOR FLANGE C	1
J60D	ADAPTOR FLANGE D	1
J70A THRU J70V	WASHER	4
J80A THRU J80V	SCREW	4
J90A THRU J90V	O-RING	1
J92A/T	PLATE COVER A	1
J92B/V	PLATE COVER B	1
J92C	PLATE COVER C	1
J92D	PLATE COVER D	1
J95A THRU J95V	SCREW HEX HD	2/4

CHARGE PRESSURE REGULATION		
ITEM	DESCRIPTION	QTY
K020 THRU K028	CHARGE PRESSURE RELIEF VALVE - PV - 20, 24, 28 BAR	
K10	PLUG ASSY CHG RELIEF	1
K50	O-RING	1
K70	SPRING HEL COMP	1
K80	POPPET CHG RELIEF	1
K90	NUT - SPECIAL	1

SHAFT CONFIGURATION		
ITEM	DESCRIPTION	QTY
L30	CARRIER SEAL	1
L35	CARRIER SEAL (1 PIECE)	1
L40	SEAL LIP	1
L50	O-RING	1
L60	PLATE RETAINING	1
L70	SCREW METRIC	3

CONTROL		
ITEM	DESCRIPTION	QTY
M0CA	CONTROL-COVER PLATE	
M1CA	PLATE - COVER	1
M11C	GASKET - CONTROL	1
M87C	WASHER - SEAL (042)	1
M90C	SCREW	6
M0DC	CONTROL- 3 POS F-N-R 12V	
M0DD	CONTROL- 3 POS F-N-R 24V	
M1DC	CONTROL 3 POS F-N-R 12V	1
M1DD	CONTROL 3 POS F-N-R 24V	1
M11D	GASKET - CONTROL	1
M90D	SCREW	6

Series 90 Variable Displacement Pump (Minor Repair)

CONTROL (CON'T)		
ITEM	DESCRIPTION	QTY
M0EA	CONTROL- EDC (MS)	
M0EP	CONTROL- EDC (PACKARD)	
M1EA	CONTROL EDC (MS)	1
M1EP	CONTROL EDC (PACKARD)	1
M11E	GASKET - CONTROL	1
M87E	WASHER - SEAL (042)	1
M90E	SCREW	6
M9EA	P C P VALVE (MS)	1
M9EP	P C P VALVE (PACKARD)	1
M91E	CAP - PLASTIC (MS)	1
M95E	O-RING	2
M96E	O-RING	1
M97E	O-RING	1
M98E	SCREW	4
M0HA	CONTROL- HDC	
M1HA	CONTROL HDC	1
M11H	GASKET - CONTROL	1
M87H	WASHER - SEAL (042)	1
M90H	SCREW	6
M0MA	CONTROL- MDC W/O NSS	
M0MB	CONTROL- MDC W/NSS	
M0MC	CONTROL- MDC W/SOL W/O NSS	
M0MD	CONTROL- MDC W/SOL W/NSS	
M0ME	CONTROL- MDC W/2 POS SOL VL	
M0MF	CONTROL- MDC W/SOL2 W/O NSS	
M0MG	CONTROL- MDC W/SOL2 W/NSS	
M1MA	CONTROL MANUAL	1
M1MB	CONTROL MDC W/NSS	1
M1MC	CONTROL MDC W/SOL	1
M1MD	CONTROL MDC W/SOL & NSS	1
M1ME	CONTROL MDC W/2 POS SOL VL	1
M1MF	CONTROL MDC W/SOL2	1
M1MG	CONTROL MDC W/SOL2 & NSS	1
M7MA THRU M7MG	HANDLE CONTROL SHAFT	1
M9ME	2 POSITION SOLENOID VALVE	1
M11M	GASKET - CONTROL	1
M71M	WASHER	1
M72M	NUT HEX	1
M74M	SOL VLV - OVERRIDE (1 POLE)	1
M75M	MANIFOLD - OVERRIDE VALVE	1
M76M	SOL VLV - OVERRIDE (2 POLE)	1
M77M	GASKET - OVERRIDE MANIFOLD	1
M78M	SCREW - OVERRIDE MANIFOLD	2
M87M	WASHER - SEAL (042)	1

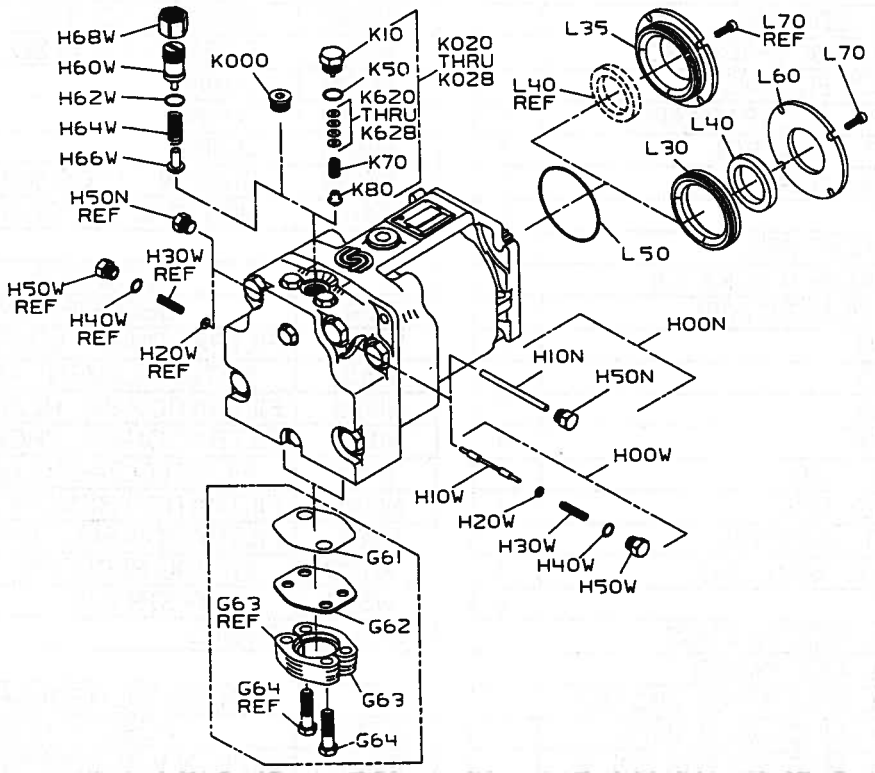
CONTROL (CON'T)		
ITEM	DESCRIPTION	QTY
M90M	SCREW - CONTROL	6
M92M	SCREW - 2 POS SOL VL	4
M95M	O-RING	1
M96M	O-RING	1
M97M	O-RING	1
M98M	SCREW - 2 POS SOL VL PLATE	4
S40	NEUTRAL SWITCH KIT	1

FILTRATION		
ITEM	DESCRIPTION	QTY
N00L	FILTRATION-INT, LONG FILTER	
N40L	FILTER ELEMENT ASSY LONG	1
N00M	FILTRATION-INT, HEAD ONLY	
N00P	FILTRATION-INT, SHORT FILTER	
N40P	FILTER ELEMENT ASSY SHORT	1
N00R	FILTRATION-REMOTE MANIFOLD	
N00S	FILTRATION-SUCTION	
N10S	FITTING REDUCER	1
N35S	PLUG STR THD	1
N15	O-RING	1

PRESSURE REGULATION		
ITEM	DESCRIPTION	QTY
P001	M-FCTN V-PL W/HPRV PORT A/B	
P2A1 THRU P2A8	M-FCTN VALVE ASSY PORT A	
P2B1 THRU P2B8	M-FCTN VALVE ASSY PORT B	
P22	O-RING	2
P30	PLUG PLASTIC	2
P34	O-RING	2

CONTROL ORIFICE		
ITEM	DESCRIPTION	QTY
T002 THRU T009	CONTROL ORIFICE	
T202 THRU T209	VALVE, ORIFICED CHECK	1
T302 THRU T309	SPRING	1
T402 THRU T409	RETAINER, SPRING	1

Series 90 Fixed Displacement Motor (Minor Repair)



END CAP (PORT COVERS)		
ITEM	DESCRIPTION	QTY
G61	GASKET - SHIPPING	2
G62	COVER, PORT - SHIPPING	2
G63	CLAMP, SPLIT 1" (CODE 61)	4
G64	SCREW, HEX HEAD (SHIPPING)	4

CHARGE SYSTEM		
ITEM	DESCRIPTION	QTY
H00N	VALVING - MF, LOOP FL DEFEAT	
H10N	SPOOL - LOOP FL DEFEATED	1
H50N	PLUG, STR THD	2
H60N	PLUG, CPRV - LP FL DEFEAT	1
H00W	VALVING -MF, LOOP FLUSHING	
H10W	SPOOL LOOP FLUSH VALVE	1
H20W	WASHER SPECIAL	2
H30W	SPRING	2
H40W	O-RING	2
H50W	PLUG SPECIAL	2
H60W	PLUG ASSY - ADJ CPRV-MF	1
H62W	O-RING	1
H64W	SPRING HEL COMP	1
H66W	POPPET CHG RELIEF	1
H68W	NUT - SPECIAL	1

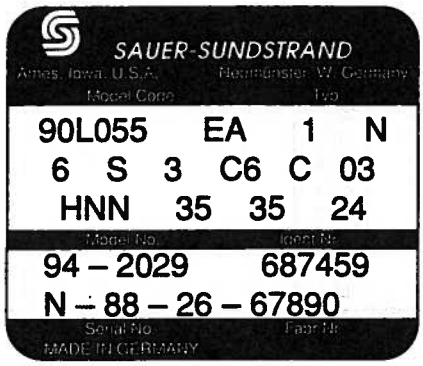
CHARGE PRESSURE REGULATION		
ITEM	DESCRIPTION	QTY
K000	CPRV-MF, LP FL DEFEAT	
K100	CPRV-MF, LP FL DEFEAT PLUG	1
K010 THRU K028	CHARGE PRESSURE RELIEF VALVE (SHIM ADJUST) - MF - 10, 20, 24, 28 BAR	
K10	PLUG ASSY CHG RELIEF	1
K50	O-RING	1
K610 THRU K628	SHIM CHARGE RELIEF - 10, 20, 24, 28 BAR	1
K70	SPRING HEL COMP	1
K80	POPPET CHG RELIEF	1

SHAFT CONFIGURATION		
ITEM	DESCRIPTION	QTY
L30	CARRIER, SEAL	1
L35	CARRIER, SEAL (1 PIECE)	1
L40	SEAL LIP	1
L50	O-RING	1
L60	PLATE RETAINING	1
L70	SCREW METRIC	3

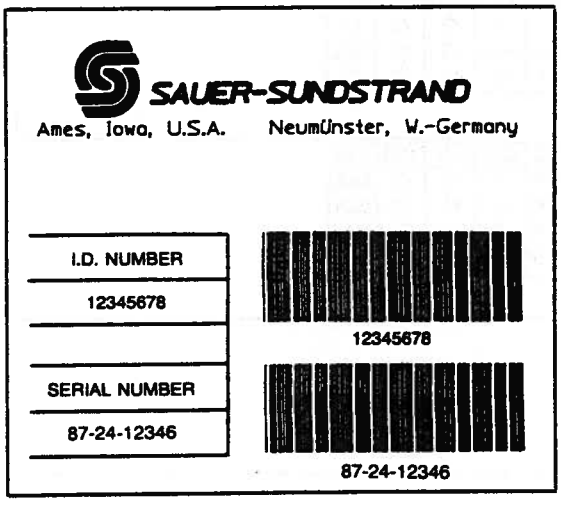
Unit Identification



Name Plate (U.S.A. Production)



Name Plate (West German Production)



Bar Coding - Tag

Name Plate

Each Series 90 pump and motor will have a name plate affixed to the housing. The name plate will include the following information:

Model (Identification) Number
The Model Number is used by the factory in manufacturing. On repeat orders, a complete unit can be ordered by the Model Number. The Model Number is cross referenced to the specific Model Code (Nomenclature) for the unit.

Model Code
The Model Code for the Series 90 pumps and motors is defined on the following pages. The Model Code completely defines the specific unit and must be used when ordering the complete unit for the first time or for ordering parts to service the product.

Serial Number
The Serial Number is used to identify the manufacturing (assembly) location, the build date, and the unit sequence in the build. The Serial Number is also used to identify the unit's warranty time period, and MUST be referenced when ordering service parts.

A "Manufacturing Location" letter code was added to the Serial Number during 1988. This code indicates the location of original manufacture (assembly). "A" indicates the unit was originally assembled in Ames, Iowa, U.S.A. "N" indicates the unit was originally assembled in Neumünster, West Germany.

NOTE: Since design configuration changes (such as product improvements) may be implemented at different manufacturing locations at different times, the Manufacturing Location code must be used with the Serial Number Date Code to identify a particular unit when ordering service parts.

The first four (4) digits in the Serial Number indicate the Build Date Code. The first number (2 digits) indicates the year of manufacture. The second number (2 digits) indicates the calendar week of manufacture. For example, "88-26" indicates a unit which was manufactured in the twenty sixth calendar week of the year 1988.

The final five (5) digits in the Serial Number represent a sequential number used to identify a specific unit.

Bar Coding - Tag

A Universal Bar Code, representing the Identification Number and the Serial Number, will also be affixed to later production units so these items can be read electronically.

Model Code

Series 90 Variable Displacement Pump — PV

9	0	R					M	P	J	G	N	F

PRODUCT OR SERIES
90 = Series 90, Closed Circuit

R: TYPE AND ROTATION
L = Pump, Left Hand (CCW)
R = Pump, Right Hand (CW)

DISPLACEMENT

042 = 42 cc/rev (2.56 in³/rev)
055 = 55 cc/rev (3.35 in³/rev)
075 = 75 cc/rev (4.57 in³/rev)
100 = 100 cc/rev (6.10 in³/rev)
130 = 130 cc/rev (7.93 in³/rev)

M: CONTROL

	042 - 100	130
CA = Cover Plate	OPT	N/A
DC = 3 Position (F-N-R) Solenoid - 12V DC	OPT	N/A
MA = Manual Displacement (MDC)	STD	STD
MB = Manual Displ (MDC) w/Neutral Start (NS)	OPT	OPT
MC = Manual Displ (MDC) w/DC Sol Override - 12 V DC	OPT	N/A
MD = Manual Displ (MDC) w/NS and DC Sol Override	OPT	N/A
HA = Hydraulic Displ (HDC)(1 - 11 BAR)	OPT	OPT
HC = Hydraulic Displ(HDC)(3 - 11 BAR)	OPT	N/A
EA = Electrical Displ (EDC) w/MS Connector	OPT	OPT
EP = Electrical Displ (EDC) w/Packard Connector	OPT	N/A

NOTE: MC and MD Controls require .018, .022, or .026 in. Dia. Control Orifice

P: PRESSURE REGULATION
1 = Pressure Limiter (PL) Range 1 (140-420 BAR) in Port A & B (Standard)
2 = High Pressure Relief Valves (HPRL) in Port A & B - No PL

6 = Pressure Limiter (PL) Range 2 (450-520 BAR) in Port A & B

J: AUXILIARY MOUNTING PAD

	042	055	075	100	130
A = SAE A w/Sealed Cover	O	O	O	O	O
B = SAE B w/Sealed Cover	O	O	O	O	O
C = SAE C w/Sealed Cover	N/A	O	O	O	O
D = SAE D w/Sealed Cover	N/A	N/A	N/A	N/A	O
N = No Auxilary Pad	STD	STD	STD	STD	STD
T = SAE A w/Sealed Cover, 11T Shaft	O	O	O	O	O
U = SAE B w/Sealed Cover, 19 T Shaft	N/A	N/A	O	O	N/A
V = SAE B-B w/Sealed Cover	O	O	O	O	O

G: END CAP PORTS (SAE J518c Code 62)

	042	055	075	100	130
1 = Twin Ports w/Special Code 61 Flange Halves*	N/A	O	O	O	N/A
2 = Side Ports w/Special Code 61 Flange Halves*	N/A	O	O	O	N/A
6 = Side Ports	N/A	O	O	O	N/A
8 = Twin Ports	STD	O	O	O	STD

N: FILTRATION
S = Suction (Standard)
R = Remote Pressure
P = Pressure Integral (Short Filter)
L = Pressure Integral (Long Filter)

F: DISPLACEMENT LIMIITATION
3 = No Limiters (Standard)
4 = Limitation Both Sides (Factory set at maximum displacement)

Series 90 Variable Displacement Pump (PV)

L H T W V Z K

K: CHARGE PRESSURE SETTING**
18 = 18 BAR (260 PSI)
20 = 20 BAR (290 PSI)
24 = 24 BAR (350 PSI)
28 = 28 BAR (400 PSI)

Z: HIGH PRESSURE SETTING PORT B**
14 = 140 BAR (2030 PSI)
17 = 170 BAR (2460 PSI)
20 = 200 BAR (2900 PSI)
23 = 230 BAR (3300 PSI)
26 = 260 BAR (3770 PSI)
29 = 290 BAR (4200 PSI)
32 = 320 BAR (4640 PSI)
35 = 350 BAR (5070 PSI)
38 = 380 BAR (5510 PSI)
42 = 420 BAR (6090 PSI)
} Range 1 (Standard)

45 = 450 BAR (6530 PSI)
48 = 480 BAR (6960 PSI)
} Range 2

Y: HIGH PRESSURE SETTING PORT A**
(Same setting ranges as above)

W: SPECIAL HARDWARE FEATURES
NNN = None (Welded Pistons)
HNN = Hollow Pistons
NBN = Downhill Kit

T: CONTROL ORIFICE
00 = No Orifice
01 = .018 in. Dia.
22 = .022 in. Dia.
02 = .026 in. Dia.
03 = .032 in. Dia. (Standard)
04 = .040 in. Dia.
05 = .054 in. Dia.
06 = .062 in. Dia.
09 = .092 in. Dia

H: CHARGING SYSTEM

	042	055	075	100	130
B = 11 cc/rev (.69 in³/rev)	STD	O	N/A	N/A	N/A
C = 14 cc/rev (.86 in³/rev)	O	STD	O	N/A	N/A
D = 17 cc/rev (1.03 in³/rev)	N/A	O	STD	O	N/A
E = 20 cc/rev (1.20 in³/rev)	N/A	N/A	O	STD	O
F = 26 cc/rev (1.60 in³/rev)	N/A	N/A	N/A	O	STD
H = 34 cc/rev (2.07 in³/rev)	N/A	N/A	N/A	N/A	O
L = Ext. Charge w/ Int. Relief	O	O	O	O	O

L: SHAFT CONFIGURATION

	042	055	075	100	130
S1 = 14T 12/24 P	N/A	STD	STD	O+	N/A
S3 = 16T 12/24 P	N/A	N/A	O	O	N/A
C3 = 15T 16/32 P	STD	N/A	N/A	N/A	N/A
C6 = 21T 16/32 P	N/A	O	O	N/A	N/A
C7 = 23T 16/32 P	N/A	N/A	O	O	N/A
C8 = 27T 16/32 P	N/A	N/A	N/A	N/A	O
F1 = 13T 8/16 P	N/A	N/A	N/A	STD	STD
K1 = 1.375 in. Str. Key	N/A	O	N/A	N/A	N/A
K2 = 1.500 in. Srt. Key	N/A	N/A	O	N/A	N/A
T1 = 1.375 in. Tapered	N/A	O	O	N/A	N/A
T2 = 1.50 in. Tapered	N/A	N/A	O	O	N/A
T3 = 1.00 in. Tapered	O	N/A	N/A	N/A	N/A
TF = 13T 8/16P, Taper Spl	N/A	N/A	N/A	O	N/A

STD = Standard
O = Optional
N/A = Not Available
* Patent pending
** All Pressure settings are nominal set pressure at factory test conditions. Actual pressures will vary due to actual conditions.
+ = Not recommended for front pump in tandem configurations.

Series 90 Fixed Displacement Motor (MF)

R			M	P	J	G	N	F	L	H	T	W	Y	Z	K
9 0	M	□□□	N C	0	N	□	N	0	□□	□	0 0	□□□	0 0	0 0	□□

PRODUCT OR SERIES
90 = Series 90, Closed Circuit

R: TYPE AND ROTATION
M = Motor, Bi-directional

DISPLACEMENT
055 = 55cc/rev (3.35 in³/rev)
075 = 75cc/rev (4.57 in³/rev)
100 = 100cc/rev (6.10 in³/rev)
130 = 130 cc/rev (7.93 in³/rev)

M: NC = Not Applicable
P: 0 = Not Applicable
J: N = Not Applicable

G: END CAP PORTS (SAE J518c Code 62)

	055	075	100	130
1 = Twin Ports, w/Special Code 61 Flange Halves*	O	O	O	N/A
3 = Axial Ports, w/Special Code 61 Flange Halves*	O	O	O	N/A
7 = Axial Ports	O	O	O	N/A
8 = Twin Ports	O	O	O	STD

N: N = Not Applicable
F: 0 = Not Applicable

L: SHAFT CONFIGURATION

	055	075	100	130
S1 = 14 T 12/24 P	STD	STD	O	N/A
C6 = 21 T 16/32 P	O	O	O	N/A
C7 = 23 T 16/32 P	N/A	O	O	N/A
C8 = 27 T 16/32 P	N/A	N/A	N/A	O
F1 = 13 T 8/16 P	N/A	N/A	STD	STD
F2 = 13 T 8/16 P (Long)	N/A	N/A	O	N/A
K1 = 1.375 in. Str. Key	O	N/A	N/A	N/A
K2 = 1.50 in. Str. Key	N/A	O	N/A	N/A
K3 = 1.75 in. Str. Key	N/A	N/A	O	N/A
T1 = 1.375 in. Tapered	O	N/A	N/A	N/A
T2 = 1.50 in. Tapered	N/A	O	O	N/A

H: CHARGING SYSTEM
N = No Loop Flushing (defeated) (Use Charge Pressure Setting 00)
W = Loop Flushing Valve (Use Charge Pressure Setting 18 thru 28) (Standard)

T: 00 = Not Applicable

W: SPECIAL HARDWARE FEATURES
NNN = None
HNN = Hollow Pistons

Y: 00 = Not Applicable
Z: 00 = Not Applicable

K: CHARGE PRESSURE SETTING**
18 = 18 BAR (260 PSI) Nominal
20 = 20 BAR (290 PSI) Nominal
24 = 24 BAR (350 PSI) Nominal
28 = 28 BAR (400 PSI) Nominal
00 = None

NOTE: Motor charge pressure setting should be the same as pump setting.

STD = Standard
O = Optional
N/A = Not Available

* Patent pending
** All Pressure settings are nominal set pressure at factory test conditions. Actual pressures will vary due to actual conditions.

Authorized Service Centers — North America

United States

ALASKA

Alaska Hydraulics, Inc.
500 West Potter
Anchorage, AK 99518
(907)562-2217

ARKANSAS

Fluid Components Inc.
7600 Fluid Drive
Little Rock, AR 72206
(501)490-0222

CALIFORNIA

Zemarc Corporation
2240 Gaspar Avenue
Los Angeles, CA 90040
(213)721-5598

Rucker Fluid Power, Inc.
15095 Wicks Blvd.-Branch Office
San Leandro, CA 94577
(415)895-7100

Rucker Fluid Power, Inc.
11021 Greenstone Ave.
Santa Fe Springs, CA 90670
(213)946-1010

COLORADO

Rucker Fluid Power, Inc.
4675 Joliet
Denver, CO 80239
(303)373-4840

CONNECTICUT

Hydro Air of Connecticut
243 State Street
North Haven, CT 06473
(203)248-8863

FLORIDA

Action Hydraulics, Inc.
7541 N.W. 54th Street
Miami, FL 33166
(305)591-7273

Rucker Fluid Power, Inc.
1529 North A Street
Tampa, FL 33606
(813)253-2837

GEORGIA

Rucker Fluid Power, Inc.
75-D Mendel Drive S.W.
Atlanta, GA 30336
(404)691-9678

Advanced Fluid Systems
751 Hurricane Shoals Road
Lawrenceville, GA 30245
(404)963-6164

HAWAII

Hawaiian Fluid Power
803 Ahua Street
Honolulu, HI 96819
(808)833-4516

IDAHO

Rucker Fluid Power, Inc.
2033 Century Way
Boise, ID 83709
(208)377-4822

Rucker Fluid Power, Inc.
1901 Main Street
Lewiston, ID 83501
(208)746-9677

ILLINOIS

Fauver Company
275 Commonwealth Drive
Carol Stream, IL 60188
(708)682-5010

Rucker Fluid Power, Inc.
28192 North Ballard Drive
Lake Forest, IL 60045
(708)680-0050

IOWA

Sauer-Sundstrand Service Center
2800 East 13th Street
Ames, Iowa 50010
(515)239-6000

Fauver Company
955 33rd Avenue S.W.
Cedar Rapids, IA 52404
(319)366-6437

LOUISIANA

Rucker Fluid Power, Inc.
404 Commerce Point
Harahan, LA 70123
(504)734-0270

MARYLAND

Dees Corporation
8860 Kelso Drive
Baltimore, MD 21221
(301)574-2900

MICHIGAN

Fauver Company
4550 40th Street
Kentwood, MI 49508
(616)957-5177

Fauver Company
1500 East Avis Drive
Madison Heights, MI 48071
(313)585-5252

MINNESOTA

Fauver Company
10290 West 70th Street
Eden Prairie, MN 55344
(612)943-1707

MISSOURI

Fauver Company
3939 33rd Terrace NE, Suite H
Kansas City, MO 64117
(816)452-4444

MONTANA

Rucker Fluid Power, Inc.
3723 Grant Creek Road
Missoula, MT 59802
(406) 549-4181

NEVADA

Reno Hydraulic & Rebuild, Inc.
1400 Marietta Way
Sparks, NV 89431
(702)356-2703

NEW JERSEY

Powertech Hydraulics
459 Route 17 North
Mahwah, NJ 07430
(201)934-9354

NEW YORK

Fitzsimmons Hydraulics Company
4400 Shisler Road
Clarence, NY 14031
(716)759-8389

NORTH CAROLINA

Rucker Fluid Power, Inc.
4030 Yancey Road
Charlotte, NC 28217
(704)525-1354

OHIO

Fauver Company
4149 Weaver Court South
Hilliard, OH 43026
(614)876-1261

OKLAHOMA

Fluid Components
6526 East 40th Street
Tulsa, OK 74145
(918)622-3781

OREGON

Rucker Fluid Power, Inc.
6350 N.E. Halsey
Portland, OR 97213
(503)288-6061

PENNSYLVANIA

West Penn Hydraulics, Inc.
R.R. #3, Box 228
Johnstown, PA 15904
(814)269-4994

Donegal Hydraulics
Route 230 West
Mount Joy, PA 17552
(717)653-2298

PUERTO RICO

H-an-D Caribbean Inc.
P.O. Box 2318
Toa Baja, Puerto Rico 00759-2318
(809)251-1865

TEXAS

Hydraquip Corporation
1119 111th Street
Arlington, TX 76011
(214)660-7230

Rucker Fluid Power, Inc.
2120 Hutton, Suite 500
Carrollton, TX 75006
(214)243-1722

Hydraquip Corporation
7230 Wynnpark Drive
Houston, TX 77008
(713)869-9471

Rucker Fluid Power, Inc.
15401 W. Vantage Parkway, Suite 120
Houston, TX 77032
(713)987-2117

UTAH

Rucker Fluid Power, Inc.
2251 West California Avenue
Salt Lake City, UT 84104
(801)977-0123

VIRGINIA

Dees Corporation
7611 Whitepine Road
Richmond, VA 23237
(804)275-9222

WASHINGTON

Rucker Fluid Power, Inc.
365 Upland Drive South
Seattle, WA 98188
(206)575-3736

Rucker Fluid Power, Inc.
North 202 Lee
Spokane, WA 99202
(509)535-4281

Canada

ALBERTA

Rucker Products Ltd.
711 48th Avenue SE, Unit 8
Calgary, Alberta T2G 4X2
(403)243-4533

Rucker Products, Ltd.
8503 Davies Road
Edmonton, Alberta T6E 4N3
(403)465-7536

BRITISH COLUMBIA

Industrial Equipment Co. Ltd.
7462 Progress Way
Delta, British Columbia V4G 1E1
(604)946-1675

Rucker Products, Ltd.
2-3331 Viking Way
Richmond, British Columbia V6V 1X7
(604)278-4411

MANITOBA

Midwest Hydraulics (Man.) Inc.
823 Sanford Street South
Winnipeg, Manitoba R3H 0E4
(204)783-2277

NEW BRUNSWICK

Rousseau Controls Inc.
300 Baig Boulevard
Moncton, New Brunswick E1E 1C8
(506)859-8992

ONTARIO

J N Fauver Canada, Ltd.
6535 Mill Creek Drive, Unit 48
Mississauga, Ontario L5N 2M2
(416)821-4230

Feldcamp Equipment, Ltd.
1234 Brookes Street
North Bay, Ontario P1B 2P1
(705)472-5885

Rousseau Controls Inc.
34 Leading Road
Rexdale, Ontario M9V 3S9
(416)745-3945

Vulcan Machinery & Equipment, Ltd.
915 Memorial Avenue, P.O. Box 2810
Thunder Bay, Ontario P7B 5G3
(807)623-4422

QUEBEC

Rousseau Controls Inc.
271 Labrosse Avenue
Pointe Claire, Quebec H9R 1A3
(514)695-1240

Rucker Products, Ltd.
2860 Halpern Street
St. Laurent, Quebec H4S 1P8
(514)337-9412

S. Huot, Inc.
1000 rue Ste-Therese, Centre Industriel
St-Malo, Quebec G1N 4N3
(418)681-0291

SASKATCHEWAN

Midwest Hydraulics
1137 Weaver Street
Regina, Saskatchewan S4N 5Y2
(306)721-2277

Midwest Hydraulics
2210 Speers Avenue
Saskatoon, Saskatchewan S7L 5X7
(306)244-2011

For Sales and Service outside of North America, please refer to the following international headquarters locations for the specific sales office closest to you.

Sauer-Sundstrand Company
2800 East 13th Street
Ames, IA 50010

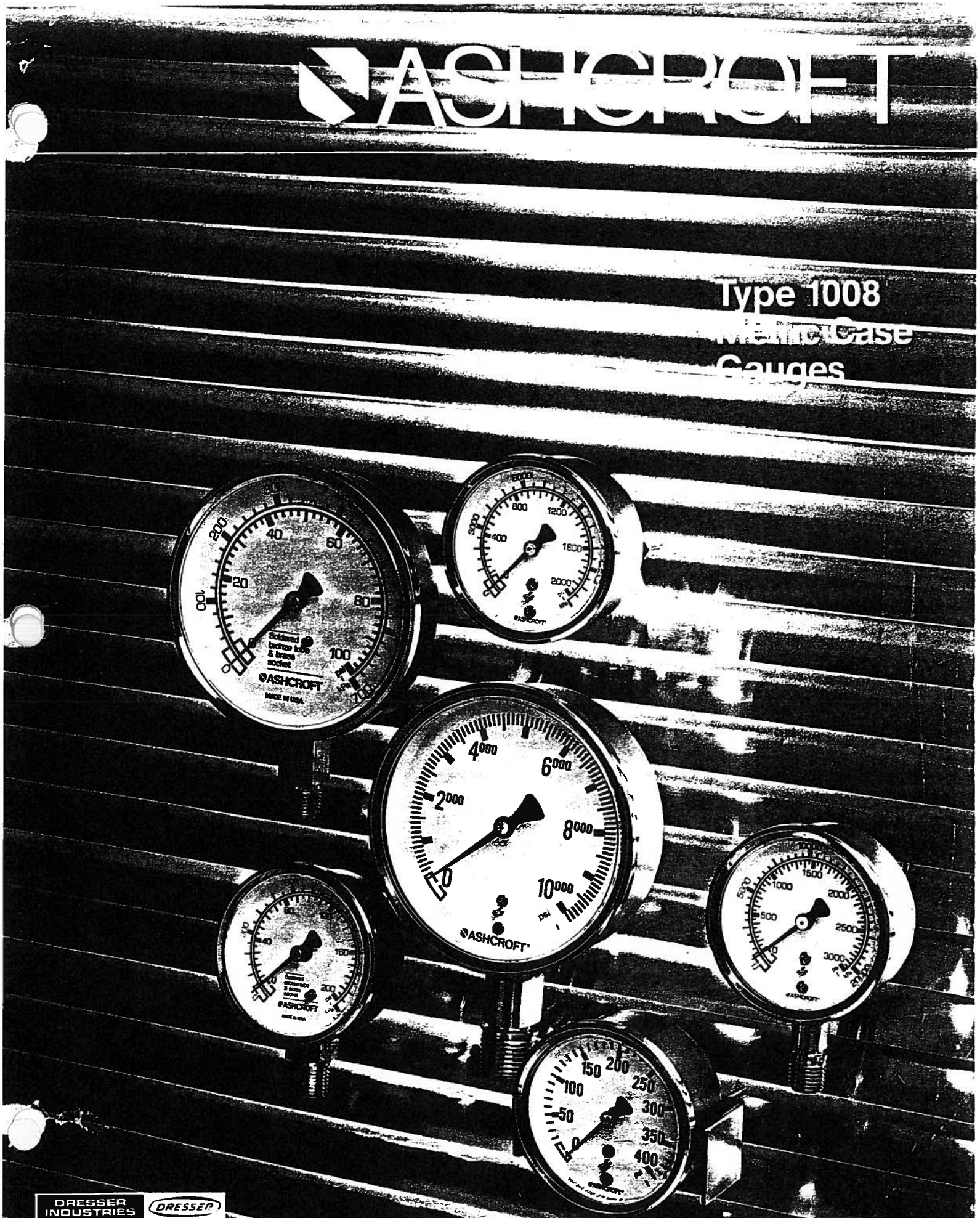
Sauer-Sundstrand Company
Krokamp 35
2350 Neumünster
West Germany

Daikin Industries, Ltd.
Yodogawa Plant
700-1 Hitotsuya
Settsu-City
Osaka 546, Japan

REFERENCE: HYDRAULIC PART NO.(S) 3, 7, 8, 11
HYDRAULIC SCHEMATIC NO. 347-8001-01

ASHCROFT

Type 1008
Metric Case
Gauges



DRESSER INDUSTRIES
DRESSER
INSTRUMENT DIVISION
SS1

Ashcroft's new Industrial Quality Type 1008 stainless steel gauge is designed to perform well even in applications where vibration, pulsation and mechanical shock are constant factors.

1008 contains the unique, spring suspended movement which adds to durability and increased gauge life. The movement is suspended between the Bourdon tube and socket, reducing the load on precision moving parts. This spring suspension helps the gauge resist mechanical shock and vibration. Spring suspension provides long life through reduced gear wear, with long term stability and greater reliability.

The helical Bourdon tube used in ranges 1,000 psi and over has high pressure capability with low internal volume, and is designed for high cycle life. All ranges are designed for maximum life under pulsating service conditions.

1008 is available in 63mm or 100mm dial sizes, stem or surface mounted, with a stainless steel case and polished stainless steel crimped ring. A standard polycarbonate window is offered with temperature compensating design. The gauge utilizes a u-clamp for panel mounting.

Type 1008A has a bronze tube and brass socket, with soft soldered pressure containing joints. The gauge has an RTV seal on the lower connection and an "O" ring seal on the back connection. Vacuum through 600 psi ranges are available.

Type 1008S has a stainless steel tube and socket with welded pressure containing joints. In addition, the socket is welded to the case. This joint protects against corrosion and provides a permanent case seal for liquid fill applications. Ranges available from vacuum to 15,000 psi.

All liquid-filled pressure gauges (300 psi and over) are supplied with a throttle device as standard.

Throttle Devices — All liquid filled 1008 gauges, 300 psi and above, are supplied with a throttle device in the gauge socket. If requested, these devices will be supplied on dry gauges or on liquid filled units below 300 psi.

Accuracy: 3-2-3%
ANSI Grade B

All gauges made in U.S.A.

The 1008AL (bronze socket) is equipped with a push in brass throttle plug with a 0.013" diameter orifice. 1008SL (stainless steel socket) is equipped with the Ashcroft annular orifice device with an orifice equivalent to 0.013" by 2¼" length. This device will attenuate up to 70% of excess pulsation.

Product Selection Information

All gauge components should be selected considering media and operating conditions, to prevent mis-application. Improper application can cause gauge failure and possible personal injury or property damage. The information contained in this catalog is offered as a guide to assist in making the proper selection of a pressure gauge. Additional information is available from Dresser Instrument Division. Consult ANSI B40.1 for guidance in gauge selection.

Gauges should be selected with a full scale pressure range of approximately twice the normal operating pressure. The maximum operating pressure should not exceed approximately 75% of the full scale range. Failure to select a gauge range within these criteria may ultimately result in fatigue of the Bourdon tube.

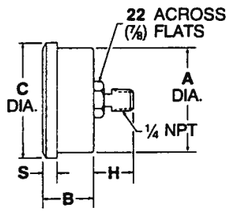
The temperature to which a gauge will be subjected should not exceed 150°F. Accuracy will be affected by approximately 0.2 psi per 10°F. A pressure relief plug is supplied in all cases to relieve case pressure buildup in the event a slow leak develops in the pressure element. Proper selection of the Bourdon system and socket material is dependent upon the process fluid to which the system will be subjected. If a standard material is not suitable, the use of a diaphragm seal may be necessary.

Gauges cleaned for gaseous oxygen or other strong oxidizing agents cannot be supplied with glycerine or silicone liquid fill. Consult factory if liquid filling is required on strong oxidizing media.

Ordering Example Below

63 1008S L 02 L · 0-1500#

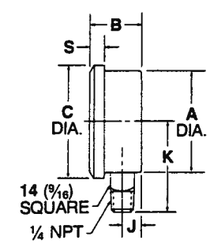
Case Size		Tube / Socket Material		Application		Connection		Connection Location		Variations	
Code		Code		Code		Code		Code		Code	
63	63mm (2½")	1008A	Bronze/Brass Soldered	A	Dry	02	¼ NPT	L	Lower	XTS	Throttle Device 1008A or AL
100	100mm (4")			AL	Liquid Fill Glycerine	02	¼ NPT	B	Back		See below for mounting hardware
										XNH	Wired St. St. Tags
63	63mm (2½")	1008S	AISI 316 Stainless Steel/AISI 316 Stainless Steel Welded	S	Dry	02	¼ NPT	L	Lower	XTS	Throttle device 1008S only
				SL	Liquid Fill Glycerine			B	Back	XGV	Silicone Fluid
100	100mm (4")					02	¼ NPT	L	Lower		See below for mounting hardware
						04	½" NPT (lower only)	B	Back		

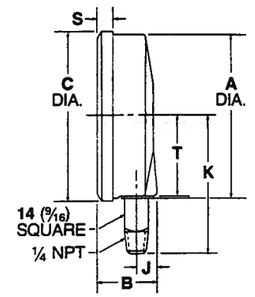


1008A BACK CONNECT

GAUGE SIZE		A	B	C	H	S
63 MM	MM	63	30	69	24	5.5
	INCH	2½	1³⁄₁₆	2²³⁄₃₂	1⁵⁄₁₆	⁷⁄₃₂
100 MM	MM	100	30	106	24	7
	INCH	3¹⁵⁄₁₆	1³⁄₁₆	4⁵⁄₃₂	1⁵⁄₁₆	⁹⁄₃₂

DIMENSIONS IN ( ) ARE INCHES

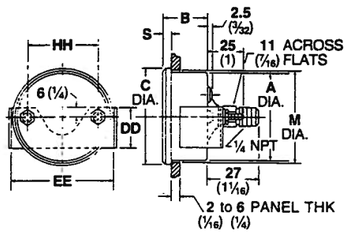


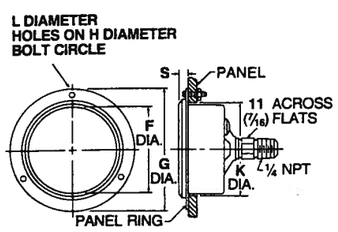


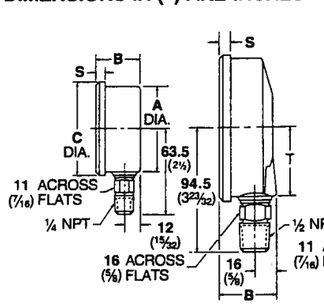
1008A LOWER CONNECT

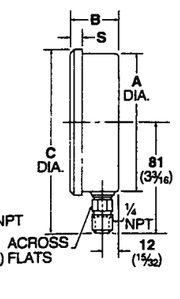
GAUGE SIZE		A	B	C	J	K	S	T
63 MM	MM	63	31	69	10	55	5.5	—
	INCH	2½	1⁷⁄₃₂	2²³⁄₃₂	1³⁄₃₂	2³⁄₃₂	¼	—
100 MM	MM	100	35	105.5	13.5	86	7	48.5
	INCH	3¹⁵⁄₁₆	1³⁄₈	4⁵⁄₃₂	1⁷⁄₃₂	3³⁄₈	⁹⁄₃₂	1²⁹⁄₃₂

DIMENSIONS IN ( ) ARE INCHES









1008S LOWER CONNECT

GAUGE SIZE		A	B	C	S	T
63 MM	MM	63	31	68	5.5	—
	INCH	2½	1⁷⁄₃₂	2¹¹⁄₁₆	⁷⁄₃₂	—
100 MM	MM	100	32.5	106	7	50
	INCH	3¹⁵⁄₁₆	1²⁄₃₂	4⁵⁄₃₂	⁹⁄₃₂	1³¹⁄₃₂

DIMENSIONS IN ( ) ARE INCHES

1008 BACK CONNECT XUC VARIATION

GAUGE SIZE		A	B	C	DD	HH	M	S	EE
63 MM	MM	63	31	68	28	49	64	5.5	70
	INCH	2½	1⁷⁄₃₂	2¹¹⁄₁₆	1⅛	1¹⁵⁄₁₆	2¹⁷⁄₃₂	⁷⁄₃₂	2¾
100 MM	MM	100	32	105	26	76	101	7	103
	INCH	3¹⁵⁄₁₆	1²⁄₃₂	4⁵⁄₃₂	1½	3	3³¹⁄₃₂	⁹⁄₃₂	4⅛

DIMENSIONS IN ( ) ARE INCHES

1008 BACK CONNECT W/PANEL RING

GAUGE SIZE		F	G	S	H (BOLT CIRCLE)	K (PANEL HOLE)	L (BOLT HOLE)
63 MM	MM	60	85	6	75	69	3.8
	INCH	2¹¹⁄₃₂	3⅜	⅜	2¹⁵⁄₁₆	2²³⁄₃₂	.150
100 MM	MM	97	132	6.3	116	102	4.6
	INCH	3¹³⁄₁₆	5³⁄₁₆	¼	4⅝	4	.180

DIMENSIONS IN ( ) ARE INCHES

Standard Ranges

Code	Single Scale Dial	Dual Scale Dial	
	psi	psi inner Arc	kPa Outer Arc
A	0/15	0/15	0/100
AL	0/30	0/30	0/200
S	0/60	0/60	0/400
SL	0/100	0/100	0/700
	0/160	0/160	0/1100
	0/200	0/200	0/1400
	0/300	0/300	0/2000
	0/400	0/400	0/2800
	0/600	0/600	0/4000
	Vacuum in Hg.	**In Hg.**	**kPa**
	30/0	30/0	-100/0
	Compound in Hg./psi	**In Hg./psi**	**kPa**
	30/15	30/15	-100/100
	30/30	30/30	-100/200
	30/60	30/60	-100/400
	30/100	30/100	-100/700
	30/150	30/150	-100/1000
	30/300	30/300	-100/2000
	psi	**psi Inner Arc**	**kPa Outer Arc**
S	1000	1000	7000
SL	1500	1500	10000
	2000	2000	14000
	3000	3000	20000
	5000	5000	34000
	6000	6000	40000
	7500	7500	50000
	10000	10000	70000
	15000	15000	100000

Dual Scale Ammonia Ranges

	Compound in Hg./psi	0°F Outer Arc
S	30/150	-40/84°F
SL	30/300	-40/125°F

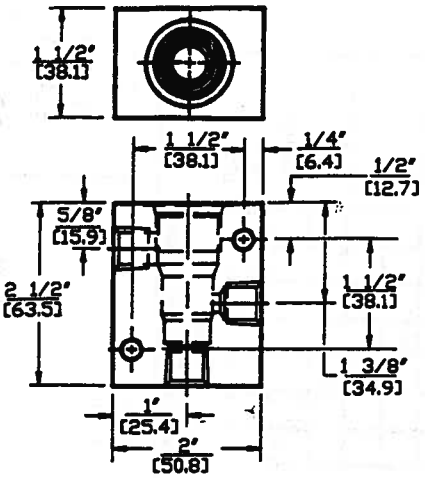
Weight in grams/ozs.

	63mm	100mm
Dry	112g/4 oz.	182g/6.5 oz. (¼ NPT) 192g/6.9 oz. (½ NPT)
Liquid Fill	205g/7.5 oz.	434g/15 oz. (¼ NPT) 444g/16 oz. (½ NPT)

Accessories For Panel Mounting	Cat. No.
63mm "U" Clamp (for panel mounting)	3520
63mm Bezel Ring (for panel mounting)	3511F
100mm "U" Clamp (for panel mounting)	3521
100mm Bezel Ring (for panel mounting)	3513G
63mm Three Hole Front Mounting Flange	3516F
100mm Three Hole Front Mounting Flange	3517G

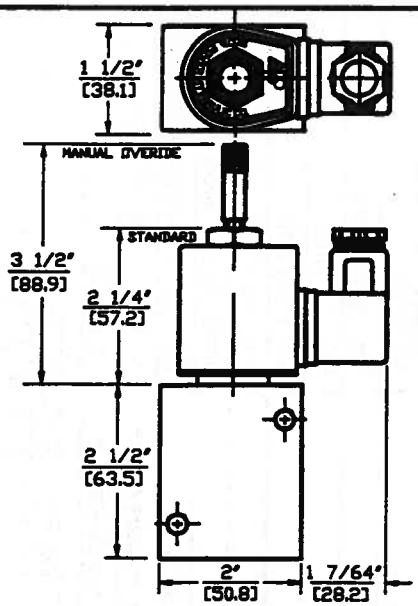
#4

STANDARD VALVE BODY DATA: F SERIES

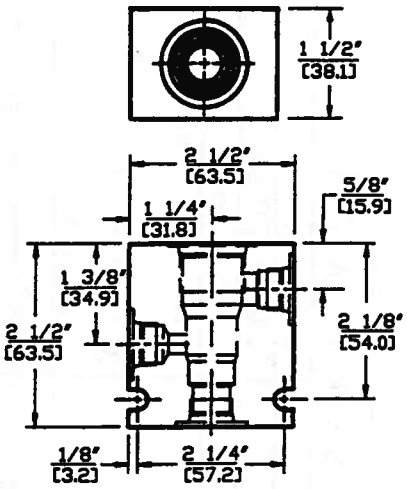


1/4-18 NPTF PORTS
STYLE N

NOTE: ALL MOUNTING HOLES .281 DIA.



FOR DETAILED CAVITY INFORMATION USE DRAWING 40200001



#6 SAE PORTS
STYLE S

BODY WEIGHT: .60 lbs./.27 Kg.

WHEN ORDERING
FILL IN ALL BOXES

ORDERING INFORMATION ~~DFS~~

DF-S3A-**-****-*

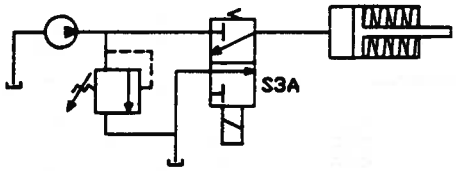
1 2 3 4 5

DF-S3A-00-HC-12-S-Traction (25N For spool winch)

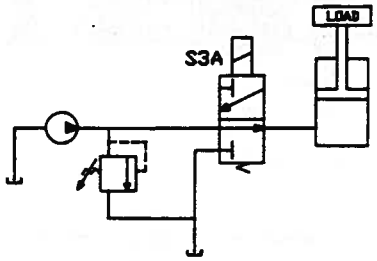
1: BASIC MODEL NO.	2: OPTIONS	3: COIL TERMINATION		4: VOLTAGE	5: BODY
		**** = WITHOUT COIL			* = WITHOUT BODY
		25 WATT STD. COIL	20.6 WATT COILS	06 -6VDC	
7/8 - 14 Thd., 3 way, 2 Position, Spool Valve	00 -Buna Standard VO -Viton Standard OM-Buna, Override, Detent VM-Viton, Override, Detent B1 -Buna, Override Nondetent V1 -Viton, Override Nondetent	DL -Double Lead * SL -Single Lead DS -Double Spade * SS -Single Spade DP -Double Post SP -Single Post HC-Hirschmann *	ML-Double Lead * MR-Single Lead MT -Double Spade * MS-Single Spade MD-Double Post MP-Single Post MH-Hirschmann *	12 -12VDC 24 -24VDC 36 -36VDC 48 -48VDC 25 -24VAC 11 -120VAC 22 -220VAC 44 -440VAC	N =1/4" NPT S =#6 SAE
		* NOTE BELOW	** NOTE BELOW		

* ONLY THESE COIL TERMINATIONS ARE STOCK.
** DO NOT USE ANY 20.6 WATT COIL AT MAX. FLOW OR PRESSURE ON SPOOL VALVES.
APPROXIMATE COIL ASSEMBLY WEIGHT: .50 lbs./.22 Kg.

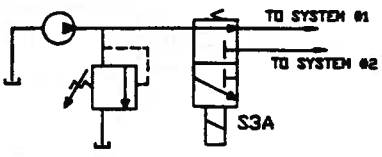
TYPICAL SCHEMATICS



CLUTCH APPLICATION: PER PORTING OPTION #1

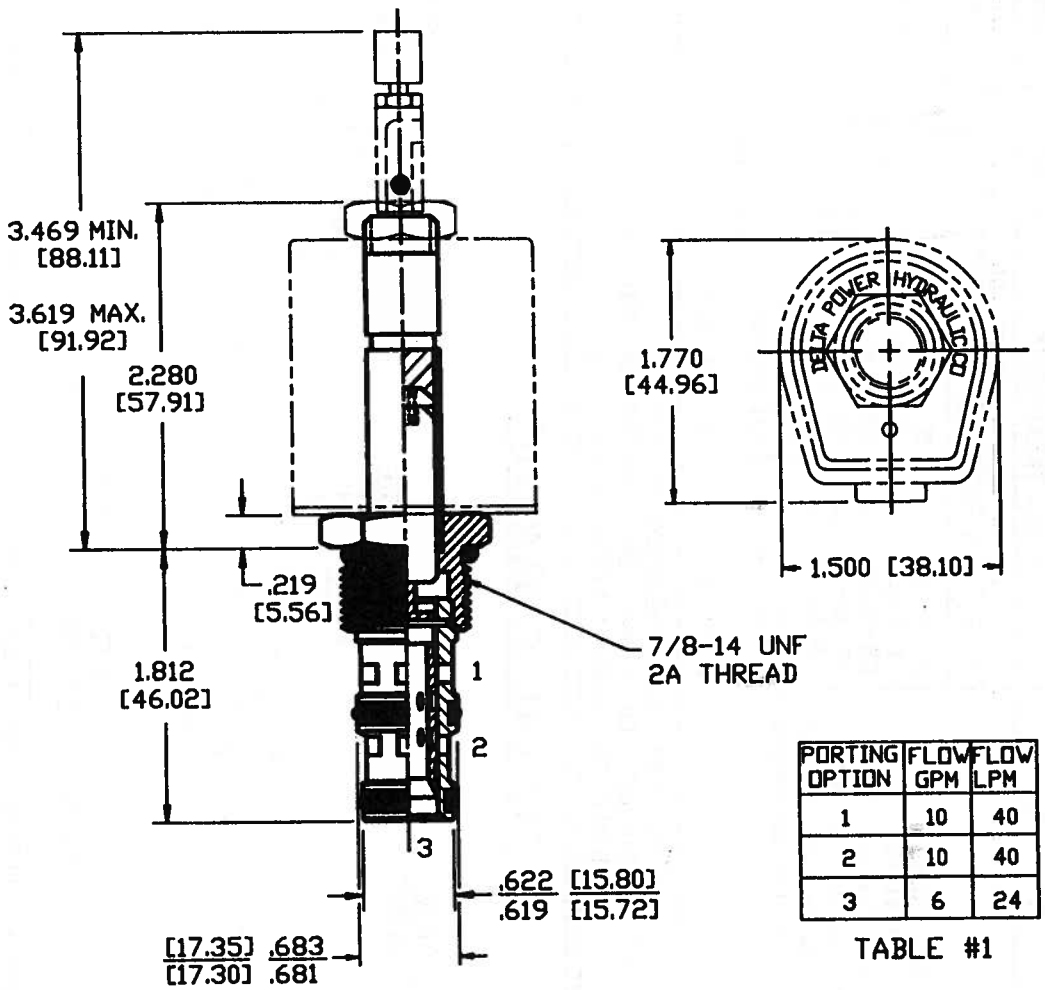


SINGLE ACTING CYLINDER
CONTROL: PER PORTING OPTION #2



SELECTOR APPLICATION: PER PORTING OPTION #3

WARNING: THE SPECIFICATIONS/APPLICATION DATA SHOWN IN OUR CATALOGS AND DATA SHEETS IS INTENDED ONLY AS A GENERAL GUIDE FOR THE PRODUCT DESCRIBED HEREIN. ANY SPECIFIC APPLICATION SHOULD NOT BE UNDERTAKEN WITHOUT INDEPENDENT STUDY, EVALUATION AND TESTING FOR SUITABILITY

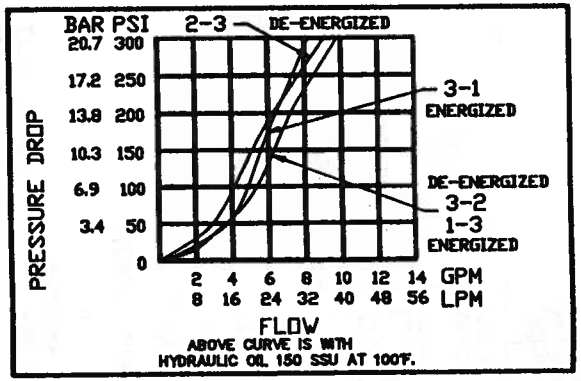


PORTING OPTION	FLOW GPM	FLOW LPM
1	10	40
2	10	40
3	6	24

TABLE #1

VALVE SPECIFICATIONS

Nominal Flow	Per Table #1
Max. Operating Pressure	3000 PSI (207 bar)
Max. Internal Leakage	5 in^3/m, 82 ml/m
Response time (average at full rated conditions)	30 mil-sec to 45 mil-sec
Viscosity Range	36 SSU (3CSC) to 3000 SSU (647CSC)
Filtration	30 micron nominal
Media Operating Temp. Range	-35°F (-37.2°C) to 200°F (93.3°C)
Seals	Buna-N O-rings, Standard
Mounting Position	No Restriction
Cavity Form Tool No.	40500001
Options	See Option Data
Electrical Data	See Coil Data
Valve Body Data	See Body Data
Weight	4.40 oz. (.125 kg)
Design	Direct Acting Spool Valve
Operating Fluid Media	All General Purpose Hydraulic Fluid
Cartridge torque requirements	30 Ft. Lbs. at 3000 psi
Coil Nut torque requirements	15 In. Lbs.



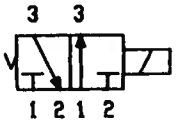
NOTE: DIMENSIONS IN BRACKETS ARE MILLIMETERS

MODEL NUMBER: DF-S3A-00

DELTA POWER HYDRAULIC CO.
ROCKFORD, ILLINOIS

DESCRIPTION: 3-WAY 2-POSITION SPOOL VALVE

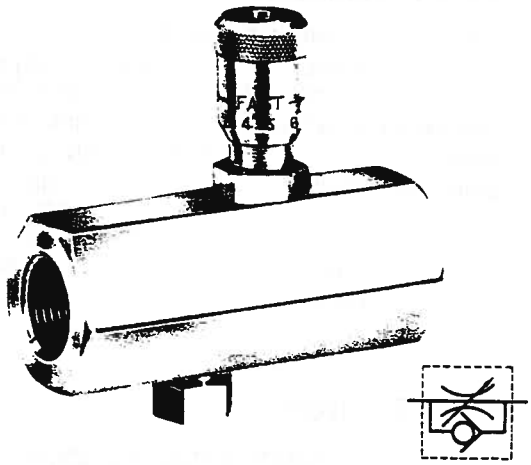
RELEASE DATE: JANUARY 1991 REV C



SYMBOL

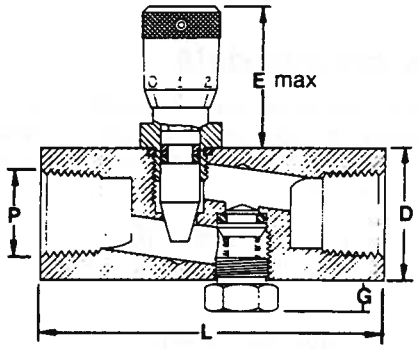
REFERENCE: HYDRAULIC PART NO.(S) 5, 19
HYDRAULIC SCHEMATIC NO. 347-8001-01

Calibrated head



MF flow control valves

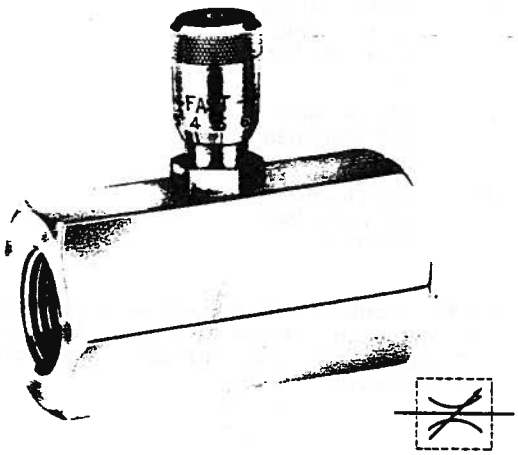
Combines two valves in one body...a floating piston-type check which provides full flow in one direction, and a tapered fine-thread needle which gives precise flow adjustment in the opposite, or controlled direction.



Dimensions (inches)

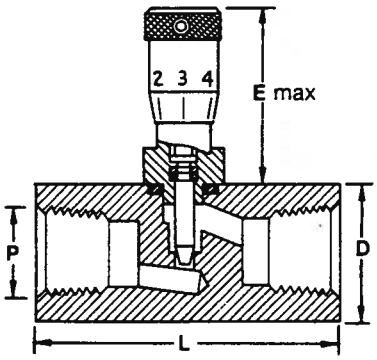
Model no.	P NPT port size	D hex.	L	E	G
MF 125	1/8	11/16	1 3/4	1 1/4	9/32
MF 250	1/4	7/8	2 3/8	1 1/4	5/16
MF 375	3/8	1 1/16	2 3/4	1 3/8	11/32
MF 500	1/2	1 5/16	3 3/16	1 3/8	3/8
MF 750	3/4	1 5/8	3 9/16	1 7/8	15/32
MF 1000	1	1 7/8	3 9/16	1 7/8	15/32

Calibrated head



MN needle valves

Combines calibrated "Micro-Head" and fine threaded stem for accurate flow control. Can be adjusted under pressure and, once set, does not "drift" from desired flow rate.



Dimensions (inches)

Model no.	P NPT port size	D hex.	L	E
MN 125	1/8	11/16	1 1/2	1 1/4
MN 250	1/4	7/8	2	1 1/4
MN 375	3/8	1 1/16	2 1/4	1 3/8
MN 500	1/2	1 5/16	2 21/32	1 3/8
MN 750	3/4	1 5/8	3	1 7/8
MN 1000	1	1 7/8	3	1 7/8

Flow control data

Flow and pressure drop characteristics for RegO valves are based on laboratory testing of random production samples. Test medium is 150 SSU oil at controlled temperature of 140°F.

$$\text{Flow in GPM} = \frac{C_v \sqrt{P_1 - P_2}}{\sqrt{G_f}}$$

Where C_v = flow coefficient
P_1 = inlet pressure (PSIG)
P_2 = outlet pressure (PSIG)
G_f = specific gravity of medium at operating temperature

C_v factors

Model		C_v controlled	C_v free
MF—KLF	125	0.237	0.322
MF—KLF	250	0.446	0.700
MF—KLF	375	0.907	1.146
MF—KLF	500	1.328	1.745
MF—KLF	750—1	2.020	2.917
MN—KLN	125	0.251	
MN—KLN	250	0.394	
MN—KLN	375	0.935	
MN—KLN	500	1.128	
MN—KLN	750—1	1.998	
PC—BC	125		0.212
PC—BC	250		0.454
PC—BC	375		1.001
PC—BC	500		1.605
PC—BC	750—1		2.209
PC—BC	1000		2.209

Specifications

Maximum operating pressures
Brass.....2,000 PSIG pneumatic air
Carbon steel.....5,000 PSIG hydraulic
Temperature range.....(O-ring) −40° to 212° F
Ports.....All NPT threads to J.I.C. standards
Materials: Body.....Hex SAE 72 brass
12L14 carbon steel
Hex 303 stainless steel
Stem.....Stainless steel
Packing.....Buna N O-ring

How to order

MF 125 B BC

Model
MF—"Micro-Head" flow control with calibrated knob
MN—Needle valve with calibrated head
KLF—"Lock-Head" flow control with knurled knob and lock nut
KLN—Needle valve with knurled knob and lock nut
PC—Check valve and stainless piston
BC—Check valve with stainless steel ball

NPT size (inches)
125—⅛
250—¼
375—⅜
500—½
750—¾
1000—1

Material
B—Brass
S—Carbon steel
SS—Stainless steel

Ball check

NOTE: To order KLN Series with male x female ports, add "-M" to number. Example: KLN 250 B - M means a ¼" NPT brass needle valve with male x female ports. Available only for Models: KLN 250 B
KLN 375 B
KLN 500 B

REFERENCE: HYDRAULIC PART NO.(S) 6
HYDRAULIC SCHEMATIC NO. 347-8001-01

Application

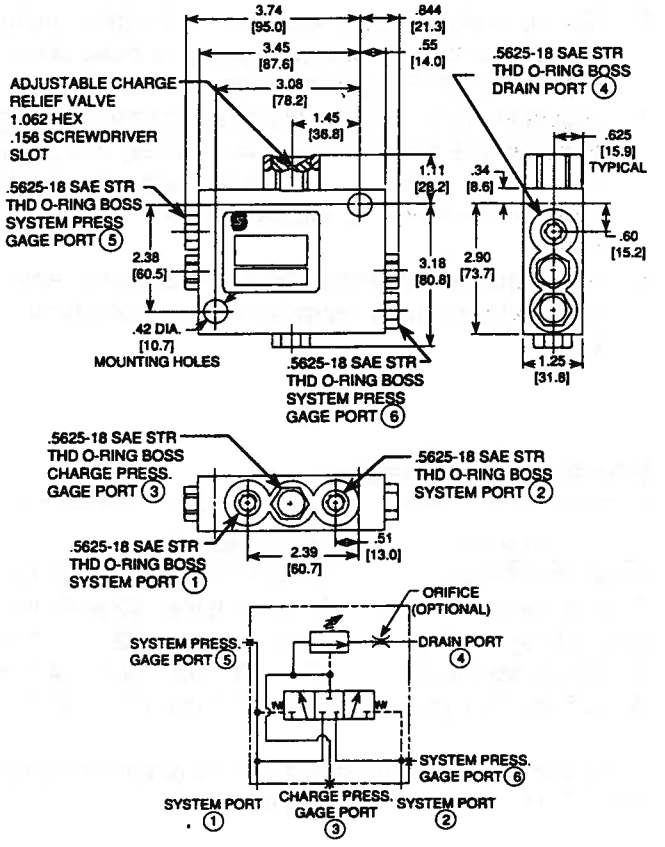
The Loop Flushing Valve is applied in a hydrostatic transmission circuit for the purpose of maintaining high quality of the working fluid in the transmission power loop. While many transmissions can operate satisfactorily without a loop flushing valve, the addition of loop flushing with a resulting improvement in fluid quality will, generally, extend transmission life.

The Loop Flushing Valve should be considered when any of the following exist:

- Sustained operation at low pressure and high speed
- Operation where continuous pressure exceeds the 1000 hours/year rating
- Cylinders in the hydrostatic circuit
- Flow restricting valves in the power loop
- Frequent operation of high pressure relief valves
- Long power loop lines
- Extraordinary life requirements

Monitoring of fluid quality under field operating conditions for extended periods of time is recommended in a determination of requirements for loop flushing. For a complete discussion of loop flushing and fluid quality refer to Sundstrand-Sauer Bulletins BLN-9886 "Transmission Circuit Recommendations" and BLN-9887 "Fluid Quality Requirements."

Installation Drawing



Description of Operation

The high pressure ports (1 and 2) of the valve are externally connected to the work or system auxiliary ports of the main hydrostatic transmission circuit. The valve drain port (4) must be externally connected to the case drain return line of the transmission — preferably at the motor so that fluid is flushed through the motor case to the pump and returned to the reservoir.

The shuttle valve responds directionally to high pressure, exposing the low pressure side of the circuit to the charge relief valve. The charge relief valve, when properly set in accordance with the "Adjustment Procedure," will flush a desired quantity of working fluid from the transmission power loop. This fluid is replaced from the charge replenishing flow entering the loop through an integral check valve system in the main pump.

A drain orifice may be specified to limit maximum flushing flow in circuits where the low side pressure is high or varies over a large pressure range.

Specifications

System Pressure (In Loop)

Maximum High Side	psi	6960
	BAR	480
Maximum Low Side	psi	1015
	BAR	70

Charge Relief Valve Setting Range

psi	44 to 435
BAR	3 to 30

NOTE: Nominal charge relief settings are ±20 psi (±1.4 BAR), and are set at a flow of 1 ±.25 gpm (3.8 ±.9 lpm) at 120°F (49° C).

Flow (Rated)

No Orifice	gpm	3
	lpm	11.4
With .093 Orifice	gpm	1
	lpm	3.8

Model Code

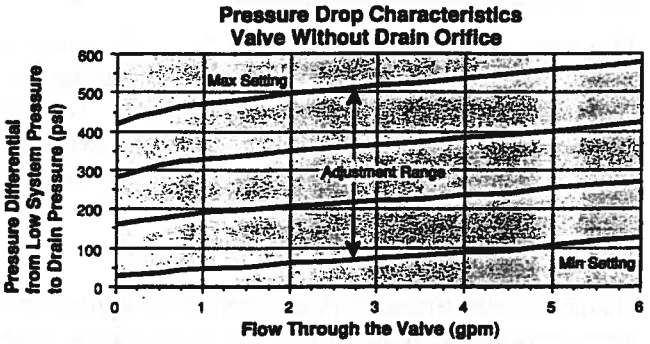
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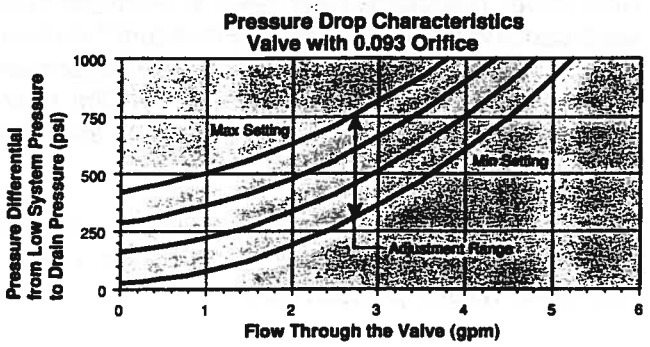
Charge Pressure
15 = 15 Bar (220 PSI)
20 = 20 Bar (290 PSI)
24 = 24 Bar (350 PSI)

Orifice
00 = None
09 = .093 in. (2.36 mm) Dia.

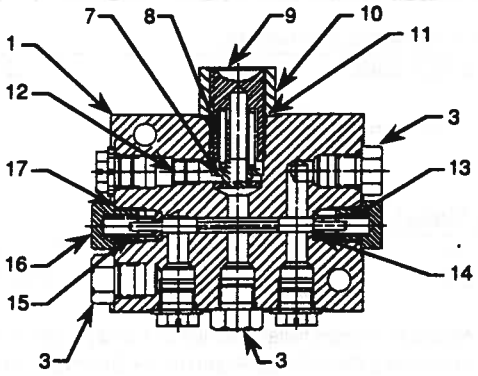
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Pressure Drop Characteristics





Service Parts List



Item Number	Part Number	Description	Qty
0001	8800487	HOUSING ASSY-MANIFOLD	1
0003	9005100-5600	PLUG-ST THD GAGE PORT	3
0007	8800449	POPPET-CHG RELIEF	1
0008	8800476	SPRING-HELICAL COMP	1
0009	8800488-1000	PLUG-CHG RELIEF	1
0010	9003575-0101	NUT-SPECIAL	1
0011	9004201-6200	O-RING	1
0012	8800242-0009	ORIFICE PLUG-.093"	A/R
0013	8800069	SPOOL-SHUTTLE VALVE	1
0014	8800265	WASHER SPECIAL	2
0015	8800067	SPRING	2
0016	9005475-0069	PLUG-SHUTTLE SPOOL	2
0017	9004201-3700	O-RING	2

Mounting

The Loop Flushing Valve may be mounted on any convenient flat surface which provides adequate support around the two mounting holes provided. While it is not necessary to provide a continuous mounting surface under the entire valve housing, care should be taken to assure that the surfaces under the mounting bolts form a flat plane. Failure to provide a flat mounting surface could create valve housing distortion when the mounting bolts are drawn up to full torque. Housing distortion may result in binding of internal components, reducing the drive and/or braking capacity of the system.

BRAKING WARNING

The loss of hydrostatic drive line power in an acceleration, deceleration, or neutral mode may cause a loss of hydrostatic braking capacity. A braking system, redundant to the hydrostatic transmission, must be provided which is adequate to stop and hold the system should such a condition develop.

Adjustment Procedure

For initial setting of the valve package:

1. Plumb an in-line flow meter into the drain line. (If a flow meter is not available, use a clean container with a known volume and a stop watch.)
2. Set the brakes or otherwise restrict machine motion and stroke the transmission pump to build at least 500 psi (34 BAR) system pressure differential.
3. Adjust the relief valve in the flushing valve package to obtain the desired drain flow, typically 2 to 3 gpm (7.5 to 11.4 lpm). (Rotate the adjusting screw counter-clockwise to increase flow.) Torque the locknut.
4. Verify that pump charge pressure is above recommended minimums. Remove the flow meter from the circuit.

Service Information

Component	Installation Torque
Gage Port Plugs	20 to 35 ft.lbs. (27 to 47 Nm)
Charge Relief Lock Nut	31 to 41 ft.lbs. (42 to 55 Nm)
Orifice Plug	16 to 20 ft.lbs. (22 to 27 Nm)
Shuttle Spool Plugs	27 to 33 ft.lbs. (36 to 44 Nm)
Hose/Tube Fittings	20 to 35 ft.lbs. (27 to 47 Nm)

The optional orifice plug may be removed and installed with a 3/16" internal hex wrench.

REFERENCE: HYDRAULIC PART NO.(S) 10
HYDRAULIC SCHEMATIC NO. 347-8001-01

REXROTH
WORLDWIDE HYDRAULICS

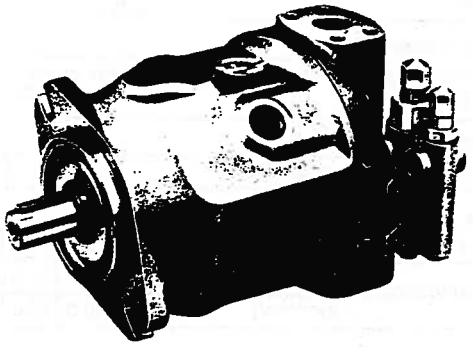
Variable Axial Piston Pump, Swashplate Design Model AA10VSO (Series 30) for Open Circuit Applications

Sizes 28 to 100	...4570 PSI (...315 bar)	...6.10 in³/rev (...100 cm³/rev)

RA 06 291/06.87

5

- 2-bolt mounting flange to SAE standards
- SAE flanged connections with UNC threads (SAE J 518)
- Special slot-controlled swashplate design
- High power to weight ratio
- Heavy duty roller bearings for extremely long pump life
- Various control options for pressure, flow and power regulation
- Fast response times and low noise level
- Continuous operating pressure of 3625 PSI (250 bar), peak pressure to 4570 PSI (315 bar)
- Axial and radial loading of the drive shaft possible
- Good self-priming suction characteristics
- Cast iron housing, aluminium free construction
- Operation on water based fluids 95/5 (HFA emulsions) possible with de-rated performance parameters

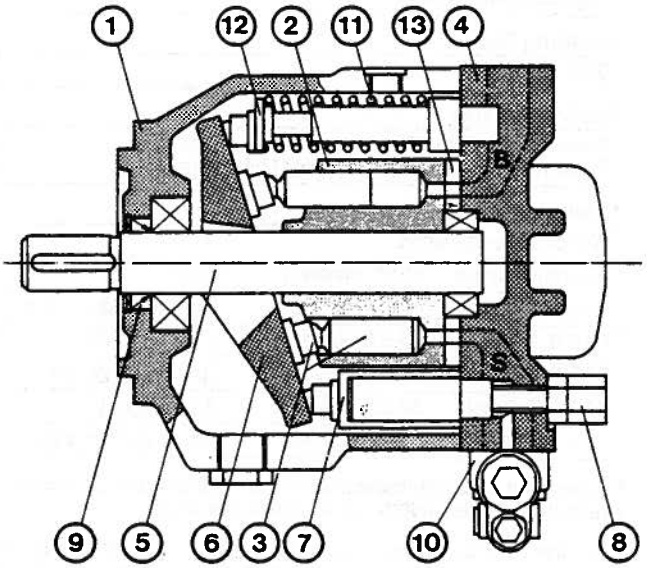


Functional Description

Axial piston pumps model AA10VSO are swashplate design, variable displacement pumps. They are designed for hydrostatic transmission in open circuit applications. The pump generates fluid flow and imparts to that fluid the necessary pressure forces up to 4570 PSI (250 bar).
They basically consist of the housing (1), cylinder barrel (2), piston and shoes (3), port plate (4), drive shaft (5), swash plate (6), control piston (7), mechanical stroke limiter adjustment (8), shaft seal (9) and compensator control (10).
Rotation of the drive shaft (5) causes a linear piston movement as the piston shoe (3) slides along the tilted swashplate (6).
As the piston retracts in the cylinder bore (2), fluid fills the developing vacuum cavity from the suction port »S« via the suction kidney in valve plate (13). At maximum retraction of the piston, shaft rotation causes the piston to go beyond the suction kidney and begin communication with the pressure kidney. Continuing rotation then extends the piston into the cylinder bore, forcing fluid into the pressure port »B«.
The stroke length of the piston is directly related to the swashplate angle, which swivels up to a maximum of 17 degrees for stepless flow adjustment.

Pressure and flow regulation

The swashplate is normally held at maximum swivel angle by a spring (11) as well as system pressure working on the stroking piston (12).
System pressure is also working on the pressure compensator against a setting spring. When system pressure overcomes the spring force, the spool shifts allowing system pressure into the control piston (7). This causes the pump to destroke to a regulating point sufficient to maintain compensator set pressure and lubricating fluid flow.
When the pressure setting is reached, only the amount of fluid necessary to satisfy the load conditions is delivered. If the load condition is such that no flow is required, only cooling and lubricating fluid is delivered. Power usage and heating of the fluid are thus kept to a minimum.
When system pressure falls below the compensator setting, spring force returns the spool back to its normal position, which drains control piston (7) to the pump case. The swashplate is then forced on stroke by the spring (11) and stroking piston (12). The flow control spool FR, also known as load sensing control, functions generally the same as the compensator spool. In the case of the FR spool, however, its response is due to a differential pressure across a flow control device. The spring setting only determines the differential pressure required to maintain constant output flow through a given orifice size.
Many control options including constant power control, electronic proportional flow and/or pressure control, etc. are available.



Variable Axial Piston Pump AA10VSO, Series 30

Ordering Code

	A	A10VS	O			/	30		–		K	C	62	

Hydraulic Fluid

Petroleum oils no designation	
HFA- HFB- and HFC-fluids	E-

Version

SAE *	A

Axial Piston Unit

Variable displacement, swashplate design for industrial use	A10VS

Function

Pump operation, open circuit	O

Size

Sizes		28	45	71	100
Displacement	in^3/rev	1.71	2.75	4.33	6.10
	(cm^3/rev)	28.0	45.0	71.0	100.0

Controls and Control Options

Pressure compensator				DR
Pressure/flow compensator**				DFR
Constant power control***				DFLR
Electrical flow control	FE			FE
	FE	D		FED
with pressure compensation				

** A bleed orifice to drain is installed in X-port standard; if plug is to be installed state in clear text.
*** When ordering please state power requirements in clear text ex. 1 1/2 HP at 1800 rpm (5 kW at 1500 rpm)

Design

Series	30

Direction of Rotation

looking at shaft end	clockwise	R
	counter-clockwise	L

Seals

Buna-N	P
Viton	V

Shaft End

Keyed parallel, SAE	K

Mounting Flange

SAE 2-bolt	C

Port Connections

Pressure port B: SAE Suction port S: SAE	on opposite sides, with UNC threads	62

Through-drive Configurations

Through-drive Configurations			28	45	71	100	
Without through-drive			●	●	●	●	N00
mounting flange	shaft/coupling	to fit:					
SAE A, 2-bolt	SAE A, spline	G2[1], S15[1], S20[1], AA 10 V 16	●	●	●		K01
SAE B, 2-bolt	SAE B, spline	G3[1], S20[1], S30[1], AA10 VO 28		●	●		K02
SAE B, 2-bolt	SAE B, keyed	AA 10 VSO 28, S30[1]	●	●	●		K03
SAE B-B, 2-bolt	SAE B-B, keyed	AA 10 VSO 45		●	●		K05
SAE C, 2-bolt	SAE C, keyed	AA 10 VSO 71, V2/50...100			●		K08

Please note: The mechanical stroke limitation from full displacement to 50 % full displacement is only available at model »N00« without through drive

[1]See the following data sheets, for further informations on the combination pumps: ● = available
G2- RA 10 030, G3- RA 10 038, S15- RA 64 756, S20- RA 64 774, S30- RA 64 789, V2/50...100- RA 10 337

Hydraulic Fluid

Before project design, please see our data sheet RA 90220 or RA 90223 for detailed information on the selection of hydraulic fluids and their application limits.

Operating viscosity range:

For optimum efficiency and pump life, we recommend that the operating viscosity (at operating temperature) be selected in the range of

ν_{opt} = optimum operating viscosity
81...167 SUS (16...36 mm²/s)

taking into consideration the reservoir temperature range.

Viscosity limits:

The following values are valid for extreme operating conditions of short duration.

ν_{min} = 60 SUS (10 mm²/s)
for short periods at max. permissible drainage oil temperature of 194° F (90° C)

ν_{max} = 4635 SUS (1000 mm²/s)
for short periods upon cold start up

Example:
VG 22 =
Viscosity grade of 22 centistokes
at 104° F (40° C)

Notes on the selection of the hydraulic fluid:

For correct selection of the hydraulic fluid, it is assumed that the operating temperature in the reservoir (open circuits) in relation to the ambient temperature is known.

The hydraulic fluid should be selected so that, within the operating temperature range, the operating viscosity lies within the optimum range ν_{opt} (see shaded area of selection diagram). We recommend that the higher viscosity grade is selected in each case.

Example: At some ambient temperature of X°, the operating temperature in the reservoir is 140° F (60° C). In the optimum operating viscosity range (ν_{opt}, shaded section), this corresponds to viscosity grades VG 46 or VG 68; VG 68 should be selected.

Important: The drainage fluid temperature is influenced by pressure and speed and is always higher than the reservoir temperature. At no point in the system, however, must the temperature be higher than 194° F (90° C).

If it is not possible to comply with the above conditions because of extreme operating parameters or high ambient temperature, please consult us.

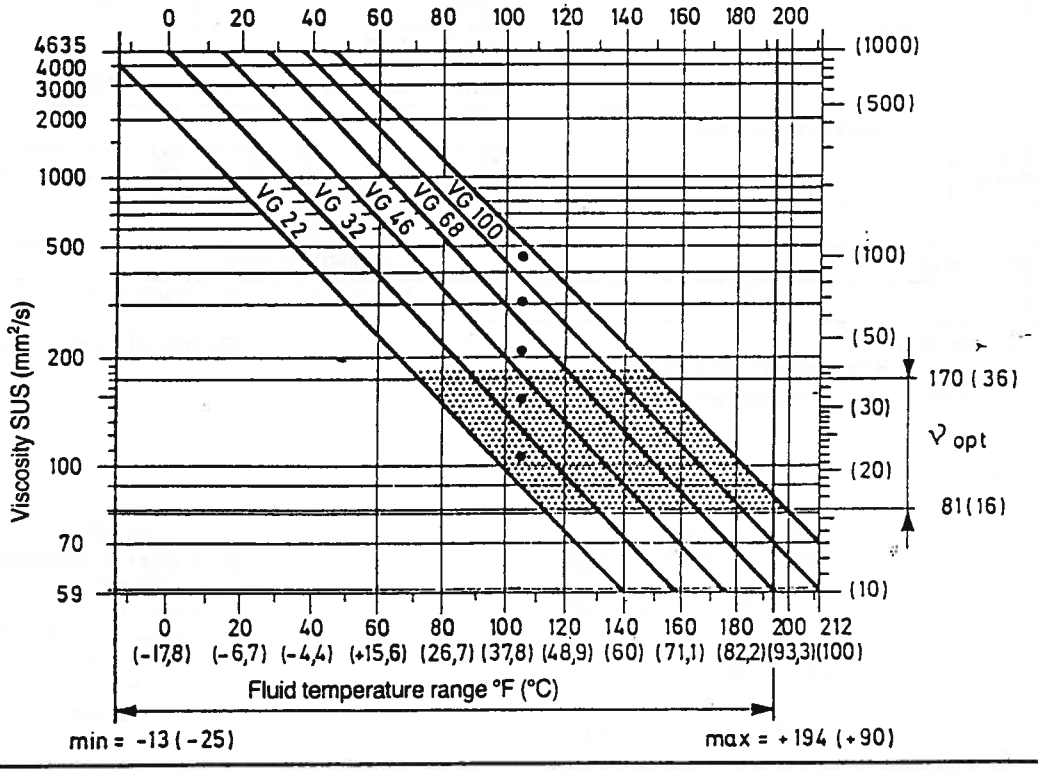
Filtration

In order to guarantee proper and reliable function, the operating fluid must be maintained to a minimum cleanliness grade of 9 to NAS 1638, 6 to SAE, ASTM, AIA or ISO grade 16/15.

This can be achieved, e.g., with filter elements type ... D 020 ... (see RA 31 278).

A beta value of $\beta_{20} \geq 100$ is thereby achieved.

Selection Diagram



Technical Data

Values are valid for petroleum oils for water-content and synthetic fluids please see data sheet RA 90223 for detailed fluid information

Operating pressure range – Inlet Side

Absolute pressure at port S (suction inlet)

$p_{abs\ min}$ ——— 12 PSIA (0.8 bar)
$p_{abs\ max}$ ——— 435 PSIA (30 bar)

Operating pressure range – Outlet Side

Pressure at port B

Nominal pressure p_N ——— 3625 PSI (250 bar)
Peak pressure p_{max} ——— 4570 PSI (315 bar)

Drainage fluid:

Maximum permissible pressure of the case drain (port L): 7 PSI (0.5 bar) maximum higher than inlet pressure at port »S«, but not higher than 30 PSI (2 bar) absolute.

Direction of flow:

Port »S« to port »B«

Speed in relation to inlet pressure and displacement:

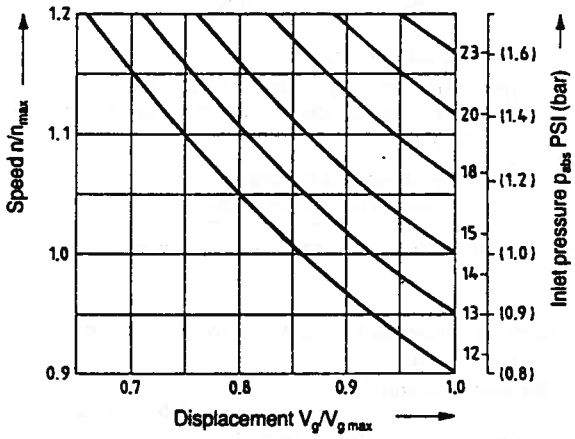


Table of Values

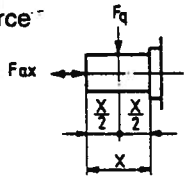
Theoretical values, without considering mechanical η_{mh} and volumetric η_v efficiencies

Size				28	45	71	100
Displacement: $V_{g\ max}$			in³/rev (cm³)	1.71 (28)	2.75 (45)	4.33 (71)	6.10 (100)
Nominal flow*: at n_E = 1750 rpm			GPM (l/min)	12.7 (48)	20.1 (76)	32.0 (121)	45.0 (170)
at $n_{o\ max}$			GPM (l/min)	21.4 (81)	29.9 (113)	40.2 (152)	51.3 (194)
Maximum speed**: (flooded suction)		$n_{o\ max}$	rpm	3000	2600	2200	2000
Max. power:	– n_E = 1750 rpm		HP (kW)	27.5 (20.5)	44.3 (33.0)	69.9 (51.9)	98.2 (73.1)
Δp = 3625 PSI (250 bar)	– $n_{o\ max}$	$P_{o\ max}$	HP (kW)	47.0 (35.0)	65.8 (49.0)	87.2 (65.0)	111.4 (83.0)
Max. torque:	Δp = 3625 PSI (250 bar)		lb-ft (Nm)	81.9 (111)	132 (179)	208 (282)	293 (397)
Torque	Δp = 1450 PSI (100 bar)		lb-ft (Nm)	33 (45)	53 (72)	83 (113)	117 (159)
Moment of inertia about the drive axis		J	lb-ft² (kgm²)	0.0403 (0.0017)	0.0783 (0.0033)	0.1968 (0.0083)	0.3960 (0.0167)
Filling volume:			Pints (l)	1.48 (0.7)	2.11 (1.0)	3.38 (1.6)	4.64 (2.2)
Weight: (approx)			lbs (kg)	33.0 (15)	46.2 (21)	72.6 (33)	99 (45)
Permissible loading on drive shaft: (see below)							
max. axial force F_{ax}			lbs (N)	225 (1000)	337 (1500)	540 (2400)	900 (4000)
max. radial force F_q			lbs (N)	540 (2400)	810 (3600)	1350 (6000)	2250 (10000)
Mounting Position:				See page 5			
Fluid temperature range:				See diagram, page 3			
Viscosity range:	SUS (mm²/S)			60-4640 (10...1000) Optimum 81-167 (16...36)			

* 3% loss of volume included

** The values shown are measured with an absolute pressure of 14.5 PSI (1 bar) at the suction inlet «S»

Direction of applied force



Sizing Calculations

Flow $Q = \frac{V_g \cdot n \cdot \eta_v}{231}$ $(Q = \frac{V_g \cdot n \cdot \eta_v}{1000})$

Drive torque $M = \frac{V_g \cdot \Delta p}{24 \cdot \pi \cdot \eta_{mh}}$ $(M = \frac{1.59 \cdot V_g \cdot \Delta p}{100 \cdot \eta_{mh}})$

Drive power $P = \frac{M \cdot n}{5252} = \frac{Q \cdot \Delta p}{1714 \cdot \eta_t}$

$(\frac{2\pi \cdot M \cdot n}{60000} = \frac{M \cdot n}{9549} = \frac{Q \cdot \Delta p}{600 \cdot \eta_t})$

V_g = geom. displacement in³/rev (cm³/rev)
Δp = pressure differential PSI (bar)
M = torque lb-ft (Nm)
Q = flow GPM (l/min)
P = drive power HP (kW)
n = speed rpm
η_v = volumetric efficiency
η_{mh} = mechanical efficiency
η_t = overall efficiency ($\eta_t = \eta_v \cdot \eta_{mh}$)

Mounting position

The unit can be mounted in a number of optional positions. The pump housing must be filled prior to start-up.
In order to achieve optimum noise level values, all connecting lines (suction, pressure and leakage) should be elastically connected to the reservoir.
Check valves in leakage return lines should be avoided. Exceptions are possible, subject to our approval in advance.

1. Vertical installation (shaft pointing upwards)

The following installation parameters should be considered:

1.1 Pump submerged in Reservoir

Prior to installation, the pump should be filled while in a horizontal position.

a) The minimum fluid level must be level with or higher than the pump face flange. Connections »L« + »L_1« should be left open (see illustration #1)

b) If the minimum fluid level is lower than the pump face flange, then connection »L_1« and possibly the suction (»S«) port must be piped, as per Illustration # 2. Conditions as per item 1.2.1. Port »L« is plugged.

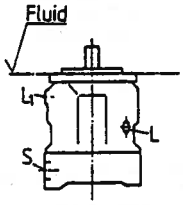


Illustration #1

1.2 Pump mounted outside of Reservoir

Prior to installation, the pump should be filled while in a horizontal position. Above-tank mounting as per Illus. # 2.

1.2.1 Operational paramaters. Minimum pump inlet pressure $p_{abs\,min}$=12 PSI (0.8 bar) under static and dynamic loads.
Note: Avoid above-tank mounting whenever a low noise level is desired.

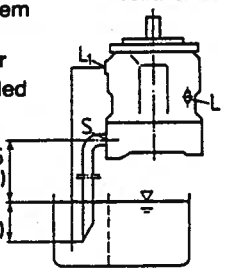


Illustration #2

The allowable suction height is a factor of the total pressure loss; it must, however not be greater than h_{max} = 31.5" (800 mm). Submerged depth $h_{T\,min}$ = 8" (200 mm).

Total Pressure loss $\Delta p_{TOTAL} = \Delta p_1 + \Delta p_2 + \Delta p_3 \leq (1 - p_{E(min)}) = 2.9$ PSI (0.2 bar)
with Δp_1: Pressure loss in piping due to acceleration of the fluid column.

$$\Delta p_1 = \frac{\varrho \cdot l \cdot dv}{dt} \cdot 10^{-5} \text{ (bar)}$$

ϱ = thickness of fluid (kg/m³)
l = pipe length (m)
dv/dt = Suction speed differential (m/s²)

Δp_2: Pressure loss through geographic altitude differences

$$\Delta p_2 = h \cdot \varrho \cdot g \cdot 10^{-5} \text{ (bar)}$$

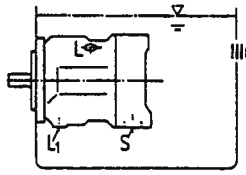
h = altitude (m)
ϱ = thickness of fluid (kg/m³)
g = acceleration of gravity (9.81 m/s²)

Δp_3: line losses (elbows, etc.)

This calculation is valid for controls DR, DFR, DFLR

2. Horizontal Installation

Installation should be so that port »L« or »L_1« is at the top of the unit.

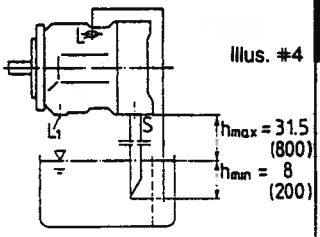


Illus. #3

2.1 Pump submerged in Reservoir

a) The minimum fluid level on the same level as or higher than the unit's upper surface: Connections »L/L_1« and »S« must be open (see illustration #3)

b) The minimum fluid level lower than the unit's upper surface: Connection »L« (or »L_1«) and possibly »S« must be piped, as per Illustration #4. Operating parameters as per Item 1.2.1.



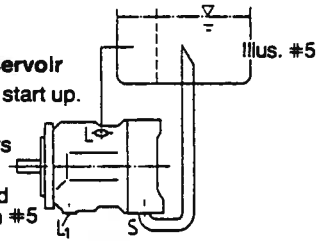
Illus. #4

2.2 Pump mounted outside of Reservoir

Pump housing must be filled prior to start up.

a) Above tank mounting as per Illustration #4. Operating parameters as per item 1.2.1.

b) Below tank mounting Ports »L« and »S« must be piped as per Illustration #5

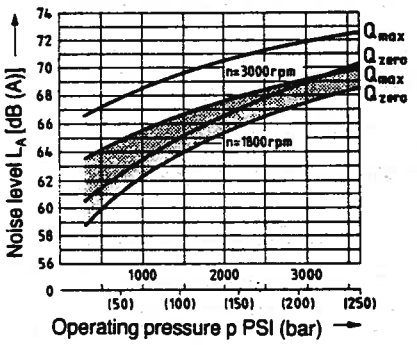


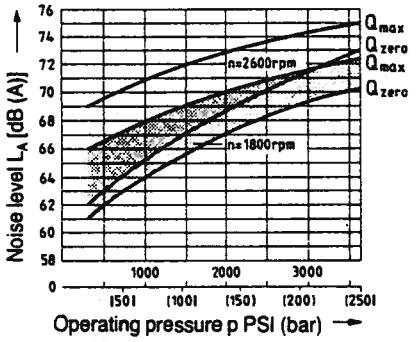
Illus. #5

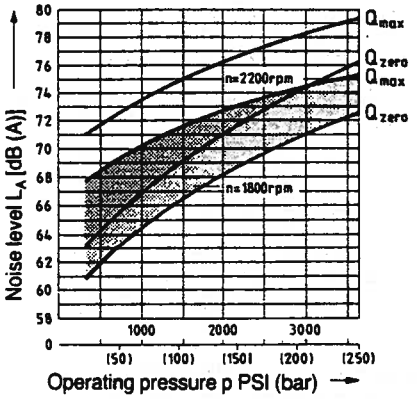
Operating curves with pressure compensator DR

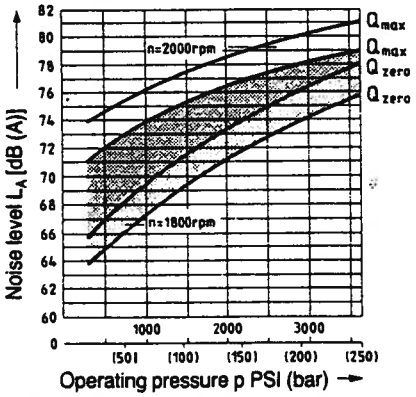
Noise level (standard range)

Measured in an anechoic chamber
Distance from microphone to pump = 3.28 ft (1 m)
Measurement error ±2 dB (A)
Fluid used: petroleum oil per ISO VG 46, DIN-standard #51519; temperature: 122° F (50° C)







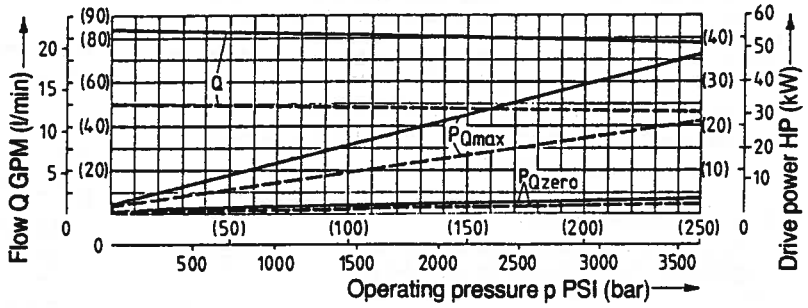


Drive power and output flow

(Fluid: petroleum oil per ISO VG 46, DIN-standard #51519, temperature 122° F (50° C)

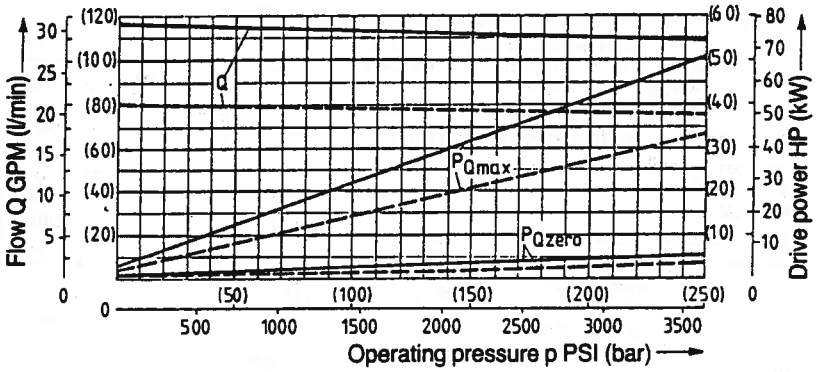
Size 28

------ n = 1800 rpm
_____ n = 3000 rpm



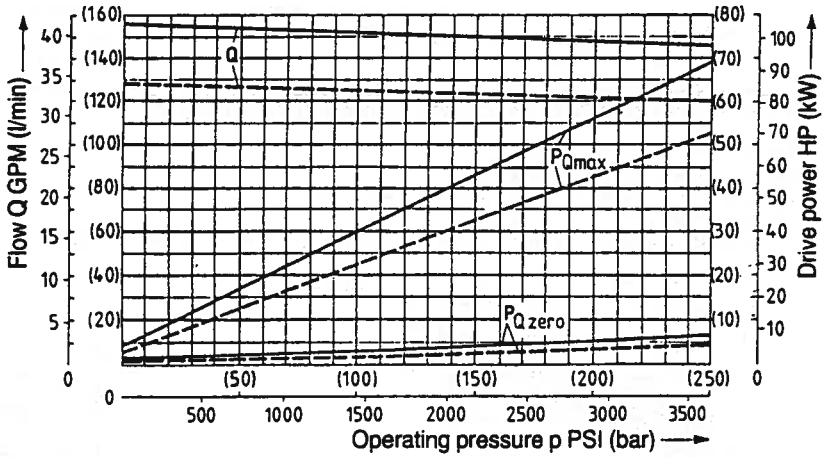
Size 45

------ n = 1800 rpm
_____ n = 2600 rpm



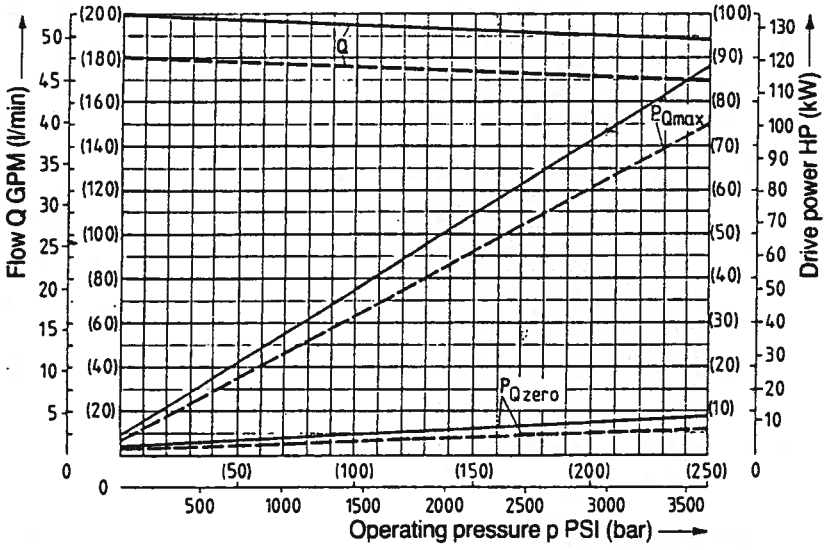
Size 71

------ n = 1800 rpm
_____ n = 2200 rpm



Size 100

------ n = 1800 rpm
_____ n = 2000 rpm



Overall efficiency:

$$\eta_t = \frac{Q \cdot p}{p_{Q\,max} \cdot 1714} \left(\frac{Q \cdot p}{p_{Q\,max} \cdot 600} \right)$$

Volumetric efficiency:

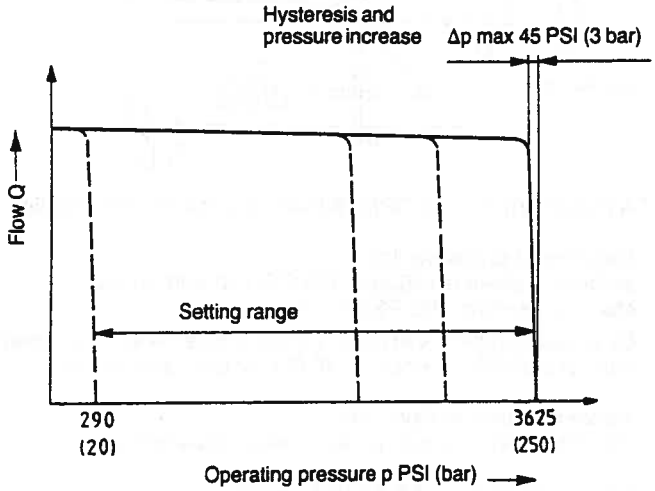
$$\eta_t = \frac{Q}{Q_{theor}}$$

Constant pressure compensator DR

The constant pressure compensator serves to maintain a constant pressure in a hydraulic system, within the control range of the pump. The pump supplies only the amount of hydraulic fluid required. Pressure may be steplessly set at the pilot valve.
Adjustable mechanical flow limiter from $V_{g\,max}$ to 50 % $V_{g\,max}$ only possible on model without through drive (N00).

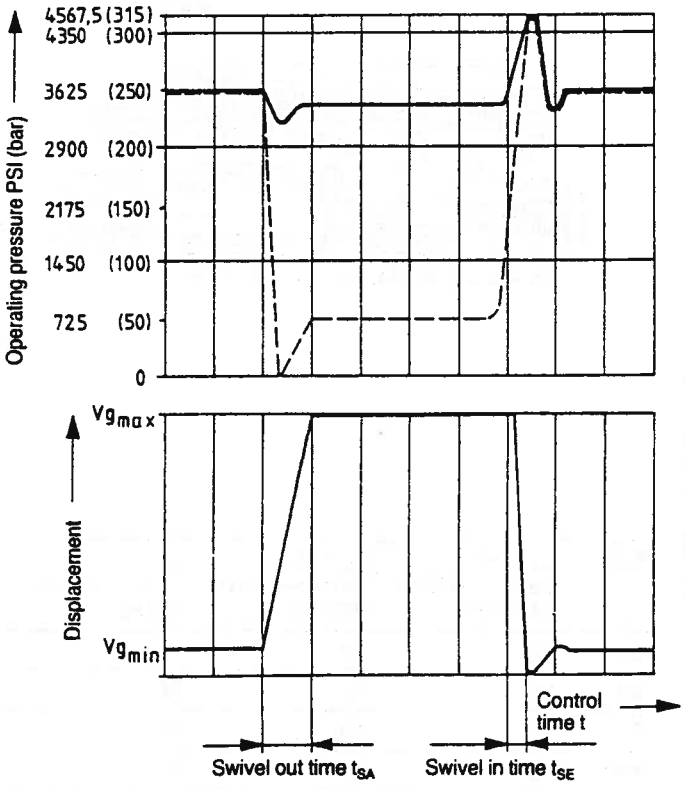
Static operating curve

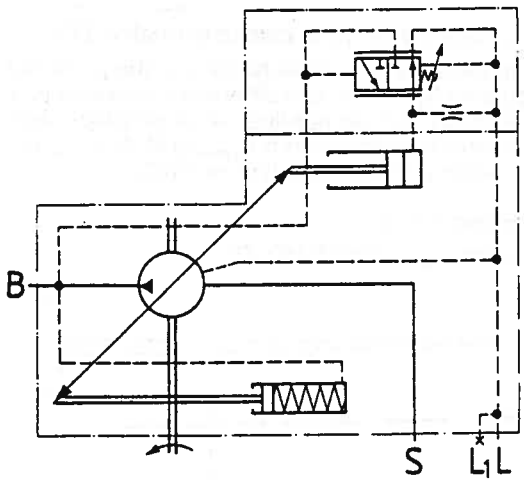
at n_1 = 1500 rpm; t_{oil} = 122° F (50° C)



Dynamic operating curves

Curves are measured average values under testconditions, with unit submerged.
Conditions: n_1 = 1500 rpm;
t_{oil} = 122° F (50° C)
relief set at 4570 PSI (315 bar)
Sudden closing of the pressure line, via relief valve DBD, approx. 3.28 ft (1 m) from the port plate of the pump.





0.80 GPM (3 l/min) pilot flow is required, taken from the high pressure side of the circuit.

Remote pressure control via port X of the flow control valve see page 9.

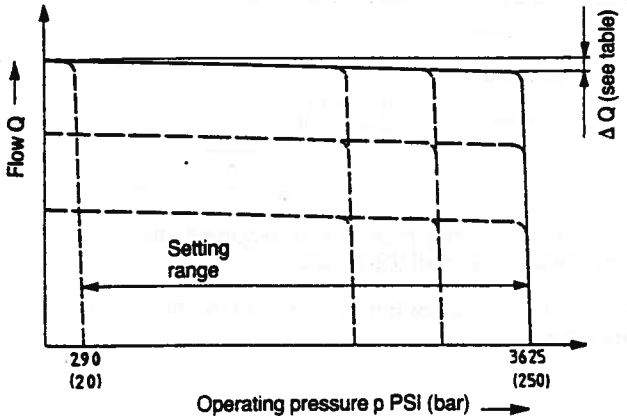
Size	t_{SA} (ms) toward 725 PSI (50 bar)	t_{SA} (ms) toward 3625 PSI (250 bar)	t_{SE} (ms) o-Displacement 3625 PSI (250 bar)
28	60	30	20
45	80	40	20
71	100	50	25
100	200	100	25

Constant pressure/flow compensator DFR

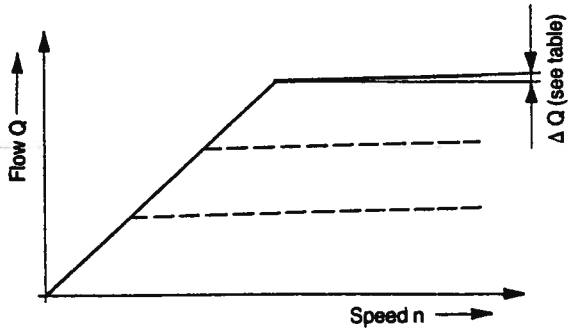
In addition to the constant pressure control, the pump flow may be regulated by means of a differential pressure (e. g. an orifice installed in the service line) »load sensing«. Adjustable mechanical flow limiter from $V_{g\,max}$ to 50 % $V_{g\,max}$ only possible on model without through drive (N00).

Static operating curve

at n_1 = 1500 rpm; t_{oil} = 122° F (50° C)



Static operating curve at variable speed



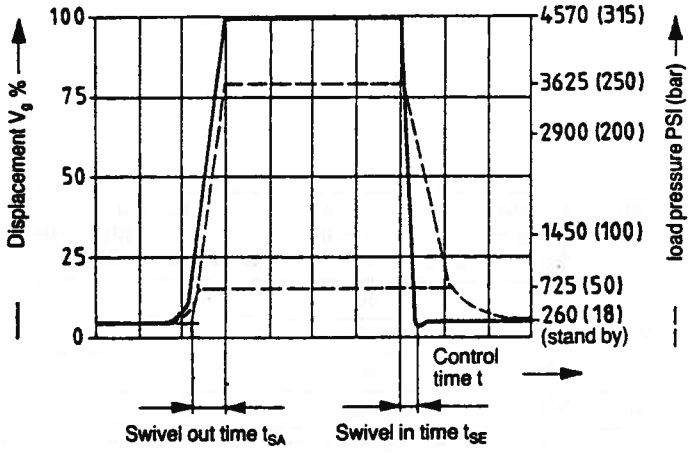
Max. flow variation

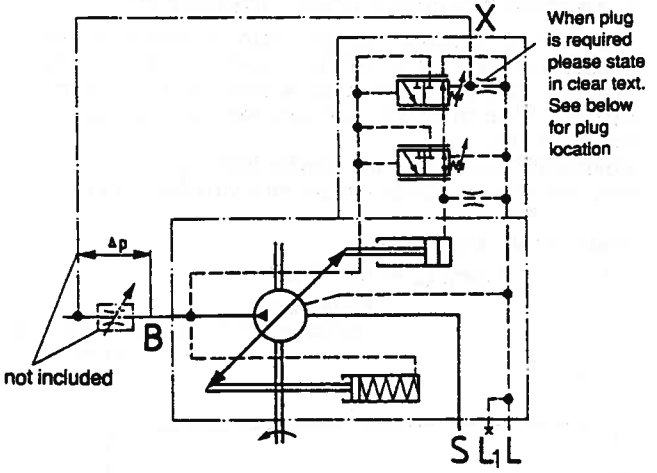
(Hysteresis and increase)
measured at drive speed n = 1500 rpm

Size		28	45	71	100
ΔQ	Gpm (l/min)	0.26 (1)	0.48 (1.8)	0.74 (2.8)	1.06 (4.0)

Dynamic operating curve

Curves are measured average values under test conditions, with unit submerged.





A maximum of 1.32 GPM (5 l/min) is required for pilot flow.

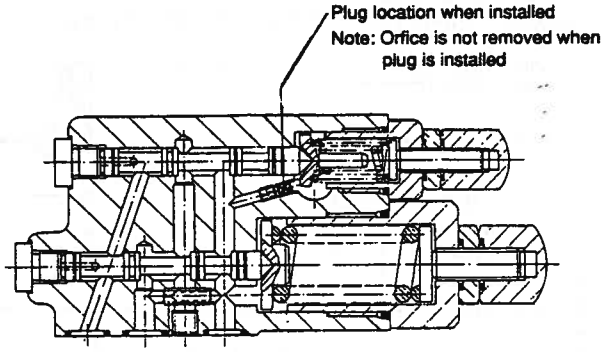
Differential pressure Δp:
settable between 145 and 435 PSI (10 and 30 bar)
standard setting 205 PSI (14 bar)

By unloading port X to tank, a zero stroke (deadhead) pressure of 260 PSI (18 bar) ± 30 PSI (2 bar) is achieved.

Valve options at Port »B«

(not included in pump, to be ordered separately)

Mobile valve block SP 12 (RA 64144)
Mobile valve block SP 18 (RA 64147)
Mobile valve block MP 18 (RA 64594)
Mobile valve block MP 22 (RA 64598)
Proportional valve 4WRE (RA 29060)



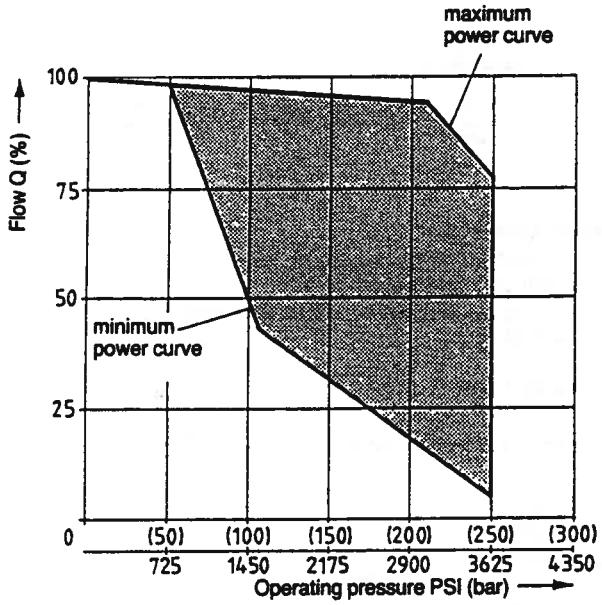
Size	t_{SA} (ms) stand by–250 bar 3625 PSI	t_{SE} (ms) 250 bar–stand by 3625 PSI	t_{SE} 50 bar–stand by 725 PSI
28	40	20	40
45	50	25	50
71	60	30	60
100	120	60	120

Constant pressure/flow/power control DFLR

In order to achieve a constant drive torque with a varying operating pressure, the swivel angle and with it the output flow of the axial piston pump is varied so that the product of flow and pressure remains constant.

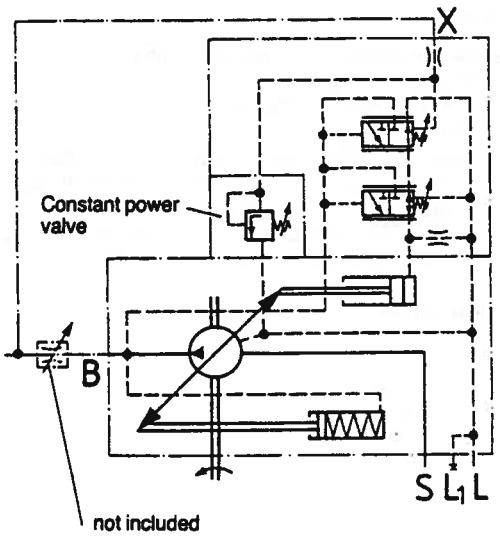
Below the power curve, it is possible to control the output flow.
Adjustable mechanical flow limiter from $V_{g\,max}$ to 50 % $V_{g\,max}$ only possible on model without through drive (N00).

Static operating curve



Begin of regulation at 725 PSI (50 bar)

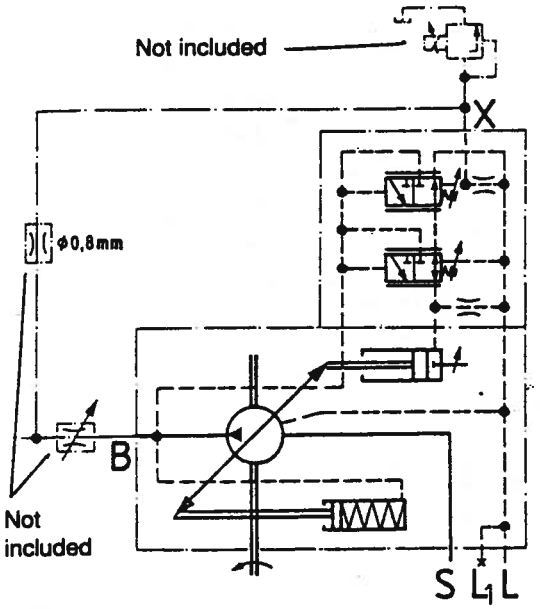
When ordering, please state power setting in clear text, e. g. 7 1/2 HP at 1800 rpm (5 kW at 1500 rpm).



A maximum of 1.45 GPM (5.5 l/min) pilot flow is required.

By unloading port X to tank, a zero stroke (deadhead) pressure of 260 PSI (18 bar) ± 30 PSI (2 bar) is achieved (»stand by«).

Optional remote pressure compensation
(by using the DFR valve)



This option is assembled by customer at time of installation. Therefore the pressure relief valve, throttle valve and orifice ø0.031in (ø0.8mm) are not included with the DFR control. As a pressure relief valve we would recommend:

DBDH-6 hydraulic (RA 25 402);
DBET-30 electrical (RA 29 142);
DBETR electrical (RA 29 166).

Note that remote relief valve is used as a pilot on the "X" port of FR valve. So the FR spool must function even if load sensing is not needed.

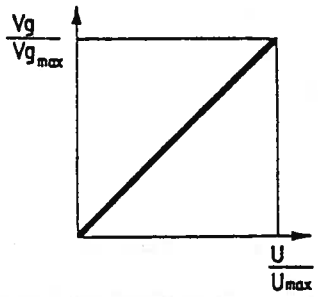
Throttle valve at "B" port is only used to illustrate load sensing or flow control if desired. This throttle is not necessary for proper operation of remote pressure control. The ø0.031in (ø0.8mm) orifice in the sensing line is needed, and must be supplied by the customer.

Max. line length should not exceed 6-1/2 ft (2m).

Electrical flow control FE

The pump displacement is controlled via an electrically operated proportional pilot valve.
The pump position feedback is realized via an inductive positional transducer.
The amplifier card VT 5036 (see page 11 and also RA 29957) regulates the pumpflow. This card is not an integral part of the pump and must be ordered separately.
Adjustable mechanic flow limiter from $V_{g\,max}$ to 50 % $V_{g\,max}$ only possible on model without throughdrive (N00).

Static operating curve

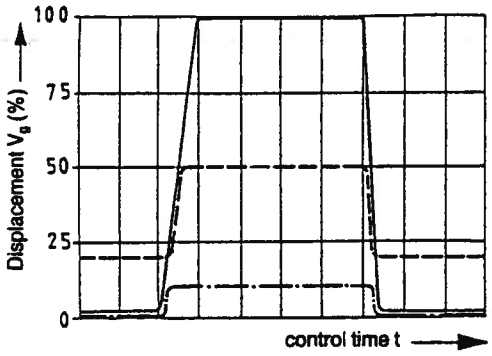


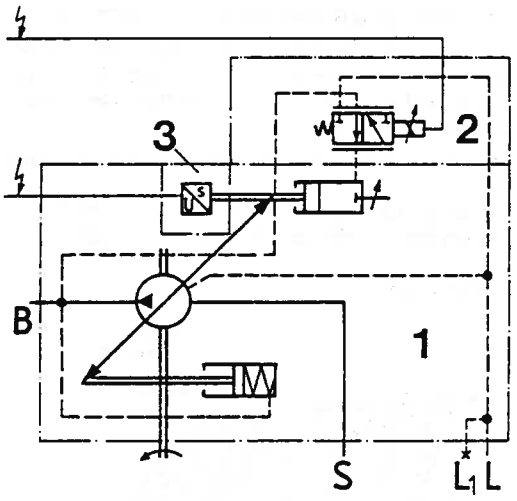
Hysteresis: ≤ ± 1 % of $V_{g\,max}$
Repeatibility: ≤ ± 1 %

Dynamic operating curve

Flow step between two different orifices upon sudden changeover.

Flow/time-curve





Design elements

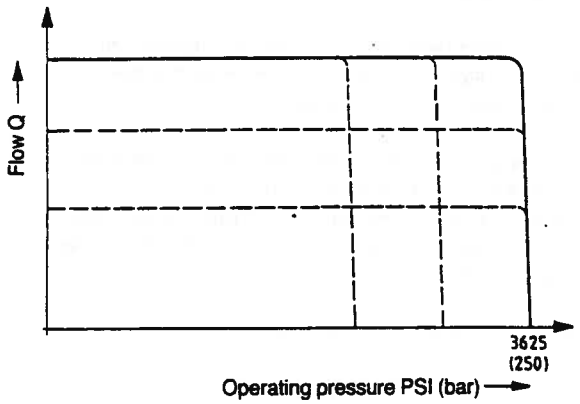
1) AA10VSO with hydraulic control
2) Control valve ENV 202-4-0
3) Inductive positional-transducer (feedback) type IW9-03-01

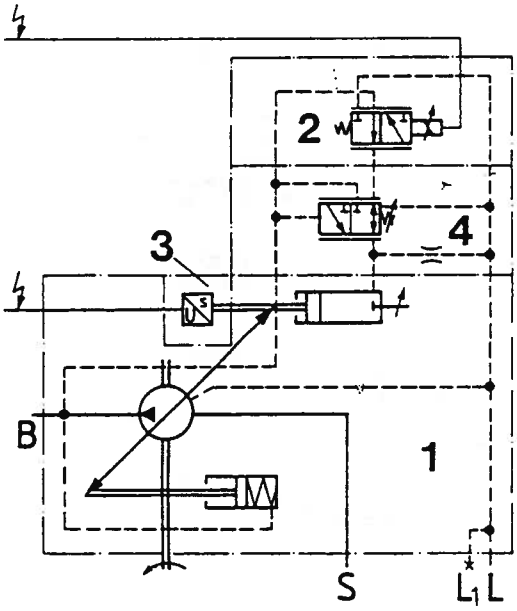
Technical Data

min. required pilot pressure	290 PSI (20 bar)
Control Valve	
current type	DC
supply voltage	24 V
load resistance at 68°F (20°C)	12 Ω
operating time	100%
ambient temperature	...122°F (50°C)
spool temperature	...302°F (150°C)
insulation per DIN 40050	IP 65
isolation class per VDE 0580	F
Inductive positional transducer:	
frequency range	1000 Hz... 5000Hz
inductivity	9.5 mH

Variation: electrical flow control with pressure compensation FED

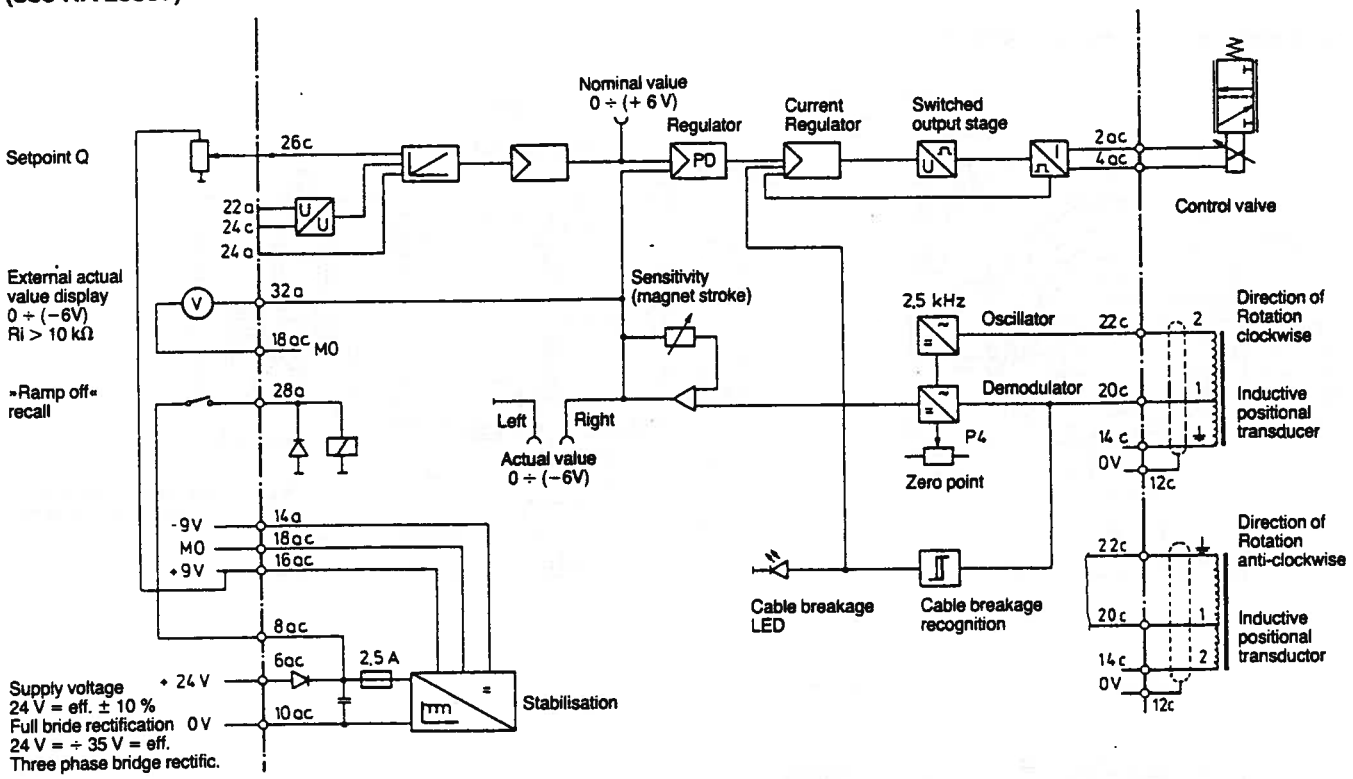
This variation incorporates an additional valve (Pos. 4) into the control, so that a hydraulic pressure compensation function is also available.





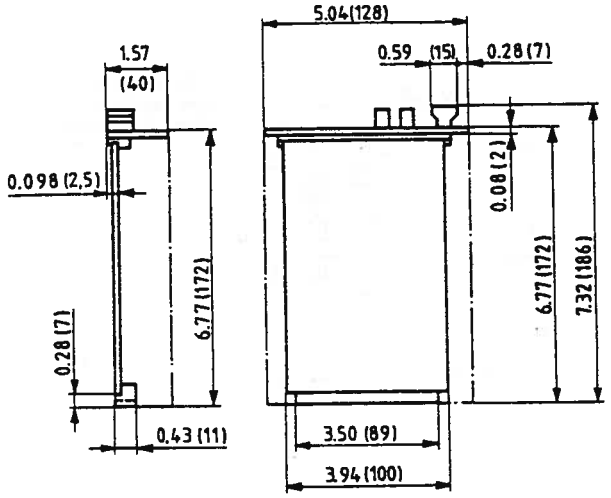
Proportional amplifier card VT 5036

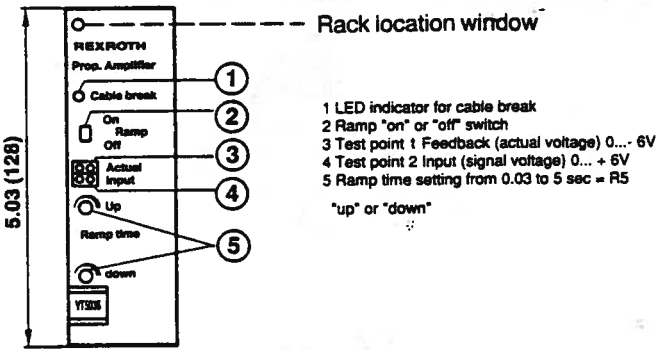
(see RA 29957)



- The amplifier may only be unplugged when switched off!
- Measurements to be made with a high resistance meter set on the voltage range!
- Measured (control) zero (M 0) is raised + 9 V with respect to 0 V of the power supply!
- M 0 may NOT be connected to 0 V of the power supply!
- The »earth« sign of the inductive positional transducer may NOT be connected to (0 V) of the supply voltage!
- Radio transmitter may not be placed within 3.6 Ft (1M) of this cardl
- Command level inputs may only be switched with dry contact switches suitable for currents of < 1 mA.
- Screen all input lines. Leave one end of the screen open. Connect one end to 0 V of the supply line!
- Do not lay solenoid lines close to power lines!

Dimensions





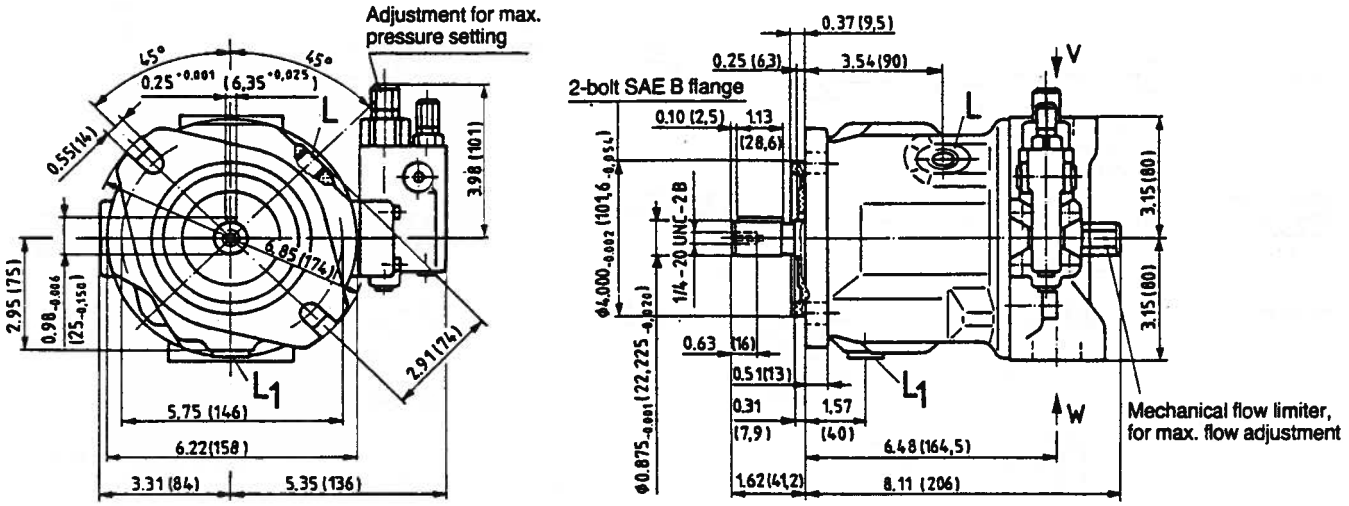
1 LED indicator for cable break
2 Ramp "on" or "off" switch
3 Test point 1 Feedback (actual voltage) 0...- 6V
4 Test point 2 Input (signal voltage) 0... + 6V
5 Ramp time setting from 0.03 to 5 sec = R5

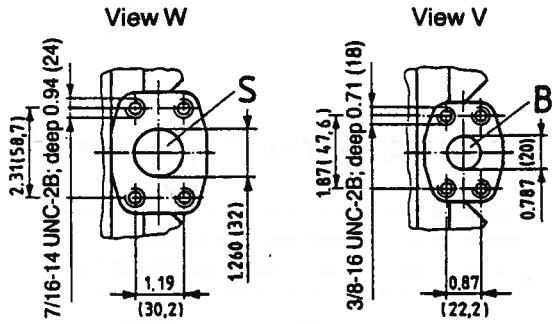
"up" or "down"

Unit dimensions, Size 28

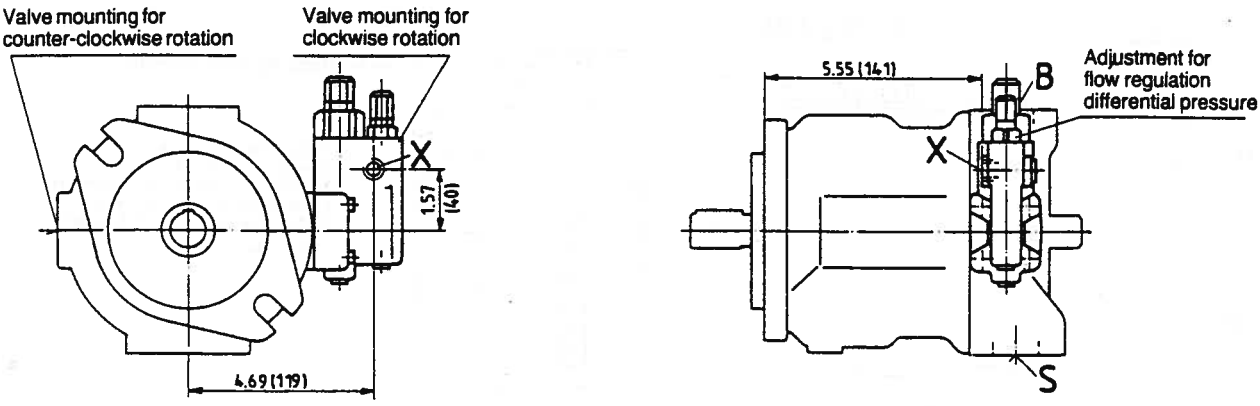
Model **N00** (without through drive)

Constant pressure compensator DR

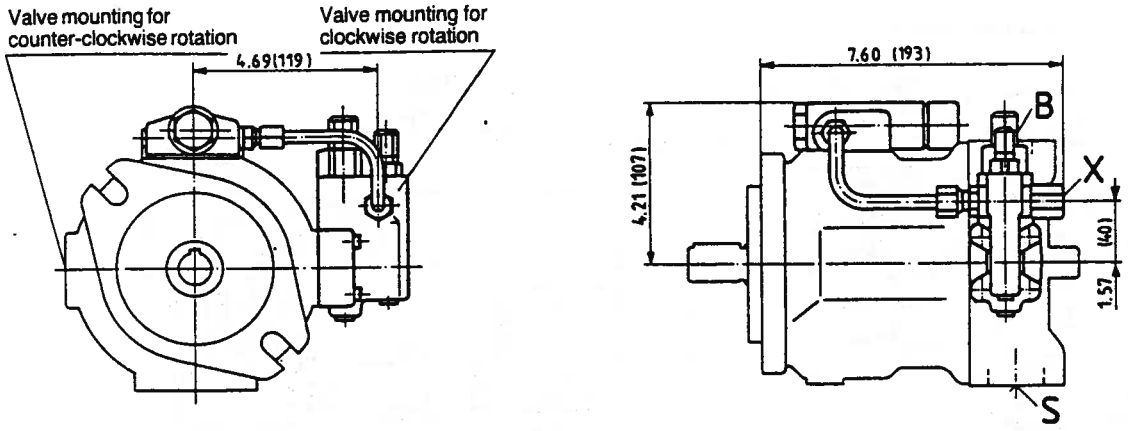




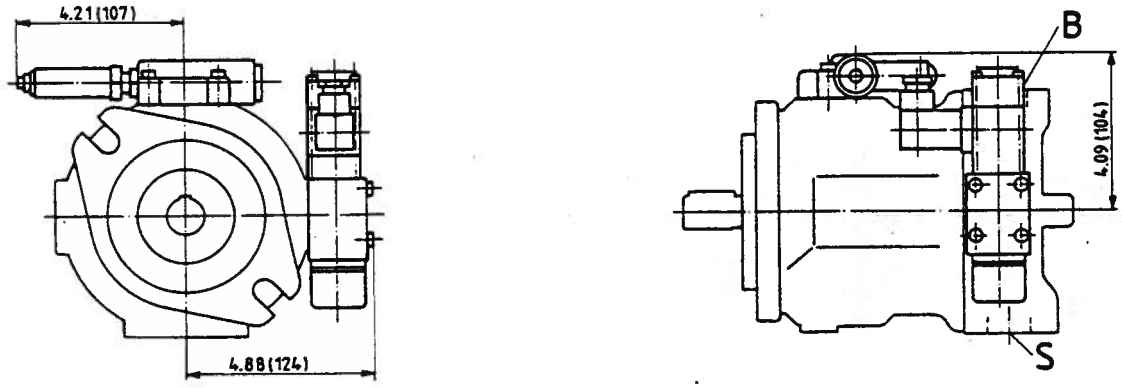
Constant pressure/flow compensator DFR



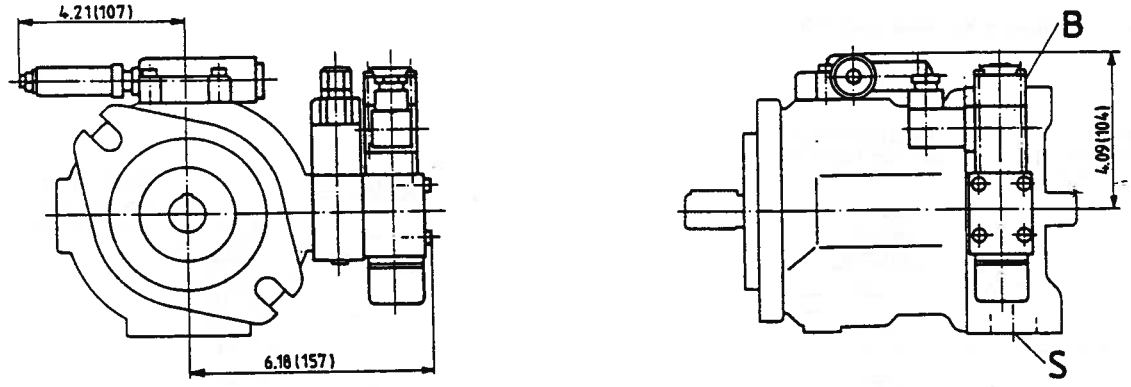
Constant pressure/flow/power control DFLR



Electrical flow control FE



Electrical flow control with pressure compensation FED



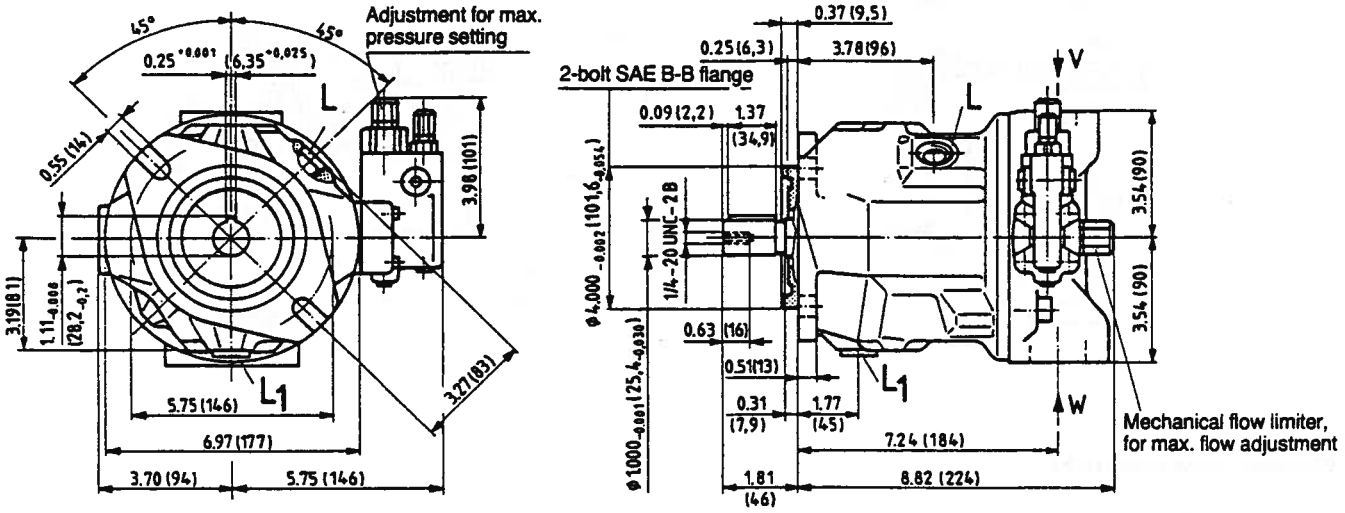
Port connections

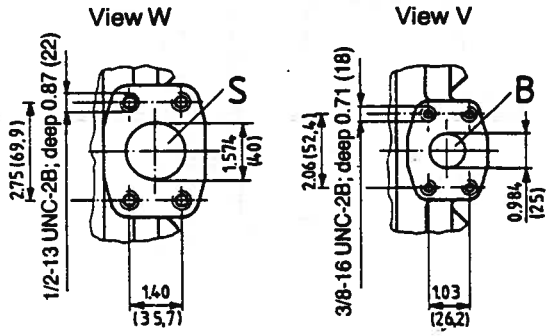
B	pressure port:	3/4" SAE flange (standard pressure range)
S	suction port:	1 1/4" SAE flange (standard pressure range)
X	pilot pressure port:	(for DFR and DFLR) 7/16-20 UNF-2B; deep 0.39(10)
L, L_1	case draining ports:	3/4-16 UNF-2B

Unit dimensions, Size 45

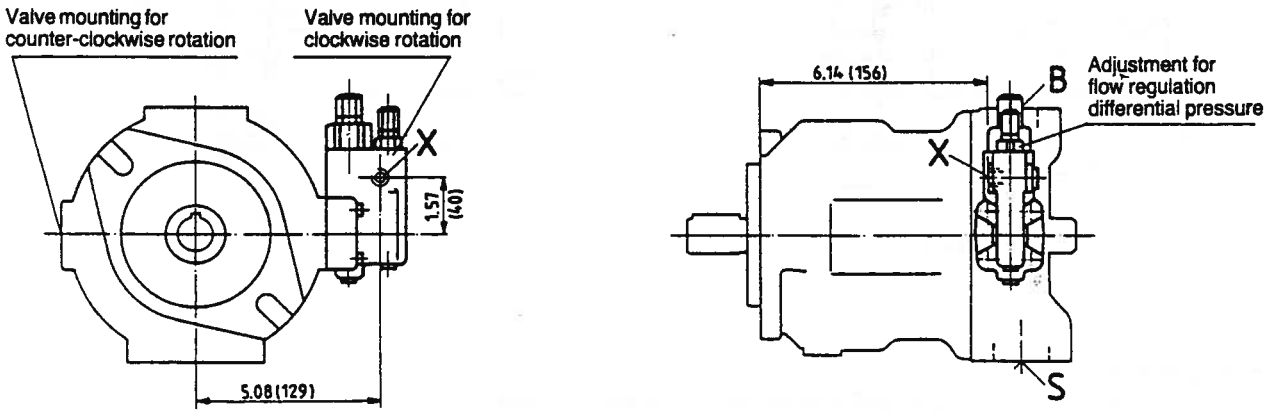
Model **N00** (without through drive)

Constant pressure compensator DR

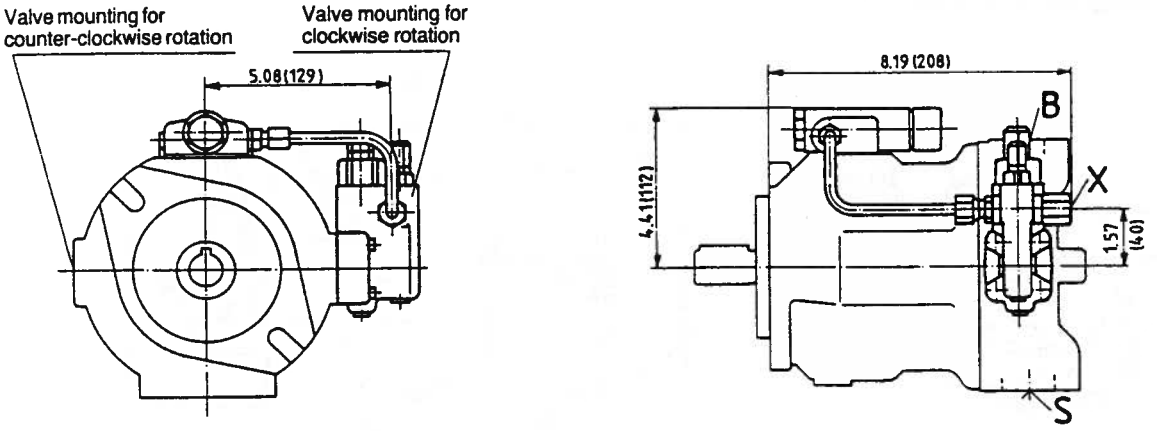




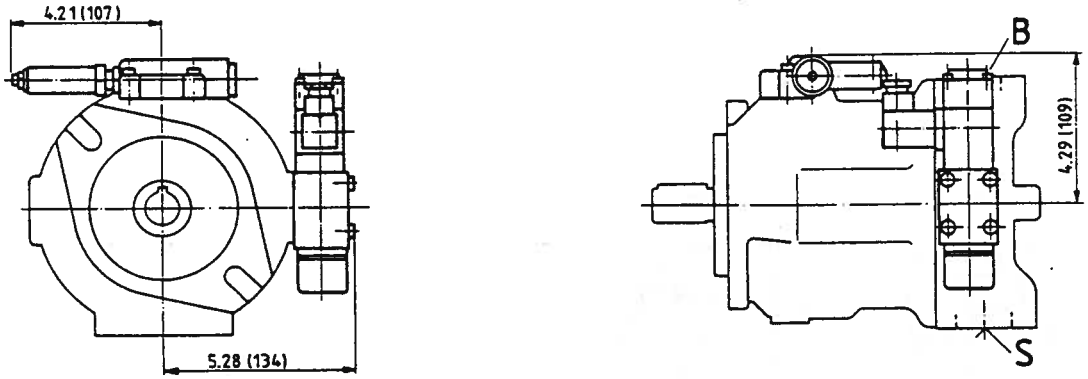
Constant pressure/flow compensator DFR



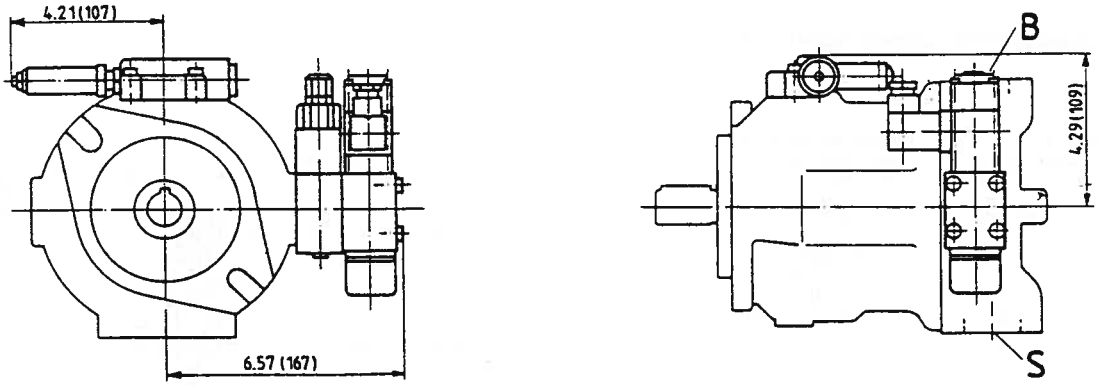
Constant pressure/flow/power control DFLR



Electrical flow control FE



Electrical flow control with pressure compensation FED



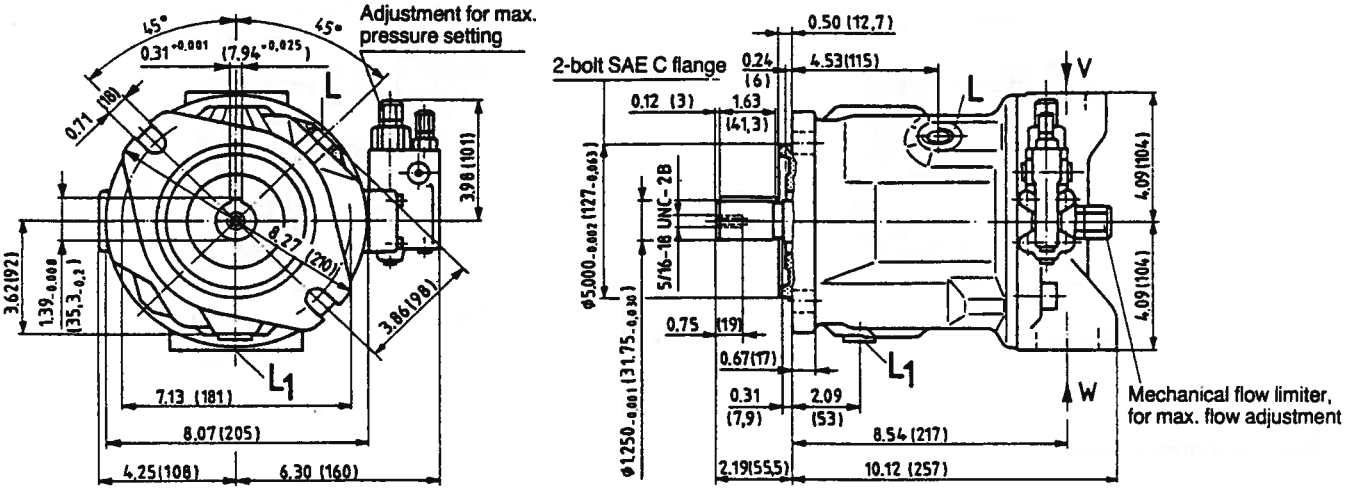
Port connections

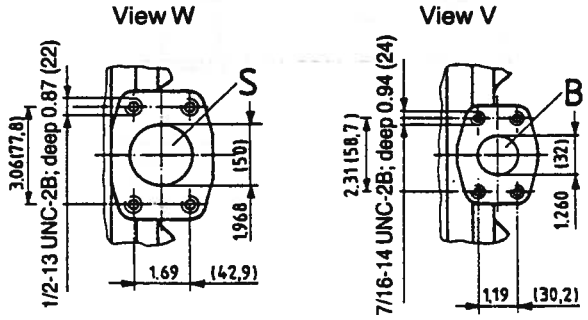
B	pressure port:	1" SAE flange (standard pressure range)
S	suction port:	1 1/2" SAE flange (standard pressure range)
X	pilot pressure port:	(for DFR and DFLR) 7/16-20 UNF-2B; deep 0.39(10)
L, L_1	case draining ports:	7/8-14 UNF-2B

Unit dimensions, Size 71

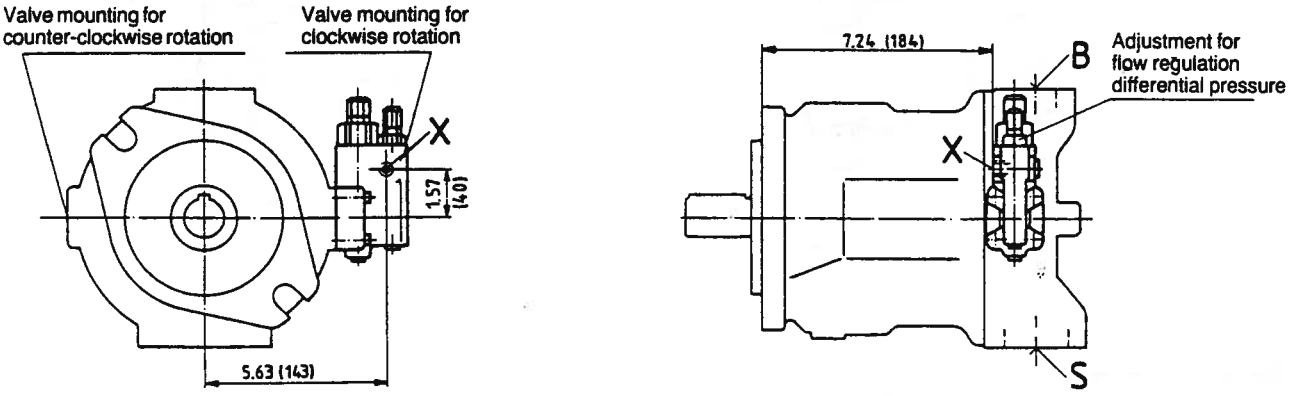
Model **N00** (without through drive)

Constant pressure compensator DR

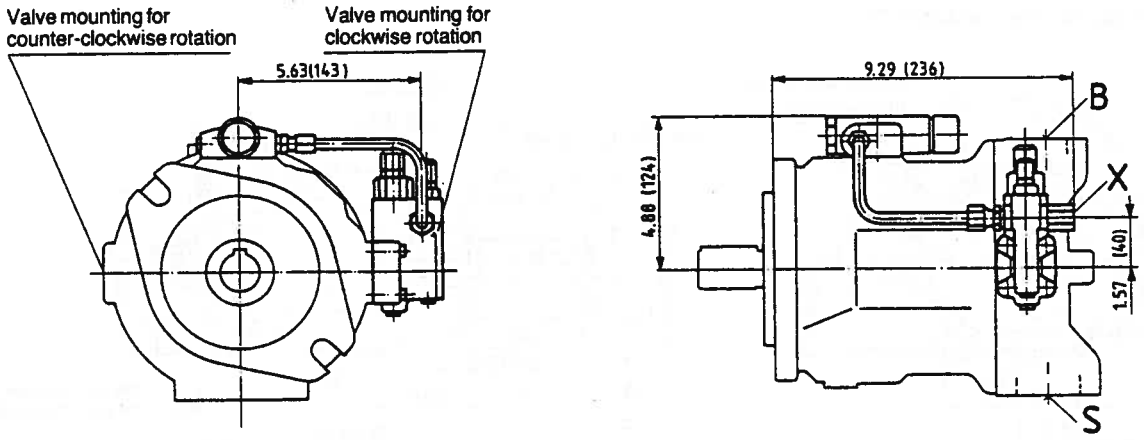




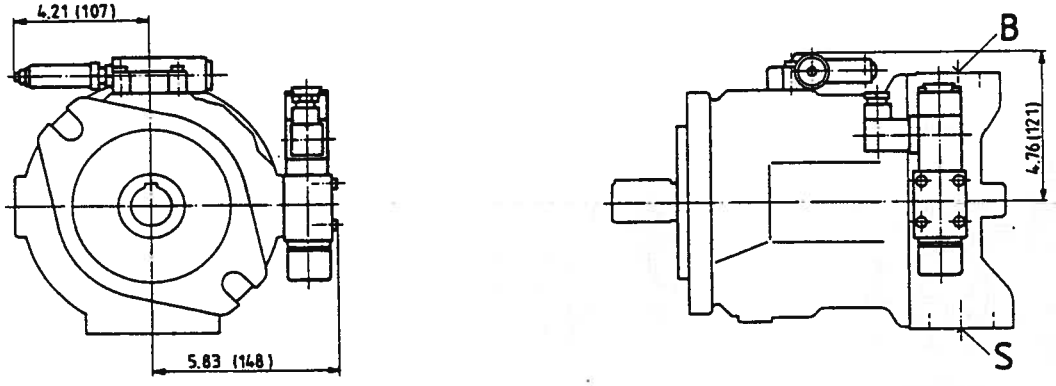
Constant pressure/flow compensator DFR



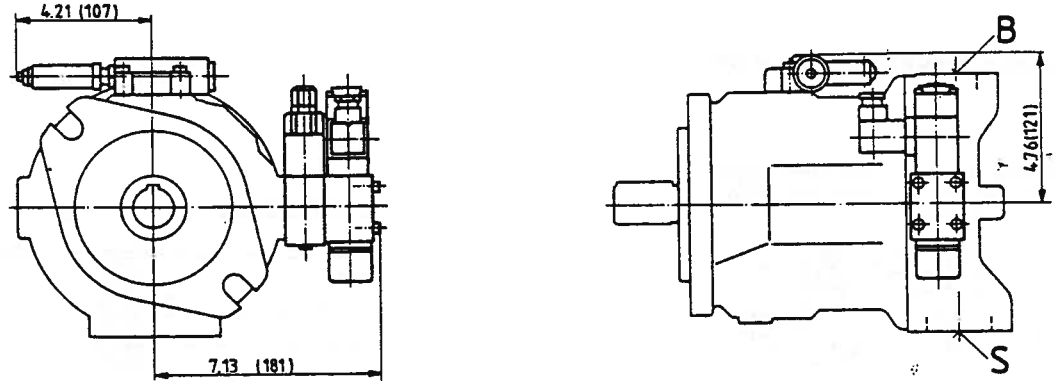
Constant pressure/flow/power control DFLR



Electrical flow control FE



Electrical flow control with pressure compensation FED



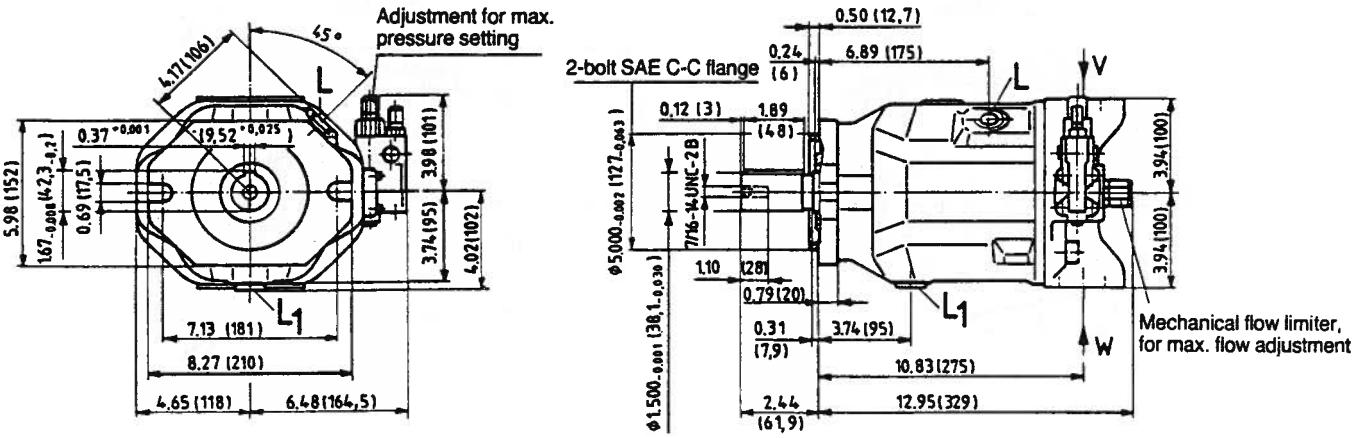
Port connections

B	pressure port:	1 1/4" SAE flange (standard pressure range)
S	suction port:	2" SAE flange (standard pressure range)
X	pilot pressure port:	(for DFR and DFLR) 7/16-20 UNF-2B; deep 0.39(10)
L, L_1	case draining ports:	7/8-14 UNF-2B

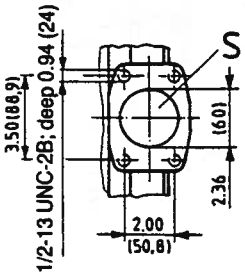
Unit dimensions, Size 100

Model **N00** (without through drive)

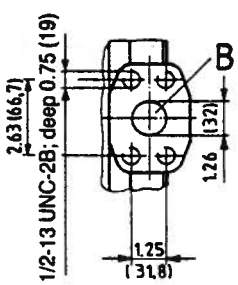
Constant pressure compensator DR



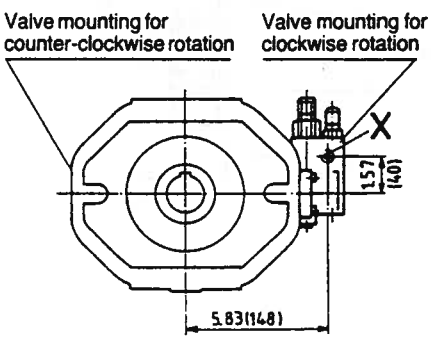
View W

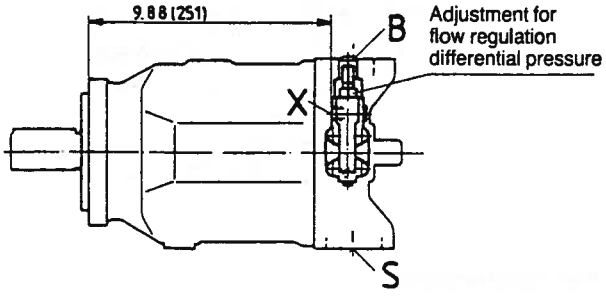


View V

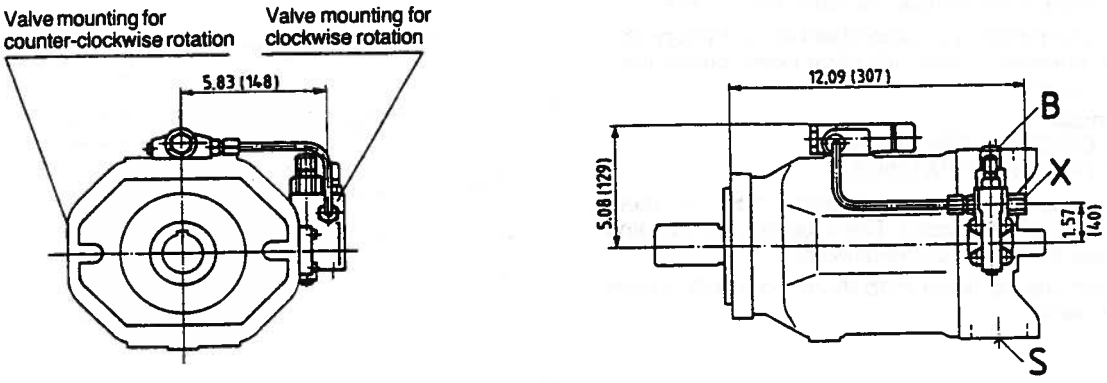


Constant pressure/flow compensator DFR

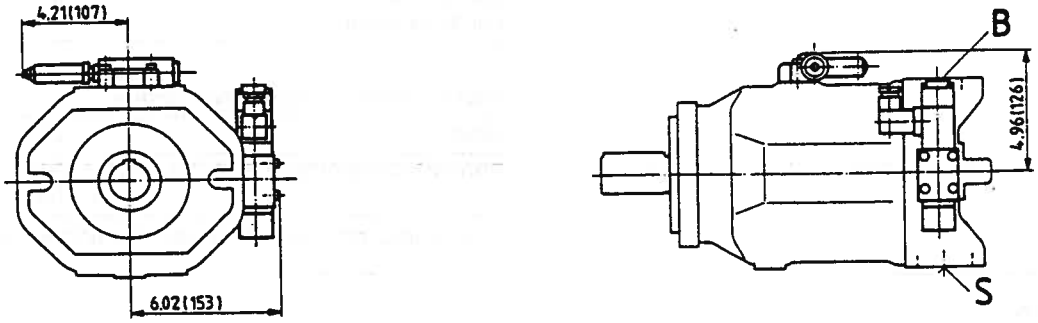




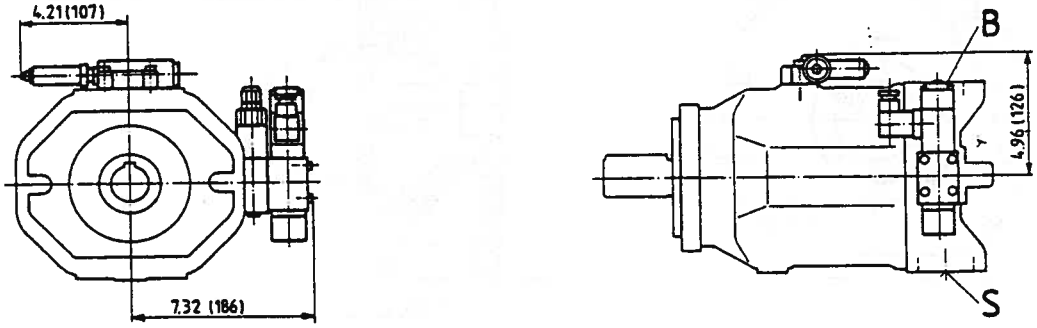
Constant pressure/flow/power control DFLR



Electrical flow control FE



Electrical flow control with pressure compensation FED



Port connections

B	pressure port:	1 1/4" SAE flange (6000 PSI, flange)
S	suction port:	2 1/2" SAE flange (standard pressure range)
X	pilot pressure port:	(for DFR and DFLR) 7/16-20 UNF-2B; deep 0.39(10)
L, L_1	case draining ports:	7/8-14 UNF-2B

Through Drive

Axial piston unit AA10VSO may be supplied with a through drive, as indicated in the ordering code page 2.

The Through Drive is determined by index (K01 – K08).

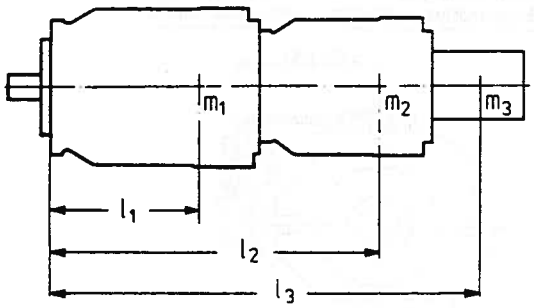
If the combination pumps are assembled in the factory, the ordering code consists of the individual pump codes connected by »+« signs.

Ordering Example:
AA10VSO 71 DR/30 R – PPA12K25 +
AA10VSO 28 DR/30 R – PPA12N00

If the second pump has not to be delivered resp. mounted, the simple type code is sufficient. The coupling, the seal and the fixing screws are a part of the delivery.

We recommend that no more than three individual pumps are coupled in series.

Permissible bending moment at mounting flange



$M_m = m_1 \times l_1 + m_2 \times l_2 + m_3 \times l_3$

Size			28	45	71
Bending Moment	M_m	lb-ft (Nm)	101 (137)	159 (216)	253 (343)
Weight (approx.)	M_1	lbs (kg)	33 (15)	46 (21)	73 (33)
Distance to center of gravity	l_1	in (mm)	4.33 (110)	5.12 (130)	5.91 (150)

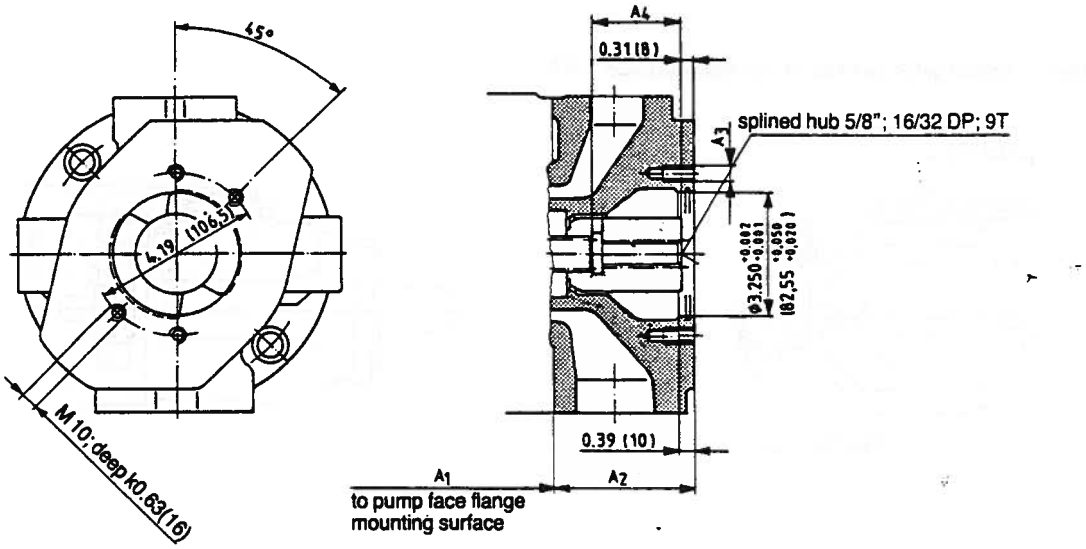
Permissible through drive torque

Size			28	45	71
Through drive torque*	M_D	lb-ft (Nm)	33 (45)	52 (70)	81 (110)

* assuming max. torque through the primary pump

Unit dimensions

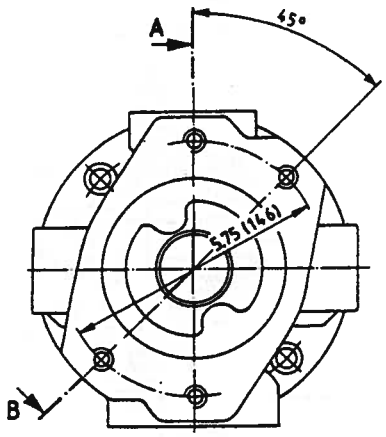
SAE A for mounting of secondary pump,
order code **K01**



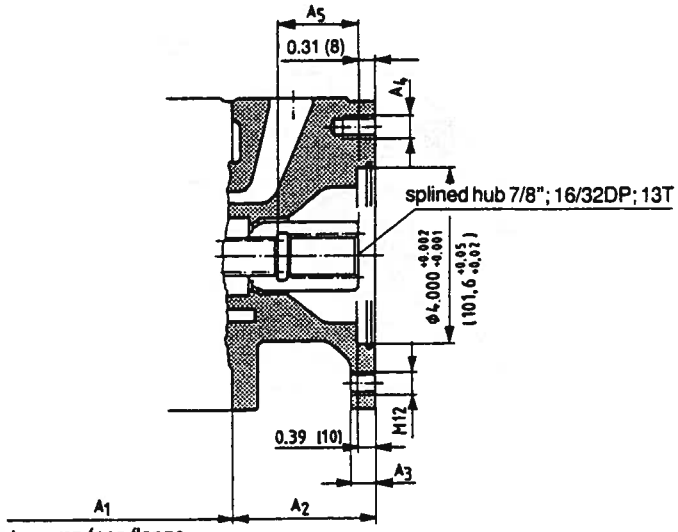
Size	A_1	A_2	A_3	A_4
28	5.268 (133.8)	2.76 (70)	M10; deep 0.63 (16)	1.49 (38)
45	5.858 (148.8)	3.15 (80)	M10; deep 0.63 (16)	1.73 (44)
71	6.960 (176.8)	3.54 (90)	M10; deep 0.79 (20)	2.05 (52)

SAE B for mounting of secondary pump,
order code **K02**

primary pump sizes 45 and 71

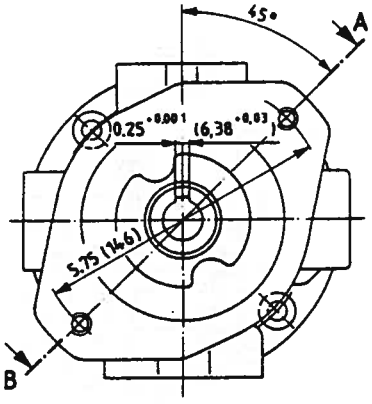


cutaway A – B

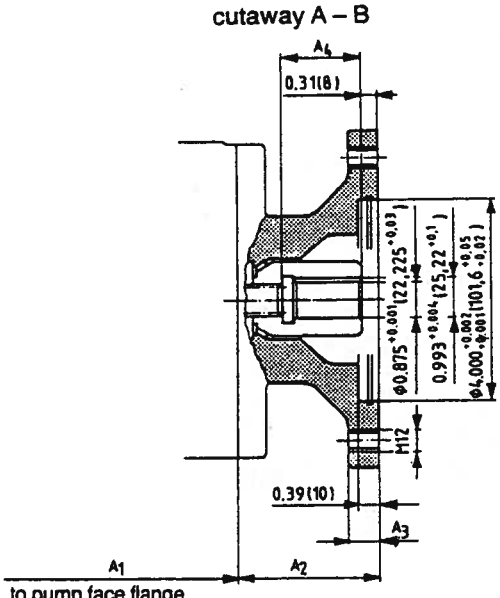


Size	A_1	A_2	A_3	A_4	A_5
45	5.858 (148.8)	3.15 (80)	0.55 (14)	M12; deep 0.71 (18)	1.73 (44)
71	6.960 (176.8)	3.54 (90)	0.71 (18)	M12; deep 0.79 (20)	2.05 (52)

Mounting of an AA10VSO 28;
order code **K 03**



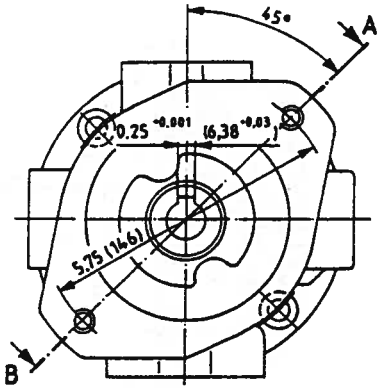
cutaway A – B



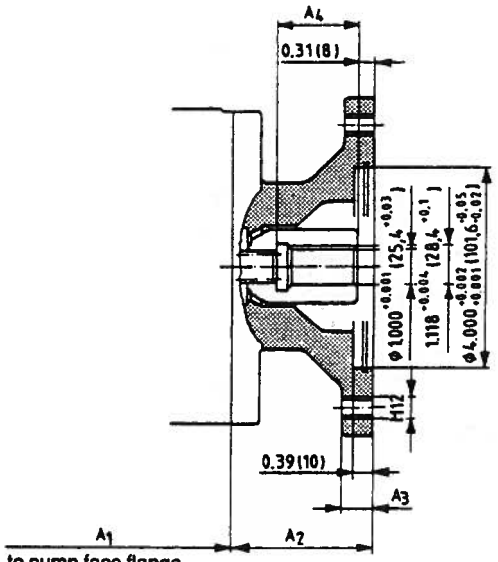
Size	A_1	A_2	A_3	A_4
28	5.268 (133.8)	2.76 (70)	0.59 (15)	1.49 (38)
45	5.858 (148.8)	3.15 (80)	0.55 (14)	1.73 (44)
71	6.960 (176.8)	3.54 (90)	0.71 (18)	2.05 (52)

Mounting of an AA10VSO 45;
order code **K 05**

primary pump sizes 45 and 71



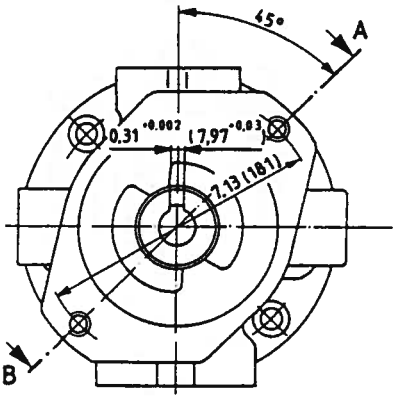
cutaway A – B

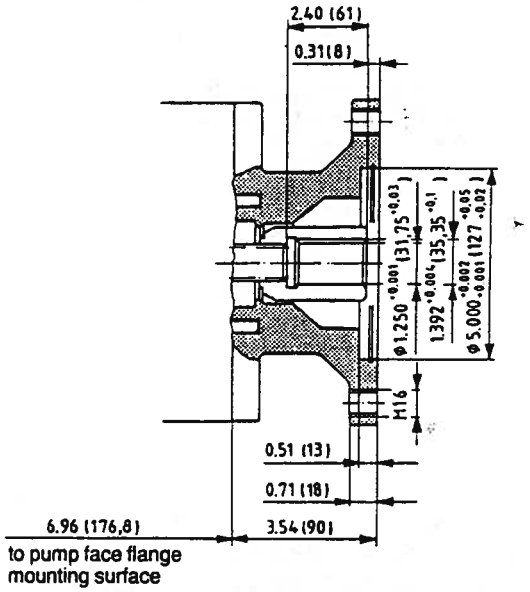


Size	A_1	A_2	A_3	A_4
45	5.858 (148.8)	3.15 (80)	0.55 (14)	1.73 (44)
71	6.960 (176.8)	3.54 (90)	0.71 (18)	2.05 (52)

Mounting of an AA10VSO 71;
order code **K 08**
primary pump size 71

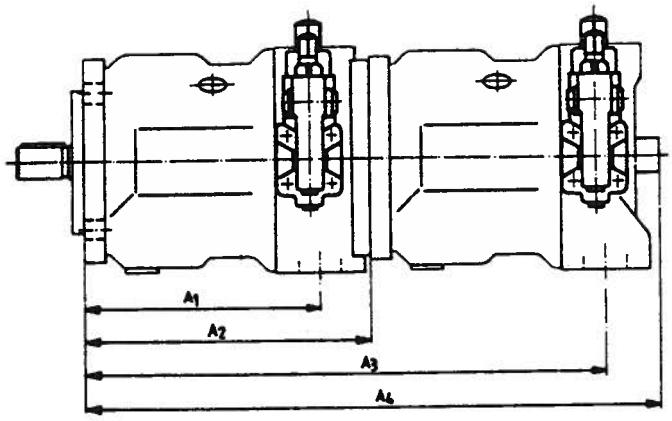
cutaway A – B





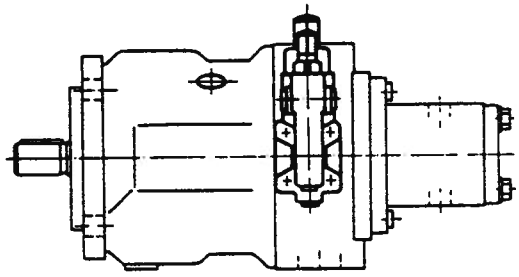
Unit dimensions, combination pumps

AA10VSO + AA10VSO



Primary pump / secondary p.	AA10VSO 28				AA10VSO 45				AA10VSO 71			
	A_1	A_2	A_3	A_4	A_1	A_2	A_3	A_4	A_1	A_2	A_3	A_4
AA10VSO 28	6.46 (164)	8.03 (204)	14.49 (368)	16.14 (410)	7.24 (184)	9.02 (229)	15.47 (393)	17.13 (435)	8.54 (217)	10.51 (267)	16.97 (431)	18.62 (473)
AA10VSO 45	–	–	–	–	7.24 (184)	9.02 (229)	16.26 (413)	17.83 (453)	8.54 (217)	10.51 (267)	17.76 (451)	19.13 (491)
AA10VSO 71	–	–	–	–	–	–	–	–	8.54 (217)	10.51 (267)	19.06 (484)	20.63 (524)

AA10VSO + Gearpump*



*Specify complete pump code see page 2

THE REXROTH CORPORATION
INDUSTRIAL HYDRAULICS DIVISION, P.O. Box 2407, 2315 City Line Road, Bethlehem, PA 18017-2131, Phone (215) 694-8300, Telex 84-7498
MOBILE HYDRAULICS DIVISION, P.O. Box 394, 1700 Old Mansfield Road, Wooster, OH 44691-0394, Phone (216) 263-3400, Telex 98-6335

REXROTH
WORLDWIDE HYDRAULICS

AA 10 VSO Series 30
Spare Parts List

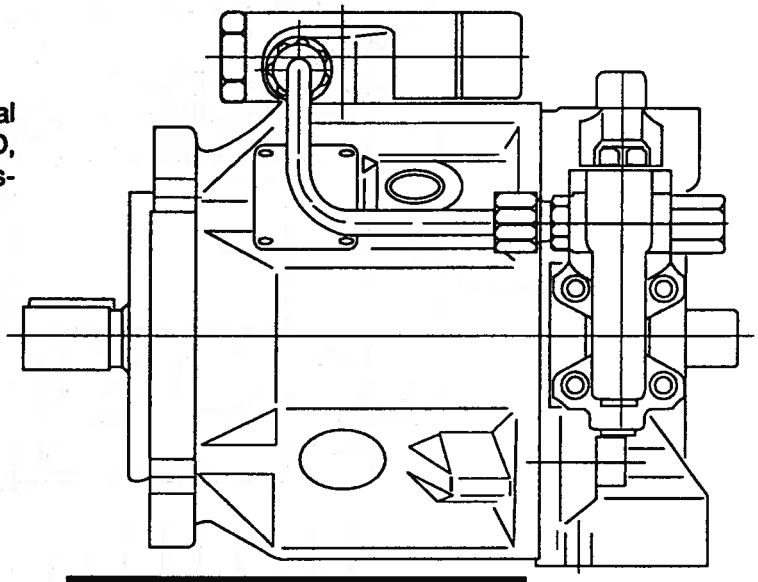
Sizes 28 to 100 | ... 4570 PSI (... 315 bar) | ... 6.10 in³/rev (... 100 cm³/rev)

RA - E 06 291/09.88

Replaces: 02.88

Introduction

This parts list identifies all assemblies and individual parts contained in 24 of the most common AA10VSO, Series 30 pumps (see page 2). Views are cross-sectional.



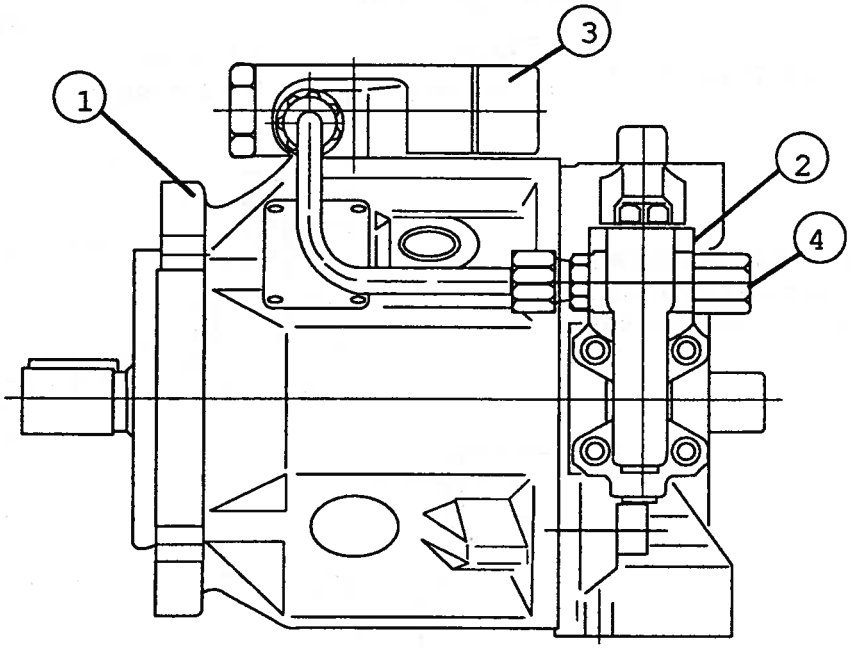
How to Find a Spare Part in this Brochure

First find the item by position number, in the section in which the part is contained, then simply locate the "X" in the appropriate model column and read the part number under the heading "Brueninghaus Part Number" (see example on right)

Description & Quantity	Position	Brueninghaus Part Number	"Model" columns																							
			AA10VSO.28.DFLR/3OR-PKC62N00	AA10VSO.28.DFLR/3OR-VKC62N00	AA10VSO.28.DFR/3OR-VKC62K01	AA10VSO.28.DFR/3OR-PKC62N00	AA10VSO.28.DFR/3OR-VKC62K03	AA10VSO.45.DFR/3OL-PKC62N00	AA10VSO.45.DFR/3OR-PKC62K01	AA10VSO.45.DFR/3OR-PKC62K03	AA10VSO.45.DFR/3OR-PKC62K05	AA10VSO.45.DFR/3OR-PKC62N00	AA10VSO.71.DFLR/3OR-PKC62N00	AA10VSO.71.DFR/3OL-PKC61N00	AA10VSO.71.DFR/3OR-PKC61N00	AA10VSO.71.DFR/3OR-PKC62K01	AA10VSO.71.DFR/3OR-PKC62K02	AA10VSO.71.DFR/3OR-PKC62K03	AA10VSO.71.DFR/3OR-PKC62K08	AA10VSO.71.DFR/3OR-PKC62N00	AA10VSO.71.DR/3OR-PKC62K01	AA10VSO.100.DFLR/3OR-PKC62N00	AA10VSO.100.DFR/3OR-PKC62K-S080	AA10VSO.100.DFR/3OR-PKC62K38-S079	AA10VSO.100.DFR/3OR-PKC62N00	AA10VSO.100.DFR/30R-PKC62K01
O-Ring - 1	(21)	574953	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		919322		X			X																			
		976302	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		247003		X			X																			
		513415	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		514098		X			X																			
		907099	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		907100	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		907098	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		907097	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

How to Order Parts from this Brochure

Assuming we want the O-Ring under the flow adjustment plug in the DFLR control (page 15) for model AA10VSO.28.DFLR/30R - VKC 62N00, we go to the second "model" column from the left, locate "X" next to Position 21 (O-Ring), we see that the part number is Brueninghaus number 919322.



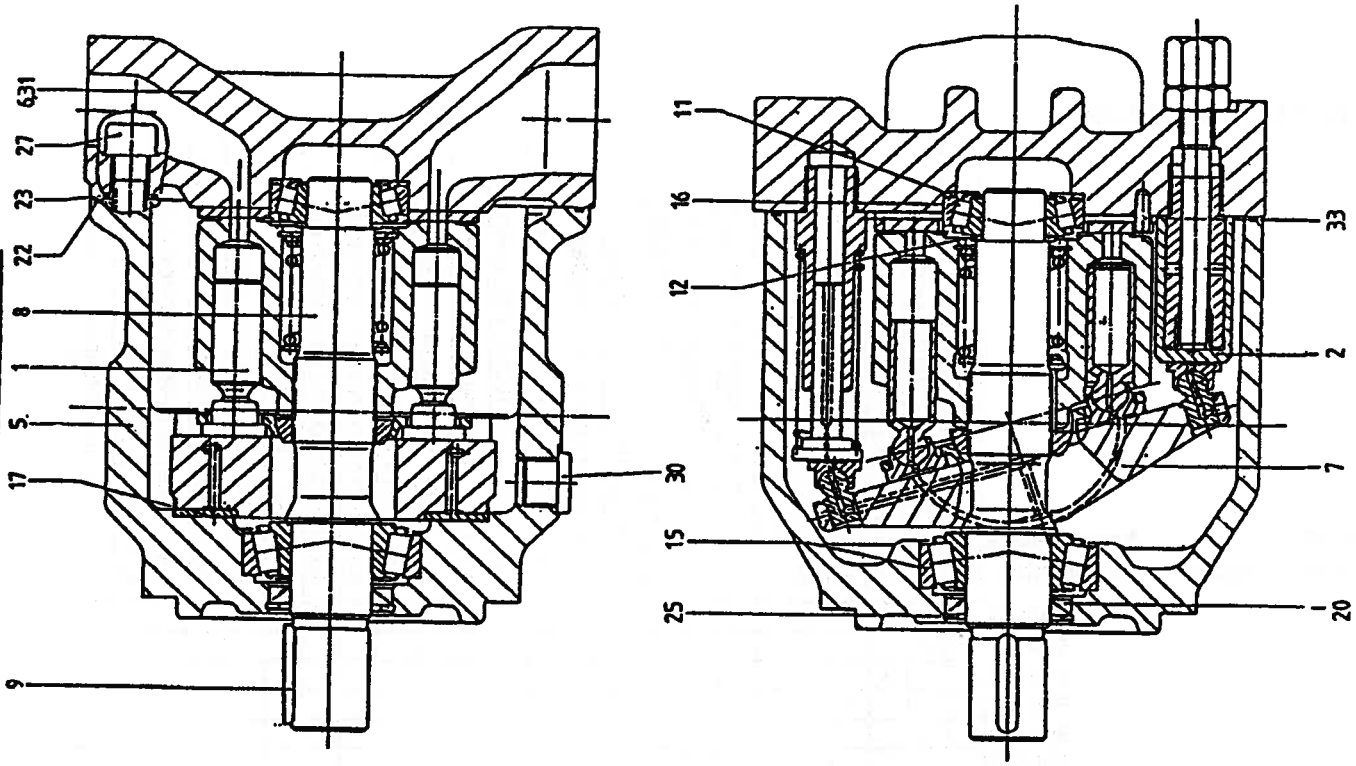
Complete Pump with Control

Brueninghaus Part Number	AA10VSO.28.DFLR/3OR-PKC62N00	AA10VSO.28.DFLR/3OR-VKC62N00	AA10VSO.28.DFR/3OR-VKC62K01	AA10VSO.28.DFR/3OR-PKC62N00	AA10VSO.28.DFR/3OR-VKC62K03	AA10VSO.45.DFR/3OL-PKC62N00	AA10VSO.45.DFR/3OR-PKC62K01	AA10VSO.45.DFR/3OR-PKC62K03	AA10VSO.45.DFR/3OR-PKC62K05	AA10VSO.45.DFR/3OR-PKC62N00	AA10VSO.71.DFLR/3OR-PKC62N00	AA10VSO.71.DFR/3OL-PKC61N00	AA10VSO.71.DFR/3OR-PKC61N00	AA10VSO.71.DFR/3OR-PKC62K01	AA10VSO.71.DFR/3OR-PKC62K02	AA10VSO.71.DFR/3OR-PKC62K03	AA10VSO.71.DFR/3OR-PKC62K08	AA10VSO.71.DFR/3OR-PKC62N00	AA10VSO.71.DR/3OR-PKC62K01	AA10VSO.100.DFLR/3OR-PKC62N00	AA10VSO.100.DFR/3OR-PKC62K-S080	AA10VSO.100.DFR/3OR-PKC62K38-S079	AA10VSO.100.DFR/3OR-PKC62N00	AA10VSO.100.DFR/30R-PKC62K01
909259	X																							
909260		X																						
909275			X																					
907683				X																				
907953					X																			
908610						X																		
909279							X																	
907990								X																
907984									X															
910016										X														
908680											X													
907108												X												
907109													X											
907107														X										
907917															X									
907986																X								
907985																	X							
907684																		X						
909758																			X					
909656																				X				
909586																					X			
909554																						X		
908603																							X	
913620																								X

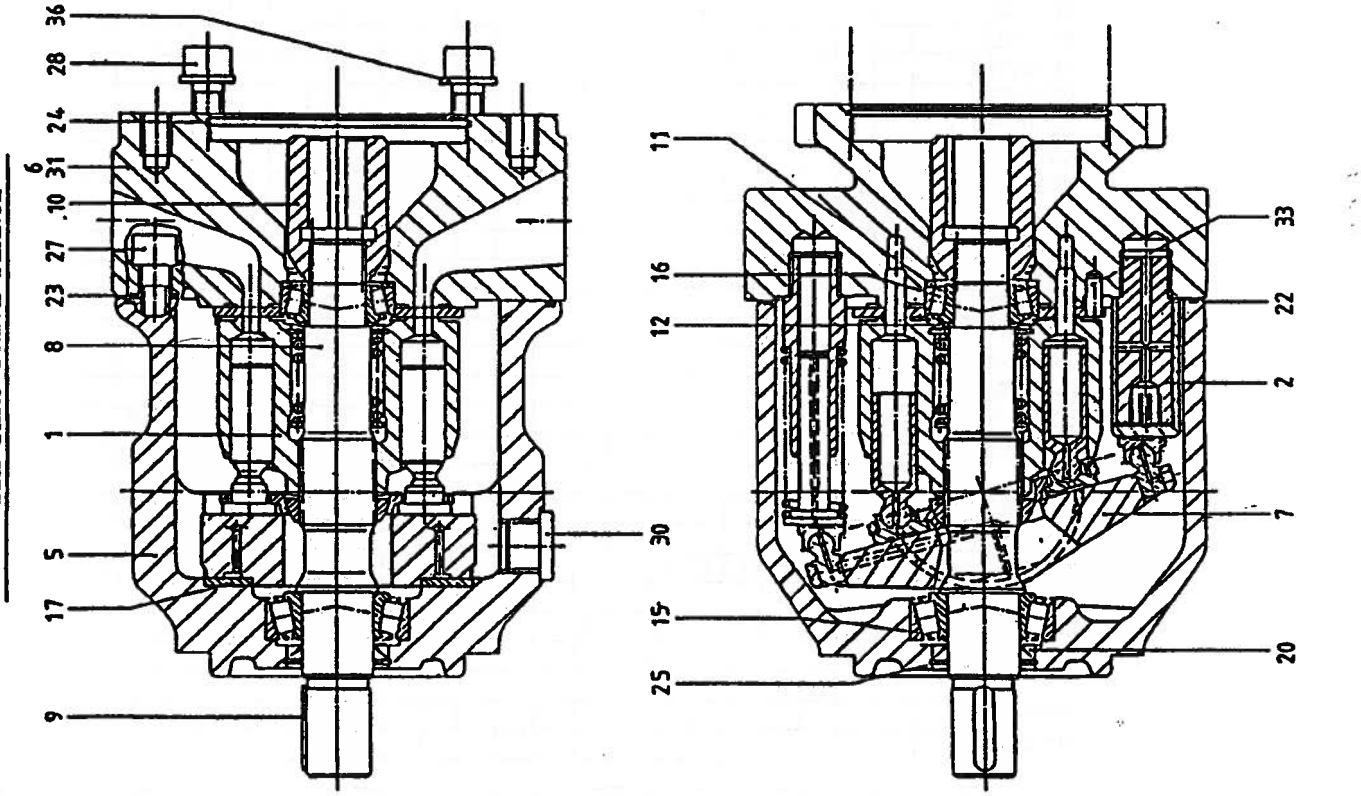
Major Subassemblies

Description & Quantity	Position	Brueninghaus Part Number	AA10VSO.28.DFLR/3OR-PKC62N00	AA10VSO.28.DFLR/3OR-VKC62N00	AA10VSO.28.DFR/3OR-VKC62K01	AA10VSO.28.DFR/3OR-PKC62N00	AA10VSO.28.DFR/3OR-VKC62K03	AA10VSO.45.DFR/3OL-PKC62N00	AA10VSO.45.DFR/3OR-PKC62K01	AA10VSO.45.DFR/3OR-PKC62K03	AA10VSO.45.DFR/3OR-PKC62K05	AA10VSO.45.DFR/3OR-PKC62N00	AA10VSO.71.DFLR/3OR-PKC62N00	AA10VSO.71.DFR/3OL-PKC61N00	AA10VSO.71.DFR/3OR-PKC61N00	AA10VSO.71.DFR/3OR-PKC62K01	AA10VSO.71.DFR/3OR-PKC62K02	AA10VSO.71.DFR/3OR-PKC62K03	AA10VSO.71.DFR/3OR-PKC62K08	AA10VSO.71.DFR/3OR-PKC62N00	AA10VSO.71.DR/3OR-PKC62K01	AA10VSO.100.DFLR/3OR-PKC62N00	AA10VSO.100.DFR/3OR-PKC62K-S080	AA10VSO.100.DFR/3OR-PKC62K38-S079	AA10VSO.100.DFR/3OR-PKC62N00	AA10VSO.100.DFR/30R-PKC62K01
Pump	(1)	909190	X																							
		909197		X																						
		909176			X																					
		905724				X																				
		907728					X																			
		908607						X																		
		906068							X																	
		907742								X																
		907743									X															
		906070										X														
		908650											X													
		907023												X												
		907019													X											
		906012														X						X				
		907748															X									
		907747																X								
		907746																	X							
		906013																		X						
		909457																					X			
		909464																						X		
		909439																							X	
		908577																								X
		913565																									X
Control	(2)	907096	X																				X			
		908384		X																						
		907094			X	X		X	X	X	X	X		X	X	X	X	X	X	X				X	X	X	X
		907371					X																				
		907096											X														
		907095																				X					
L/R Control	(3)	949302	X										X										X				
		901473		X																							
Adaptor	(4)	921696	X										X										X				
		902409		X																							

PUMP WITHOUT THRU-DRIVE



PUMP WITH THRU-DRIVE FLANGE



Description & Quantity	Position	Brueninghaus Part Number	AA10VSO.28.DFLR/3OR-PKC62N00	AA10VSO.28.DFLR/3OR-VKC62N00	AA10VSO.28.DFR/3OR-VKC62K01	AA10VSO.28.DFR/3OR-PKC62N00	AA10VSO.28.DFR/3OR-VKC62K03	AA10VSO.45.DFR/3OL-PKC62N00	AA10VSO.45.DFR/3OR-PKC62K01	AA10VSO.45.DFR/3OR-PKC62K03	AA10VSO.45.DFR/3OR-PKC62K05	AA10VSO.45.DFR/3OR-PKC62N00	AA10VSO.71.DFLR/3OR-PKC62N00	AA10VSO.71.DFR/3OL-PKC61N00	AA10VSO.71.DFR/3OR-PKC61N00	AA10VSO.71.DFR/3OR-PKC62K01	AA10VSO.71.DFR/3OR-PKC62K02	AA10VSO.71.DFR/3OR-PKC62K03	AA10VSO.71.DFR/3OR-PKC62K08	AA10VSO.71.DFR/3OR-PKC62N00	AA10VSO.71.DR/3OR-PKC62K01	AA10VSO.100.DFLR/3OR-PKC62N00	AA10VSO.100.DFR/3OR-PKC62K-S080	AA10VSO.100.DFR/3OR-PKC62K38-S079	AA10VSO.100.DFR/3OR-PKC62N00	AA10VSO.100.DFR/30R-PKC62K01
Rotary Group - 1	(1)	958654	X	X	X	X	X																				
		900510						X	X	X	X	X															
		956007											X	X	X	X	X	X	X	X	X						
		911929												X													
		906871																					X	X	X	X	X
Control Piston Assembly - 1	(2)	904013	X			X																					
		904680		X																							
		904029			X		X																				
		904642						X				X															
		904645							X	X	X																
		902804											X								X						
		902806												X	X	X	X	X	X			X					
		906709																					X			X	
		908940																						X	X		X
Housing - 1	(5)	909189	X	X																							
		905722			X	X	X																				
		905262						X	X	X	X	X															
		906009											X	X	X	X	X	X	X	X							
		906353											X														
		906814																					X				
		906803																						X	X	X	X
Port Plate - 1	(6)	948039	X	X																							
		951994			X																						
		948039				X																					
		948187						X																			
		952087							X																		
		952168								X	X																
		948179										X															
		948292											X								X						
		948233												X													
		948241													X												
		952435														X						X					
		952311															X	X									
		952419																	X								
		906800																					X			X	
		909410																						X	X		
		951943					X																				
		910375																									X
Swash Plate - 1	(7)	903873	X	X																							
		903859			X	X	X																				
		904991						X																			
		904992							X	X	X	X															
		903882											X														
		904689												X													
		903881													X	X	X	X	X	X	X						
		906873																					X				
		906872																						X	X	X	X

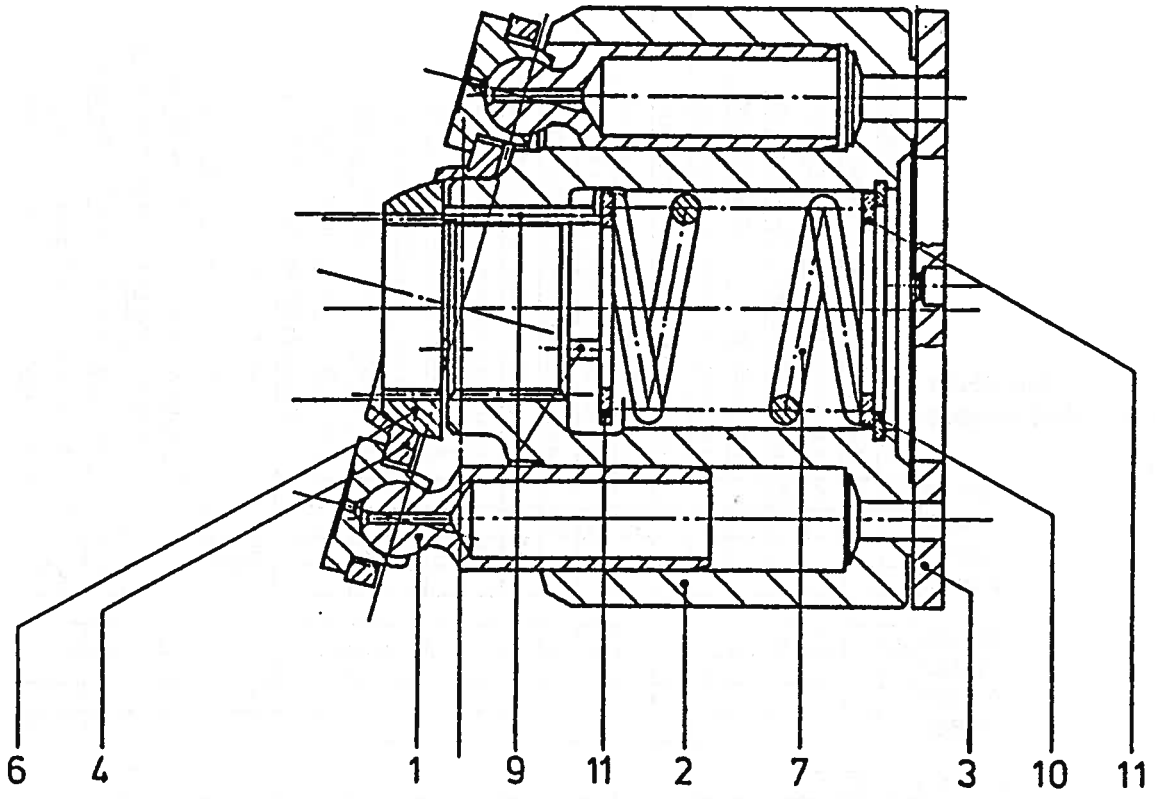
Description & Quantity	Position	Brueninghaus Part Number	AA10VSO.28.DFLR/3OR-PKC62N00	AA10VSO.28.DFLR/3OR-VKC62N00	AA10VSO.28.DFR/3OR-VKC62K01	AA10VSO.28.DFR/3OR-PKC62N00	AA10VSO.28.DFR/3OR-VKC62K03	AA10VSO.45.DFR/3OL-PKC62N00	AA10VSO.45.DFR/3OR-PKC62K01	AA10VSO.45.DFR/3OR-PKC62K03	AA10VSO.45.DFR/3OR-PKC62K05	AA10VSO.45.DFR/3OR-PKC62N00	AA10VSO.71.DFLR/3OR-PKC62N00	AA10VSO.71.DFR/3OL-PKC61N00	AA10VSO.71.DFR/3OR-PKC61N00	AA10VSO.71.DFR/3OR-PKC62K01	AA10VSO.71.DFR/3OR-PKC62K02	AA10VSO.71.DFR/3OR-PKC62K03	AA10VSO.71.DFR/3OR-PKC62K08	AA10VSO.71.DFR/3OR-PKC62N00	AA10VSO.71.DR/3OR-PKC62K01	AA10VSO.100.DFLR/3OR-PKC62N00	AA10VSO.100.DFR/3OR-PKC62K-S080	AA10VSO.100.DFR/3OR-PKC62K38-S079	AA10VSO.100.DFR/3OR-PKC62N00	AA10VSO.100.DFR/30R-PKC62K01
Drive Shaft - 1	(8)	748838	X	X																						
		775703			X		X																			
		748838				X																				
		748625						X				X														
		763756							X	X	X															
		748846											X	X	X						X					
		775681														X	X	X	X		X					
		906856																				X			X	
		909412																					X	X		X
Shaft Key - 1	(9)	751138	X	X	X	X	X																			
		749265						X	X	X	X	X														
		749273											X	X	X	X	X	X	X	X	X					
		935395																				X	X	X	X	X
Shaft Coupling - 1	(10)	776726			X																					
		764981					X																			
		762628						X																		
		763764							X																	
		766933								X																
		792179														X				X						
		761206															X									
		795682																X								
		766895																	X							
		909466																					X			
		909418																						X		
		909514																								X
Disc - 1	(11)	744158	X	X	X	X	X																			
		743879						X	X	X	X	X														
		744131											X	X	X	X	X	X	X	X	X					
Control Plate Spacer - 1	(12)	939013	X	X	X	X	X																			
		938955						X	X	X	X	X														
		939005											X	X	X	X	X	X	X	X	X					
		906878																				X	X	X	X	X
Tapered Roller Bearing - 1	(15)	730068	X	X	X	X	X																			
		704946						X	X	X	X	X														
		720224											X	X	X	X	X	X	X	X	X					
		906908																				X	X	X	X	X
Intermediate Flange - 1	(13)	909409																						X		
		909407																					X			
Intermediate Flange - 1	(14)	909468																					X			

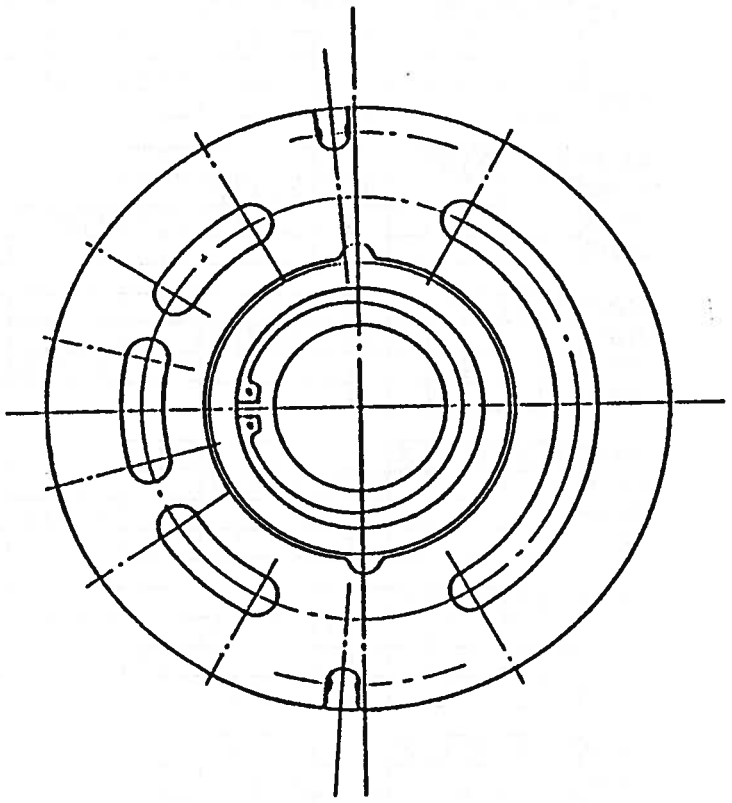
Description & Quantity	Position	Brueninghaus Part Number	AA10VSO.28.DFLR/3OR-PKC62N00	AA10VSO.28.DFLR/3OR-VKC62N00	AA10VSO.28.DFR/3OR-VKC62K01	AA10VSO.28.DFR/3OR-PKC62N00	AA10VSO.28.DFR/3OR-VKC62K03	AA10VSO.45.DFR/3OL-PKC62N00	AA10VSO.45.DFR/3OR-PKC62K01	AA10VSO.45.DFR/3OR-PKC62K03	AA10VSO.45.DFR/3OR-PKC62K05	AA10VSO.45.DFR/3OR-PKC62N00	AA10VSO.71.DFLR/3OR-PKC62N00	AA10VSO.71.DFR/3OL-PKC61N00	AA10VSO.71.DFR/3OR-PKC61N00	AA10VSO.71.DFR/3OR-PKC62K01	AA10VSO.71.DFR/3OR-PKC62K02	AA10VSO.71.DFR/3OR-PKC62K03	AA10VSO.71.DFR/3OR-PKC62K08	AA10VSO.71.DFR/3OR-PKC62N00	AA10VSO.71.DR/3OR-PKC62K01	AA10VSO.100.DFLR/3OR-PKC62N00	AA10VSO.100.DFR/3OR-PKC62K-S080	AA10VSO.100.DFR/3OR-PKC62K38-S079	AA10VSO.100.DFR/3OR-PKC62N00	AA10VSO.100.DFR/3OR-PKC62K01
Tapered Roller Bearing - 1	(16)	730076	X	X	X	X	X																			
		704954						X	X	X	X	X														
		720232											X	X	X	X	X	X	X	X	X					
		906909																					X	X	X	X	X
Bearing Shell - 2	(17)	902778	X	X	X	X	X																			
		900198						X	X	X	X	X														
		902777											X	X	X	X	X	X	X	X	X					
		906881																					X	X	X	X	X
Shaft Seal Ring - 1	(20)	730092	X		X	X																				
		794325		X			X																			
		724904						X	X	X	X	X														
		727229											X	X	X	X	X	X	X	X	X					
		906910																					X	X	X	X	X
O-Ring - 1	(21)	111937																						X	X		
O-Ring - 1	(22)	730041	X		X	X																				
		923397		X			X																			
		704997						X	X	X	X	X														
		720194											X	X	X	X	X	X	X	X	X					
		906911																					X	X	X	X	X
O-Ring - 4	(23)	102075	X		X	X																				
		241806		X			X																			
		111066						X	X	X	X	X														
		720208											X	X	X	X	X	X	X	X	X					
		919497																					X	X	X	X	X
O-Ring - 1	(24)	111937			X				X													X					X
		905441					X																				
		787655								X	X							X	X					X			
		791555														X											
		231118																		X					X		
V - Packing Ring - 1	(25)	791407	X	X	X	X	X																			
		776939						X	X	X	X															
		791555										X	X	X	X	X	X	X	X	X	X					
		906912																					X	X	X	X	X
Hex-Head Screw - 2	(26)	124214																							X		
		120006																						X		X	

Description & Quantity	Position	Brueninghaus Part Number	AA10VSO.28.DFLR/3OR-PKC62N00	AA10VSO.28.DFLR/3OR-VKC62N00	AA10VSO.28.DFR/3OR-VKC62K01	AA10VSO.28.DFR/3OR-PKC62N00	AA10VSO.28.DFR/3OR-VKC62K03	AA10VSO.45.DFR/3OL-PKC62N00	AA10VSO.45.DFR/3OR-PKC62K01	AA10VSO.45.DFR/3OR-PKC62K03	AA10VSO.45.DFR/3OR-PKC62K05	AA10VSO.45.DFR/3OR-PKC62N00	AA10VSO.71.DFLR/3OR-PKC62N00	AA10VSO.71.DFR/3OL-PKC61N00	AA10VSO.71.DFR/3OR-PKC61N00	AA10VSO.71.DFR/3OR-PKC62K01	AA10VSO.71.DFR/3OR-PKC62K02	AA10VSO.71.DFR/3OR-PKC62K03	AA10VSO.71.DFR/3OR-PKC62K08	AA10VSO.71.DFR/3OR-PKC62N00	AA10VSO.71.DR/3OR-PKC62K01	AA10VSO.100.DFLR/3OR-PKC62N00	AA10VSO.100.DFR/3OR-PKC62K-S080	AA10VSO.100.DFR/3OR-PKC62K38-S079	AA10VSO.100.DFR/3OR-PKC62N00	AA10VSO.100.DFR/30R-PKC62K01
Socket Head Cap Screw - 4	(27)	110191	X	X	X	X	X																				
		220264						X	X	X	X	X															
		110272											X	X	X	X	X	X	X	X	X	X					
		389714																					X			X	X
		802651																						X	X		
Plug - 1	(28)	531294	X			X																					
Plug - 1		647101		X																							
Socket Screw - 2		109606			X				X								X					X					X
Socket Screw - 2		109762					X			X	X																
Plug - 1		531286						X				X															
Plug - 1		531308											X								X						
Socket Screw - 2		109789															X	X									
Socket Screw - 2		120472																	X								
Plug - 1		632511																						X	X		
Plug - 1	(30)	516392	X		X	X																					
		901969		X			X																				
		824976						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					
		932795																					X	X	X	X	X
Breakaway Plug -1	(31)	977663	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dowel Pin - 1	(33)	707481	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Socket Screw - 4	(34)	109495																						X			
Bonded Ring - 4	(35)	114774																						X			
Disc - 2	(36)	186732							X	X								X									
		186767																	X						X		
O-Ring - 1	(37)	111775																						X			

Rotary Group

Description & Quantity	Position	Brueninghaus Part Number	AA10VSO.28.DFLR/3OR-PKC62N00	AA10VSO.28.DFLR/3OR-VKC62N00	AA10VSO.28.DFR/3OR-VKC62K01	AA10VSO.28.DFR/3OR-PKC62N00	AA10VSO.28.DFR/3OR-VKC62K03	AA10VSO.45.DFR/3OL-PKC62N00	AA10VSO.45.DFR/3OR-PKC62K01	AA10VSO.45.DFR/3OR-PKC62K03	AA10VSO.45.DFR/3OR-PKC62K05	AA10VSO.45.DFR/3OR-PKC62N00	AA10VSO.71.DFLR/3OR-PKC62N00	AA10VSO.71.DFR/3OL-PKC61N00	AA10VSO.71.DFR/3OR-PKC61N00	AA10VSO.71.DFR/3OR-PKC62K01	AA10VSO.71.DFR/3OR-PKC62K02	AA10VSO.71.DFR/3OR-PKC62K03	AA10VSO.71.DFR/3OR-PKC62K08	AA10VSO.71.DFR/3OR-PKC62N00	AA10VSO.71.DR/3OR-PKC62K01	AA10VSO.100.DFLR/3OR-PKC62N00	AA10VSO.100.DFR/3OR-PKC62K-S080	AA10VSO.100.DFR/3OR-PKC62K38-S079	AA10VSO.100.DFR/3OR-PKC62N00	AA10VSO.100.DFR/30R-PKC62K01
Piston - 9	(1)	729779	X	X	X	X	X																				
		705047						X	X	X	X	X															
		720011											X	X	X	X	X	X	X	X	X						
		906809																					X	X	X	X	X
Cylinder Barrel - 1	(2)	907125	X	X	X	X	X																				
		786454						X	X	X	X	X															
		907126											X	X	X	X	X	X	X	X	X						
		906882																					X	X	X	X	X
Control Plate - 1	(3)	907755	X	X	X	X	X																				
		717622						X	X	X	X	X															
		907759											X		X	X	X	X	X	X	X						
		907639																					X	X	X	X	X
		907760												X													
Retaining Plate - 1	(4)	729957	X	X	X	X	X																				
		752703						X	X	X	X	X															
		720119											X	X	X	X	X	X	X	X	X						
		906885																					X	X	X	X	X
Retaining Ball - 1	(6)	749737	X	X	X	X	X																				
		705268						X	X	X	X	X															
		749745											X	X	X	X	X	X	X	X	X						
		906813																					X	X	X	X	X
Spring - 1	(7)	730017	X	X	X	X	X																				
		071072						X	X	X	X	X															
		720178											X	X	X	X	X	X	X	X	X						
		906894																					X	X	X	X	X
Pressure Pin - 3	(9)	785407	X	X	X	X	X																				
		785415						X	X	X	X	X															
		785423											X	X	X	X	X	X	X	X	X						
		906879																					X	X	X	X	X
Snap Ring - 1	(10)	303372	X	X	X	X	X																				
		150657						X	X	X	X	X															
		720216											X	X	X	X	X	X	X	X	X						
		906888																					X	X	X	X	X
Thrust Ring - 2	(11)	939048	X	X	X	X	X																				
		939056						X	X	X	X	X															
		720186											X	X	X	X	X	X	X	X	X						
		906880																					X	X	X	X	X


6
4
1
9
11
2
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3
10
11



Control Piston Assembly

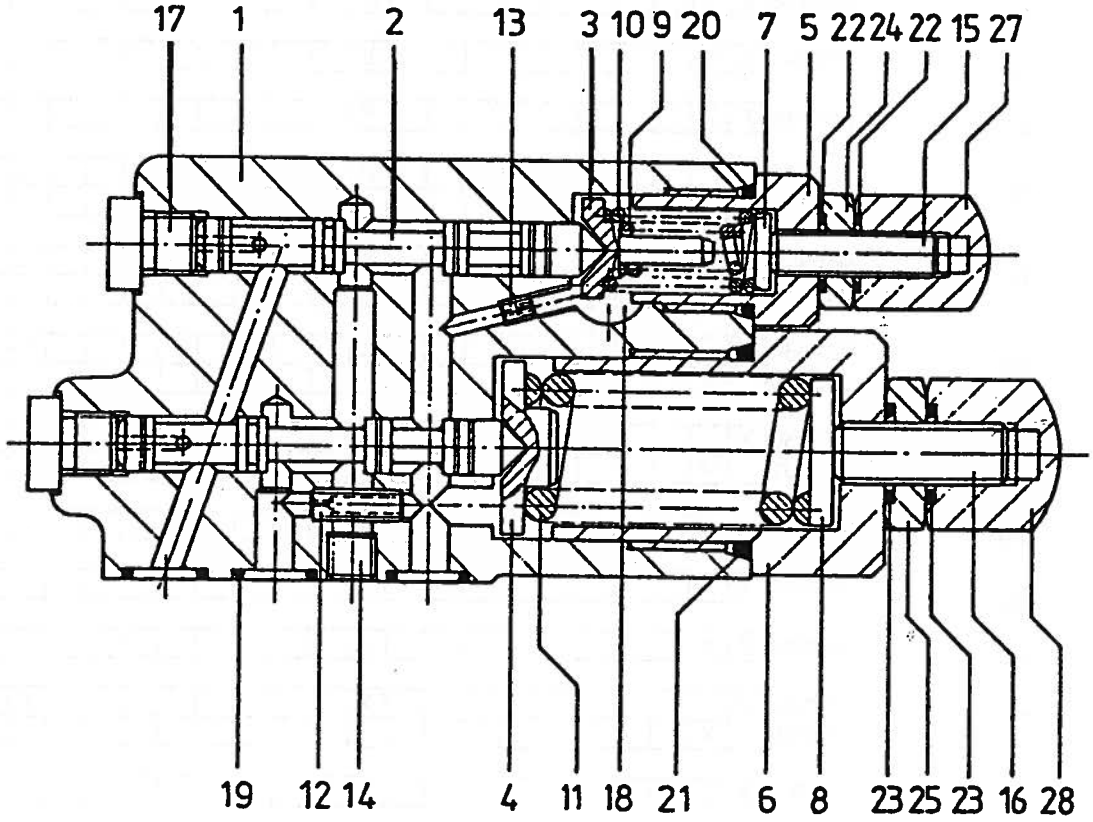
Description & Quantity	Position	Brueninghaus Part Number	AA10VSO.28.DFLR/3OR-PKC62N00	AA10VSO.28.DFLR/3OR-VKC62N00	AA10VSO.28.DFR/3OR-VKC62K01	AA10VSO.28.DFR/3OR-PKC62N00	AA10VSO.28.DFR/3OR-VKC62K03	AA10VSO.45.DFR/3OL-PKC62N00	AA10VSO.45.DFR/3OR-PKC62K01	AA10VSO.45.DFR/3OR-PKC62K03	AA10VSO.45.DFR/3OR-PKC62K05	AA10VSO.45.DFR/3OR-PKC62N00	AA10VSO.71.DFLR/3OR-PKC62N00	AA10VSO.71.DFR/3OL-PKC61N00	AA10VSO.71.DFR/3OR-PKC61N00	AA10VSO.71.DFR/3OR-PKC62K01	AA10VSO.71.DFR/3OR-PKC62K02	AA10VSO.71.DFR/3OR-PKC62K03	AA10VSO.71.DFR/3OR-PKC62K08	AA10VSO.71.DFR/3OR-PKC62N00	AA10VSO.71.DR/3OR-PKC62K01	AA10VSO.100.DFLR/3OR-PKC62N00	AA10VSO.100.DFR/3OR-PKC62K-S080	AA10VSO.100.DFR/3OR-PKC62K38-S079	AA10VSO.100.DFR/3OR-PKC62N00	AA10VSO.100.DFR/30R-PKC62K01
Control Piston - 1	(1)	966193	X	X	X	X	X																			
		939196						X	X	X	X	X														
		942073											X	X	X	X	X	X	X	X	X					
		906707																					X	X	X	X	X
Piston Guide - 1	(2)	966185	X	X		X																				
		900836			X		X																			
		939528						X				X														
		939218							X	X	X															
		900360											X													
		942081												X	X	X	X	X	X	X	X					
		906706																					X	X		X	
		908943																							X		X
Counter - Piston - 1	(4)	902961	X	X	X	X	X																				
		904629						X	X	X	X	X															
		902800											X	X	X	X	X	X	X	X	X						
		906705																					X	X	X	X	X
Piston Guide - 1	(4)	737283	X	X	X	X	X																				
		737291						X	X	X	X	X															
		737305											X	X	X	X	X	X	X	X	X						
		906704																					X	X	X	X	X
Socket Screw - 4	(5)	900443	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Spring - 1	(6)	799041	X	X	X	X	X																				
		790079						X	X	X	X	X															
		790052											X	X	X	X	X	X	X	X	X						
		906703																					X	X	X	X	X
Threaded Pin - 1	(7)	904676	X	X		X																					
		904626						X				X															
		904681											X														
		906702																					X			X	
Nut - 1	(8)	904042	X			X																					
		903390						X				X															
		903387											X														
		903326																					X			X	
O-Ring - 2	(9)	514691	X			X																					
		804886		X																							
		515124						X				X															
		401803											X														
		827916																					X			X	

Pilot Valve DF

Description & Quantity	Position	Brueninghaus Part Number	AA10VSO.28.DFLR/3OR-PKC62N00	AA10VSO.28.DFLR/3OR-VKC62N00	AA10VSO.28.DFR/3OR-VKC62K01	AA10VSO.28.DFR/3OR-PKC62N00	AA10VSO.28.DFR/3OR-VKC62K03	AA10VSO.45.DFR/3OL-PKC62N00	AA10VSO.45.DFR/3OR-PKC62K01	AA10VSO.45.DFR/3OR-PKC62K03	AA10VSO.45.DFR/3OR-PKC62K05	AA10VSO.45.DFR/3OR-PKC62N00	AA10VSO.71.DFLR/3OR-PKC62N00	AA10VSO.71.DFR/3OL-PKC61N00	AA10VSO.71.DFR/3OR-PKC61N00	AA10VSO.71.DFR/3OR-PKC62K01	AA10VSO.71.DFR/3OR-PKC62K02	AA10VSO.71.DFR/3OR-PKC62K03	AA10VSO.71.DFR/3OR-PKC62K08	AA10VSO.71.DFR/3OR-PKC62N00	AA10VSO.71.DR/3OR-PKC62K01	AA10VSO.100.DFLR/3OR-PKC62N00	AA10VSO.100.DFR/3OR-PKC62K-S080	AA10VSO.100.DFR/3OR-PKC62K38-S079	AA10VSO.100.DFR/3OR-PKC62N00	AA10VSO.100.DFR/30R-PKC62K01
Valve Housing DF - 1	(1)	900303	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Piston - 2	(2)	900311	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Spring Retainer - 1	(3)	929875	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Spring Retainer - 1	(4)	707023	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Plug F - 1	(5)	900346	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Plug D - 1	(6)	900354	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Disc F - 1	(7)	900362	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Disc D - 1	(8)	900389	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Spring - 1	(9)	924695	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Spring - 1	(10)	924709	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Spring - 1	(11)	707031	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Orifice - 1	(12)	903137	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Orifice - 1	(13)	900419	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Threaded Pin - 1	(14)	100943	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Threaded Pin - 1	(15)	118087	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Threaded Pin - 1	(16)	101109	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Plug - 2	(17)	585017	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		788317		X			X																			
Plug - 1	(18)	705454	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		764467		X			X																			
O-Ring - 3	(19)	515078	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		514497		X			X																			
O-Ring - 1	(20)	515124	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		919314		X			X																			

Pilot Valve DF

Description & Quantity	Position	Brueninghaus Part Number	AA10VSO.28.DFLR/3OR-PKC62N00	AA10VSO.28.DFLR/3OR-VKC62N00	AA10VSO.28.DFR/3OR-VKC62K01	AA10VSO.28.DFR/3OR-PKC62N00	AA10VSO.28.DFR/3OR-VKC62K03	AA10VSO.45.DFR/3OL-PKC62N00	AA10VSO.45.DFR/3OR-PKC62K01	AA10VSO.45.DFR/3OR-PKC62K03	AA10VSO.45.DFR/3OR-PKC62K05	AA10VSO.45.DFR/3OR-PKC62N00	AA10VSO.71.DFLR/3OR-PKC62N00	AA10VSO.71.DFR/3OL-PKC61N00	AA10VSO.71.DFR/3OR-PKC61N00	AA10VSO.71.DFR/3OR-PKC62K01	AA10VSO.71.DFR/3OR-PKC62K02	AA10VSO.71.DFR/3OR-PKC62K03	AA10VSO.71.DFR/3OR-PKC62K08	AA10VSO.71.DFR/3OR-PKC62N00	AA10VSO.71.DR/3OR-PKC62K01	AA10VSO.100.DFLR/3OR-PKC62N00	AA10VSO.100.DFR/3OR-PKC62K-S080	AA10VSO.100.DFR/3OR-PKC62K38-S079	AA10VSO.100.DFR/3OR-PKC62N00	AA10VSO.100.DFR/30R-PKC62K01
O-Ring - 1	(21)	574953	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		919322		X			X																			
O-Ring - 2	(22)	976302	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		274003		X			X																			
O-Ring - 2	(23)	513415	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		514098		X			X																			
Nut - 1	(24)	907099	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Nut - 1	(25)	907100	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cap Nut - 1	(27)	907098	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cap Nut - 1	(28)	907097	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

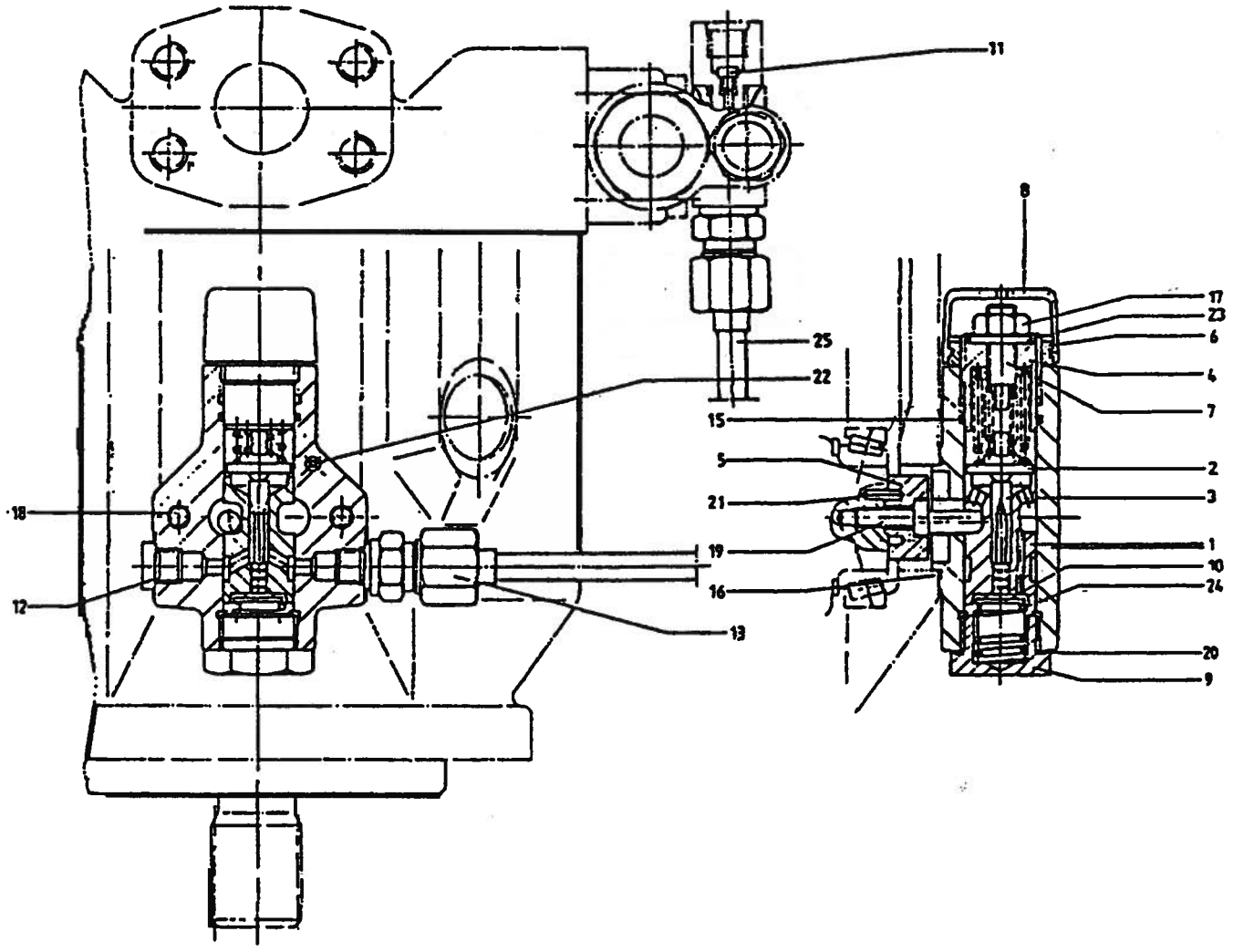


LR Pilot Valve

Description & Quantity	Position	Brueninghaus Part Number	AA10VSO.28.DFLR/3OR-PKC62N00	AA10VSO.28.DFLR/3OR-VKC62N00	AA10VSO.28.DFR/3OR-VKC62K01	AA10VSO.28.DFR/3OR-PKC62N00	AA10VSO.28.DFR/3OR-VKC62K03	AA10VSO.45.DFR/3OL-PKC62N00	AA10VSO.45.DFR/3OR-PKC62K01	AA10VSO.45.DFR/3OR-PKC62K03	AA10VSO.45.DFR/3OR-PKC62K05	AA10VSO.45.DFR/3OR-PKC62N00	AA10VSO.71.DFLR/3OR-PKC62N00	AA10VSO.71.DFR/3OL-PKC61N00	AA10VSO.71.DFR/3OR-PKC61N00	AA10VSO.71.DFR/3OR-PKC62K01	AA10VSO.71.DFR/3OR-PKC62K02	AA10VSO.71.DFR/3OR-PKC62K03	AA10VSO.71.DFR/3OR-PKC62K08	AA10VSO.71.DFR/3OR-PKC62N00	AA10VSO.71.DR/3OR-PKC62K01	AA10VSO.100.DFLR/3OR-PKC62N00	AA10VSO.100.DFR/3OR-PKC62K-S080	AA10VSO.100.DFR/3OR-PKC62K38-S079	AA10VSO.100.DFR/3OR-PKC62N00	AA10VSO.100.DFR/30R-PKC62K01
Valve Housing - 1	(1)	928402	X	X									X									X				
Spring Retainer - 1	(2)	936286	X	X									X									X				
Pilot Piston - 1	(3)	927996	X	X									X									X				
Adjusting Screw - 1	(4)	783218	X	X									X									X				
Carrier - 1	(5)	905186	X	X									X									X				
Nut - 1	(6)	783234	X	X									X									X				
Threaded Pin - 1	(7)	783242	X	X									X									X				
Insulation Cap - 1	(8)	783277	X	X									X									X				
Plug - 1	(9)	926612	X	X									X									X				
Lock Washer - 1	(10)	935247	X	X									X									X				
Orifice - 1	(11)	593044	X	X									X									X				
Plug - 1	(12)	705454	X										X									X				
		764647		X																						
Flare Fitting - 1	(13)	949337	X										X									X				
		901477		X																						
O-Ring - 1	(15)	977054	X										X									X				
		609994		X																						
O-Ring - 1	(16)	671959	X										X									X				
		756601		X																						
Hex Nut - 1	(17)	934194	X	X									X									X				
Socket Screw - 2	(18)	109312	X	X									X									X				
Socket Screw - 1	(19)	109282	X	X									X									X				
O-Ring - 1	(20)	577944	X										X									X				
		972258		X																						
Locking Pin - 1	(21)	106607	X	X									X									X				

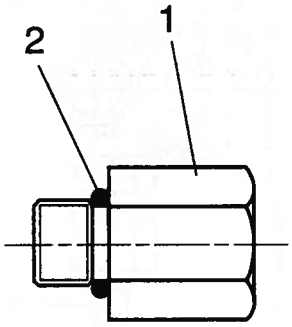
LR Pilot Valve

Description & Quantity	Position	Brueninghaus Part Number	AA10VSO.28.DFLR/3OR-PKC62N00	AA10VSO.28.DFLR/3OR-VKC62N00	AA10VSO.28.DFR/3OR-VKC62K01	AA10VSO.28.DFR/3OR-PKC62N00	AA10VSO.28.DFR/3OR-VKC62K03	AA10VSO.45.DFR/3OL-PKC62N00	AA10VSO.45.DFR/3OR-PKC62K01	AA10VSO.45.DFR/3OR-PKC62K03	AA10VSO.45.DFR/3OR-PKC62K05	AA10VSO.45.DFR/3OR-PKC62N00	AA10VSO.71.DFLR/3OR-PKC62N00	AA10VSO.71.DFR/3OL-PKC61N00	AA10VSO.71.DFR/3OR-PKC61N00	AA10VSO.71.DFR/3OR-PKC62K01	AA10VSO.71.DFR/3OR-PKC62K02	AA10VSO.71.DFR/3OR-PKC62K03	AA10VSO.71.DFR/3OR-PKC62K08	AA10VSO.71.DFR/3OR-PKC62N00	AA10VSO.71.DR/3OR-PKC62K01	AA10VSO.100.DFLR/3OR-PKC62N00	AA10VSO.100.DFR/3OR-PKC62K-S080	AA10VSO.100.DFR/3OR-PKC62K38-S079	AA10VSO.100.DFR/3OR-PKC62N00	AA10VSO.100.DFR/30R-PKC62K01
Locking Pin - 1	(22)	106712	X		X									X								X				
Threaded Seal - 1	(23)	900435	X											X								X				
		940445		X																						
Spring - 1	(24)	926647	X		X									X								X				
Piping - 1		997196	X		X									X								X				



Adaptor with O-Ring

Description & Quantity	Position	Brueninghaus Part Number	AA10VSO.28.DFLR/3OR-PKC62N00	AA10VSO.28.DFLR/3OR-VKC62N00	AA10VSO.28.DFR/3OR-VKC62K01	AA10VSO.28.DFR/3OR-PKC62N00	AA10VSO.28.DFR/3OR-VKC62K03	AA10VSO.45.DFR/3OL-PKC62N00	AA10VSO.45.DFR/3OR-PKC62K01	AA10VSO.45.DFR/3OR-PKC62K03	AA10VSO.45.DFR/3OR-PKC62K05	AA10VSO.45.DFR/3OR-PKC62N00	AA10VSO.71.DFLR/3OR-PKC62N00	AA10VSO.71.DFR/3OL-PKC61N00	AA10VSO.71.DFR/3OR-PKC61N00	AA10VSO.71.DFR/3OR-PKC62K01	AA10VSO.71.DFR/3OR-PKC62K02	AA10VSO.71.DFR/3OR-PKC62K03	AA10VSO.71.DFR/3OR-PKC62K08	AA10VSO.71.DFR/3OR-PKC62N00	AA10VSO.71.DR/3OR-PKC62K01	AA10VSO.100.DFLR/3OR-PKC62N00	AA10VSO.100.DFR/3OR-PKC62K-S080	AA10VSO.100.DFR/3OR-PKC62K38-S079	AA10VSO.100.DFR/3OR-PKC62N00	AA10VSO.100.DFR/30R-PKC62K01
Adaptor - 1	(1)	921726	X		X									X									X				
O-Ring - 1	(2)	514543	X											X									X				
		593168		X																							



Notes:

Notes:

THE REXROTH CORPORATION
INDUSTRIAL HYDRAULICS DIVISION P.O. Box 2407, 2315 City Line Road, Bethlehem, PA 18017-2131 Phone (215) 694-8300 Telex: 84-7498
MOBILE HYDRAULICS DIVISION P.O. Box 394, 1700 Old Mansfield Road, Wooster, OH 44691-0394 Phone (216) 263-3400 Telex: 98-6335

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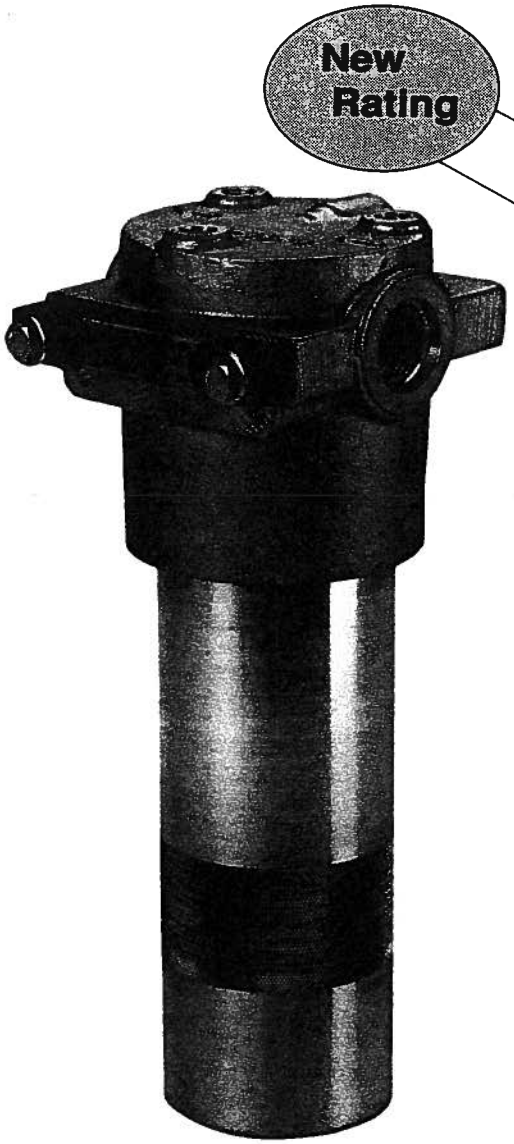
REFERENCE: HYDRAULIC PART NO.(S) 12, 12A
HYDRAULIC SCHEMATIC NO. 347-8001-01

HPK02 Fluid Filter
High Pressure

1200-451

(Rev 9/91)

Donaldson® Brand *Hydraulic Products*



Features

Working Pressures up to:
2000 PSI/13790 kPa/137.9 bar

Minimum Burst (Rated Static) Pressure up to
4500 PSI/31030 kPa/310.3 bar

Flow: Up to 30 gpm (113.6 lmin)

T-Type Porting
Port Size: 3/4" SAE O-Ring

Bypass Rating:
50 PSID/345 kPa/3.5 bar

Visual Indicators Tamper Resistant

Cast Aluminum Head and Bowl Construction

Bypass Valves have a unique curved design to eliminate jamming caused by chip build-up

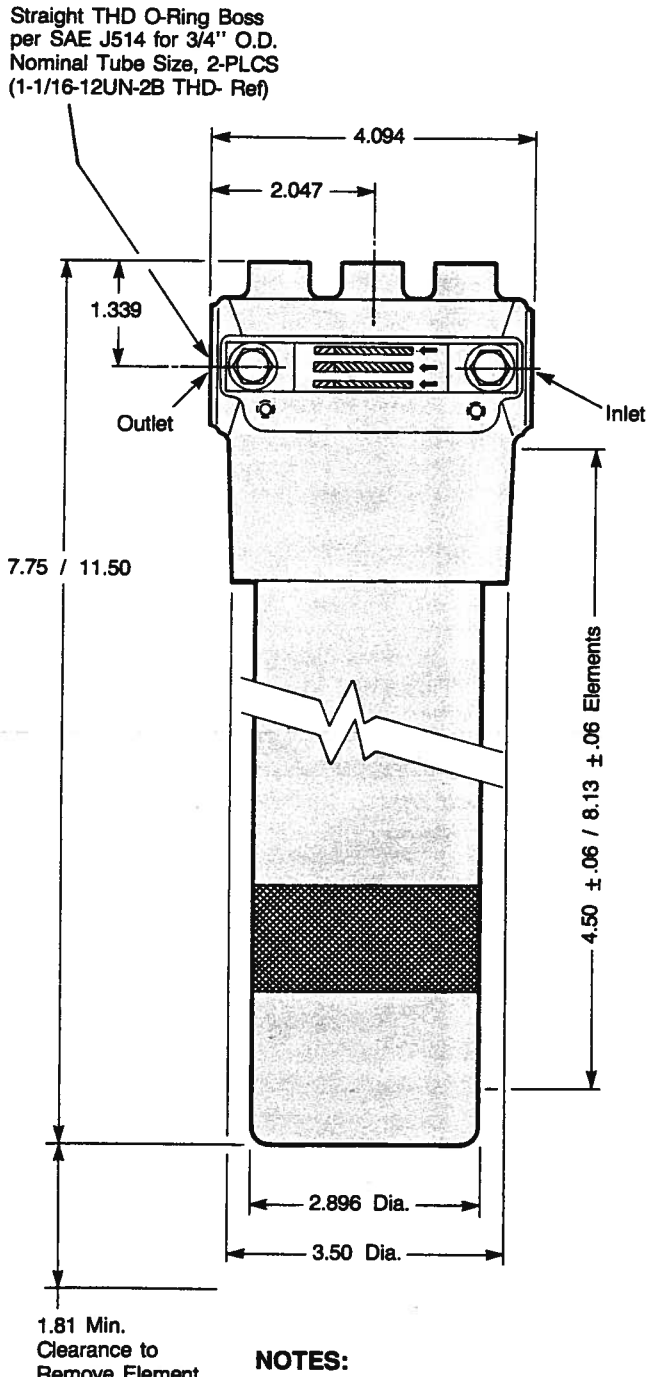
Operating Temperatures
-20° F to 250° F
-29° C to 121° C

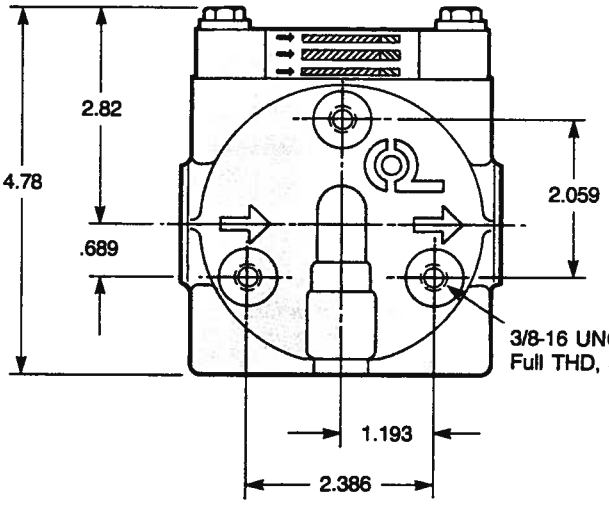
Service elements
- available in full range of SYNTEQ^{R} (synthetic) media - performance down to 3 micron absolute
- 150 psid/1034 kPa minimum collapse
- 2000 psid/13790 kPa on NO BYPASS model(s)
- Viton & BunaN elements available

Application

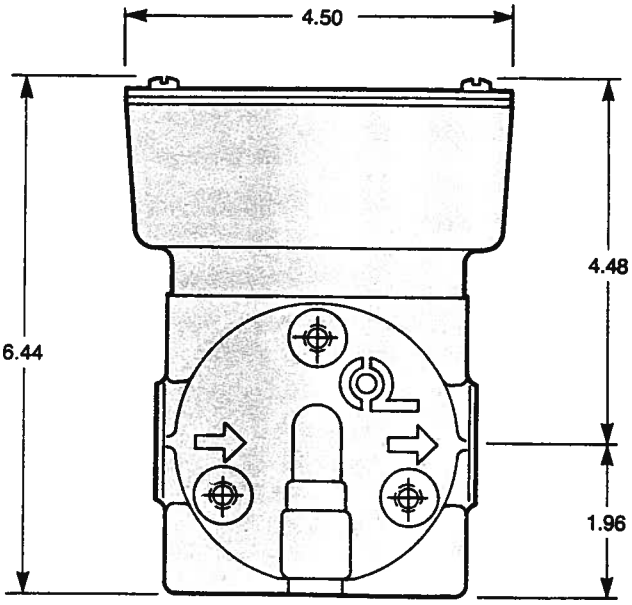
In-Plant or Mobile Equipment Applications
High Pressure Circuits
Servo-Valves
Power Steering Circuits

DIMENSIONS





Head Assembly with AC/DC Electrical Indicator

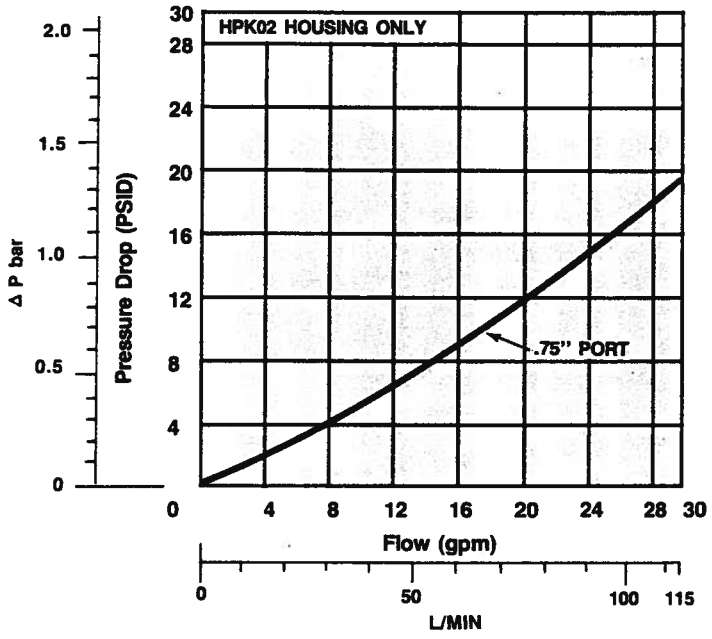


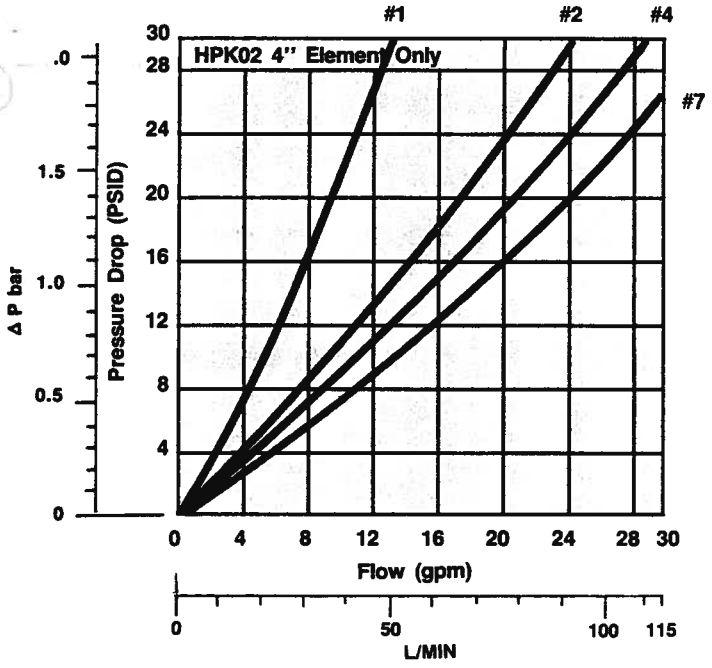
NOTES:
Minimum burst (rated static pressure per NFPA/T2.6.1, 1974, category 1/90); 4500 PSI/31030 kPa/310.3 bar

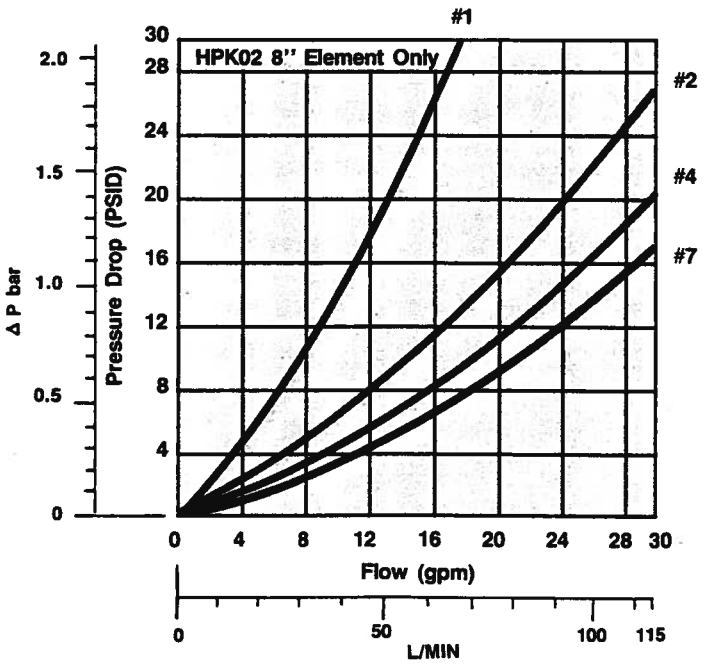
AC or DC Electrical Indicators
- 3-Wire Switch in conduit Box
- Voltage:120V AC/100V DC
- Current: 250 mA
- Circuit: Normally open/Normally closed

Approximate Assembly Weight
- 4" Assembly - 4.3 lbs/1.95 Kilograms
- 8" Assembly - 5.5 lbs/2.49 Kilograms

PERFORMANCE







FLOW CURVE NOTES:

1. All flow measurements were made with 150 SSU hydraulic oil at 100°F.

2. The numbers on curves refer to media numbers. See the 'Media Specifications Chart' for the Beta 2/20/75 ratings and part numbers.

3. **Pressure Drop Calculation Procedure**
   A. Clean filter assembly = Housing Δ P + Element Δ P.
   B. The above applies, for any given flow, when the fluid specific gravity is 0.9 and the fluid viscosity is 150 SSU (32 cSt).
   C. Housing pressure drop is directly proportional to specific gravity. Therefore, housing Δ P from the curve should be corrected when using fluid with a different specific gravity. To correct housing pressure drop for specific gravity, use the following formula:
   Corrected housing Δ P = Δ P from curve x $\frac{\text{new specific gravity}}{0.9}$
   D. Element pressure drop is directly proportional to absolute viscosity. Absolute viscosity (measured in centipoise, cP) is dependent on kinematic viscosity and specific gravity. Therefore, element Δ P from the curve should be corrected when using fluid with a different viscosity or specific gravity. To correct element Δ P for viscosity or specific gravity, use the following formula:
   Corrected element Δ P = Δ P from curve x $\frac{\text{new SSU viscosity}}{150}$ x $\frac{\text{new specific gravity}}{0.9}$

   OR

   Corrected element Δ P = Δ P from curve x $\frac{\text{new cSt viscosity}}{32}$ x $\frac{\text{new specific gravity}}{0.9}$

   OR

   Corrected element Δ P = Δ P from curve x $\frac{\text{new cP viscosity}}{29}$

ORDER INFORMATION

Stock Assemblies

Assembly Information					Service Element Information		
Port Size	Bypass Rating	Indication	Beta(x) = 2/20/75 Rating	HPK02 Assembly Model	Media Number	Element Length	Service Element
3/4" SAE O-Ring	50 PSID 345 kPa	Visual Left Side	2μ/3μ/5μ	K020007	No. 2	4.37 Inches 111.0 mm	P165041
3/4" SAE O-Ring	50 PSID 345 kPa	Visual Left Side	2μ/3μ/5μ	K020006		8.00 Inches 203.2 mm	P165043
3/4" SAE O-Ring	No Bypass	Visual Left Side	+μ/+μ/3μ	K020009	No. 1	8.12 Inches 206.2 mm	P167182**

** High Collapse Elements

+ - Particles Less Than 2μ

Stock Service Elements

Media Number	Media Type	B(x) = 2/20/75 Rating	Element Length	Element Mm	Part Number
No. 1	Synthetic	+μ/+μ/3μ	4.37	111.0	P169429
			8.00	203.2	P167838
			8.18	206.2	P167182**
No. 2	Synthetic	2μ/3μ/5μ	4.37	111.0	P165041
			8.00	203.2	P165043
No. 4	Synthetic	4μ/10μ/13μ	4.37	111.0	P165006
			8.00	203.2	P165015
No. 7	Synthetic	7μ/17μ/22μ	4.37	111.0	P165136
			8.00	203.2	P165138

** High Collapse Elements

+ - Particles Less Than 2μ

P16-7183
HIGH COLLAPSE
NON-BYPASS

Non-Stock Product Options

Contact Donaldson Company or your local Donaldson distributor for build-to-order non-stock product option availability and manufacturer's lead time requirements. Note--not all option combinations can be made.

Bulletin # 1200-451 (9/91)

For More Information, Contact:

J/T HYDRAULICS & SERVICE CO
1511 Bingle, Suite B2
Houston, Texas 77055
(713) 984-9727

donaldson

Donaldson Company, Inc.
Hydraulic Products
P. O. Box 1299
Minneapolis, MN 55440
(800) 874-1874
FAX: (612) 887-3716

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REFERENCE: HYDRAULIC PART NO.(S) 13
HYDRAULIC SCHEMATIC NO. 347-8001-01

SAUER SUNDSTRAND

MCV103/113
Flow Control Servovalve

BLN-95-8964-6 Issued: March 1991

DESCRIPTION

The MCV103/113 Flow Control Servovalve (FCS) is a two-stage electrohydraulic servovalve that provides an output flow rate proportional to an input current signal. The FCS consists of a closed loop Pressure Control Pilot (PCP) valve and a pilot-pressure actuated, spring-centered second stage that features a unique dual spool arrangement.

The FCS provides true proportional servo control and has a dynamic response bandwidth suitable for use in many precision closed loop applications. It is a low cost alternative to conventional high performance servovalves. Six flow ratings are available, based on a 1000 psi pressure drop and rated input current: 2.5, 5, 10, 14, 15 and 20 gpm.



FEATURES

- Closed loop pressure control pilot stage valve eliminates the need for mechanical feedback from the second stage.
- Double spool second stage allows factory adjustment of output null ambient pressure levels for specific customer requirements.
- Full signal current of 42 mA is available for all flow ratings - mounting/porting patterns and electronic controller output stages can be used interchangeably with different flow rates. Other full signal current ratings are available.
- PCP manual operator allows hydraulic operation to be verified without electrical signal.
- GM Packard or MS connectors available.
- Closed loop pressure control first stage maintains constant output with varying pilot pressure or other disturbances.
- Compatible with standard 10 micron (B_{10}=2) nominal filtration.
- Null shift stability over a wide temperature and pressure range.

ORDERING INFORMATION

A range of options to the basic servovalve allows it to be custom-tailored to each application. The control is specified by filling in each slot of the order number, as is shown in Table A, with the appropriate model code.

TABLE A. INFORMATION NECESSARY TO SPECIFY THE SERVOVALVE.

MCV 103/113 X X X XX

- DEVICE IDENTITY
- SUPPLY PRESSURE
- FLOW RATING
- NULL PRESSURE
- PILOT STYLE

1. DEVICE IDENTITY
This is the basic FCS. The model code is MCV103/113.

2. SUPPLY PRESSURE

MODEL CODE	SUPPLY PRESSURE
A	500-3000 psi (34.5-207 bar)
C	200-1000 psi (13.8-69 bar)
E	500-2000 psi (34.5-138 bar)
F	500-2500 psi (34.5-172.5 bar)
G	500-2500 psi (34.5-172.5 bar)

3. FLOW RATING

MODEL CODE	FLOW RATING
2	2.5 gpm (9.5 lpm)
5	5.0 gpm (19 lpm)
6	10 gpm (38 lpm)
7	15 gpm (57 lpm)
8	20 gpm (76 lpm)
9	14 gpm (53 lpm)

ORDERING INFORMATION *(continued)*

4. NULL PRESSURE

MODEL CODE	NULL PRESSURE
1	50% of supply
2	1-2% of supply

5. PILOT STYLE

MODEL CODE	PILOT STYLE	DESCRIPTION
01	MCV101A1255	Packard connector, 150 mA, single 23 Ohm coil, oil filled
02	MCV101A1347	MS connector, 150 mA,single 23 Ohm coil, oil filled
03	MCV101A1248	Packard connector, 221 mA, dual 15.5 and 19 Ohm coils, oil filled
05	MCV101A1370	MS connector, 42 mA, single 69 Ohm coil
06	MCV101A1412	MS connector, 42 mA (10 & 15 gpm) 31 mA (2 1/2 & 5 gpm) single 106 Ohm coil
07	MCV101A1404	Packard connector, 42 mA (10 & 15 gpm) 31 mA (2 1/2 & 5 gpm) single 106 Ohm coil, oil filled

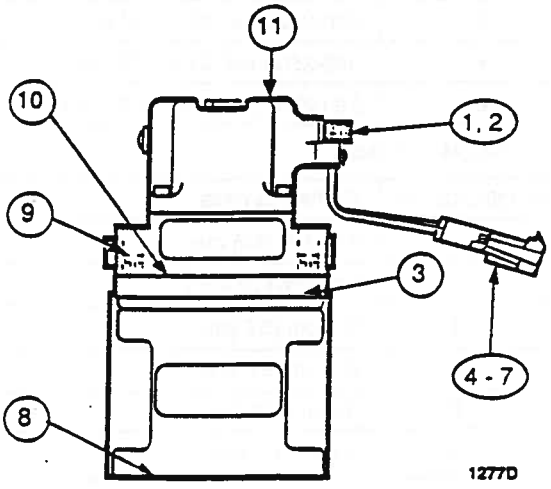
5. PILOT STYLE *(continued)*

MODEL CODE	PILOT STYLE	DESCRIPTION
08	MCV101A1396	Packard connector, 42 mA, single 69 Ohm coil, oil filled
09	MCV101A1420	MS connector, 13.5 and 19.75 mA, 643 Ohm coil
10	MCV101A1456	Twin Packard connector, 221 mA, dual 15.5 and 19 Ohm coils
11	MCV101C1014	MS connector, MCV103A2X11, MCV103A5X11, 72 mA MCV103A6X11, MCV103F7X11, 108 mA 23 Ohm intrinsically safe
12	MCV101A1479	Packard connector,2 pin 150 mA, 35 Ohm seriesed coils
14	MCV101A1289	MS Connector MCV113A6X14 MCV113F7X14 96 mA, single 23 Ohm coil, oil filled

6. SPECIAL

A blank field indicates that the valve is standard. 'A' to 'ZZ' indicates that the valve is non-standard and has special requirements.

PARTS LIST



NO.	PART NO.	DESCRIPTION
1	K01314	DEVICE MS CONNECTOR (MS3102C-14S-2P)
2	K07685	MATING MS CONNECTOR (CLASS FOR R OPTIONAL)
3	K00829	O-RING (.364 I.D. X .070)
4	K03378	DEVICE PACKARD CONNECTOR 2 PIN
5	K03379	DEVICE PACKARD CONNECTOR 4 PIN
6	K03383	MATING PACKARD CONNECTOR 2 PIN
7	K03384	MATING PACKARD CONNECTOR 4 PIN
8	K00830	O-RING (.426 I.D. X .070)
9	K04793	SOCKET HEAD CAP SCREW (10-32 X 3/4)
10	K00832	O-RING (.551 I.D. X .070)
11	MCV101	PILOT*

* COMPLETE PILOTS MAY BE ORDERED SEPARATELY. CONTACT SAUER-SUNDSTRAND FOR FURTHER INFORMATION.

TECHNICAL DATA

ELECTRICAL

NOMINAL FULL FLOW CURRENT

CURRENT	MODEL CODE
150 mA	01, 02, 12, 13
200 mA	03
42 mA	05, 06, 07, 08
31 mA	06*, 07*
13.5 and 19.75 mA	09
72 mA and 108 mA	11
96 mA	14

• 2 1/2 and 5 gpm only

COIL RESISTANCE @ 24° C (76° F)
(SINGLE COIL)

RESISTANCE	MODEL CODE
23 Ohms	01, 02, 11, 14
69 Ohms	05, 08
106 Ohms	06, 07
643 Ohms	09
35 Ohms	12

COIL RESISTANCE @ 24° C (76° F)
(DUAL COIL, MODEL CODE 03)
15.5 Ohm (across the A - B coil)
19 Ohm (across the C - D coil)

See Ordering Information.

COIL INDUCTANCE (HENRIES)
.085 (23 Ohm coil)
.037 (A - B of dual coil)
.029 (C - D of dual coil)
.257 (69 Ohm coil)
.452 (106 Ohm coil)
2.372 (643 Ohm coil)

MAXIMUM CONTINUOUS VOLTAGE @ 93.3° C (200° F)
7.5 Vdc

HYDRAULIC

FLUID
Petroleum base standard. Other with compatible seals.

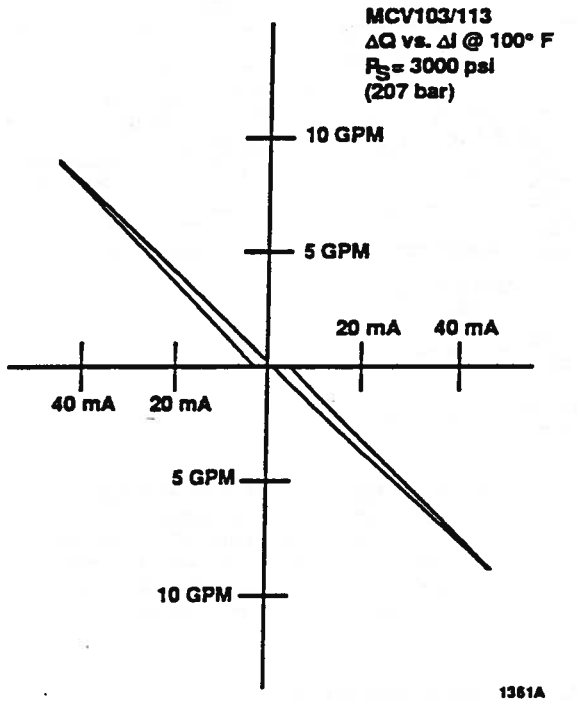
OIL VISCOSITY
40 - 20,000 SSU

FLUID AND AIR OPERATING TEMPERATURE RANGE
-40° to 93° C (-40° to 200° F)

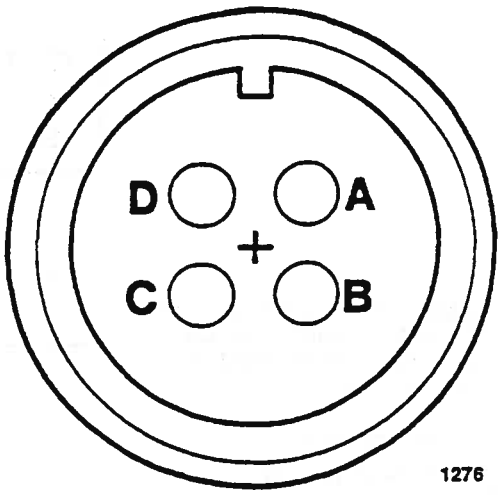
FLUID AND AIR RATED TEMPERATURE RANGE
-29° to 93° C (-20° to 200° F)

FILTRATION
10 micron in-line pressure filter.

TYPICAL FULL STROKE CURRENT

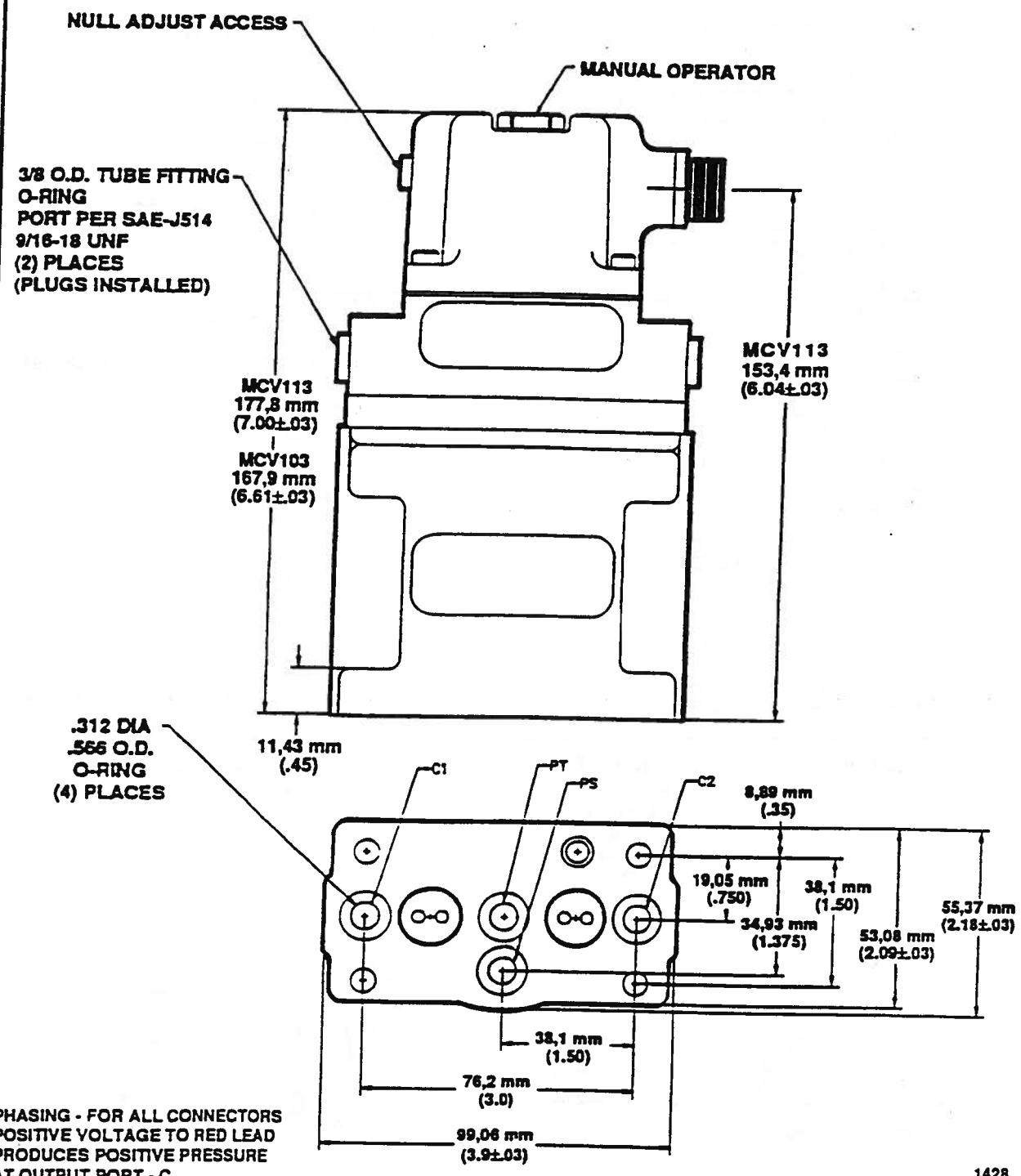


CONNECTION DIAGRAM



Pin Orientation of the Optional MS Connector. Part Number K01314 (MS3102C14S-2P).

DIMENSIONS



PHASING - FOR ALL CONNECTORS POSITIVE VOLTAGE TO RED LEAD PRODUCES POSITIVE PRESSURE AT OUTPUT PORT - C_1

P_T - TANK PRESSURE;

P_S - SYSTEM PRESSURE;

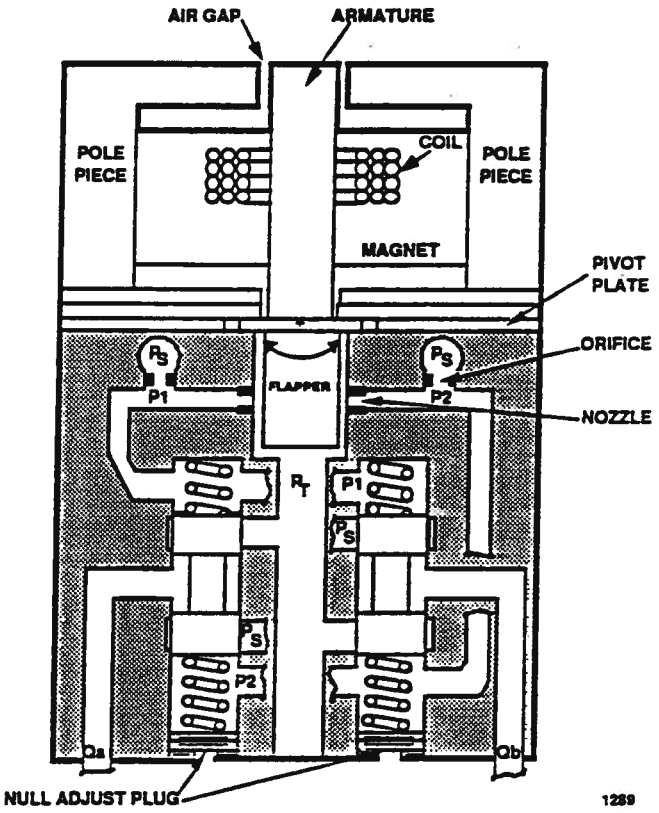
C_1 AND C_2 - CONTROL PORT PRESSURE

1428

NOTE: IF THE SERVOVALVE IS TO BE RE-NULLED, REMOVE THE SLOTTED HEAD SCREW FROM THE SERVOVALVE, THEN INSERT A 3/32-INCH ALLEN WRENCH IN THE ADJUSTING SET SCREW AND SLOWLY ROTATE THE SET SCREW IN SMALL INCREMENTS UNTIL THE VALVE IS CENTERED.

Dimensions of the MCV103/113 in Millimeters (Inches).

INTERNAL WORKINGS SCHEMATIC



Schematic of the Internal Workings of the MCV103/113.

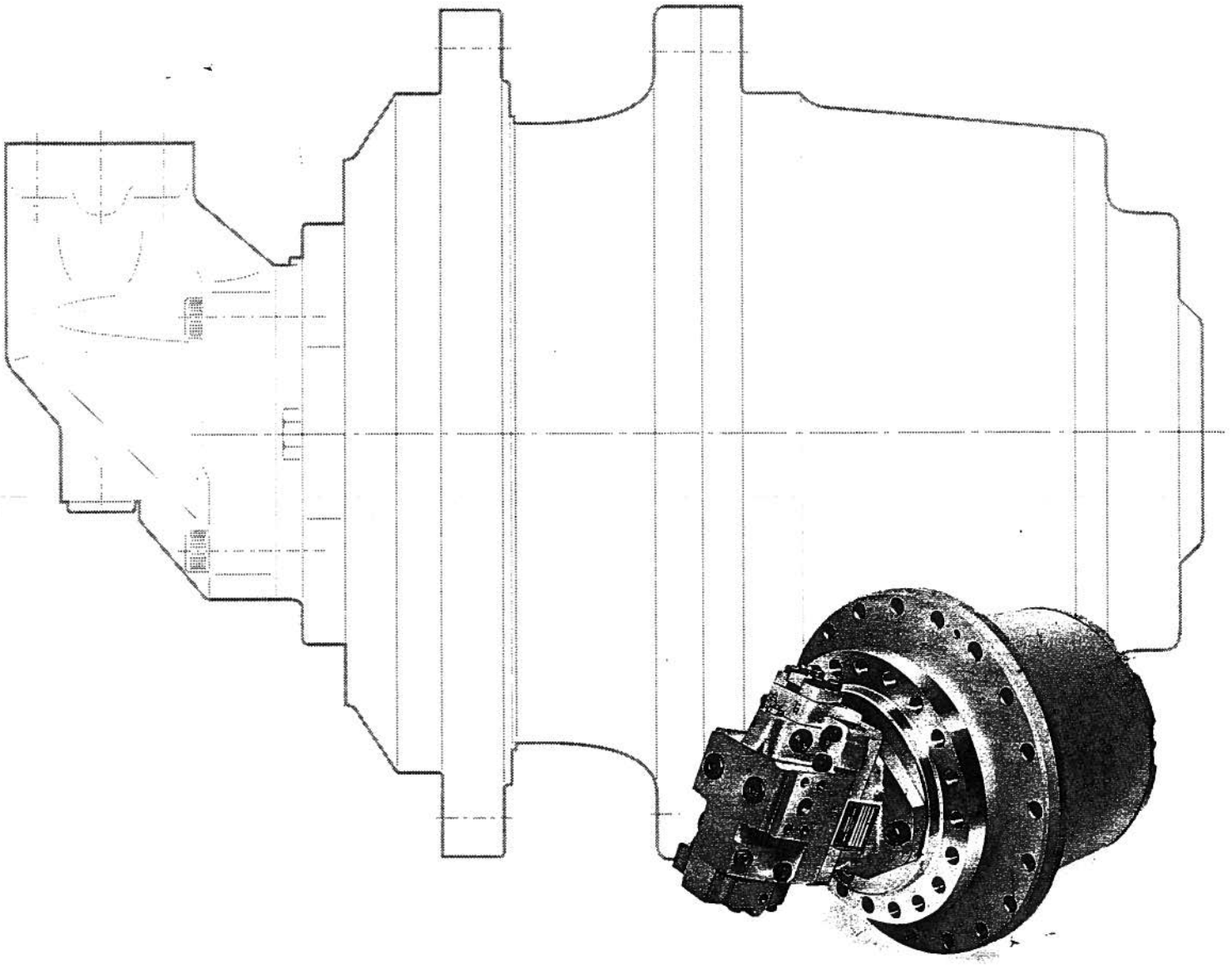
THEORY OF OPERATION

The MCV103/113 FCS uses a torque motor actuated, double nozzle, flapper pilot and a double sliding spool boost stage. See Internal Workings Schematic. The pilot differs from the traditional pilot stage in that the sizing of the nozzles together with a scaled magnetic circuit produces a single-stage, true integrating, closed loop pressure control pilot stage. The magnetic circuit accepts the current command from the external control source and yields a net stiffness dominated by pressurized oil impinging on the flapper. The nozzles are sized to take advantage of this oil pressure dependence to give the pilot a net effective scale factor. Dynamically, the resulting hydraulic circuit produces an output pressure (independent of supply pressure variations) which controls its output load (i.e., boost stage spool), yet maintains tight and constant closed loop control of the load. For further information on the MCV101, see BLN 95-8955.

The differential pressure from the pilot is applied across both spools of the boost stage and is balanced by the springs of the second stage, producing a spool position proportional to the differential pressure and therefore to the input current to the pilot stage. Porting edges on each spool are then uncovered, allowing oil to flow from the supply port of one spool out the workport and back to the other spool's return port.

REFERENCE: HYDRAULIC PART NO.(S) 15
HYDRAULIC SCHEMATIC NO. 347-8001-01

FD



Hydrostatic Planetary Drives

VOLVO
Hydraulics

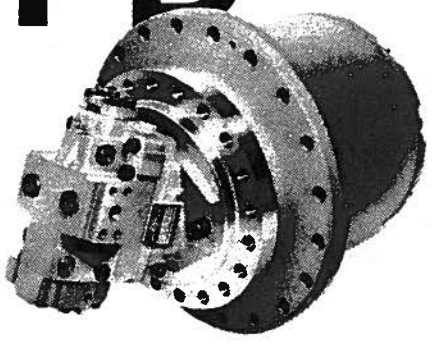
HYDROSTATIC PLANETARY DRIVES

High radial load capacity, low weight, and small installation dimensions are some of the most important features of the hydro static planetary drives from Volvo Hydraulics.

The drives, consisting of a planetary gearbox and an integrated high speed hydraulic motor, enjoy a reputation for high dependability and long service life. They are used mainly in mobile track and wheel drives, but also in a wide range of industrial and marine applications.

The cartridge type hydraulic motors, with fixed or variable displacement, have been selected from our high performance Compact Power series F12 and V12.

FD



FD

Series FD hydrostatic planetary drives from Volvo Hydraulics features high performance characteristics in a very compact, low weight, low noise, and dependable design.
The drives can fully utilize the entire high speed capability of the fixed or variable displacement motors.

- High radial loads
- Large selection of gear ratios
- Load sharing planetary gear stages
- Floating planet carriers
- Roller bearings throughout
- Fixed or variable displacement, high speed motor
- Control and accessory valves for most applications
- Optional, easily serviced multi-disc parking brake
- Proven reliability

HIGH PERFORMANCE

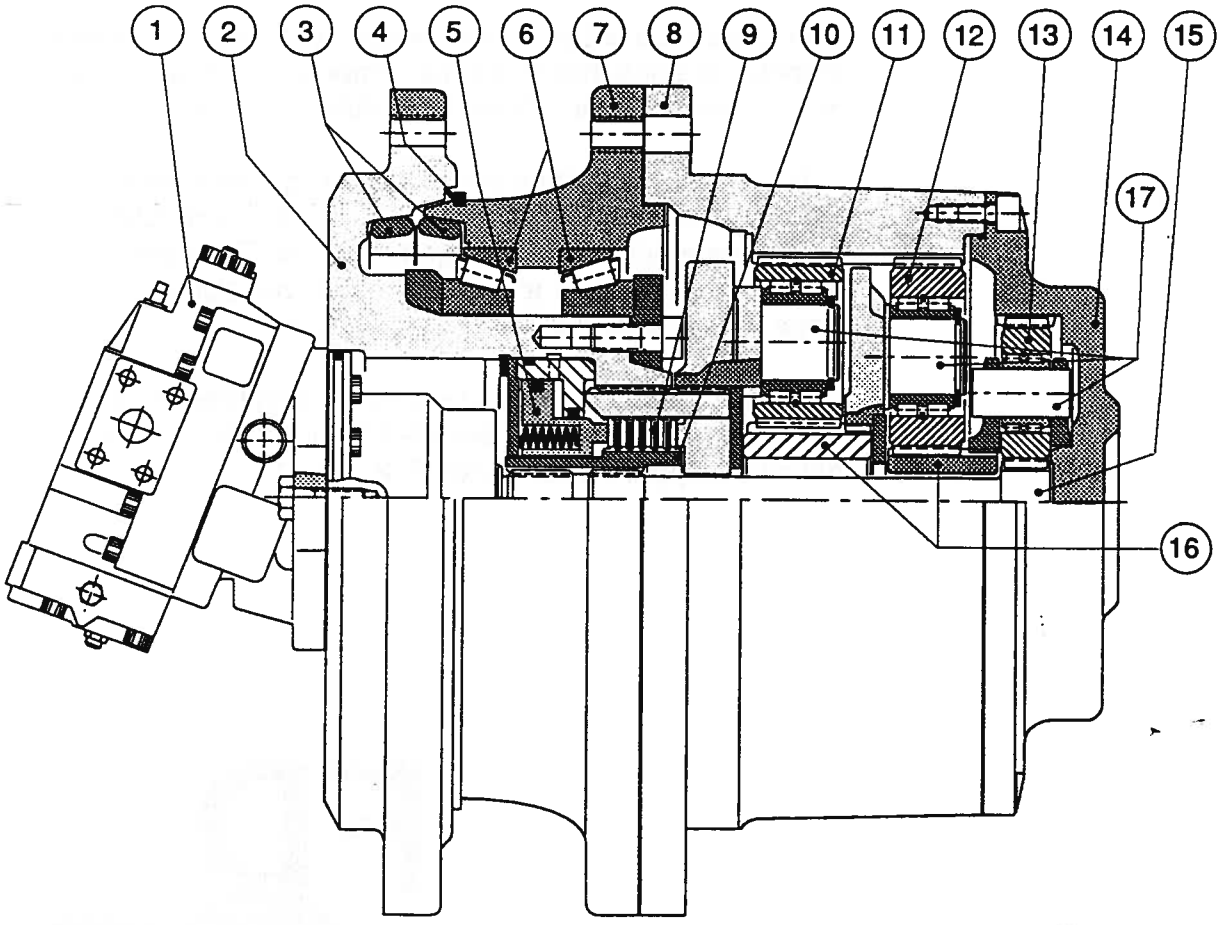
A small, high speed motor, ground sun and planet gears, and free-floating planet carriers make up for a very compact, low weight design. Planet gears are carried on cageless roller bearings, contributing to the low noise.

LONG SERVICE LIFE

The pre-loaded heavy-duty roller bearings supporting the output hub are protected by an efficient mechanical shaft seal and an external scraper ring. The sun and planet gears have a fully ground, load sharing tooth form allowing a very high torque capacity.

INTEGRATED MOTOR

A cartridge type, high speed hydraulic motor, series F12 or V12, is integrated in the planetary gearbox. These high performance motors offer proven reliability, and are available with control and accessory valves for most application requirements.



LEGEND

1. Hydraulic motor (V12 shown)
2. Spindle
3. Mechanical shaft seal
4. Scraper ring
5. Brake disengage piston
6. Tapered roller bearings
7. Output hub
8. Ring gear
9. Multidisc brake
10. Input coupling
11. Third stage planet gear ass'y
12. Second stage planet gear ass'y
13. First stage planet gear ass'y
14. Cover (first stage ring gear)
15. Intermediate shaft (first stage sun wheel)
16. Second and third stage sun wheel
17. Planetary carrier

SPECIFICATIONS

Frame size	FD8	FD12	FD18	FD20	FD28	FD30	FD34	FD44	FD60	FD100	FD130	FD160	FD360
Output torque [in.lbs.]													
Intermittent (x100)	708	1062	1600	1770	2478	2655	3010	3899	5310	8850	11,505	14,160	31,860
Continuous (x100)	390	585	876	973	1362	1460	1660	2141	2920	4867	5327	7788	17,523
Standard gear ratio	50.6	92.3	92.3	102.6	115.6	115.6	127.5	147.8	147.8	174.9	206.3	190.4	223.2
Max speed (F12*) [rpm]													
Intermittent (at std. ratio)	142	77	77	61.5/ 55	55/ 48	55/ 48	50.5/ 44	43/ 38	35	26.9	22.8	–	–
Continuous (at std. ratio)	112	61	61	49	43	43	34	34	27	20.6	17.5	–	–
Max speed (V12**) [rpm]													
Intermittent (at std. ratio)	–	–	–	68.5	60.5	60.5	55	47.5	42	32	27.1	–	–
Continuous (at std. ratio)	–	–	–	55	48.5	48.5	44	38	34	25.7	21.8	–	–
Weight													
(w/brake, no motor) [lb.]	158	198	202	229	268	295	319	363	506	715	994	1551	2376
Brake													
Braking torque [in.lbs.]	1327	1777	1777	1777	2655	2655	2655	2655	3982	5310	5310	7965	15,045
Min release press. [psi]	174	217	217	188	188	188	188	188	217	188	188	203	174
*) **F12 cartr. motor size**	-30	-30	-30	-40/ -60	-40/ -60	-40/ -60	-40/ -60	-40/ -60	-80	-110	-110	1)	1)
Shaft speed [rpm]													
Max intermittent	7100	7100	7100	6400/ 5600	6400/ 5600	6400/ 5600	6400/ 5600	6400/ 5600	5200	4700	4700	–	–
Max continuous	5600	5600	5600	5000/ 4300	5000/ 4300	5000/ 4300	5000/ 4300	5000/ 4300	4000	3600	3600	–	–
Weight [lb.]	26	26	26	36 21	36 21	36 21	36 21	36 21	57				
) **V12 cartr. motor size	–	–	–	-60	-60	-60	-60	-60	-80	-110	-110	1)	1)
Shaft speed [rpm]													
Max intermittent[2]	–	–	–	7000	7000	7000	7000	7000	6250	5600	5600	–	–
Max continuous	–	–	–	5600	5600	5600	5600	5600	5000	4500	4500	–	–
Weight [lb.]	–	–	–	62	62	62	62	62	72	101	101	–	–
Operating pressure [psi]													
Intermittent	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	–	–
Continuous	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	–	–

1) Contact Volvo Hydraulics for information on suitable non-cartridge fixed and variable displacement motors.

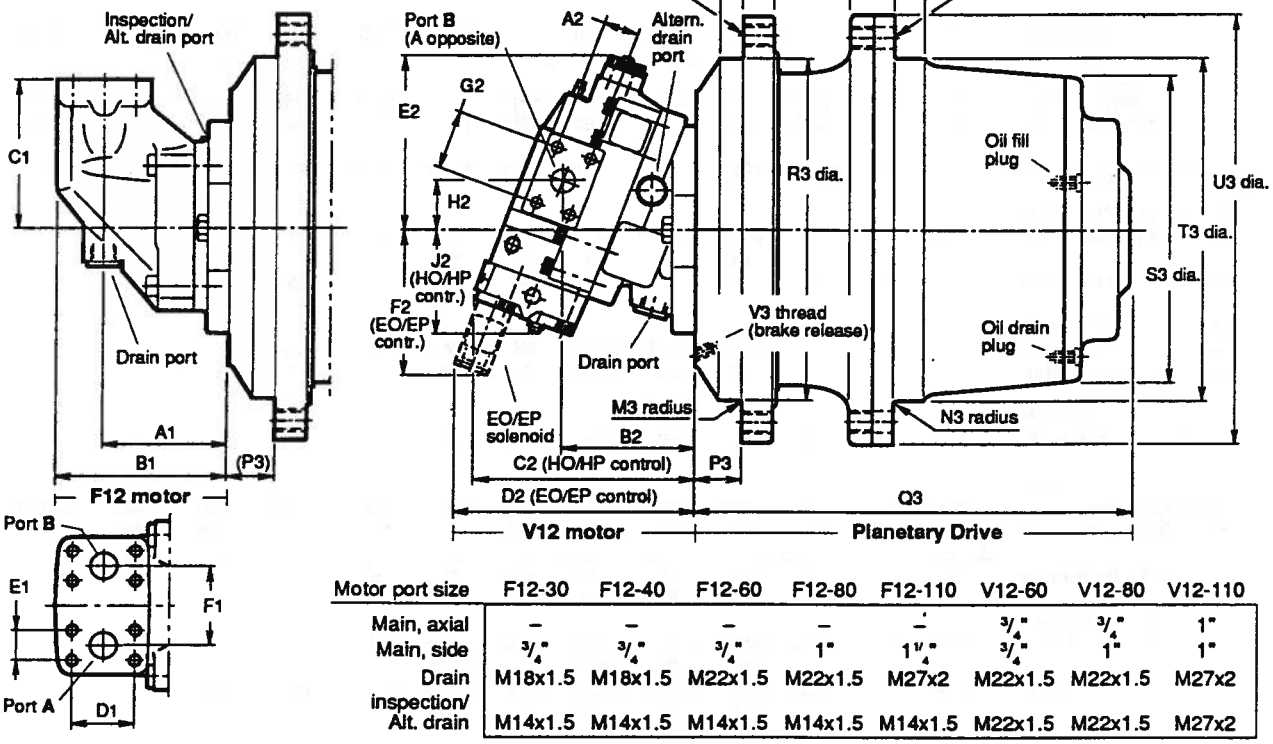
2) At reduced displacement

GEAR RATIOS

Frame size	Standard gear ratio	Optional gear ratios										
FD8	**51**	31	35	41	66							
FD12	**92**	61	77	102	109	116	122	132	143	156	172	237
FD18	**92**	61	77	102	109	116	122	132	143	156	172	237
FD20	**103**	36	61	92								
FD28	**116**	92	102	143	172							
FD30	**116**											
FD34	**128**	78	90	99	152	191						
FD44	**148**	96	124	186								
FD60	**148**	96	109	117	124	169	186					
FD100	**175**	84	121	192								
FD130	**206**	167										
FD160	**190**	153	169	273								
FD360	**223**											

Note: Additional gear ratios are available; contact Volvo Hydraulics for further information.

INSTALLATION



Motor port size	F12-30	F12-40	F12-60	F12-80	F12-110	V12-60	V12-80	V12-110
Main, axial	–	–	–	–	–	3/4"	3/4"	1"
Main, side	3/4"	3/4"	3/4"	1"	1 1/4"	3/4"	1"	1"
Drain	M18x1.5	M18x1.5	M22x1.5	M22x1.5	M27x2	M22x1.5	M22x1.5	M27x2
inspection/ Alt. drain	M14x1.5	M14x1.5	M14x1.5	M14x1.5	M14x1.5	M22x1.5	M22x1.5	M27x2

Plan. Drive size	FD8	FD12	FD18	FD20	FD28	FD30	FD34	FD44	FD60	FD100	FD130	FD160	FD360
F12 motor size	-30	-30	-30	-40/-60	-40/-60	-40/-60	-40/-60	-40/-60	-80	-110	-110	1)	1)
V12 motor size	–	–	–	-60	-60	-60	-60	-60	-80	-110	-110	1)	1)
F12 motor A1	91	91	91	97/110	97/110	97/110	97/110	97/110	114	123	123	–	–
B1	127	127	127	133/146	133/146	133/146	133/146	133/146	157	175	175	–	–
C1	100	100	100	110/125	110/125	110/125	110/125	110/125	135	145	145	–	–
D1	50.8	50.8	50.8	50.8	50.8	50.8	50.8	50.8	57.2	66.7	66.7	–	–
E1	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	27.8	31.8	31.8	–	–
F1	66	66	66	66	66	66	66	66	75	83	83	–	–
V12 motor A2	–	–	–	23.8	23.8	23.8	23.8	23.8	27.8	27.8	27.8	–	–
B2	–	–	–	127	127	127	127	127	120.5	130	130	–	–
C2	–	–	–	213	213	213	213	213	206	217	217	–	–
D2	–	–	–	233	233	233	233	233	227	237	237	–	–
E2	–	–	–	166	166	166	166	166	173	188	188	–	–
F2	–	–	–	145	145	145	145	145	144	146	146	–	–
G2	–	–	–	50.8	50.8	50.8	50.8	50.8	57.2	57.2	57.2	–	–
H2	–	–	–	45	45	45	45	45	48.3	51	51	–	–
J2	–	–	–	108	108	108	108	108	108	109	109	–	–
Plan. Drive A3	72	75	75	135	135	91	135	91	130	165	190	167	130
B3	10	14	14	20	19	20	19	20	20	35	45	52	100
C3	15	20	20	20	25	20	25	20	28	28	35	40	40
D3	20	35	35	35	43	36	43	36	43	53	58	65	60
E3	20	25	25	20	25	18	30	30	30	43	45	35	80
F3*)	M16	M16	M16	M16	M20x1.5	M16	M20x1.5	M20x1.5	M24x2	M24x2	M24x2	M24x2	M30
G3	12	12	18	20	20	20	20	20	24	30	32	38	30
H3	230	275	275	285	335	285	335	285	400	460	500	600	680
J3*)	M16	M16	M16	M16	M20x1.5	M16	M20x1.5	M20x1.5	M24x2	M24x2	M24x2	M24x2	M30
K3	8	12	18	18	20	20	20	20	24	24	32	38	30
L3	260	305	305	305	335	335	360	400	425	460	500	600	720
M3	1.6	4	4	4	6	4	6	4	8	12/60	25	16	16
N3	1.6	4	4	2.5	4	1.6	6	2.5	6	5	4	4	10
P3	30	18	18	20	38	20	38	20	25	35	45	52	100
Q3	270	323	323	337	369	354	366	383	409	461	530	551	658
R3	190	240	240	240	295	240	295	240	350	390	390	460	580
S3	219	255	255	255	278	278	280	331	357	407	449	540	649
T3	220	270	270	270	295	300	318	350	375	408	450	542	650
U3	293	340	340	335	375	365	400	435	466	500	550	650	775
V3	R1/4"	M12x1.5	M12x1.5	M12x1.5	M16x1.5	M12x1.5	M16x1.5	M16x1.5	M16x1.5	M16x1.5	M18x1.5	M18x1.5	M22x1.5

Note: Dimensions in mm *) Metric thread 1) Contact Volvo Hydraulics for information on suitable non-cartridge motors

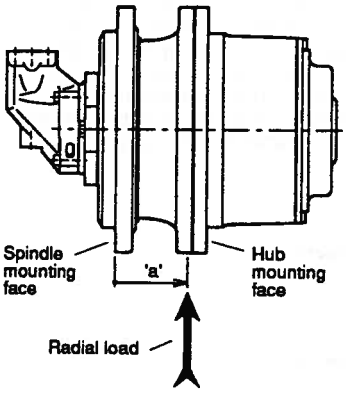
RADIAL LOAD CAPACITY

The tapered roller bearings supporting the output hub allow a substantial radial load. The bearing curve to the right shows, as an example, max allowable radial load versus load distance from the spindle mounting face at an L_{10} bearing life of 10 million revolutions.

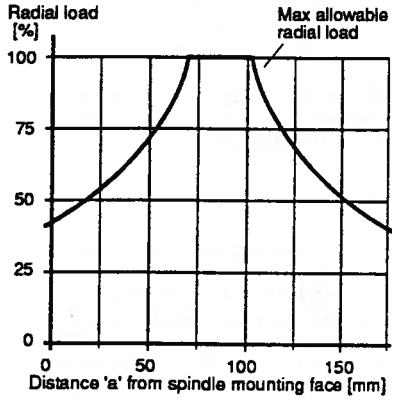
The actual radial load is calculated from the normal ground load and the tractive effort force.

The table below shows dynamic (C_{dyn}) and static (C_{stat}) bearing capacities for the FD frame sizes.

Frame size	Bearing capacity [lb.] C_{dyn}	C_{stat}
FD8	38,218	62,946
FD12	39,566	67,442
FD18	39,566	67,442
FD20	50,357	91,047
FD28	50,357	91,047
FD30	50,357	91,047
FD34	50,357	91,047
FD44	50,357	91,047
FD60	67,442	128,141
FD100	111,954	227,056
FD130	117,575	229,305
FD160	154,668	371,709
FD360	233,801	550,781



A typical bearing curve (radial load vs. distance from spindle mounting face) is shown to the right.
A bearing curve for each frame size is available from Volvo Hydraulics as well as assistance in the selection of a suitable planetary drive in a particular application.



PLANETARY DRIVE ORDERING CODE

Example: **FD28 – 115 – B – A – V12 – 060 – M A – C H – C – 000 – A – 060 / 012 – HO S 01 I – 010 / 000 – L 01**

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

Planetary Drive | F12 / V12 (basic motor) | V12 (displacement, control, valve, etc.)

1. Planetary drive frame size
   8, 12, 18, 20, 28, 30, 34, 44, 60, 100, 130, 160, or **360**
2. Gear ratio
   Select from table of available gear ratios, page 5
3. Parking brake
   B Multi-disc brake
   O Without brake
4. Status
   (Factory assigned)
5. Hydraulic motor
   F12 (fixed displacement)
   V12 (variable displacement)
6. Motor frame size
   F12: **30** (FD8 through FD18)
   40 (FD20 through FD44)
   60 (FD20 through FD44)
   80 (FD60)
   110 (FD100 through FD130)
   V12: **60** (FD20 through FD44)
   80 (FD60)
   110 (FD100 through FD130)
   Note: Contact Volvo Hydraulics for information on suitable motors for FD160 through 360
7. Function (end cap position)
   M Motor; bi-directional; (V12: standard end cap position for EO, EP, HO, and HP controls)
8. Main circuit ports
   A ISO metric axial ports (not available on F12; standard on V12)
   F ISO metric side ports (std. on F12; optional on V12)
9. Motor mounting flange
   C Cartridge flange
10. Motor shaft seal
    H Nitrile rubber
    V Fluorocarbon ('Viton')
11. Motor shaft end
    C Spline (DIN 5480); for FD8 through 44
    D Spline (DIN 5480); for FD 60
12. Serial number (assigned for special V12 versions only)
13. Technical status (V12 only)
    (Factory assigned)
14. Max displacement (V12 only)
    Specify in cm³
15. Min displacement (V12 only)
    Specify in cm³
16. Control (V12 only; page 8 and 9)
    EO Electrohydr. two-position
    EP Electrohydr. proportional
    HO Hydraulic two-position
    HP Hydraulic proportional
17. Function
    L 12 VDC solenoid (EO, EP)
    H 24 VDC solenoid (EO, EP)
    S Standard (HO, HP)
18. Version number
    (Factory assigned)
19. Servo supply
    E External
    I Internal
20. Threshold current (EO, EP), or threshold pressure (HO, HP)
    EO, EP 12 VDC: **400** [mA]
    EO, EP 24 VDC: **200** [mA]
    HO, HP: **010** [bar] (standard)
21. Modulating current (EO, EP), or modulating pressure (HO, HP)
    EO: **000**
    EP 12 VDC: **600** [mA]
    EP 24 VDC: **300** [mA]
    HO: **000**
    HP: **010, 015,** or **025** [bar]
22. Loop flushing valve (V12 only)
    L Valve integrated in end cap
    000 Not applicable
23. Flushing valve orifice (for 21)
    01, 02, etc. - refer to Volvo Hydraulics for information on orifice size

NOTE: The following accessory valve blocks are available for series F12 and V12 (refer to page 10):
- Loop flushing valve (F12)
- Crossover relief valve
- Counterbalance valve

V12 MOTOR CONTROLS

The following controls satisfy most application requirements:
- Two-position (EO and HO)
- Proportional (EP and HP)

All controls utilize a servo piston that connects to the valve segment (refer to the V12 Bulletin).

The built-in four-way servo valve acts on the servo piston and determines the displacement. The displacement angle ranges from 35° (max) to 6.5° (min). Servo supply pressure is usually obtained from the main high pressure port through the built-in double check valve.

When using external servo supply, the servo pressure should be at least 30 bar.

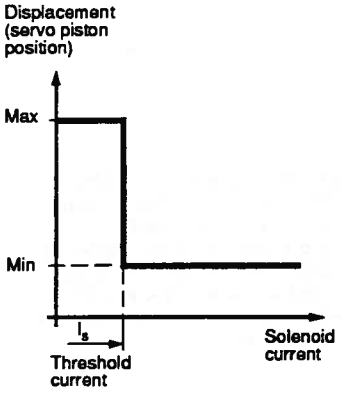
Note: Additional controls (shown in the V12 Bulletin) are available; contact Volvo Hydraulics for further information.

EO

The EO is a two-position control, where the max/min displacement is governed by an electrohydraulic solenoid valve attached to the control cover (refer to the installation drawing on page 12). The EO is utilized in transmissions where only two operating modes are required (low speed/high torque and high speed/low torque).

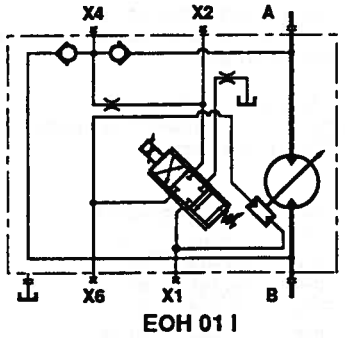
The servo piston stays in the max displacement position until the solenoid is activated, when the piston moves to the opposite, max displacement position. Intermediate displacements cannot be obtained with this control.
Servo pressure is supplied internally (through the double check valve from the main high pressure port) or externally (port X2).

The solenoid is either 12 or 24 VDC, requiring 1.2 and 0.6 A respectively. An electrical connector is included (DIN 43650/IP54).

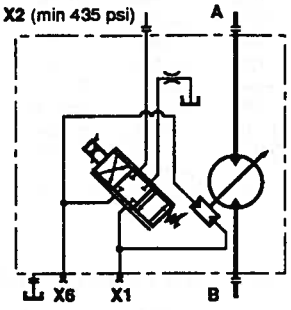


The EO two-position control is available in four versions:

EOH 01 I -Internal servo supply, 24 V
EOL 01 I -Internal servo supply, 12 V
EOH 01 E -Extern. servo supply, 24 V
EOL 01 E -Extern. servo supply, 12 V



EOH 01 I



EOH 01 E

EP

The EP electrohydraulic proportional control is used in hydrostatic transmissions requiring a continuously variable shaft speed. The servo valve is governed by a DC solenoid attached to the control cover.

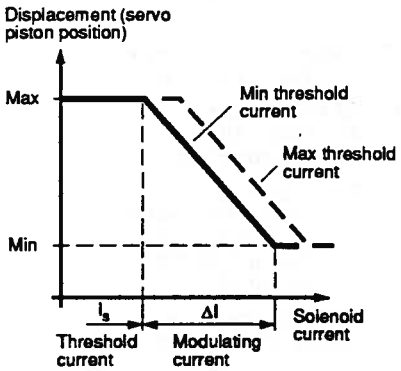
When the solenoid current increases above the threshold value, the servo piston starts to move from the max towards the min displacement position. The displacement vs. solenoid current is shown in the diagram to the right. The shaft speed vs. current is non-linear; refer to the lower diagram.

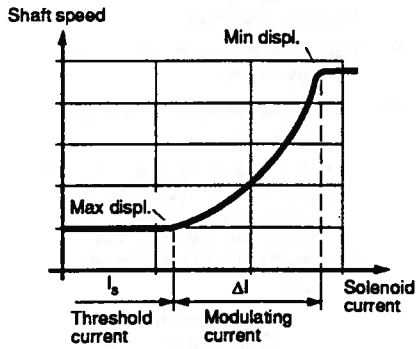
Solenoids are available in 12 and 24 VDC versions, requiring a max current of approx. 1.1 and 0.55 A respectively. The threshold current (I_s) is factory set but is adjustable (12 VDC: 0.25 - 0.45 A; 24 VDC: 0.10 - 0.23 A). When utilizing the full displacement range, the required modulating current (ΔI; non-adjustable) is 0.6 and 0.3 A respectively.

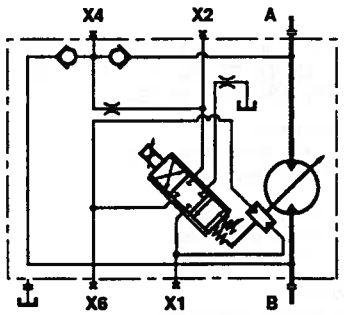
In order to minimize hysteresis, a pulse-width modulated control signal of 50 to 80 Hz should be utilized.

The EP proportional control is available in the following four versions:

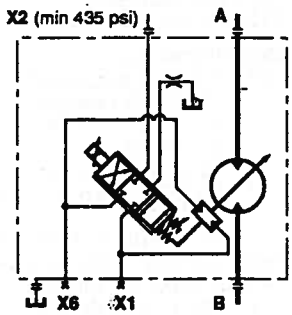
EPH 01 I- Internal servo supply, 24 V
EPL 01 I - Internal servo supply, 12 V
EPH 01 E -Extern. servo supply, 24 V
EPL 01 E -Extern. servo supply, 12 V







EPH 01 I



EPH 01 E

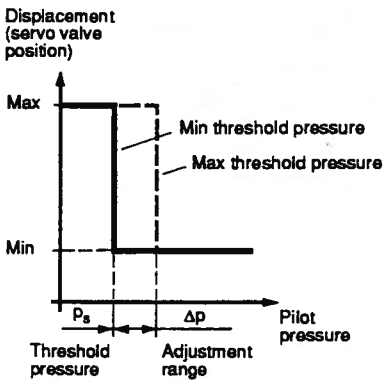
HO

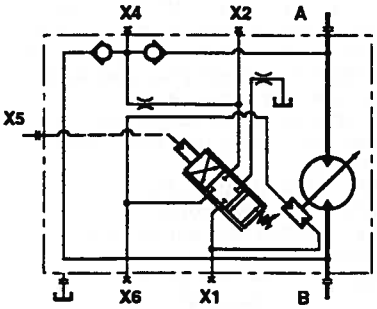
The two-position HO control is similar to the EO (page 11) but the pilot signal is hydraulic.
The position of the servo piston is governed by the built-in servo valve (same as on all previous controls).
When the applied pilot pressure (port X5) equals the pre-set threshold value, the piston moves from the max to the min displacement position.

The threshold pressure is factory set but can be adjusted between 72 and 362 psi.
An optional control spring provides an adjustment range of 15 to 160 psi).

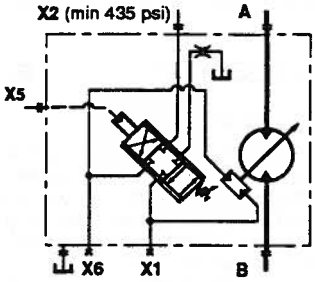
The following HO two-position control versions are available:

HOS 01 I - Internal servo supply
HOS 01 E - External servo supply (port X2)





HOS 01 I



HOS 01 E

HP

Like the EP described on page 8 the HP proportional control offers continuously variable displacement, but the pilot signal is hydraulic.

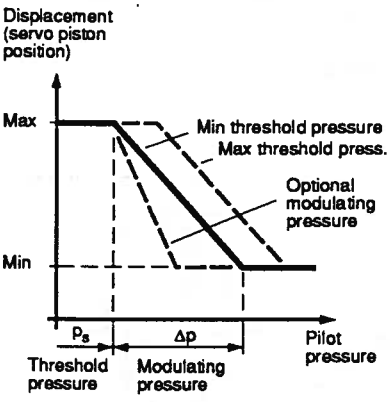
Normally, the servo piston stays in the max displacement position.
When a sufficiently high pilot pressure (p_s) is applied to port X5, the piston starts to move towards the min displacement position.

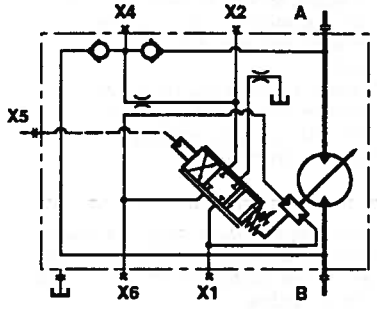
As can be seen from the displacement/pressure diagram, the displacement changes in proportion to the applied modulating pressure.
The following modulating pressures (Δp) can be selected:
145, 217, or 363 psi

The threshold pressure (p_s) is factory set but can be adjusted between 72 and 362 psi.
An optional control spring provides an adjustment range of 15 to 160 psi.
Shaft speed vs. pilot pressure is shown in the diagram to the right.

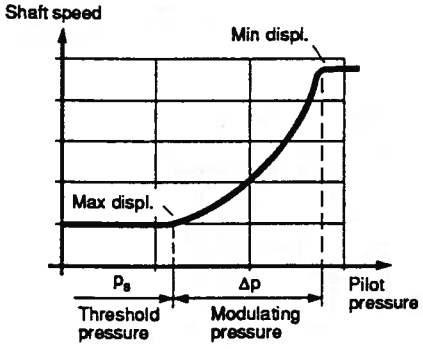
The following versions of the HP proportional control are available:

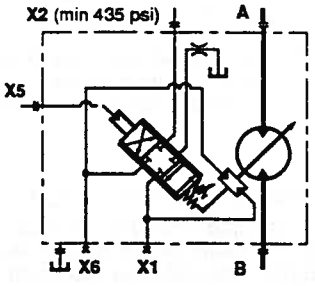
HPS 01 I - Internal servo supply
HPS 01 E - External servo supply (port X2)





HPS 01 I

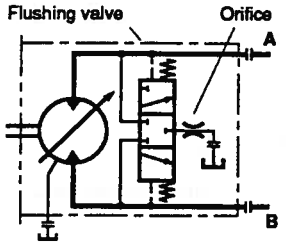


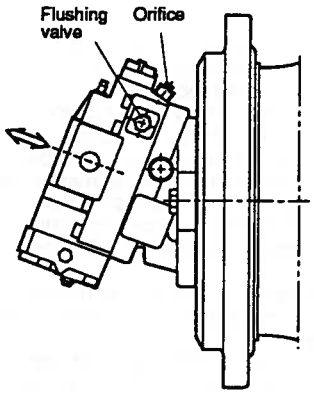


HPS 01 E

V12 LOOP FLUSHING VALVE

As an option, the V12 is available with a flushing (or shuttle) valve that supplies the motor with the necessary cooling flow when operating at high speeds and power levels.
It consists of a three-position, three-way spool valve built into a special end cap.
The valve connects the low pressure side of the main circuit to an orifice that empties fluid into the motor case.
Another important feature of the flushing valve is that it removes part of the main circuit fluid, which is continuously being replaced by cool, filtered fluid from the low-pressure charge pump of the main pump.

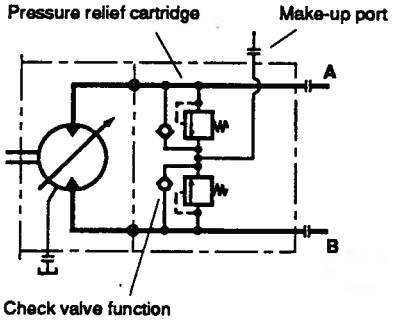


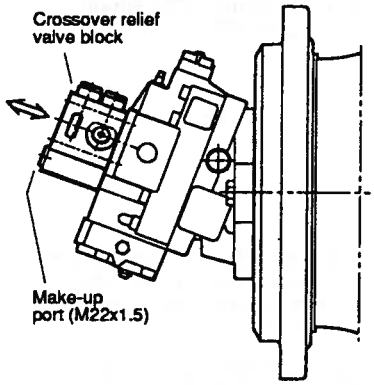


ACCESSORY VALVE BLOCKS

V12 CROSSOVER RELIEF

To protect the main hydraulic circuit from unwanted pressure peaks, an add-on valve block with two independent pressure relief cartridges (including check valve function) can be ordered for series V12.
The individual cartridge has a fixed, factory-set pressure setting.
An external port for make-up fluid is provided. When sufficiently pressurized, it prevents motor cavitation due to pressure losses in the main circuit.
The valve block sandwich mounts between the motor end cap and the main line flanges, utilizing long mounting screws.

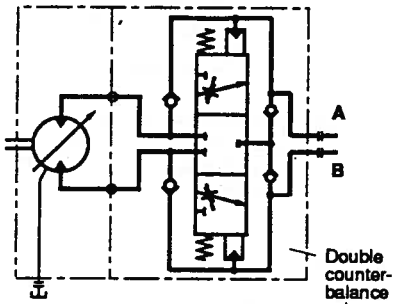


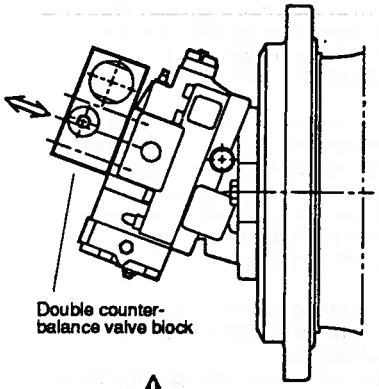


V12 COUNTERBALANCE VALVE

Some applications, such as open circuit track and wheel drives, require a so called 'brake valve' or counterbalance valve.
A double counterbalance valve is available for the V12 motor. It mounts directly on the end cap.

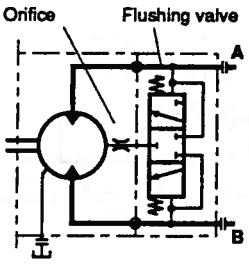
Note: Crossover relief and counterbalance valve blocks are also available for the F12 motor

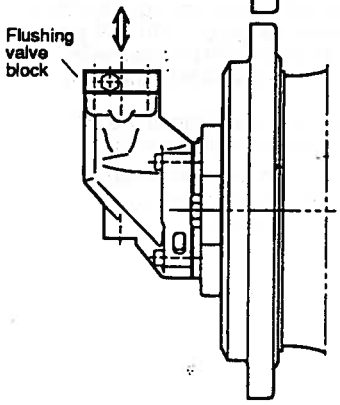




F12 LOOP FLUSHING VALVE

The flushing valve (type FV) supplies the F12 motor with a cooling flow usually required when operating at high speeds and power levels. It consists of a block containing a three-position, three-way valve, which connects the low pressure side of the main hydraulic system with the motor case. At a pressure differential of 290 psi, the cooling flow is approx. 4 gpm. An orifice can be installed in the motor port flange to limit the flow if required.





ACCESSORY VALVE BLOCK INFORMATION

Additional information (technical specifications, installation dimensions, availability, etc.) can be requested from Volvo Hydraulics.

GEARBOX INSTALLATION

MOUNTING SURFACES AND SCREWS

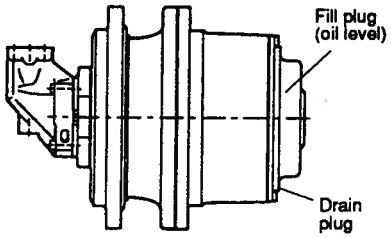
Gearbox, vehicle frame, and wheel mounting surfaces must be clean and free from paint as the torque must be transferred by friction.

Fine thread, high tensile strength metric screws are utilized to install the gearbox to the frame, as well as the rim to the gearbox. Contact Volvo Hydraulics for information on available sizes.

IMPORTANT

There is no oil in the gearbox when delivered; before start-up, the gearbox must be filled to at approx. 60% with a lubricant recommended to the right.
The fill plug hole indicates correct oil level (when the drain plug is in the vertical/down position).

Note: A relief valve, set at 15-30 psi, is installed in the gearbox to prevent excessive case pressure.



The hydraulic motor and the planetary drive hub turn in opposite directions; refer to 'Rotation' below left.

LUBRICATION

A good quality, standard EP 80W90 gearbox lubricant is satisfactory in most operating conditions.
In high or low temperatures the viscosity of the gearbox fluid can be guided by the viscosity recommended for the vehicle's diesel engine.
Hydraulic fluids can also be used, but under certain operating conditions.

Volvo Hydraulics will aid in the selection of a suitable lubricant for a particular application.

MULTI-DISC PARKING BRAKE

The optional, integrated disc brake is designed to hold more than the max output torque from the hydraulic motor.

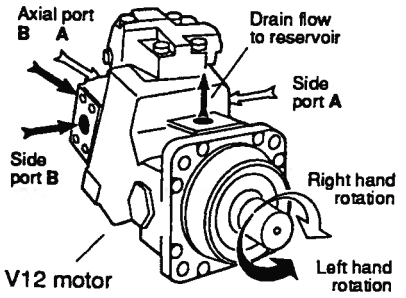
Release pressure:
Min required: 188 psi
Max allowed: 4350 psi

HYDRAULIC MOTOR INSTALLATION

ROTATION

The F12 and V12 motors are bi-directional. The illustration to the right shows shaft rotation vs. direction of flow for the V12 (with EO, EP, HO, or HP control). When fluid enters according to the black arrow the motor turns counter clockwise (left hand rotation), and when it enters according to the open arrow the motor shaft turns clockwise (right hand rotation). The same is valid for the F12 motor (as illustratred below right).

Note: The gearbox hub turns in the opposite direction



DRAIN PORTS

There are two drain ports on the motor. The uppermost drain port should always be utilized to insure bearing lubrication and cooling.
In order to avoid high case pressures, the drain line should be connected directly to the reservoir.

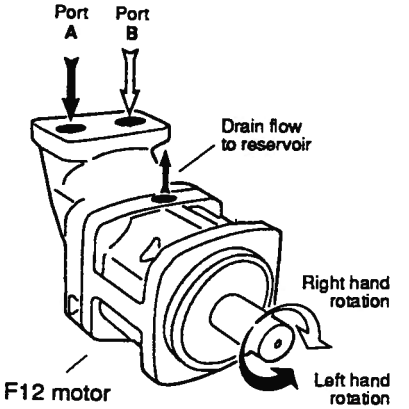
BEFORE START-UP

Make sure the motor case as well as the entire hydraulic system is filled with hydraulic fluid.
When the motor is running, the case must be filled to at least 50%.

CASE PRESSURE

The highest recommended case pressure (F12 and V12 shaft seal type H) at selected shaft speeds is shown in the following table. To obtain longest seal life, case pressure should be limited to 50% or less of the figures shown.

Motor size	Press. [bar] vs.shaft speed [rpm] 1500	3000	4000	5000	6000
F12-30	14	7	5.5	4.5	3.5
F12-40	12	6	4.5	3.5	-
F12-60	12	6	4.5	3.5	-
F12-80	10	5	4	-	-
F12-110	9.5	4.5	-	-	-
V12-60	12	6	4.5	3.5	3
V12-80	12	6	4.5	3.5	3
V12-110	10	5	4	3	-



FILTRATION

Maximum motor sevice life is obtained when the fluid cleanliness meets or exceeds ISO code 18/13 (ISO 4406).
A 10 µm (absolute) filter is recommended.

HYDRAULIC FLUIDS

Ratings and performance data for series F12 and V12 motors are based on operating with a good quality contamination-free petroleum-based fluid.
Hydraulic fluids type HLP (according to DIN 51524), automatic transmission fluids type A, or API CD engine oils can be used.
When the hydraulic system has reached full operating temperature, the drain oil viscosity should be above 52 ssu.
At start-up, the viscosity should not exceed 7000 ssu.
The ideal operating range for the motor is 78 to 150 ssu.
Fire resistant fluids, when used under modified operating conditions, as well as synthetic fluids are also suitable.
Contact Volvo Hydraulics for further information.

OPERATING TEMPERATURE

The following temperatures should not be exceeded (type H shaft seal):

Main circuit: 175°F
Drain fluid: 212°F

Continuous operation at high power levels usually requires case flushing in order to stay above the minimum fluid viscosity requirements.
A flushing valve and restrictor, built into a special end cap providing the necessary main circuit flushing flow, is available; refer to information on page 10.

REQUIRED INLET PRESSURE

In a hydrostatic transmission the motor sometimes operates as a pump (e g when the vehicle is going downhill).
The inlet port must then be supplied with fluid of sufficient pressure, or increased noise and gradually deteriorating performance due to cavitation may otherwise be experienced.

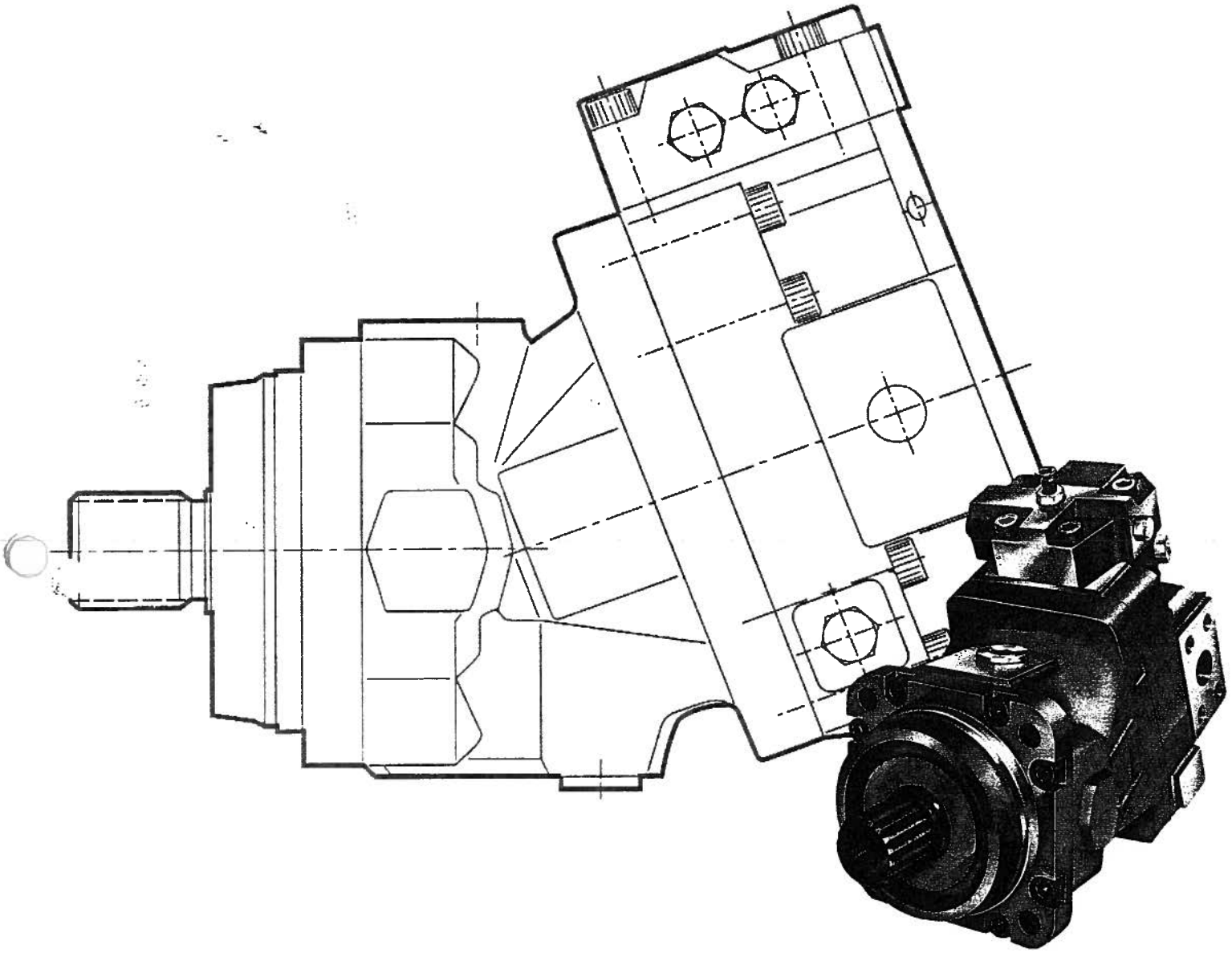
A minimum of 145 psi, measured at the motor inlet port, satisfies most operating conditions.

VOAC
Hydraulics

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Publ. No. 1345-9205 NA

V12



Variable displacement hydraulic motor

VOLVO
Hydraulics

COMPACT POWER

High power, low weight, and small installation dimensions are the most important features of the V12 series variable displacement motors from Volvo Hydraulics.

The motors, which enjoy a reputation for dependability and long service life, are used in a wide range of applications, mainly in mobile, industrial, and marine hydraulic installations.

Accessories such as safety valves that complement the basic motors are also available.



V12

The new series V12 hydraulic motors feature substantially improved performance capability, a more compact design, and much lower weight as compared to previous variable displacement motors from Volvo Hydraulics.

- Pressures to 7000 psi
- Increased speed range
- Higher output power
- Higher starting torque
- Displacement ratio to 5:1
- Controls for most needs
- Accessory valves
- SAE-, ISO, and cartridge versions

HIGH PRESSURE

Max intermittent pressure is 7000 psi, and the highest continuous operating pressure 6000 psi.

HIGHER OUTPUT POWER

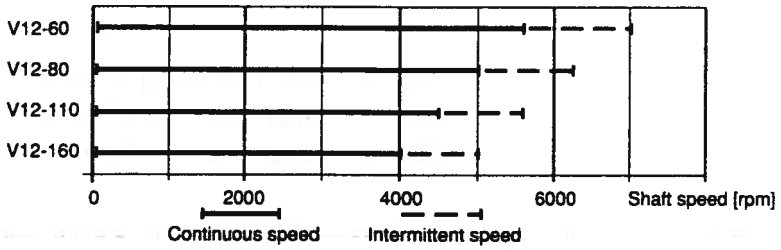
Higher allowable output speeds and operating pressures produce higher output power, both intermittent and continuous.
The output power also remains high at low displacements thanks to the high overall efficiency.

HIGHER STARTING TORQUE

The V12 motor offers very high starting torque, mainly because of 9 pistons. This also leads to a smoother operating motor.

WIDER SPEED RANGE

The low weight pistons with laminated piston rings as well as the compact design of the rotating parts permit both high intermittent and high continuous operating speeds. The diagram to the right shows the extremely wide speed range of the V12 motors.



SMALLER OUTSIDE DIMENSIONS

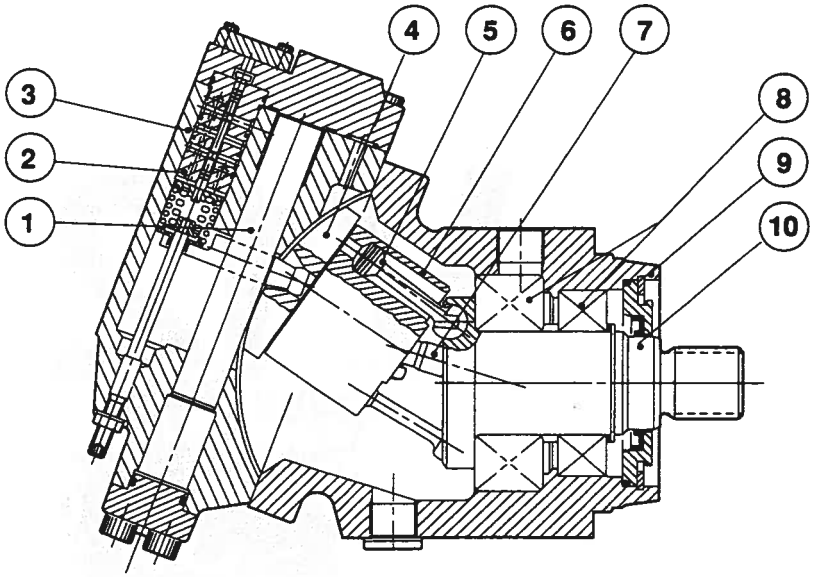
Thanks to new ideas, the V12 is very compact with small outside installation dimensions.

LOWER WEIGHT

The small envelope size and efficient utilization of material has resulted in a hydraulic motor with very low weight.

SAE-, ISO, AND CARTRIDGE VERSIONS

The V12 motors conform to the SAE mounting flange and shaft standard. Metric (ISO) and cartridge versions are also available.



LEGEND

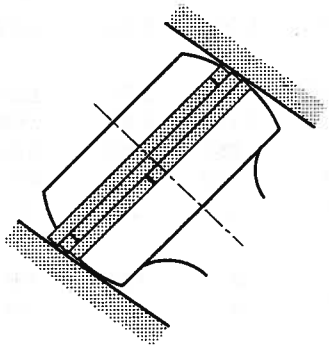
1. Servo piston
2. Servo control valve
3. End cap
4. Valve segment
5. Spherical piston with laminated piston ring
6. Cylinder barrel
7. Synchronizing shaft
8. Heavy duty roller bearings
9. Bearing housing
10. Output shaft

The V12 design is similar to that of other variable displacement motors produced by Volvo Hydraulics.
Over the years, there have been a number of very important improvements made to the basic concept, leading to increased dependability, and longer service life.

LAMINATED PISTON RING

The laminated piston ring, which consists of three identical parts, is a recently introduced design, offering many important advantages:

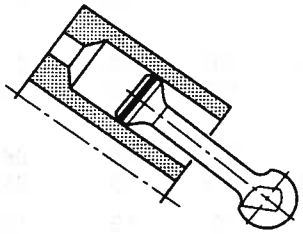
- Low internal leakage
- Thermal shock tolerance
- Minimal wear



SPHERICAL PISTON

The spherical piston, the key element of the V12 concept, has a very low weight, providing benefits such as:

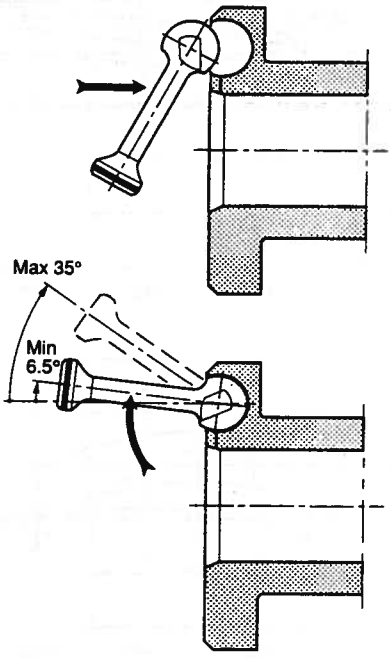
- Compact design due to a large max displacement angle
- Tolerance to very high speeds
- High pressure capability
- Very simple and reliable design



DEPENDABLE PISTON LOCKING

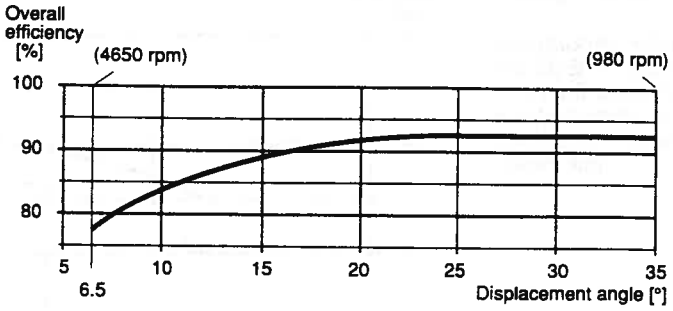
The spherical piston end fits inside a corresponding socket in the output shaft. There is no conventional hold-down device. This lowers the number of parts, and contributes to:

- Very high reliability
- Easy assembly and disassembly
- Large useable displacement ratio (5:1)



HIGH EFFICIENCY

The laminated piston ring and the moment-free spherical piston provides a minimum of internal leakage and low mechanical losses. The diagram shows, as an example, the overall efficiency of the V12-80 between 6.5° and 35° displacement angle, at a constant 20 gpm and 3000 psi operating pressure.
As can be seen, the overall efficiency is very high at low displacement angles and high speeds.



LOW NOISE LEVEL

The V12 shows very low noise levels at high operating speeds and pressures due to:

- Nine lightweight pistons
- A very compact design
- Sturdy output shaft and cylinder barrel support bearings
- Smooth fluid passages

RELIABLE SYNCHRONIZATION

The strong synchronizing shaft between the cylinder barrel and the output shaft contributes to the dependability of the V12 motor, and leads to other benefits such as:

- Substantially lower piston side forces
- Moment-free pistons
- Tolerance to torsional vibrations and accelerations

LONG SERVICE LIFE

The positive piston locking, the synchronizing shaft, bearing set-up, and small number of parts add up to a compact and robust motor design with long service life and proven dependability.

Motor frame size	V12-60	V12-80	V12-110	V12-160
Displacement [cu in/rev]				
at 35° (max)	3.66	4.88	6.71	9.76
at 6.5° (min)	0.73	0.98	1.34	1.95
Operating pressure [psi]				
max intermittent	7 000	7 000	7 000	7000
max continuous	6 000	6 000	6 000	6000
Operating speed [rpm]				
at 35°, max intermittent	4 400	4 000	3 600	3200
max continuous	3 600	3 100	2 800	2500
at reduced angle, max intermittent	7 000	6 250	5 600	5000
max continuous	5 600	5 000	4 500	4000
min continuous	50	50	50	50
Flow [gpm]				
max intermittent	70	85	104	135
max continuous	57	66	82	106
Torque [lb ft]				
at 1000 psi (theor.)	48.5	64.6	88.9	129.6
Output power [hp]				
max intermittent	200	235	290	375
max continuous	125	140	175	230
Corner power [hp]				
intermittent	450	535	665	860
continuous	315	375	460	605
Weight [lbs]	62	73	101	128

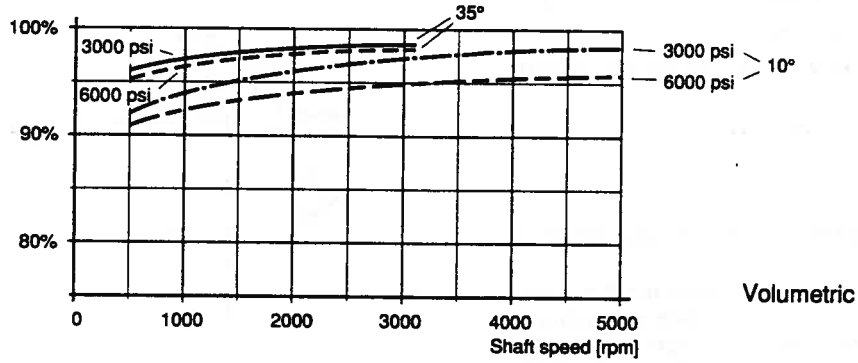
REQUIRED INLET PRESSURE

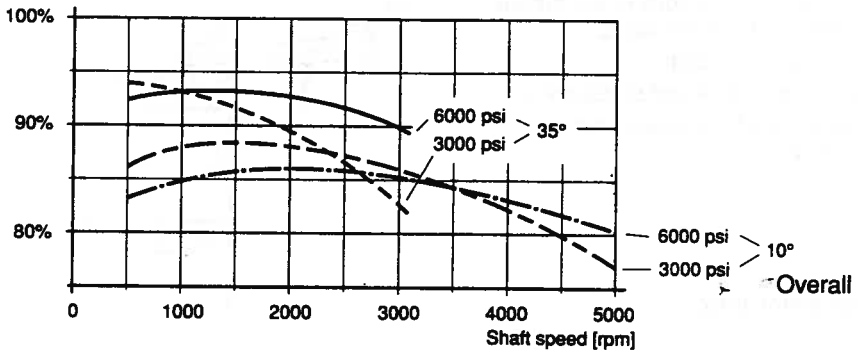
In certain driving conditions, for example when the V12 is used in a propel transmission on a vehicle going downhill, the motor operates as a pump.
To avoid cavitation and unwanted noise, the fluid at the inlet port must have a certain minimum pressure. In general, about 145 psi (10 bar; measured at the inlet port of the motor) is recommended.

Contact Volvo Hydraulics for more specific information on inlet pressure requirements.

EFFICIENCY

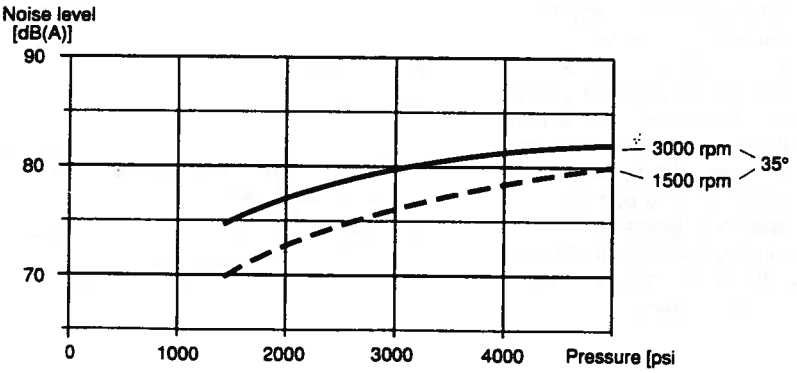
The following diagrams show, for the V12-80, volumetric and overall efficiencies vs. shaft speed at 3000 and 6000 psi operating pressure,and at full and reduced displacements. Corresponding diagrams for the V12-60, -110, and -160 are available from Volvo Hydraulics.





NOISE LEVEL

Noise levels at selected speeds and full displacement for the V12-80 are shown in the diagram to the right. The noise level is measured in a semi-anechoic room, 1 m behind the motor.



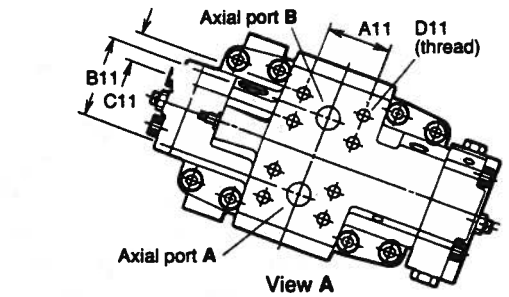
V12 INSTALLATION - SAE version

Dim.	V12-60	V12-80	V12-110	V12-160
A9	4.51	4.51	6.36	6.36
B9	5.87	5.87	7.83	7.87
C9	0.56	0.56	0.81	0.81
D9	0.43	0.43	0.87	0.55
A10	6.26	6.50	7.76	7.76
B10	5.31	5.63	6.14	7.05
C10*	1/2"-13	1/2"-13	1/2"-13	1/2"-13
D10	1.23	1.23	1.72	1.72
E10	5.000/ 4.998	5.000/ 4.998	6.000/ 5.998	6.000/ 5.998
G10	1.89	1.89	2.64	2.64
H10	1.10	1.10	1.42	1.42
A11	2.00	2.00	2.25	2.63
B11	2.60	2.60	2.60	3.27
C11	0.94	0.94	1.09	1.25
D11*	3/8"-16 x0.79	3/8"-16 x0.79	7/16"-14 x0.91	1/2"-13 x0.91
A12	7.40	7.60	7.87	8.58
B12	3.43	3.54	3.86	4.49
C12	1.77	1.90	2.01	2.20
D12	0.53	0.52	0.53	0.56
E12	2.99	3.07	3.35	3.70
F12	3.03	3.15	3.74	3.70
G12	2.17	2.24	2.24	2.64
H12	8.35	8.78	9.67	10.87
J12	0.50	0.50	0.50	0.50
K12	1.40	1.36	1.40	1.47
L12	4.65	4.92	5.54	6.18
N12	2.00	2.25	2.25	2.63
P12	0.94	1.09	1.09	1.25
Q12*	3/8"-16 x0.79	7/16"-14 x0.91	7/16"-14 x0.91	1/2"-13 x0.91
R12	0.79	0.79	0.79	0.93
S12	3.21	3.33	3.79	4.29

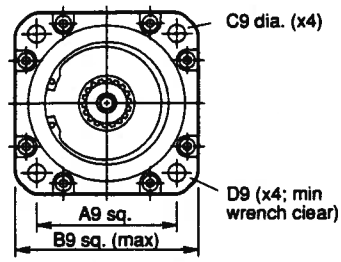
* UNC threads

Note: Dimensions in inches

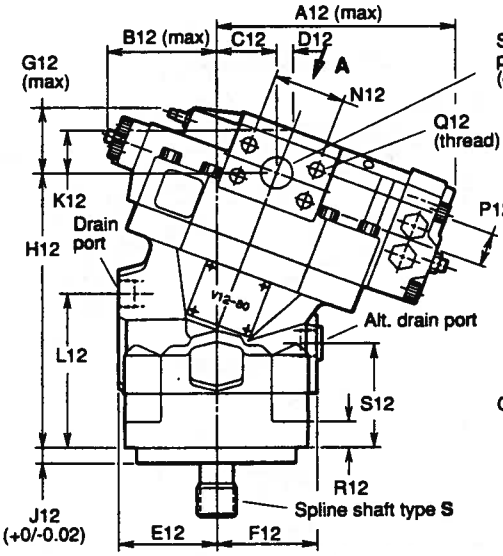
Shown: V12-080 with AC control

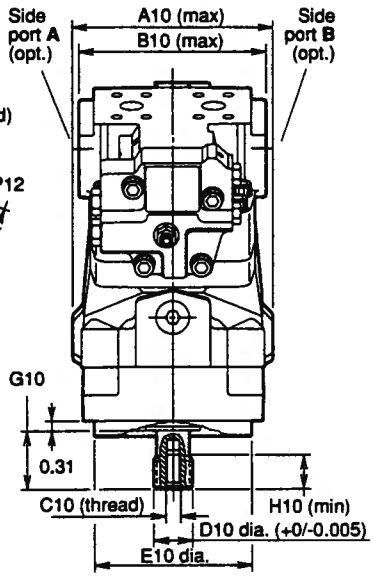


View A



Mounting flange type S





Ports	V12-60	V12-80	V12-110	V12-160
Axial	3/4"	3/4"	1"	1 1/4"
Side	3/4"	1"	1"	1 1/4"
Drain	7/8"-14	7/8"-14	1 1/16"-12	1 1/16"-12

Main ports: SAE 6000 psi flange (SAE J518c)
Drain ports: Straight thread O-ring boss (SAE J514)

Flange type **S**

V12-60	SAE 'C' (5.000 dia.)
-80	SAE 'C' (5.000 dia.)
-110	SAE 'D' (6.000 dia.)
-160	SAE 'D' (6.000 dia.)

Spline type **S** (SAE J744c)

V12-60	SAE 'C' (14T; 12/24 DP)
-80	SAE 'C' (14T; 12/24 DP)
-110	SAE 'D' (13T; 8/16 DP)
-160	SAE 'D' (13T; 8/16 DP)

V12 ORDERING CODE

Example: **V12 - 080 - TU - SH - S - 000 - A - 080/040**

Frame size (cm^3/rev)
060, 080, 110, or **160**

Function (end cap position)
M Motor; bi-directional; normal end cap position for EO, EP, HO, and HP controls
T Motor; bi-directional; normal end cap position for AC, and AH controls

Main circuit ports
S SAE side ports (optional)
U SAE axial ports

Mounting flange
S SAE flange

Seals
H Nitrile rubber
V Fluorocarbon ('Viton')

Shaft end
S SAE spline

Serial number
(Assigned for special versions only)

Technical status
(Assigned by the factory)

Displacement
Specify max and min (in cm^3)

Note: Control and accessory valve information appears on pages 13 and 14.

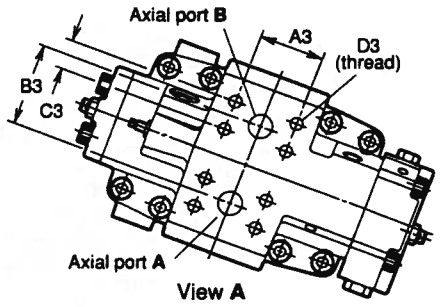
V12 INSTALLATION - ISO Version

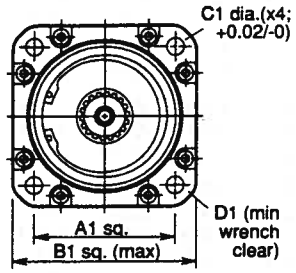
Dim.	V12-60	V12-80	V12-110	V12-160
A1	4.46	4.46	5.57	5.57
B1	5.94	5.94	7.48	7.48
C1	0.55	0.55	0.71	0.71
D1	0.43	0.43	0.55	0.55
A2	6.26	6.50	7.80	7.76
B2	5.31	5.63	6.14	7.05
C2*	M12	M12	M16	M16
D2	1.362/ 1.356	1.559/ 1.553	1.756/ 1.750§	1.953/ 1.947
E2	4.921/ 4.919	4.921/ 4.919	6.299/ 6.297	6.299/ 6.297
F2	2.87	3.07	3.54	3.74
G2	1.57	1.77	1.97	2.17
H2	1.10	1.10	1.42	1.42
A3	2.00	2.00	2.25	2.63
B3	2.60	2.60	2.60	3.27
C3	0.94	0.94	1.09	1.25
D3*	M10 x0.79	M10 x0.79	M12 x0.91	M14 x0.98
A4	7.40	7.60	7.87	8.58
B4	3.43	3.54	3.86	4.49
C4	1.77	1.90	2.01	2.20
D4	0.53	0.52	0.53	0.56
E4	2.99	3.07	3.35	3.70
F4	3.03	3.15	3.74	3.70
G4	2.17	2.24	2.24	2.64
H4	7.40	7.83	8.39	9.57
J4	1.24	1.24	1.56	1.56
K4	1.40	1.36	1.40	1.47
L4	3.70	3.98	4.25	4.92
M4	0.35	0.35	0.35	0.35
N4	2.00	2.25	2.25	2.63
P4	0.94	1.09	1.09	1.25
Q4	M10 x0.79	M12 x0.91	M12 x0.91	M14 x0.98
R4	0.79	0.79	0.87	0.87
S4	2.26	2.38	2.52	3.03

* Metric threads

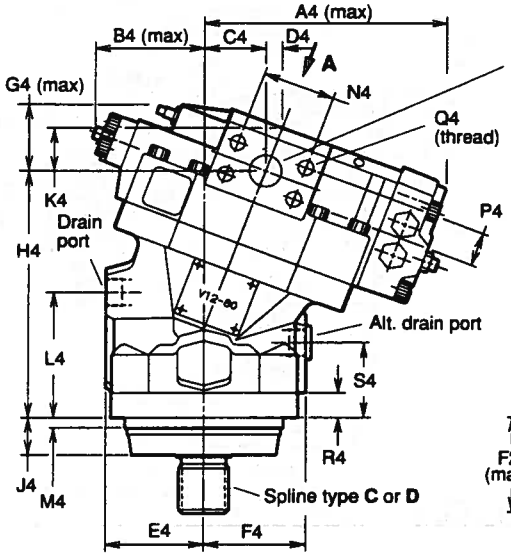
Note: Dimensions in inches

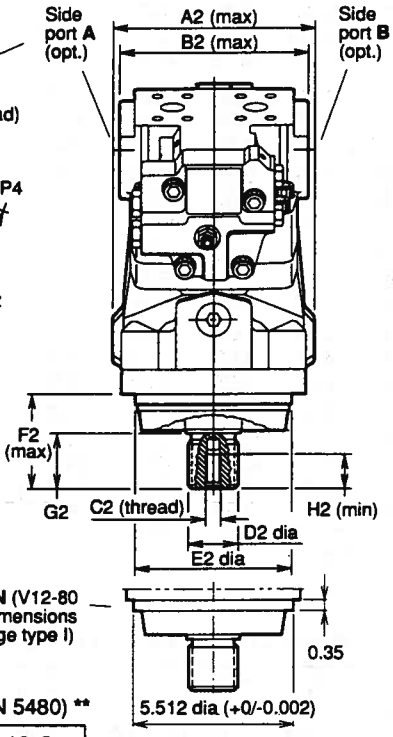
Shown: V12-080 with AC control

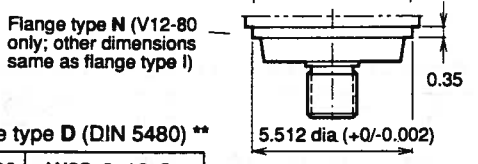




Mounting flange type I (ISO 3019/2)







Ports	V12-60	V12-80	V12-110	V12-160
Axial	3/4"	3/4"	1"	1 1/4"
Side	3/4"	1"	1"	1 1/4"
Drain*	M22x1.5	M22x1.5	M27x1.5	M27x1.5

Main ports: 6000 psi flange (SAE J518c)

Spline type C (DIN 5480) **	
V12-60	W30x2x14x9g
-80	W35x2x16x9g

Spline type D (DIN 5480) **	
V12-60	W35x2x16x9g
-80	W40x2x18x9g
-110	W45x2x21x9g
-160	W50x2x24x9g

** Dimensions in mm

V12 ORDERING CODE

Example: **V12 - 080 - M A - I H - D - 000 - A - 080/040**

Frame size (cm^3/rev)
060, 080, 110, or 160

Function (end cap position)
M Motor; bi-directional; normal end cap position for EO, EP, HO, and HP controls
T Motor; bi-directional; normal end cap position for AC, and AH controls

Main circuit ports
F ISO metric side ports (optional)
A ISO metric axial ports

Mounting flange
I ISO flange
N ISO flange, non-preferred (V12-80 only)

Seals
H Nitrile rubber
V Fluorocarbon ('Viton')

Shaft end
C Spline (DIN 5480; V12-60 and -80 only)
D Spline (DIN 5480)

Serial number (Assigned for special versions only)

Technical status (Assigned by the factory)

Displacement Specify max and min (in cm^3)

Note: Control and accessory valve information appears on pages 13 and 14.

V12 INSTALLATION - Cartridge version

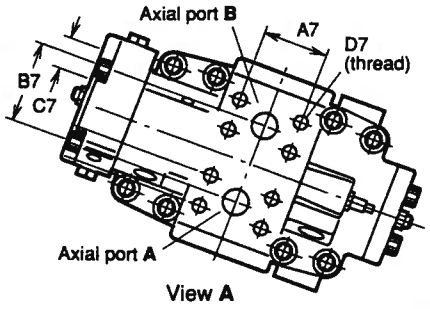
Dim. [in]	V12-60	V12-80
A5	7.87	8.82
B5	9.37	10.35
C5	0.71	0.87
E5	3.03	3.46
F5	3.23	3.86
B6	5.31	5.63
C6*	M12	M12
D6	1.362	1.559
E6	6.299/ 6.297	7.480/ 7.477
F6	5.22	6.12
G6	1.57	1.77
H6	1.10	1.10
A7	2.00	2.00
B7	2.60	2.60
C7	0.94	0.94
D7*	M10x0.87	M10x0.87
A8	6.54	6.81
B8	4.25	4.25
C8	1.77	1.90
D8	0.53	0.52
E8	2.87	3.07
F8	1.59	1.50
G8	3.39	3.35
H8	5.00	4.74
J8	3.54	4.17
K8	1.40	1.36
L8	1.30	1.54
M8	0.59	0.59
N8	2.00	2.25
P8	0.94	1.09
Q8*	M10 x0.87	M12 x0.91
R8	0.79	0.79
S8	1.77	1.48
T8	4.69	5.47
V8	6.10	6.97
X8	6.03	7.21
Z8	0.87	0.87

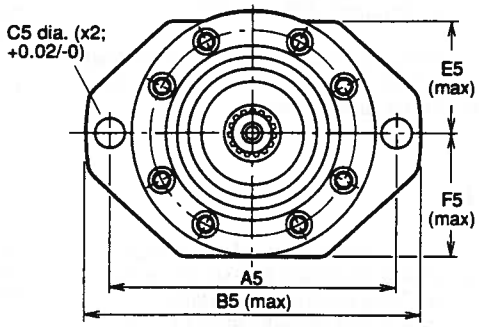
* Metric threads

Ports	V12-60	V12-80
Axial	3/4"	3/4"
Side	3/4"	1"
Drain*	M22x1.5	M22x1.5
Altern. drain*	M18x1.5	M18x1.5

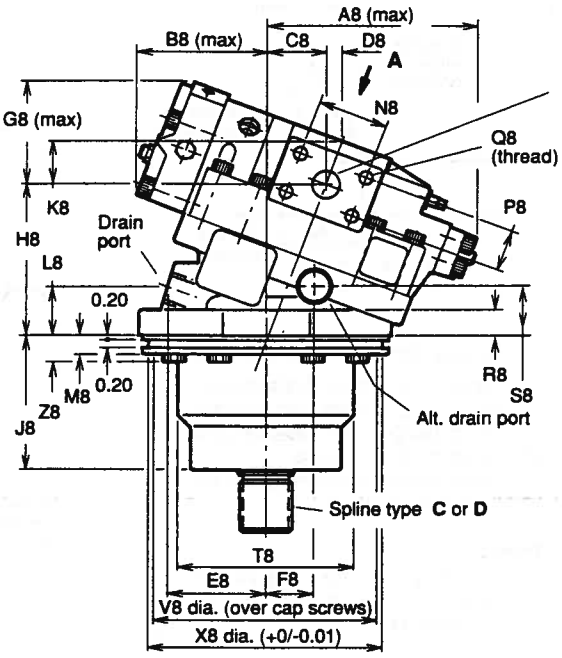
Main ports: SAE 6000 psi (SAE J518c)

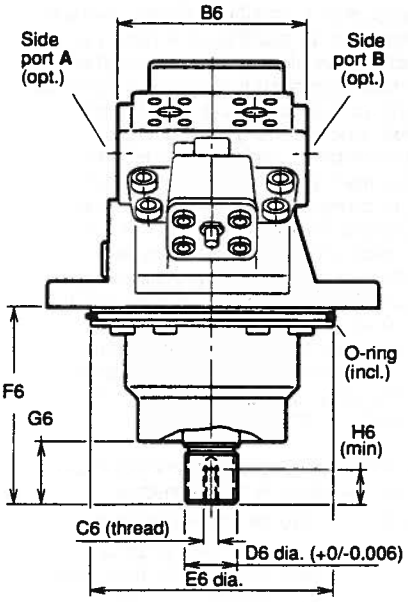
Shown: V12-080 with HO control





Mounting flange type **C**





Spline type **C** (DIN 5480)	
V12-60	W30x2x14x9g
-80	W35x2x16x9g

Dimensions in mm

Spline type **D** (DIN 5480)	
V12-60	W35x2x16x9g
-80	W40x2x18x9g

Dimensions in mm

O-ring dimensions (70° IRH)	
V12-60	150x4 *(5.906x0.157)*
-80	180x4 *(7.087x0.157)*

Dimensions in mm *(in)*

V12 ORDERING CODE

Example: **V12 - 080 - M A - C H - D - 000 - A - 080 / 040**

Frame size (cm^3/rev)
060, or **080**

Function (end cap position)
M Motor; bi-directional; normal end cap position for EO, EP, HO, and HP controls
T Motor; bi-directional; normal end cap position for AC, and AH controls

Main circuit ports
F ISO metric side ports (optional)
A ISO metric axial ports

Mounting flange
C Cartridge flange

Seals
H Nitrile rubber
V Fluorocarbon ('Viton')

Shaft end
C Spline (DIN 5480)
D Spline (DIN 5480)

Serial number
(Assigned for special versions only)

Technical status
(Factory assigned)

Displacement
Specify max and min (in cm^3)

Note: Control and accessory valve information appears on pages 13 and 14.

The V12 controls described below satisfy most application requirements. There are six basic controls:
- Pressure compensator (AC and AH)
- Two-position (EO and HO)
- Proportional (EP and HP)

All controls utilize a servo piston that connects to the valve segment (refer to the picture on page 4).

The built-in four-way servo valve acts on the servo piston and determines the displacement. The displacement angle ranges from 35° (max) to 6.5° (min).
Servo supply pressure is usually obtained from the main high pressure port through the built-in double check valve.

When using external servo supply, the servo pressure should be at least 435 psi (30 bar).
The response time (i e from max to min displacement) is determined by orifices in the servo valve supply and return lines.

Note: Control ordering codes and installation dimensions are shown on page 13.

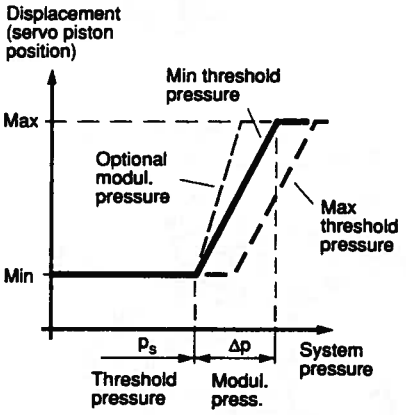
AC

The AC control is used in off-road vehicle hydrostatic propel transmissions. This control automatically adjusts motor displacement to the output torque requirement. Normally, the motor stays in the minimum displacement position. When there is a demand for additional torque i e when the vehicle enters an upgrade, the displacement increases (providing more torque) while the motor shaft speed decreases proportionally.
The threshold pressure, where displacement starts to increase (refer to the diagram), is adjustable between 2200 and 5800 psi (150 and 400 bar).
To reach max displacement, an additional modulating pressure (Δp) above the threshold pressure (p_s) is required.
To satisfy specific hydraulic circuit requirements, a modulating pressure of 220, 360, or 725 psi (15, 25, or 50 bar) can be selected.

The AC pressure compensator control is available in two versions:

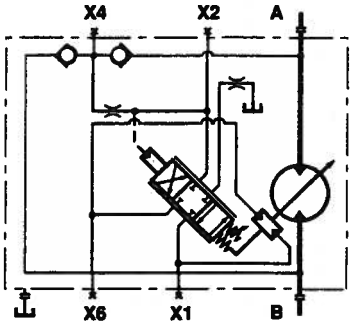
ACI 01 I - Internal pilot pressure

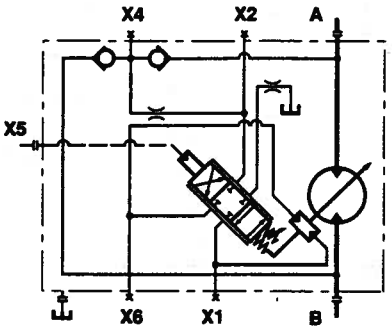
ACE 01 I - External pilot pressure; port X5 can, for example, be connected to the 'forward drive' pressure line of a vehicle transmission to prevent motor displacement compensation when the vehicle is going downhill



Gauge/pilot ports (AC and AH controls):
X1 Servo press. (max displacement)
X2 Servo supply press. (after orifice)
X4 Servo supply press. (before orifice)
X5 External pilot pressure
X6 Servo pressure (min displacement)
X7 Override pressure

Ports are:
$^9/_{16}$"-18 O-ring boss (SAE version)
M14x1.5 (metric threads; ISO and Cartridge versions)





AH

The AH pressure compensator control is very similar to the AC above but incorporates an override device. It is utilized in transmissions where a high degree of maneuverability at low speeds is desirable. When the override is pressurized (min 300 psi) the servo piston moves to the max displacement position irrespective of system pressure.

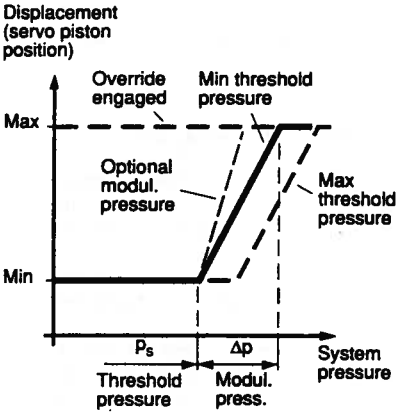
The AH control is available in two versions:

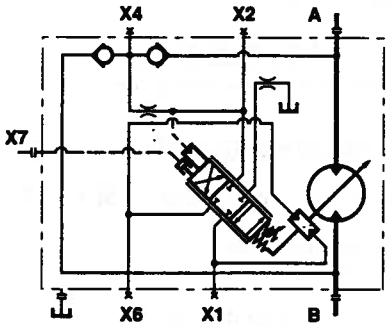
AHI 01 I - Same as the ACI except for the override; internal pilot pressure

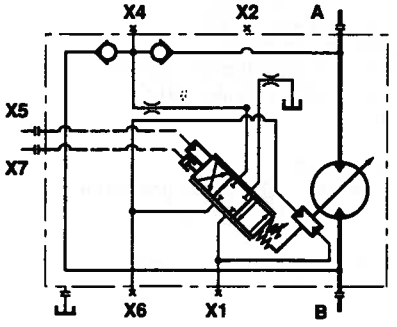
AHE 01 I - External pilot pressure (port X5; compare ACE above)

Required override pressure (port X7):

$$p_7 = \frac{p_s + \Delta p}{24} \text{ [psi]}$$







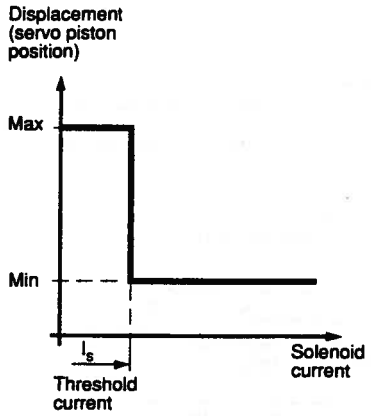
EO

The EO is a two-position control, where the max/min displacement is governed by an electrohydraulic solenoid valve attached to the control cover (refer to the installation drawing on page 12). The EO is utilized in transmissions where only two operating modes are required (low speed/ high torque and high speed/low torque).

The servo piston stays in the max displacement position until the solenoid is activated, when the piston moves to the opposite, max displacement position. Intermediate displacements cannot be obtained with this control.
Servo pressure is supplied internally (through the double check valve from the main high pressure port) or externally (port X2).

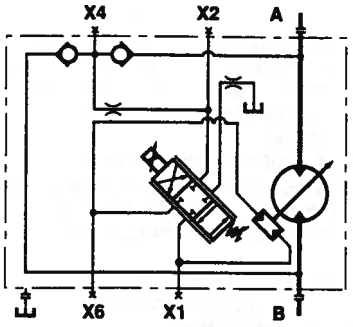
The solenoid is either 12 or 24 VDC, requiring 1.2 and 0.6 A respectively. An electrical connector is included (DIN 43650/IP54).

The EO two-position control is available in four versions:
EOH 01 I -Internal servo supply, 24 V
EOL 01 I -Internal servo supply, 12 V
EOH 01 E -Extern. servo supply, 24 V
EOL 01 E -Extern. servo supply, 12 V

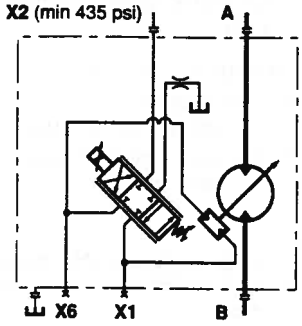


Gauge ports (EO and EP controls):
X1 Servo press. (max displacement)
X2 Servo supply press. (after orifice)
X4 Servo supply press. (before orifice)
X5 External pilot pressure
X6 Servo press. (min displacement)

Ports are:
$^9/_{16}$"-18 O-ring boss (SAE version)
M14x1.5 (metric thread; ISO and Cartridge versions)



EOH 01 I



EOH 01 E

EP

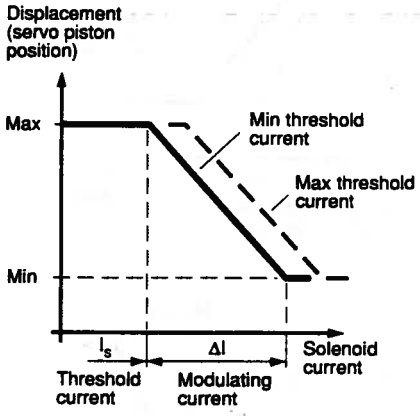
The EP electrohydraulic proportional control is used in hydrostatic transmissions requiring a continuously variable shaft speed. The servo valve is governed by a DC solenoid attached to the control cover.

When the solenoid current increases above the threshold value, the servo piston starts to move from the max towards the min displacement position. The displacement vs. solenoid current is shown in the diagram to the right. The shaft speed vs. current is non-linear; refer to the lower diagram.

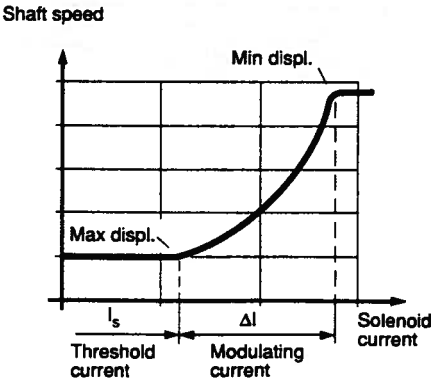
Solenoids are available in 12 and 24 VDC versions, requiring a max current of approx. 1.1 and 0.55 A respectively. The threshold current (I_s) is factory set but is adjustable (12 VDC: 0.25 - 0.45 A; 24 VDC: 0.13 - 0.23 A). When utilizing the full displacement range, the required modulating current (ΔI) is 0.6 and 0.3 A respectively.

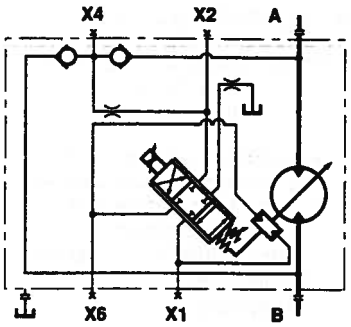
In order to minimize hysteresis, a pulse-width modulated control signal of 50 to 80 Hz should be utilized.

The EP proportional control is available in the following four versions:
EPH 01 I- Internal servo supply, 24 V
EPL 01 I - Intern. servo supply, 12 V
EPH 01 E -Extern. servo supply, 24 V
EPL 01 E -Extern. servo supply, 12 V

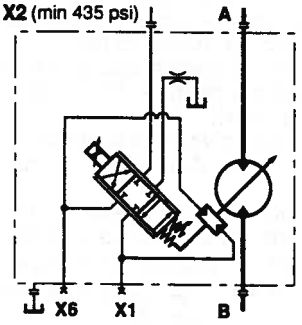


Note: The modulating current (ΔI) is non-adjustable





EPH 01 I



EPH 01 E

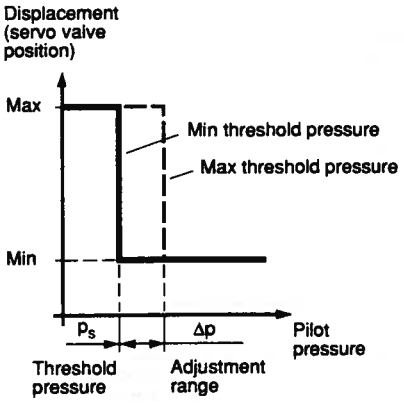
HO

The two-position HO control is similar to the EO (page 11) but the pilot signal is hydraulic. The position of the servo piston is governed by the built-in servo valve (same as on all previous controls).
When the applied pilot pressure (port X5) equals the pre-set threshold value, the piston moves from the max to the min displacement position.

The threshold pressure is factory set but can be adjusted between 70 and 360 psi (5 and 25 bar).
An optional control spring provides an adjustment range of 15 to 160 psi (1 to 11 bar).

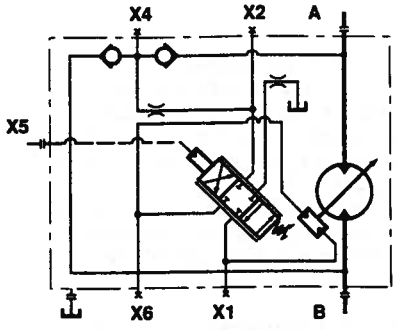
The following HO two-position control versions are available:
HOS 01 I - Internal servo supply
HOS 01 E - External servo supply (port X2)

Ports are:
$^{9}/_{16}$"-18 O-ring boss (SAE version)
M14x1.5 (metric; ISO and Cartridge versions)

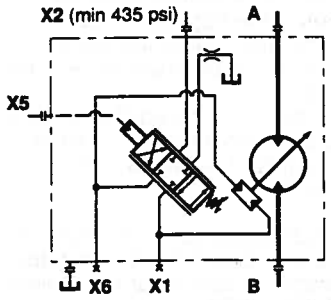


Gauge ports (HO and HP controls):
X1 Servo press. (max displacement)
X2 Servo supply press. (after orifice)
X4 Servo supply press. (before orifice)
X5 External pilot pressure
X6 Servo pressure (min displacement)

Ports are:
$^{9}/_{16}$"-18 O-ring boss (SAE version)
M14x1.5 (metric threads; ISO and Cartridge versions)



HOS 01 I



HOS 01 E

HP

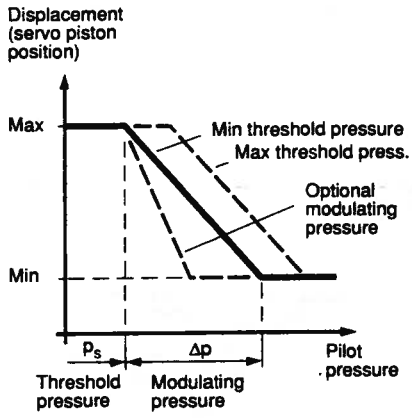
Like the EP described on page 11 the HP proportional control offers continuously variable displacement, but the pilot signal is hydraulic.

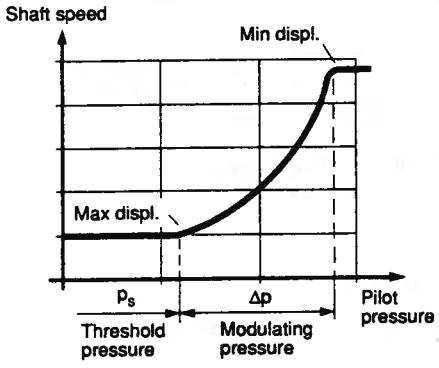
Normally, the servo piston stays in the max displacement position.
When a sufficiently high pilot pressure (p_s) is applied to port X5, the piston starts to move towards the min displacement position.

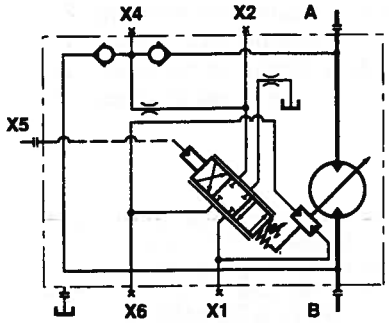
As can be seen from the displacement/pressure diagram, the displacement changes in proportion to the applied modulating pressure.
The following modulating pressures (Δp) can be selected:
145, 220, or 360 psi (10, 15, or 25 bar).

The threshold pressure (p_s) is factory set but can be adjusted between 70 and 360 psi (5 and 25 bar).
An optional control spring provides an adjustment range of 15 to 160 psi (1 to 11 bar).
Shaft speed vs. pilot pressure is shown in the diagram to the right.

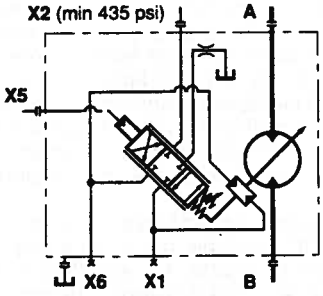
The following versions of the HP proportional control are available:
HPS 01 I - Internal servo supply
HPS 01 E - External servo supply (port X2)







HPS 01 I



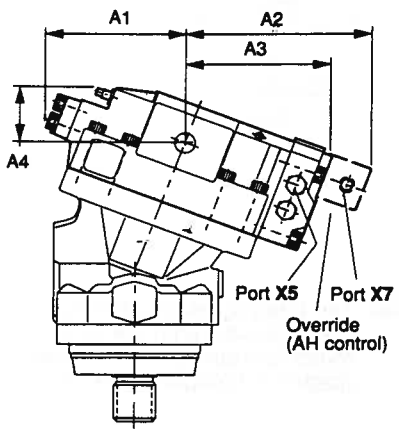
HPS 01 E

CONTROL INSTALLATION

Note: -The basic motor side port locations are shown on pages 7 through 9
- End cap position: Refer to the basic motor ordering code

- Control ports are:
  - $^{9}/_{16}$"-18 UNF (SAE version)
  - M14x1.5 (metric thread; ISO and cartridge versions)
- All dimensions are max

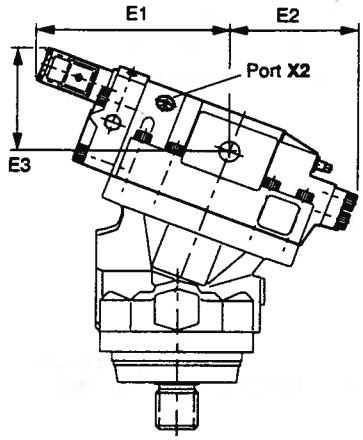
AC and **AH**



Note: End cap position **T**

Dim. [in]	V12-60	-80	-110	-160
A1	5.20	5.43	5.87	6.69
A2	7.32	7.40	7.56	8.11
A3	5.63	5.71	5.87	6.38
A4	2.17	2.24	2.24	2.64

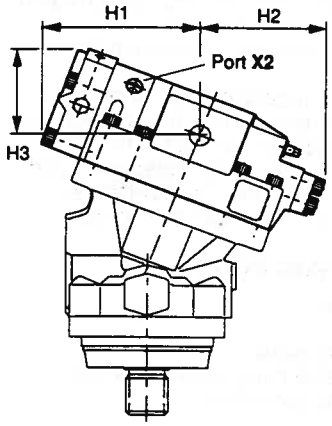
EO and **EP**



Note: End cap position **M**

Dim. [in]	V12-60	-80	-110	-160
E1	7.48	7.56	7.76	8.19
E2	4.76	4.92	5.31	6.10
E3	4.17	4.17	4.21	4.53

HO and **HP**



Note: End cap position **M**

Dim. [in]	V12-60	-80	-110	-160
H1	6.02	6.14	6.26	6.69
H2	4.76	4.92	5.31	6.02
H3	3.39	3.35	3.35	3.62

CONTROL ORDERING CODES

AC, AH (example): **- A C I 01 I - 150 / 015 -**

Type of control
AC Pressure compensator
AH Pressure compensator with hydraulic override

Pilot pressure signal
I Internal
E External

Version number
01 Factory assigned (indicates orifice size, etc.)

Modulating press. (Δp) [bar]
015, 025, or **050** (standard)
(220, 360, or 725 psi)

Threshold pressure (p_s) [bar]
150, 200 or **250** (std.)
(2200, 2900, or 3600 psi)

Servo supply
I Internal

EO, EP (example): **- EP L 01 I - 400 / 600 -**

Type of control
EO Electrohydraulic two-position
EP Electrohydraulic proportional

Solenoid voltage
L 12 VDC
H 24 VDC

Version number
01 Factory assigned

Modulating current (ΔI) [mA]
EO: **000**
EP: **600** (12 VDC); **300** (24 VDC)

Threshold current (I_s) [mA]
400 (12 VDC); **200** (24 VDC)

Servo supply
I Internal
E External

HO, HP (example): **- HP S 01 I - 010 / 010 -**

Type of control
HO Hydraulic two-position
HP Hydraulic proportional

Function
S Standard

Version number
01 Factory assigned

Modulating press. (Δp) [bar]
HO: **000**
HP: **010, 015,** or **025** (std.)
(145, 220, or 360 psi)

Threshold pressure (p_s) [bar]
010 (standard; 145 psi)

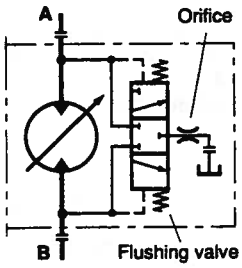
Servo supply
I Internal
E External

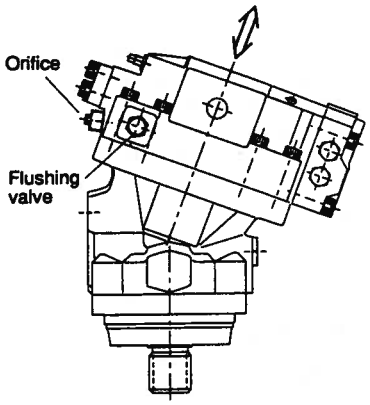
Note: - The basic motor ordering code (precedes the control ordering code) is shown on pages 7–9.
- Information on optional and accessory valves appear on page 14.

VALVE OPTION

LOOP FLUSHING VALVE

The V12 is available with a flushing (or shuttle) valve that supplies the motor with the necessary cooling flow when operating at high speeds and power levels. It consists of a three-position, three-way spool valve built into a special end cap.
The valve connects the low pressure side of the main circuit to an orifice that empties fluid into the motor case.
Another important feature of the flushing valve is that it removes part of the main circuit fluid, which is continuously being replaced by cool, filtered fluid from the low-pressure charge pump of the main pump.





ORDERING CODE

Example: **– L 01**

Flushing valve
L Valve integrated in end cap
000 Not applicable

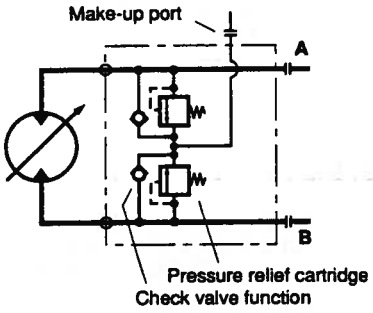
Orifice size
01, **02**, etc. Refer to Volvo Hydraulics

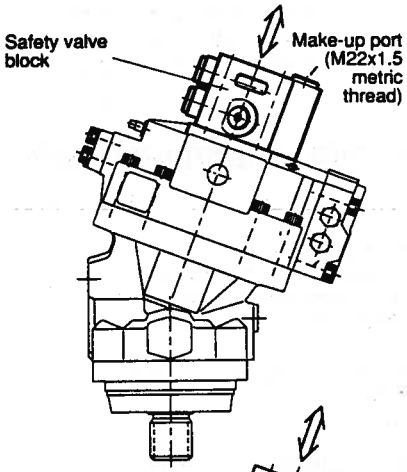
Note: The flushing valve ordering code appears after the basic motor and control valve codes (pages 7 through 9, and 13).

ACCESSORY VALVE BLOCKS

SAFETY VALVE

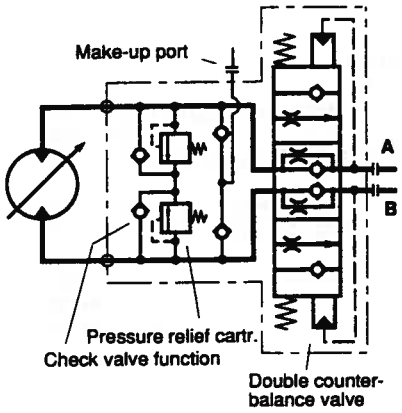
To protect the main hydraulic circuit from unwanted pressure peaks, an add-on valve block with two independent pressure relief cartridges (including check valve function) can be ordered for series V12.
The individual cartridge has a fixed, factory-set pressure setting.
An external port for make-up fluid is provided. When sufficiently pressurized, it prevents motor cavitation due to pressure losses in the main circuit.
The valve block sandwich mounts between the motor end cap and the main line flanges, utilizing long mounting screws.

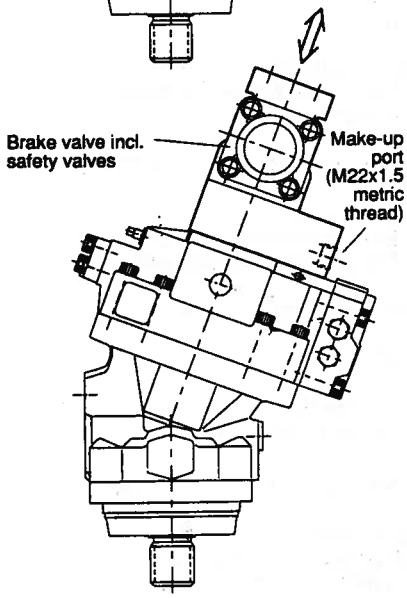




BRAKE VALVE

Some applications, such as open circuit track and wheel drives, require a so called 'brake valve' or counterbalance valve.
A double counterbalance valve, including safety valve cartridges, is available for the V12 motor. It mounts directly on the end cap.
A port for make-up fluid is provided. When supplied at sufficient pressure, it compensates for main circuit pressure losses, preventing motor cavitation.

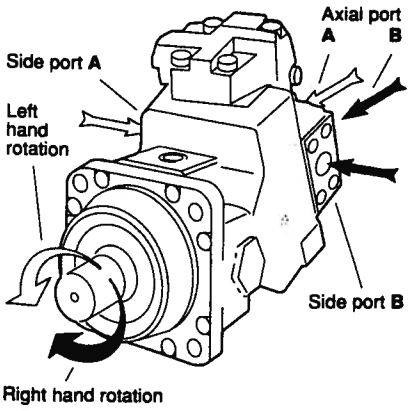


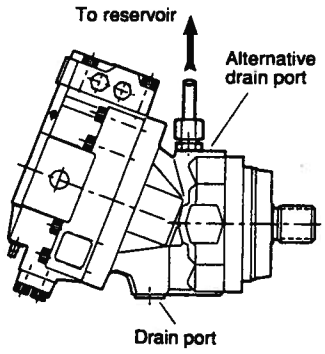


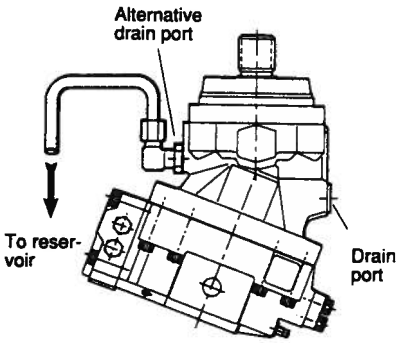
ACCESSORY VALVE INFORMATION

Additional information (technical specifications,installation dimensions, availability, etc.) can be obtained separately from Volvo Hydraulics.

MOTOR INSTALLATION







ROTATION

The V12 motor is bi-directional. The illustration above shows shaft rotation vs. direction of flow (end cap position **T**; AC and AH controls). When fluid enters a **B** port (black arrow) the motor turns clockwise (right hand rotation), and when one of the **A** ports is pressurized (open arrow) the shaft turns counter-clockwise (left hand rotation).
On end cap position **M** (EO, EP, HO, and HP controls) A and B port positions interchange (A to B, B to A).

FILTRATION

Maximum motor sevice life is obtained when the fluid cleanliness meets or exceeds ISO code 18/13 (ISO 4406).
A 10 µm (absolute) filter is recommended.

CASE PRESSURE

The highest recommended case pressure (V12 with shaft seal type **H**) at selected shaft speeds is shown in the table to the right.
To obtain longest seal life, the case pressure should be limited to 50% or less of the figures shown.

Note: Contact Volvo Hydraulics for information on other shaft seals.

OPERATING TEMPERATURE

The following temperatures should not be exceeded (type **H** shaft seal):

Main circuit: 175 °F (80 °C)
Drain fluid: 210 °F (100 °C)

Viton shaft seals (type **V**) can be used to 240 °F (115 °C).

Continuous operation at high power levels usually requires case flushing in order to stay above the minimum fluid viscosity requirements.
A flushing valve and restrictor, built into a special end cap providing the necessary main circuit flushing flow, is available; refer to information on page 14.

DRAIN PORTS

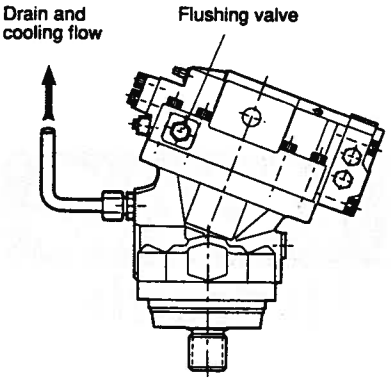
There are two drain ports on the V12. The uppermost drain port should be utilized. When the motor is mounted with 'shaft up' a drain line loop should be provided to insure bearing lubrication and cooling. In order to avoid excessively high case pressure, the drain line should be connected directly to the reservoir.

Note: When the motor is operating, the case must be filled with fluid to at least 50%.

BEFORE START-UP

Make sure the motor case as well as the entire hydraulic system is filled with hydraulic fluid.
The internal leakage, especially at low operating pressures, is not sufficient to provide lubrication at start-up.

Frame size	Max case pressure [psi] vs.shaft speed [rpm] 1500	3000	4000	5000	6000
V12-60	175	85	65	50	45
-80	175	85	65	50	45
-110	145	70	60	45	-
-160	145	70	60	45	-



HYDRAULIC FLUIDS

Ratings and performance data for series V12 are based on operating with a good quality contamination-free petroleum-based fluid.
Hydraulic fluids type HLP (according to DIN 51524), automatic transmission fluids type A, or API CD engine oils can be used.

When the hydraulic system has reached full operating temperature, the motor drain oil viscosity should be above 52 SUS (8 cSt).
At start-up, the viscosity should not exceed 10 000 SUS (1500 cSt).
The ideal operating range for series V12 is 80 to 150 SUS (15 to 30 cSt).

Fire resistant fluids, when used under modified operating conditions, and synthetic fluids are also suitable. Contact Volvo Hydraulics for further information.

REQUIRED INLET PRESSURE

As previously mentioned on page 6, the motor sometimes operates as a pump. The inlet port must then be supplied with fluid of sufficient pressure. Increased noise and gradually deteriorating performance due to cavitation may otherwise be experienced.
A 145 psi (10 bar) inlet pressure, measured at the motor inlet port, satisfies most operating conditions.

VOAC Hydraulics

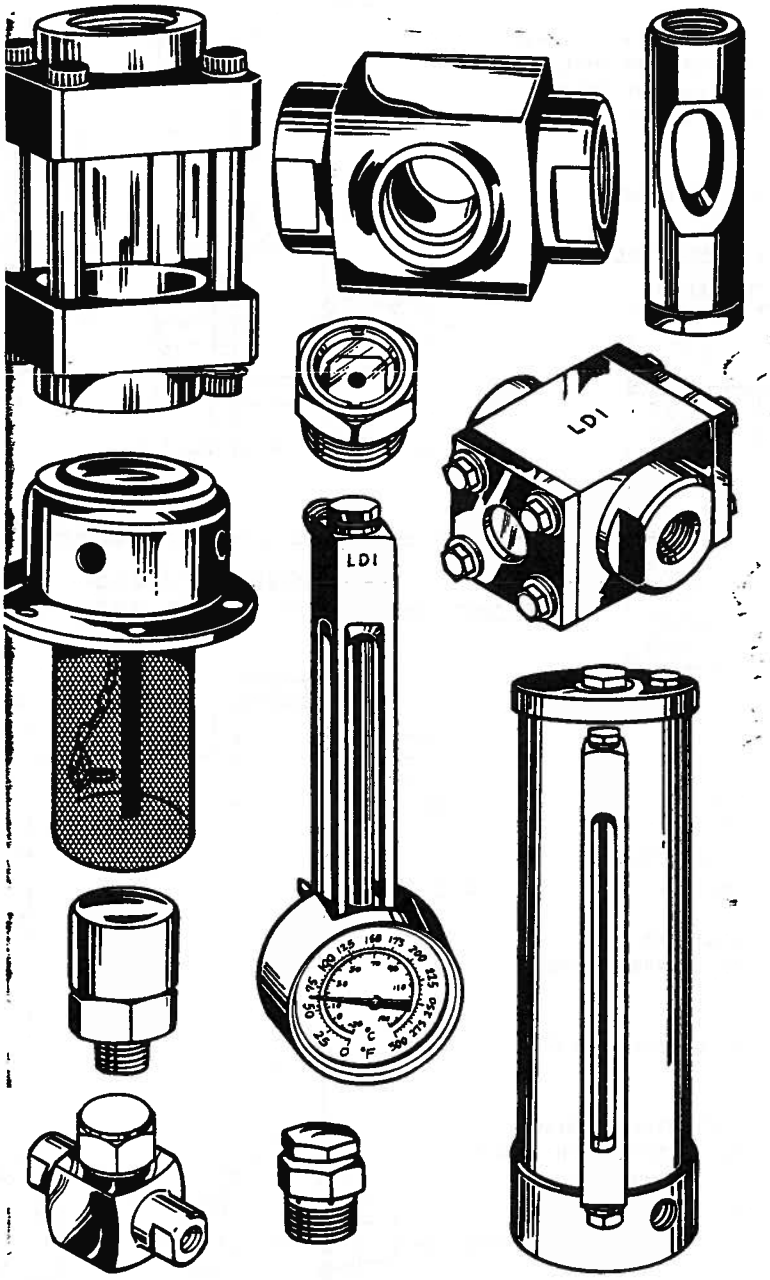
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- THERMOMETER SERIES GAGES HAVE A FULLY PROTECTED SENSING ELEMENT THAT EXTENDS WELL INTO THE TANK - UNAFFECTED BY UNRELATED AMBIENT TEMPERATURES.
- GAGES ARE FURNISHED COMPLETE, INCLUDING "O" RING SEALS AND HEX NUTS FOR MOUNTING. A 1/16" ALIGNMENT ADJUSTMENT AT EACH STUD FACILITATES MOUNTING.
- THIS GAGE CAN BE INSTALLED FROM THE OUTSIDE ON 1/2" - 20 TAPPED HOLES WHEN RESERVOIRS DO NOT HAVE ACCESS TO THE INTERIOR AND TANK WALL THICKNESS PERMITS TAPPING. FOR INSTALLATIONS WHERE GAGE IS BOLTED TO CYLINDRICAL TANK WALL, CONICAL SLEEVES ARE FURNISHED AT NO ADDITIONAL COST - BE SURE TO SPECIFY.

▶ SERIES NUMBERS IN TABLE BELOW ARE AVAILABLE FROM STOCK.

SERIES G605 (without thermometer)
SERIES G615 (with thermometer)

SERIES NO.	SERIES NO.	A CENTERS	B SIGHT	C LENGTH
G605	G615	3	1-1/2	4-5/8
G605	G615	4	2-1/2	5-5/8
G605	G615	5	3-1/2	6-5/8
G605	G615	6	4-1/2	7-5/8
G605	G615	7	5-1/2	8-5/8
G605	G615	8	6-1/2	9-5/8
G605	G615	9	7-1/2	10-5/8
G605	G615	10	8-1/2	11-5/8
G605	G615	11	9-1/2	12-5/8
G605	G615	12	10-1/2	13-5/8

AVAILABLE 3" THRU 142" MOUNTING CENTERS

HOW TO ORDER: (SEE BACK SIDE)

GAGES ARE AVAILABLE WITH MOUNTING CENTERS UP TO 142" IN 1" INCREMENTS. WHEN ORDERING, SEE "HOW TO ORDER". NOTE: SIGHT OPENING IN ALL CASES IS 1-1/2", LESS THAN MOUNTING CENTERS AND OVER-ALL LENGTH IS 1-5/8" GREATER THAN MOUNTING CENTERS.

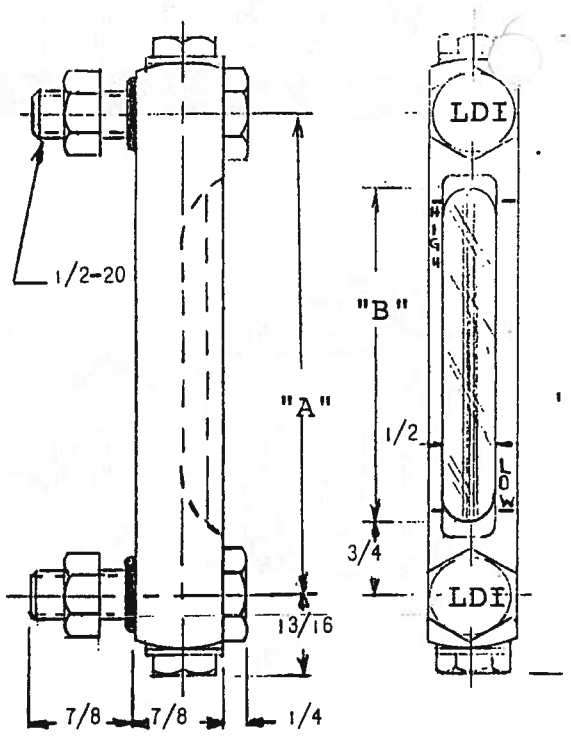
GAGES WITH 13" AND GREATER MOUNTING CENTERS ARE FURNISHED WITH SPACER SLEEVES TO SPACE GAGE FROM TANK TO ALLOW FOR BOWING OF THE TANK WALL IN LARGER RESERVOIRS.

CENTER MOUNTING KIT IS FURNISHED WITH GAGES 48" AND GREATER MOUNTING CENTERS.

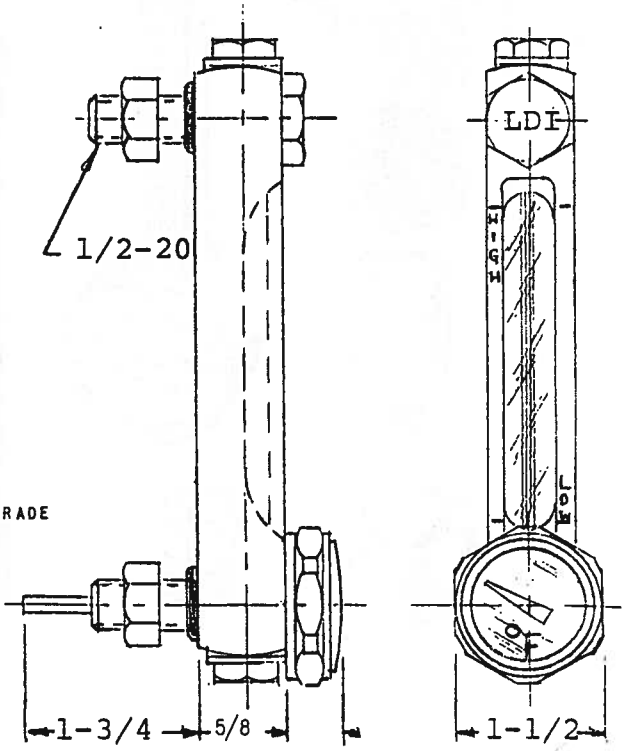
STAINLESS STEEL DIAL THERMOMETERS: 1-3/8 DIAMETER FAHRENHEIT DIAL (0 TO 300°) IS STANDARD. ALSO AVAILABLE WITH 1-3/8 DIAMETER CENTIGRADE DIAL (-20 TO 150°). IF CENTIGRADE DIAL THERMOMETER IS WANTED - SPECIFY. FOR G615 AND G620 SERIES, SEE BACK SIDE.

MODIFICATIONS ARE AVAILABLE

SERIES G605
FRONT MOUNTING
WITHOUT DIAL THERMOMETER



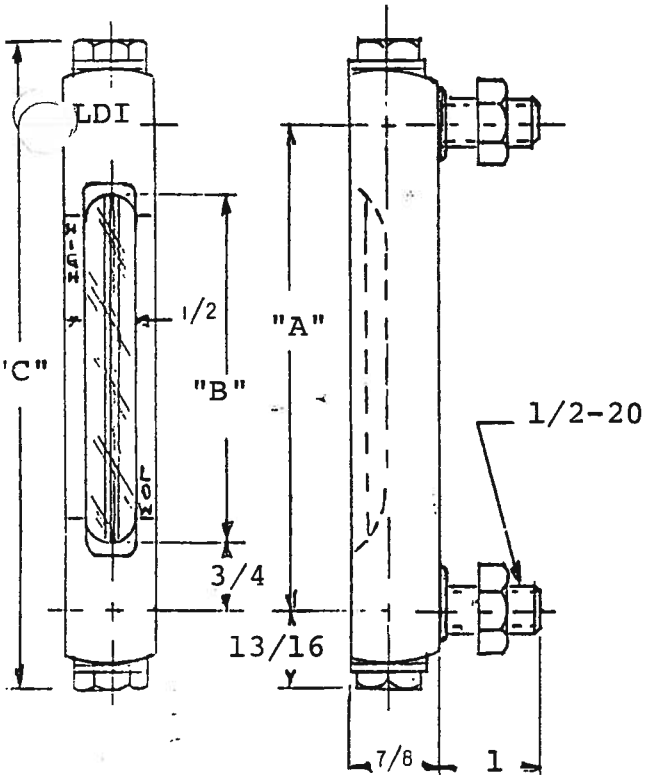
SERIES G615
FRONT MOUNTING WITH DIAL THERMOMETER



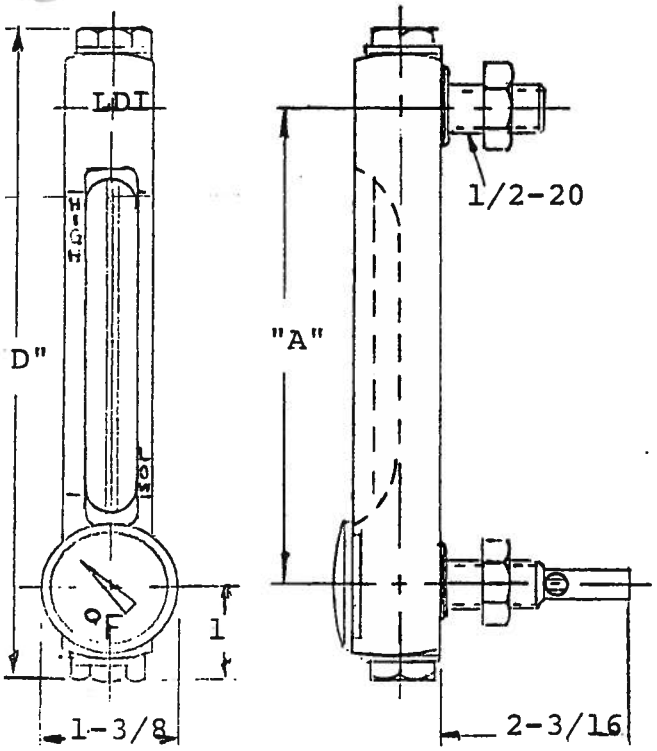
LUBE DEVICES, INC.
1964 Hoole Blvd P.O. Box 1148 Manitowoc, WI 54220-0848

FRONT MOUNTING LIQUID LEVEL GAGES WITH AND WITHOUT THERMOMETER

BACK MOUNTING
WITHOUT DIAL THERMOMETER



SERIES G620
BACK MOUNTING
WITH DIAL THERMOMETER



- AN ECONOMICAL SLOTTED STYLE LIQUID LEVEL GAGE SIMILAR TO OUR SERIES G615 EXCEPT THAT IT IS FOR INSTALLATION WHERE THERE IS ACCESS TO THE INSIDE OF THE TANK. IT OFFERS MINIMUM PROTRUSION FROM THE TANK AND BECAUSE THERE ARE NO BOLT HEADS ON THE EXTERIOR FACE OF THE GAGE, IT HAS A SMOOTH, CLEAN PROFILE. SIGHT IS PYREX GLASS, RED LINE, WHITE BACKGROUND.

- THERMOMETER SERIES GAGES HAVE A FULLY PROTECTED SENSING ELEMENT THAT EXTENDS WELL INTO THE TANK–UNAFFECTED BY UNRELATED AMBIENT TEMPERATURES.

- GAGES ARE FURNISHED COMPLETE, INCLUDING "O" RING SEALS AND HEX NUTS FOR MOUNTING.

- MOUNTING REQUIRES TWO 33/64" DIAMETER HOLES TO MATCH THE GAGE MOUNTING CENTERS. MOUNTING STUDS ACCOMMODATE ALL TANK WALLS THROUGH 3/4" THICKNESS. FOR INSTALLATION WHERE GAGE IS BOLTED TO CYLINDRICAL TANK WALL, CONICAL SLEEVES ARE FURNISHED AT NO ADDITIONAL COST – BE SURE TO SPECIFY.

▶ SERIES NUMBERS IN TABLE BELOW ARE AVAILABLE FROM STOCK.

SERIES G610 (without thermometer)
SERIES G620 (with thermometer)

SERIES NO.	SERIES NO.	A CENTERS	B SIGHT	C LENGTH	D LENGTH
G610	G620	3	1-1/2	4-5/8	4-13/16
G610	G620	4	2-1/2	5-5/8	5-13/16
G610	G620	5	3-1/2	6-5/8	6-13/16
G610	G620	6	4-1/2	7-5/8	7-13/16
G610	G620	7	5-1/2	8-5/8	8-13/16
G610	G620	8	6-1/2	9-5/8	9-13/16
G610	G620	9	7-1/2	10-5/8	10-13/16
G610	G620	10	8-1/2	11-5/8	11-13/16
G610	G620	11	9-1/2	12-5/8	12-13/16
G610	G620	12	10-1/2	13-5/8	13-13/16

AVAILABLE 3" THRU 142" MOUNTING CENTERS

HOW TO ORDER:

USE CODE LETTERS FOR BODY MATERIAL
A – ALUMINUM
B – BRASS

USE CODE NUMBERS FOR SEAL MATERIAL
1 – BUNA N SEALS
2 – BUTYL SEALS
3 – VITON A (R) SEALS
4 – ETHYLENE PROPYLENE SEALS
5 – SILICONE

FIRST, SPECIFY SERIES NUMBER, THEN MOUNTING CENTERS, THEN KIND OF METAL, THEN SEAL MATERIAL, SEPARATING EACH WITH A DASH

EXAMPLE: G620 – 5 – A – 1

- 1 – BUNA N SEALS
- A – ALUMINUM BODY
- 5 – 5" MOUNTING CENTERS
- G620 – SERIES G620

GAGES ARE AVAILABLE WITH MOUNTING CENTERS UP TO 142" IN 1" INCREMENTS. WHEN ORDERING, SEE "HOW TO ORDER" ABOVE. NOTE: SIGHT OPENING IN ALL CASES IS 1-1/2" LESS THAN MOUNTING CENTERS AND OVER-ALL LENGTH IS 1-5/8" GREATER THAN MOUNTING CENTERS.

GAGES WITH 13" AND GREATER MOUNTING CENTERS ARE FURNISHED WITH SPACER SLEEVES TO SPACE GAGE FROM TANK TO ALLOW FOR BOWING OF THE TANK WALL IN LARGER RESERVOIRS.

MODIFICATIONS AVAILABLE

BACK MOUNTING LIQUID LEVEL GAGES WITH AND WITHOUT THERMOMETER

F327-10/-20

LUBE DEVICES, INC.
1864 nagle ave., p.o. box 1148, manitowoc, wi. 54220-0949

REFERENCE: HYDRAULIC PART NO.(S) 18
HYDRAULIC SCHEMATIC NO. 347-8001-01

E-WINCH

HYDRAULIC PARTS LIST HYDRAULIC SCHEMATIC NO. 347-8001-01			
ITEM	**PART NUMBER**	**MANUFACTURER**	**DESCRIPTION**
14	NO PART		
15	F028-116-B-A-V-12-60TFC HC 000 A-060/024 AHI01IO-200/015	VOAC	GEARBOX/BRAKE/ MOTOR
16	G615-5-A-1	LUBE DEVICES	SITE GAUGE
17	HC-EC-12	HYDROCRAFT	CLEANOUT COVER
18	151-7043 OMP-100	DANFOSS	LEVELWIND MOTOR
19	MF-250SBC	REGO	FLOW CONTROL VALVE
20	DF S3A 00HC 25N	DELTA	FAN MOTOR SOLENOID VALVE
21	MGG2-0010-BA1A3	GRESEN	FAN MOTOR
22	ME1H-H202S	BARKSDALE	TEMPERATURE SWITCH
23	AB1010-3 ALL STAINLESS STEEL	FLOW EZY	FILLER BREATHER
24	M324762B(4B)	MAGNALOY	PUMP MOUNT
25	10924S1	HAYDEN	HEAT EXCHANGER
26	347-8001-99	DYNACON	PUMP/MOTOR COUPLING ASSEMBLY

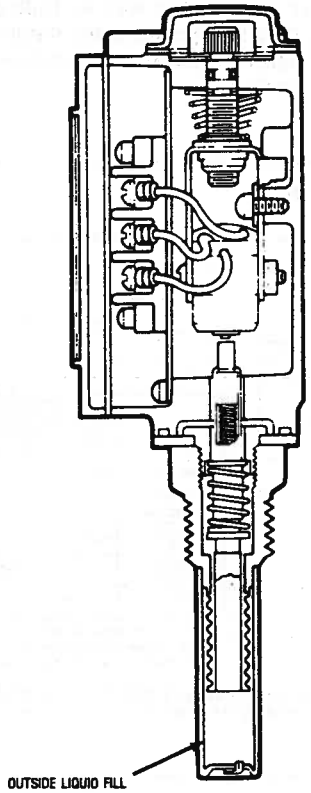
$ 5005602

Magnaloy Coupling Co.
Alpena, MI.
Model 5.00
.5x.5 x 4"
C3 = 15T 16/32 P

REFERENCE: HYDRAULIC PART NO.(S) 22
HYDRAULIC SCHEMATIC NO. 347-8001-01

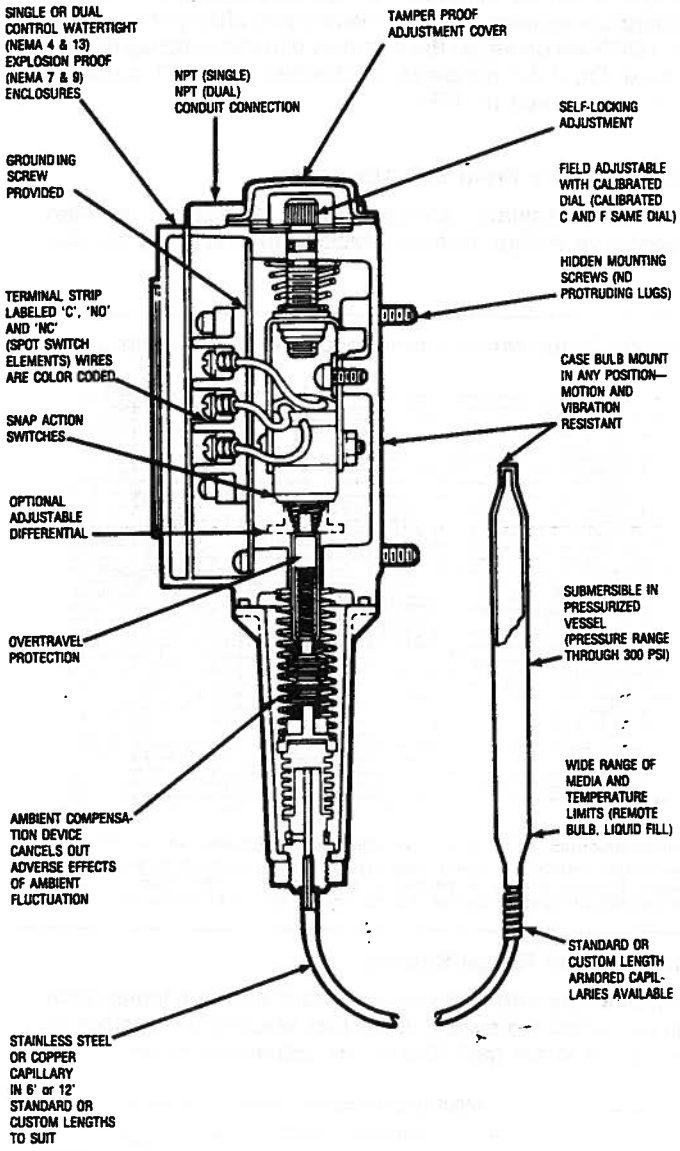
Local Mount Type

Local mount type temperature switches are installed in the pipe or vessel.In this type of sensor, the filling fluid surrounds the bellows. A negative temperature change forces the fluid to contract—expanding the bellows to actuate the switch. Positive temperature changes produce the opposite effect.



Remote Bulb and Capillary Type

Remote temperature switches allow the switch enclosure to be placed up to 25 feet from the media. These models use a bulb and capillary sensing device which may be ordered in standard six and 12 foot lengths. Extra lengths up to 25 feet are available. Six and 12 foot sensors can be copper or stainless steel with or without protective spiral-wound armor. The 25 foot lengths are armored stainless steel only.



Barksdale offers both remote and local mount temperature switches in housed, explosion proof and stripped designs.

All are available with adjustable temperature set point and fixed or adjustable differential.

Ambient Compensation Performance From Barksdale Electromechanical Temperature Switches

Barksdale was the first manufacturer to offer effective ambient compensation in electromechanical switches—revolutionizing temperature switch accuracy through extreme temperature changes.

In a liquid filled bulb and capillary system, ambient temperature changes affect the expansion of the fluid resulting in "false" temperature sensing. An extreme ambient change from -65°F to +165°F will decrease the accuracy of most switches by 20% or more. Or, if the temperature changes only 70°, accuracy can be decreased by 15%.

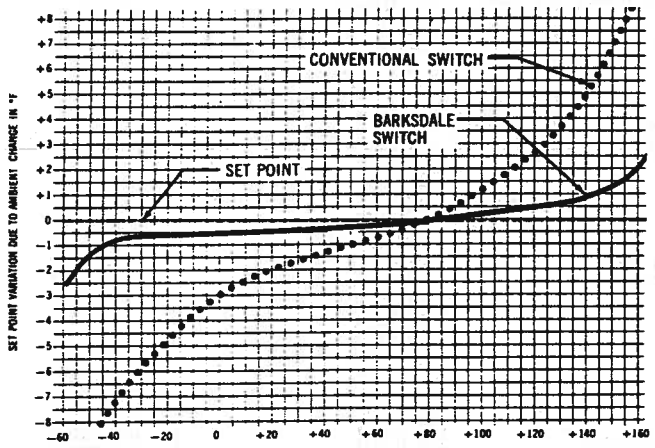
±1% Accuracy From Barksdale

Bulb and capillary configurations overcome ambient temperature swings through stacking of precision, concave bimetal washers. An ambient temperature change causes the liquid fill in the bulb, capillary and bellows to expand or contract, an equal and opposite reaction occurs between the washers. This compensates for ambient temperature change assuring high repeatable accuracy even under wide ambient temperature swings.

By reacting to ambient temperature changes as extreme as -65°F to +165°F, the accuracy of the mid-60% of the adjustable range is still within ±1% of full scale. Accuracy at constant ambient is ±0.5% full scale.

Local mount temperature switches are not affected by ambient temperature changes in the same way as bulb and capillary types. All of the filling fluid is exposed to the media temperature the bulb is sensing. Therefore, there is no ambient temperature influence on the filling fluid.

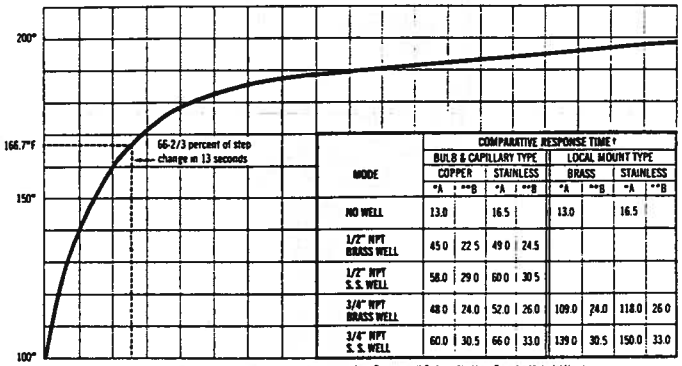
Ambient Temperature Compensation Comparison Curve



Ambient temp. range −65 to +165°F all models (except -H600 series 0 to +165°F)
Curves reflect averages of a series of tests. Results of specific conditions are available on request. Barksdale switches are designed for ±1/2 percent accurate response through the mid 60% of the adjustable range (±2% at min. or max. adjustable set point).

Good Response Time

100°F Step Change Curve (Copper Bulb in Water)



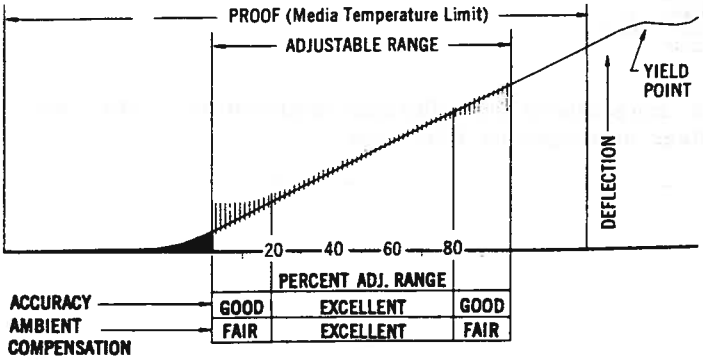
MODE	COMPARATIVE RESPONSE TIME† BULB & CAPILLARY TYPE COPPER *A	COPPER **B	STAINLESS *A	STAINLESS **B	LOCAL MOUNT TYPE BRASS *A	BRASS **B	STAINLESS *A	STAINLESS **B
NO WELL	13.0		16.5		13.0		16.5	
1/2" NPT BRASS WELL	45.0	22.5	49.0	24.5				
1/2" NPT S.S. WELL	58.0	29.0	60.0	30.5				
3/4" NPT BRASS WELL	48.0	24.0	52.0	26.0	109.0	24.0	118.0	26.0
3/4" NPT S.S. WELL	60.0	30.5	66.0	33.0	139.0	30.5	150.0	33.0

*A = Thermowell Only — No Heat Transfer Material Used
**B = Thermowell With Heat Transfers Used
†These response times are based on Standard Copper & Stainless -25 smdts in water

Local Mount Type response times apply to Models ML1H, ML1H-RD, L2H, L2H-RD, L1X. For EL1S and L1C Models multiply the Brass "A" and "B" values by 3.

Select for Mid-Range Setting

For optimum repeat accuracy in areas of extreme temperature change, select the switch range that enables the desired set point to fall in the mid 60% of the adjustable range.

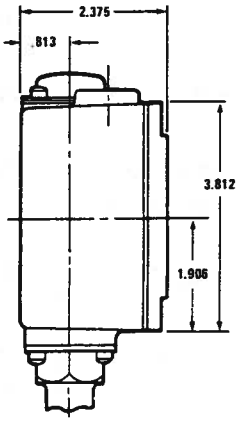


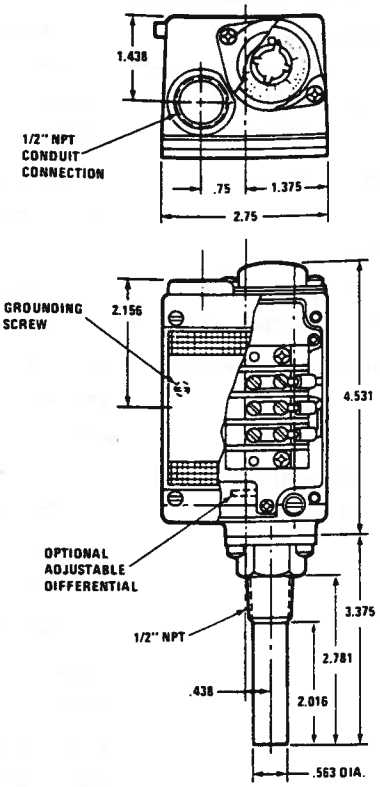
Barksdale Temperature Switches

ML1H Description:

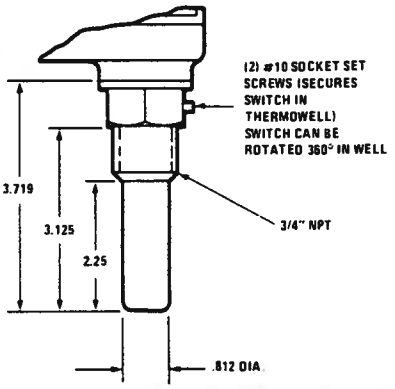
Single Setting
Local Mount
Watertight and Dusttight—
Indoor and Outdoor (NEMA 4)
Oiltight and Dusttight—
Indoor (NEMA 13)
Enclosed Terminal Strip
Tamperproof External Adjustment







THERMOWELL MODELS ONLY
(See -WS Designation)



Operating Characteristics • Ordering Data • Items in Stock

	Media Temperature Limits (Proof)				Adjustable Range				Differential (Approx.) Liquid*		Catalog Numbers		
Calibrated Dial Adjustment	°F Low	°F High	°C Low	°C High	°F Low	°F High	°C Low	°C High	°F	°C	Brass Sensor These do not have thermowells and cannot be field adapted for use with thermowells.	304 Stainless Steel Sensor	304 Stainless Steel Sensor W/316SS Thermowell
Calibrated 2° Subdivision 125° Span	-100	+250	-73	+121	-50	+75	-45	+24	1 to 3	.5 to 1.6	ML1H-H201	ML1H-H201S	ML1H-H201S-WS
	-100	+250	-73	+121	+15	+140	-9	+60	1 to 3	.5 to 1.6	ML1H-H202	ML1H-H202S	ML1H-H202S-WS
	-100	+250	-73	+121	+75	+200	+24	+93	1 to 3	.5 to 1.6	ML1H-H203	ML1H-H203S	ML1H-H203S-WS
	-100	+400	-73	+205	+100	+225	+38	+107	1 to 3	.5 to 1.6	ML1H-H351	ML1H-H351S	ML1H-H351S-WS
	-100	+400	-73	+205	+165	+290	+74	+143	1 to 3	.5 to 1.6	ML1H-H352	ML1H-H352S	ML1H-H352S-WS
	-100	+400	-73	+205	+225	+350	+107	+177	1 to 3	.5 to 1.6	ML1H-H353	ML1H-H353S	ML1H-H353S-WS
Calibrated 5° Subdivision 250° Span	-100	+250	-73	+121	-50	+200	-45	+93	1 to 3	.5 to 1.6	ML1H-H204	ML1H-H204S	ML1H-H204S-WS
	-100	+400	-73	+205	+100	+350	+38	+177	1 to 3	.5 to 1.6	ML1H-H354	ML1H-H354S	ML1H-H354S-WS
Calibrated 5° Subdivision 150° Span	0	+500	-18	+260	+150	+300	+66	+149	3 to 6	1.6 to 3.3	ML1H-H451	ML1H-H451S	ML1H-H451S-WS
	0	+500	-18	+260	+230	+380	+110	+193	3 to 6	1.6 to 3.3	ML1H-H452	ML1H-H452S	ML1H-H452S-WS
	0	+500	-18	+260	+300	+450	+149	+232	3 to 6	1.6 to 3.3	ML1H-H453	ML1H-H453S	ML1H-H453S-WS
Calibrated 10° Subdivision 300° Span	0	+500	-18	+260	+150	+450	+66	+232	3 to 6	1.6 to 3.3	ML1H-H454	ML1H-H454S	ML1H-H454S-WS

*Test conditions and media used could affect differential.

Approx. Shipping Weight 1½ lbs.

Detail Data

Electrical Characteristics: All models incorporate Underwriters' Laboratories, Inc. listed single pole double throw snap-action switching elements. Electrical rating (continuous inductive) 10 amps 125 or 250 volts AC, 3 amps 480 volts AC. Automatically reset by snap-action of switch. For more details and other switch classes, see page 14.

Electrical Connection: Screw terminals on covered terminal strip through ½" npt conduit connection.

Terminals Identified: C (Common), N.C. (Normally Closed), N.O. (Normally Open).

Wire Coding: Purple (Common), Blue (Normally Closed), Red (Normally Open).

Adjustment Instructions: Turn adjustment knob clockwise to increase actuation point (switch setting).

Optional Modifications

MANUAL RESET AVAILABLE. Consult factory for price and delivery.

Green epoxy paint available on exterior surfaces of completely assembled and tested housed models.

All models on this page have the following U.L. and C.S.A. listings:

Underwriters' Laboratories, Inc.
Temperature indicating and regulating equipment. File No. E56247. Guide No. XAPX.

Canadian Standards Association listed for temperature indicating and regulating equipment. File No. LR34555. Guide NO. 400-E-0. Class 4813.

Trouble-shooting for Electromechanical Switches

Suspected Switch Trouble	Things to Check	Probable Causes	Remedy
A. Will not actuate at desired temperature.	1. Check catalog for range of switch.	1. Desired setting out of switch range.	1. Replace with proper range switch.
	2. Maximum current and voltage through switch with ammeter and voltmeter.	2. Current or voltage beyond switch capacity.	2. Install relay or replace temperature switch.
	3. Sensing unit for evidence of filling fluid on external parts.	3. Loss of filling fluid.	3. Replace temperature switch.
	4. Plunger bound, will not move.	4. Mounting bracket (sensor) bent, dirt in plunger bore or bent sensor.	4. Readjust switch.
	5. Conical Spring interfering with Plunger movement.	5. Plunger being stopped by off-center spring.	5. Replace temperature switch.
		6. Switch not set at proper temperature.	6. Select switch with proper proof temperature.
		7. Defective switch element.	
		8. Loose adjusting screw or bracket.	
		9. Maximum system temperature exceeds proof temperature.	
B. Will not reactuate at desired temperature.	1. Check catalog for actuation value range.	1. Specification does not match switch.	1. Change specification or get proper switch.
	2. Check 2 under A above.	2. See 2 under A above.	2. See 2 under A above.
	3. Check 4 and 5 under A above.	3. Check 4 and 5 under A above.	3. Check 4 and 5 under A above.
C. Actuation point of switch changes over period of time.	1. See 2 and 3 under A above.	1. See 5, 7, 2 and 3 under A above.	1. See 7, 8, 2 and 3 under A above.
	2. Moisture in switch.	2. Corrosion of parts.	2. Seal conduit.
D. Cannot get current through switch when actuates or reactuates.	1. Check for power at switch.	1. Line not "hot".	1. Get power to switch.
	2. Check maximum current through switch.	2. Corroded or loose connections.	2. Make new or tight connection.
	3. Poor electrical connections.	3. Connected to wrong leads on switch.	3. Make proper connection (consult wiring diagram or color code).
	4. Desired electrical circuit.	4. Contacts fused.	4. See 2 under A above.

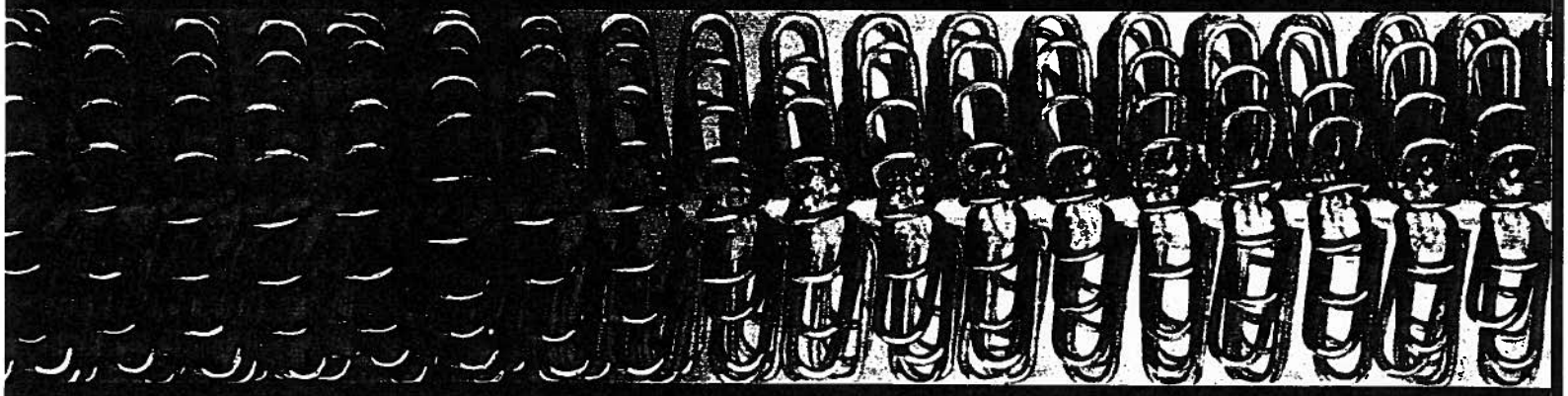
WARNING: Field repair of UL, CSA or other listed units will void the UL or CSA listing of the repaired unit.

REFERENCE: HYDRAULIC PART NO.(S) 25
HYDRAULIC SCHEMATIC NO. 347-8001-01

HAYDEN INC.



OIL COOLERS FOR INDUSTRIAL AND O.E.M. APPLICATIONS



HAYDEN-SHE

INDUSTRIES SERVED:

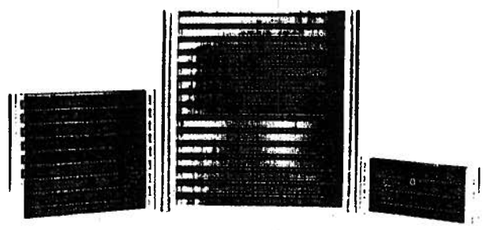
AGRICULTURE & IRRIGATION • COMPRESSORS • COMPUTER • DIESEL & GAS TURBINES • EARTHMOVING & CONSTRUCTION • ELECTRONICS • GENERAL INDUSTRY • GOVERNMENT — FEDERAL & LOCAL • LEISURE MARINE • MATERIAL HANDLING • MILITARY • MINING • OIL & GAS • TIMBER • TRANSPORTATION • UTILITIES • PETRO-CHEMICAL

REFERENCE: HYDRAULICS - NO PART NUMBER
CHARGE PUMP FILTER/ELEMENT

SWIRL COOL STANDARD

APPLICATIONS

Torque Converter Coolers
Mobile Hydraulics
Hydrostatic Drive
Fuel Cooling
Engine Oil Cooling
Hydraulic Tools



SPECIFICATIONS

Parts:	Coolers with headers are built to Spec. No. 16.
Fins:	Aluminum, ¼ hard, rippled edge, triple inner rib, full collar at tube interface, 10 fins per inch.
Tubing:	¾" copper, mechanically expanded to join fins to tube.
"Inner-Swirl" Heat Extractor:	Aluminum extrusion, spiral cut, mechanically expanded to inside of copper tube.
Joining:	Silver brazing alloys.
Pressure Ratings:	
Test (100%)	300 PSI (air under water)
Working	300 PSI at 350°F
Estimated Burst	1500 PSI at 350°F

STOCK ITEMS

MODEL NO.	DWG. NO.	AVERAGE COOLING POWER												OIL FLOW PRESSURE DROP			NORMAL FLOW RATE		OUTSIDE DIM. WIDTH		OUTSIDE DIM. HEIGHT		OUTSIDE DIM. DEPTH		FITTING SIZE	UNIT WEIGHT		OPTION MTG BKT
		500 FPM			1000 FPM			1500 FPM			2000 FPM																	
		Btu/HR	HP	KW	Btu/HR	HP	KW	Btu/HR	HP	KW	Btu/HR	HP	KW	SUS	PSI	KPa	Gal/Min	L/Min	INCH	MM	INCH	MM	INCH	MM	INCH	LBS	KG	KIT NO.
		2018	0.79	0.59	2650	1.12	0.84	3318	1.30	0.97	3603	1.42	1.06	80	9.37	64.61												1-K112
10215S1	001243	4035	1.59	1.18	5700	2.24	1.67	6635	2.61	1.94	7205	2.83	2.11	50	6.53	45.02	5.0	18.93	15	381.0	4.5	114.3	1.5	38.1	½ FPT	2.2	1.0	1-K223
(10215R1)	(003108)	8070	3.17	2.36	11400	4.48	3.34	13270	5.21	3.89	14410	5.66	4.22	35	4.56	31.44			(15.5)	(393.7)	(4.68)	(119.08)	(1.5)	(38.1)	(¾ FPT)	(2.7)	(1.22)	(1-K103)
		3026	1.19	.89	4274	1.68	1.25	4977	1.96	1.46	5403	2.12	1.58	80	8.26	57.10												K112
10315S1	002514	6052	2.38	1.77	8548	3.36	2.50	9954	3.91	2.92	10807	4.24	3.17	50	5.77	39.79	7.5	28.39	15	381.0	6.56	166.62	1.5	38.1	½ FPT	2.63	1.19	K223
		12103	4.76	3.55	17097	6.72	5.01	19908	7.82	5.83	21613	8.49	6.33	35	4.03	27.79												
		3815	1.50	1.12	5375	2.11	1.57	6255	2.46	1.83	6785	2.67	1.99	80	11.24	77.50												1-K112
10318S1	001269	7630	3.00	2.24	10750	4.22	3.15	12510	4.92	3.67	13570	5.33	3.98	50	7.84	54.06	7.5	28.39	18	457.2	6.5	165.1	1.5	38.1	½ FPT	3.9	1.77	1-K223
(10318R1)	(002615)	15260	6.00	4.47	21500	8.45	6.30	25020	9.83	7.33	27140	10.66	7.95	35	5.47	37.72			(18.5)	(469.9)	(6.68)	(169.88)	(1.5)	(38.1)	(¾ FPT)	(4.2)	(1.91)	(1-K103)
		5370	2.11	1.57	7538	2.96	2.21	8743	3.44	2.56	9470	3.72	2.77	80	14.99	103.36												1-K112
10324S1	001563	10740	4.22	3.15	15075	5.92	4.42	17485	6.87	5.12	18940	7.44	5.55	50	10.45	72.05	7.5	28.39	24	609.6	6.5	165.1	1.5	38.1	½ FPT	5.0	2.27	1-K223
(10324R1)	(002616)	21480	8.44	6.29	30150	11.85	8.83	34970	13.74	10.25	37880	14.88	11.10	35	7.30	50.33			(24.5)	(622.3)	(6.68)	(169.88)	(1.5)	(38.1)	(¾ FPT)	(5.3)	(2.40)	(1-K103)
		5085	2.00	1.49	7170	2.82	2.10	8338	3.28	2.44	9045	3.55	2.65	80	11.24	77.50												1-K112
10418S1	003109	10170	4.00	2.98	14340	5.63	4.20	16675	6.55	4.89	18090	7.11	5.30	50	7.84	54.06	10.0	37.85	18	457.2	8.5	215.9	1.5	38.1	½ FPT	5.1	2.31	1-K223
(10418R1)	(002617)	20340	7.99	5.96	28680	11.27	8.40	33350	13.10	9.77	36180	14.22	10.60	35	5.47	37.72			(18.5)	(469.9)	(8.68)	(220.68)	(1.5)	(38.1)	(¾ FPT)	(5.6)	(2.54)	(1-K103)
		6130	2.41	1.80	8620	3.39	2.53	10010	3.93	2.93	10850	4.26	3.18	80	13.12	90.46												1-K112
10421S1	001564	12260	4.82	3.59	17240	6.77	5.05	20020	7.87	5.87	21700	8.53	6.36	50	9.15	63.09	10.0	37.85	21	533.4	8.5	215.9	1.5	38.1	½ FPT	5.9	2.68	1-K223
(10421R1)	(002613)	24520	9.63	7.18	34480	13.55	10.10	40040	15.73	11.73	43400	17.05	12.72	35	6.39	44.06			(21.5)	(546.1)	(8.68)	(220.68)	(1.5)	(38.1)	(¾ FPT)	(6.3)	(2.86)	(1-K103)
		7160	2.81	2.10	10050	3.95	2.94	11655	4.58	3.41	12625	4.96	3.70	80	14.99	103.36												1-K112
10424S1	001810	14320	5.63	4.20	20100	7.90	5.89	23310	9.16	6.83	25250	9.92	7.40	50	10.45	72.05	10.0	37.85	24	609.6	8.75	222.25	1.5	38.1	½ FPT	6.7	3.04	1-K223
(10424R1)	(002614)	28640	11.25	8.39	40200	15.80	11.78	46620	18.32	13.66	50500	19.84	14.80	35	7.30	50.33			(24.5)	(622.3)	(8.68)	(220.68)	(1.5)	(38.1)	(¾ FPT)	(7.1)	(3.22)	(1-K103)
		7368	2.89	2.16	10388	4.08	3.04	12083	4.75	3.54	13110	5.15	3.84	80	11.24	77.50												1-K103
10618S1	001251	14735	5.79	4.32	20775	8.16	6.09	24165	9.50	7.08	26220	10.30	7.68	50	7.84	54.06	15.0	56.78	18	457.2	12.68	322.28	1.5	38.1	¾ FPT	7.6	3.45	2-K223
(10618R1)	(002618)	29470	11.58	8.63	41550	16.33	12.17	48330	18.99	14.16	52440	20.61	15.36	35	5.47	37.72			(18.5)	(469.9)	(12.87)	(327.03)	(1.5)	(38.1)	(1 FPT)	(8.2)	(3.72)	(1-K107)
		8935	3.51	2.62	12570	4.94	3.68	14600	5.74	4.28	15828	6.22	4.64	80	13.12	90.46												1-K103
10621S1	001565	17870	7.02	5.24	25140	9.88	7.37	29200	11.47	8.56	31655	12.44	9.27	50	9.15	63.09	15.0	56.78	21	533.4	12.68	322.68	1.5	38.1	¾ FPT	8.7	3.95	2-K223
(10621R1)	(003110)	35740	14.04	10.47	50280	19.76	14.73	58400	22.95	17.11	63310	24.87	18.55	35	6.39	44.06			(21.5)	(546.1)	(12.87)	(327.03)	(1.5)	(38.1)	(1 FPT)	(9.3)	(4.22)	(1-K107)
		10485	4.12	3.07	14720	5.78	4.31	17075	6.71	5.00	18495	7.27	5.42	80	14.99	103.36												1-K103
10624S1	001267	20970	8.24	6.14	29440	11.57	8.63	34150	13.42	10.01	36990	14.53	10.84	50	10.45	72.05	15.0	56.78	24	609.6	12.68	322.68	1.5	38.1	¾ FPT	9.8	4.45	2-K223
(10624R1)	(002611)	41940	16.48	12.29	58880	23.14	17.25	68300	26.84	20.01	73980	29.07	21.68	35	7.30	50.33			(24.5)	(622.3)	(12.87)	(327.03)	(1.5)	(38.1)	(1 FPT)	(10.0)	(4.54)	(1-K107)
		10485	4.12	3.07	14720	5.78	4.31	17075	6.71	5.00	18495	7.27	5.42	80	14.99	103.36												1-K103
10624S2	001272	20970	8.24	6.14	29440	11.57	8.63	34150	13.42	10.01	36990	14.53	10.84	50	10.45	72.05	15.0	56.78	24	609.6	14.125	358.78	1.5	38.1	¾ FPT	9.8	4.45	2-K223
		41940	16.48	12.29	58880	23.14	17.25	68300	26.84	20.01	73980	29.07	21.68	35	7.30	50.33												
		12233	4.81	3.58	17173	6.75	5.03	19923	7.83	5.84	21580	8.48	6.32	80	14.99	103.36												1-K103
10724S1	001264	24465	9.61	7.17	34345	13.50	10.06	39845	15.66	11.67	43160	16.96	12.65	50	10.45	72.05	17.5	66.24	24	609.6	14.68	373.08	1.5	38.1	¾ FPT	11	4.99	2-K223
(10724R1)	(003111)	48930	19.23	14.34	68690	26.99	20.13	79690	31.31	23.35	86320	33.92	25.29	35	7.30	50.33			(24.5)	(622.3)	(14.87)	(377.83)	(1.5)	(38.1)	(1 FPT)	(11.6)	(5.26)	(1-K107)
		13980	5.49	4.10	19825	7.71	5.75	22768	8.95	6.67	24663	9.69	7.23	80	14.99	103.36												1-K103
10824S1	001262	27960	10.99	8.19	39250	15.42	11.50	45535	17.89	13.34	49325	19.38	14.45	50	10.45	72.05	20.0	75.70	24	609.6	16.68	423.88	1.5	38.1	¾ FPT	12	5.44	3-K223
(10824R1)	(003112)	55920	21.97	16.38	78500	30.84	23.00	91070	35.78	26.68	98650	38.76	28.90	35	7.30	50.33			(24.5)	(622.3)	(16.87)	(428.63)	(1.5)	(38.1)	(1 FPT)	(12.6)	(5.72)	(1-K107)
		15728	6.18	4.61	22078	8.67	6.47	25615	10.06	7.51	27745	10.90	8.13	80	14.99	103.36												1-K103
10924S1	001260	31455	12.36	9.22	44155	17.35	12.94	51230	20.13	15.01	55490	21.80	16.26	50	10.45	72.05	22.5	85.16	24	609.6	18.68	474.68	1.5	38.1	¾ FPT	13	5.90	3-K223
(10924R1)	(002610)	62910	24.72	18.43	88310	34.70	25.87	102460	40.26	30.02	110980	43.61	32.52	35	7.30	50.33			(24.5)	(622.3)	(18.87)	(479.43)	(1.5)	(38.1)	(1 FPT)	(14)	(6.35)	(1-K107)
		15728	6.18	4.61	22078	8.67	6.47	25615	10.06	7.51	27745	10.90	8.13	80	14.99	103.36												1-K103
10924S2	001338	31455	12.36	9.22	44155	17.35	12.94	51230	20.13	15.01	55490	21.80	16.26	50	10.45	72.05	22.5	85.16	24	609.6	20.125	511.18	1.5	38.1	¾ FPT	13	5.90	3-K223
		62910	24.72	18.43	88310	34.70	25.87	102460	40.26	30.02	110980	43.61	32.52	35	7.30	50.33												
		15570	6.12	4.56	20955	8.23	6.14	23695	9.31	6.94	25242	9.92	7.40	80	14.59	100.60												1-K103
X-11024S2	002971	31140	12.24	9.12	41910	16.47	12.28	47390	18.62	13.89	50485	19.84	14.79	50	9.53	65.71	7.5	28.39	24	609.6	22.13	561.98	1.5	38.1	¾ FPT	14.8	6.71	3-K223
		62280	24.47	18.25	83820	32.94	24.56	94780	37.24	27.78	100970	39.67	29.58	35	5.98	41.23												
		20455	8.04	5.99	28725	11.29	8.42	33333	13.10	9.77	36110	14.19	10.58	80	14.99	103.36												1-K107
11224S1	001778	40910	16.07	11.99	57450	22.57	16.83	66665	26.19	19.53	72220	28.38	21.16	50	10.45	72.05	30	113.55	24	609.6	24.87	631.83	1.5	38.1	1 FPT	17	7.71	3-K223
(11224R1)	(002609)	81820	32.15	23.97	114900	45.15	33.67	133330	52.39	39.07	144440	56.75	42.32	35	7.30	50.33			(24.5)	(622.3)	(25.06)	(636.57)	(1.5)	(38.1)	(1¼ FPT)	(18)	(8.16)	(1-K108)
		18255	7.17	5.35	24598	9.67	7.21	27828	10.93	8.15	29658	11.65	8.69	80	14.59	100.60												1-K107
X-11224S2	003587	36510	14.35	10.70	49195	19.33	14.41	55655	21.87	16.31	59315	23.31	17.38	50	9.53	65.71	9	34.07	24	609.6	26.5	637.1	1.5	38.1	1 FPT	17	7.71	3-K223
		73020	28.69	21.39	98390	38.66	28.83	111310	43.74	32.61	118630	46.61	34.76	35	5.98	41.23												
		23247	9.13	6.81	30933	12.15	9.06	34758	13.66	10.18	36893	14.50	10.81	80	18.24	125.76												1-K107
X-11230S2	001821	46495	18.27	13.62	61865	24.31	18.13	69515	27.31	20.37	73785	28.99	21.62	50	11.91	82.12	9	34.07	30	762	26.5	637.1	1.5	38.1	1 FPT	21	9.53	3-K223
		92990	36.54	27.25	123730	48.62	36.25	139030	54.63	40.74	147570	57.98	43.24	35	7.48	51.57												
		26581	10.44	7.79	37166	14.60	10.89	43018	16.90	12.60	46529	18.28	13.63	80	17.02	117.38												1-K107
11230S1	001695	53162	20.89	15.58	74331	29.21	21.78	86035	33.81	25.21	93058	36.57	27.27	50	11.87	81.86	30	113.55	30	762	24.88	631.95	1.5	38.1	1 FPT	22.77	10.33	3-K223
		106323	41.78	31.15	148663	58.41	43.56	172071	67.61	50.42	186115	73.13	54.53	35	8.29	57.17												
		25568	10.05	7.49	35905	14.11	10.52	41665	16.37	12.21	45138	17.74	13.23	80	14.99	103.36												1-K107-1
11524S1	001865	51135	20.09	14.98	71810	28.22	21.04	83330	32.74	24.42	90275	35.47	26.45	50	10.45	72.05	37.5	141.94	24	609.6	30.87	784.23	1.5	38.1	1 FPT	21	9.53	3-K223
(11524R1)	(002612)	102270	40.18	29.96	143620	56.43	42.08	166660	65.48	48.83	180550	70.94	52.90	35	7.30	50.33			(24.5)	(622.3)	(31.06)	(788.97)	(1.5)	(38.1)	(1¼ FPT)	(22)	(9.98)	(1-K108)
		33225	13.06	9.73	46458	18.25	13.61	53773	21.13	15.76	58160	22.85	17.04	80	18.74	129.21												1-K107-1
11530S1	001860	66450	26.11	19.47	92915	36.51	27.22	107545	42.26	31.51	116320	45.71	34.08	50	13.07	90.12	37.5	141.94	30	762.0	30.87	784.23	1.5	38.1	1 FPT	26	11.79	3-K223
(11530R1)	(003113)	132900	52.22	38.94	185830	73.02	54.45	215090	84.51	63.02	232640	91.41	68.16	35	9.12	62.88			(30.5)	(774.7)	(31.06)	(788.97)	(1.5)	(38.1)	(1¼ FPT)	(27)	(12.25)	(1-K108)
		40740	16.01	11.94	56718	22.24	16.62	65483	25.73	19.19	70715	27.79	20.72	80	22.49	155.07												1-K107-1
11536S1	001861	81480	32.02	23.87	113435	44.57	33.24	130965	51.46	38.37	141430	55.57	41.44	50	15.68	108.11	37.5	141.94	36	914.4	30.87	784.23	1.5	38.1	1 FPT	31	14.06	3-K223
(11536R1)	(003114)	162960	64.03	47.75	226870	89.14	66.47	261930	102.92	76.74	282860	111.14	82.88	35	10.95	75.50			(36.5)	(927.1)	(31.06)	(788.97)	(1.5)	(38.1)	(1¼ FPT)	(32)	(14.52)	(1-K108)
		39113	15.37	11.46	54708	21.50	16.03	63335	24.89	18.56	68513	26.92	20.07	80	18.74	129.21												1-K108
11830S1	001788	78225	30.74	22.92	109415	42.99	32.06	126670	49.77	37.11	137025	53.84	40.15	50	13.07	90.12	45	170.33	30	762.0	37.12	942.98	1.5	38.1	1¼ FPT	31	14.06	4-K223
(11830R1)	(003115)	156450	61.47	45.84	218830	85.98	64.12	253340	99.54	74.23	274050	107.68	80.30	35	9.12	62.88			(31)	(787.4)	(37.75)	(958.85)	(1.5)	(38.1)	(2 FPT)	(33)	(14.97)	(4-K223)

50°F (27.8°C) initial temp. differential | 100°F (55.6°C) initial temp. differential | 200°F (111.1°C) initial temp. differential | For requirements not covered by charts, please contact your distributor or Hayden direct.

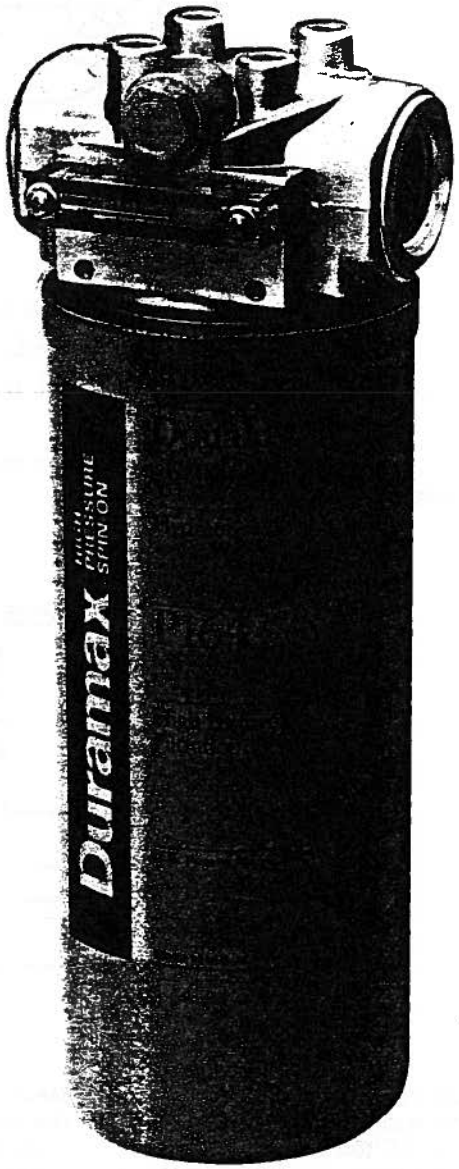
SWIRL COOL STANDARD

HMK04
Fluid Filter Spin-On

1200-73

Rev. 3/91

Donaldson® Brand Hydraulic Products



APPLICATION

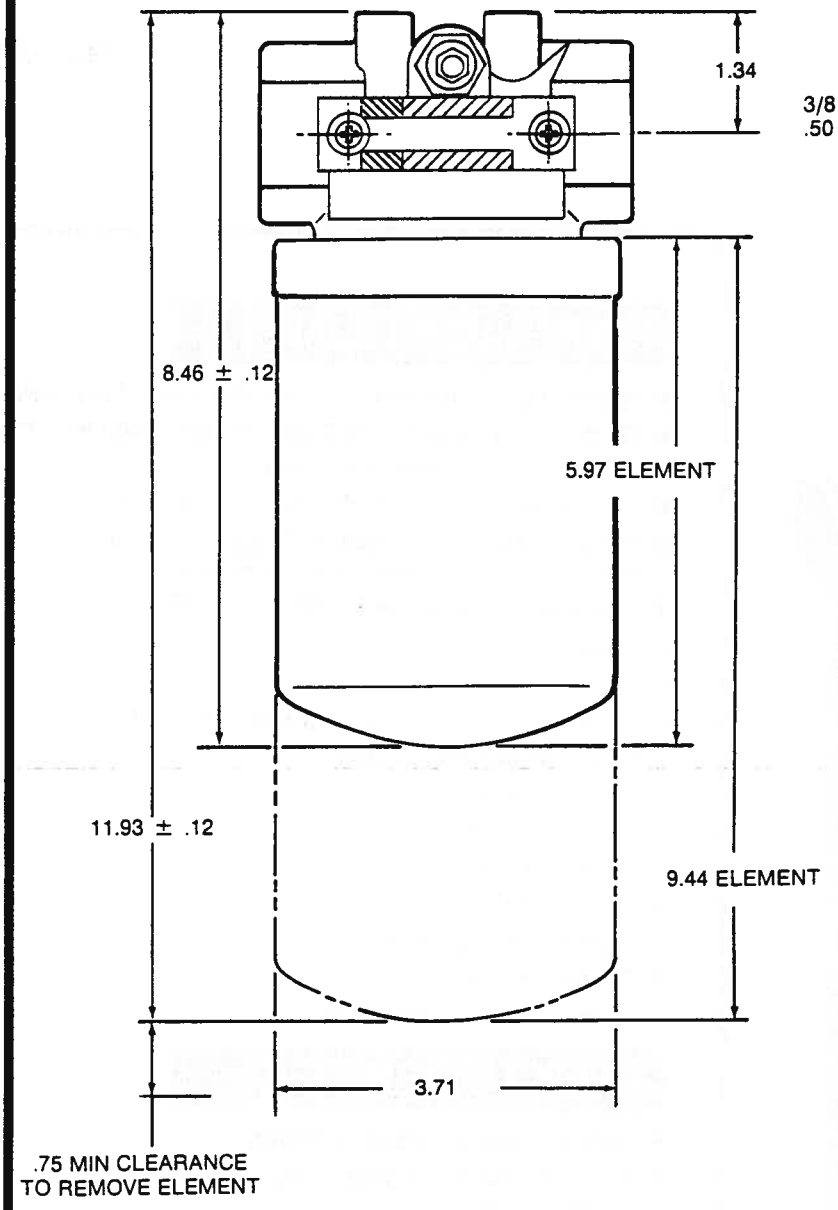
- Working pressure up to 500 psi (34.5 bar) (3450 kPa)
- Static pressure up to 1000 psi (69 bar) (6900 kPa)**
- Flows up to 35 gpm (132.5 lmin)
- Port options; 3/4" & 1" NPT, 3/4" & 1" SAE O-ring
- Standard bypass-25 PSID (1.7 bar) (172.5 kPa) (other options; 15 PSID and no bypass)
- Operating temperatures; -20° F to 250° F
- Inplant or mobile
- T type porting
- Return line, suction line and side loop systems
- Fluid conditioning systems
- Process systems
- Lube oil systems
- Power transmissions
- Case drains
- Hydrostatic charge pumps
- Cooling circuit systems

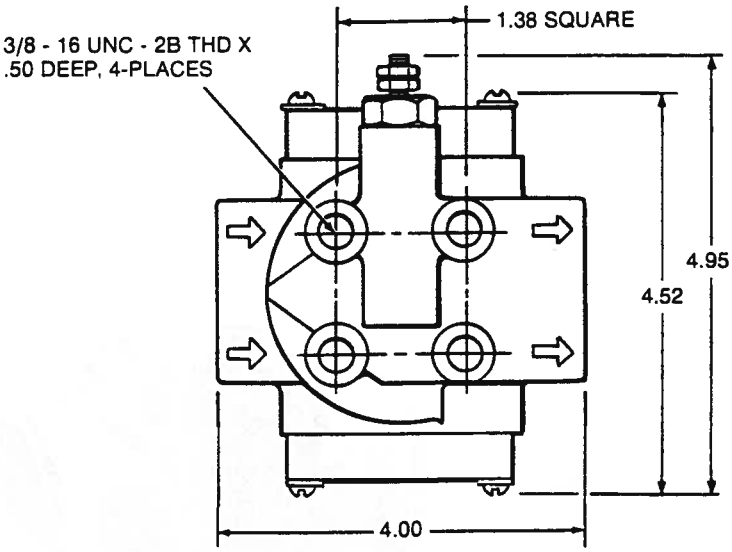
** See dimensions notes section

FEATURES

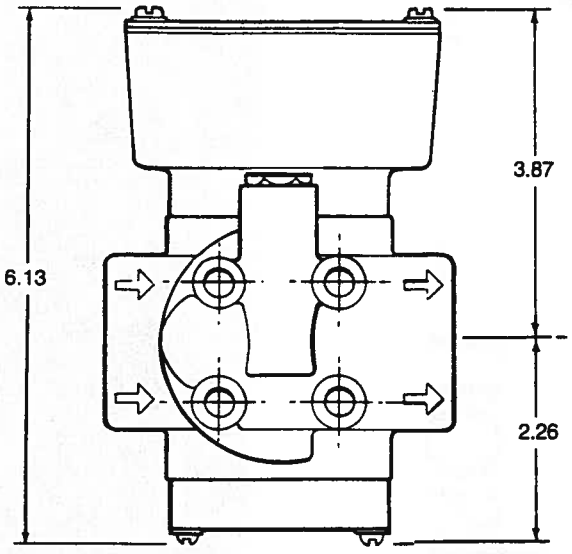
- Tamper resistant visual indicators
- AC or DC electrical indicators, normally open or normally closed
- Spin-on design simplifies servicing and lowers maintenance costs
- Heavy duty steel spin-on canister has a unique die cast top plate for added strength
- Head-to-canister o-ring seal design insures seal integrity beyond 1000 psi
- Die cast aluminum head
- Bypass valves have a unique curved design to eliminate jamming caused by chip build-up
- Full range of media; cellulose or synthetic, performance down to 2 micron absolute
- Two element lengths to choose from
- Viton and Buna-N elements available

DIMENSIONS





Head Assembly
with AC/DC
Electrical Indicator

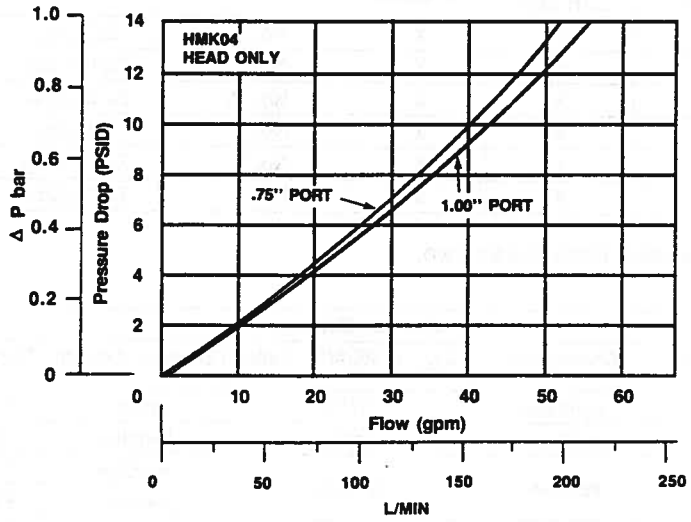


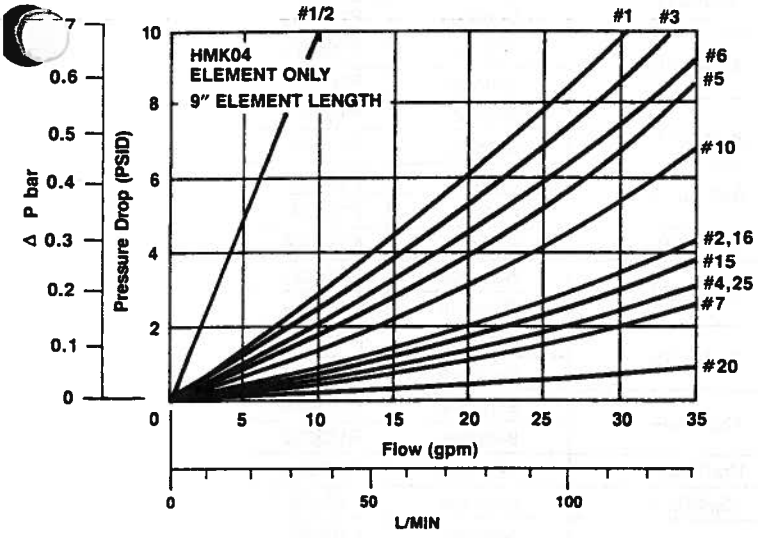
NOTE:

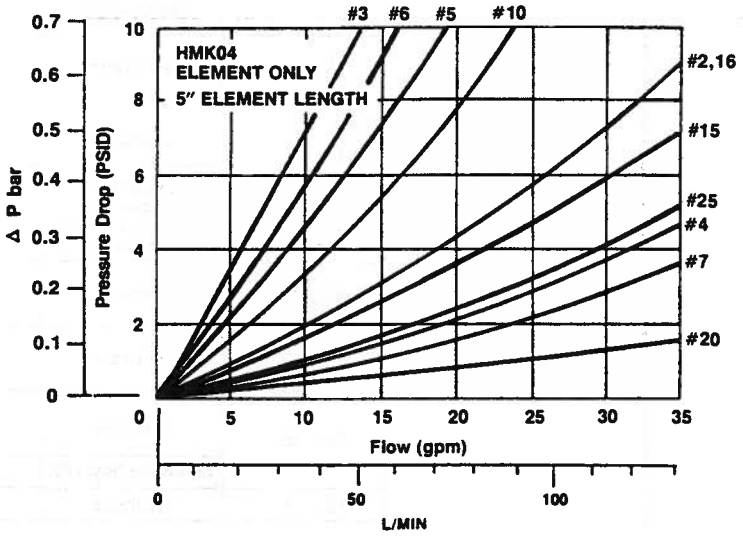
1. Minimum burst (rated static pressure per NFPA/T2.6.1-1974 category 1/90); 1000 P.S.I.
2. D.C. In-Oil Single-Post Electrical Indicator Data:
   Voltage: 6-30V.
   Current: 200 mA Max.
   Circuit: Normally open.
   Ground: Thru filter head.
3. AC/DC Electrical Indicator Data:
   (3 wire switch in conduit box)
   Voltage: 120 V. AC/100 V. DC
   Current: 250 mA Max.
   Circuit: Normally Open/Normally Closed
4. Approximate assembly weight:
   5.25 lbs. (9" element)
   3.50 lbs. (5" element)
5. HMK04 Fatigue Strength Rating:
   (Working Pressure)*
   100,000 cycles at 0-500 psi
   300,000 cycles at 0-400 psi
   1,000,000 cycles at 0-350 psi

*(per NFPA/T2.6.1-1974 category 1/90)

PERFORMANCE







FLOW CURVE NOTES:

1. All flow measurements were made with 150 SSU hydraulic oil at 100°F.

2. The numbers on curves refer to media numbers. See the 'Media Specifications Chart' for the Beta 2/20/75 ratings and part numbers.

3. **Pressure Drop Calculation Procedure**
   A. Clean filter assembly = Housing Δ P + Element Δ P.
   B. The above applies, for any given flow, when the fluid specific gravity is 0.9 and the fluid viscosity is 150 SSU (32 cSt).
   C. Housing pressure drop is directly proportional to specific gravity. Therefore, housing Δ P from the curve should be corrected when using fluid with a different specific gravity. To correct housing pressure drop for specific gravity, use the following formula:
   Corrected housing Δ P = Δ P from curve x $\frac{\text{new specific gravity}}{0.9}$

   D. Element pressure drop is directly proportional to absolute viscosity. Absolute viscosity (measured in centipoise, cP) is dependent on kinematic viscosity and specific gravity. Therefore, element Δ P from the curve should be corrected when using fluid with a different viscosity or specific gravity. To correct element Δ P for viscosity or specific gravity, use the following formula:
   Corrected element Δ P = Δ P from curve x $\frac{\text{new SSU viscosity}}{150}$ x $\frac{\text{new specific gravity}}{0.9}$

   OR

   Corrected element Δ P = Δ P from curve x $\frac{\text{new cSt viscosity}}{32}$ x $\frac{\text{new specific gravity}}{0.9}$

   OR

   Corrected element Δ P = Δ P from curve x $\frac{\text{new cP viscosity}}{29}$

ORDER INFORMATION

Donaldson Preferred Assembly Models

Specifications*							Part Numbers	
Port Size		Bypass Rating	Indication	Element Length	Media Type	$\beta_{(x)}$ = 2/20/75 Rating	Service Element	HMK04 Filter Assembly
1" NPT	1" SAE O-Ring	25 PSID	Visual Left Side	9-inches				
X		X	X	X	No. 2	2μ/3μ/5μ	P165332	K045486
X		X	X	X	No. 7	7μ/17μ/22μ	P164384	K045497
X		X	X	X	No. 10	9μ/19μ/25μ	P163324	K045006
	X	X	X	X	No. 2	2μ/3μ5/μ	P165332	K045529
	X	X	X	X	No. 7	7μ/17μ/22μ	P164384	K045379
	X	X	X	X	No. 10	9μ/19μ/25μ	P163324	K045281

* See bulletin #1400-73 for Illustrated Parts Breakdown.

Service Elements				
Media Type	Description	$\beta_{(x)}$ = 2/20/75 Rating	Element Length	Part Number
No. 1/2	synthetic	†/†/2μ	9-inches	P165185
No. 1	synthetic	†/†/3μ	9-inches	P167590
No. 2	synthetic	2μ/3μ/5μ	5-inches	P165354
			9-inches	P165332
No. 3	cellulose	3μ/8μ/11μ	5-inches	P163405
			9-inches	P163323
	cellulose heavy-duty	3μ/8μ/11μ	5-inches	P163552
			9-inches	P163564
No. 4	synthetic	4μ/10μ/13μ	5-inches	P164375
			9-inches	P164378
No. 5	cellulose	6μ/11μ/15μ	5-inches	P163412
			9-inches	P163434
	cellulose heavy-duty	6μ/11μ/15μ	5-inches	P163542
			9-inches	P163555
No. 6	synthetic	5μ/10μ/13μ	9-inches	P164056**
No. 7	synthetic	7μ/17μ/22μ	5-inches	P164381
			9-inches	P164384
No. 10	cellulose	9μ/19μ/25μ	5-inches	P163419
			9-inches	P163324
No. 15	cellulose	15μ/30μ/—	5-inches	P163496
			9-inches	P163322
	cellulose hvy.-dty.	15μ/30μ/—	9-inches	P163561
No. 16	synthetic	15μ/30μ/—	9-inches	P164059**
No. 20	synthetic	20μ/33μ/—	5-inches	P165335
			9-inches	P165338
No. 25	cellulose	25μ/50μ/—	5-inches	P163428
			9-inches	P163425
	cellulose heavy-duty	25μ/50μ/—	5-inches	P163546
			9-inches	P163558

† = Particles less than 2 microns.
**Compatible with all hydraulic fluids except for some phospate esters. Contact Donaldson for details.

ORDER INFORMATION

Donaldson Kit Program Options

The Donaldson Kit Program provides alternatives to the Preferred Assembly Models by offering a choice of:
— Head Assembly — Element Media — Electrical Indication
See Bulletin #1200-73A "HMK04 Spin-On Kit Program" for specifications and part numbers.

Donaldson Non-Stock Product Options

Contact your local distributor or Donaldson Company for build-to-order non-stock product option availability and manufacturer's lead time requirements. Note, not all option combinations can be made.

Non-Stock Product Order Code Guideline

A letter or number code has been assigned to each assembly option for non-stock products. When requesting non-stock product, fill in one letter or number designation for each option as shown in the example below. Providing a *complete* option order code to Donaldson Company or your Donaldson Distributor simplifies the ordeirng procedure and assures accuracy.

Donaldson determines product availability for non-stock option combinations, minimum quantity requirements and delivery schedules.

Port Size
A = 3/4" NPT
B = 1" NPT
K = 3/4" SAE O-Ring
L = 1" SAE O-Ring

Bypass Rating
00 = No Bypass
05 = 5 PSID
15 = 15 PSID
25 = 25 PSID
50 = 50 PSID

Indication
A = Visual RH
B = Visual LH
C = Visual Both
E = DC Elec. LH, 2-Pole
F = DC Elec. LH, 2-Pole, Visual RH
I = AC Elec. w/conduit box LH, 2-Pole
K = AC Elec. w/conduit box LH, 2-Pole, Visual RH
M = DC Elec. LH, Single Post
N = None
P = DC Elec. LH, Single Post, Visual RH
R = Remote
U = Visual & Elec. LH, Single Post

HMK04	K	15	F	09	05	R

Model

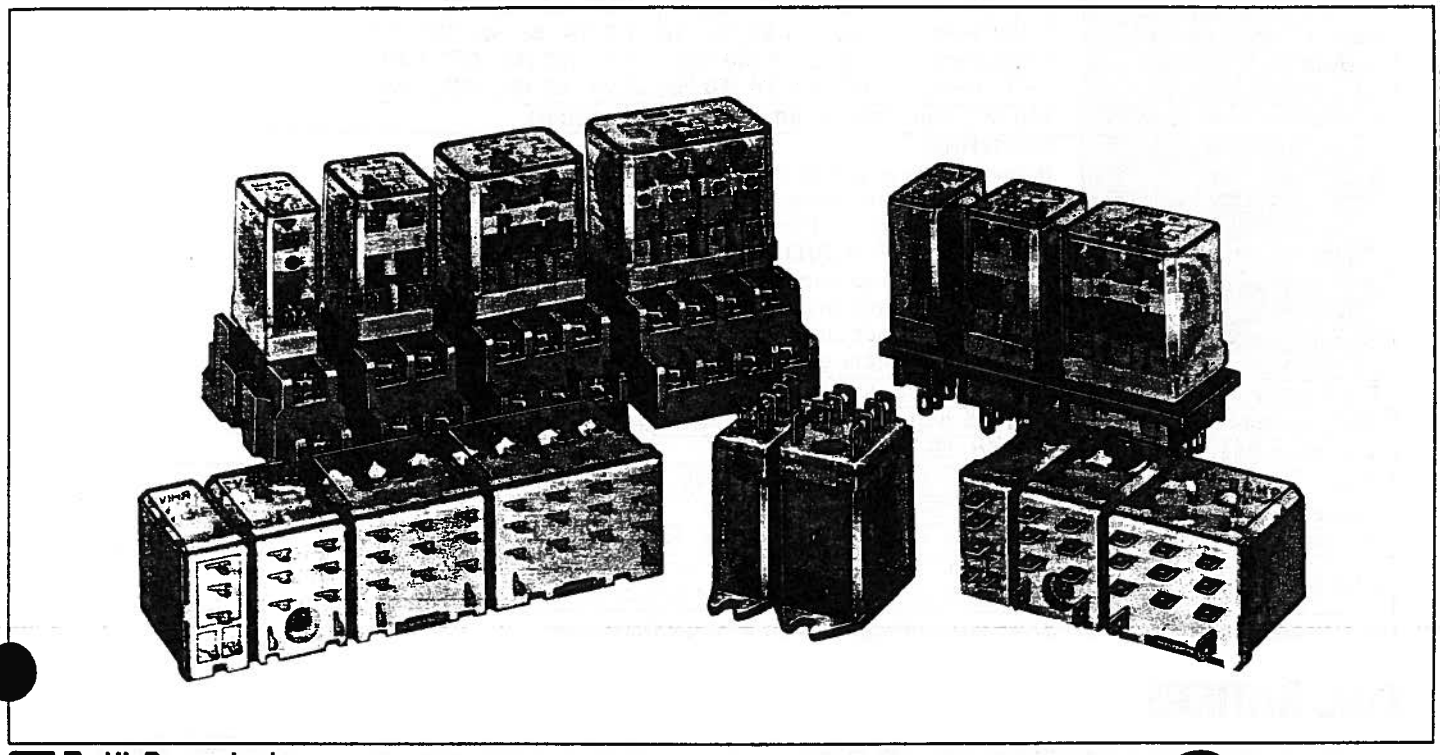
Element Length
05 = 5"
09 = 9"

Media
β(x) = 2/20/75
.05 (1/2) = < 2μ/ < 2μ/2μ
*01 = 1/2μ/1-1/2μ/2μ
*02 = 2μ/3μ/5μ
03 = 3μ/8μ/11μ
*04 = 4μ/10μ/13μ
05 = 6μ/11μ/15μ
*06 = 5μ/10μ/13μ
*07 = 7μ/17μ/22μ
10 = 9μ/19μ/25μ
15 = 15μ/30μ/—
*16 = 15μ/30μ/—
*20 = 20μ/33μ/—
25 = 25μ/50μ/—
*Synthetic media

Accessories
D = Viton Seals
N = None
Q = Pressure Drop Indication at 5 PSID
R = Pressure Drop Indication at 25 PSID
S = Pressure Drop Indication at 50 PSID
W = Wire Backed Element (Heavy Duty)
Z = Water Base Fluids

REFERENCE: ELECTRICAL PART NO.(S) 1-5, 60
ELECTRICAL SCHEMATIC NO. 347-9001-01

MIDGET POWER TYPE RELAYS
LARGE CAPACITY 10AMP–1, 2, 3, and 4 POLES



UL Recognized
File No. E67770
E59804
E64245

CSA Certified
File No. LR35144

GENERAL

IDEC's Midget Power RH relays are similar to our general purpose RR series relays with full 10 amp switching capacity. Compact in size, the RH series relays reduce space requirements which are an important feature in todays downsized equipment.

RH Midget Power relays are available in SPDT, DPDT, 3PDT and 4PDT contact configurations driven by AC or DC coils with a choice of either blade or PCB mount .078 inch(2mm) terminals. Top bracket mounting is available for SPDT, DPDT and 4PDT terminal blade models.

FEATURES

- Miniature size package allows compact system designing.
- 10 amp contact capacity.
- Dielectric strength–up to 2,000 volts.
- UL recognized and CSA certified.
- Indicator light or check button available on 2, 3 and 4-pole models.
- Complete accessories include IDEC's broad line of sockets, hold-down springs and mounting rails.

TYPE LIST

Terminal Style	Contact Configuration	Basic Type	With Indicator Light	With Check Button	Top Bracket Mounting Type
B (Blade)	SPDT	RH1B-U	—	—	RH1B-UT
	DPDT	RH2B-U	RH2B-UL	RH2B-UC	RH2B-UT
	3PDT	RH3B-U	RH3B-UL	RH3B-UC	—
	4PDT	RH4B-U	RH4B-UL	RH4B-UC	RH4B-UT
V2 (PCB 0.078" wide)	SPDT	RH1V2-U	—	—	—
	DPDT	RH2V2-U	RH2V2-UL	RH2V2-UC	—
	3PDT	RH3V2-U	RH3V2-UL	RH3V2-UC	—
	4PDT	RH4V2-U	RH4V2-UL	RH4V2-UC	—

SPECIFICATIONS

Contact Material	Silver cadmium oxide (Ag-CdO)
Contact Resistance	50 mΩ max. (initial value)
Operate Time	SPDT(RH1), DPDT(RH2) . . . 20 msec max., 3PDT(RH3), 4PDT(RH4) . . . 25 msec max.
Release Time	SPDT(RH1), DPDT(RH2) . . . 20 msec max., 3PDT(RH3), 4PDT(RH4) . . . 25 msec max.
Power Consumption (Approx.)	SPDT(RH1) . . . AC: 1.1 VA (50 Hz), 1 VA (60 Hz), DC: 0.8W DPDT(RH2) . . . AC: 1.4 VA (50 Hz), 1.2 VA (60 Hz), DC: 0.9W 3PDT(RH3) . . . AC: 2 VA (50 Hz), 1.7 VA (60 Hz), DC: 1.5W 4PDT(RH4) . . . AC: 2.5 VA (50 Hz), 2 VA (60 Hz), DC: 1.5W
Insulation Resistance	100 MΩ min. (measured at 500V DC megger)
Dielectric Strength	SPDT(RH1) Between live and non-live parts: 2000V AC, 1 minute Between contact circuit and operating coil: 2000V AC, 1 minute Between contacts of the same pole: 1000V AC, 1 minute DPDT(RH2), 3PDT(RH3), 4PDT(RH4) Between live and non-live parts: 2000V AC, 1 minute Between contact circuit and operating coil: 2000V AC, 1 minute Between contact circuits: 1500V AC, 1 minute Between contacts of the same pole: 1000V AC, 1 minute
Frequency Response	1800 operations/hour
Temperature Rise	Coil: 85 deg. max., Contact: 65 deg. max.
Vibration Resistance	0 to 6g (55 Hz max.)
Shock Resistance	SPDT(RH1), DPDT(RH2) . . . 20g, 3PDT(RH3), 4PDT(RH4) . . . 10g
Operating Temperature	-22° to +158°F (-30°C to +70°C)
Weight (Approx.)	RH1: 24g, RH2: 37g, RH3: 50g, RH4: 74g
Life Expectancy	Electrical: 500,000 operations or more (120V AC, 10A)* Mechanical: 50,000,000 operations or more

Note:* 200,000 operations or more (120V AC, 10A) in SPDT(RH1), 3PDT(RH3), 4PDT(RH4) types.

COIL RATINGS

Rated Voltage (V)		Rated Current (mA) ±15% at 20°C								Coil Resistance (Ω) ±10% at 20°C				Continuous Applied Voltage (Max.) 20°C	Pick up Voltage (min.) at 20°C
		60 Hz				50 Hz									
		SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT		
AC	6V	150	200	280	330	170	238	330	387	18.8	9.6	6.0	5.4	110% of rated voltage without overheating	80% of rated voltage
	12V	75	100	140	165	86	118	165	196	76.8	40.5	25.3	21.2		
	24V	37	50	70	83	42	59.7	81	98	300	156.7	103	84.5		
	120V	7.5	11	14.2	16.5	8.6	12.9	16.4	19.5	7680	4280	2770	2220		
	*240V	—	5.5	7.1	8.3	—	6.5	8.2	9.8	—	15720	12110	9120		
DC		SPDT		DPDT		3PDT		4PDT		SPDT	DPDT	3PDT	4PDT		
	6V	128		150		240		250		47	40	25	24	110% of rated voltage without overheating	80% of rated voltage
	12V	64		75		120		125		188	160	100	96		
	24V	32		36.9		60		62		750	650	400	388		
	48V	18		18.5		30		31		2600	2600	1600	1550		
	*110V	8.0		9.1		12.8		15		13800	12100	8600	7340		

Note: Rated voltages marked with * are not available for SPDT models.

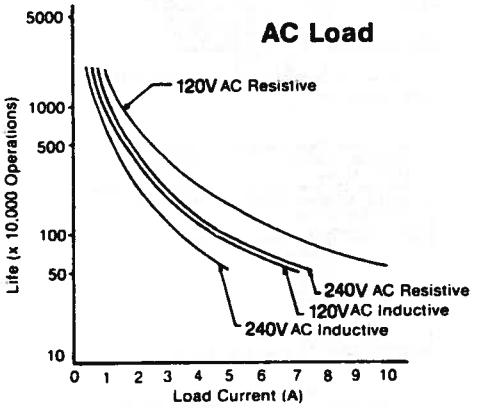
CONTACT RATING UL RATINGS (RH1, RH2, RH3, RH4)

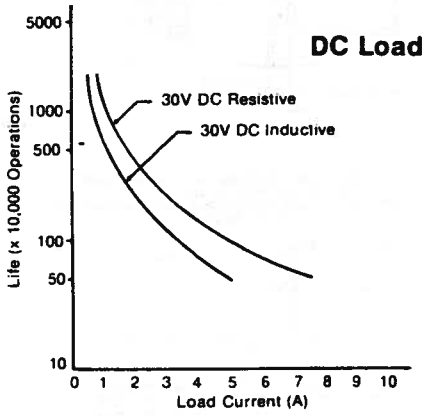
VOLTAGE (V)	RESISTIVE (A)				INDUCTIVE (A)				HORSE POWER SPDT	
	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	DPDT	3PDT
120 AC	—	—	10	10	7	7	—	7.5	1/6	1/6
240 AC	10	10	—	7.5	7	7	6.5A/Pole 20A Total	5	1/3	1/3
30 DC	10	10	10	—	7	7	—	—	—	—

CSA RATINGS (RH1, RH2, RH3, RH4)

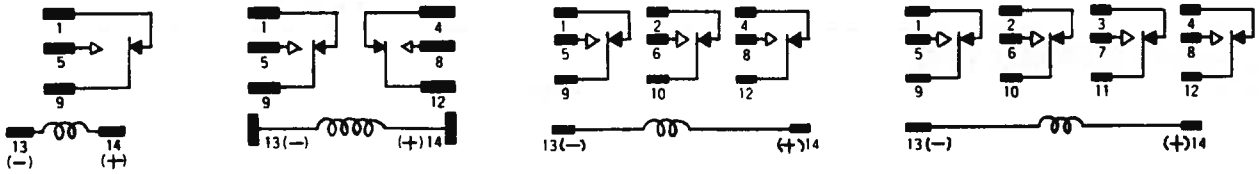
VOLTAGE (V)	RESISTIVE (A)				INDUCTIVE (A)				HORSE POWER		
	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT
120 AC	10	10	10	10	7.5	7.5	–	7.5	1/6	1/6	1/6
240 AC	10	10	–	7.5	7	7	7	5	1/3	1/3	1/3
30 DC	10	10	10	10	7	7.5	–	–	–	–	–

ELECTRICAL LIFE (RH2)





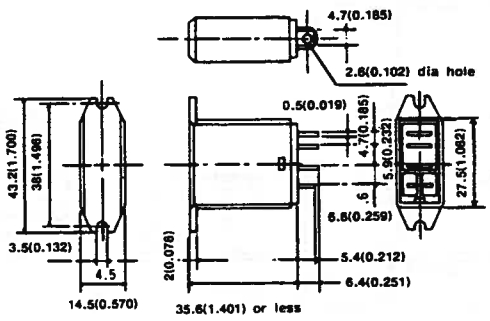
CIRCUIT DIAGRAM



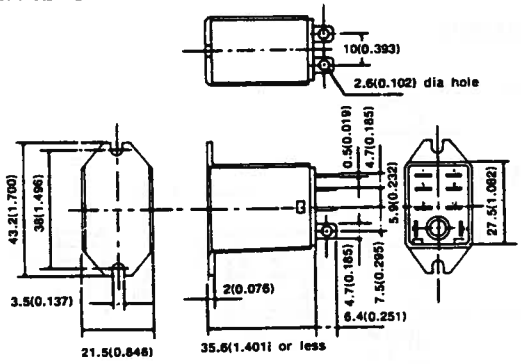
RELAY DIMENSIONS

TOP BRACKET MOUNTING TYPE (Blade Terminal)

RH1B-UT



RH2B-UT

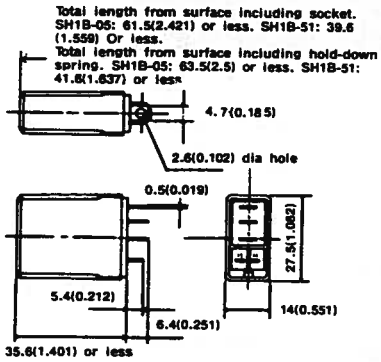


All dimensions indicated in millimeters, ( ) indicate inches

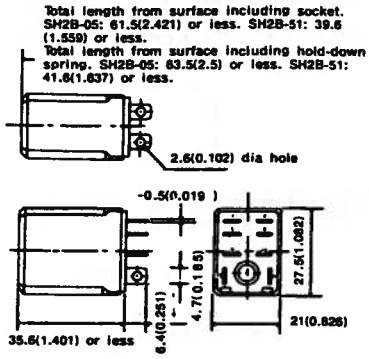
RELAY DIMENSIONS

PLUG-IN TYPE (Blade Terminal)

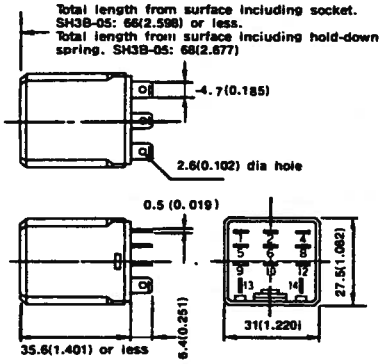
RH1B



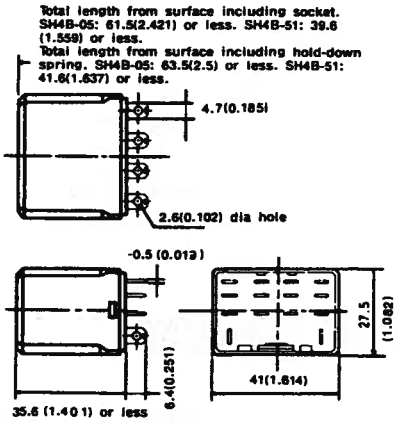
RH2B



RH3B

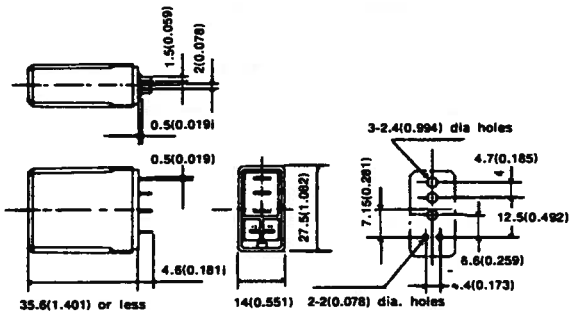


RH4B

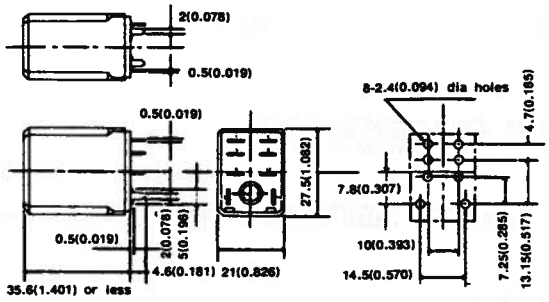


P.C. BOARD TERMINAL TYPE

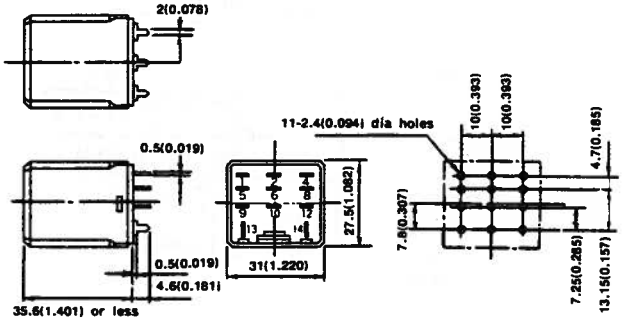
RH1V2



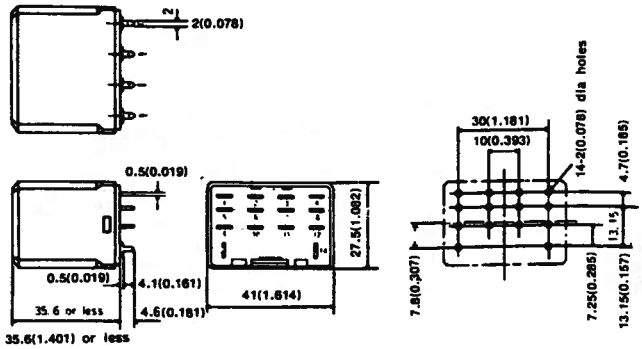
RH2V2



RH3V2



RH4V2



All dimensions indicated in millimeters, ( ) indicate inches

SOCKETS

UL Recognized File No. E64245 | CSA Certified File No. LR35144

For details on sockets and dimensions, see p.44 in socket section.

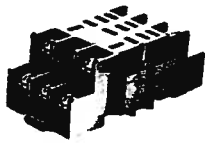
SNAP-MOUNT



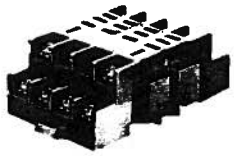
SH1B-05
For: RH1B
*SY2S-02F1
*SFA-101
*SFA-202



SH2B-05
For: RH2B
*SY4S-02F1
*SFA-101
*SFA-202

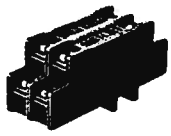


SH3B-05
For: RH3B
*SH3B-05F1
*SFA-101



SH4B-05
For: RH4B
*SH4B-02F1
*SFA-101

SURFACE MOUNT



SH2B-02
For: RH2B
*SY4S-02F1

PANEL MOUNT



SH1B-51
For: RH1B
*SY4S-51F1
*SFA-302
*SFA-301



SH2B-51
For: RH2B
*SY4S-51F1
*SFA-302
*SFA-301



SH3B-51
For: RH3B
*SY4S-51F1



SH4B-51
For: RH4B
*SY4S-51F1

P.C. MOUNT



SH1B-62
For: RH1B
*SY4S-51F1
*SFA-302
*SFA-301



SH2B-62
For: RH2B
*SY4S-51F1
*SFA-302
*SFA-301



SH3B-62
For: RH3B
*SY4S-51F1



SH4B-62
For: RH4B
*SY4S-51F1

HOLD-DOWN SPRINGS



SY4S-02F1



SY4S-51F1



SH4B-02F1



SFA-101



SFA-202

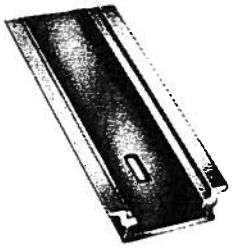


SFA-301



SFA-302

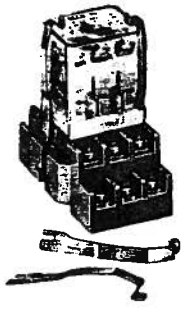
MOUNTING RAIL



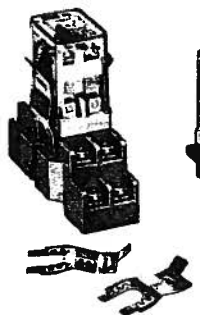
BND-1000
DIN/Screw Mount

ACCESSORIES

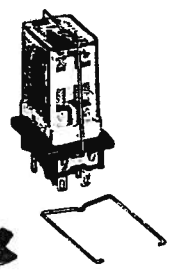
For more details on socket accessories, see p.45 in socket section under accessories guide.



SFA-101



SFA-202



SY4S-51F1

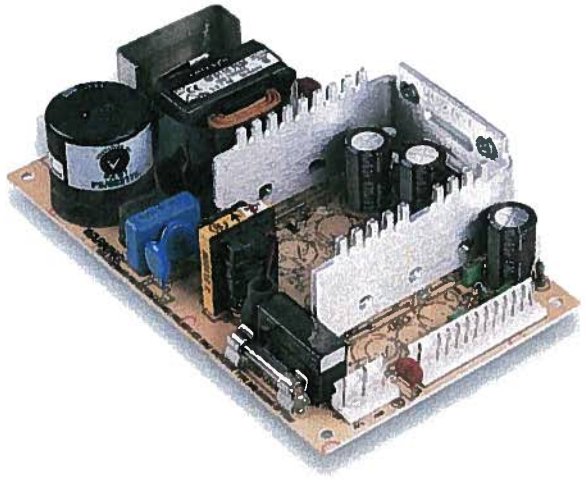
*Indicates hold-down spring.

REFERENCE: ELECTRICAL PART NO.(S) 6
ELECTRICAL SCHEMATIC NO. 347-9001-01

NFS110 Series

Single and quad output

Total Power:	80 - 110W
Input Voltage:	85 - 264VAC 120 - 370VDC
# of Outputs:	Single, quad



Special Features

- 7.0 x 4.25 x 1.8 inch package
- Overvoltage and short circuit protection
- 110 W with 20 CFM
- Adjustable outputs
- EN55022, EN55011 conducted emissions level B
- UL, VDE and CSA safety approvals
- CE mark
- Available RoHS compliant
- 2 year warranty

Safety

VDE0805/EN60950/
IEC950/IEC1010
File No. 10401-3336-0213

Licence No. 40014677

UL1950 File No. E136005

CSA C22.2 No. 950
File No. LR41062C

The NFS110 series is a 110 W universal input ac-dc power supply on a 7 x 4.25 inch card. The NFS110 series has four single and three quad output models and has proven itself to be highly reliable and versatile product for a wide range of communication and industrial applications, with a very high peak current capability on each output for drive and motor applications. The NFS110 provides 80 W of output power with free air convection cooling which can be boosted to 110 W with 20 CFM of air. Standard features include overvoltage and short circuit protection. The series, with full international safety approval and the CE mark, meets conducted emissions EN55022 level B. The NFS110 series is designed for use in low power data networking, computer, telecom and industrial applications such as servers, thermal printers, storage devices, vending machines and POS equipment.

ARTESYN

EMERSON
Network Power

Specifications

All specifications are typical at nominal input, full load at 25°C unless otherwise stated

OUTPUT SPECIFICATIONS

Voltage adjustability	+5.1 V o/p on multi's 5.1 V single output 12 V single output 15 V single output 24 V single output	±3.0% ±3.0% 12-14 V 15-18 V 24-30 V
Line regulation	LL to HL, FL All outputs on all units	±0.1% max.
Overshoot/undershoot	At turn-on	0%
Temperature coefficient	All outputs	±0.02%/°C
Overvoltage protection	Multi o/p 5.1 V only 5.1 V single 12 V single 15 V single 24 V single	6.25 V ±0.75 V 6.25 V ±0.75 V 15.75 V ±1.0 V 22 V ±1.5 V 33 V ±2.5 V
Output power limit	Primary power limited	Pin max. 160 W Pout min. 110 W
Minimum output current	(See Note 13)	0 A
Short circuit protection		Burst mode operation

INPUT SPECIFICATIONS

Input voltage range		85-264 Vac 120-370 Vdc
Input frequency range		47-440 Hz
Input surge current	230 Vac	35 A
Safety ground leakage current	110 Vac, 50 Hz 230 Vac, 50 Hz	0.2 mA, max. 0.4 mA, max.

EMC CHARACTERISTICS

Conducted emissions	EN55022, FCC part 15	Level B
Radiated emissions	EN55022, FCC part 15	Level A
ESD air	EN61000-4-2, level 3	Perf. criteria 1
ESD contact	EN61000-4-2, level 4	Perf. criteria 1
Surge	EN61000-4-5, level 3	Perf. criteria 1
Fast transients	EN61000-4-4, level 3	Perf. criteria 1
Radiated immunity	EN61000-4-3, level 3	Perf. criteria 2
Conducted immunity	EN61000-4-6, level 3	Perf. criteria 1

GENERAL SPECIFICATIONS

Hold-up time	110 Vac @ 80 W 110 Vac @ 110 W 230 Vac @ 80 W 230 Vac @ 110 W	35 ms 17 ms 140 ms 100 ms
Efficiency	Multiple outputs +5.1 V single 12 V and 15 V singles 24 V single	70% typical 70% typical 72% typical 75% typical
Isolation voltage	Input/output Input/chassis	3000 Vac 1500 Vac
Switching frequency	At 100 Watts output At zero load	20-70 kHz 100-250 kHz
Approvals and standards (See Note 12)		VDE0805, EN60950, IEC950 IEC1010, UL1950 CSA C22.2 No. 950
Weight	Singles Multiple outputs	550 g (19.4 oz) 600 g (21.2 oz)
MTBF (See Note 9)	MIL-HDBK-217E	125,000 hours

ENVIRONMENTAL SPECIFICATIONS

Thermal performance (See Notes 9, 10)	Operating, see curve Non-operating 0 °C to +50 °C, amb. convection cooled +50 °C to +70 °C, amb. convection cooled 0 °C to +50 °C, 20 CFM forced air +50 °C to +70 °C, 20 CFM forced air Peak, 0 °C to +50 °C, max. 60 seconds	0 °C to +70 °C –40 °C to +85 °C 80 W Derate 2 W/°C 110 W Derate 2.75 W/°C 110 W
Relative humidity	Non-condensing	5% to 95% RH
Altitude	Operating Non-operating	10,000 feet max. 40,000 feet max.
Vibration (See Note 11)	5-500 Hz	2.4 G approx.

Specifications Contd.

OUTPUT VOLTAGE	OUTPUT CURRENTS			RIPPLE [4]	TOTAL REGULATION [5]	MODEL NUMBERS [13,14,15]
	MAX [1]	PEAK [2]	FAN [3]			
+5.1 V	8 A	20 A	10 A	50 mV	±2.0%	NFS110-7601PJ
+12 V	4.5 A	9 A	5 A	120 mV	±3.0%	
–12 V	0.5 A	1.5 A	1 A	120 mV	±3.0%	
–5 V	0.5 A	1.5 A	1 A	50 mV	±3.0%	
+5.1 V (I_A)	8 A	20 A	10 A	50 mV	±2.0%	NFS110-7602PJ [6]
+24 V (I_B) [6]	3.5 A	4.5 A	4.5 A	240 mV	+10/–5.0%	
+12 V	4.5 A	9 A	5 A	120 mV	±3.0%	
–12 V	0.5 A	1.5 A	1 A	120 mV	±3.0%	
+5.1 V	8 A	20 A	10 A	50 mV	±2.0%	NFS110-7604PJ
+15 V	4 A	7.5 A	5 A	150 mV	±3.0%	
–15 V	0.5 A	1.5 A	1 A	150 mV	±3.0%	
–5 V	0.5 A	1.5 A	1 A	50 mV	±3.0%	
5.1 V	16 A	22 A	20 A	50 mV	±2.0%	NFS110-7605J [7,8]
12 V	7 A	9 A	9 A	120 mV	±2.0%	NFS110-7612J [7,8]
15 V	5 A	7.3 A	7.3 A	150 mV	±2.0%	NFS110-7615J [7,8]
24 V	3.5 A	4.5 A	4.5 A	240 mV	±2.0%	NFS110-7624J [7,8]

Notes

1. Convection cooled, 80 W maximum.
2. Peak outputs lasting less than 60 seconds with duty cycle less than 10%. Total peak power must not exceed 110 W.
3. Forced air, 20 CFM at 1 atmosphere, 110 W maximum.
4. Figure is peak-to-peak. Output ripple is measured across a 50 MHz bandwidth using a 12 inch twisted pair terminated with a 47 µF capacitor.
5. Total regulation is defined as the static output regulation at 25 °C, including initial tolerance, line voltage within stated limits and output voltages adjusted to their factory settings.
6. To achieve stated regulation on the 24 V output on the NFS110-7602PJ, the following load condition must be true: $I_A / I_B \leq 5$, where:
   I_A = +5.1 V output current, and
   I_B = +24 V output current
   The +24 V output will maintain ±5.0% regulation under the following additional condition: $I_A \leq 5$ A.
7. Single output models have floating outputs which may be referenced as either positive or negative. Higher voltage supplies may be adjusted over a wide output voltage range, as long as the total output power does not exceed 80 Watts (natural convection) or 110 Watts (forced air).
8. Power fail detect not available on single output models.
9. Derating curve is application specific for ambient temperatures >50 °C, for optimum reliability no part of the heatsink should exceed 90 °C and no semiconductor case temperature should exceed 100 °C.
10. Caution: Allow a minimum of 1 second after disconnecting the power when making thermal measurements.
11. Three orthogonal axes, random vibration, 10 minute test for each axis.
12. This product is only for inclusion by professional installers within other equipment and must not be operated as a stand alone product.
13. Artesyn Technologies recommends a minimum load of 11 W to achieve the design MTBF. See the derating curve on page 3.
14. The 'J' suffix indicates that these parts are Pb-free (RoHS 6/6) compliant. TSE RoHS 5/6 (non Pb-free) compliant versions may be available on special request, please contact your local sales representative for details.
15. NOTICE: Some models do not support all options. Please contact your local Artesyn representative or use the on-line model number search tool at http://www.artesyn.com/powergroup/products.htm to find a suitable alternative.

TRANSIENT RESPONSE		
NFS110-7601PJ	+5.1 V (7.5 A to 10 A)	150 mV peak, 1 ms recovery
	+12 V (2.5 A to 5 A)	100 mV peak, 0.5 ms recovery
	-12 V (0.5 A to 1 A)	100 mV peak, 0.5 ms recovery
	-5 V (0.5 A to 1 A)	100 mV peak, 0.5 ms recovery
NFS110-7602PJ	+5.1V (7.5 A to 10 A)	150 mV peak, 1 ms recovery
	+24 V (1.5 A to 3 A)	300 mV peak, 1 ms recovery
	+12 V (2.5 A to 5 A)	100 mV peak, 0.5 ms recovery
	-12 V (0.5 A to 1 A)	100 mV peak, 0.5 ms recovery
NFS110-7604PJ	+5.1 V (7.5 A to 10 A)	150 mV peak, 1 ms recovery
	+15 V (2.5 A to 5 A)	100 mV peak, 0.5 ms recovery
	-15 V (0.5 A to 1 A)	100 mV peak, 0.5 ms recovery
	-5 V (0.5 A to 1 A)	100 mV peak, 0.5 ms recovery
NFS110-7605J	+5.1 V (10 A to 20 A)	250 mV peak, 1 ms recovery
NFS110-7612J	+12 V (4.5 A to 9 A)	360 mV peak, 1 ms recovery
NFS110-7615J	+15 V (3.65 A to 7.3 A)	450 mV peak, 1 ms recovery
NFS110-7624J	+24V (2.25 A to 4.5 A)	720 mV peak, 1 ms recovery

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Business-Critical Continuity

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2008/04/10

NFS110-7602PJ — ARTESYN — 5.1v, 24v, 12v, -12v 110W 4.25 Inch X 7 Inch, Compliant RoHS Compliant: Yes

Manufacturer: ARTESYN

Newark Part Number: 71K8861

Manufacturer Part No: NFS110-7602PJ

RoHS Compliance : **Yes**

Description

- 5.1v, 24v, 12v, -12v 110W 4.25 inch x 7 inch, Compliant RoHS Compliant: Yes

ARTESYN

Availability

Availability: 111

Price For: 1 Each

Minimum Order Quantity: 1

Order Multiple Quantity: 1

Price: $110.53

Enter Quantity

Price

Qty	List Price
1 - 9	$110.53
10 - 24	$101.74
25 - 49	$94.83
50 - 99	$91.69
100 +	$87.92

PRODUCT INFORMATION

RoHS Certificate of Compliance

Get ADOBE READER

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Web Site Support:
1.800.NEWARK.T (1.800.639.2758)

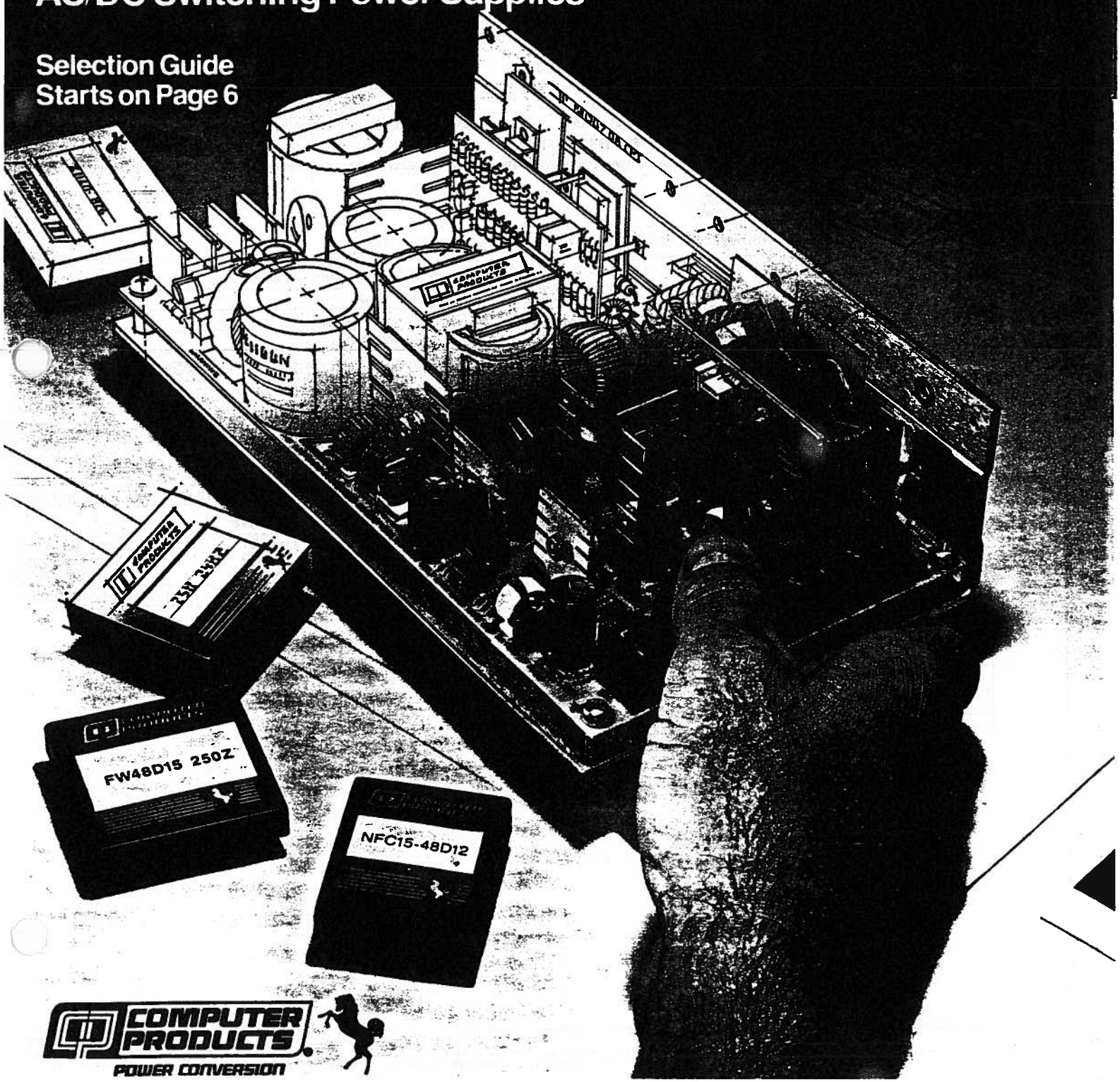
Contact Newark:
1.800.4.NEWARK (1.800.463.9275)

FooterLogoRight

Power Supply Engineering Handbook

DC/DC Converters
AC/DC Switching Power Supplies

Selection Guide
Starts on Page 6



COMPUTER PRODUCTS
POWER CONVERSION

PM500 SERIES
1 to 10 Watt Dual and Triple Output Encapsulated Power Modules

- Split-Bobbin Wound
- 2500 VAC Isolation
- UL Recognized
- CSA Certified
- 115, 220, or 240 VAC Input
- Short Circuit Protection
- 2 Year Warranty



These popular PC-mountable linear power modules feature dual and triple outputs with different dual and triple models. The most commonly used output voltages of 5V, ±12V, ±15V, and ±24V are featured. Overvoltage crowbar protection is a standard feature on 5V outputs. Most models are UL recognized and CSA certified. For maximum safety, all power transformers are split-bobbin wound, rather than layer wound, to give total isolation between primary and secondary. Standard input voltage is 115 VAC at 50 to 400 Hz; other optional inputs are 100, 220, and 240 VAC. The industry standard 2.5 × 3.5 inch cases are available in standard and alternate pin configurations, for second sourcing applications. Input/output isolation voltage is 2500 VAC and output current-limiting short circuit protection is standard.

SPECIFICATIONS

All Specifications are Typical at Nominal Line, Full Load and 25°C Unless Otherwise Noted.

OUTPUT SPECIFICATIONS		
Voltage Accuracy		±1.0%, max.
Voltage Balance	Dual Outputs	±1.0%, max.
Temperature Coefficient		±0.02%/°C.
Short Circuit Protection		Automatic
Overvoltage Crowbar	5V Outputs	6.2V, nominal
INPUT SPECIFICATIONS		
Input Voltage Range	No Suffix Other Models	105 to 125 VAC See Table
Input Frequency		50 to 400 Hz
Derating at 400 Hz		Consult Factory

NOTE:
All models are available with alternate pin-outs designated by suffix letter "S". Consult Factory. All models are also available with four optional input voltage ranges designated by the suffixes shown in table.
When ordering, specify the complete model number followed by input voltage and alternate pin-out designatons, if any.
For example, PM505, etc.

Input Voltage	Suffix
115 ± 10 VAC	(NONE)
220 ± 20 VAC	D
240 ± 20 VAC	K

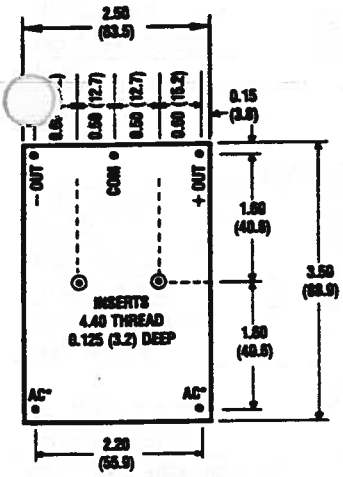
GENERAL SPECIFICATIONS		
Isolation Voltage		2500 VRMS
Isolation Capacitance		50 pF
Isolation Resistance		50 megohms
ENVIRONMENTAL SPECIFICATIONS		
Operating Temperature Range		-25°C to +71°C
Derating	50°C to 71°C	2.5%/°C
Storage Temperature Range		-25°C to +85°C
Humidity	Non-Condensing	20% to 95% RH
Cooling		Free-Air Convection
MTBF	See Application Notes	710,000 hours
PHYSICAL SPECIFICATIONS		
Weight	Case B1 Case B2 Case B3	12 oz. (340 grams) 14.4 oz. (408 grams) 22.4 oz. (635 grams)
Case Material		Non-Conductive Black Plastic

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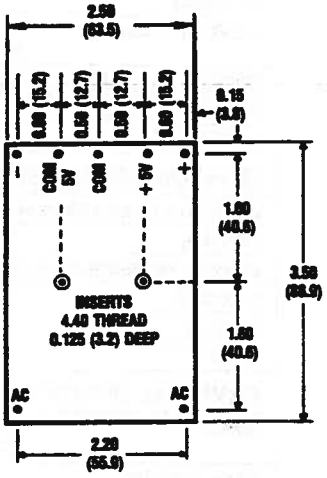
Output Voltage	Output Current	OVP	Regulation Line	Regulation Load	Ripple and Noise	UL	CSA	Alt Pin Out	Case	Model Number
±12 VDC	± 25 mA		±0.2%	±0.2%	2.0 mV RMS	✓	✓	S	B1	PM509
±12 VDC	± 50 mA		±.02%	±.02%	0.5 mV RMS	✓	✓	S	B1	PM510
±12 VDC	±120 mA		±.02%	±.02%	0.5 mV RMS	✓	✓	S	B1	PM536
±12 VDC	±240 mA		±.02%	±.02%	0.5 mV RMS	✓	✓	S	B2	PM537
±12 VDC	±400 mA		±.02%	±.02%	0.5 mV RMS	✓	✓	S	B3	PM597
±15 VDC	± 25 mA		±0.2%	±0.2%	2.0 mV RMS	✓	✓	S	B1	PM538
±15 VDC	± 65 mA		±.02%	±.02%	0.5 mV RMS	✓	✓	S	B1	PM553
±15 VDC	±100 mA		±.02%	±.02%	0.5 mV RMS	✓	✓	S	B1	PM505
±15 VDC	±150 mA		±.02%	±.02%	0.5 mV RMS	✓	✓	S	B2	PM570
±15 VDC	±200 mA		±.02%	±.02%	0.5 mV RMS	✓	✓	S	B2	PM565
±15 VDC	±350 mA		±.02%	±.02%	1.0 mV RMS	✓	✓	S	B3	PM501
Triple Output										
5V±12 VDC	300/±180 mA	✓	±.02%	±.05%/±.02%	0.5 mV RMS	✓	✓	S	B2	PM595
5V±12 VDC	500/±120 mA	✓	±.02%	±.05%/±.02%	0.5 mV RMS	✓	✓	S	B2	PM591
5V±12 VDC	1000/±150 mA	✓	±.02%	±.01%/±.02%	1.0/0.5 mV RMS		✓	S	B3	PM592
5V±15 VDC	300/±150 mA	✓	±.02%	±.05%/±.02%	0.5 mV RMS	✓	✓	S	B2	PM594
5V±15 VDC	500/±100 mA	✓	±.02%	±.05%/±.02%	0.5 mV RMS	✓	✓	S	B2	PM590
5V±15 VDC	1000/±150 mA	✓	±.02%	±.01%/±.02%	1.0/0.5 mV RMS		✓	S	B3	PM593

NOTE 1: Overvoltage protection is on 5V output.

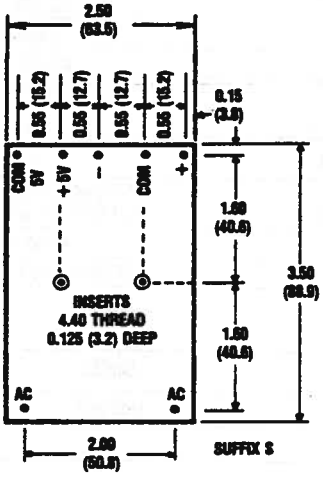
DUAL OUTPUT MODELS



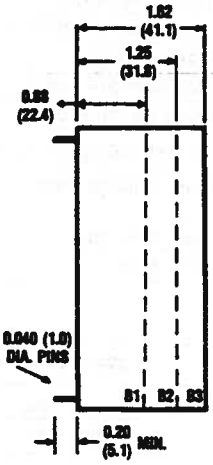
TRIPLE OUTPUT MODELS STANDARD PINOUT



TRIPLE OUTPUT MODELS ALTERNATE PINOUT



SIDE VIEW



ALL DIMENSIONS IN INCHES (mm)

International Safety Standard Approvals

CSA 22.2–143 and –154 Reg. File No. LR59996

UL478 Reg. File No. E65890

Application Notes

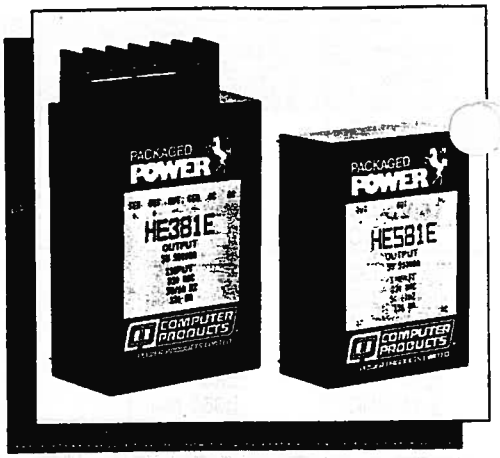
(1) The insert on the left-hand side of each case drawing is connected to AC ground.
(2) See MTBF Ratings, page 173, for details.

New # 510 657 6700

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HE300/500 SERIES
25 Watt Single Output Switching Power Modules

- 60-75% Efficiency
- Excellent Regulation
- OVP on 5V Output
- 115 or 230 VAC Input
- Short Circuit Protection
- Internal Input Filter
- 2 Year Warranty



This series of off-line switching power modules provides 25 watts of output power at 5, 12 or 15 VDC. The HE300/500 series both incorporate a pulse-width modulated flyback circuit. Both series operate at over 25 kHz and achieve 60 to 75% conversion efficiency with excellent line and load regulation. The HE300/500 series have a pi network, balun input filter and a continuous six-sided shield. All 5 VDC output models have overvoltage protection. Other pertinent specifications include ±2.0% output voltage accuracy, 100 to 130 VAC or 200 to 260 VAC input voltage range, and 900 to 1500 VAC isolation voltage. In addition, the HE300 series has remote sensing to compensate for up to 0.3V drop in the load distribution lines.

SPECIFICATIONS

All Specifications are Typical at Nominal Line, Full Load and 25°C Unless Otherwise Noted.

OUTPUT SPECIFICATIONS		
Voltage Accuracy		±2.0%, max.
Temperature Coefficient		±0.02%/°C
Warm-up Drift		±0.4%, max.
Overvoltage Crowbar		6.2V
Short Circuit Protection		Automatic
INPUT SPECIFICATIONS		
Input Voltage Range	'E' Suffix	100 VAC to 130 VAC 200 VAC to 260 VAC
Input Frequency		47 to 400 Hz
Input Filter		Pi Network & Balun

Input Voltage	Suffix
115 VAC	(NONE)
230 VAC	E

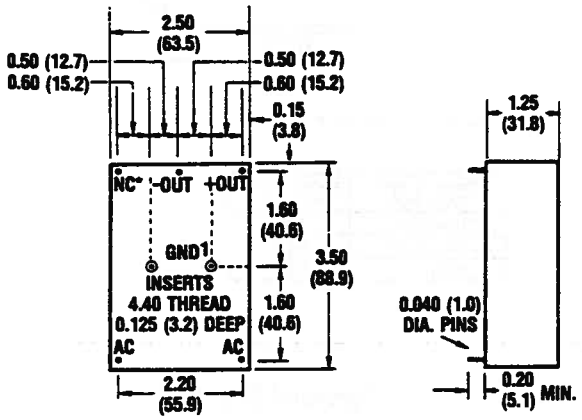
GENERAL SPECIFICATIONS		
Efficiency		75%
Isolation Voltage	115 VAC Input 230 VAC Input	900 VAC RMS, min. 1500 VAC RMS, min.
Isolation Capacitance		100 pF
Isolation Resistance		50 megoh
Switching Frequency		25 kHz
ENVIRONMENTAL SPECIFICATIONS		
Operating Temperature Range		-25°C to +71°C
Derating	50°C to 70°C	2.5%/°C
Storage Temperature Range		-25°C to +85°C
Humidity	Non-Condensing	20% to 95% RH
Cooling		Free-Air Convection
MTBF[1]		210,000 hours
PHYSICAL SPECIFICATIONS		
Weight	B2 Case C1 Case	12 oz. (340 grams) 16 oz. (454 grams)
Case Material		Non-Conductive Black Plastic

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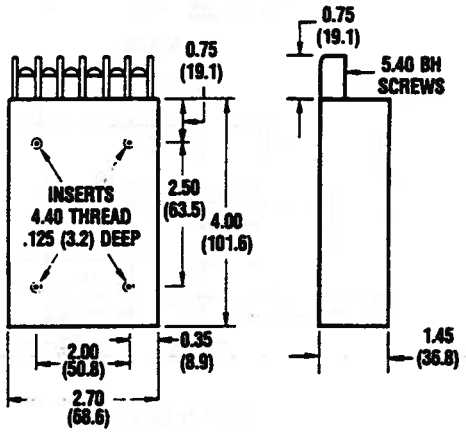
Output Voltage	Output Current	OVP	Regulation		Ripple and Noise	Input Filter and Shield	Remote Sense	Case	Model Number
			Line	Load					
25 Watt PC Mountable									
5 VDC	5.0 A	✓	±0.05%	±0.1%	100 mV P-P	✓		B2	HE581
12 VDC	2.2 A		±0.05%	±0.1%	100 mV P-P	✓		B2	HE583
15 VDC	1.8 A		±0.05%	±0.1%	100 mV P-P	✓		B2	HE584
25 Watt Chassis Mountable									
5 VDC	5.0 A	✓	±0.05%	±0.1%	100 mV P-P	✓	✓	C1	HE381
12 VDC	2.2 A		±0.05%	±0.1%	100 mV P-P	✓	✓	C1	HE383
15 VDC	1.8 A		±0.05%	±0.1%	100 mV P-P	✓	✓	C1	HE384

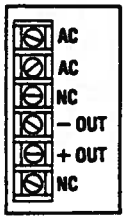
ALL DIMENSIONS IN INCHES (mm)

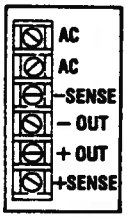
CASE B2



CASE C1



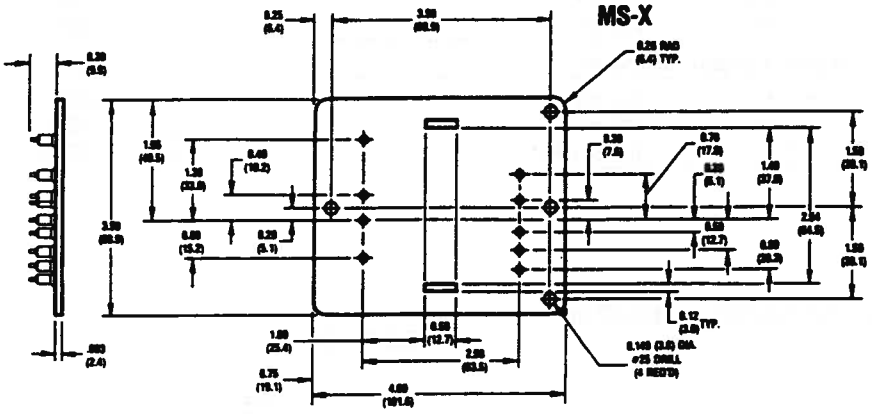




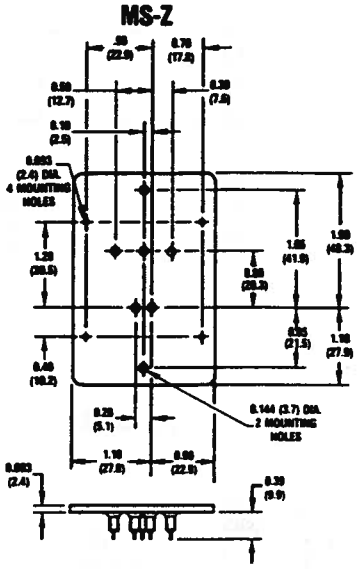
Notes:
(1) See MTBF Ratings, page 173, for details.
(2) In the mechanical diagram for case C1, the insert in the top left corner is connected to the internal AC ground. Connecting this point to external AC ground improves input noise filtering. To insure good electrical connection, use a star washer to cut through any film or paint on the grounded system chassis.

Mating Sockets

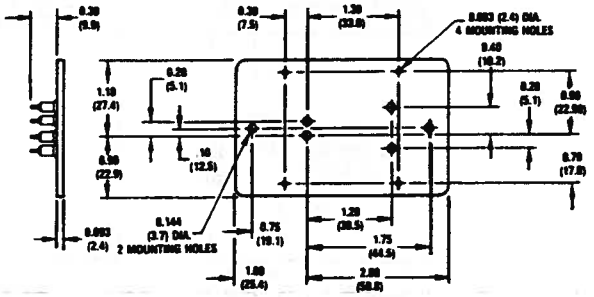
MS-X



MS-Z



MS-W

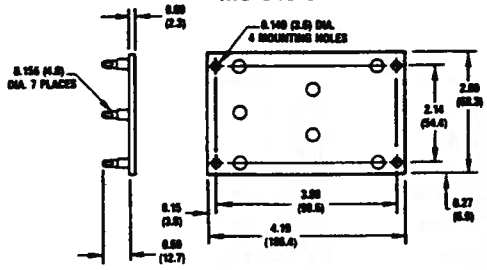


ALL DIMENSIONS IN INCHES (mm)

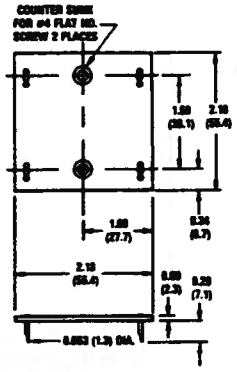
Power Supply Case Size	Mating Socket Model No.
H Series Only	MS-W
X, XC, XA, U	MS-X
Z, W, R	MS-Z

Solder Lug Type

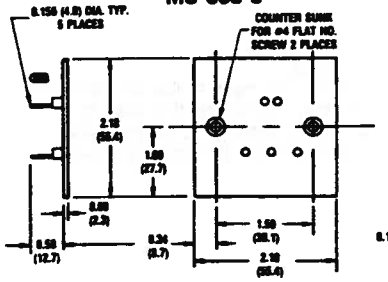
MS 013-0



MS 040-0



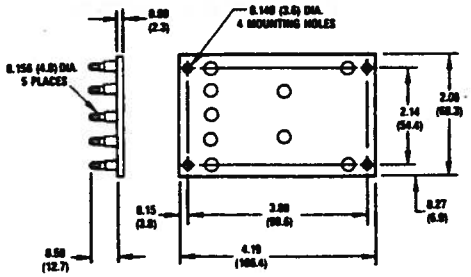
MS 038-0



Power Supply Case Size	Mating Socket Model No.
B Single & Dual	MS-013-0*
B Triple	MS-022-0*
G	MS-038-0
GA	MS-040-0
B One Supply	MS-148-0
B Two Supplies	MS-149-0

*Note: For suffix "S" power supplies specify either MS-013-1 or MS-022-1.

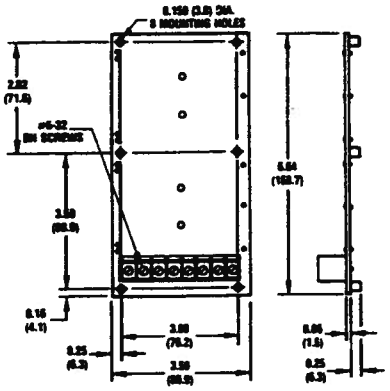
MS 022-0



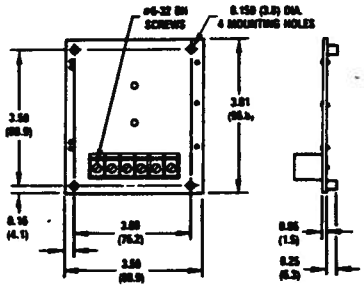
ALL DIMENSIONS IN INCHES (mm)

Terminal Strip Type

MS 149-0

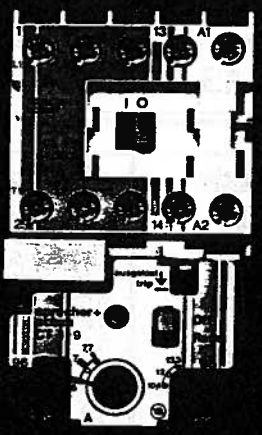


MS 148-0



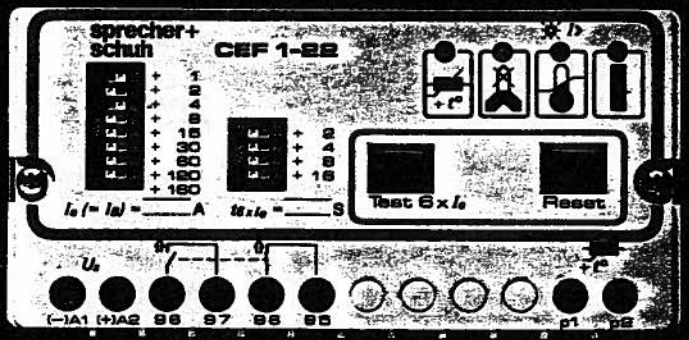
ALL DIMENSIONS IN INCHES (mm)

REFERENCE: ELECTRICAL PART NO.(S) 11
ELECTRICAL SCHEMATIC NO. 347-9001-01



sprecher+
schuh





Industrial Motor Control
And Protection Catalog

Series CA1, CA3 & CA5

Configuration

CA	Contactor
CB	Contactor (Single Phase)
CAT	Starter
CBT	Starter (Single Phase)
CAU	Reversing Contactor
CBU...	Reversing Contactor (Single Phase)
CAUT	Reversing Starter
CBUT...	Reversing Starter (Single Phase)
CAZTT	Multispeed-Two Wind. (Const/Var TQ)
CAZHT	Multispeed-Two Wind. (Const HP)
CAETT	Multispeed-One Wind. (Const/Var TQ)
CAEHT	Multispeed-One Wind. (Const HP)
CAAT...	Autotransformer Starter
CAYT	Wye-Delta Starter
CAPWT	Part Winding Starter
CAPT	Pump Panel Starter
CADPT	Duplex Pump Starter

Contactor Series

Series CA1	Series CA3
1-55	3-9①
1-60	3-12①
1-100	3-16①
1-150	3-23A①
1-250	3-23①
1-480	3-30①
	3-37
Series CA5	3-43
5-550	3-60
5-700	3-72
5-860	
5-1000	3-9C①
5-1200	3-12C①
	3-16C①

① Select additional suffix -10 or -01 for CA, CAU, CB & CBU configurations only.

-10	N.O. Base Auxiliary
-01	N.C. Base Auxiliary

Coil Code

AC	DC
24	24D
120	48D
208	110D
220	220D
220W	
240	No Coil
277	XXX
380	
480	
575	

For voltage ranges, refer to Coil Codes section of catalog (page A62).

Control Xfmr

Code	Primary	Secondary
XA	208	120
XB	240	120
XC	480	120
XD	575	120
XE	240	24
XF	480	24
XG	380	110

For additional **Control Transformer Codes**, refer to Modifications section of catalog (page A71).

Overload Relay Selection

CA3-9 thru CA3-30	
0.16	0.10-0.16
0.24	0.15-0.24
0.38	0.24-0.38
0.62	0.38-0.62
1.0	0.62-1.0
1.6	1.0-1.6
2.5	1.6-2.5
4.0	2.5-4.0
6.0	3.8-6.0
9.5	6.0-9.5
12.5	8.5-12.5
17.5	12-17.5
23	16-23
32	23-32

CA3-37 thru CA3-72	
32	25-32
42	32-42
52	40-52
63	52-63
72.5	58-72.5

CA1-55 thru CA1-100	
72	42-72
100	65-100
150	100-150

CA1-150	
100	65-100
150	100-150
200	140-200

CA1-250	
200	140-200
290	180-290

CA1-480	
200	140-200
290	180-290
400	275-400
500	320-500

CA5-550 thru CA5-12(	
500	320-500
800	500-800
1250	780-1250

Blank None

CAT 3-30 - 480 - 23 - B50 G 3

Motor Circuit Protector

B3	3 Amp
B7	7 Amp
B15	15 Amp
B30	30 Amp
B50	50 Amp
B100	100 Amp
B150	150 Amp
B225	225 Amp
B400	400 Amp
B600	600 Amp

Blank None

Fusible Disconnect

F21	250V/30A
F22	250V/60A
F23	250V/100A
F24	250V/200A
F25	250V/400A
F26	250V/600A
F61	600V/30A
F62	600V/60A
F63	600V/100A
F64	600V/200A
F65	600V/400A
F66	600V/600A

Blank None

Non Fusible Disconnect

U61	600V/30A
U62	600V/60A
U63	600V/100A
U64	600V/200A
U65	600V/400A
U66	600V/600A

Blank None

Enclosure

G	General Purpose (M1)
D	Dusttight (M12)
W	Watertight (M4)
C	Watertight Corrosion Resistant (F4)
R	Raintight (M3R)
E	Explosionproof (M7)
N	Open Device

Enclosure Cover Control

Non-Reversing

1	Pilot Light Only
2	Pilot Lights(2) Only
3	"Start-Stop" PB
4	"On-Off" PB
5	"Hand-Auto" S/S
6	"On-Off" S/S
7	"Hand-Off-Auto" S/S
0	None

Reversing

2	Pilot Lights(2) Only
3	"For-Stop-Rev" PB
4	"Up-Stop-Down" PB
5	"Open-Stop-Close" PB
6	"For-Off-Rev" S/S
7	"Up-Off-Down" S/S
8	"Open-Off-Close" S/S
0	None

Multi-Speed

2	Pilot Lights(2) Only
3	"High-Stop-Low" PB
4	"Fast-Stop-Slow" PB
5	"High-Off-Low" S/S
6	"Fast-Off-Slow" S/S
0	None

For additional **Cover Control Codes**, refer to Modifications section of catalog (page A71).

Options

For complete listing of **Options Codes**, refer to Modifications section of catalog (page A71).

This Chart For Reference Only - To Be Used With Sprecher+Schuh Industrial Control Catalog.

Example CAT3-30-480-23-B50G3 Noted Above:
Three phase starter with CA3-30 contactor, 480 volt AC coil, 16-23 amp overload relay, 50 amp Motor Circuit Protector, general purpose M1 enclosure and "Start-Stop" pushbutton.

Non-Reversing CAT1 & CAT5 (Open, M1 & M12/M3)

Continuous Ampere Rating		Maximum Horsepower Three Phase				Standard Auxiliary Contacts		Open Type		M1 General Purpose		DIM ①	M12 (M3②) Industrial Dusttight		DIM ①
Open	Encl.	200V	230V	460V	575V	NO	NC	Catalog Number		Catalog Number			Catalog Number		
120	100	30	30	60	75	1	1	CAT1-55-✱-◆-N0		CAT1-55-✱-◆-G0		D	CAT1-55-✱-◆-D0		Q
135	125	40	40	75	100	1	1	CAT1-60-✱-◆-N0		CAT1-60-✱-◆-G0		D	CAT1-60-✱-◆-D0		Q
160	150	50	50	100	125	1	1	CAT1-100-✱-◆-N0		CAT1-100-✱-◆-G0		E	CAT1-100-✱-◆-D0		R
200	180	60	60	150	150	1	1	CAT1-150-✱-◆-N0		CAT1-150-✱-◆-G0		G	CAT1-150-✱-◆-D0		T
300	270	75	100	200	250	1	1	CAT1-250-✱-◆-N0		CAT1-250-✱-◆-G0		H	CAT1-250-✱-◆-D0		H
420	400	150	150	350	400	1	1	CAT1-480-✱-◆-N0		CAT1-480-✱-◆-G0		I	CAT1-480-✱-◆-D0		I
~	550	200	200	400	500	2	2	CAT5-550-✱-◆-N0		CAT5-550-✱-◆-G0		~	CAT5-550-✱-◆-D0		~
~	700	250	300	600	700	2	2	CAT5-700-✱-◆-N0		CAT5-700-✱-◆-G0		~	CAT5-700-✱-◆-D0		~
~	860	300	350	700	800	2	2	CAT5-860-✱-◆-N0		CAT5-860-✱-◆-G0		~	CAT5-860-✱-◆-D0		~
~	1000	350	400	800	1000	1	2	CAT5-1000-✱-◆-N0		CAT5-1000-✱-◆-G0		~	CAT5-1000-✱-◆-D0		~
~	1200	400	450	900	1100	1	2	CAT5-1200-✱-◆-N0		CAT5-1200-✱-◆-G0		~	CAT5-1200-✱-◆-D0		~

Non-Reversing CAT1 & CAT5 (M4 & F4)

Continuous Ampere Rating		Maximum Horsepower Three Phase				Standard Auxiliary Contacts		M4 Watertight		DIM ①	F4 Watertight Corrosion Resistant		DIM ①
Open	Encl.	200V	230V	460V	575V	NO	NC	Catalog Number			Catalog Number		
120	100	30	30	60	75	1	1	CAT1-55-✱-◆-W0		Q	CAT1-55-✱-◆-C0		W1
135	125	40	40	75	100	1	1	CAT1-60-✱-◆-W0		Q	CAT1-60-✱-◆-C0		W1
160	150	50	50	100	125	1	1	CAT1-100-✱-◆-W0		R	CAT1-100-✱-◆-C0		X1
200	180	60	60	150	150	1	1	CAT1-150-✱-◆-W0		T	CAT1-150-✱-◆-C0		X1
300	270	75	100	200	250	1	1	CAT1-250-✱-◆-W0		H	CAT1-250-✱-◆-C0		Y1
420	400	150	150	350	400	1	1	CAT1-480-✱-◆-W0		W	CAT1-480-✱-◆-C0		Y1
~	550	200	200	400	500	2	2	CAT5-550-✱-◆-W0		~	CAT5-550-✱-◆-C0		~
~	700	250	300	600	700	2	2	CAT5-700-✱-◆-W0		~	CAT5-700-✱-◆-C0		~
~	860	300	350	700	800	2	2	CAT5-860-✱-◆-W0		~	CAT5-860-✱-◆-C0		~
~	1000	350	400	800	1000	1	2	CAT5-1000-✱-◆-W0		~	CAT5-1000-✱-◆-C0		~
~	1200	400	450	900	1100	1	2	CAT5-1200-✱-◆-W0		~	CAT5-1200-✱-◆-C0		~

Ordering Instructions

- Specify Catalog Number
- Replace (✱) With Coil Code
- Replace (◆) With O/L Relay Code

Refer To Page A62 For Codes

① Refer to page A86 for dimensional information.

② For M3 outdoor applications, replace "D" in catalog number with an "R". Price and dimensions remain the same.
Example: CAT1-60-✱-◆-D0 becomes CAT1-60-✱-◆-R0.

Coil Codes (AC & DC)

All Contactor and Starter Configurations

Contactor Coil Code & Voltage Ranges ④

A.C. COIL ⇓ CODES ⇓	CA4-9	CA3-9 CA3-12 CA3-16	CA3-23A CA3-23 CA3-30	CA3-37 CA3-43 CA3-60 CA3-72	CA1-55 CA1-60 CA1-100	CA1-150 CA1-250 CA1-480	CA5-550 thru CA5-860 ⑥
24	24Volts/60Hz 24Volts/50Hz	24Volts/60Hz 21Volts/50Hz	24Volts/60Hz 21Volts/50Hz	24Volts/60Hz 21Volts/50Hz	24Volts/60Hz 21Volts/50Hz	N/A	N/A
120	110-120V/60Hz 110Volts/50Hz	120Volts/60Hz 110Volts/50Hz	120Volts/60Hz 110Volts/50Hz	120Volts/60Hz 110Volts/50Hz	120Volts/60Hz 110Volts/50Hz	120Volts/60Hz 110Volts/50Hz	110-120Volts 50/60Hz
208	R/F	208Volts/60Hz 180Volts/50Hz	208Volts/60Hz 180Volts/50Hz	208Volts/60Hz 180Volts/50Hz	208Volts/60Hz 180Volts/50Hz	208Volts/60Hz 180Volts/50Hz	N/A
220	220-240V/60Hz 220Volts/50Hz	220Volts/60Hz 190Volts/50Hz	220Volts/60Hz 190Volts/50Hz	220Volts/60Hz 190Volts/50Hz	220Volts/60Hz 190Volts/50Hz	220Volts/60Hz 190Volts/50Hz	N/A
220W①	R/F	208-240Volts 60Hz	208-240Volts 60Hz	N/A	N/A	N/A	N/A
240	240Volts/60Hz 240Volts/50Hz	240Volts/60Hz 220Volts/50Hz	240Volts/60Hz 220Volts/50Hz	240Volts/60Hz 220Volts/50Hz	240Volts/60Hz 220Volts/50Hz	240Volts/60Hz 220Volts/50Hz	220-240Volts 50/60Hz
277	R/F	277Volts/60Hz 240Volts/50Hz	277Volts/60Hz 240Volts/50Hz	277Volts/60Hz 240Volts/50Hz	277Volts/60Hz 240Volts/50Hz	277Volts/60Hz 240Volts/50Hz	N/A
380	380Volts/50Hz 380Volts/60Hz	380Volts/50Hz 440Volts/60Hz	380Volts/50Hz 440Volts/60Hz	380Volts/50Hz 440Volts/60Hz	380Volts/50Hz 440Volts/60Hz	380Volts/50Hz 440Volts/60Hz	380-415Volts 50/60Hz
480	480Volts/60Hz 440Volts/50Hz	480Volts/60Hz 440Volts/50Hz	480Volts/60Hz 440Volts/50Hz	480Volts/60Hz 440Volts/50Hz	480Volts/60Hz 440Volts/50Hz	480Volts/60Hz 440Volts/50Hz	440-480Volts 50/60Hz
575	R/F	575Volts/60Hz 500Volts/50Hz	575Volts/60Hz 500Volts/50Hz	575Volts/60Hz 500Volts/50Hz	575Volts/60Hz 500Volts/50Hz	575Volts/60Hz 500Volts/50Hz	N/A
XXX	N/A	Supplied Without Coil	Supplied Without Coil	Supplied Without Coil	Supplied Without Coil	Supplied Without Coil	Supplied Without Coil
D.C. COIL ⇓ CODES ⇓	Voltage ②	Voltage	Voltage	Voltage	Voltage	Voltage	Voltage
24D	24 Volts DC	24 Volts DC	24 Volts DC	24 Volts DC	22-28 Volts DC	22-28 ⑤ Volts DC	AC coils noted above also rated for DC: Code 120: 100-110VDC Code 240: 200-220VDC Code 380: 345-380VDC Code 480: 400-440VDC
48D	48 Volts DC	48 Volts DC	48 Volts DC	48 Volts DC	44-55 Volts DC	44-55 Volts DC	
110D	110 Volts DC	110 Volts DC	110 Volts DC	110 Volts DC	110-140 Volts DC	110-140 Volts DC	
220D	220 Volts DC	220 Volts DC	220 Volts DC	220 Volts DC	220-280 Volts DC	220-280 Volts DC	

Further modify catalog number by adding a "C" after contactor size designation. Example:
CA3-16-10-✱-N0 *becomes*
CA3-16**C**-10-**24D**-N0
Do this for ***all*** contactor/starter configurations that use these contactors. Price includes special two lead coil and DC magnet frame (AC and DC coils are not interchangeable). ②

Coils have high current "pick-up" winding and a low current "seal-in" winding wired in parallel. The "pick-up winding is taken out of the circuit after the armature pulls in. Price includes three lead coil and a N.C. late break auxiliary contact.

Coil control circuit is designed so that after the armature pulls in, a resistor is connected in series with the coil. Price includes two lead coil, resistor, resistor support and a N.C. late break auxiliary contact. ③

Please note that the price adders are for each DC coil required for any particular application. For example, a reversing contactor requires two DC coils (Price Adder x 2).

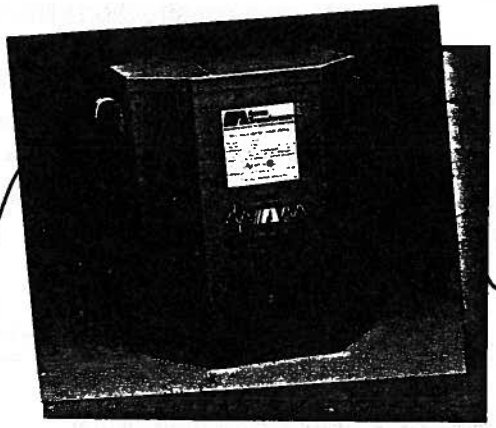
① Wide range coil.
② CA4 contactor/starter configurations requiring mechanical interlock (reversing, etc) not available in DC voltages.
③ Coil available without resistor, resistor support and N.C. late break auxiliary contact (special applications). Contact factory for price deduct.
④ Other coil voltages available. Refer to Replacements Parts section of this catalog, or contact nearest Sprecher+Schuh sales office.
⑤ Not available for CA1-480.
⑥ For CA5-1000 & CA5-1200 Coil Codes and voltage ranges, please refer to Replacement Parts section of this catalog.

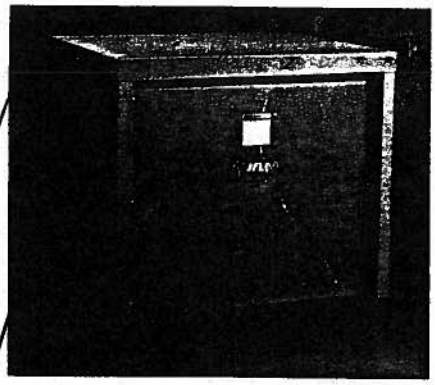
REFERENCE: ELECTRICAL PART NO.(S) 13, 14
ELECTRICAL SCHEMATIC NO. 347-9001-01

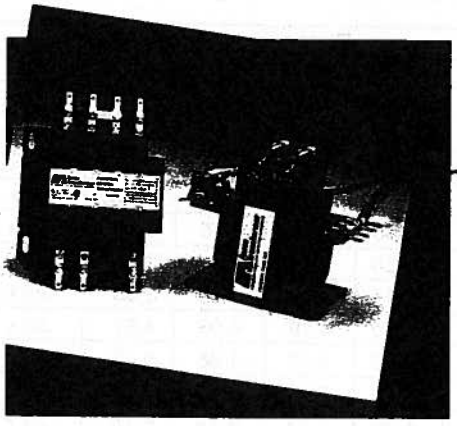
$3.00

Acme Transformer

General Catalog







Power and Performance

1. Constructed with high quality silicon steel lamination to minimize core losses and increase efficiency.
2. Designs incorporate precision wound coils for improved regulation.
3. Primary fuse blocks and secondary fuse kits available and easily adaptable.
4. Series-parallel connecting links save wiring and labor costs.
5. Sturdy glastic terminal panel protects the coil from foreign objects and mechanical damage.
6. Copper windings on all groups.
7. 130°C Insulation class.
8. Wire retention on both primary and secondary terminals.
9. Welded construction eliminates core bolt shorts and provides rugged one piece construction.
10. Mounting plate adapts to various mounting dimensions.
11. Voltage regulation exceeds NEMA requirements.
12. UL Listed CSA Certified.
13. Attractive finish, nameplate, and design features enhance the end product.



New!

50 to 2000 VA
(Jumper Link Connections Available on 50-150 VA Units)

Specifications and Dimensions

All Transformers Listed are Carried in Stock

UL Listed and CSA® Certified

GROUP A

Primary Volts — 120 x 240			Secondary Volts — 24						50/60 Hz	Primary Fuse Block	Secondary Fuse Kit	Secondary Fuse Size
Catalog No.	VA Rating	Output Amps	Dimensions (Inches) A	B	C	D	E	F	Weight (Lbs.)	Part No.	Part No.	24 Volts
TA-2-81141	50	2.08	4.35	3.00	2.59	2.50	2.13	.22 x .50	4	PL-112700	PL-112602	3⁹⁄₁₀ amps
TA-2-81142	75	3.13	4.84	3.00	2.59	2.50	2.61	.22 x .50	4	PL-112700	PL-112602	5 amps
TA-2-81143	100	4.17	5.00	3.00	2.59	2.50	2.81	.22 x .50	4	PL-112700	PL-112602	6¼ amps
TA-2-81144	150	6.25	4.90	3.75	3.21	3.125	2.625	.22 x .50	6	PL-112701	PL-112602	10 amps
TA-2-81146	250	10.42	5.08	4.50	3.84	3.75	3.05	.22 x .50	9	PL-112702	PL-112601	15 amps
TA-2-81148	350	14.58	6.12	4.50	3.84	3.75	4.06	.22 x .50	13	PL-112702	PL-112601	20 amps
TA-2-81149	500	20.83	5.90	5.25	4.47	4.38	4.19	.31 x .50	16	PL-112704	PL-112601	30 amps
TA-2-81150	750	31.25	7.49	5.25	4.47	4.38	5.25	.31 x .50	24	PL-112704	—	—
TA-2-81151	1000	41.67	6.66	6.75	5.72	5.75	3.81	.31 x .50	26	PL-112705	—	—

GROUP B

Primary Volts — 240 x 480, 230 x 460, 220 x 440 Secondary Volts — 120, 115, 110 50/60 Hz										Primary Fuse Block	Secondary Fuse Kit	Secondary Fuse Size
Catalog No.	VA Rating	Output Amps	Dimensions (Inches) A	B	C	D	E	F	Weight (Lbs.)	Part No.	Part No.	120 Volts
TA-2-81210	50	0.42	4.35	3.00	2.59	2.50	2.13	.22 x .50	4	PL-112700	PL-112602	⁵⁄₁₀ amp
TA-2-81201	75	0.63	4.84	3.00	2.59	2.50	2.61	.22 x .50	4	PL-112700	PL-112602	1 amp
TA-2-81211	100	0.83	5.00	3.00	2.59	2.50	2.81	.22 x .50	4	PL-112700	PL-112602	1¼ amps
TA-2-81212	150	1.25	5.09	3.75	3.21	3.125	2.810	.22 x .50	6	PL-112701	PL-112602	2 amps
TA-2-81213	250	2.08	5.57	4.50	3.84	3.75	3.05	.22 x .50	9	PL-112702	PL-112601	3⁹⁄₁₀ amps
TA-2-81200	300	2.50	5.57	4.50	3.84	3.75	3.13	.22 x .50	10	PL-112702	PL-112601	4 amps
TA-2-81214	350	2.92	6.32	4.50	3.84	3.75	3.83	.22 x .50	12	PL-112702	PL-112601	4½ amps
TA-2-81215	500	4.17	6.30	4.88	4.15	4.06	3.81	.22 x .50	15	PL-112703	PL-112601	6¼ amps
TA-2-81216	750	6.25	6.59	5.25	4.47	4.38	5.13	.31 x .50	23	PL-112704	PL-112601	10 amps
TA-2-81217	1000	8.33	6.83	6.75	5.72	5.75	3.69	.31 x .50	25	PL-112705	PL-112601	12 amps
TA-2-81218	1500	12.50	7.99	6.75	5.72	5.75	5.75	.31 x .50	43	PL-112705	PL-112601	15 amps
TA-2-81219	2000	16.67	8.44	6.75	5.72	5.75	6.38	.31 x .50	49	PL-112705	PL-112601	20 amps
TA-2-81220	3000	25.00	8.85	7.50	8.25	6.50	7.52	.406 x .813	70	PL-112706	—	—
TA-2-81221	5000	41.67	9.24	11.92	9.34	6.75	6.25	.406 x .813	125	PL-112707	—	—

GROUP C

UL Listed and CSA® Certified

Primary Volts — 240/480/600, 230/460/575, 220/440/550 Secondary Volts — 120/100, 115/95, 110/90 50/60 Hz										Primary Fuse Block	Secondary Fuse Kit	Secondary Fuse Size
Catalog No.	VA Rating	Output Amps	Dimensions (Inches) A	B	C	D	E	F	Weight (Lbs.)	Part No.	Part No.	120 Volts
TA-2-81000	50	0.42	4.68	3.00	2.59	2.50	2.61	.22 x .50	4	PL-112700	PL-112600	9/10 amp
TA-2-81009	75	0.63	5.00	3.00	2.59	2.50	2.81	.22 x .50	4	PL-112700	PL-112600	1 amp
TA-2-81001	100	0.83	5.46	3.00	2.59	2.50	3.26	.22 x .50	5	PL-112700	PL-112600	1¼ amps
TA-2-81002	150	1.25	5.09	3.75	3.21	3.125	3.06	.22 x .50	7	PL-112701	PL-112600	2 amps
TA-2-81003	250	2.08	5.57	4.50	3.84	3.75	3.50	.22 x .50	11	PL-112702	PL-112601	3 3/10 amps
TA-2-81020	300	2.50	6.48	4.88	4.15	4.06	4.06	.22 x .50	15	PL-112703	PL-112601	4 amps
TA-2-81004	350	2.92	6.48	4.88	4.15	4.06	4.06	.22 x .50	15	PL-112703	PL-112601	4½ amps
TA-2-81005	500	4.17	6.37	5.25	4.47	4.38	4.56	.31 x .50	21	PL-112704	PL-112601	6¼ amps
TA-2-81006	750	6.25	6.38	6.75	5.72	5.75	3.81	.31 x .50	25	PL-112705	PL-112601	10 amps
TA-2-81007	1000	8.33	7.15	6.75	5.72	5.75	4.63	.31 x .50	32	PL-112705	PL-112601	12 amps
TA-2-81008	1500	12.50	8.65	6.75	5.72	5.75	6.38	.31 x .50	47	PL-112705	PL-112601	15 amps
TA-2-53929	2000	16.67	7.90	7.50	7.75	6.50	6.57	.406 x .813	55	PL-112706	PL-112601	20 amps
TA-2-53930	3000	25.00	8.74	11.92	8.68	6.75	5.75	.406 x .813	75	PL-112707	—	—
TA-2-53931	5000	41.67	9.24	11.92	9.34	6.75	6.25	.406 x .813	110	PL-112707	—	—

GROUP D

Primary Volts — 208/240/277/380/480 Secondary Volts — 24 50/60 Hz										Primary Fuse Block	Secondary Fuse Kit	Secondary Fuse Size
Catalog No.	VA Rating	Output Amps	Dimensions (Inches) A	B	C	D	E	F	Weight (Lbs.)	Part No.	Part No.	24 Volts
TA-2-81321	50	2.08	4.19	3.75	3.21	3.125	2.19	.22 x .50	4	PL-112701	PL-112602	3 3/10 amps
TA-2-81322	75	3.13	4.42	3.75	3.21	3.125	2.31	.22 x .50	5	PL-112701	PL-112602	5 amps
TA-2-81323	100	4.17	4.64	3.75	3.21	3.125	2.62	.22 x .50	5	PL-112701	PL-112602	6¼ amps
TA-2-81324	150	6.25	4.75	4.50	3.84	3.75	3.05	.22 x .50	9	PL-112702	PL-112602	10 amps
TA-2-81325	250	10.42	5.24	4.88	4.15	4.06	3.25	.22 x .50	11	PL-112703	PL-112601	15 amps
TA-2-81326	350	14.58	5.99	5.25	4.47	4.38	4.00	.31 x .50	18	PL-112704	PL-112601	20 amps
TA-2-81327	500	20.83	6.44	5.25	4.47	4.38	4.19	.31 x .50	19	PL-112704	PL-112601	30 amps
TA-2-81328	750	31.25	6.23	6.75	5.72	5.75	3.81	.31 x .50	26	PL-112705	—	—
TA-2-81329	1000	41.67	6.62	6.75	5.72	5.75	4.63	.31 x .50	33	PL-112705	—	—

GROUP E

Primary Volts — 208/277/380 Secondary Volts — 115/95 50/60 Hz										Primary Fuse Block	Secondary Fuse Kit	Secondary Fuse Size
Catalog No.	VA Rating	Output Amps	Dimensions (Inches) A	B	C	D	E	F	Weight (Lbs.)	Part No.	Part No.	115 Volts
TA-2-81301	50	0.43	4.46	3.00	2.59	2.50	2.61	.22 x .50	4	PL-112700	PL-112600	9/10 amp
TA-2-81302	75	0.65	4.84	3.00	2.59	2.50	2.81	.22 x .50	4	PL-112700	PL-112600	1 amp
TA-2-81303	100	0.87	4.57	3.75	3.21	3.125	2.44	.22 x .50	5	PL-112701	PL-112600	1¼ amps
TA-2-81304	150	1.30	5.09	3.75	3.21	3.125	3.06	.22 x .50	5	PL-112701	PL-112600	2 amps
TA-2-81305	250	2.17	5.68	4.50	3.84	3.75	4.06	.22 x .50	13	PL-112702	PL-112601	3½ amps
TA-2-81306	350	3.04	6.30	4.88	4.15	4.06	4.75	.22 x .50	18	PL-112703	PL-112601	5 amps
TA-2-81307	500	4.35	6.16	5.25	4.47	4.38	4.56	.31 x .50	20	PL-112704	PL-112601	7 amps
TA-2-81308	750	6.52	6.01	6.75	5.72	5.75	3.69	.31 x .50	24	PL-112705	PL-112601	10 amps
TA-2-81309	1000	8.70	7.15	6.75	5.72	5.75	4.44	.31 x .50	31	PL-112705	PL-112601	12 amps

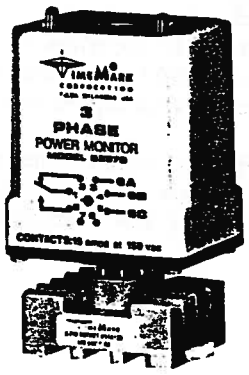
GROUP F

Primary Volts — 380/440/550/600 Secondary Volts — 115/230 50/60 Hz										Primary Fuse Block	Secondary Fuse Kit	Secondary Fuse Size*
Catalog No.	VA Rating	Output Amps	Dimensions (Inches) A	B	C	D	E	F	Weight	Part No.	Part No.	115 V
TA-2-54535	50	0.43	4.24	3.75	3.21	3.125	2.19	.22 x .50	4	PL-112701	PL-112600	9/10 amp
TA-2-54536	100	0.87	4.68	3.75	3.21	3.125	2.31	.22 x .50	5	PL-112701	PL-112600	1¼ amps
TA-2-54537	150	1.30	5.11	3.75	3.21	3.125	3.06	.22 x .50	10	PL-112701	PL-112600	2 amps
TA-2-54538	250	2.17	5.49	4.50	3.84	3.75	3.50	.22 x .50	11	PL-112702	PL-112601	3½ amps
TA-2-81197	350	3.04	6.03	4.88	4.15	4.06	4.38	.22 x .50	17	PL-112703	PL-112601	5 amps
TA-2-54539	500	4.35	6.76	4.88	4.15	4.06	5.75	.22 x .50	23	PL-112703	PL-112601	7 amps
TA-2-81240	750	6.52	6.38	6.75	5.72	5.75	3.69	.31 x .50	25	PL-112705	PL-112601	10 amps
TA-2-81241	1000	8.70	6.96	6.75	5.72	5.75	4.44	.31 x .50	30	PL-112705	PL-112601	12 amps

*Secondary fuse kit application for 115V only.

REFERENCE: ELECTRICAL PART NO.(S) 15
ELECTRICAL SCHEMATIC NO. 347-9001-01

Model 257
3-Phase Power Monitor



- Detects phase loss, low voltage and phase reversal
- Automatic Reset
- Socket Mounted

The Time Mark Model 257 3-Phase Power Monitor is designed to continuously monitor 3-phase power lines for abnormal conditions. The device consists of a solid-state voltage and phase-angle sensing circuit driving a SPDT electromechanical output relay. When correct voltage and phase sequence are applied, the internal relay will energize. Fault conditions will cause the relay to drop out, even if regenerated voltage is present. The Model 257 does not require a neutral connection, and can be used in either Wye or Delta configurations.

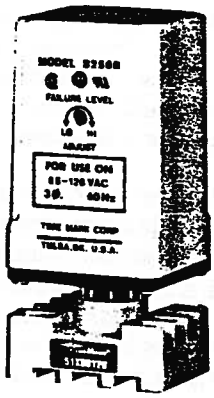
All voltage versions are UL Recognized (380V-50Hz, and 480V-60Hz, versions require Time Mark socket part number 51X120 to meet UL requirements). In addition, the 120V and 208/240V versions are CSA certified. Adjustment and indicator lights are on top of the case for easy access and viewing after installation.

Specifications

Model #	B257B	257B	A257B	EX257B
Nominal Supply Voltage	120vac	208/240vac	480vac	380vac-50Hz
Supply Voltage Range	85-120vac	160-250vac	380-480vac	300-380vac
Power Consumption	.25W/ph.	.50W/ph.	1.25W/ph.	1.25W/ph.
Case Color	Gray	Red	Yellow	Yellow
Output	SPDT			
Contact Ratings	(See chart pg 15)			
Terminal Configuration	(see pg 15, figure A)			
Dimensions	(see pg 16, figure A)			
Weight	6 oz.			

See page 15 for additional specifications
For use on 600 vac, plug into Smart Socket (see page 14)

Model 258
3-Phase Power Monitor



- Detects phase loss, low voltage and phase reversal
- Automatic or optional manual reset
- 60 Hz and 50 Hz Models

The Time Mark Model 258 is designed to continuously monitor 3-phase power lines for abnormal conditions. When properly adjusted, the Model 258 will detect phase loss on a loaded motor even when regenerated voltage is present. The Model 258 consists of a solid-state voltage and phase-angle sensing circuit driving an electromechanical relay. When correct voltage and phase rotation are applied, the internal relay will energize. A fault condition will de-energize the relay; when the fault is corrected the Model 258 will automatically reset (a manual reset version is available).

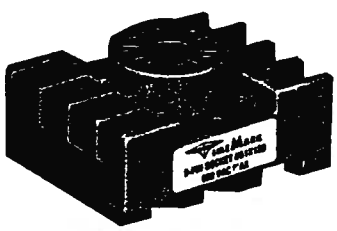
The Model 258 does not require a neutral connection and can be used with Wye or Delta Systems. All voltage versions are UL Recognized (380V-50Hz and 480V-60Hz versions require Time Mark Socket part number 51X120 to meet UL requirements). In addition, the 120V and 208/240V models are CSA Certified.

Specifications

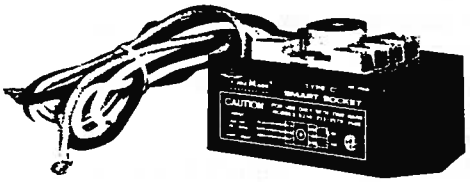
Model #	B258B	258B	A258B	EX258B
Nominal Supply Voltage	120vac	208/240vac	480vac	380vac-50Hz
Supply Voltage Range	85-120vac	160-250vac	380-480vac	300-380vac
Power Consumption	.25W/ph.	.50W/ph.	1.5W/ph.	1.25W/ph.
Case Color	Gray	Red	Yellow	Yellow
Output	SPDT			
Contact Ratings	(see chart pg 15)			
Terminal Configuration	(see pg 15, figure A)			
Dimensions	(see pg 16, figure B)			
Weight	5 oz.			

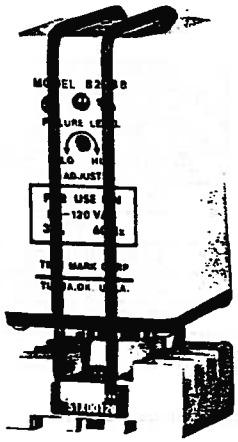
See page 15 for additional specifications
For use on 600 vac, plug into Smart Socket (see page 14)

Time Mark 8-Pin Sockets are surface or DIN rail mounted sockets which feature an electrical rating of 10 amps at 600 vac. The sockets are suitable for use with Time Mark 480 vac relays (Models 257, 258 and 260). The thermoplastic body can withstand up to 300°F continuously without melting or electrical breakdown. Terminals are #6-32 screws with captive wire clamps. UL Recognized and CSA Certified.



Time Mark's exclusive Smart Socket is designed to lower 480 or 600 vac input voltages to 240 vac, allowing the Models 246, 253, 257 and 258 to be used on higher voltages. The Smart Socket is CSA Certified. Patent Pending.





Hold Down Clamps

Hold Down Clamps are designed to secure the mounted relay against vibration. The clamp consists of two stainless steel brackets joined with a rubber O-ring. The clamp is designed to fit all Time Mark socket-mounted relays. The O-ring secures the relay in the socket and, on knob adjustable timers, helps secure the knob position. The clamp is attached to the socket with existing mounting hardware.

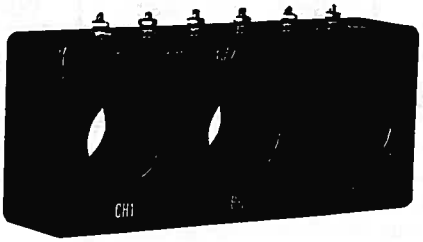
-Phase Current Transformers

The Time Mark Model 276A Current Transformer is a low cost open-frame type transformer. It is designed for use with up to 8-gauge wire. Ranges up to 40 amps on the primary are available. The Model 276A has a frequency range of 25-400 Hz. 2500 VRMS insulation is standard.

The Model 276B Current Transformer is a ring-type transformer for primary currents from 50 to 1200 amps. The transformers have an accuracy rating (60 Hz) of ±2% for 50 to 100 amps CT's and ±1% for CT's over 100 amps. The CT's can be used on 25-400 Hz applications. Secondary connections are #8-32 terminals. Mounting brackets are provided. Polarity markings are stamped on the transformer. The 276B is UL Recognized (file no. E93779).

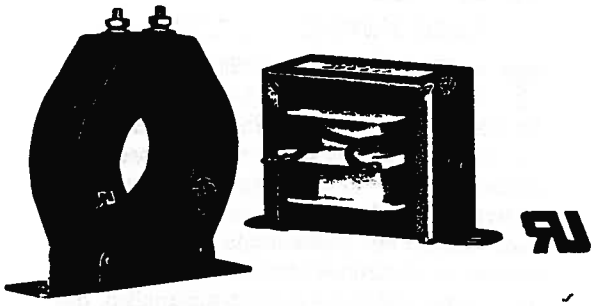
-Phase Current Transformer

The Model 276B3 is a ring-type, 3-phase current transformer for currents from 50 to 1200 amps. Secondary terminals are #8-32 brass studs with one flat washer. Polarity markings are stamped on the transformer. Holes at the corners of the transformer case are for attaching a mounting plate (not supplied).



Selection Chart for 276A and 276B

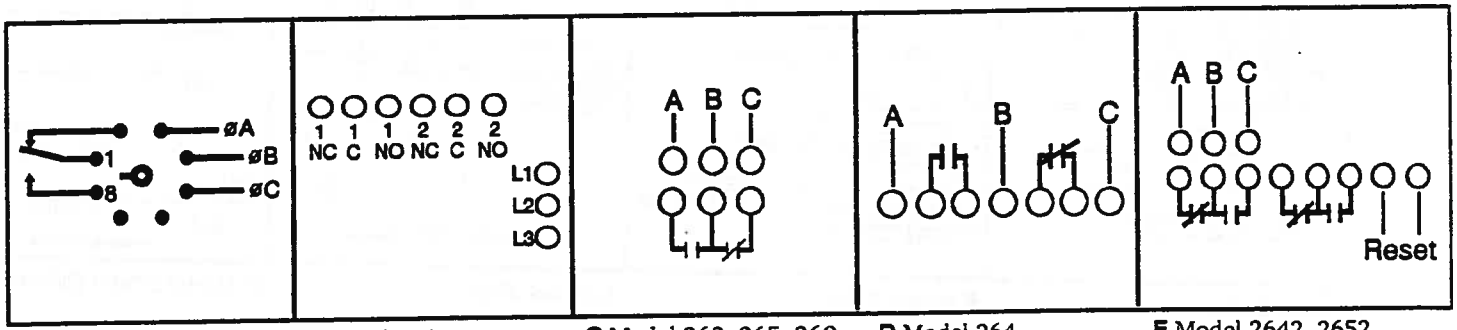
Ratio	Part No.	Ratio	Part No.	Burden	Ratio	Part No.	Burden
10:5	276A-10	50:5	276B-50	1.0	300:5	276B-300	12.5
15:5	276A-15	60:5	276B-60	1.0	400:5	276B-400	12.5
20:5	276A-20	75:5	276B-75	1.5	500:5	276B-500	25.0
25:5	276A-25	80:5	276B-80	1.5	600:5	276B-600	15.0
30:5	276A-30	100:5	276B-100	2.0	750:5	276B-750	7.0
35:5	276A-35	150:5	276B-150	5.0	800:5	276B-800	8.0
40:5	276A-40	200:5	276B-200	5.0	1000:5	276B-1000	10.0
		250:5	276B-250	12.5	1200:5	276B-1200	12.5



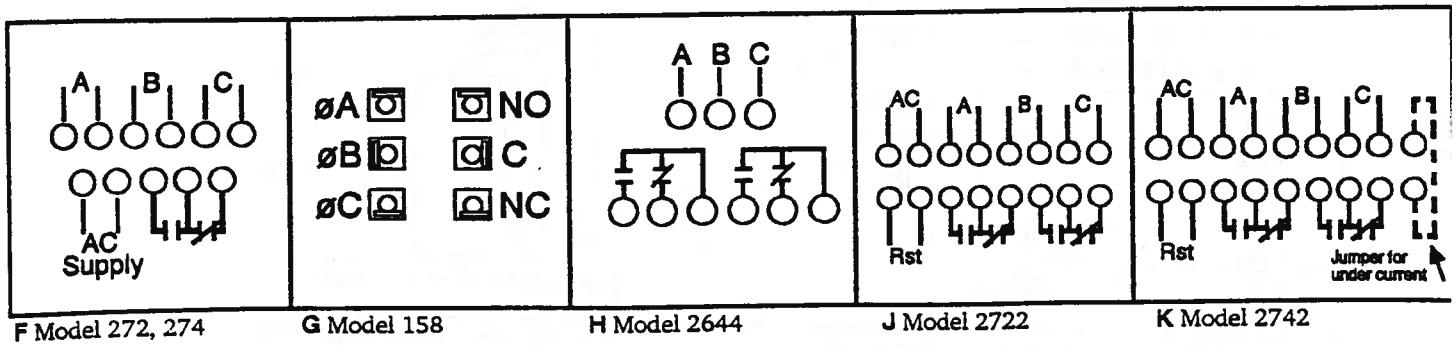
Selection Chart for 276B3

Current Ratio	Part No.	Max. VA for 1% accuracy	Sec. winding resist. at 75°C
50:5	276B3-50	2.5	.0153
100:5	276B3-100	2.5	.0306
150:5	276B3-150	7.5	.0459
200:5	276B3-200	10	.0612
250:5	276B3-250	12	.0765
300:5	276B3-300	20	.0919
400:5	276B3-400	25	.1220
500:5	276B3-500	40	.1530
600:5	276B3-600	10	.0771
750:5	276B3-750	15	.0964
800:5	276B3-800	15	.1030
1000:5	276B3-1000	20	.1290
1200:5	276B3-1200	25	.1540

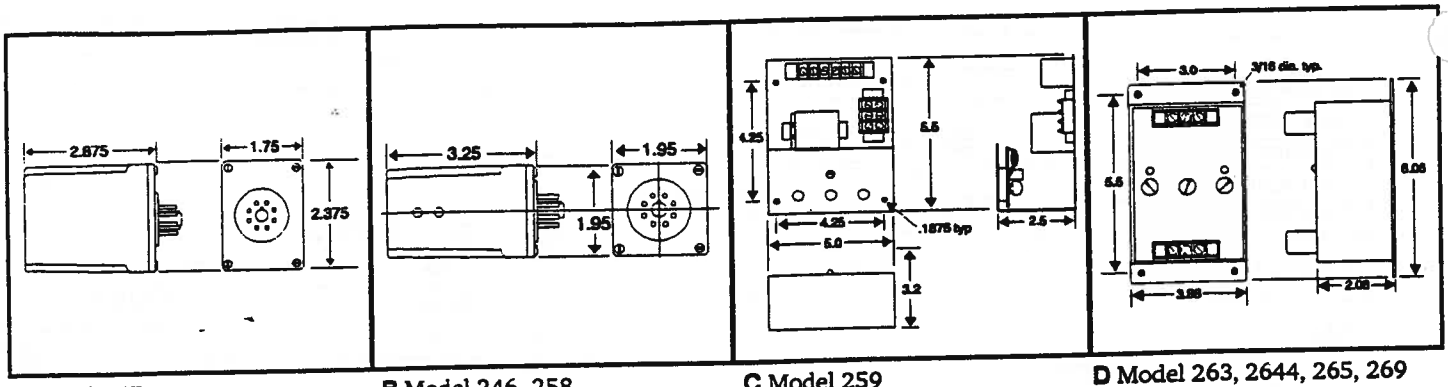
		Exceptions
Repeat Accuracy	±0.1% of set point	
Dead Band	2%	
Transient Protection	2500 VRMS for 10 msec.	
Operating Temperature	-40° to +55° C	
Humidity Tolerance	0-97% without condensation	
Response Time	0.05 seconds	**158:** 0.5 sec; **259:** 1-5 sec; **264/2644:** .2-20 sec; **269:** 1-10 sec ±5%; **2642/2652:** 2-20 sec ±5%
Reset	Automatic	**258/263:** Optional manual reset; **2642/2652:** Selectable auto/manual reset
Reset Time	0.05 sec	**158:** 0.5 sec; **158R:** 300 sec; **259:** .2-10 min; **265:** .2-5 min ±10%
Contact Rating	Resistive: 15A at 150vac, 10A at 240vac, 15A at 28vdc Inductive: 4A at 120vac, 2A at 240vac Pilot Duty: 480 VA at 240vac Tungsten lamp operation: 600W on N.O. contact, 240W on N.C. contact	**259:** 3A at 480/600vac, 80% pf; 10A at 28vdc/120vac/240vac, 80%pf; 1/2 hp at 240/480/600vac; 1/3 hp at 120vac



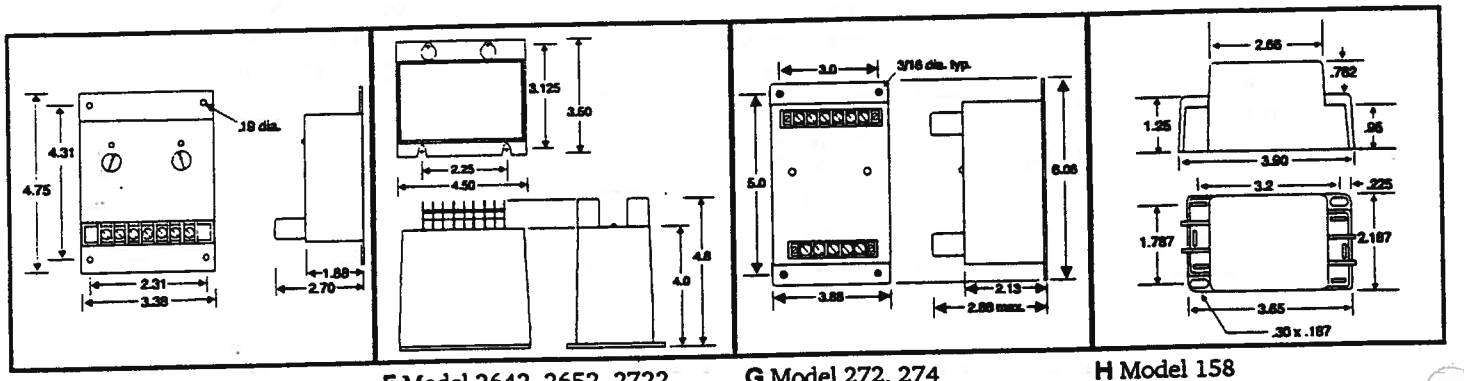
A Model 246, 253, 257, 258 **B** Model 259 **C** Model 263, 265, 269, 2532 **D** Model 264 **E** Model 2642, 2652



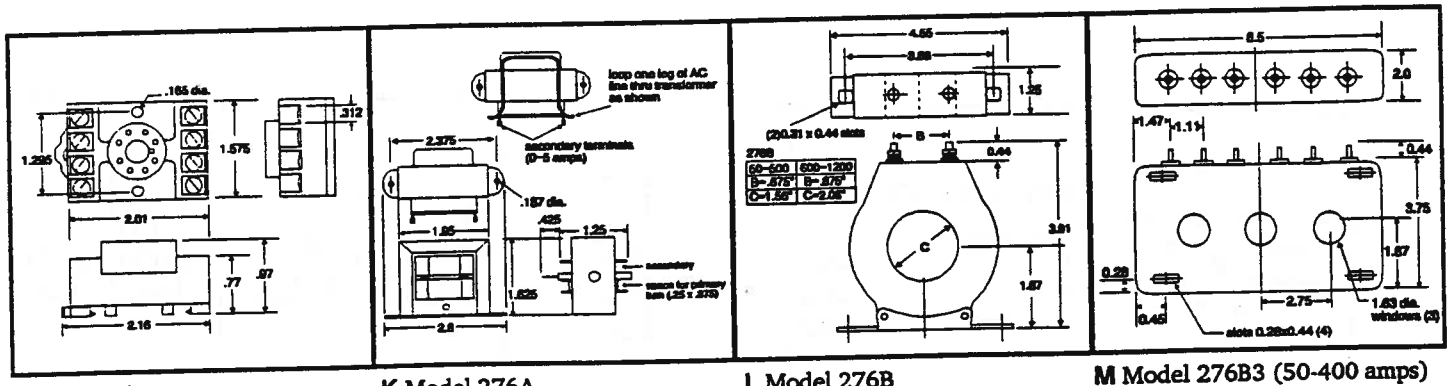
F Model 272, 274 **G** Model 158 **H** Model 2644 **J** Model 2722 **K** Model 2742



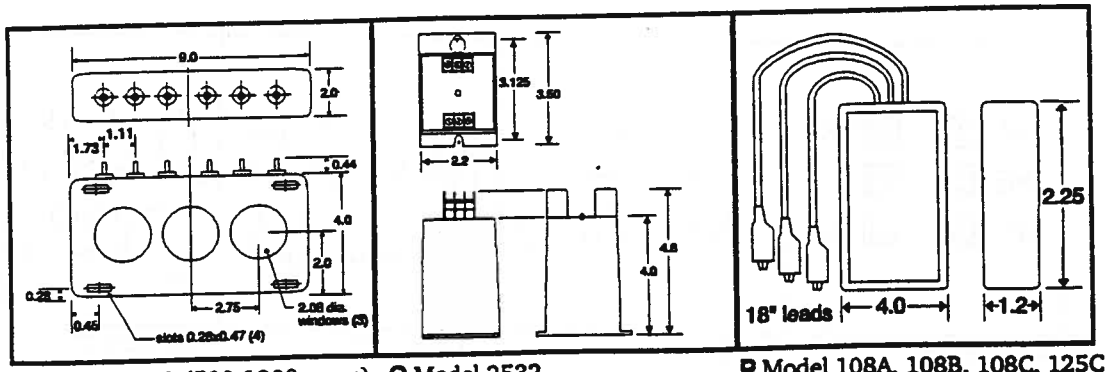
A Model 257 B Model 246, 258 C Model 259 D Model 263, 2644, 265, 269



E Model 264 F Model 2642, 2652, 2722, 2742 G Model 272, 274 H Model 158



J 8-Pin Socket K Model 276A L Model 276B M Model 276B3 (50-400 amps)



N Model 276B3 (500-1200 amps) O Model 2532 P Model 108A, 108B, 108C, 125C

REFERENCE: ELECTRICAL PART NO.(S) 23, 24, 26, 27
ELECTRICAL SCHEMATIC NO. 347-9001-01

5 YEAR WARRANTY

	s_n mm	output	type designation/order no.
DC PNP	8 nf		IW-3008-BPOG IB044ALOBNL3DAXX IW-3008-APOG IB044ALOBNL3DBXX
DC NPN	8 nf		IW-3008-ANOG IB044ALOBNL3NAXX
AC/DC			
AC			

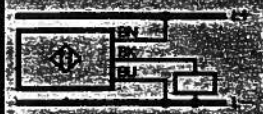
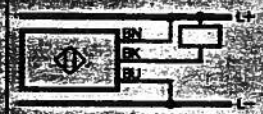
type IW

plastic

sensing range
8 mm nf
cable
6' long × 1/8" OD



60 × 36 × 10 mm
drawing: A10

Technical data at +20°C	DC PNP	DC NPN	AC/DC dual voltage	AC
operating voltage	10–55 V DC incl. residual ripple	10–55 V DC incl. residual ripple		
max. load current continuous	400 mA	400 mA		
inrush	400 mA	400 mA		
voltage drop	typ. <1 V at max. load	typ. <1 V at max. load		
leakage current (2 wire)				
supply current (3 wire)	<7 mA at 24 V	<7 mA at 24 V		
minimum load current	–	–		
max. switching rate	typ. 120 Hz to s_n 8 mm nf			
switching status indication	LED	LED		
housing rating	IP 67 ▣ NEMA 3, 4, 6, 12, 13			
ambient temperature	–25°C to +80°C (–13°F to +176°F)			
nominal sensing range s_n	8 mm, non-flush mountable			
switching hysteresis	3%–15% of the sensing range			
correction factors (approx.)	mild steel 1; stainless steel 0.7; brass 0.4; aluminum 0.4; copper 0.3			
switch point drift/repeatability	<±10% of s_r over entire temperature range and voltage range/<1%			
housing	plastic: polybutyleneterephthalate			
wiring color code black: BK brown: BN blue: BU				

Concerning Safety . . . **efector** makes every effort to build a dependable product, but every product will eventually fail and so your equipment must be designed to prevent property damage and personal injury if our products fail. – Prices F.O.B. Exton, Pa. Prices and specifications subject to change without notice.

type IME

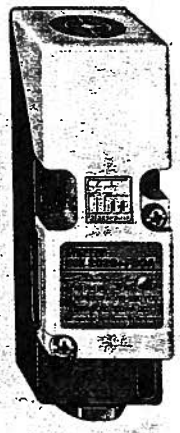
plastic

sensing range
15 mm f; 15 mm nf;
20 mm nf

terminal chamber
screw terminals

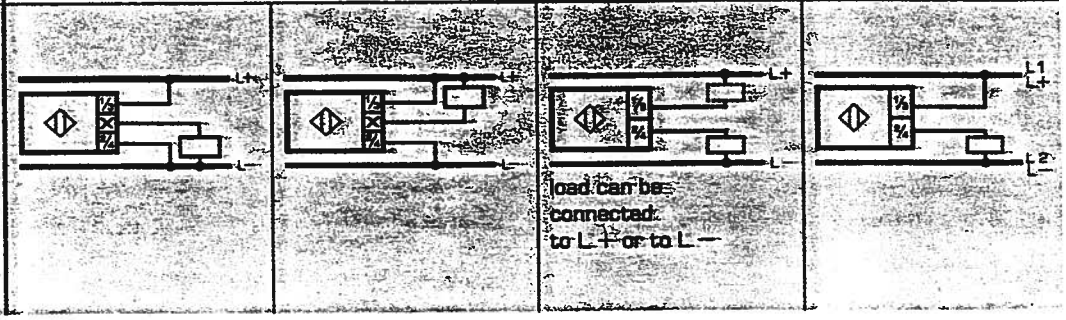
programmable output function by internal jumper

5 positions of the active zone possible



120 × 40 × 40 mm
drawing: A.10

	s_n mm	output	type designation/order no.
DC PNP	15 f	or	IME 3015BFPKG (8015AL15FL3DPXX)
	20 nf	progr.	IME 3020-FPKG (8015AL20NL3DPXX)
DC NPN	15 nf	or	IME 3015 FNOG (8015AL15NL3NPXX)
		prog.	
DC PNP NPN	15 f	or	IME 2015 BFROG (8015AL15FL2DPXX)
	20 nf	prog.	IME 2020-FROG (8015AL20NL2DPXX)
AC DC	15 f	or	IME 2015 BFBOA (8015AL15FL2CPXX)
	20 nf	prog.	IME 2020 FBOA (8015AL20NL2CPXX)

Technical data at +20°C	**DC PNP**	**DC NPN**	**DC PNP/NPN**	**AC/DC dual voltage**
operating voltage	10–55 V DC incl. residual ripple	10–55 V DC incl. residual ripple	8–30 V DC incl. residual ripple	20–250 V AC 45–65 Hz; 15–250 V DC
max. load current continuous:	250 mA short-circuit and overload protection	100 mA	200 mA	350 mA AC to +50°C 250 mA AC to +80°C 100 mA DC
inrush:	250 mA	100 mA	200 mA	t: 2 A/20 ms at f: 0.5 Hz
voltage drop	< 2.5 V at max. load	1 V	typ. < 5.5 V at max. load	< 8.5 V AC; < 6.0 V DC at max. load
leakage current (2 wire)				< 1.3 mA at 120 V AC; < 0.8 mA at 24 V DC
supply current (3 wire)	< 5 mA at 24 V	< 5 mA at 24 V	ca. 1 mA at 24 V	
minimum load current			5 mA	5 mA
max. switching rate	typ. 15 Hz at s_n 15 mm f typ. 10 Hz at s_n 20 mm nf	typ. 15 Hz at s_n 15 mm nf	typ. 18 Hz at s_n 15 mm f typ. 30 Hz at s_n 20 mm nf	20 Hz at AC 20 Hz at DC
switching status indication	LED	LED	LED	LED
housing rating	IP 65 ▣ NEMA 3, 4, 12 (when used with cables from .25" OD thru .5" OD)			
ambient temperature	−25°C to +80°C (−13°F to +176°F)			
nominal sensing range s_n	15 mm, flush mountable; 15 mm, non-flush mountable; 20 mm non-flush mountable			
switching hysteresis	3%–15% of the sensing range			
correction factors (approx.)	mild steel: 1; stainless steel 0.7; brass 0.4; aluminium 0.4; copper 0.3			
switch point drift/repeatability	< ±10% of s_r over entire temperature range and voltage range/< 1%			
housing	plastic: Noryl			
wiring	 load can be connected to L+ or to L−			

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INSTALLATION INSTRUCTIONS

efector, inc.

a subsidiary of ifm electronic

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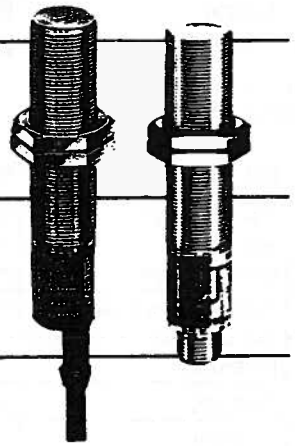
quadronorm Type IGA Inductive Proximity Switch

IGA-2005-FRKG
IGA-2005-FRKG/US-100-IRF

DC PNP NPN or progr

IGA-2008-FRKG
IGA-2008-FRKG/US-100-IRF

DC PNP NPN or progr.



Caution: This *quadronorm* is programmable open or closed by wiring. Check that the wiring is correct before applying power so no logic output error can occur.

Description

An 18 mm x 1 threaded tubular inductive proximity switch that senses all types of metals. Provides a solid state switched output.

quadronorm construction means a 2-wire DC switch programmable N.O. or N.C. by wiring.

These units are normally supplied with a 2 meter (6 foot) long cable and color coded wires.

Units supplied as a plug connector/quick disconnect type are wired in accordance with the supplemental information provided.

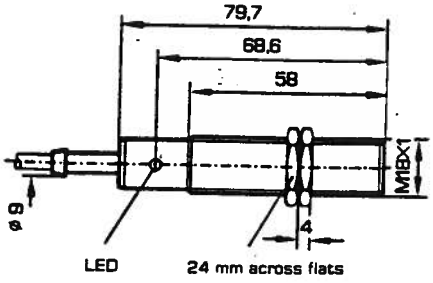
Technical Data at +20°C

	quadronorm **DC PNP/NPN**
operating voltage	10–55 V DC incl. residual ripple
max. current load continuous:	400 mA short-circuit and overload protection
inrush:	400 mA
voltage drop	≤4.6 V
leakage current	≤0.6 mA
minimum load current	4 mA
switching frequency	700 Hz flush mountable; 300 Hz non-flush mountable.
switching status indication	LED
housing rating	IP 67 NEMA 3, 4, 6, 12, 13
ambient temperature	–25°C to +80°C (–13°F to +176°F)
nominal sensing range s_n	**5 mm, flush mountable; 8 mm, non-flush mountable.**
switching hysteresis	3%–15% of the sensing range
correction factors	mild steel: 1; stainless steel 0.7; brass 0.4; aluminum 0.4; copper 0.2
switch point drift/ repeatability	< ±10% of s_r over entire temperature range and voltage range/<1%
housing	metal: nickel-plated brass; stainless steel

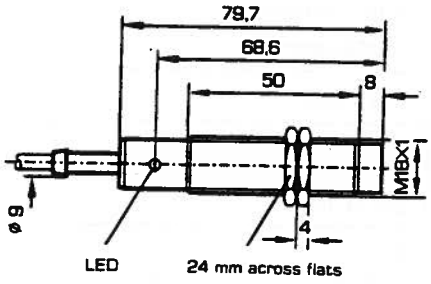
Dimensions

Cabled Units

Flush-mountable



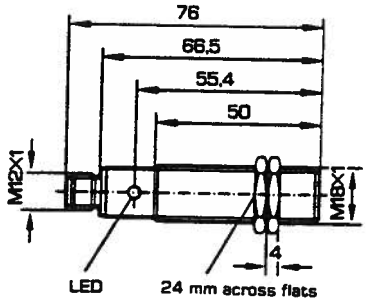
Nonflush-mountable



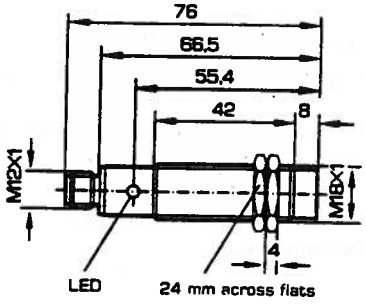
Plug-in (US-100) Connector Units

Units supplied as a plug-connector/quick disconnect type are wired in accordance with the supplemental information provided with the connector.

Flush-mountable



Nonflush-mountable



Design/Mounting Instructions

MECHANICAL

Mounting

This 18 mm unit is easy to mount with the two jam nuts provided. Do not overtighten. The nickel-plated brass unit can be torqued to about 260 inch-pounds, and the stainless steel unit can be torqued to about 400 inch-pounds. For heavy vibration resistance, use a thread locker such as Loctite 242. Flush mountable models (5 mm range) are not sensitive to the sides of its tubular construction. Non-flush mount models (extended range, 8 mm) are side sensitive; see Installation below.

ELECTRICAL



DO NOT use a lamp load to test a DC switch without consulting factory. Cold filament inrush can be 10 times the steady state current demand.

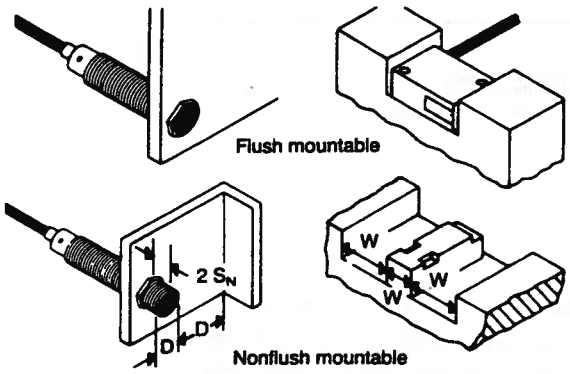
2 wire DC *quadronorm* unit

Use color coded cable to wire the unit because the unit is programmable N.O. or N.C. by how it is wired. See the wiring diagrams. *quadronorm* units are short circuit and overload protected within the voltage range of the switch.

(continued)

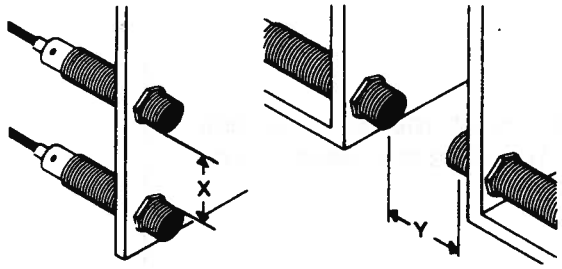
Installation

Flush-mountable models can be mounted so they are completely surrounded by metal, except for the sensing face. Nonflush-mountable models must have an open zone around them.



S_N = Nominal detection range

Inductive units can interfere with each other if they are mounted too close. The X distance must be greater than twice the diameter for nonshielded units and one times the diameter for shielded units. Y must be greater than eight times the nominal detection range.

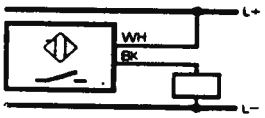


Wiring

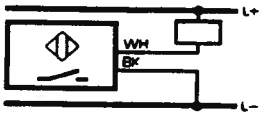
Cabled Units

color code
black: BK
white: WH

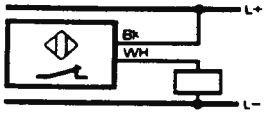
PNP switching
normally open



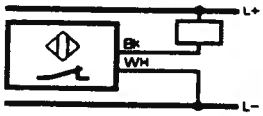
NPN switching
normally open



PNP switching
normally closed



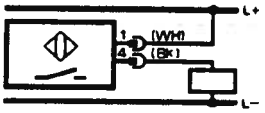
NPN switching
normally closed



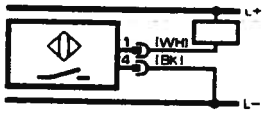
Plug-In (US 100) Connector Units

Units supplied as a plug connector/quick disconnect types are wired in accordance with the supplemental information provided.

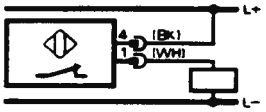
PNP switching
normally open



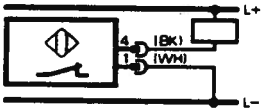
NPN switching
normally open



PNP switching
normally closed



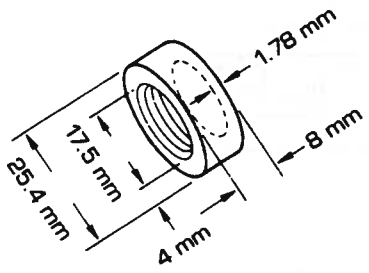
NPN switching
normally closed



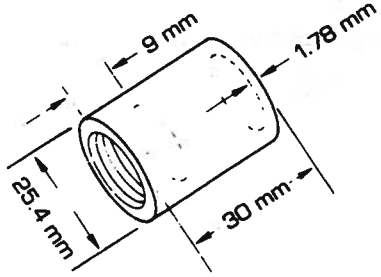
Concerning Safety . . . **efector** makes every effort to build a dependable product, but every product will eventually fail and so your equipment must be designed to prevent property damage and personal injury if our products fail.

Accessories—optional

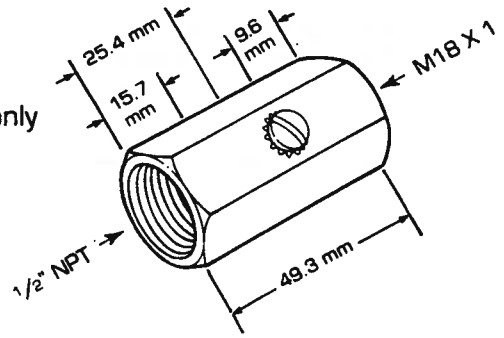
Teflon top
IG-STFL-TOP



Teflon cap
IG-STFL-CAP



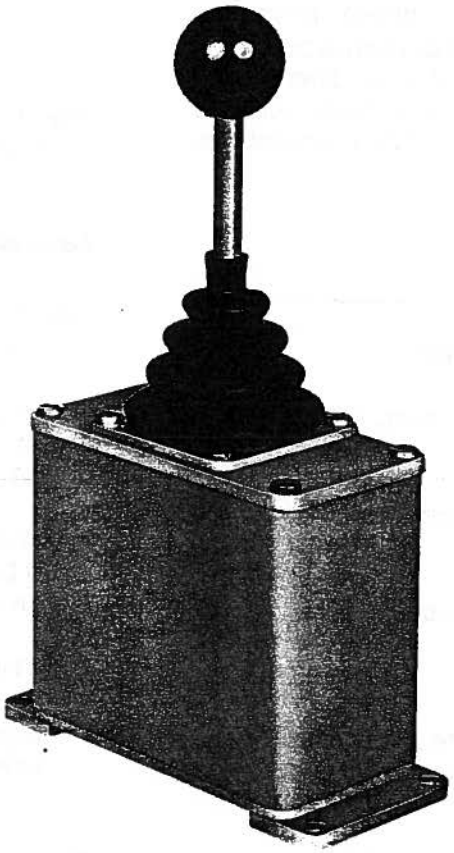
Conduit adapters
for cabled units only
IG NPT METAL



REFERENCE: ELECTRICAL PART NO.(S) 30, 43
ELECTRICAL SCHEMATIC NO. 347-9001-01

SUNDSTRAND SAUER

MCHXXX



Control Handle

Application

The MCHXXX Control Handle is intended for use in open loop systems or as a setpoint for analog or microprocessor closed loop systems for controlling position, speed, pressure, horsepower or other dynamic parameters.

The Control Handle is designed to provide remote electrical actuation of the MCV101 Pressure Control Pilot Valve or other pilots for pressure and flow control servovalves as well as directly controlling main spool valves. It may also be used to power the V7058 Hydrotransmission Valve for Sundstrand-Sauer pumps/motors, or other electrically-actuated pump strokers such as the MCV104 Electrical Displacement Control.

Features

- Shock and vibration resistant
- Choice of three mounting styles, with or without watertight case
- Rugged components designed for the construction environment
- High-torque handle actuation gives sure feel
- Simple to install
- Mechanical options include center-lock, spring-return, friction drag uni/bi-directionality and Packard connector
- Electrical characteristics customized to the application

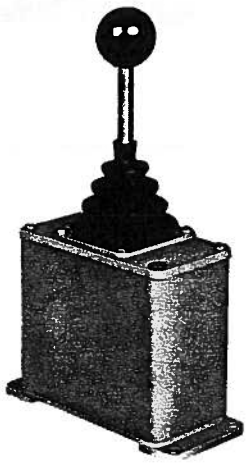
Specifications

Electrical

OPERATING VOLTAGE
11 - 15 Vdc (12 volt models)
22 - 30 Vdc (24 volt models)

POWER
See Ordering Information

LOAD RESISTANCE
Customer specified. See Ordering Information.



SWITCH CURRENT CAPABILITY
3 amps inductive at 28 Vdc.

Mechanical

HANDLE STROKE
± 30° (± .52 radians)

SPRING TORQUE
11 ± 4 in-lbs. (1.2 ± .4 N-m) at center breakaway
18 ± 6 in-lbs. (2.0 ± .7 N-m) at full stroke

DETENT TORQUE (OVER AND ABOVE FRICTION DRAG)
10 in - lbs. (1.1 N-m)

FRICTION DRAG
13.5 ± 3 in-lbs. (1.5 ± .3 N-m). Friction is adjusted at the brake with a 5/32 English Allen wrench and 3/8 open end wrench.

Environmental

TEMPERATURE
- 40° to 170° F (- 40° to 77° C) operating
- 30° to 150° F (- 34° to 66° C) storage

HUMIDITY
After being placed in a controlled atmosphere of 95% humidity at 38° C (100° F) for 10 days, the Control Handle will perform within specification limits.

RAIN
After being showered from all directions by a high pressure hose down, the Control Handle will perform within specification limits (applied to cased models only). This test fulfills NEMA 4 specifications.

VIBRATION

Withstands a vibration test designed for mobile equipment controls consisting of two parts:

1. Cycling from 5 to 2000 Hz in each of the 3 axes.
2. Resonance dwell for one million cycles for each resonance point in each of the 3 axes.

SHOCK

50 g for 11 milliseconds. Three shocks in both directions of the 3 mutually perpendicular axes for a total of 18 shocks.

LIFE

Greater than 1,000,000 cycles excluding potentiometers. Potentiometers with greater than 1,000,000 cycles available for most applications.

DIMENSIONS

See Figure 1.

Performance

NULL CURRENT

± 5 ma maximum if not switched (12 Vdc models)
± 8 ma maximum if not switched (24 Vdc models)

CENTER DEADZONE (OPTIONAL)

± 3° nominal

FULL STROKE CURRENT CAPABILITY

Customer specified. See Ordering Information.

STEP CURRENT

Customer specified. See Ordering Information. Step current occurs at end of deadzone.

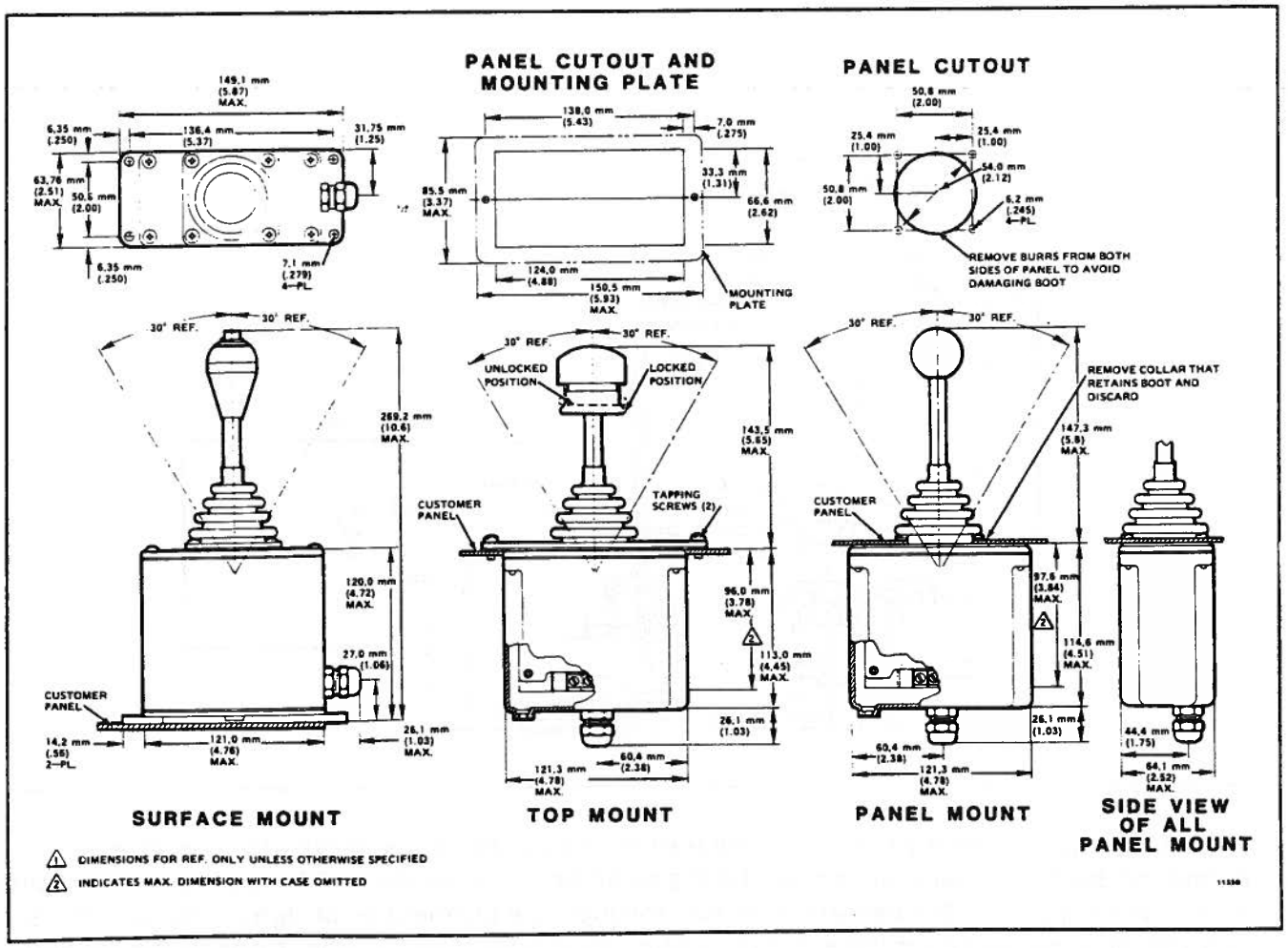


FIGURE 1. Dimensions of the MCHXXX Control Handle in millimeters (inches).

Wiring

If no external cabling is ordered, access to power, ground and the potentiometer(s) is gained through a barrier terminal strip inside the handle's case. The customer should run a cable from the strip through the connector on the side or bottom of the case. See Figure 2. A clockwise handle movement causes a current flow from terminal B to A when the terminal strip is facing you.

In most applications, auxiliary switches must be customer-wired, as shown in Figure 2. When the switch is used as a center-off, power is connected

WARNING

A failure may cause an output which could activate the valve or pump. If this occurs, the apparatus may move, possibly endangering people or equipment. It is strongly recommended that handles be equipped with a neutral OFF switch to prevent this eventuality. For cases in which an active neutral is necessary, an emergency shut down and/or braking system sufficient to stop the system or vehicle immediately should be provided.

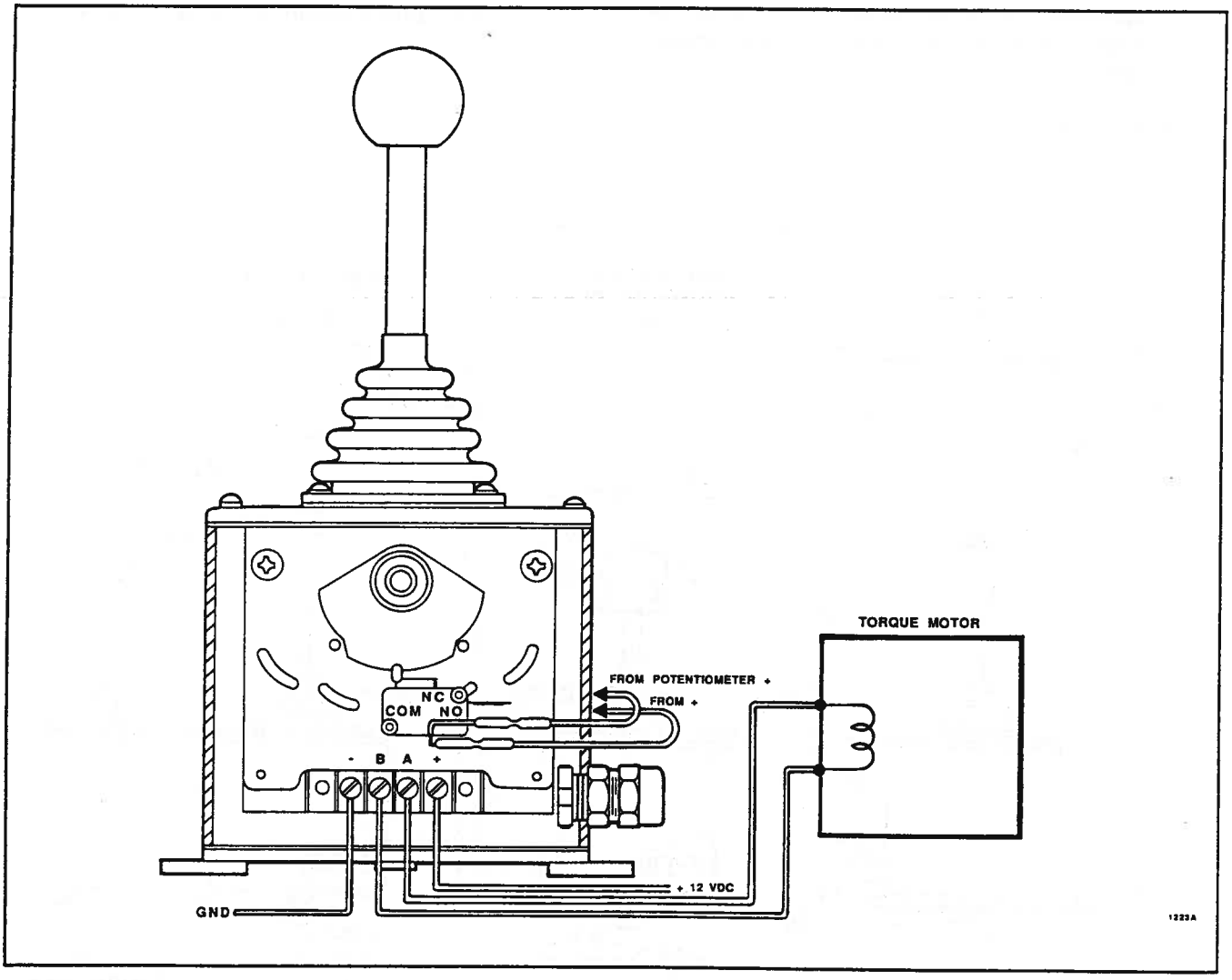


FIGURE 2. Center-off switch assembly and wiring connections for the Control Handle. If no center-off switch is used the power lead should be wired to the "+" terminal on the terminal strip. Ground and A, B wires are attached through the connector, at right. The terminal strip can also be accessed from the other (potentiometer) side of the handle. Connecting the center-off switch necessitates wrapping wires from one side to the other.

from the external 12 volt supply to the terminal labeled "common". The switch terminals are 3/16" quick-connect. Figure 3 shows a pre-wired Control Handle with center-off switch and Packard connector, exhibiting the handle phasing and color coding of the wires.

Figure 4 demonstrates how to assemble the mating Packard connector (male shell, female sockets) shown in Figure 3. The necessary parts are shipped in a bag assembly (Part Number K03370) composed of six sockets and one plastic connector body.

Figure 5 shows the location of the three trim potentiometers on the "L" handle. See the "Electrical Characteristics" section of the Ordering Information.

In order to avoid damaging the Control Handle, a 1 amp fuse wired in series is recommended for applications with low current-drawing requirements.

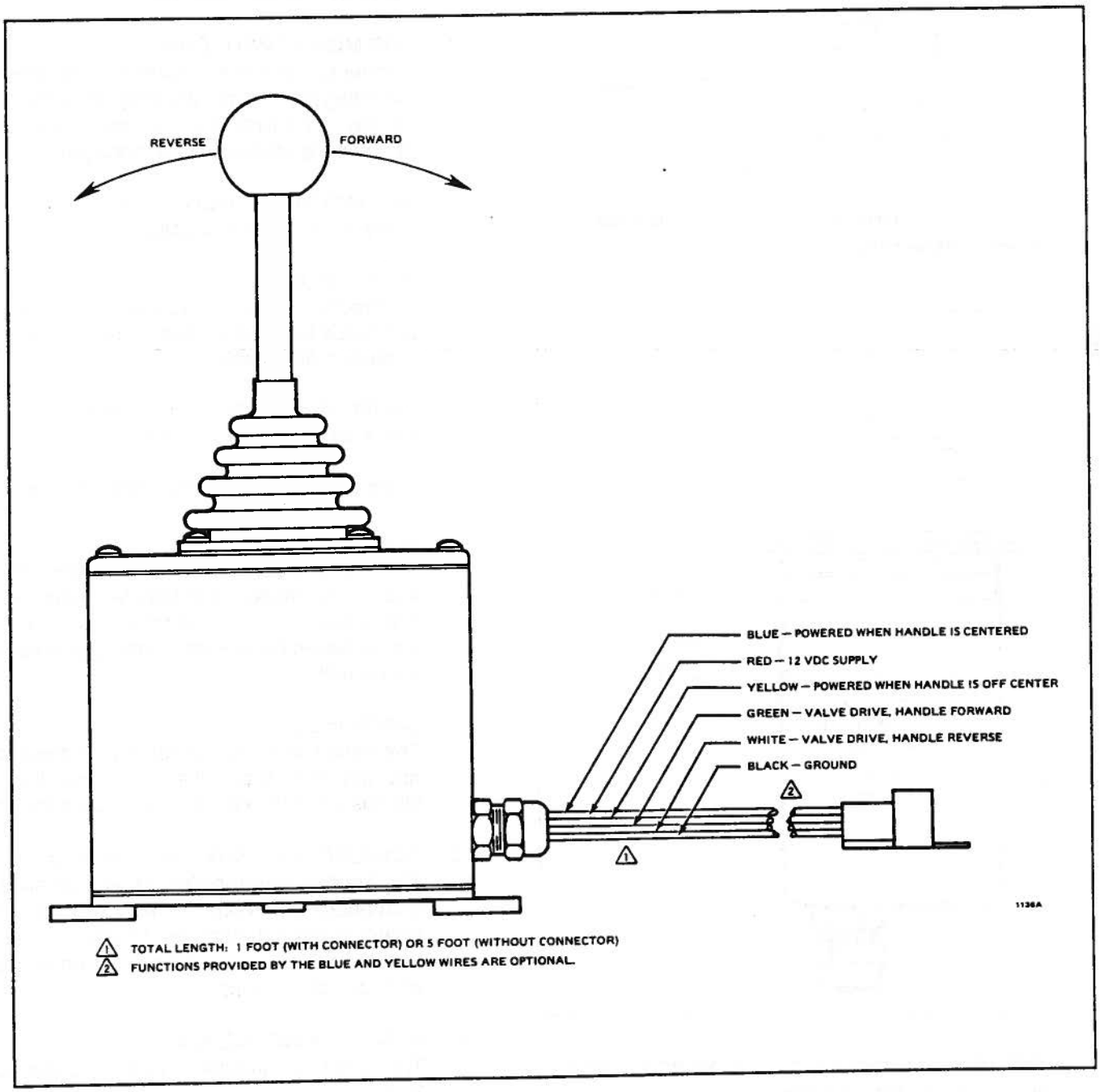


FIGURE 3. Phasing and color scheme for handle with cable and connector.

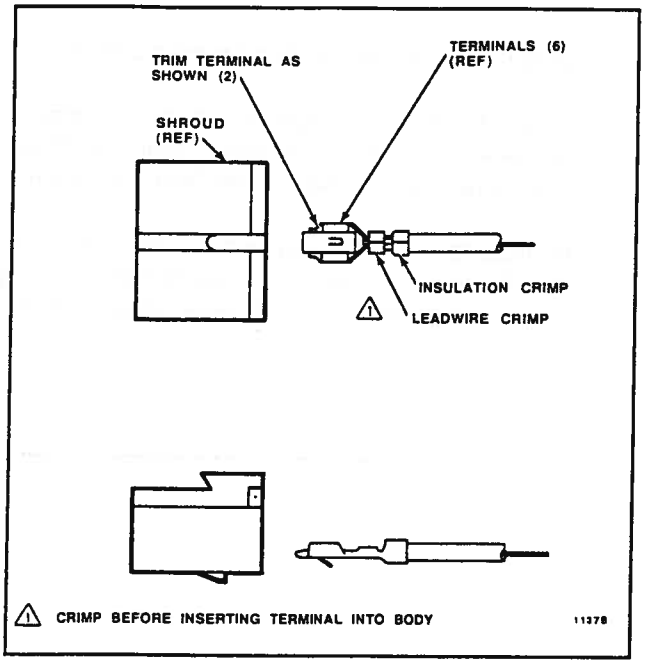


FIGURE 4. Unsealed Packard mating connector assembly.

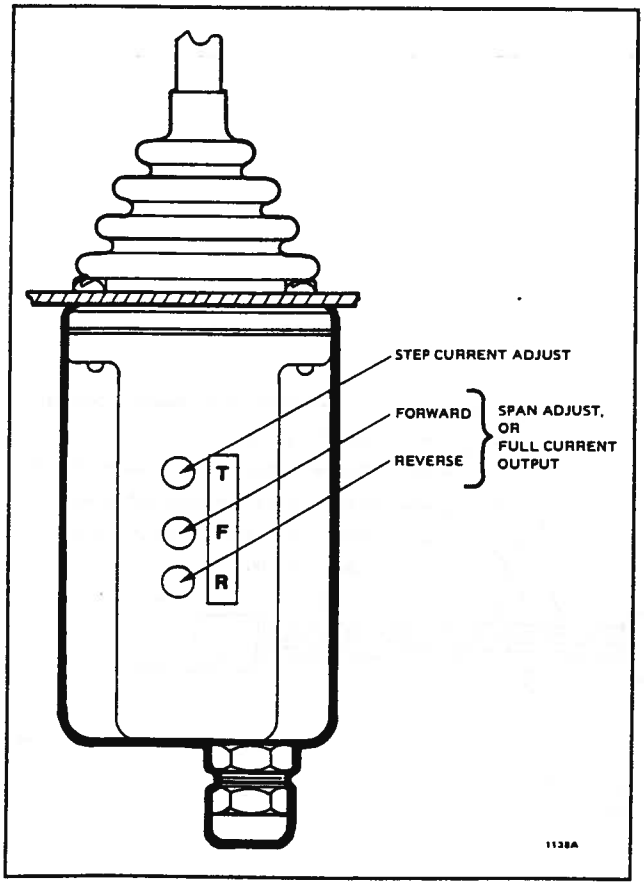


FIGURE 5. Location of trim potentiometers on "L" Control Handles.

Ordering Information

A wide range of options to the basic Control Handle allows it to be custom-tailored to each application. See Ordering Specification chart on page 9. Other options are possible; consult Sundstrand-Sauer with further questions.

I. Mounting (See Figure 1)

1. BASE OR SURFACE MOUNT
   Connection is via four screws to the flanges on the bottom of the metal case.

2. TOP MOUNT WITH CASE
   Connection is via two screws to an enlarged mounting plate. Top mounting allows the entire handle to be removed from above the panel. The case is made of black nylon plastic.

3. TOP MOUNT WITHOUT CASE
   Same as 2, but without case.

4. PANEL MOUNT WITH CASE
   Connection is via four screws to the top plate that holds the boot in place. The case is made of black nylon plastic.

5. PANEL MOUNT WITHOUT CASE
   Same as 4, but without case.

II. Type Of Control Knob (See Figure 1)

1. NON-LOCKING
   The non-locking handle has a standard ball knob. The friction-held handle detents with a spring-loaded ball to indicate null, while the spring-return handle has a spring-preload indicating null.

2. CENTER-LOCK
   The center-lock handle has a cylindrical knob and provides a positive center-lock that unlatches when the operator pulls up on the knob.

3. NON-LOCKING, AUXILIARY SWITCH
   This knob is teardrop shaped, with an auxiliary momentary push-button switch on top. The switch is wired through the handle shaft to the body with three wires (common, normally open and normally closed).

5. NON-LOCKING, NO KNOB
   The customer provides his own customized knob.

6. THREE POSITION MAINTAINED ROCKER SWITCH IN KNOB
The cylindrical knob has a boot covering the three position switch in the knob. The switch, wired through the handle, is used for auxiliary functions.

9. THREE POSITION MOMENTARY ROCKER SWITCH IN KNOB
This is the same as II.6, but the switch returns to the center position when released.

III. Handle Actuation

A. SPRING-RETURN, BI-DIRECTIONAL
This handle uses a torsion spring to return to the mechanical center position, and has 30 degrees of handle throw on either side of center.

B. FRICTION-HELD, BI-DIRECTIONAL
This handle has an adjustable drag, set with a clamp-type brake, that holds the handle at the set position, and has 30 degrees of handle throw on either side of the center detent.

C. FRICTION-HELD, UNI-DIRECTIONAL
This handle has a high-resolution 60 degrees of handle throw, rotating on only one side of mechanical null, which is at full stroke. It has no detent mechanism.

IV. Electrical Characteristics

A. PROPORTIONAL, NO SWITCHES, 12 VOLT BI-POLAR
This handle's output curve is fairly linear (see Figure 6), with output voltages a function of handle stroke. The supply voltage is 12 volts, and there are no auxiliary function switches.

B. PROPORTIONAL, CENTER-OFF SWITCH, 12 VOLT, BI-POLAR
This handle has a center-off switch that ensures zero output voltage over + 3 degrees handle throw.

C. PROPORTIONAL, CENTER-OFF SWITCH, 24 VOLT, BI-POLAR
This handle runs on a supply voltage of 24 volts.

D. PROPORTIONAL, CENTER-OFF SWITCH, AUXILIARY SWITCH, 12 VOLT, BI-POLAR
This handle has a second switch that actuates at + 2 or - 2 degrees.

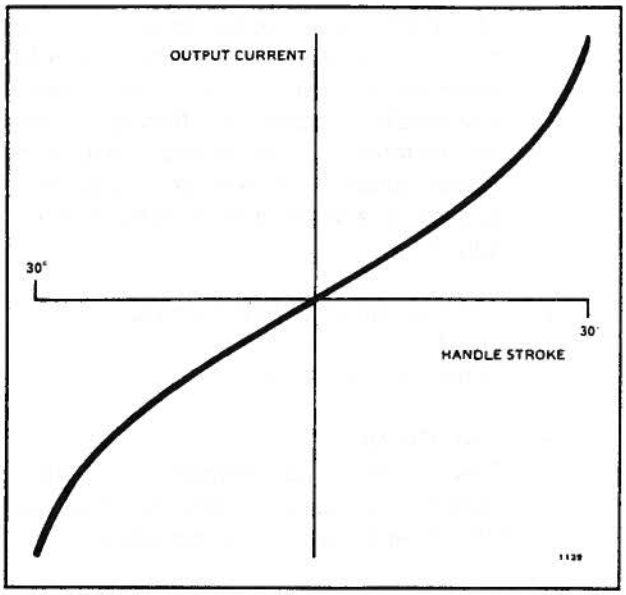


FIGURE 6. Proportional Control Handle Output Current vs. Control Handle Travel.

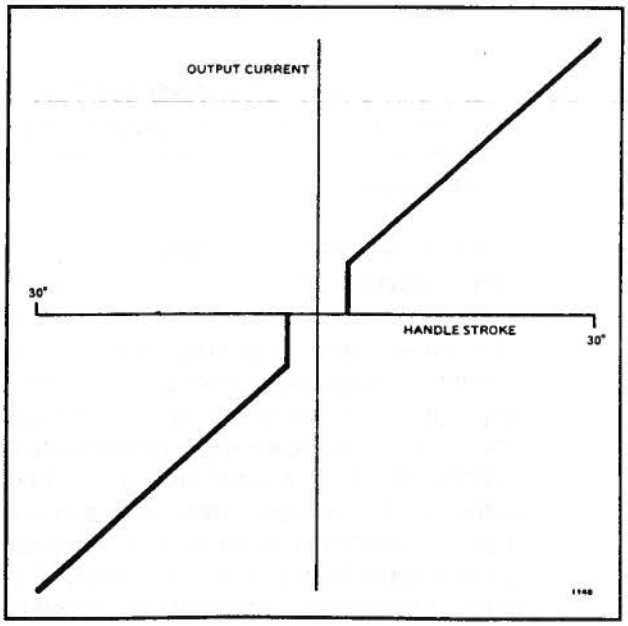


FIGURE 7. Step-Plus-Proportional Control Handle.

E. PROPORTIONAL, CENTER-OFF SWITCH, 12 VOLT, UNI-POLAR
This handle maintains a single direction of current or voltage flow at all handle angles.

F. STEP-PLUS-PROPORTIONAL, 12 VOLT, BI-POLAR
This handle uses two switches to give the step-

plus-proportional output current on either side of null. This is used to overcome deadbands in spool valves. See Figure 7. Current beyond this step output is proportional through the rest of the handle throw. Full current output at 30 degrees handle stroke is maximum of 250 ma. Step current is a maximum of 50% of full current output.

G. STEP-PLUS-PROPORTIONAL, 24 VOLT, BI-POLAR
Same as F, but 24 volt.

H. SWITCHING
This handle is non-proportional. Moving the handle off null activates switches that power ON/OFF devices (e.g., solenoid valves).

J. STEP-PLUS-PROPORTIONAL, FULL AUXILIARY SWITCHING, 12 VOLT, BI-POLAR
This handle uses the step switches for additional secondary functions. Full current output at 30 degrees handle stroke is a maximum of 250 ma. Step current is a maximum of 50% of full current output.

K. PROPORTIONAL, UNWIRED SWITCH
The customer provides an auxiliary function, such as a neutral start interlock, with the unwired center switch.

L. STEP-PLUS-PROPORTIONAL, FULL AUXILIARY SWITCHING, 12 VOLT, BI-POLAR ELECTRONIC, PULSE WIDTH MODULATED
This handle uses a printed circuit board that makes the step height and output current fully adjustable, accomodating high current applications. It also has pulse width modulation, which "dithers" the load to avoid stiction. Full current output at 30 degrees handle stroke is a maximum of 2 amps into a 5 ohm load. Step current is a maximum 50% of full current output. Typical dither frequencies (dependent on resistance of the load, specified in the suffix number) are: 60 Hz for the HPI solenoid actuator, approximately 400 Hz for the V7058 Hydrotransmission Valve and approximately 1000 Hz for the MCV101A Pressure Control Pilot Valve.

M. PROPORTIONAL, THREE SWITCHES
The three switches are: a wired centerswitch, one unwired switch in forward and one unwired switch in reverse.

V. Connector

1. TERMINAL STRIP
Electrical connections are made to a set of four internal screw terminals.

2. PIGTAIL WITHOUT CONNECTOR
Four wires extend from the handle case. See Figure 3 for lengths.

3. PIGTAIL WITH CONNECTOR
The wires from the case terminate in a Packard environmental connector. See Figure 3.

4. PIGTAIL WITH BOTH HALVES OF UNSEALED PACKARD CONNECTOR
Both halves of the unmounted connector are included. Unsealed connectors are generally used inside a sealed panel.

5. SEALED PACKARD CONNECTOR WITH MATING HALF
A weather-sealed Packard connector and unassembled mate. See Figure 8.

6. SEALED PACKARD CONNECTOR (FOUR PIN MALE AND FEMALE)
These are two separate connectors, each connected to a separate potentiometer.

7. PIGTAIL SEALED PACKARD CONNECTOR
Same as V.5 with no unassembled mate.

VI. Suffix Number

These final three numbers are factory-generated. To create the suffix number, the following information must be supplied: number of additional switches needed and actuation angle of each with respect to null, full current output, resistance of the driven load and step current needed (if necessary).

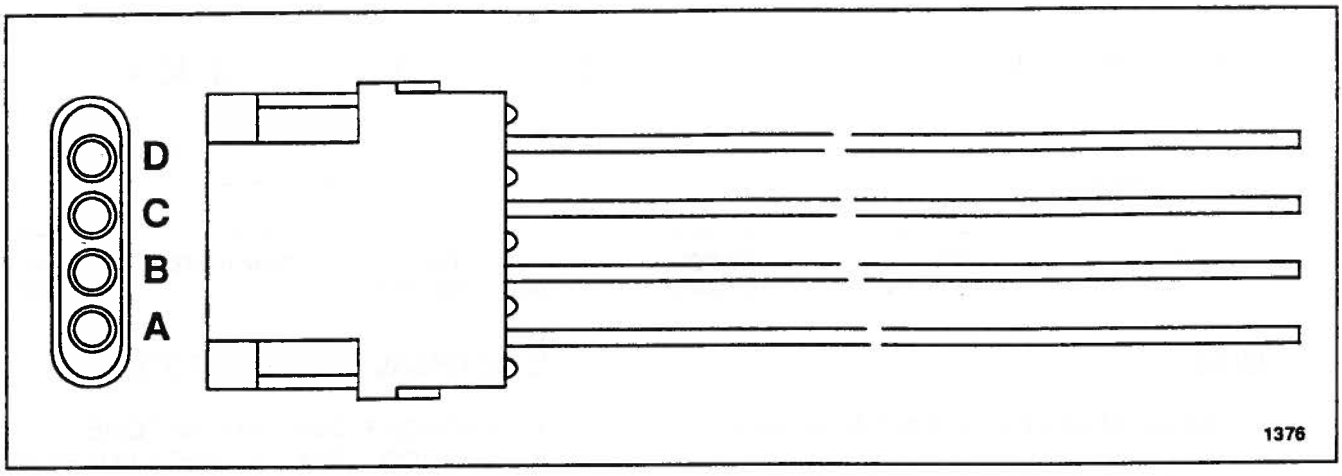


FIGURE 8. Sealed Packard connector

Ordering Information

Order From

SUNDSTRAND-SAUER
3900 Annapolis Lane North
Minneapolis, Minnesota 55447
(612) 559-2121

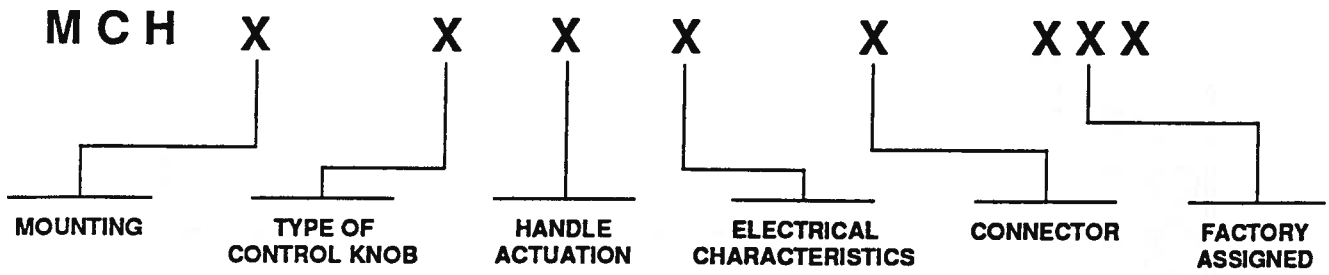
Device Repair

For devices in need of repair, include a description of the problem, a copy of the purchase order and your name and address.

Return To

SUNDSTRAND-SAUER
Return Goods Department
3900 Annapolis Lane North
Minneapolis, Minnesota 55447

MCHXXX Ordering Specification Chart



MOUNT/

1 BASE (SURFACE) MOUNT ALUMINUM CASE
2 TOP MOUNT (DROP IN) WITH PLASTIC CASE
3 TOP MOUNT (DROP IN) WITHOUT CASE
4 PANEL MOUNT WITH PLASTIC CASE
5 PANEL MOUNT WITHOUT CASE

TYPE OF CONTROL KNOB

1 NON LOCKING
2 CENTER LOCK
3 PUSH BUTTON IN KNOB
4 TRON MAINTAINED ROCKER SWITCH
5 NON-LOCKING NO KNOB
6 3 POSITION MAINTAINED ROCKER SWITCH IN KNOB
7 TRON MOMENTARY ROCKER SWITCH
8 SPECIAL (NO HANDLE OR KNOB)
9 3 POSITION MOMENTARY ROCKER SWITCH IN KNOB

HANDLE ACTUATION

A SPRING RETURN, BI-DIRECTIONAL
B FRICTION HELD, BI-DIRECTIONAL
C FRICTION HELD, UNI-DIRECTIONAL
D SPECIAL (FRICTION HELD, CENTER DE-TENT ONLY, NO BRAKE)

ELECTRICAL CHARACTERISTICS

A PROPORTIONAL, NO SWITCHES
B PROPORTIONAL, 12 VDC CENTER OFF SWITCH
C PROPORTIONAL, 24 VDC CENTER OFF SWITCH
D PROPORTIONAL, CENTER OFF AND AUX SWITCH
E PROPORTIONAL, SET-POINT POTENTIOMETER
F STEP PLUS PROPORTIONAL, 12 VDC
G STEP PLUS PROPORTIONAL, 24 VDC
H SWITCHING
J STEP PLUS PROPORTIONAL, AUX SWITCHING
K PROPORTIONAL, UNWIRED SWITCH
L ELECTRONIC PWM AUX SWITCHING
M 3 SWITCHES
X SPECIAL
Y SPECIAL
Z SPECIAL

CONNECTOR

1 TERMINAL STRIP INTERNAL
2 PIGTAIL 60 INCH WITH NO CONNECTOR
3 PIGTAIL WITH UNSEALED PACKARD CONNECTOR
4 PIGTAIL WITH BOTH HALVES OF UNSEALED PACKARD CONNECTOR
5 SEALED PACKARD CONNECTOR WITH MATING HALF
6 SEALED PACKARD CONNECTOR 4 PIN MALE AND FEMALE

SAUER SUNDSTRAND

The 1987 joint venture between Sundstrand Corporation and Sauer Getriebe was changed in April of 1989 when Sundstrand Corporation sold its 50% ownership to the SUNDSTRAND-SAUER Company. The worldwide business of Sundstrand-Sauer is now consolidated under one common name, SAUER-SUNDSTRAND COMPANY, effective January 1, 1990. Sauer-Sundstrand is in the process of rewriting its specification literature to reflect this title change. In the interim, information found in previous literature is current and accurate.

SAUER-SUNDSTRAND COMPANY, 3900 Annapolis Lane North, Minneapolis, MN 55447
Phone: (612) 559-2121 • Telex: 9105762716 • Telecopy: (612) 559-5769

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SUNDSTRAND-SAUER is a world leader and your source for hydraulic power system technology, utilizing both North American and European resources in design and manufacturing. SUNDSTRAND-SAUER specializes in integrating a full range of system components including closed circuit hydrostatic transmissions, electrohydraulic controls, open circuit pumps, and gear pumps and motors.



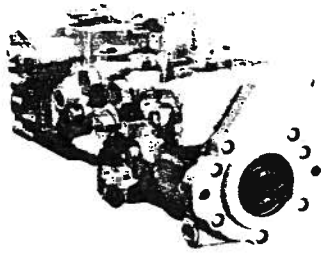
Heavy Duty Pumps and Motors



Open Circuit Pumps



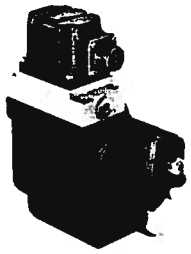
Variable Motors



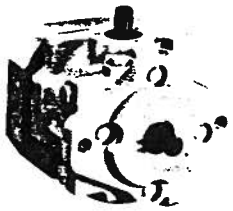
Series 40 Pumps and Motors



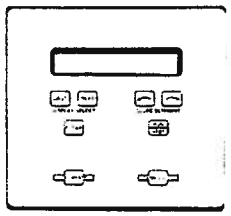
Bantam Duty Transmissions



Electrohydraulic Controls



Light Duty Pumps and Motors



Microcontrollers



Gear Pumps and Motors

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Phone: (612) 559-2121 • FAX: (612) 559-5769

BLN 95-8956-2, March 1989

REFERENCE: ELECTRICAL PART NO.(S) 31, 32, 44, 56
ELECTRICAL SCHEMATIC NO. 347-9001-01

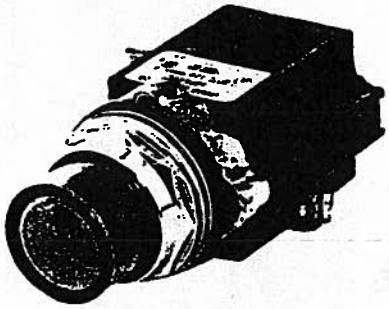
Furnas

Industrial Control Catalog 290

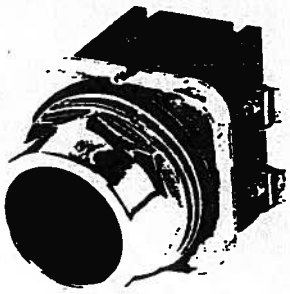
Motor Control Specialists

The Right Choice

- Octagonal Mounting Nuts
- Meets NEMA and Automotive Standards
- Heavy Duty Rated NEMA A600 Contacts
- Positive Indexing Selectors
- Bifurcated Movable Contacts
- Attractive Chrome Plating
- Boots Not Required for NEMA 4
- UL Listed File # E22655
- CSA Certified File #LR6535



Pilot Light



Push Button

APPLICATION

Furnas oil tight pilot controls and accessories are designed to provide long, trouble free service in the most demanding industrial applications. These controls are oil and dust tight and meet NEMA 3, 4, 12 and 13 specifications.

FEATURES

Rugged Furnas industrial control operators are durable one piece castings. Heavy duty plastic buttons resist oils and corrosion. Silver contacts carry heavy duty ratings.

Flexible accessories modify standard push buttons, selector switches and pilot lights. Building block construction of contact blocks makes possible many circuitry combinations. Push button units may be assembled into a variety of custom control stations.

Industrial Appearance
Furnas pilot controls add lustre to panels. Chrome plating covers exposed metal parts. Button function is indicated by eight vivid and permanent colors. Pilot lights transmit 180° of bright light through lenses in six attractive colors.

Push Button Operators
The Operator Base consists of a durable, one piece casting equipped with a heavy duty acrylic actuator with a stainless steel spring, a neoprene actuator sealing ring to prevent oil and dust from penetrating to the contact blocks, a neoprene gasket to seal operator mounting hole and a chrome plated lock nut.

Mushroom Head Push Button Operators
The Mushroom Head base construction of the operator is identical to the push button base. The actuator is molded of high impact material for either a 1⅝ inch or 2½ inch diameter molded acrylic head. Mushroom heads provide palm operating ease. They offer a large target which is convenient for gloved hand operation or emergency situations.

Contact Blocks
Contact Blocks have double break bifurcated silver contacts which improve contact fidelity. Contact blocks are heavy duty rated NEMA A600 and suitable for applications with low current draw. Molded bodies and pushers resist arcing and tracking. All units have stainless steel springs that resist corrosion and provide strong contact pressure. Captive mounting screws speed panel assembly.

Pneumatic Timer
Furnas Class 55 Pneumatic Timer is mounted on a standard black flush push button operator. It has an adjustable 0.2 second to 180 second timing range.

Push Pull Operators
Push Pull Operators combine two or three functions in one unit. The maintained operator has two positions, typically pull to start, push to stop. The momentary operator with three positions provides spring return from both pull and push positions. The chrome plated mushroom type head, an inch higher than a flush button, makes access and quick recognition easy. These units are also available with a pilot light.

■ Control Units

2 Button Maintained Operator
Maintained Push Buttons consist of two push buttons and a latching assembly. When actuated the button remains depressed and is freed only by the release operator to which it is linked. The button assembly adjusts for mounting from a 1 13/16 inch to a 2 5/8 inch center.

Transformer Type Pilot Lights
Transformer Type Pilot Lights are available with a 120, 240, 480 or 600 volt primary (50/60 Hertz) and a separate secondary winding which supplies reduced voltage to a miniature bayonet base 6 volt lamp. These units are suitable for applications where vibration is present and long bulb life is desirable.

Full Voltage Type Pilot Lights
Full Voltage Pilot Lights are available for 6, 12, 24, 120 and 240 volt AC and DC applications. The 240 volt pilot light is supplied with a 120 volt lamp and a voltage dropping resistor.

Plastic lenses are shatter resistant, retain their color, and perform well within the operating temperature range of low voltage lamps.

Neon Type Pilot Lights
Neon Pilot Lights are available for 120, 240, 480 and 600 volt AC and DC applications. Each is supplied with a 120 volt neon bayonet base lamp and a clear lens. A shunting resistor minimizes the tendency to glow after opening the lamp circuit. Neon lights will withstand considerable vibration.

Selector Operators
Selector Lever Operators with positive action indexing have a short or long lever which makes them easy to turn. The molded black lever is designed to accept eight color inserts. Each operator is equipped with a cam to actuate plungers of contact blocks assembled behind the operator. Two, three and four position operators are available with seven different cams.

Lever color inserts offer the ability to color code selector operators with other machine or plant functions. Lever color inserts are available in 8 colors.

ORDERING INFORMATION

- Accessories page E32.
- Selector Position and Contact Operation page E28.
- Legend Plates page E33.
- Enclosures page E30.
- Dimensions page E34.
- Replacement Parts page E32.

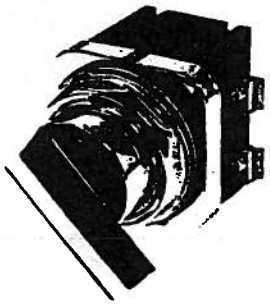
ELECTRICAL RATINGS

NEMA AC Ratings 50/60 Hz

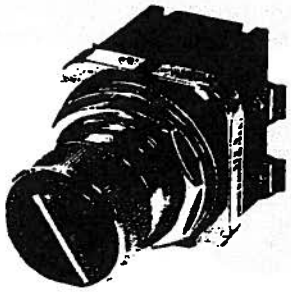
NEMA A600 10 Cont. Amps

Volts	Make	Break
120	60	6
240	30	3
480	15	1.5
600	12	1.2
VA	7200	720

Maximum Panel Thickness: ¼"



Selector Operator



Selector Push Operation

REFERENCE LITERATURE

Control Unit	Instruction Sheet
Maintained Push Buttons	52-HMA2
Compact Pilot Light	52-HMA5G
Oil Tight Push Pull with Pilot Light	52-HPA2
Oil Tight Push Pull	52-HPA2C
Pilot Light	52-HPA4
Push to Test Pilot Light	52-HPA6
Push Button	52-HPA8
Selector Operator	52-HSA2
Oil Tight Illuminated Selector	52-HSA7

Promotional Bulletin 52-P2

Pilot Devices

- Control Units
- Push Buttons
- Contact Blocks

Push Button Operators

Push Button



Color	Flush Cap Cat No	⅜" Extended Cap Cat No
Black	52PA8A1	52PA8B1
Red	52PA8A2	52PA8B2
Green	52PA8A3	52PA8B3
Less Cap	52PA8	52PA8

Actuator Cap





Color	Cat No
Black	52RA1A1
Red	52RA1A2
Green	52RA1A3
Yellow	52RA1A4
Blue	52RA1A5
Gray	52RA1A6
Brown	52RA1A7
Orange	52RA1A8

Color	1⅝" Head Cat No	Price	2½" Head Cat No
Black	52RA1B1		
Red	52RA1B2		
Green	52RA1B3		
Yellow	52RA1B4		
Blue	52RA1B5		
Gray	52RA1B6		
Brown	52RA1B7		
Orange	52RA1B8		

Mushroom Head



Color	1⅝" Head Cat No	Price	2½" Head Cat No
Red	52PB9D2	$34.20	52PB9E2
Less Head	52PB9	28.20	52PB9

Mushroom Head Only



Color	Cat No	Price	Cat No
Black	52RB3D1	6.00	52RB3E1
Red	52RB3D2	6.00	52RB3E2
Green	52RB3D3	6.00	52RB3E3
Yellow	52RB3D4	6.00	52RB3E4
Blue	52RB3D5	6.00	52RB3E5
Gray	52RB3D6	6.00	52RB3E6
Brown	52RB3D7	6.00	52RB3E7
Orange	52RB3D8	6.00	52RB3E8

Contact Blocks





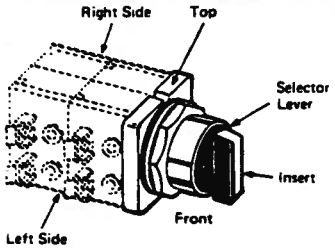
NEMA Rating	Contacts	Cat No
Q300 (DC SPDT)	NO	52BAK
Q600 (DC SPST)	NC	52BAJ
A600 (AC)	NO-NC (SPDT)	52BJK
8 max/operator	NO (Early Make)	52BAH
	Early make contact block closes before 52BAK.	
	NC (Late Break)	52BAE
	Late Break contact block opens after 52BAJ.	

Suitable for use on low energy level circuits. Hermetically sealed.

Logic Reed Switch UL Listed For Class 1 Division 2.	NO-NC (SPDT) .5 Amp, 200VAC 10 Watt Max Resistive Load Only	52BAR

Ordering Instructions

- For other colored operators, add last 2 digits of color cap.
  Example: Yellow Flush Button: 52PA8A4 (**A4** indicates 52RA1**A4** Color Cap).
  Example: Green Mushroom Head: 52PB9D3 (**D3** indicates 52RB3**D3** Head).
- Contact blocks are ordered separately.
- Legend Plates page E33.
- Lens guard page E26.
- Accessories page E32.



Lever or Key Operator

Selector Position	Level Position X indicates contact closed		Cam Ltr	Contact Block Cat No		Mounting
	Left	Right				Left Right
						Viewed from front
2	X	O	A	52BAJ	(NC)	L or R
	O	X		52BAK	(NO)	L or R
	Illuminated					
	X	O	A	52BAJ	(NC)	L
	O	X		52BAK	(NO)	L

Selector Position	Left	Center	Right	Cam Ltr	Contact Block Cat No		Mounting
3	X	O	O	B	52BAK	(NO)	R
	O	O	X		52BAK	(NO)	L
	X	X	O		52BAJ	(NC)	L
	O	X	X		52BAJ	(NC)	R
	X	O	X	(2)	*52BAK	(NO)	L or R
	X	O	O	C	52BAJ	(NC)	L or R
	O	O	X		52BAK	(NO)	L or R
	O	X	O	D	52BAJ	(NC)	L or R
	O	O	X		52BAK	(NO)	L or R
	X	O	O	E	52BAK	(NO)	L or R
	O	X	O		52BAJ	(NC)	L or R
	X	O	O	G	52BAJ	(NC)	L
	O	X	O		52BAJ	(NC)	R
	O	O	X		52BAK	(NO)	L or R
	Illuminated						
	X	O	O	C	52BAJ	(NC)	L
	O	O	X		52BAK	(NO)	L
	O	X	O	B	52BAK	(NO)	R
	O	O	X		52BAJ	(NC)	R

*Wired in parallel.

Selector Position	Left	Left Center	Right Center	Right	Cam Ltr	Contact Block Cat No		Mounting
4	X	O	O	O	H	52BAK	(NO)	R
	O	X	O	O		52BAJ	(NC)	L
	O	O	X	O		52BAJ	(NC)	R
	O	O	O	X		52BAK	(NO)	L

Contact and Cam Selection

1. Under Selector Position find the selector operation required (2, 3 or 4 positions).
2. Select the contact operation required for each selector Lever Position (X indicates when contacts are closed).
3. The Cam Letter column identifies the cam of the selector operator.
4. Contact block must be assembled in position shown for each circuit application.
5. Cam D, E or G may be ordered at the same price by changing the 6th character of the selector catalog number. Ex: Selector with D cam: 52SA2DAB.
6. C cam on spring return selectors are limited to 4 contact blocks.
7. Contact scheme for each cam shows possibilities for that cam.
8. To order selectors with different color inserts, take last digit of insert and substitute for last digit of selector.
   Example: White-52SA2AAB Red-52SA2AA2
9. 52BJK(SPDT) block can be used on cams A, B, C, D, E & G, where NO & NC are mounted on the same side.

Push Operators

Selector Position	Level Position X indicates contact closed				Cam Ltr	Contact Block Cat No		Mounting
	Left		Right					Left Right
	N	D	N	D				Viewed from front
2	X	O	O	O	Q	52BAJ	(NC)	R
	X	X	O	O		52BAJ	(NC)	L
	O	X	O	X		52BAK	(NO)	R
	O	O	O	X		52BAK	(NO)	L
	X	O	O	O	P	52BAJ	(NC)	L or R
	O	X	X	X		52BAK	(NO)	L or R
	X	X	X	O	R	52BAJ	(NC)	L
	X	O	X	X		52BAJ	(NC)	R
	O	X	O	O		52BAK	(NO)	R
	O	O	O	X		52BAK	(NO)	L

Selector Position	Left		Center		Right		Cam Ltr	Contact Block Cat No		Mounting
	N	D	N	D	N	D				
3	X	X	O	O	O	O	S	52BAJ	(NC)	L
	X	O	X	X	O	O		52BAJ	(NC)	R
	O	X	O	O	O	X		52BAK	(NO)	R
	O	O	O	X	O	X		52BAK	(NO)	L

D Button depressed.
N Button not depressed.

Ordering Instructions

- Other color inserts are available by ordering separate inserts.
- Contact blocks are ordered separately page E22.
- Legend Plates page E33.
- Accessories page E32.

■ Accessories
■ Replacement Lamps

Accessories

			Cat No
Clear Protective Boot	Boot covers the flush or raised push button operator so that ice or other foreign substances cannot interfere with button operation.		**52AABA**
Push Button Guard	Prevents accidental operation of the push button and requires operation to be premeditated. Fits any push button. Push button guard, when installed, provides a recess of ½" on a flush push button operator.		**52AAGP**
Guard for Mushroom Head	For 1⅝" mushroom head. If guards are required on adjacent buttons, additional hole spacing is required. Can be used on push-pull devices.		**52AAGM**
Padlock Attachment		Fits flush push button. Fits raised push button.	**52AALA** **52AALB**
Padlock Cover	Fits push button selector operator illuminated and non illuminated mushroom heads. Can be used to lock these devices in the off position.		**52AALS**
Lock Nut Wrench	For tightening lock nuts on all oil tight push buttons, selector switches, pilot lights.	Class 52 and BJ Type Class 52 Automotive and Compact Type	**52MAWB** **52MAWA**
Hole Plug	Provides oil tight seal for unused mounting holes in stations.	Corrosion Resistant Steel, Gray Stainless Steel	**52AAH6** **52ABH6** **52ABHS**
Spare Keys		501CH (1 Key)	**D28671015**
Grounding Kit	Provides grounding for all Class 52 when used in plastic enclosures.	Grounding Ring	**52AL109145**

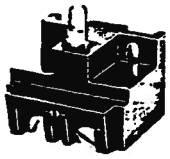
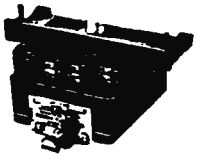
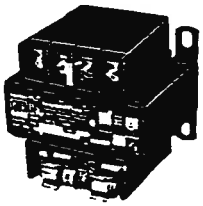
Replacement Lamps

Base	Class	Type	Lamp Volts	Lamp No	Cat No
Miniature Bayonet	51, 52	Flashing Lamp (Replaces 755 Lamp)	6	267	**D13758017**
	51, 52	6V Units, Full Voltage	6	755	**D13758024**
	51, 52	Transformer	6	755	**D13758024**
	51, 52	12V Units, Full Voltage	12	1816	**D13758008**
	52	120, 240V, Full Voltage Push to Test	24	1829	**D13758009**
	51, 52	24V Units, Full Voltage	24	1829	**D13758009**
	52	120V, Full Voltage	120	120MB	**D13758019**
	52	Neon		B2A (NE-51H)	**D13758010**

			Voltage 6VAC/DC	Voltage 24VAC/DC	Voltage 120VAC/DC
LED	52	Color			
		Red	**D13758035**	**D13758038**	D13758041
		Green	**D13758036**	**D13758039**	D13758042
		Amber	**D13758037**	**D13758040**	D13758043

Modifications

■ Field Modifications

Description			Controller Size	Enclosure	Cat No
Melting Alloy Overload Kit 	NEMA A600	NO Contact NC Contact	00-3½ 4½-6	All	48ACNO 48ACNC
On Delay Pneumatic Timer 0.2-180 sec 	NEMA B600	14, 40	0-2½ 3, 3½	Open All	49SAT
	Enclosure Only	14	0-1¾ 2, 2½	1	49EA14EFBT 49EA14GFBT
		40	0-1¾ 2, 2½	1 1	49EA40EFBT 49EA40GFBT
Transformer 	Transformers Listed are: 50/60 Hz Pri 240/480 Volt Sec 120 Volt 49TA kits are supplied with fused secondary. Extra capacity transformers may require larger enclosures. contact factory for dimensions.	50 VA 75 VA 100 VA 150 VA 200 VA 250 VA 350 VA 500 VA For 208 Volt Pri For 600 Volt Pri	All	All	49TA050A 49TA075A 49TA100A 49TA150A 49TA200A 49TA250A 49TA350A 49TA500A Use price shown and change catalog number Suffix A to T. Use price shown and change catalog number Suffix A to C.

49TA kits are supplied with fused secondary.
For primary fusing see Fuse Block

				Class	Size	Enclosure	Cat No
Overload Reset 	 Miniature Reset			14 22 14	0-2½ 0-1¾ 3, 3½	1 1	49MARTG 49MARTI
	Red Buttons Engraved Reset	Single Reset	Red Black	All	0-3½ 4½-6	1, 3, 12	49MARSR 49MARSB
		Multi Unit Reset	Red Black	All	4	1, 3, 12	49MARUR 49MARUB
	Oil Tight Boot	For Single & Multi Unit Resets				4, 4X	52AABA Ⓔ
Mechanical Interlock Innova 	Horizontal	Includes wire		14, 40	0-1 1¾ 2, 2½ 3, 3½	Open	49CCF22H 49EEF22H 49GGF22H 49HHP22H
		Includes wire & mounting plate		14, 40	00-1 1¾ 2, 2½ 3, 3½	Open	49EEF22HP 49EEF22HP 49GGF22HP 49HHP22HP
Mechanical Interlock US/15		Interlock with mounting plate		15, 21	B,C D,E, Q	Open	49CCB24HP 49EEB24HP
		Interlock only			B-E, Q		49D7C035001
		Interlock with mounting plate and wire			F-H		49HHA24HP

REFERENCE: ELECTRICAL PART NO.(S) 33, 35
ELECTRICAL SCHEMATIC NO. 347-9001-01

Minarik Electric
Masters of Control

8076 El Rio, Houston, TX 77054
TELEPHONE (713) 748-0808

MICRO SWITCH Sensors & Manual Controls

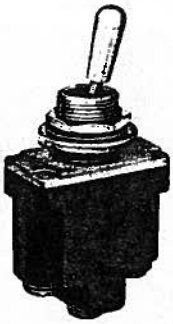


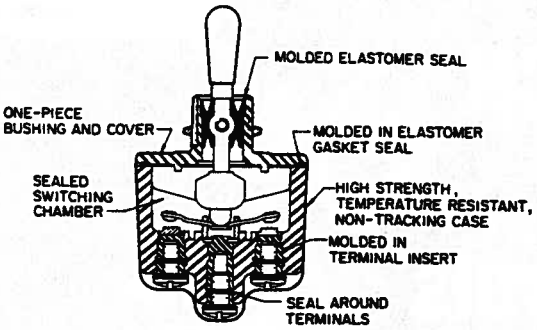
Consolidated Catalog

Issue 8

MICRO SWITCH
a Honeywell Division

TL Toggle switches





FEATURES

- *Qualified to MIL-S-3950*
- *Environment-proof sealing*
- *1, 2, and 4 pole circuitry*
- *Standard and pull to unlock levers*
- *2 and 3 position, maintained, and momentary toggle action.*
- *Temperature range: −65°C to +71°C (−85°F to +160°F)*
- *UL listed, CSA certified.*

2-POSITION ORDER GUIDE

No. of Poles	Circuit(s) Made w/Toggle At: Keyway Position	Opposite Keyway	Electrical Rating Code G36	UL/CSA Rating Code G35	Standard Toggle: Catalog Listing	Standard Toggle: Military Number	Pull-to-Unlock Toggle: Add Suffix to Standard Listing	Pull-to-Unlock Toggle: Military Number**
1	OFF	2-3	1	L191	1TL1-2	MS24523-22	D, F, G	MS24658-22
	OFF*	2-3	2	L192	1TL1-4	MS24523-29	F	MS24658-29
	1-2*	OFF	2	L192	1TL1-6	MS24523-30	F	MS24658-30
	1-2	2-3	1	L191	1TL1-3	MS24523-23	D, F, G	MS24658-23
	1-2*	2-3	2	L192	1TL1-8	MS24523-26	F	MS24658-26
2	OFF	2-3, 5-6	3	L191	2TL1-2	MS24524-22	D, F, G	MS24659-22
	1-2, 4-5*	OFF	4	L192	2TL1-6	MS24524-30	F	MS24659-30
	1-2, 4-5	2-3, 5-6	3	L191	2TL1-3	MS24524-23	D, F, G	MS24659-23
	1-2, 4-5*	2-3, 5-6	4	L192	2TL1-8	MS24524-26	F	MS24659-26
4	OFF	2-3, 5-6 8-9, 11-12	5	L191	4TL1-2	MS24525-22	D, F, G	MS24660-22
	1-2, 4-5 7-8, 10-11	2-3, 5-6 8-9, 11-12	5	L191	4TL1-3	MS24525-23	D, F, G	MS24660-23

*These positions only are momentary. All others are maintained.
**Also add the appropriate suffix letter to the Military number.

3-POSITION ORDER GUIDE

No. of Poles	Circuit(s) Made w/Toggle At: Keyway Position	Center Position	Opposite Keyway	Electrical Rating Code G36	UL/CSA Rating Code G35	Standard Toggle: Catalog Listing	Standard Toggle: Military Number**	Pull-to-Unlock Toggle: Add Suffix to Standard Listing	Pull-to-Unlock Toggle: Military Number**
1	1-2	OFF	2-3	1	L191	1TL1-1	MS24523-21	ALL TYPES	MS24658-21
	1-2*	OFF	2-3	2	L192	1TL1-5	MS24523-31	E, F, K, L, M, N	MS24658-31
	1-2*	OFF	2-3*	2	L192	1TL1-7	MS24523-27	E, L, N	MS24658-27
2	1-2, 4-5	OFF	2-3, 5-6	3	L191	2TL1-1	MS24524-21	ALL TYPES	MS24659-21
	1-2, 4-5*	OFF	2-3, 5-6	4	L192	2TL1-5	MS24524-31	E, F, K, L, M, N	MS24659-31
	1-2, 4-5*	OFF	2-3, 5-6*	4	L192	2TL1-7	MS24524-27	E, L, N	MS24659-27
	1-2, 4-5	1-2, 5-6	2-3, 5-6	3	L191	2TL1-10	MS27407-4	ALL TYPES	MS27408-4
	1-2, 4-5*	1-2, 5-6	2-3, 5-6	4	L192	2TL1-50	MS27407-5	E, F, K, L, M, N	MS27408-5
	1-2, 4-5*	1-2, 5-6	2-3, 5-6*	4	L192	2TL1-70	MS27407-6	E, L, N	MS27408-6
4	1-2, 4-5 7-8, 10-11	OFF	2-3, 5-6 8-9, 11-12	5	L191	4TL1-1	MS24525-21	ALL TYPES	MS24660-21
	1-2, 4-5 7-8, 10-11*	OFF	2-3, 5-6 8-9, 11-12*	6	L192	4TL1-7	MS24525-27	E, L, N	MS24660-27
	7-8, 4-5 7-8, 10-11	2-3, 4-5 7-8, 11-12	2-3, 5-6 8-9, 11-12	5	L191	4TL1-12	MS27406-1	ALL TYPES	MS27409-1

*These postions only are momentary. All others are maintained.
**Also add appropriate suffix letter to the Military number.

REFERENCE: ELECTRICAL PART NO.(S) 36-39, 59
ELECTRICAL SCHEMATIC NO. 347-9001-01

OIL-TIGHT INDICATORS

DIALIGHT

Oil-tight indicators are manufactured with a rubber gasket installed between the plastic lens and metal housing, as well as with a rubber O-ring which fits into a notch in the base. These make assembly virtually impervious to oil, water and dust. The lens holder is brass with either satin chrome or white nickel finish, and the base is white nickel-plated brass. *Order lamps separately; see lamp index, pages 982-983.*

103 SERIES BASE - 1" MOUNTING HOLE

Stock No.	Type	Lens Fig	Lamp Type	Fig
45F590	103-3101-05-103	3, 4, 5	S6 candelabra in	1
65F1095	103-3201-05-103	3, 4, 5	S6 Bayonet inc	1
65F1096	103-3227-05-103	3, 4, 5	C7 Bayonet inc	1
45F607	103-3114-05-103	3, 4, 5	87A, F4A neon	2

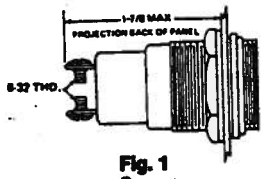


Fig. 1
Screw Terminal

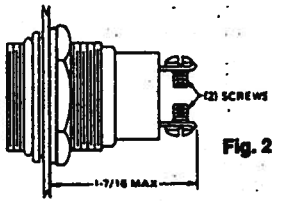


Fig. 2



Fig. 3
Dome Lens

103 SERIES CAP - UNFROSTED

Stock No.	Type	Color	Fig
45F608	103-1231-403	Red	3
65F1098	103-1232-403	Green	3
45F609	103-1233-403	Amber	3
45F602	103-1235-403	White	3
45F591	103-1331-403	Red	4
45F592	103-1332-403	Green	4
45F593	103-1333-403	Amber	4
45F595	103-1335-403	White	4
65F1099	103-0531-403	Red	5
65F1100	103-0532-403	Green	5
65F1101	103-0533-403	Amber	5
65F1102	103-0535-403	White	5

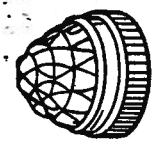


Fig. 4
Torpedo Faceted Lens



Fig. 5
Torpedo Lens

125 SERIES BASE - 11/16" MOUNTING HOLE

Stock No.	Type	Lens Fig	Lamp Type	Accommodates Voltage	Fig
45F586	125-0410-11-103	8, 9	T-3¼ MB INC	2 - 55	6
25F906	125-1310-11-103	8, 9	T-3¼ MB INC	2 - 55	7
[illegible]F587	125-0408-11-143	8, 9	B1A neon	56k 105-125 AC DC	6
[illegible]F907	125-1308-11-143	8, 9	B1A neon	56k 105-125 AC DC	7
[illegible]5F818	125-0463-11-113	8, 9	B2A neon	22K 110-125VAC	6
65F1106	125-1363-11-113	8, 9	B2A neon	22K 110-125VAC	7

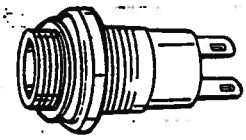


Fig. 6
Solder Terminal

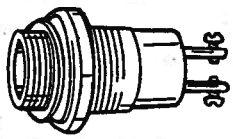


Fig. 7
Screw Terminal

125 SERIES CAP - UNFROSTED

Stock No.	Type	Color	Fig
45F582	125-1131-403	Red	8
45F583	125-1132-403	Green	8
45F584	125-1133-403	Amber	8
45F586	125-1135-403	White	8
45F588	125-1137-403	Clear	8
45F568	125-1191-403	Red	9
45F569	125-1192-403	Green	9
45F570	125-1193-403	Amber	9
45F572	125-1195-403	White	9
45F574	125-1197-403	Clear	9

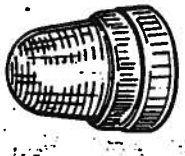


Fig. 8
Stovepipe Lens

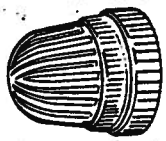


Fig. 9
Stovepipe Lens
(Internal Fluting)

177 SERIES BASE - 15/32" MOUNTING HOLE

Stock No.	Type	Lens Fig	Lamp Type	Accommodates Voltage	Fig
25F1637	177-8430-09-503	11	T-1¾ MF inc	1.35-28	10



Fig. 10
Solder Terminal

177 SERIES CAP - UNFROSTED

Stock No.	Type	Color	Fig
25F1638	177-0931-003	Red	11
25F1639	177-0932-003	Green	11
25F1640	177-0933-003	Amber	11
25F1642	177-0935-003	White	11
25F1644	177-0937-003	Clear	11



Fig. 11
Stovepipe Lens

181 SERIES BASE - 15/32" MOUNTING HOLE

Stock No.	Type	Lens Fig	Lamp Type	Accommodates Voltage	Fig
45F510	181-8864-09-553	11	C7A neon	62K 105-125 VAC	12
45F511	181-8836-09-553	11	C9A neon	22K 110-125 VAC	12

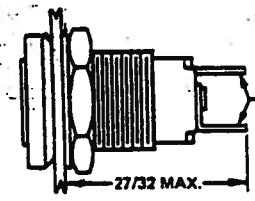


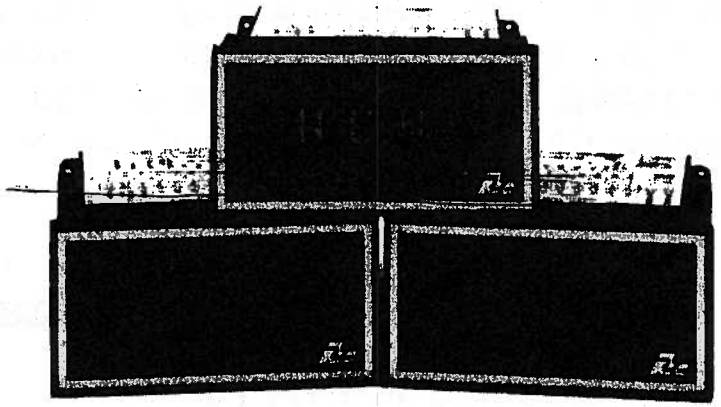
Fig. 12
Solder Terminal



1

REFERENCE: ELECTRICAL PART NO.(S) 41
ELECTRICAL SCHEMATIC NO. 347-9001-01

THE MESSAGE CENTER
SLAVE SERIES



MODEL MCS INSTRUCTION MANUAL

ADDENDUM NO. XMCI/S-A

APOLLO MESSAGE CENTERS

PARALLEL PORT STROBING
(MCI Manual, Page 32)
(MCS Manual, Page 13)

When using a solid-state device to actuate the strobe of the parallel port, you must be in a Negative Logic State on the control lines. This is true for both Sinking and Sourcing style outputs. For mechanical strobing you may use either Negative or Positive Logic on the control lines. Data inputs may be either Negative or Positive Logic, regardless of their source.

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GENERAL DESCRIPTION

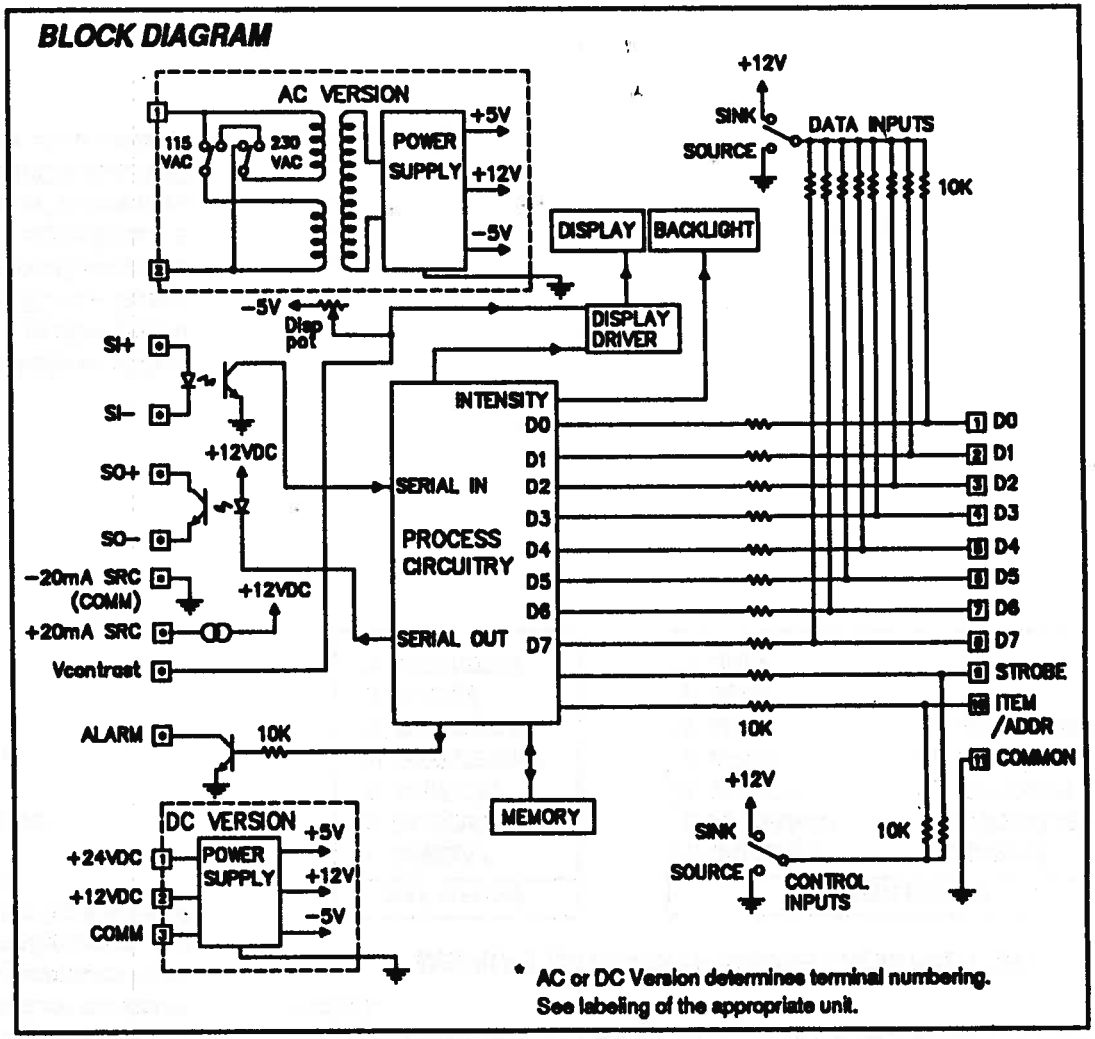
The Message Center Slave Unit (MCS) is a compact, programmable, display capable of displaying full alphanumeric information received via the serial port. Information received may be from a host computer, PLC, or any Red Lion Controls product with 20mA serial communications. The MCS display is a positive or negative image, transmissive, 5 x 7 dot-matrix Liquid Crystal Display available in configurations of either 2 lines of 20 characters or 1 line of 10 characters. Available LED backlight colors for the display are yellow/green or red. Communication with the MCS is accomplished via a serial port and/or an optional parallel port. A nonvolitale memory retains all set-up information when power is removed. The die-cast metal front bezel meets NEMA 4/IP65 requirements, allowing for washdown when properly installed. All connections are made through removeable terminal blocks for ease of installation and removal.

The MCS can be configured for any one of the following three modes of operation:

1) **REMOTE SLAVE MODE:** Operates primarily in conjunction with a Message Center Intelligent unit (MCI). In this mode the MCI transmits a message to the MCS display.
2) **SERIAL SLAVE MODE:** In this mode the MCS accepts standard ASCII transmissions for the display from a computer, ASCII terminal etc.
3) **RLC REMOTE DISPLAY SLAVE MODE:** This mode allows the MCS to receive and display the information from transmissions of other RLC products in the 20mA communication loop. This mode is available ONLY on MCS models with the parallel port.

The selected mode of operation determines the communications protocol and the function of the unit. For units without a parallel port, the mode selection for the Remote Slave and the Serial Slave modes is accomplished by sending the appropriate command. With a parallel port, the mode selection is determined on every reset command or power-up based on the settings of the data line bits (DO-D7) on the parallel port.

BLOCK DIAGRAM



CONFIGURATION SETTINGS

The Configuration Parameters determine the basic operation of the Message Center Slave Unit. The Configuration Parameter settings are programmed into the MCS at the factory, however, settings can be modified using the optional Apollo Message Center User Software or by sending the appropriate command via the serial port. If the optional User Software is used, only the parameters listed below will affect the MCS operation and all remaining configuration file parameters pertain to Message Center Intelligent units. The following is a list of the default configuration settings when shipped from the factory:

CONFIGURATION PARAMETER	DEFAULT SETTINGS:
Alarm Function	Enabled
Alarm Time-out	0 Secs (0=Latched)
Blink Time, Bottom Line	0.50 Secs
Blink Time, Top Line	0.50 Secs
Block Scroll Time, Bottom Line	1 Sec
Block Scroll Time, Top Line	1 Sec
Character Scroll Time, Bottom Line	0.32 Secs
Character Scroll Time, Top Line	0.32 Secs
Debounce Time	0.05 Secs
Display Intensity	8
Data Time-out	2 Secs
Serial Transmit Delay	0.50 Secs

Units without a parallel port are shipped with a default Unit Address of Zero and the Slave Mode operation is the Serial Slave Mode. If a parallel port is installed, the Slave Mode will be determined on power-up. The MCS has default Day/Month names that are stored in the MCS's ROM. The Day/Month names are accessed only in a message which utilizes the Date/Time field capabilities. If Day/Month names, other than those listed are desired, the *"custom"* names must be loaded into the MCS each time it is powered up or reset. The MCS does NOT have the capability of retaining these custom Day/Month names when power is removed.

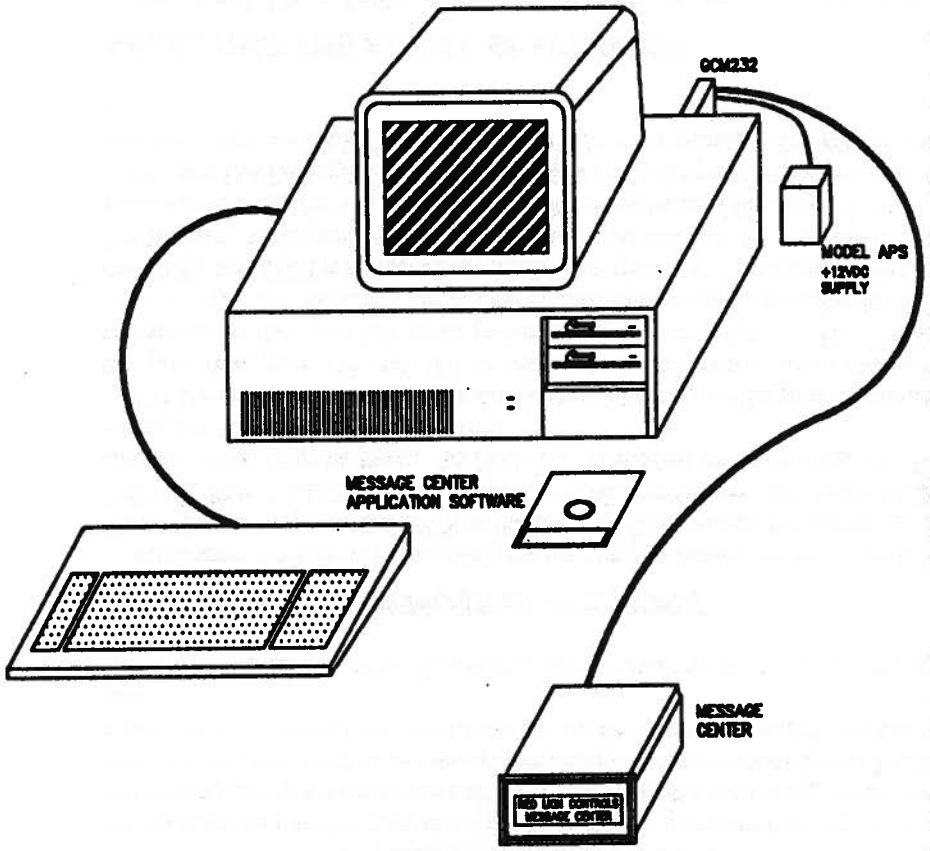
In applications where the MCS is used in conjunction with an MCI, the MC can be programmed to automatically download the Day/Month names using th MCI's command message capabilities (Refer to the MCI manual for more info: mation).

DEFAULT DAY/MONTH NAMES FROM FACTORY

DAY NAMES
1: *SUNDAY*
2: *MONDAY*
3: *TUESDAY*
4: *WEDNESDAY*
5: *THURSDAY*
6: *FRIDAY*
7: *SATURDAY*

MONTH NAMES	
1: *JANUARY*	8: *AUGUST*
2: *FEBRUARY*	9: *SEPTEMBER*
3: *MARCH*	10: *OCTOBER*
4: *APRIL*	11: *NOVEMBER*
5: *MAY*	12: *DECEMBER*
6: *JUNE*	
7: *JULY*	

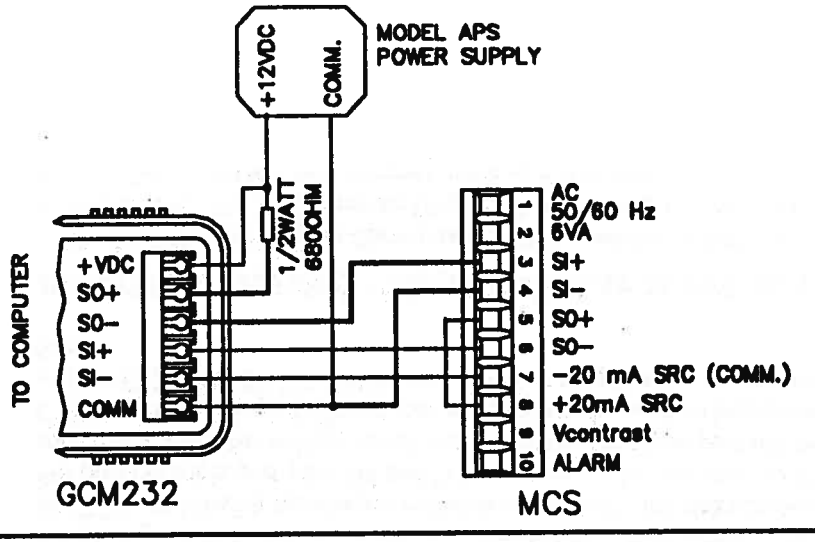
The Apollo Message Center Software can be used to change the configuration parameters by changing the User Software configuration file and downloading the file to the MCS. The following items are required to perform the above objectives and the diagram shows a typical hook-up:



MINIMUM REQUIREMENTS:

IBM* or IBM* compatible computer with:
RS232 serial port.
512K RAM.
DOS 3.0 or Later.
Monitor with MDA, CGA, EGA, or VGA Graphics Card.
Serial communication cable.
GCM232 - Serial Converter Module *(RS232/20mA Current Loop).*
APS (Accessory Power Supply) or equivalent (+12VDC power supply).
Message Center User Software *(available in 5.25" or 3.5" disk)*
Note: Downloading may only be performed via the serial port.

TYPICAL HOOK-UP



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SLAVE MODE SELECTION

MCS units WITHOUT a parallel port can be set for either the Serial Slave or the Remote Slave Mode. The slave mode is selected through the transmission of a command over the serial port. The Apollo Message Center User Software's Terminal Emulator Mode can be used to transmit the command to the MCS unit. The MCS saves the desired slave mode setting in non-volatile memory and the MCS remains in the selected mode until another command is sent to change it.

For MCS units with a parallel port, the desired slave mode is selected by tying the appropriate parallel port data pins (D0-D7) to common (for negative logic) and then applying power to the unit. The MCS checks the setting on the parallel port on every unit reset or power-up. To change the slave mode for an MCS with a parallel port, change the setting on the parallel port and reapply power to the unit.

NOTE: The three modes of operation are available to units with a parallel port.

SELECTING THE REMOTE SLAVE MODE

MCS units WITHOUT a parallel port are shipped from the factory in the Serial Slave Mode. To place the MCS in the Remote Slave mode, the command string "<CTRL B>xxC52DR*" is sent over the serial port (where "xx" is the MCS unit address which must be sent). "<CTRL B>" is entered by depressing the "B" key while the "CTRL" key is held down.

The Remote Slave mode is selected on units with a parallel port by connecting the port data pins D6 and D7 to common (hexadecimal value C0) and the remainder of the pins left open *(when using negative logic)*. The CTRL and DATA logic DIP switches are placed in the negative logic position (down) and the CTRL and DATA sink/source switches are placed in the sink position (down). For positive logic port pins D6 and D7 are connected to an external DC power source *(see specs for voltage level)* and the remainder of the pins left open. The CTRL and DATA logic DIP switches are placed in the positive logic position (up) and the CTRL and DATA sink/source switches are placed in the source position (up).

SELECTING THE SERIAL SLAVE MODE

The Serial Slave Mode is the default mode of operation for MCS units WITHOUT a parallel port. If the MCS had been previously placed in the Remote Slave Mode, the command string "NxxC52DS*" is sent over the serial port t place the MCS in the Serial Slave Mode *(where xx is the MCS unit address whic must be sent)*.

The Serial Slave Mode is selected on units with a parallel port by connectin the port data pins D5 and D7 to common (hexadecimal value A0) and th remainder of the pins left open (when using negative logic). The CTRL an DATA logic DIP switches are placed in the negative logic position (down) an the CTRL and DATA sink/source switches are placed in the sink position (down For positive logic port pins D5 and D7 are connected to an external DC pow source *(see specs for voltage level)* and the remainder of the pins left open. Th CTRL and DATA logic DIP switches are placed in the positive logic position (up and the CTRL and DATA sink/source switches are placed in the source positic (up).

SELECTING THE RLC REMOTE DISPLAY SLAVE MODE

The RLC Remote Display Slave mode is NOT available on MCS units witho a parallel port. The RLC Remote Display Slave mode is selected by connectin the port data pin(s) to a hexadecimal value of 99h or less.

REMOTE SLAVE & SERIAL SLAVE MODES

REMOTE SLAVE MODE

The Remote Slave Mode should be selected when it is desired to interface a Message Center Intelligent Unit (MCI) with one or more MCS units. The MCS will also display information that is transmitted from a host computer, provided that the information is sent in the correct format. To display a message on the MCS from an MCI, the desired message is requested at the MCI. The MCI assembles and transmits the requested message designated for the serial port to the MCS unit(s). This mode of operation allows the MCI to act as a message library for multiple Message Center Slave units. In order for an MCS unit to properly recognize and process the MCI transmission, it must have the Remote Slave Mode selected (Refer to Slave Mode Selection section).

The MCS also has the capabilities of blinking and scrolling characters, issuing alarms, requesting an elapsed timer, and displaying message text for a predetermined message time-out value. The MCS automatically selects character scrolling for message text which is longer than the MCS's display line length. The elapsed time fields are continuously updated with a time resolution of .01 seconds and the maximum accumulated elapsed time is 99:59:59:99 at which point the timer restarts from zero.

The most recent message text transmission is always placed on the display. Any message text residing on the display at that time is removed. Once the displayed message times out or is cancelled, the MCS will blank the display.

SERIAL SLAVE MODE

The Serial Slave Mode should be selected when it is desired to have the MCS display standard ASCII transmissions. All ASCII characters received by the MCS will be displayed, if the characters are in the MCS character set. The MCS will automatically select character scrolling for message blocks that are longer than the MCS's display line length. Control Codes are used to perform commands that affect the message time-out value, alarm functions, blinking, block scrolling, dual line messages, and date/time functions. The elapsed time fields are continuously updated with a time resolution of .01 seconds, and the maximum accumulated elapse time is 99:59:59:99 at which point the timer restarts from zero.

If the unit address code is sent, all MCS units in the Serial Slave Mode on the loop check the unit address code to verify that the address corresponds with the MCS unit address(es) before processing the character string. A unit address of "00" must be sent to access unit "00" exclusively. If the address code is not present, all MCS units in the Serial Slave Mode on the loop will process the transmitted string, regardless of their address.

If a command code is transmitted without the address code, all units will process the string as a command rather than a message. If neither the address code nor the command code precedes the character string, the string is processed as message text by all MCS units on the loop.

DISPLAY FUNCTIONS

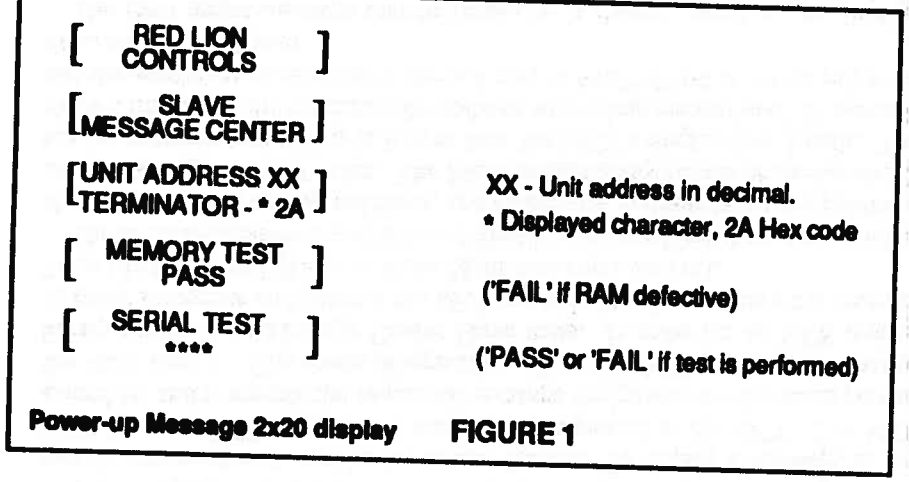
There are various functions that affect how and what information is presented on the display. Some of these are programmed in the configuration parameters and some are specified in the transmitted message text.

POWER-UP MESSAGE

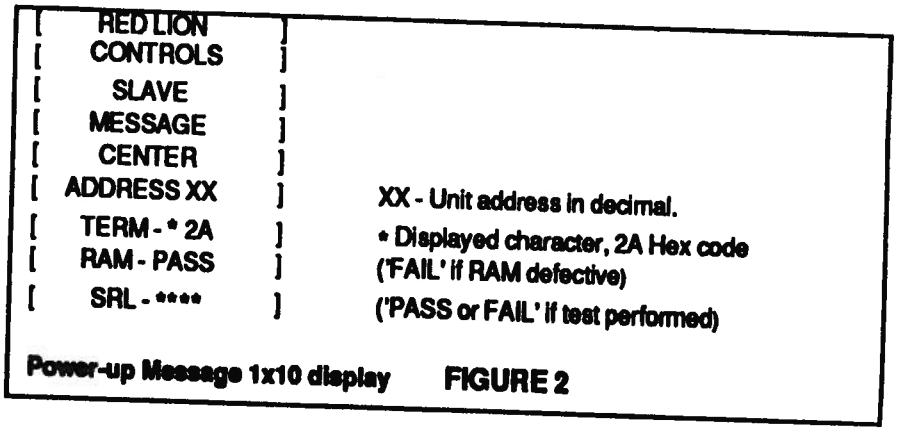
When the MCS is powered up or receives a *"RESET"* command, it will conduct a series of self-diagnostics. The results are shown on the MCS display if the MCS is in the Remote Slave or Serial Slave mode. The display indicates unit address, serial terminator, and diagnostics results about the Message Center.

The MCS will transmit two characters over the serial port regardless of the slave mode setting. First a *"P"* or *"F"* to indicate the results of a RAM test. Second a *"P"* or *"F"* to indicate the results of a serial loop back test or an *"N"* if this test was NOT invoked *(refer to serial communications section)*.

With the block scroll time set for one second, the message will scroll twice on the display. The message text is shown in figure 1 for a 2x20 display unit and a 1x10 display unit is shown in figure 2.



Power-up Message 2x20 display **FIGURE 1**



Power-up Message 1x10 display **FIGURE 2**

BLINKING CHARACTERS

Control codes included in the message text cause characters to blink when placed onto the display. This will allow individual and/or multiple characters of text, and date/time fields to blink in the message text. The blink time configuration parameter has separate rates for top and bottom lines for a 2x20 display. A 1x10 display uses the top line value for its rate.

CHARACTER SCROLLING

The MCS will automatically designate a display line for character scrolling if the received message text is longer than the MCS's display line length. The top and bottom lines of a 2x20 display have separate programmable scroll rates and a 1x10 display scroll rate is programmed using the top line. Scroll rate times can be changed in the configuration parameters by sending the appropriate command or by using the optional Message Center User Software. The message text scrolls from right to left across the display and blank spaces will follow the last character of text until the last character scrolls off the left of the display. At this time, the line will repeat or the next segment of text will begin to scroll.

A message received from an MCI unit that was designated for character scrolling, will only character scroll on a receiving MCS unit, if the block of text for the given line exceeds the MCS unit's display line length. Otherwise, that message will be static or will block scroll. Consequently, a message displayed on an MCI unit may not be displayed in the same manner on an MCS unit.

BLOCK SCROLLING

Message text can be arranged in segments to be scrolled in block fashion, displaying each block segment for the programmed block scroll time before sequencing to the next block segment in the message text. A 2x20 display may be programmed for different block scroll times for the top and bottom lines. A 1x10 display scroll time is programmed using the top line. Scroll rate times can be changed in the configuration parameters by sending the appropriate command or by using the optional Message Center User Software. If the characters in a block segment exceed the display character width, the MCS will automatically designate the line containing that block for character scrolling. When the last block of text for a line has been reached, the display will blank and the message text is then repeated for that line, starting with the first block of text. The message text will continue to scroll, until the message times out or is removed from the display.

MESSAGE TIME-OUT

If a message time-out value is sent to the MCS with the message, it will automatically expire after the time-out value is attained. A message can have a time-out value from 1 to 250 seconds. If the message time-out value is NOT sent with the message, the message will remain on the display until a new message is received, power is removed from the unit, a cancel displayed message is sent, or a reset unit command is sent.

ALARM OUTPUT

The alarm output functions as a message triggered ALARM output. If the message alarm code is sent and the alarm function is enabled, the open collector NPN transistor will go low when the message is displayed. The alarm output can have a time-out value of 0-250 seconds, with 0 indicating latched alarm.

The possible operating modes for the alarm are described below:

LATCHED ALARM

If the MCS configuration parameter is set for a latched alarm (alarm time-out of 0), and the alarm function is enabled for the unit, the MCS will activate the alarm output when a message requesting an alarm is placed on the display. The alarm will remain active until the message times-out, is replaced, is cancelled, or a cancel alarm command is issued.

TIMED ALARM

If the MCS configuration parameter is set for an alarm time-out value other than zero, and the alarm function is enabled for the unit, the MCS will activate the alarm output when a message requesting an alarm is placed on the display. The alarm will remain active until the alarm times-out, the message times-out, is replaced, is cancelled, or a cancel alarm command is issued.

EMBEDDED FUNCTIONS

In addition to text, a message may also contain Date and Time fields. Since the MCS does not have a real time clock, the Date/Time fields must be continually updated by an external unit in order for the MCS to be able to display the latest date and time.

CURRENT DATE/TIME

The current date/time fields can be embedded into the message text using control codes and arranged in any order in the message text. A list of the date and time capabilities is shown below:

Date:

Day of Week: Full (ie. MONDAY); abbreviated (ie. MON)
Day of Month : Numeric (ie.1-31)
Month: Full (ie. JANUARY); abbreviated (ie. JAN); numeric (ie. 1 = January)
Year: 4 digit (ie. 1990); 2 digit (ie. 90)

Time:

12 hour clock: In Hours, Minutes, Seconds, Tenths of seconds, and/or Hundredths of seconds. Also, the AM or PM designator may be included *(ie. 4:30 PM)*.

24 hour clock: In Hours, Minutes, Seconds, Tenths of seconds, and/or Hundredths of seconds *(ie. 1630)*.

Separators:

Date and Time Field: Any character NOT used in the individual date/time fields can be inserted into the date/time string (*ie.* "-", ":", "/"). (*Examples 16:30:00, 01/03/57*).

ELAPSED TIME

An elapsed timer in the MCS allows a timing function to be included with a message. The elapsed time will begin running when the message is requested and continues to run until the message is removed from the display. All elapsed time fields are continuously updated by the MCS with a time resolution of .01 seconds. The time fields available are HH:NN:SS:UU:U and the maximum accumulated elapsed time is 99:59:59.99 at which point the timer restarts from zero.

CONTROL CODES

The following is a list of Control Codes that the MCS will respond to along with their description. These codes are used when transmitting message text to the MCS from a host unit and the MCS must be in either the Remote Slave or the Serial Slave Mode. The CTRL Key Code is entered by depressing the appropriate letter key while holding the CTRL key down or the ALT Key Code is entered by depressing the appropriate numeric keys on the numeric keypad while holding down the ALT key.

MCI units will automatically place any applicable MCS control codes in the message before transmitting the message to an MCS unit. The resultant transmitted character string contains only characters of 7F hex or less. Consequently, the MCS is compatible with the seven data bit serial format with no loss of functionality.

HEX	CONTROL KEY	ALT KEY	
(01)	<CTRL A>	<ALT 1>	- Extended characters 80H to B8H must be reduced to a 7-bit number before being transmitted to the MCS. Therefore, 50H must be subtracted from the desired extended character number and the difference is sent, preceded by the control code. Example: Extended character 91 is transmitted as <CTRL A> 41.
(07)	<CTRL G>	<ALT 7>	- Message alarm code. Activates the MCS ALARM pin if the Alarm function is enabled.
(08)	<CTRL H>	<ALT 8>	- Message time out code. Followed by a three digit message time out value. Leading zeroes must be sent. Example: <CTRL H>030 specifies a time out value of 30 seconds.
(0A)	<CTRL J>	<ALT 10>	- Line feed, identifies the end of the top line of the message text.
(0D)	<CTRL M>	<ALT 13>	- Carriage return, identifies the end of a block scroll segment for message text. If the number of characters in any block exceeds the display line length that line of text will character scroll.
(15)	<CTRL U>	<ALT 21>	- Identifies the beginning of a blinking field.
(16)	<CTRL V>	<ALT 22>	- Identifies the end of a blinking field. Example: <CTRL U>TEST<CTRL V> would cause the word "TEST" to blink.
(17)	<CTRL W>	<ALT 23>	- Identifies the beginning of a date/time field.
(18)	<CTRL X>	<ALT 24>	- Identifies the end of a date/time field. Example: <CTRL W>HA:NN:SS<CTRL X> would cause the stored values for the current hour, minute, and second to be displayed.
(19)	<CTRL Y>	<ALT 25>	- Identifies the beginning of an elapsed time field.
(1A)	<CTRL Z>	<ALT 26>	- Identifies the end of an elapsed time field. Example: <CTRL Y>HH:NN:SS.UU<CTRL Z> would cause the MCS to reset and start its elapsed timer and display the running elapsed time.
(1F)	<CTRL>	<ALT 31>	- Code used for sending an asterisk as text to an MCS, instead of as a terminator.

Message transmission string examples:

Remote Slave Mode:

N01M<CTRLG><CTRLH>040<CTRL U>Message<CTRL V>*

Serial Slave Mode:

<CTRL B> 01M <CTRL G><CTRL H> 040 <CTRL U> Message <CTRLV>*

"N"	-	MCS Unit Address Follows.
"01"	-	Unit Address.
<CTRL B>	-	Indicates MCS Unit Address Follows.
"M"	-	Indicates start of message text.
<CTRL G>	-	Issues alarm.
<CTRL H>	-	Indicates message times out.
"040"	-	Message time out value, 40 seconds.
"Message"	-	The word "Message" will blink on the display.
"*"	-	End of transmission.

Remote Slave Mode: N01M SLAVE MESSAGE *

Serial Slave Mode: SLAVE MESSAGE *

"N"	-	MCS Unit Address Follows.
"01"	-	Unit Address.
"M"	-	Indicates start of message text.

"SLAVE MESSAGE - "SLAVE MESSAGE" will be static on a 2x20 display, but on a 1x10 display "SLAVE MESSAGE" will character scroll.

"*" - End of transmission.

DATE/TIME FIELD CODES

The following codes are used in conjunction with the appropriate control codes when requesting the date/time fields. The MCS will process the date and time field according to the latest clock time that was received by the MCS. The clock in the MCS must be continually updated if the current time is to be viewed when sending date/time fields. The MCS will NOT retain clock settings if powered down or when it receives a reset command. The clock value may be sent from a terminal or from an MCI unit.

The elapsed time fields do NOT need to be updated, the MCS will update automatically.

Date/Time Field Codes

AA	-	Day name, abbreviated
AF	-	Day name, full
U	-	Tenths of a second
UU	-	Hundredths of a second
SS	-	Seconds
NN	-	Minutes
HM	-	Hours, 24 hour clock
HA	-	Hours, 12 hour clock
HH	-	Hours, elapsed time
P	-	AM/PM
DD	-	Day of month, numeric
MM	-	Month, numeric
MA	-	Month name, abbreviated
MF	-	Month name, full
Y2	-	Year, 2 digits
Y4	-	Year, 4 digits

NOTE: Field codes must be sent in capital letters.

RLC REMOTE DISPLAY SLAVE MODE (1x10 Display Only)

The RLC Remote Display Slave Mode should be selected when it is desired to interface directly to one or more Red Lion Controls products with 20mA serial communications. The MCS is set-up by the user to interrogate a specific address number of an RLC unit and then the MCS will repeatedly transmit a Print Request Command to that RLC unit. The RLC unit will transmit to the MCS per the print function programmed for that RLC unit (refer to appropriate RLC manual for print functions). The MCS will display the received data item string selected by the user. The specified RLC unit address and the data item string to be displayed by the MCS is selected over the MCS's parallel port in BCD.

A BCD thumbwheel or rotary switch can be connected to the MCS's parallel port to select the address number and data item. The data port pins D0 through D7 can be set-up to sink or source current and use negative or positive logic. When the BCD values are set on the parallel port data pins, D7 is the most significant bit and D0 the least significant bit. The address of the desired RLC unit is selected by placing the RLC unit address on the parallel port data pins, taking the ITEM/ADDR pin to the ADDR logic state and activating the strobe pin. The strobe pin must remain low until the address number is accepted. After the strobe goes high and the debounce timer expires, the RLC unit address number is requested.

Selection of a data item for display is accomplished by placing the data item number on the data pins, taking the ITEM/ADDR pin to the ITEM logic state and activating the strobe pin. The strobe pin must remain low until the data item number is accepted. After the strobe goes high and the debounce timer expires, the item number will be displayed on the MCS.

The MCS uses the last unit address number entered until a new address number is requested. Therefore, it is possible to access each data item for a given RLC unit by entering the unit address number once and the data item numbers as desired. Also, the MCS uses the last data item number entered until a new item number is requested. Therefore, it is possible to access the same data item from several different units simply by entering the data item number once and the unit address numbers as desired. The address and item numbers that were last requested are saved when power is removed.

The MCS will update the data item number for the display once every 250 milliseconds to every five seconds depending on the serial loop baud rate and the number of data item strings the MCS receives from the selected RLC unit. The initial power up values for the unit are address "0" and item 1. If the intended u is with an RLC unit with an address of "0" and only one item is being require the parallel port need not be used.

If the addressed RLC unit transmits its unit address and mnemonics, the addre and mnemonics are displayed along with the data by the MCS.

If the MCS does not receive a response within the Data Time-out value specifie in the configuration parameters, the MCS inserts the address number selected wi the text "NO DATA" in the data field. If the MCS receives an "*" from the RL unit indicating unit overflow, it inserts the text "OVERFLOW" along with th data.

To display the 2nd data item string of an RLC Gemini 5200 unit with addres number 3 and print option number 4 selected, the following steps are performec

1. Place the BCD value 03 on the port pins.
2. Place the ITEM/ADDR control line in the ADDR state.
3. Activate the strobe pin.
4. Place the BCD value 02 on the port pins.
5. Place the ITEM/ADDR control line in the ITEM state.
6. Activate the STROBE

The MCS transmits N03P* and the Gemini 5200 with address #3 transmits the following data item strings:

Data Item 1
"3 CTA 123456<CR>"

Data Item 2
"3 CTB 123456<CR>"

Data Item 3
"3 CTC 123456<CR> <LF>"

The MCS selects the 2nd data item transmission for display "3 CTB 123456"

The MCS will alternate between displaying the address and mnemonics, and the data as shown below:

[3 CTB]
[123456]

All data is centered in display and the amount of time that the address and mnemonic, and the data are displayed is determined by the block scroll time.

PARALLEL PORT

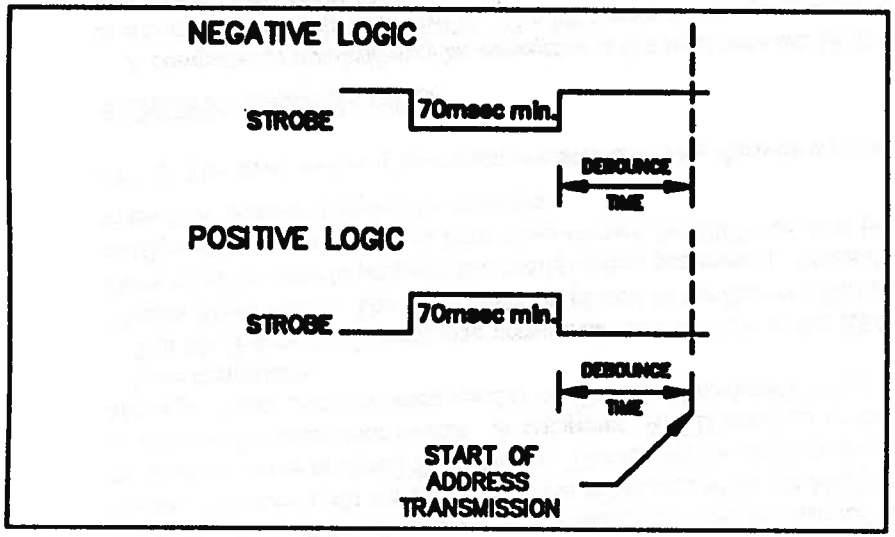
The parallel port has two control lines (STROBE & ITEM/ADDR), 8 data lines, and a common. The data and control lines can either sink or source current and are DIP switch selectable. When the switches are set to the SINK position, the input lines are pulled high to +12VDC through an internal 10Kohm resistor. When the switches are set to the SOURCE position, the input lines are pulled to common through the same resistor. The switches are located next to terminal block TBB.

The data and control lines can be set separately for positive or negative logic. The data lines are active low for negative logic and active high for positive logic. For the ITEM/ADDR line, ADDR is active low for negative logic and active high positive logic. Therefore the ITEM line is active high for negative logic and active low for positive logic. The strobe line can also be either positive or negative logic. The CTRL logic DIP switch sets both the ITEM/ADDR and strobe line logic. The DIP switches are located at the side of the unit.

The parallel port is used to set the unit address and select the desired data item in the RLC Remote Display Slave Mode in which the MCS expects information presented on the parallel port to be in 8-bit BCD representation (00-99).

Also the parallel port selects the Slave Mode on a power-up or reset. (Refer to Slave mode selection section).

Timing of the parallel port lines should be considered when connecting to various external devices as shown below:



STROBE AND ITEM/ADDR LINES

The parallel port STROBE pin is used to signal the MCS that it should read the current information on the parallel port data lines.

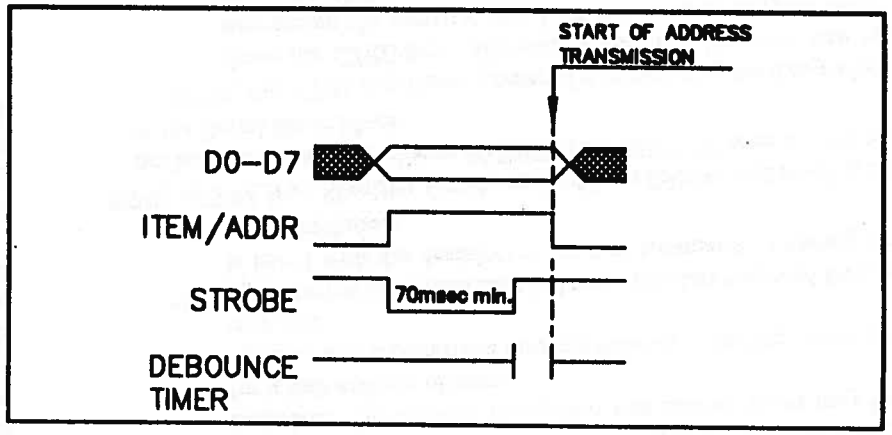
The strobe pin is recognized when an edge is detected, and the pin remains in its active state. After the strobe goes to its inactive state and the debounce timer expires, the information on the data lines is accepted. The strobe has a minimum inactive time equal to the programmed debounce time.

PARALLEL PORT STROBE PIN DEBOUNCING

A user adjustable software debounce timer is available for the parallel port STROBE pin. The user can adjust the debounce time from 50 msec to 2.5 seconds. The debounce timer starts when the strobe pin goes to its inactive state. This insures that no additional requests for address or data items will be generated if there is contact bounce. The debounce timer can only be programmed while the MCS is in the Remote Slave or Serial Slave Mode.

The active state pulse width of the strobe must be 70msec minimum. The active state pulse width, as well as the inactive state pulse width of the strobe, each must be longer than the time programmed for the debounce timer. (The active state and the inactive state may be the same.)

NOTE: To keep system response time to a minimum, these pulse widths should be kept as short as possible.



COMMANDS

The user may reconfigure the MCS *"on-line"* through the use of commands. Commands are used to change configuration parameters or perform various functions. Such parameters as scroll and blink rates can be changed with commands. All commands are issued over the serial port while the MCS is in either the Remote Slave or Serial Slave Mode. The format for sending the commands is different for these two modes. A computer, ASCII terminal or the optional Message Center User Software, used in the Terminal Emulator Mode, can be used to issue commands.

The MCS does NOT recognize commands issued while in the RLC Remote Display Slave mode. The MCS must be placed in the Remote Slave or Serial Slave mode in order to program the configuration parameters. When the desired configuration parameters have been programmed, the MCS can then be returned to the RLC Remote Display Slave mode.

NOTE: The three modes of operation are available to units with a parallel port.

SENDING COMMANDS

A computer or terminal may be connected in the loop with the MCS and MCI to transmit commands to the MCS. The MCI may also be programmed to send commands to the MCS (Refer to MCI manual).

Commands sent to the MCS will depend on whether the MCS is in the Remote Slave or Serial Slave Mode. The following transmission formats are shown for each mode:

1) Remote Slave Mode

NC format NnnCcc*

NCD format NnnCccDdd..d*

nn - Unit Address.

cc - Command Number.

dd.d - Command Data.

2) Serial Slave Mode

<CTRL B>C format — <CTRL B>nnCcc*

<CTRL B>CD format — <CTRLB>nnCccDdd..d*

<CTRL C> format — <CTRLC>cc*

<CTRL C>D format — <CTRL C>ccDdd..d*

"N" Signifies that the unit address follows and leading zeros need not b included. The address designator and address bytes may be omitte for a unit address of zero.

"C" Signifies that a command number follows. Leading zeros need not b included.

"D" Signifies that command data follows. The data required for a comman is listed with the description for that command. Leading zeros nee not be included.

(02H) <CTRL B> - Signifies that the unit address follows and leading zeros nee not be sent. To access address 00 EXCLUSIVELY, 00 must be sent to an MC in the Serial Slave Mode.

NOTE: The CTRL Key Code is entered by depressing the B key while holdin down the CTRL key. Alternately, the ALT key code can be used b depressing the numeric key 2 on the numeric keypad while holdin down the ALT key.

(03) <CTRL C> - Signifies that command data follows and ALL Serial Slave Mode units on the loop will respond to the command, regardless of their unit address

NOTE: The CTRL Key Code is entered by depressing the C key while holding down the CTRL key. Alternately, the ALT key code can be used by depressing the numeric key 3 on the numeric keypad while holding down the ALT key.

""* Signifies the serial port terminator character.

NOTE: All command characters must be in capital letters.

COMMAND LIST

Following is a list of commands that the MCS will respond to along with their description and proper command format:

ALARM FUNCTION, DISABLE

This command disables the alarm function for the ALARM output.

Remote Slave Command Format: NnnC9*
Serial Slave Command Format: <CTRL B>nnC9*

ALARM FUNCTION, ENABLE

This command enables the ALARM function.

Remote Slave Command Format: NnnC8*
Serial Slave Command Format: <CTRL B>nnC8*

ALARM OFF

This command turns off the alarm output. This command has no effect if the ALARM function is disabled.

Remote Slave Command Format: NnnC39*
Serial Slave Command Format: <CTRL B>nnC39*

ALARM ON

This command turns on the alarm output. This command has no effect if the ALARM function is disabled.

Remote Slave Command Format: NnnC40*
Serial Slave Command Format: <CTRL B>nnC40*

ALARM TIME OUT VALUE

This command sets the alarm time-out value. The alarm time-out value ranges from 0-250 seconds. An alarm time-out of 0 seconds indicates the Alarm will latch and NOT time-out when set.

Remote Slave Command Format: NnnC41Dddd*
Serial Slave Command Format: <CTRL B>nnC41ddd*

CANCEL DISPLAYED MESSAGE

This command cancels the message on the display.

Remote Slave Command Format: NnnC20DD*
Serial Slave Command Format: <CTRL B>nnC20DD*

CANCEL ERROR MESSAGE

This command cancels an error code on the MCS display. Error codes can also be cancelled using the Cancel Displayed Message Command.

Remote Slave Command Format: NnnC16*
Serial Slave Command Format: <CTRL B>nnC16*

CLOCK, SET TIME

This command loads a clock field value into the MCS. The clock fields can be accessed for viewing by sending the proper Date/Time fields after the clock time is sent (Refer to Date/Time field codes section).

The format for the data section of the command is as follows:

Remote Slave Command Format: NnnC6Duussnnhhaddmmyy*
Serial Slave Command Format: <CTRL B>nnC6Duussnnhhaddmmyy*

uu	-	Hundredths
ss	-	Seconds
nn	-	Minutes
hh	-	Hours in 24 hour clock time (00-23)
a	-	Day of the week (Sunday = 1)
dd	-	Numeric Day of month
mm	-	Numeric Month
yy	-	Last two digits of the year

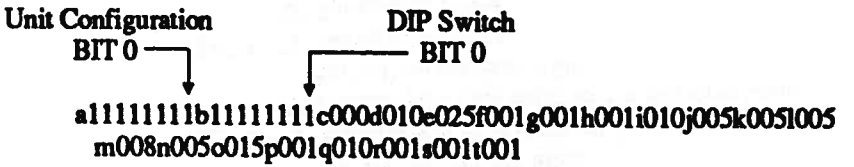
The clock values must be sent in this order and leading zeros must be sent.

DUMP UNIT CONFIGURATION

This command causes the current configuration parameters of the addressed unit to be dumped to the serial port.

Remote Slave Command Format: NnnC30*
Serial Slave Command Format: <CTRL B>nnC30*

OUTPUT of MCS UNIT: All data fields are three digit decimal, except where noted.



DUMP UNIT CONFIGURATION (Cont'd)

a	-	Unit configuration byte in binary (see the following).
b	-	DIP switch settings in binary (see the following).
c	-	N/A
d	-	Unit address.
e	-	Alarm time-out value (in seconds).
f	-	RLC Remote Display Slave Mode data item displayed (in decimal).
g	-	Parallel port strobe debounce time (in 10msec increments).
h	-	Display intensity level (0-15).
i	-	N/A
j	-	Serial transmit delay time (in 10msec increments).
k	-	RLC Remote Display Slave Mode unit address displayed (in decimal).
l	-	Serial port terminator character (in hex).
m	-	Character scroll time, top line (in 10 msec increments).
n	-	Character scroll time, bottom line (in 10msec increments).
o	-	Block scroll time, top line (in seconds).
p	-	Block scroll time, bottom line (in seconds).
q	-	Blink time, top line (in 10msec increments).
r	-	Blink time, bottom line (in 10msec increments).
s	-	Data time-out value (in seconds).
t	-	N/A

UNIT CONFIGURATION BYTE

BIT 7 - Unused.
BIT 6 - "1" MCS has a 2 line by 20 character display.
"0" MCS has a 1 line by 10 character display.
BIT 5 - "1" The MCS has a parallel port.
"0" The MCS has no parallel port.
BIT 4 - Unused
BIT 3 - Unused
BIT 2 - "1" ALARM output is enabled.
"0" ALARM output is disabled.
BIT 1 - Unused
BIT 0 - Unused

DIP SWITCH SETTINGS

BIT 7 - "1" Parallel port control logic set for positive logic.
"0" Parallel port control logic set for negative logic.
Set to 0 on portless units.
BIT 6 - "1" Parallel port data logic set for positive logic.
"0" Parallel port data logic set for negative logic.
Set to 0 on portless units.
BIT 5 - "1" Serial data 8-bits.
"0" Serial data 7-bits.
BIT 4 - "1" Odd parity.
"0" Even parity.
BIT 3 - "1" Parity bit.
"0" No parity bit.
BIT 2 - Bits 0, 1, & 2 indicate the serial baud rate as listed below:

Bit	2	1	0	
	0	0	0	300
	0	0	1	600
	0	1	0	1200
	0	1	1	2400

BIT 1
BIT 0

DUMP UNIT DAY/MONTH NAMES

This command causes the current Day/Month names to be dumped to the serial port.

Remote Slave Command Format: NnnC37*
Serial Slave Command Format: <CTRL B>nnC37*
MCS outputs: ddd...d*
ddd...d - 7 day names and 12 month names, including spaces and in order.

DATA TIME-OUT

This command sets the amount of time-the MCS will wait for data from an RLC unit when the MCS is in the RLC Remote Display Slave mode.

Remote Slave Command Format: NnnC38DRddd*
Serial Slave Command Format: <CTRL B>nnC38DRddd*

The time-out value ranges from 0-250 seconds. 0 indicates that the MCS will wait indefinitely for data.

RESET UNIT

This command resets the unit to the power up condition. Any message on the display is cleared. The MCS will display the power up message when this command is issued. The Day/Month names will default to the factory settings and the clock is cleared. See power up message section.

Remote Slave Command Format: NnnC28*
Serial Slave Command Format: <CTRL B>nnC28*

SET BLINK TIME

This command sets the blink time for both top and bottom lines. The blink times range from .01 to 2.50 seconds, in increments of 10 msec.

Remote Slave Command Format: NnnC23DTddd*
Serial Slave Command Format: <CTRL B>nnC23DTddd*

SET BLINK TIME, 2ND LINE

This command sets the blink time for the bottom line only. The blink time ranges from .01 to 2.50 seconds, in increments of 10 msec.

Remote Slave Command Format: NnnC23DBddd*
Serial Slave Command Format: <CTRL B>nnC23DBddd

SET BLOCK SCROLL TIME

This command sets the block scroll time for both the top and bottom lines. The scroll times range from 1 to 250 seconds, in increments of 1 second.

Remote Slave Command Format: NnnC24DTBddd*
Serial Slave Command Format: <CTRL B>nnC24DTBddd*

SET BLOCK SCROLL TIME, 2ND LINE

This command sets the block scroll time for the bottom line only. The scroll time ranges from 1 to 250 seconds, in increments of 1 second.

Remote Slave Command Format: NnnC24DBBddd*
Serial Slave Command Format: <CTRL B>nnC24DBBddd*

SET CHARACTER SCROLL TIME

This command sets the character scroll time for both the top and bottom lines. The scroll times range from .01 to 2.50 seconds, in increments of 10 msec.

Remote Slave Command Format: NnnC24DTHddd*
Serial Slave Command Format: <CTRL B>nnC24DTHddd*

SET CHARACTER SCROLL TIME, 2ND LINE

This command sets the character scroll time for the bottom line only. The scroll time ranges from .01 to 2.50 seconds, in increments of 10 msec.

Remote Slave Command Format: NnnC24DBHddd*
Serial Slave Command Format: <CTRL B>nnC24DBHddd*

SET DEBOUNCE TIME

This command sets the parallel port STROBE pin debounce time for the RLC Remote Display Slave Mode. The time ranges from .05 to 2.50 seconds in 10msec increments.

Remote Slave Command Format: NnnC29Dddd*
Serial Slave Command Format: <CTRL B>nnC29Dddd*

SET DISPLAY INTENSITY

This command sets the desired backlight intensity level. The intensity level ranges from 0 - 15. A setting of 0 turns the backlight off.

Note: Display contrast variations may be observed at higher ambient temperatures, with intensity settings greater than 8.

Remote Slave Command Format: NnnC10Ddd*
Serial Slave Command Format: <CTRL B>nnC10Ddd*

SET SERIAL TRANSMIT DELAY

This command sets the serial port transmit delay time for the RLC Remote Display Slave Mode. Serial port transmissions are delayed by the specified value. The time ranges from .01 to 2.50 seconds, in increments of 10 msec.

Remote Slave Command Format: NnnC48Dddd*
Serial Slave Command Format: <CTRL B>nnC48Dddd*

SET UNIT ADDRESS

This command changes the unit address, *(0 - 99)*.

Remote Slave Command Format: NnnC3dd*
Serial Slave Command Format: <CTRL B>nnC3dd*

SERIAL COMMUNICATION

The serial port has two 20mA current loops and provides half duplex, isolated two-way communication. Some typical devices that can be connected to the serial port are; ASCII terminals, programmable controllers, host computers, and Red Lion Controls products with 20mA current loop. Two loops are required for all hook-ups; a transmit loop (SO+ & SO-) and a receive loop (SI+ & SI-). The built-in +20mA current source can be used for either the transmit loop or receive loop. The -20mA SRC (Common) is the current return connection. Multiple units can be connected to the serial loop, but the actual number is limited by the Serial Hardware Specifications. To eliminate problems with ground loops, keep the -20mA common isolated from earth ground.

The serial port can be used to perform the following operations; issue commands, receive data for the display, and download a configuration file using the Message Center User Software. The MCS has a built-in feature that can be used to test the Serial Communications Hardware. Refer to the Serial Hardware (loop-back) Test section.

COMMUNICATION FORMAT

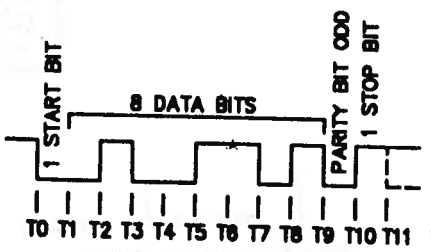
Data is transmitted by switching off and on the current in the 20mA current loop. Data is received by monitoring the switching action and interpreting the codes that are transmitted. The data format and baud rate must be identical between the transmitting and receiving units for the data to be interpreted correctly. There are three data formats available:

1) 11 Bits - 1 start bit, 8 data bits, 1 parity bit, 1 stop bit.
2) 10 Bits - 1 start bit, 7 data bits, 1 parity bit, 1 stop bit,
   1 start bit, 8 data bits, 1 stop bit.
3) 9 Bits - 1 start bit, 7 data bits, 1 stop bit.

The data format and baud rate are DIP switch selectable. There are three data formats available:

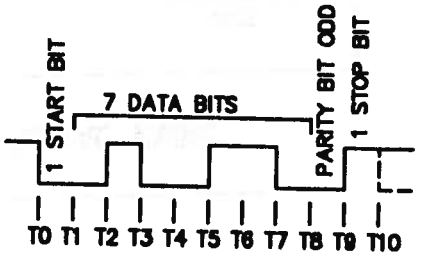
The baud rates available are 300, 600, 1200 and 2400. The parity bit can be even or odd. Valid address numbers from 0-99 may be assigned. The address number can be changed using the Message Center User Software or by issuing the appropriate command. Although there are 99 valid addresses, the built in current source, if used , is only capable of driving a maximum of 7 units.

11 BIT DATA FORMAT

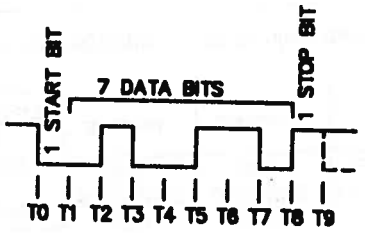


10 BIT DATA FORMAT

(Can be 8 Data Bits and 1 Stop Bit)



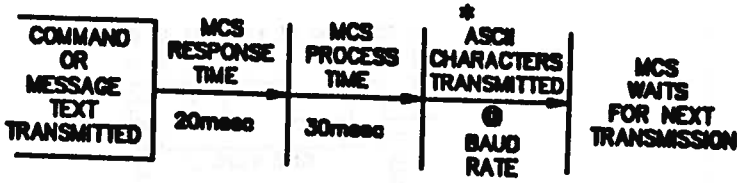
9 BIT DATA FORMAT



SERIAL TIMING

The MCS in the Remote Slave or Serial Slave mode has a serial response time of 50 msec. Only one transmission should be sent to the MCS within any 50 msec. period and the transmission string is terminated with an asterisk "*".

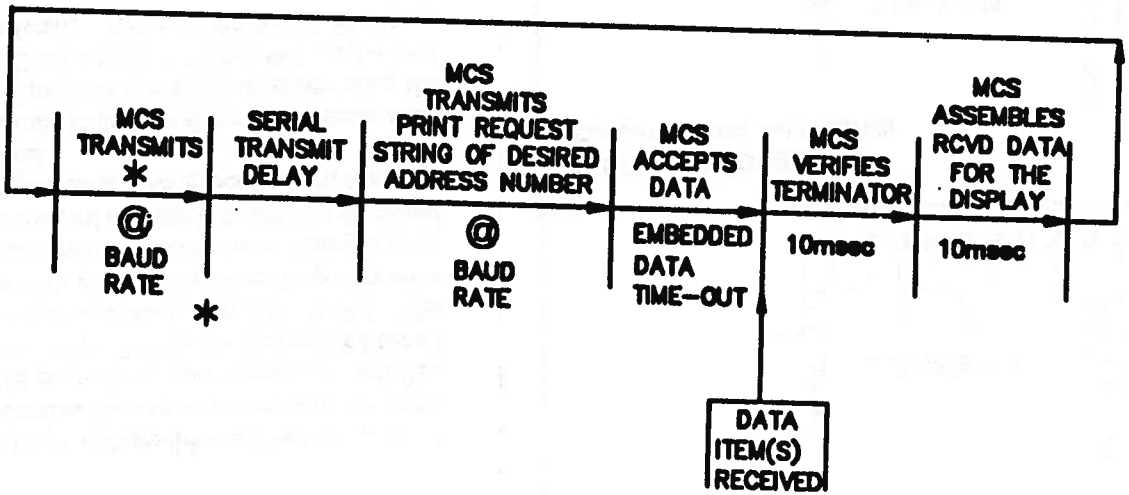
REMOTE SLAVE AND SERIAL SLAVE MODE TIMING



NOTE: Only for a command that requires transmission from an MCS unit.

In the RLC Remote Display Slave Mode, the data time-out value may have to be increased if the MCS did NOT have time to receive all data item strings from the specified RLC unit.

RLC REMOTE DISPLAY SLAVE MODE SERIAL TIMING



CURRENT LOOP INSTALLATION

WIRING CONNECTIONS

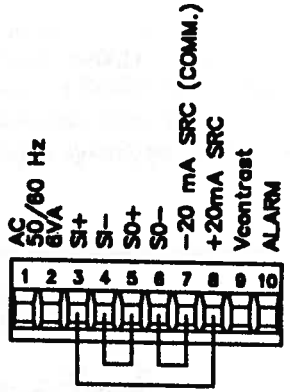
Connections for the 20mA current loop are made on the bottom terminal block TBA. Power should be turned off to the MCS before removing TBA. Install wires into the proper location on the terminal block. Refer to the label on top of the unit for description and location of each terminal. When all connections are completed, replace terminal block. Terminal block is keyed for proper installation. Power can now be applied.

SERIAL TERMINAL DESCRIPTIONS

1. SI+ (Serial In +)
   SI- (Serial In -)
   The MCS receives data for the display and commands on these terminals. They are connected in series with the transmit (output) terminals of the device connected to the MCS.
2. SO+ (Serial Out +)
   SO- (Serial Out -)
   The MCS transmits the requested data on these terminals. They are connected in series to the receive input of the external device to be connected.
3. -20mA SRC
   +20mA SRC
   These terminals provide a source current and current return for one of the loops.

SERIAL HARDWARE (LOOP-BACK) TEST

The internal serial communications hardware in the MCS can be tested to verify proper operation. The procedure consists of connecting the serial input (SI), serial output (SO), and 20mA source in a simple loop. The baud rate DIP switches are all set in the up position. If the unit has a parallel port, the proper data line must be set so that the MCS is in either the Remote Slave or Serial Slave Mode. The test will be performed when unit power is applied.



If the serial communication hardware is working properly, a "PASS" will be displayed in the power up message. Conversely, if there is an internal problem, "FAIL" will be displayed.

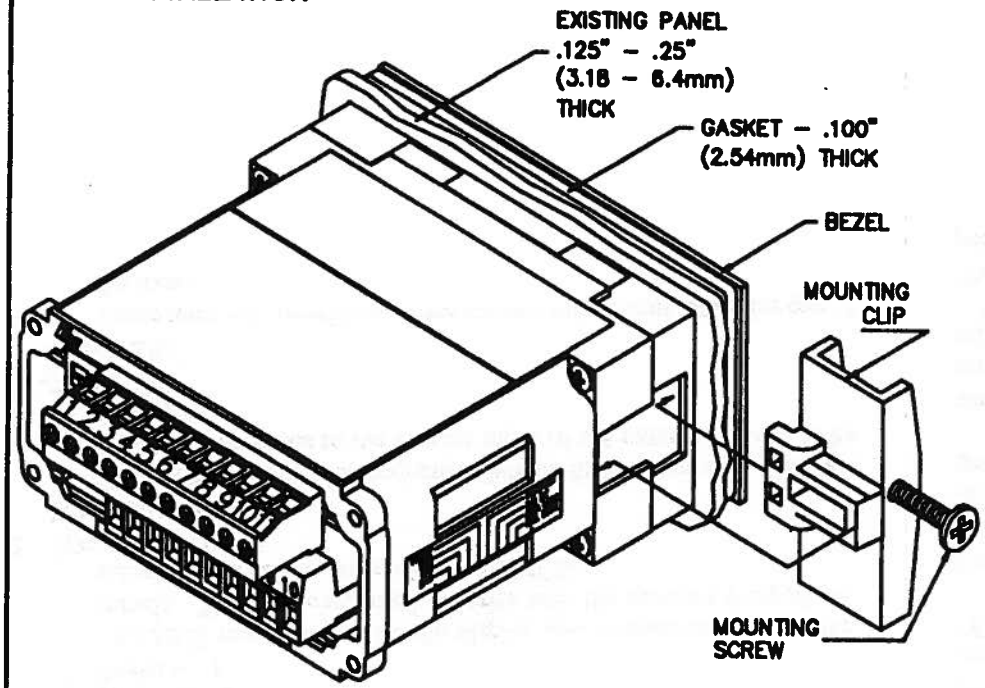
The test consists of the transmission of selected characters at various baud rates. Since the serial output is looped back to the serial input, the MCS will receive each character that it transmits. The MCS will compare the character it receives to that which it transmitted. If they agree, the test progresses. If not, an error is generated and the test is terminated.

After all the selected characters are sent and received, a "P" will be sent to the serial port (after the RAM check character) if the test was good or an "F" will be sent if a failure was detected. If the unit was powered up and self test was not selected, an "N" will be sent.

The display will also show the results of this test in the power up message. "Pass" and "Fail" indicate the test results and "****" indicated that no test was performed.

APPENDIX "A" - INSTALLATION AND CONNECTIONS

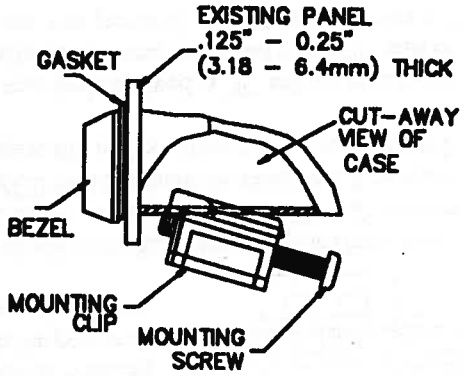
PANEL INSTALLATION



The Message Center Slave Unit is designed to be panel-mounted with a gasket to provide a water-tight seal. Two mounting clips and screws are provided for easy installation. Consideration should be given to the thickness of the panel. A panel which is too thin may distort and not provide a water-tight seal. (Recommended minimum panel thickness is 1/8").

After the panel cut-out has been completed and deburred, carefully apply the gasket to the panel. DO NOT APPLY THE ADHESIVE SIDE OF THE GASKET TO THE BEZEL. Insert the unit into the panel. As depicted in the drawing, install mounting clips. Thread the screws into the clips until the pointed end just protrudes through the other side. Install each of the mounting clips by inserting the wide lip of the clips into the wide end of the hole, located on either side of the case. Then snap the clip into the case. Tighten the screws evenly to apply uniform compression, thus providing a water-tight seal.

CAUTION: Only minimum pressure is required to seal panel. Do NOT overtighten screws.



WIRING CONNECTIONS

After the unit has been mechanically mounted, it is ready to be wired. All wiring connections are made on removable plug-in terminal blocks. There is a separate terminal block for the bottom board (TBA) and top board (TBB). When wiring the unit, remove the terminal block and use the numbers on the label to identify the position number with the proper function. Strip the wire, leaving approximately 1/4" bare wire exposed *(stranded wires should be tinned with solder)*. Insert the wire into the terminal and tighten down the screw until the wire is clamped tightly. Each terminal can accept up to one 14-gauge, two 18-gauge or four 20-gauge wire*(s)*. After the terminal block is wired, install it into the proper location on the PC board. Wire each terminal block in this manner.

AC POWER WIRING

The AC power is connected to TBA #1 and #2 located on the bottom terminal block. The voltage selector switch, located to the left side of TBA, is used to select the proper voltage. The switch is a slide movement type and can be set by using a small screwdriver. If the switch is showing 115, it is set for 115VAC input; and if 230 is showing, it is set for 230VAC input. The switch will be in the 230V position when shipped from the factory.

(NOTE: Before applying power to the unit, make sure the switch is set for the proper voltage setting)

To reduce the chance of noise spikes entering the AC line and affecting the unit, the AC power should be relatively "clean" and within the specified +/-10% variation limit. Connecting power from heavily loaded circuits or circuits which also power loads that cycle on and off, *(contactors, relays, motors, etc.)* should be avoided.

DC POWER WIRING

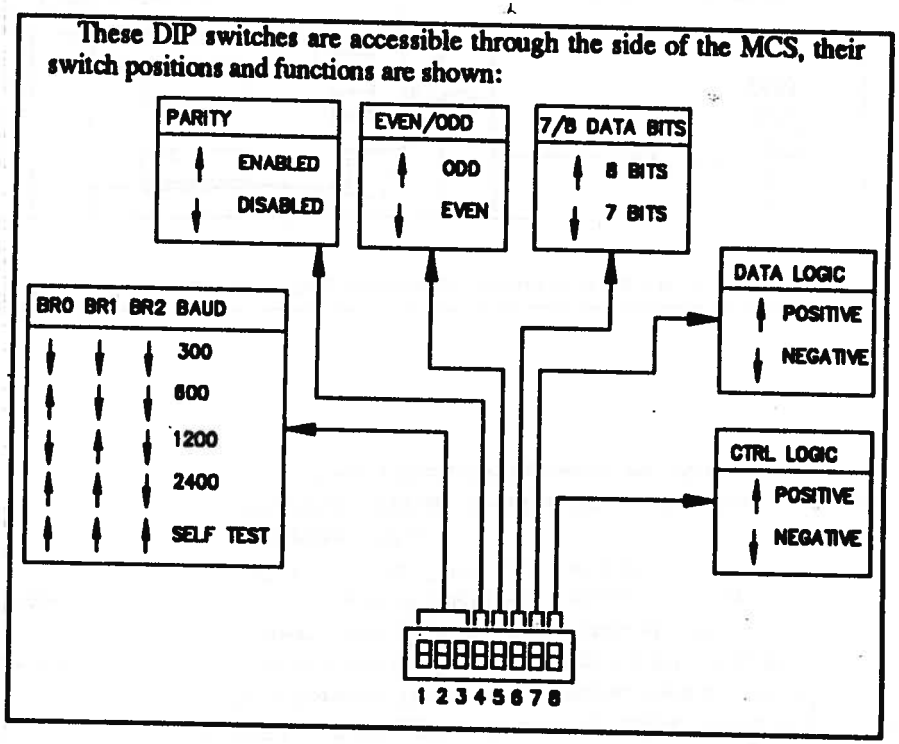
The DC power is connected to either TBA #1 and TBA #3 (common) for +24VDC input or TBA #2 and TBA #3 (common) for +12VDC input. The DC power source must be capable of supplying the unit's rated current *(300mA)*. It is not necessary to provide battery backup to retain programmable information. The MCS has nonvolatile memory and information is stored on power down (Refer to block diagram).

Vcontrast:

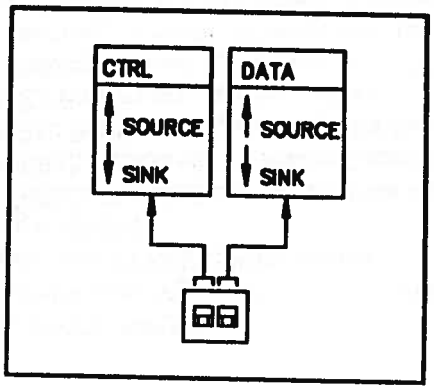
The viewing angle of the display may be adjusted by connecting an external 50KΩ ¼ Watt potentiometer between Vcontrast and Common. The external potentiometer should be adjusted to mid-range and then adjust the internal potentiometer for desired view. With the internal pot set, the external pot can now be used to vary the viewing angle. The internal potentiometer may be adjusted without the use of an external potentiometer.

DIP SWITCH SET-UP

These DIP switches are accessible through the side of the MCS, their switch positions and functions are shown:



These DIP switches are located at the rear of the MCS, their switch positions and functions are shown at right:



APPENDIX "B" - SPECIFICATIONS AND DIMENSIONS

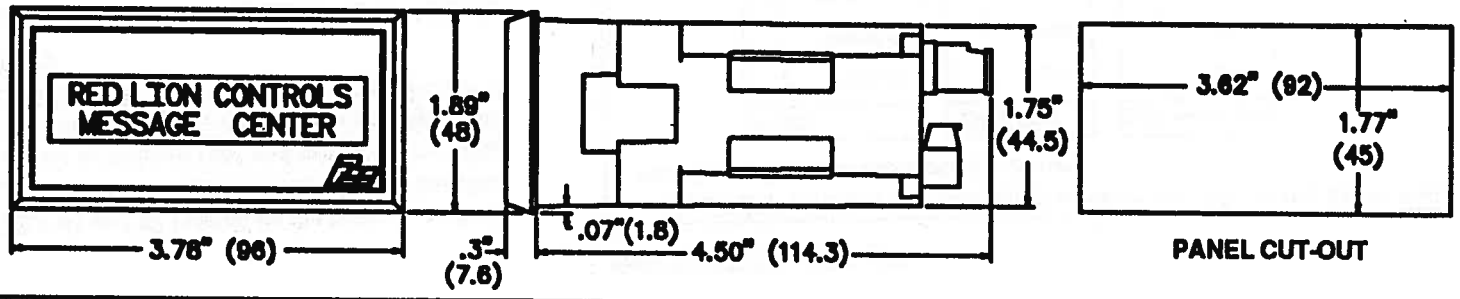
1. **POWER:** *(See Ordering Information)*
   AC Version:
   115/230VAC +/-10%, 50/60 Hz, 6VA, switch selectable.
   DC Version:
   12/24VDC +/-10% 300mA maximum.
2. **DISPLAY:** *(available in various configurations)*
   2x20, 0.2" *(5mm)* high characters, Transmissive LCD, LED backlighting. Negative image TN LCD for red display, Negative or Positive image STN LCD for yellow-green display.
   1x10, 0.35" *(9mm)* high characters, transmissive LCD, LED backlighting. Negative image TN LCD for red display, Negative or Positive image STN LCD for yellow-green display.
   The viewing angle of the display may be adjusted through the on-board pot or by connecting an external pot to the Vcontrast pin.
   The brightness of the backlight LED's is software adjustable through 16 levels.
3. **PARALLEL COMMUNICATIONS:**
   Data Format:
   BCD: 8 bits.

PARALLEL PORT INPUTS:
Data (D0-D)7 Inputs: V_{IH} = 8VDC, V_{IL} = 4VDC, V_{MAX} = 30VDC
Ctrl (Strobe and ITEM/ADDR) Inputs: V_{IH} = 4VDC, V_{IL} = 1
V_{MAX} = 30VDC.
Data SNK/SRC: Current sink or source Data inputs, switch selectabl
Ctrl SNK/SRC: Current sink or source Control inputs, switch selecta
Data LOGIC: Positive or negative logic for Data inputs, switch selec
Ctrl LOGIC: Positive or negative logic for control inputs, switch selec
Current Sinking: Internal 10K pull-up to +12VDC, I_{MAX} =1.3mA.
Current Sourcing: Internal 10K pull-down, I_{MAX} =3.1mA @ 30 VD
Debounce Time: 0.05 TO 2.50 seconds (programmable).

4. **SERIAL COMMUNICATIONS:** 20mA current loop, half duplex.
   Data Format: Three types available. Switch selectable.
   11 bits: 1 start bit, 8 data bits, 1 parity bit, 1 stop bit.
   10 bits: 1 start bit, 8 data bits, 1 stop bit; OR
   1 start bit 7 data bits, 1 parity bit, 1 stop bit.
   9 bits: 1 start bit, 7 data bits, 1 stop bit.
   Data code: ASCII
   Maximum Address: 0 - 99, software selectable *(Actual number in a sin loop is limited by hardware specifications).*

DIMENSIONS In Inches (mm)

NOTE: Recommended clearance (behind the panel) for mounted units is 2.1"(H) x 5.5"(W).



4. **SERIAL COMMUNICATIONS: (Cont'd)**
   Baud Rate: 300 to 2400, Switch selectable.
   Parity: Enable or Disabled, Switch selectable.
   Even/Odd: Selects parity type, Switch selectable.
   7/8 BIT: Selects number of data bits, Switch selectable.
   Serial Hardware: Terminal TBA.
      +20mA SRC: Provides 20mA @ 12VDC *(Powers up to 7 units in a loop).*
      -20mA SRC: Loop return for +20mA SRC.
   SO Output Transistor Rating: V_{MAX} = 30VDC, V_{SAT} = 1VDC @ 20mA
      Note: This will allow up to 28 units maximum in a loop.
   SI Input Diode Rating: V_F = 1.25VDC$_{TYP}$; 1.5VDC$_{MAX}$ @ 20mA.
      Note: The compliance voltage rating of the source must be greater than the sum of the diode voltage drops around the loop. Typically a 30VDC powered source would be capable of operating between 18 and 22 units in a loop.
5. **ALARM OUTPUT:** Functions as an Alarm output. The NPN open collector output *"ON"* state will be a low for Alarm.
   Solid state: NPN open collector, current sinking, V_{MAX} = 30VDC, I_{MAX} = 100mA, V_{SAT} = 1V_{MAX} @ 100mA.
6. **TEMPERATURE RANGE:**
   Operational: 0 to +50^{O}C
   Storage: -20 to +60^{O}C
7. **CONSTRUCTION:** Zinc, die-cast front bezel, that meets NEMA 4/IP65 specifications for use in wash-down or dusty environments when properly installed. Case is high impact plastic.
8 **CONNECTIONS:** Removable terminal blocks.
9. **WEIGHT:** 1.1lbs (0.5Kg)

APPENDIX "C" - DISPLAYABLE CHARACTER SET

The MCS has 153 different ASCII characters that can be displayed. The standard ASCII set ranges from 20h to 7Fh, and the character range from 80h to B8h includes European and special characters.

ASCII TABLE OF STANDARD CHARACTERS

HEXA DECIMAL	DECIMAL	MCS CHARACTER
20	32	
21	33	!
22	34	"
23	35	#
24	36	$
25	37	%
26	38	&
27	39	'
28	40	(
29	41	)
2A	42	*
2B	43	+
2C	44	,
2D	45	-
2E	46	.
2F	47	/
30	48	0
31	49	1
32	50	2
33	51	3
34	52	4
35	53	5
36	54	6
37	55	7
38	56	8
39	57	9
3A	58	:
3B	59	;
3C	60	<
3D	61	=
3E	62	>
3F	63	?
40	64	@
41	65	A
42	66	B
43	67	C
44	68	D
45	69	E
46	70	F
47	71	G
48	72	H
49	73	I
4A	74	J
4B	75	K
4C	76	L
4D	77	M
4E	78	N
4F	79	O

ASCII TABLE OF STANDARD CHARACTERS

HEXA DECIMAL	DECIMAL	MCS CHARACTER
50	80	P
51	81	Q
52	82	R
53	83	S
54	84	T
55	85	U
56	86	V
57	87	W
58	88	X
59	89	Y
5A	90	Z
5B	91	[
5C	92	\
5D	93	]
5E	94	^
5F	95	_
60	96	`
61	97	a
62	98	b
63	99	c
64	100	d
65	101	e
66	102	f
67	103	g
68	104	h
69	105	i
6A	106	j
6B	107	k
6C	108	l
6D	109	m
6E	110	n
6F	111	o
70	112	p
71	113	q
72	114	r
73	115	s
74	116	t
75	117	u
76	118	v
77	119	w
78	120	x
79	121	y
7A	122	z
7B	123	{
7C	124	|
7D	125	}
7E	126	~
7F	127	DEL

APPENDIX "C" - DISPLAYABLE CHARACTER SET (Cont'd)

ASCII TABLE OF EXTENDED CHARACTERS

HEXA DECIMAL	DECIMAL	MCS CHARACTER	HEXA DECIMAL	DECIMAL	MCS CHARACTER
80	128	Ç	9D	157	¥
81	129	ü	9E	158	Á
82	130	é	9F	159	Í
83	131	â	A0	160	á
84	132	ä	A1	161	í
85	133	à	A2	162	ó
86	134	å	A3	163	ú
87	135	ç	A4	164	ñ
88	136	ê	A5	165	Ñ
89	137	ë	A6	166	Ó
8A	138	è	A7	167	Ú
8B	139	ï	A8	168	¿
8C	140	î	A9	169	⌐
8D	141	ì	AA	170	À
8E	142	Ä	AB	171	ø
8F	143	Å	AC	172	Ø
90	144	É	AD	173	¡
91	145	æ	AE	174	Ù
92	146	Æ	AF	175	ã
93	147	ô	B0	176	õ
94	148	ö	B1	177	'
95	149	ò	B2	178	'
96	150	û	B3	179	≠
97	151	ù	B4	180	Ω
98	152	ÿ	B5	181	°
99	153	Ö	B6	182	±
9A	154	Ü	B7	183	≥
9B	155	¢	B8	184	≤
9C	156	£			

APPENDIX "D" - ERROR CODES

The MCS detects certain errors in command transmissions and displays one of the following error codes. Error messages have a time-out value of 10 seconds. Any message that was on the display will be removed.

The format for the error code is:

--> XX <-- XX = Error code listed below.

ERROR CODES

MCS DISPLAY	ERROR DESCRIPTION
01	Three digit numeric field > 255.
02	Non-numeric character in numeric field.
05	Invalid command number.
12	Invalid data for specified command.

APPENDIX "E" - TABLE OF COMMANDS IN NUMERIC ORDER

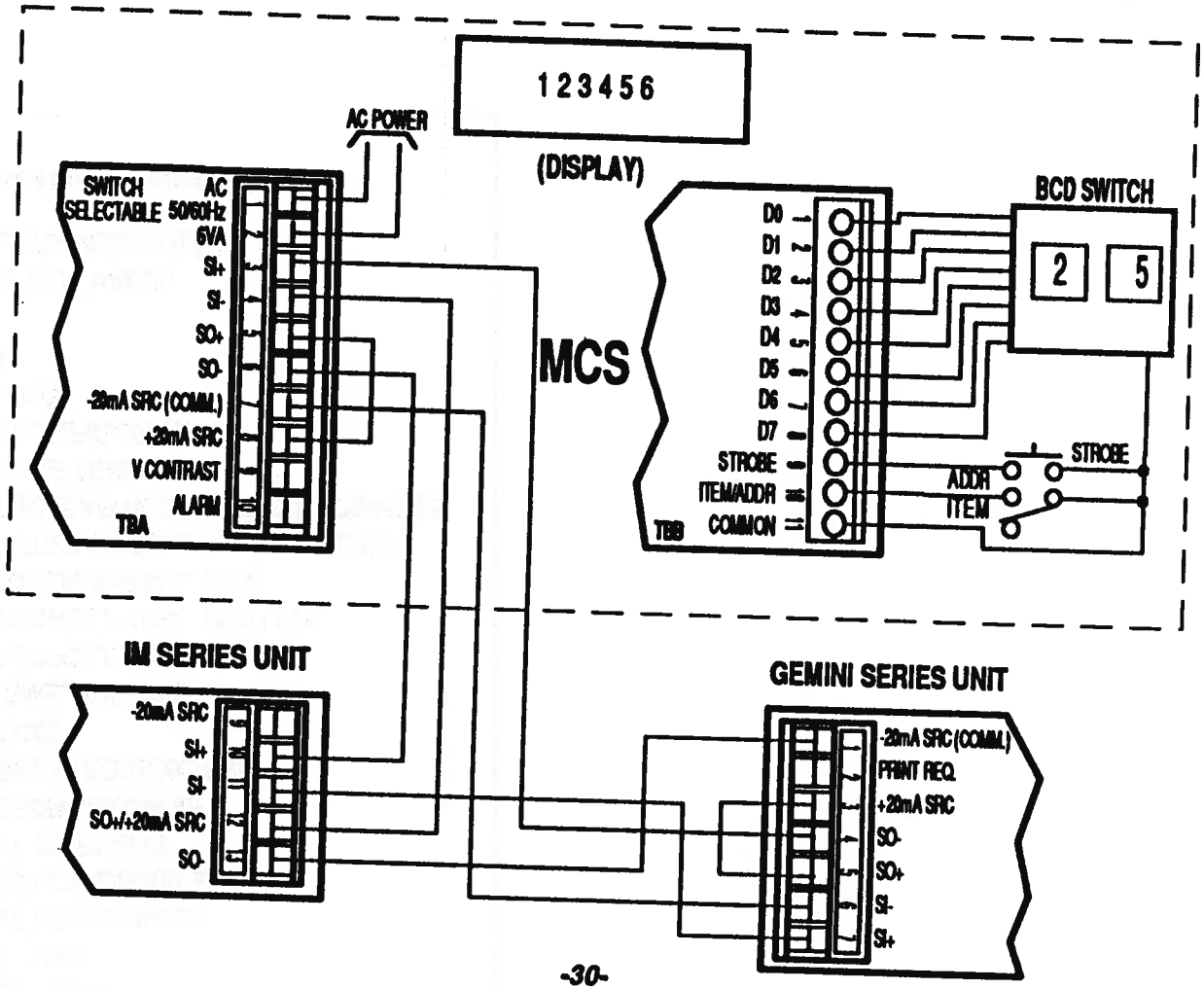
NnnC3*	SET UNIT ADDRESS
NnnC6*	CLOCK SET, TIME
NnnC8*	ALARM FUNCTION ENABLE
NnnC9*	ALARM FUNCTION DISABLE
NnnC10*	SET DISPLAY INTENSITY
NnnC16*	CANCEL ERROR MESSAGE
NnnC20DD*	CANCEL DISPLAYED MESSAGE
NnnC23DTddd*	SET BLINK TIME
NnnC23DBddd*	SET BLINK TIME, 2ND LINE
NnnC24DTBddd*	SET BLOCK SCROLL TIME
NnnC24DBBddd*	SET BLOCK SCROLL TIME, 2ND LINE
NnnC24DTHddd*	SET CHARACTER SCROLL TIME
NnnC24DBHddd*	SET CHARACTER SCROLL TIME, 2ND LINE
NnnC28*	RESET UNIT (CLEAR REQUESTED MESSAGES)
NnnC29*	SET DEBOUNCE TIME
NnnC30*	DUMP UNIT CONFIGURATION
NnnC38DRddd*	DATA TIME-OUT
NnnC39*	ALARM OFF
NnnC40*	ALARM ON
NnnC41*	ALARM TIME-OUT VALUE
NnnC48Dddd*	SET SERIAL TRANSMIT DELAY

NOTE: All command characters must be in capital letters.

APPENDIX "F" - APPLICATIONS

RLC REMOTE DISPLAY SLAVE MODE

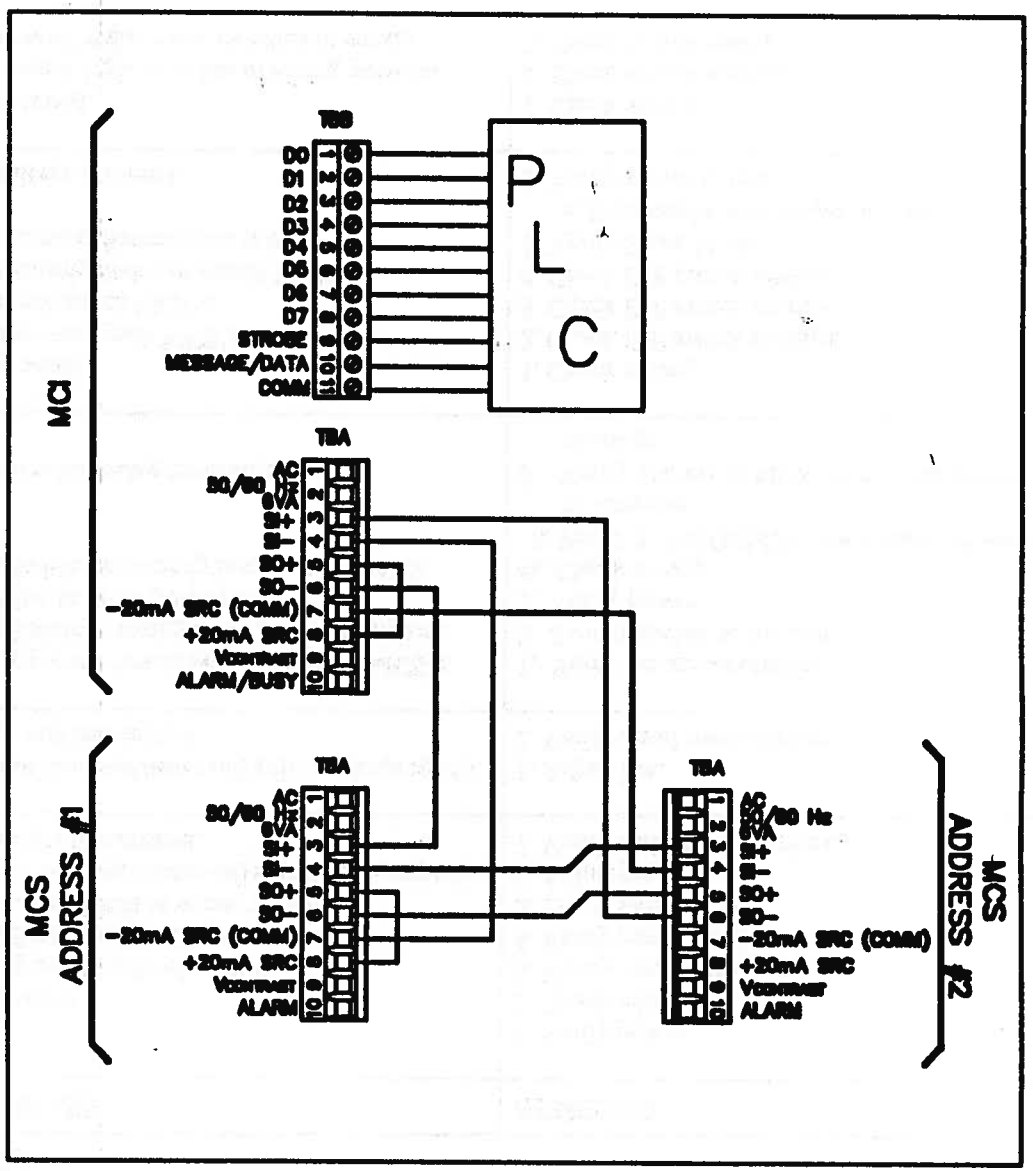
A manufacturing plant contains various Red Lion Controls products with 20mA serial communications throughout the plant. These units are controlling and monitoring numerous processes. An operator wishes to view pertinent information from these units from a central location. An MCS used in the RLC Remote Display Slave mode is installed to meet the necessary requirement. The MCS is requesting the count from a Gemini unit and then displaying the count information. A typical wiring connection is shown below:



APPENDIX "F" - APPLICATIONS (Cont'd)

REMOTE SLAVE MODE: MACHINE MONITORING

A requirement exists for monitoring various machines and providing maintenance messages and unsafe condition messages for each machine. An MCS set up in the Remote Slave Mode, used in conjunction with an MCI is installed to satisfy the requirement. The MCI receives a message request from the PLC, requesting a message for machine #1, EXCESSIVE LOAD. This message request is processed by the MCI and is transmitted to an MCS in the serial loop for local display. The periodic message feature of the MCI is used for regular maintenance requirements of each particular machine. These messages will be generated automatically on a periodic basis. An example would be BELT INSPECTION.



APPENDIX "G" - TROUBLESHOOTING GUIDE

PROBLEMS	POSSIBLE CAUSE	REMEDIES
DARK DISPLAY (No Backlighting Apparent)	1. Power off 2. Improperly wired 3. Backlighting intensity level set to 0. 4. Power in a Brown-out condition 5. Voltage selector switch in wrong position 6. Vcontrast pot *(internal /external)* adjusted improperly. 7. No message text transmitted.	1. Verify power. 2. Check wiring. 3. Verify level setting. 4. Verify power reading. 5. Check switch setting. 6. Adjust pot. 7. Verify serial transmissions.
BLANK DISPLAY (Backlighting Apparent But No Discernible Characters)	1. Vcontrast pot *(internal /external)* adjusted improperly. 2. No message text transmitted.	1. Adjust Pot. 2. Verify serial transmissions.
MCS IS NOT RESPONDING TO MESSAGE CENTER USER SOFTWARE	1. Serial set-up parameters do NOT match the MCS's. 2. GCM232 Module in wrong serial port of computer. 3. GCM232 Module NOT powered. 4. GCM232 Module improperly connected to MCS. 5. Wrong address(es) being transmitted.	1. Verify set-up parameters 2. Switch module to the port. 3. Verify power. 4a. Check wiring. b. Pins 2 & 3 of GCM232 not connected properly to computer. 5. Verify address of MCS, by viewing power-up message.
MCS IS NOT RECEIVING DATA FROM SERIAL EXTERNAL UNIT(S)	1. Improperly wired. 2. Baud rates do not match MCS's. 3. Parity does not match MCS's. 4. Data bits transmitted do not match MCS's. 5. Proper terminator character not sent. 6. External unit not powered.	1. Check wiring. 2. Check DIP switch settings. 3. Check DIP switch settings. 4. Check DIP switch settings. 5. Verify Slave Mode. a. Retransmitt with proper terminator. 6. Verify power to unit.
MCS IS NOT RESPONDING TO ITEM AND ADDRESS SELECTION OVER PARALLEL PORT	1. Improperly wired. 2. Data and control logic switches in wrong position. 3. Data and control sink/source switches in wrong position. 4. ITEM/ADDR lines in wrong state when strobe.	1. Check wiring. 2. Check switch settings. 3. Check switch settings. 4. Verify logic setting.

APPENDIX "H" - ORDERING INFORMATION

ORDERING INFORMATION MCS

MODEL NO.	DESCRIPTION	PARALLEL PORT.	12/24VDC	115/230VAC
MCS MESSAGE CENTER SLAVE	1X10 Red. Negative Image/TN	YES	MCS1R01D	MCS1R01A
	1X10 Yel-Grn. Negative Image/STN	YES	MCS1Y01D	MCS1Y01A
	1X10 Yel-Grn. S.N.L. positive Image/STN	YES	MCS3Y01D	MCS3Y01A
	2X20 Red. Negative Image/TN	NO	MCS2R00D	MCS2R00A
	2X20 Yel-Grn. Negative Image/STN	NO	MCS2Y00D	MCS2Y00A
	2X20 Yel-Grn. Positive Image/STN	NO	MCS4Y00D	MCS4Y00A
NOTE: #1 STN displays have a greater viewing angle than TN displays				

ORDERING INFORMATION FOR MESSAGE CENTER ACCESSORIES

MODEL NO.	DESCRIPTION	PART NUMBER
SFMC	Apollo Message Center User Software (5¼": 360K)	SFMC0010
	Apollo Message Center User Software (3½": 720K)	SFMC0210
GCM232	Serial Converter Module RS-232	GCM23201
APS01	+12VDC Unregulated Power Supply, 115VAC	APS01000
APS02	+12VDC Unregulated Power Supply, 230VAC	APS02000

NOTE: Only one copy of software is required for multiple units.

ALL PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE

RED LION CONTROLS

INTERNATIONAL HEADQUARTERS
20 Willow Springs Circle, York, Pa. 17402 (717) 767-6511 TWX: 510 657 4214 RLC YRK FAX: (717) 764-0839

EUROPEAN HEADQUARTERS
Cranford Lane, H[illegible]on, Hounslow, Middlesex TW59NQ ENGLAND 01-759-0694 TWX: 24178 F[illegible] G

REFERENCE: ELECTRICAL PART NO.(S) 45
ELECTRICAL SCHEMATIC NO. 347-9001-01

THE ASTRO LINE SERIES

GEMINI 4-100 INSTRUCTION MANUAL

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GENERAL DESCRIPTION

The Gemini 4000 series *(4100 & 4200)* instruments are two input microprocessor based dual function counter/rate or dual counter instruments. The 6 digit display features .56" LED's with negative sign, overflow and displayed value indicators *(A & B)* located to the left of the display. When programmed as a counter/rate instrument, the A indicator will be on when the rate is displayed and the B indicator will be on when the count is being displayed. Pushing the *"DISP"* button toggles the display between the counter and rate or the two counters depending on the personality selected.

The Gemini 4000 series consists of two basic units, a single preset version, the Gemini 4100, and a two preset version, the Gemini 4200. Each basic unit is also available in 115VAC and 230VAC versions, with or without Serial communications and an optional relay board. The 20mA current loop option *(serial communications)* makes possible remote or computerized monitoring or control of the Count, Preset and Scale Factors.

Flexibility and usefulness are insured through user programmability. With simple front panel keystrokes and rear panel switch settings, any one of a number of configurations can be selected. Once the selection is made, all or part of the keyboard can be disabled to protect the settings and guarantee that no unwanted changes can occur during the measurements.

Each time the power is turned off, the unit automatically saves the settings and data in its special no power memory. When power is restored, the Gemini sets itself back to the operational modes and restores the data it had at power down. The *"no power"* E^2PROM's life expectancy is at least 100,000 cycles of power being applied to and removed from the unit.

Whenever the power comes on, the Gemini 4100 performs a series of internal diagnostics to verify the integrity of the stored data. There is also a self-test mode and a "watchdog" timer to help prevent processor lockup.

The Gemini 4000 series counters can accept bi-directional, uni-directional, or quadrature signals. They also have the capability to double or quadruple *(Quadrature X4)* the resolution of the incoming count signal.

A separate input mode is available to make the counter/rate or dual counters completely independent of each other.

One input provides the signal for the rate or counter and the other input provides the signal for the counter. An anti-coincidence add/subtract mode is also provided to obtain a difference between two input signals.

Each channel features separate scaling and decimal point placement for readout in different units or at different resolutions.

A counter load feature enables the operator to modify the count value under circumstances that occur when flawed material has been counted and it is necessary to adjust the count value accordingly. The counter load feature can be *"locked out"* in applications where it is not required.

The Rate indicator portion uses a time interval method *(1/tau)* to calculate the rate value. This method enables high resolution at all count rates. The unit counts input pulses and after a programmable minimum update time has occurred, it waits until the next count edge occurs, takes the elapsed time and number of edges, and calculates the rate value. At slower rates, averaging can be accomplished by programming the *"Rate Minimum Update Time" (0.5 sec. to 16 sec.)* for the desired response. Extensive scaling capabilities allow practically any desired reading at very slow count rates.

For maximum flexibility, the Gemini 4100's output can be assigned to either the rate or count channel. When in dual counter mode, the output is assigned to the Counter B channel.

The optional relay is mounted on a plug-in board which makes it easy to field upgrade your Gemini 4100. The contacts are rated for 240VAC or 28VDC at 5amps.

The construction of the Gemini 4100 features a metal, die cast bezel for maximum durability with high quality appearance. The sealed front panel is designed to meet NEMA 4/IP65 specifications for washdown and/or dust. Electrical connections are made with removable, plug-in terminal strips at the rear of the unit. Clamp-type pressure plate terminals accept stripped #14 AWG wire without lugs.

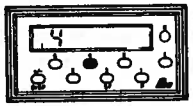
PROGRAMMING THE GEMINI 4100

When your Gemini 4100 arrives from the factory, it has already been programmed to function as a counter and rate indicator. It is programmed with the factory settings listed in the *"Initial Factory Configuration"* section. If it is required to have the unit operate as two counters, the Unit Personality function code can be changed to do so.

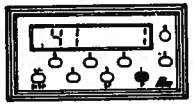
The personality, functions, and modes are accessed by pressing the appropriate keys as indicated by the embossed numbers above them. A function is defined by a two-digit code which appears on the left side of the display. The mode of that function is shown as a one-digit code on the right side of the display. At times there will be a "-" sign modifier to the left of the mode.

Data for the Preset, Scale Factors, Timed Output Value, and Counter Load Value are entered differently. Each digit key controls the digit on the display directly above it. Changing the digits can be done by repeatedly pressing the key beneath the digit position you wish to change or by holding the key down. As you hold it down, or repetitively press it, the value of that digit will change cyclically, counting up to 9, then to 0, and then up again. The 6 numbered keys correspond to the six digits, and the "+/-" key corresponds to polarity.

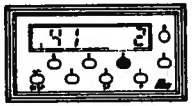
PROGRAMMING THE PERSONALITY



Entering function and mode is easily accomplished by pressing the appropriate digit key as indicated by the embossed number above it. For the personality function, you would enter 41 by pressing the front panel keys, 4 and 1.

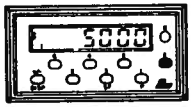


The digits on the left side of the display show the function code; the digits on the right side show the current programmed mode.



A mode selection is made by entering a new number. On some of the entries, you have the option of a plus "+" or minus "-" sign. In the cases where a "+" sign is required, no sign will be displayed. If you do enter a "-" sign (using the "+/-" key), a minus sign will be displayed in front of the appropriate digit.

Pressing the "E" key finalizes the change. The display will now show the count or rate value immediately.



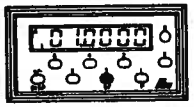
If you do not press the "E" key, the change will not be recorded. The display will remain in the programming mode for 15 seconds, and then return to normal operating mode using the old functional mode setting.

Whenever the Unit Personality is changed, the factory settings will automatically be loaded into the unit. The factory settings can also be programmed into the unit by calling up the Unit Personality, putting a "-" in front of the mode by pushing the "+/-" button, and entering it.

Refer to the "Initial Factory Configuration" section for more details.

PROGRAMMING THE PRESET, SCALE FACTORS, TIMED OUTPUT & COUNTER LOAD VALUES

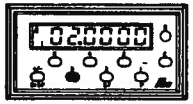
The Preset and Scale Factor Values are commonly reprogrammed on a daily basis. As such, single keystroke access has been provided.



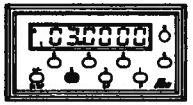
The Gemini 4100 has two Scale Factors, one for display A (Counter A or Rate A), and one for display B (Counter B). Pressing the "SF"(3) key will call up the Scale Factor for the current value being displayed (Rate A/Counter A, or Counter B).

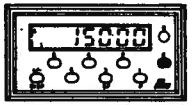
To call up the "other" Scale Factor, the "DISP" key is first pushed to change the display to the "other" value, then the "SF" key is pushed to display the Scale Factor for that "other" value.

PROGRAMMING THE PRESET, SCALE FACTORS, TIMED OUTPUT & COUNTER LOAD VALUES [Cont'd]



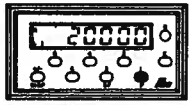
Once the Scale Factor is displayed, changing the digits can be accomplished by repeatedly pressing the key beneath the digit position you wish to change or by holding the key down, allowing the digit to cycle.



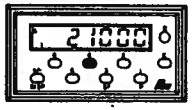


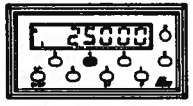
The new value will be entered when the "E" key is pressed.

The internal count value is multiplied by the Scale Factor Value, which changes the displayed value accordingly. It is important to note that the precision of an application cannot be improved by using a Scale Factor greater than one. To accomplish greater precision, more pulse information must be generated per measuring unit. For example, if 5 pulses are being received per foot of material, the precision of 10th of feet cannot be attained by simply programming a Scale Factor of 2.0000, even though the display is reading in tenths. In this case, the display will increment by two for each count input. Thus, if an odd Preset Value is entered, such as 6.7 ft., the Gemini 4100 will alter the Preset display to read in even tenths of feet.

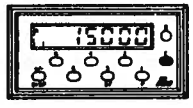


To display the Preset Value the "P"(1) key is pushed.



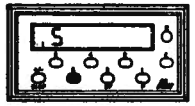


To change the value, the digits can be cycled through in the same manner as discussed for the Scale Factor. The Preset Value can range from -999999 to +999999.

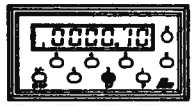


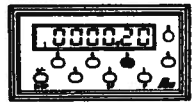
The new value will be entered when the "E" key is pressed.

The Scale Factor Value will have a direct effect on the Preset being entered (if assigned to the counter). For Scale Factors greater than one, the Preset Value should be an integer multiple of the Scale Factor. If it is not, the Gemini will automatically adjust the Preset Value up or down to force it to be evenly divisible by the Scale Factor.

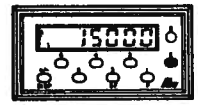


The Timed Output Value is changed by entering a two-digit function code. After the code is entered, the display will show the present Timed Output Value in seconds with two decimal place resolution. The Timed Output Value can be set from .01 to 599.99 seconds.





To change the Timed Output Value, enter function code 53 and enter the new value by holding down or repeatedly pressing the key below the digit position you wish to change. The new value will be entered when the "E" key is pressed. The display will immediately return to the count value.

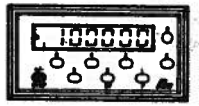


NOTE: A Timed Output Value of zero cannot be programmed into the Gemini 4100. If a value of 0 is entered into the display and the "E" key is pressed, the unit will remain in data entry mode. If a new value is not entered, it will time out and the unit will continue to use its previous setting.

As with the other functions, you must press "E" to record the changes. For the data entry modes, if you do not press the "E" key, a time out of 5 seconds occurs, and the display returns to operating mode without any changes to the value. The only time any change will occur is when the "E" key is pressed.

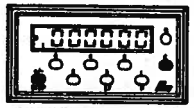
It is possible to change the counter values of the Gemini 4100. This feature can be enabled or disabled by the programming of the "Operator Accessible Functions Modes", function code 66. The "Counter Load Value" is not stored when the unit is powered down. When the unit is powered up, the counter load values for both counters (if Dual counter personality) are reset to zero. Once changed, the values will be held until the unit is again powered down.

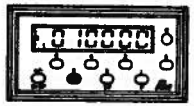
To access the Counter Load Value for the desired counter; first, press the "DISP" key, if necessary, so that the display is indicating the counter value which is to be changed.



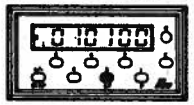
Secondly, press the "E" key and while holding it down press the "DISP" key.

The Gemini will now display the displayed Counter Load value. (It will be zero, unless the value had been changed since the unit was powered up.)

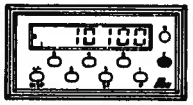




To change the value, press the key under the digit to be changed as explained previously for the Preset.



To load the value into the counter, press the "E" key. The display will flash momentarily and will display the counter with the new value.



INITIAL FACTORY CONFIGURATION

Keys struck	Display	Description
4.1	41 1	Personality selected as COUNTER/RATE
4.2	42 3	Reset A & B
4.3	43 1	Count with Inhibit
4.4	44 1	Single edge counting (B)
4.5	45 1	Scale multiplier of 1.0
4.6	46 1	Counter B leading zero blanking and no decimal poin
5.1	51 2	Output assigned to Counter (B)
5.2	52 3	Output terminates at Reset, Normal Phase
5.3	0000.10	Output time delay of 0.1Sec
5.6	56 1	Counter (B), manual reset to zero
6.1	61 4	No Rate (A) right hand dummy zeros
6.2	62 1	Rate per Second
6.3	63 1	Rate (A) 0.5Sec Minimum Update Time
6.4	64 4	Rate (A) Scale multiplier of 1
6.5	65 1	Rate (A) leading zero blanking, no decimal point
6.6	66 1	No functions except Reset enabled
SFA	01.0000	Scale Factor A (Rate) set to 1.0000
SFB	01.0000	Scale Factor B (Counter) set to 1.0000
P(1)	001000	Preset set to 1000

DUAL COUNTER FACTORY SETTINGS*

Keys struck	Display	Description
4.1	41 2	Personality selected as DUAL COUNTER
4.2	42 3	Reset Counters A & B
4.3	43 1	Count with Inhibit
4.4	44 1	Single edge counting (A & B)
4.5	45 1	Counter B Scale multiplier of 1.0
4.6	46 1	Counter B leading zero blanking and no decimal point
5.1	51 2	Output assigned to Counter B
5.2	52 3	Output terminates at Reset, Normal Phase.
5.3	0000.10	Output time delay of 0.1Sec
5.6	56 1	Counter B, manual reset to zero
6.1	61 1	Counter A, manual reset to zero
6.4	64 1	Counter A scale multiplier of 1
6.5	65 1	Counter A Leading zero blanking, no decimal point
6.6	66 1	No functions except Reset enabled
SFA	01.0000	Scale Factor A set to 1.0000
SFB	01.0000	Scale Factor B set to 1.0000
P(1)	001000	Preset set to 1000

* If [41 1] is changed to [41 2], then the factory settings are as shown.

OPERATOR ACCESSIBLE FUNCTIONS WITH PROGRAMMING DISABLED

(For details on keyboard entry, see preceding section)

One of the important features of the Gemini 4100 is the ability to disable programming. With this ability, accidental bumping of the keys or tampering by unauthorized personnel can be prevented. However, it may be necessary to allow reset and certain programming functions, such as Preset and Scale Factor Values, to be changed in daily operation. The Gemini 4100, through the use of the "Operator Accessible Functions" modes can enable these functions even when the "PGM. DIS." terminal is connected to "COMMON".

The "Operator Accessible Functions" modes are programmed by entering a two-digit function code (66) and the desired mode. Unlike other function codes, the mode does not take effect immediately. The "PGM. DIS." terminal must be connected to "COMMON" in order for the Gemini to disable programming and operate as per the mode programmed.

There are six basic "Operator Accessible Functions" Modes available. These modes enable the following functions.

1. NO FUNCTIONS EXCEPT RESET ENABLED - In this mode, manual reset is enabled, but none of the programming functions can be changed. However, the functions can be interrogated.
2. PRESET PROGRAMMING AND RESET ENABLED - The entire front panel is disabled with the exceptions of Preset programmability and manual reset. All functions can be interrogated.
3. SCALE FACTOR PROGRAMMING AND RESET ENABLED - The entire front panel is disabled with the exceptions of Scale Factor programmability and manual reset. All functions can be interrogated.
4. SCALE FACTOR AND PRESET PROGRAMMING, AND RESET ENABLED - The entire front panel is disabled with the exceptions of Scale Factor and Preset programmability, and manual reset. All functions can be interrogated.
5. PRESET AND COUNTER LOAD PROGRAMMING ENABLED - The entire front panel is disabled with the exceptions of Preset and Counter Load programmability. All functions can be interrogated.
6. PRESET, SCALE FACTOR AND COUNTER LOAD PROGRAMMING ENABLED - The entire front panel is disabled with the exceptions of Preset, Scale Factor and Counter Load programmability. All functions can be interrogated.

All of these modes can be modified with the addition of a "-" sign. The minus sign disables the manual reset, at the front panel and the remote reset (RST., not RST.A) terminal, at the rear of the unit.

There is also a rear panel DIP switch which permits disabling of the front panel reset button. This is independent of the rear terminal remote reset, and can be used in conjunction with any front panel disable mode. The combination of a manual and remote reset inputs provides a high level of security without sacrificing flexibility.

DIAGNOSTICS, SELF-TEST, & "WATCHDOG" TIMER

The security of the Gemini 4100 is further enhanced by its self-test diagnostic and "watchdog" timer capabilities.

The diagnostics are concerned with the special, no power memory of the Gemini 4100. Whenever the power is turned off, all pertinent function settings and measurements (except the counter load value) are automatically saved. When power is restored, the functions and data are re-instated. This allows you to program the unit once and not have to re-program it until you wish to use it in another mode.

When the function codes and data are saved, computations are made with these values. The result of these computations is stored in the memory to serve as a check against possible error. On power up the same computations are repeated on the stored data. If the results do not agree with the stored results, a "P" will appear on the left side of the display. If this occurs, refer to the "Trouble Shooting Guide" for directions.

The Gemini 4100 also contains a "watchdog" timer. In order to insure the software is functioning properly, the program constantly monitors itself. If the proper sequence and timing of internal events does not occur, an "E" will appear on the left side of the display. If this occurs, refer to the "Trouble Shooting Guide" for directions.

DIAGNOSTICS,SELF-TEST, & "WATCHDOG" TIMER [Cont'd]

The final type of built-in check is the front panel initiated self-test. It can be performed at any time, even when the Gemini 4100 is running. It will not interfere with the accumulation of counts or control functions. A function code of "6", "+/-" starts the test. At this time, whatever was displayed will disappear and be replaced by a string of decimal points and the overflow indicator. Then the display will show a string of 9's, then 8's etc., until a string of 0's are shown. The self-test will then turn off the overflow indicator and activate the minus "-" sign. Then the unit shows an interlace pattern of -010101, then -212121, followed by 232323 etc., until -898989 is reached. At this time the output can be tested by pressing the "P" key. (The program disable pin must be disconnected in order to allow activation of the output. Also, when operating the output, use caution when testing the output so as not to cause any undesirable or hazardous conditions in the system.) An automatic exit will take place after six seconds or immediately if the Program Disable terminal is connected to common. Normal length of display time for each of the patterns is approximately 0.5 sec. Rapidly pressing "E" during self-test can speed up the sequence.

INPUT CIRCUITRY & SET-UP

There are two independent input channels on the Gemini 4100. Various types of sensor outputs can be accommodated by appropriate DIP switch set-up. These include: TTL or CMOS logic, current sinking, current sourcing, or dry contact and more.

Channel 1 consists of a logic input and a separate low level magnetic pickup input.

Channel 2 is a completely independent count or control input channel. Like Channel 1, it can be programmed with DIP switches for a wide variety of logic inputs, and is identical to Channel 1 in this regard. For a complete detailed description of input set-up, see Appendix "A".

OVERFLOW INDICATION

The Gemini 4100 features an overflow indicator (LED) which is located to the left of the sixth digit and above the polarity annunciator. This LED will turn on if the capacity of the display (6-digits) is exceeded or if the internal count capacity (9-digits) is exceeded. Use of extremely small scale multiplier and Scale Factor Values can cause the internal count capacity to overflow before the displayed value would overflow. It should also be noted that the use of Right Hand Dummy Zeros or Scale Factors larger than one could cause the displayed value to overflow before a value of 999,999 (6-digits) is accumulated.

When the capacity of the display is exceeded, the count value will be maintained and will be valid. But if the internal count value is exceeded, then this value may no longer be valid.

When the Gemini 4100 is programmed as a counter/rate instrument; upon power up, the rate indicator will display a zero and the overflow LED will be on. This indicates that the zero on the display is not an actual measured value. The LED will turn off after the first rate measurement.

The overflow LED can also turn on under certain conditions when the rate input frequency exceeds the maximum 3250cps allowed for a rate update period of 16sec. See Code 63 - "Rate Minimum Update Time".

PROGRAMMING INSTRUCTIONS FOR THE COUNTER/RATE VERSION OF THE GEMINI 4100

The first part of this section provides detailed descriptions of the function command codes for Inputs Response modes, reset modes, output terminations, etc. Then, using an actual application example, the programming instructions for a Counter/Rate version will be "walked through", to give the user a full understanding of the Gemini 4100 programming procedure. The descriptions below give the function command code first, followed by the individual mode identifier. The Function Command Code Summary in the appendix, lists all codes. (Only commands and modes pertaining to the Counter/Rate personality will be discussed in this section.)

CODE 41 - UNIT PERSONALITY

The Gemini 4100 can be programmed to operate in one of two different personalities. In each of the two unit personalities, the Gemini 4100 operates as a dual function indicator. The personality selected determines whether display channel A will indicate rate or count. In both personalities, display channel B operates as a counter.

When the Unit Personality is changed and entered, all modes and data values (Preset, Scale Factors, function codes etc.) will be automatically loaded with the factory settings for that personality. If, for any reason during programming, it is desired to return to the factory settings, the "+/-" key can be pushed while in code 41. When the "E" key is pressed the unit will load the factory settings into the Gemini 4100. The programming procedure will vary for the two unit personalities. This entire section deals with the unit programmed as a Counter/Rate indicator, [41 1].

[41 1] COUNTER (B)/RATE (A) - In this mode display channel A functions as a rate indicator and display channel B functions as a counter.

[41 2] DUAL COUNTER - In this mode both display channels, A & B, function as counters.

[41 -1]]
[41 -2]] A minus sign preceding the mode will cause the factory settings to be loaded when entered.

CODE 42 - RESET BUTTON & TERMINAL ACTUATION MODES

The "Reset Button & Terminal Actuation Modes" controls the affect that the reset button and terminal have on the two display channels. Resetting will not affect the rate display in any manner. If the output is assigned to the rate channel, activating the reset button or terminal will reset the rate output if that particular response mode is programmed.

There is a separate "RST. A" terminal, which resets the Rate (A) output when activated (if output is assigned to rate). It is provided to allow independent resetting of each channel.

[42 1] RESET RATE (A) OUTPUT
[42 2] RESET COUNTER (B)
[42 3] RESET RATE (A) OUTPUT AND COUNTER (B)

CODE 43 - INPUTS 1 & 2 RESPONSE MODES

The Gemini 4100 has six different input response modes. They are: Count(1) with Inhibit(2); Count(1) with Up/Down Control (2); Two input anticoincidence Add(1)/Subtract(2); Separate Input mode; Quadrature; and Quadrature X4. In all modes, except [43 4], Input 1 is used by both the counter and rate channels.

[43 1] COUNT WITH INHIBIT - Input 1 serves as the count and rate input. Input 2 serves as the Inhibit input. When Input 2 is low, the counter will ignore the count signal appearing at Input 1. The rate channel, however, will continue to indicate the rate of the signal on Input 1. When Input 2 is at a high level, the signal appearing on Input 1 will be counted. The "Counter (B) Reset Modes" will determine the count direction. In applications where the Inhibit function is not actually used, the Input 2 "SRC/SNK" position of the "INPUT CONFIGURATION DIP SWITCH" should be set to the "SNK" position to provide a 7.8Kohm pull-up resistor. This will set Input 2 to the Non-Inhibit state.

CODE 43 - INPUTS 1 & 2 RESPONSE MODES [Cont'd]

[43 2] COUNT WITH UP/DOWN CONTROL - In this mode, count direction can be controlled by the second input. Input 1 serves as the count and rate input and Input 2 serves as the direction control signal input. When Input 2 is at a high level, the counter will count up. When Input 2 is at a low level, the counter will count down. The rate is not affected by the directional control Input 2.

[43 3] TWO INPUT ANTICOINCIDENCE ADD/SUBTRACT - This mode effectively separates count pulses which may simultaneously appear at the two inputs. The Gemini unit processes the count pulses into a string of time-separated pulses, so the internal counter will not lose any count pulses. Input 1 serves as the add and rate input (count increments) and Input 2 serves as the subtract input (count decrements).

[43 4] SEPARATE INPUT - In this mode, the two functions, Counter (B) and Rate (A) are independently controlled by the inputs. Input 1 serves as the Rate (A) input and Input 2 serves as the Counter (B) input.

[43 5] QUADRATURE COUNTING - Quadrature counting modes are primarily used in positioning and anti-jitter applications. The reason this mode works is due to the manner in which two pickups are positioned relative to each other. The signal on Input 2 is a pulse train signal shifted 90° away from the Input 1 signal. These two signals are processed by the Gemini as follows:

Input 1 serves as the count and rate input, while Input 2 serves as the quadrature input. For quadrature with single edge counting, the counter will count in a positive direction when Input 1 is a negative going edge and Input 2 is at a low level. The counter will count in a negative direction when Input 1 is a positive going edge and Input 2 is at a low level. All transitions on Input 1 are ignored when Input 2 is at a high level. These logic rules provide the basis for anti-jitter operation which will prevent false counts from occurring due to back-lash, vibration, chatter, etc.

When two edge counting is used, the quadrature mode works the same as with single edge counting when Input 2 is low. But when Input 2 is at a high level, counts at Input 1 are no longer ignored. Instead the logic rules for Input 1 are complemented, allowing both edges of Input 1 to be counted. This doubles the effective resolution of the encoded input. The rate indicator will only use the falling edge of the Input 1 signal, due to the method of rate indication used.

[43 6] QUADRATURE TIMES 4 - This mode takes the quadrature mode, with two edge counting, one step further. In quadrature times 4, both Input 1 and Input 2 serve as the count or quadrature input, depending on their state. In one instance, Input 1 will serve as the count input and Input 2 will serve as the quadrature input. In another instance, Input 1 will be the quadrature input and Input 2 will be the count input. This enables each edge, positive and negative going, of both inputs, 1 and 2, to be counted. This results in a resolution four times greater than in the basic quadrature X1 mode. As in the other modes, Input 1 is also used for the rate input. The rate indicator will only use the falling edge of the Input 1 signal, due to the method of rate indication used.

CODE 44 - COUNTER (B) NUMBER OF COUNT EDGES

The counter of the Gemini 4100 can be programmed for either single or two edge (X2) counting. The number of count edges cannot be set when the count mode is programmed for quadrature X4 operation. The Gemini will ignore any attempt to enter function command code 44 when set for quadrature X4.

[44 1] SINGLE EDGE COUNTING (X1) - The unit counts on the negative going (falling) edge of the count input signal. The count mode descriptions describe how each mode uses this method of edge counting.

[44 2] TWO EDGE COUNTING (X2) - This mode is used when doubling of the count signal input is required. The unit counts on the positive going (rising) edge of the count input signal, as well as, the negative going (falling) edge.

CODE 45 - COUNTER (B) SCALE MULTIPLIER

There are four counter scale multipliers that are available. They effectively divide the internal count value by 1, 10, 100, and 1000 respectively, to yield the displayed count value. Note: Use of a small scale multiplier in conjunction with a small Scale Factor could cause the internal count value to be exceeded before the 6-digit display value is exceeded. See "Programming the Preset, Scale Factors, Timed Output & Counter Load Values" section for more details.

[45 1] X1
[45 2] X 0.1
[45 3] X0.01
[45 4] X0.001

CODE 46 - COUNTER (B) DECIMAL POINT & LEADING ZERO BLANKING

There are six basic modes of decimal point placement for the counter of the Gemini 4100. The decimal point is placed to the right of the display digit that corresponds to the mode identifier. (The right most decimal point, digit 1, is never turned on.) A "-" sign in front of the mode identifier will inhibit leading zero blanking. The absence of a "-" sign will enable leading zero blanking.

[46 1]	0	LEADING ZERO BLANKING
[46 2]	0.0	
[46 3]	0.0 0	
[46 4]	0.0 0 0	
[46 5]	0.0 0 0 0	
[46 6]	0.0 0 0 0 0	
[46 -1]	0 0 0 0 0 0	LEADING ZERO BLANKING INHIBITED
[46 -2]	0 0 0 0 0.0	
[46 -3]	0 0 0 0.0 0	
[46 -4]	0 0 0.0 0 0	
[46 -5]	0 0.0 0 0 0	
[46 -6]	0.0 0 0 0 0	

CODE 51 - OUTPUT ASSIGNMENT

The output of the Gemini 4100 can be assigned to either the rate or count channel. Assigning the output to the rate will automatically configure the "Counter (B) Reset Mode" to Reset to Zero, [56 1].

[51 2] OUTPUT ASSIGNED TO COUNTER (B)
[51 3] OUTPUT ASSIGNED TO RATE (A)

CODE 52 - OUTPUT TERMINATION MODES

The Gemini 4100 has four "Output Termination Modes" which control the way the output will terminate or reset. In all modes, the output will terminate immediately when the channel to which it is assigned is reset.

A reverse phase mode is available on the Gemini 4100. This refers to the complementing of the logic state of the output. With normal phase operation, when the display value reaches the Preset, the output will turn on. The reset condition of the output is output off. In reverse phase operation, the output turns off when the Preset is reached. The reset condition of the output is output on. (Note: The state of the relay, if used, is also reversed.) A "-" sign in front of the mode identifier will provide for reverse phase operation. The absence of a "-" sign will indicate normal phase operation.

[52 3] TERMINATE AT MANUAL RESET - The output activates when the rate or count, whichever it is assigned to, is greater than or equal to the Preset Value. In this mode, once the output is activated, it does not deactivate until the moment a reset occurs. The output is set for normal phase operation.

[52 4] TERMINATE AT MANUAL RESET END - This mode is like the preceding, except the output deactivates when reset ends. The output is set for normal phase operation.

[52 5] TERMINATE AFTER TIMED OUTPUT - Once the output has been activated, it will deactivate after the predetermined length of time (code 53) has expired. Manual reset will override the timed output and reset the output. The output is set for normal phase operation.

CODE 52 - OUTPUT TERMINATION MODES [Cont'd]

When the output is assigned to the rate [51 3] the output will activate when the rate is greater than or equal to the Preset Value. This will occur every update time period for which the above condition is true. If the output duration time is greater than the programmed update time, the output will appear to be latched on, deactivating when the rate drops below the Preset and the output time expires.

[52 6] BOUNDARY MODE - When in boundary mode, the Preset Value serves as the boundary point. When the display value (count or rate) is less than the Preset, the output is not activated (normal phase). When the display value is greater than or equal to the Preset, the output is activated. If the display value were to drop below the Preset, the output would then deactivate. For negative Preset points, the output is not activated when the count value is more positive than the Preset Value. When the count is more negative than (only possible with counter) or equal to the Preset, the output is activated. If the count becomes more positive than the Preset, the output again deactivates. Upon power up, the output, if assigned to Counter B, will "remember" it's power down boundary condition and go to that state. The output is set for normal phase operation.

[52 -3]
[52 -4]
[52 -5]
[52 -6]

These modes are the same as above with the exception that the output is set for reverse phase operation.

CODE 53 - TIMED OUTPUT VALUE

The Gemini 4100 has the capability of varying the timed output from 0.01 second to 599.99 seconds. When the code is entered, instead of a single mode identifier digit being displayed, six digits will be shown. Refer to "Programming the Preset, Scale Factors, Timed Output & Counter Load Values" section for more details about entering. The timed output will be terminated if the unit is manually reset.

The Timed Output Value is used only when in timed output termination mode, [52 5].

NOTE: A Timed Output Value of zero cannot be programmed into the Gemini 4100. If a value of 0 is entered into the display and the "E" key is pressed, the unit will not enter the 0, but will stay in the data entry mode. If a new value is not entered, it will time out and the unit will continue to use its previous setting.

CODE 56 - COUNTER (B) RESET MODES

The Gemini 4100 has six different counter reset modes. There are also two methods by which manual reset can act on the counter (reset must be enabled, see function code 66 and dip switch set-up). The first is a "maintained" reset action, where the unit is held at reset for as long as the reset terminal or reset button is activated. The second is a "momentary" reset, in which the unit resets, when reset is activated, and starts counting even though the terminal or reset button may still be active. A "-" sign in front of the mode identifier indicates "momentary" reset action, the absence of the "-" sign indicates "maintained" reset action.

In reset to zero modes the output activates at the Preset Value. In reset to Preset modes the output activates at zero.

In the "Reset to Preset" modes, for proper operation, the counter normally counts down. In the "Count with Inhibit" and "Separate Inputs" input response modes, [43 1,or 4], the unit will automatically count down if a Reset to Preset mode is selected. In the other input response modes, proper input phasing is required for down counting. See "CODE 43 - INPUTS 1 & 2 RESPONSE MODES" section for more details.

The activation and de-activation response time for reset is 10msec.

[56 1] MANUAL RESET TO ZERO (RTZ) - Manual reset to zero is accomplished by pulling the "RST." terminal to "COMMON" or, if the front panel reset is enabled, by pressing the front panel reset button. Reset is "maintained".

[56 2] MANUAL RESET TO PRESET (RTP) - Manual reset to Preset is accomplished by pulling the "RST." terminal to "COMMON" or, if the front panel reset is enabled, by pressing the front panel reset button. Reset is "maintained".

[56 3] AUTOMATIC RESET TO ZERO AFTER TIMED OUTPUT - The counter automatically resets to zero when the timed output ends. Manual reset is "maintained" and will override automatic reset. The "Output Termination Mode" should be programmed for timed output operation, [52 5], when in this mode.

[56 4] AUTOMATIC RESET TO PRESET AFTER TIMED OUTPUT - The counter automatically resets to Preset when the timed output ends. Manual reset is "maintained" and will override automatic reset. The "Output Termination Mode" should be programmed for timed output operation, [52 5], when in this mode.

[56 5] AUTOMATIC RESET TO ZERO AT BEGINNING OF TIMED OUTPUT (AT PRESET) - In this reset mode, the counter will automatically reset to zero at the beginning of the timed output (at Preset). The Timed Output Value (code 53) must be shorter than the time required for the counter to count to the Preset Value, otherwise, the output will appear to be latched on. Manual reset is "maintained" and will override automatic reset. The "Output Termination Mode" should be programmed for timed output operation, [52 5], when in this mode.

[56 6] AUTOMATIC RESET TO PRESET AT BEGINNING OF TIMED OUTPUT (AT ZERO) - In this reset mode, the counter will automatically reset to Preset at the beginning of the timed output (at zero). The Timed Output Value (code 53) must be shorter than the time required for the counter to count to zero, otherwise, the output will appear to be latched on. Manual reset is "maintained" and will override automatic reset. The "Output Termination Mode" should be programmed for timed output operation, [52 5], when in this mode.

[56 -1]
[56 -2]
[56 -3]
[56 -4]
[56 -5]
[56 -6]

These modes are the same as above with the exception that manual reset is set for "momentary" operation.

CODE 61 - RATE (A) RIGHT HAND DUMMY ZEROS

Dummy zeros can be used to alleviate display fluctuations due to an unstable input signal. These zeros effectively move significant digits to the left. Therefore, a normal rate display of 1 could be shown as a 10, 100, or 1000. Using the dummy zeros will make it necessary to adjust the scaling if they were not considered before.

[61 1] 1 RIGHT HAND DUMMY ZERO
[61 2] 2 RIGHT HAND DUMMY ZEROS
[61 3] 3 RIGHT HAND DUMMY ZEROS
[61 4] NO RIGHT HAND DUMMY ZEROS

CODE 62 - RATE CONVERSION FACTOR

The rate conversion factor provides a simple means of obtaining the desired rate reading, using the same Scale Factor Value as the counter, when the rate and count units are the same. In most scaling applications, it is simply programmed to the desired time units that the rate is to be displayed in. See Appendix "F" - Scaling For Rate.

[62 1] Rate Per Second (X1)
[62 2] Rate Per Minute (X60)
[62 3] Rate Per Hour (X3600)

CODE 63 - RATE MINIMUM UPDATE TIME

The determination of the rate value uses a method in which the elapsed time is measured between the first and last pulse of the update period. The minimum update time is the shortest the time period can be. Once the minimum update time has expired, the unit will end the measurement period when the next negative going count edge occurs. If the unit does not receive the next negative count edge within the maximum update time at the start of the measurement period, the unit will end the time period and the rate display will go to zero. At very slow count rates the update time period will be the actual period of one count cycle.

[63 1] 0.5 Sec. minimum/1 Sec. maximum
[63 2] 1 Sec. minimum/2 Secs. maximum
[63 3] 2 Secs. minimum/4 Secs. maximum
[63 4] 4 Secs. minimum/8 Secs. maximum
[63 5] 8 Secs. minimum/16 Secs. maximum (max. rate = 7500cps)
[63 6] 16 Secs. minimum/32 Secs. maximum (max. rate = 3250cps)

CODE 64 - RATE SCALE MULTIPLIER

The Rate Scale Multiplier is used in conjunction with the Rate Scale Factor A and Rate Conversion Factor to scale the actual signal input to obtain the desired reading.

[64 1] X 1000
[64 2] X 100
[64 3] X 10
[64 4] X 1
[64 5] X 0.1
[64 6] X 0.01

CODE 65 - RATE (A) DECIMAL POINT & LEADING ZERO BLANKING

There are six basic modes of decimal point placement for the Rate indicator of the Gemini 4100. The decimal point is placed to the right of the display digit that corresponds to the mode identifier. (The right most decimal point, digit 1, is never turned on.) A "-" sign in front of the mode identifier will inhibit leading zero blanking. The absence of a "-" sign will enable leading zero blanking.

[65 1]	0	LEADING ZERO BLANKING
[65 2]	0.0	
[65 3]	0.0 0	
[65 4]	0.0 0 0	
[65 5]	0.0 0 0 0	
[65 6]	0.0 0 0 0 0	
[65 -1]	0 0 0 0 0 0	LEADING ZERO BLANKING INHIBITED
[65 -2]	0 0 0 0 0.0	
[65 -3]	0 0 0 0.0 0	
[65 -4]	0 0 0.0 0 0	
[65 -5]	0 0.0 0 0 0	
[65 -6]	0.0 0 0 0 0	

CODE 66 - "OPERATOR ACCESSIBLE FUNCTIONS" MODES

The Gemini 4100 has six basic levels of "Operator Accessible Functions". Each of these levels can be modified to enable or disable manual reset. When the "PGM. DIS." (program disable) terminal is connected to "COMMON", access to all functions is disabled except for those listed below which will remain enabled. All of the function codes and parameters can be interrogated, regardless of the "Operator Accessible Functions" mode selected.

A "-" sign in front of the mode identifier will disable the front panel Reset button and the "RST." terminal.

NOTE: The front panel reset button can be independently disabled by using the disable reset DIP switch.

[66 1] NO FUNCTIONS ENABLED EXCEPT RESET - In this mode, manual reset is enabled, but none of the programming functions can be changed.

[66 2] PRESET PROGRAMMING AND RESET ENABLED - In this mode, manual reset and the programming of the Preset Value are enabled.

[66 3] SCALE FACTOR PROGRAMMING AND RESET ENABLED - In this mode, manual reset and the programming of the Scale Factor Values are enabled.

[66 4] SCALE FACTOR, PRESET PROGRAMMING AND RESET ENABLED - In this mode, manual reset and the programming of the Scale Factors and Preset Value are enabled.

[66 5] PRESET AND COUNTER LOAD PROGRAMMING ENABLED - In this mode, manual reset and the programming of the Preset and Counter Load Value are enabled.

[66 6] PRESET, SCALE FACTOR AND COUNTER LOAD PROGRAMMING ENABLED - In this mode, manual reset and the programming of the Preset, Scale Factors and Counter Load Value are enabled.

[66 -1]	These Modes are the same as above with the exception that manual reset is disabled.
[66 -2]	
[66 -3]	
[66 -4]	
[66 -5]	
[66 -6]	

PRESET VALUE

Whenever the display value equals the Preset Value, an output action will occur. This action depends on the previously programmed modes. The Preset Value may vary from -999,999 to 999,999. *(Refer to "Programming the Preset, Scale Factors, Timed Output & Counter Load Values" section for instructions on entering the Preset Value.)*

The Counter (B) Scale Factor, SFB, will have a direct effect on the Preset Value being entered *(if assigned to the counter)*. For a Scale Factor Value greater than one, the Preset Value should be an integer multiple of the Scale Factor. If it is not, the Gemini will automatically adjust the Preset Value up or down to force it to be evenly divisible by the Scale Factor.

"P"(1) - PRESET VALUE

SCALE FACTORS A & B

"SF"(3) SCALE FACTOR - The Scale Factor, for which Value *(count or rate)* is currently being displayed, is accessed by pressing the "SF"(3) key. To access the Scale Factor of the *"other"* display value, the "DISP" key would be pushed *(to change the display to the other value)*, then the "SF"(3) key would be pushed.

The number of pulses counted *(internal count value)* is multiplied by the Scale Factor, which changes the displayed value accordingly. A Scale Factor Value of 1.0000 would result in a display of the actual number of input pulses that have been counted. The Scale Factor is used primarily for conversion from existing pulses per unit of measure to the required displayed units. This includes conversion from different units of measure (i.e feet to meters, etc.).

The Scale Factor Value may range from -5.9999 to +5.9999 (positive only for Rate (A) Scale Factor, SFA). Refer to "Programming the Preset, Scale Factors, Timed Output & Counter Load Values" section for entering instructions. It is important to note that the precision of a counter application cannot be improved by using a Scale Factor greater than one. To accomplish greater precision, more pulse information must be generated per measuring unit. For example, if 5 pulses are being received per foot of material, the precision of 10th of feet cannot be attained by simply programming a Scale Factor of 2.0000, even though the display is reading in 10ths. In this case, the display will increment by two for each count input. Thus if an odd Preset Value was entered, such as 6.7ft., the Gemini will alter the Preset to read in even tenths of feet.

NOTE: Use of a small Scale Factor in conjunction with a small scale multiplier could cause the internal count value (counter) to be exceeded before the 6-digit display value is exceeded.

COUNTER LOAD VALUE

The Counter Load Value is provided to allow the user to modify the count value. The Counter Load Value is reset to zero when the Gemini is powered up. Once the Counter Load Value has been changed, it will remain set to that value until the unit is powered down and up. Accessing the Counter Load Value for the counter that is currently being displayed is done by pushing the "E" button and while being held down also pushing the "DISP" button. See "Programming the Preset, Scale Factors, Timed Output & Counter Load Values" section for entering instructions.

"E" & "DISP" - Counter Load Value for the currently displayed counter.

SINGLE PRESET COUNTER & RATE INDICATION APPLICATION

A Lumber processing plant has an application for it's planing machines. The application has two requirements; provide a gate control of the boards entering the planer and to count the total number of boards run through the planer. The Gemini 4100 can offer a solution to both these requirements, in one unit. By programming in the counter/rate unit personality [41 1], Display A will function as the rate indicator and Display B as the counter.

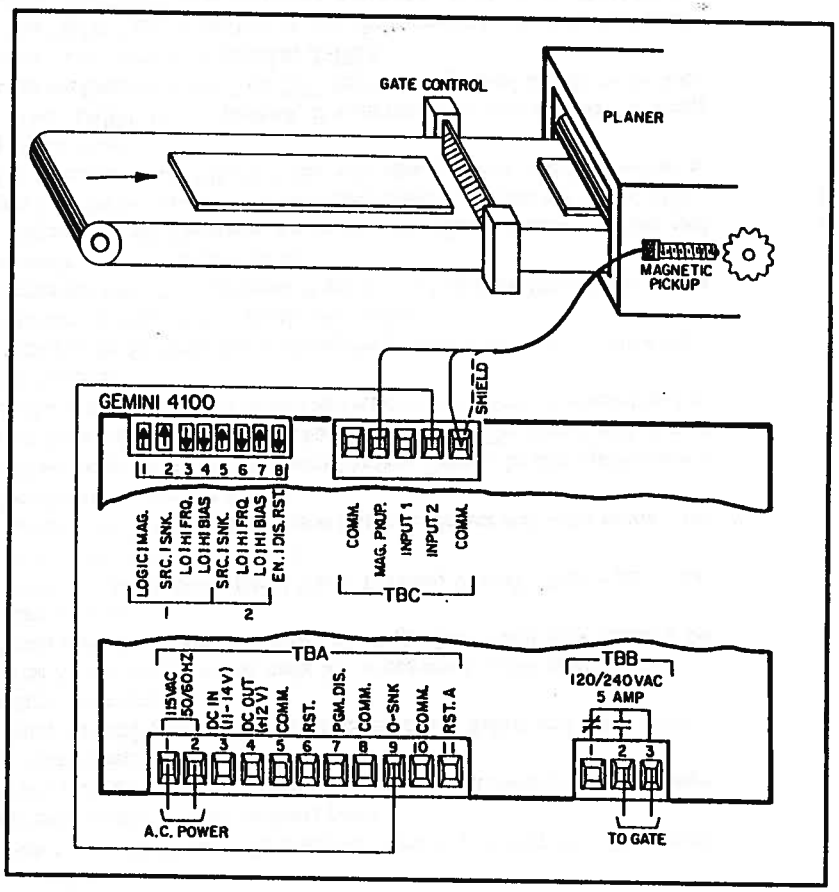
The gate control involves opening and closing the entrance gate to the planer based on the motor speed of the planer. When the motor speed reaches 5,000 RPM, the gate will be opened and a board will enter. The preset output will be used to control an air solenoid, which will operate the gate. (The motor speed of the planer will drop to approximately 4800 RPM during planing, which will close the gate control until the speed goes back to 5000 RPM.) Using the boundary "Output Termination Mode" [52 6], and a Preset of 5000, will provide the proper modes for the control of the solenoid. Since the gate will be opened once each time a board enters, the output which controls the gate can also serve as the input to the counter. The counter will then totalize the number of boards planed during the day.

An existing 48 tooth gear is available for sensing the motor speed.

HARDWARE SET-UP

The accompanying drawing shows how the hardware is set-up for this application. A magnetic pickup is used to sense the teeth on the gear that is coupled to the motor shaft of the planer. The Gemini will be programmed for "Separate Input" Input Response mode. In this mode, Input channel 1 is the Rate input and Input Channel 2 is the counter input. The magnetic pickup is connected between the "MAG. PKUP." input and "COMM." Appendix "A" shows the proper connections and switch settings for various sensors including magnetic pickup. S1, "LOGIC/MAG", is set in the "MAG" position. S2, "SNK/SRC" is set in the "SNK" position, as required for magnetic pickup operation. The switch settings of S3 and S4 do not apply when using a magnetic pickup. The counter input, Input 2, is connected to the open collector output, "O-SNK", of the Gemini 4100. The switch settings for an open collector sensor will be used. S5, "SNK/SRC" is set in the "SNK" position to provide a pull-up resistor for the open collector output. The "LO/HI FRQ." switch, S6, is set in the "LO FRQ." position, since the count rate will be slow. This will provide higher noise immunity. S7, "LO/HI BIAS", is set in the "HI BIAS" position, to also provide higher noise immunity.

The relay output of the Gemini is connected to operate the solenoid, as shown.



SCALING THE RATE INDICATOR

In order to calculate the scaling parameters, the procedure and formulas in Appendix "F" - "Scaling For Rate" are used.

In converting pulse units to "Display Units", we know that 48 pulses is equivalent to 1 revolution of the motor shaft. Therefore, the "Display Unit" will be 1 and the "Number of Pulses" to obtain 1 "Display Unit" is 48.

STEP 1 - Calculate the Total Scaling Factor, "K_T", using formula #1 of Appendix "F" - "Scaling For Rate".

$$K_T = \text{Display Unit/Number of Pulses}$$
$$K_T = 1/48 = 0.020833$$

STEP 2 - Determine the "Rate Scale Multiplier" Value and calculate the "Scale Factor A" Value using Formula #2 of Appendix "F" - "Scaling For Rate". A "Rate Scale Multiplier" Value of 0.01 is chosen to provide for a "Scale Factor A" Value which has the most amount of significant digits possible. The resulting Scale Factor value is 2.0833.

$$SF = K_T/SCM$$
$$SF = 0.020833/0.01 = 2.0833$$

Since the rate is to be in rate per minute, the "Rate Conversion Factor" is selected as "Rate per Minute" [62 2].

SCALING THE COUNTER

The counter is to display the total number of boards that have gone through the planer. Since the rate indicator output will open the gate each time a board is planed, the same output will be used to provide the input to the counter. In this application there will be a 1 to 1 correspondence between input pulses and boards counted. With this in mind, the Scale Factor and Scale Multiplier for the Counter, can be set to the factory configured values of 1.

STEP BY STEP PROGRAMMING OF THE GEMINI 4100

STEP 1 - Enter code 41 (Unit Personality). Select and enter a mode identifier of 1, for the Gemini to operate as a Counter and Rate indicator.

STEP 2 - Enter Code 42 (Reset Button & Terminal Actuation Modes). Select and enter mode 2 to reset the counter when reset is activated.

STEP 3 - Enter code 43 ("Inputs 1 & 2 Response Modes"). Select and enter mode 4, "Separate Input" mode, to provide separate inputs for the rate indicator and counter.

STEP 4 - Enter code 44 ("Counter B Number of Count Edges"). Select and enter mode 1 for single edge counting.

STEP 5 - Enter code 45 (Counter B Scale Multiplier). Select and enter mode 1 for a scale multiplier of 1.

STEP 6 - Enter code 46 (Counter B Decimal Point & Leading Zero Blanking). Select and enter mode 1 for no decimal point.

STEP 7 - Enter code 51 (Output Assignment). Select and enter mode 3 to assign the preset and output to the rate indicator.

STEP 8 - Enter code 52 (Output Termination Modes). Select and enter mode 6 for boundary operation.

NOTE: The Timed Output value, code 53, is not used in this application.

STEP 9 - Enter code 56 (Counter B Reset Modes). Select and enter mode 1 for manual reset to zero.

STEP 10 - Enter code 61 (Rate Right Hand Dummy Zeros). Select and enter mode 4 for no right hand dummy zeros.

STEP 11 - Enter code 62 (Rate Conversion Factor). Select and enter mode 2 for a Rate Per Minute conversion factor.

STEP 12 - Enter code 63 (Rate Minimum Update Time). In this application a short update time will allow the output to update faster. (The output will change only when the display updates.) Select and enter mode 1 for a minimum update time of 0.5 Second.

STEP 13 - Enter code 64 (Rate Scale Multiplier). Select and enter mode 6 for a Scale Multiplier of 0.01, as previously determined.

STEP 14 - Enter code 65 (Rate Decimal Point & Leading Zero Blanking). Select and enter mode 1 for no decimal point.

STEP 15 - Enter code 66 (Operator Accessible Functions Modes). Select and enter mode (+)1 for no functions except reset enabled. When the "PGM.DIS." terminal is connected to "COMM.", the only changes that will be possible is resetting the counter.

STEP 16 - The "DISP" key is pushed, if necessary, so that the rate is being indicated on the Gemini 4100. The "SF" key is then pushed to call up the Rate Scale Factor. The value is changed to 2.0833.

STEP 17 - The "DISP" key is pushed, so that the count is being indicated on the Gemini 4100. The "SF" key is then pushed to call up the Counter Scale Factor. The value is changed to, or left at its factory set value of 1.0000.

STEP 18 - Enter a Preset value of 5000, by pushing the "P" key.

After the unit is programmed, the "PGM. DIS." terminal is connected to "COMM." to prevent any unauthorized or accidental mode changes. The function codes can, however, be called up to view or verify that the proper modes are entered.

PROGRAMMING INSTRUCTIONS FOR THE DUAL COUNTER VERSION OF THE GEMINI 4100

The first part of this section provides detailed descriptions of the function command codes for Inputs Response modes, reset modes, output terminations, etc. Then, using an actual application example, the programming instructions for the Dual Counter version will be "walked through", to give the user a full understanding of the Gemini 4100 programming procedure. The descriptions below give the function command code first, followed by the individual mode identifier. The Function Command Code Summary in the appendix, lists all codes. (Only commands and modes pertaining to the Dual Counter personality will be discussed in this section.)

CODE 41 - UNIT PERSONALITY

The Gemini 4100 can be programmed to operate in one of two different unit personalities. In each of the two personalities the Gemini 4100 operates as a dual function indicator. The personality selected determines whether display channel A will indicate rate or count. In both personalities, display channel B operates as a counter.

When the Unit Personality is changed and entered, all modes and data values (Preset, Scale Factors, function codes, etc.) will be automatically loaded with the factory settings for that personality. If, for any reason during programming, it is desired to return to the factory settings, the "+/" key can be pushed while in code 41. Then, when the "E" key is pressed the unit will load the factory settings into the Gemini 4100.

The programming procedures for the two unit personalities will vary. This entire section deals with the unit programmed as a Dual Counter indicator, [41 2].

[41 1] COUNTER (B)/ RATE (A) - In this mode, display channel A functions as a rate indicator and display channel B functions as a counter.

[41 2] DUAL COUNTER - In this mode, both display channels, A & B, function as counters.

CODE 42 - RESET BUTTON & TERMINAL ACTUATION MODES

The "Reset Button & Terminal Actuation modes" control the affect that the reset button and terminal have on the two display channels.

There is a separate "Rst A" terminal which resets Counter A, when activated. It is provided to allow independent resetting of each channel.

[42 1] RESET COUNTER (A)
[42 2] RESET COUNTER (B)
[42 3] RESET COUNTER (A) AND COUNTER (B)

CODE 43 - INPUTS 1 & 2 RESPONSE MODES

The Gemini 4100 has six different input response modes. They are: Count(1) with Inhibit(2); Count(1) with Up/Down Control (2); Two input anticoincidence Add(1)/Subtract(2); Separate Input mode; Quadrature; and Quadrature X4. In all modes, except [43 4], both counters will respond identically to both inputs. These modes are most suitable for applications where one channel is used for control, and the other for totalizing counts.

[43 1] COUNT WITH INHIBIT - Input 1 serves as the count input. Input 2 serves as the Inhibit input. When Input 2 is low, the counters will ignore the count signal appearing at Input 1. When Input 2 is at a high level, the pulses appearing at Input 1 will be counted.

[43 2] COUNT WITH UP/DOWN CONTROL - In this mode, count direction can be controlled by the second input. Input 1 serves as the count input and Input 2 serves as the direction control signal input. When Input 2 is at a high level, the counters will count up. When Input 2 is at a low level, the counters will count down.

[43 3] TWO INPUT ANTICOINCIDENCE ADD/SUBTRACT - This mode effectively separates count pulses which may simultaneously appear at the two inputs. The Gemini unit processes the count pulses into a string of time-separated pulses, so the internal counters will not lose any counts. Input 1 serves as the add input (count increments) and Input 2 serves as the subtract input (count decrements).

[43 4] SEPARATE INPUT - In this mode, the two counters, A & B, are independently controlled by the inputs. Input 1 serves as the Counter A input and Input 2 serves as the Counter B input.

[43 5] QUADRATURE COUNTING - Quadrature counting modes are primarily used in positioning and anti-jitter applications. The reason this mode works is due to the manner in which two pickups are positioned relative to each other. The signal on Input 2 is a pulse train signal shifted 90° away from the signal on Input 1. These two signals are processed by the Gemini as follows:
Input 1 serves as the count input, while Input 2 serves as the quadrature input. For quadrature with single edge counting, the counters will count in a positive direction when Input 1 is a negative going edge and Input 2 is at a low level. The counters will count in a negative direction when Input 1 is a positive going edge and Input 2 is at a low level. All transitions on Input 1 are ignored when Input 2 is at a high level. These logic rules provide the basis for anti-jitter operation which will prevent false counts from occurring due to back-lash, vibration, chatter, etc.
When two edge counting is used, the quadrature mode works the same as with single edge counting when Input 2 is low. But when Input 2 is at a high level, counts at Input 1 are no longer ignored. Instead the logic rules for Input 1 are complemented, allowing both edges of Input 1 to be counted. This doubles the effective resolution of the encoded input.

[43 6] QUADRATURE TIMES 4 - This mode takes the quadrature mode, with two edge counting, one step further. In quadrature times 4, both Input 1 and Input 2 serve as the count or quadrature input, depending on their state. In one instance, Input 1 will serve as the count input and Input 2 will serve as the quadrature input. In another instance, Input 1 will be the quadrature input and Input 2 will be the count input. This enables each edge, positive and negative going, of both inputs, 1 and 2, to be counted. This results in a resolution four times greater than in the basic quadrature X1 mode.

CODE 44 - COUNTERS A & B NUMBER OF COUNT EDGES

The counters of the Gemini 4100 can be programmed for either single or two edge (X2) counting. The number of count edges cannot be set when the count mode is programmed for quadrature X4 operation. The Gemini will ignore any attempt to enter function command code 44, when set for quadrature X4.

[44 1] SINGLE EDGE COUNTING (X1) - The unit counts on the negative going (falling) edge of the count input signal. The Inputs 1 and 2 Response mode descriptions describe how each mode uses this method of edge counting.

[44 2] TWO EDGE COUNTING (X2) - This mode is used when doubling of the count signal input is required. The unit counts on the positive going (rising) edge of the count input signal, as well as, the negative going (falling) edge.

CODE 45 - COUNTER B SCALE MULTIPLIER

There are four "Counter B Scale Multipliers" that are available. They effectively divide the internal Count B value by 1, 10, 100, and 1000 respectively, to yield the displayed Counter B value. Note: Use of a small scale multiplier in conjunction with a small Scale Factor could cause the internal count value to have exceeded before the 6-digit display value is exceeded. See "Programming the Preset, Scale Factors, Timed Output & Counter Load Values" section for more details.

[45 1] X1
[45 2] X0.1
[45 3] X0.01
[45 4] X0.001

CODE 46 - COUNTER B DECIMAL POINT & LEADING ZERO BLANKING

There are six basic modes of decimal point placement for the counter of the Gemini 4100. The decimal point is placed to the right of the display digit that corresponds to the mode identifier. (The right most decimal point, digit 1, is never turned on.) A "-" sign in front of the mode identifier will inhibit leading zero blanking. The absence of a "-" sign will enable leading zero blanking.

[46 1]	0	LEADING ZERO BLANKING
[46 2]	0.0	
[46 3]	0.0 0	
[46 4]	0.0 0 0	
[46 5]	0.0 0 0 0	
[46 6]	0.0 0 0 0 0	
[46 -1]	0 0 0 0 0 0	LEADING ZERO BLANKING INHIBITED
[46 -2]	0 0 0 0 0.0	
[46 -3]	0 0 0 0.0 0	
[46 -4]	0 0 0.0 0 0	
[46 -5]	0 0.0 0 0 0	
[46 -6]	0.0 0 0 0 0	

CODE 51 - OUTPUT ASSIGNMENT

The output of the Gemini 4100 is assigned to Counter B.

[51 2] OUTPUT ASSIGNED TO COUNTER (B)

CODE 52 - OUTPUT TERMINATION MODES

The Gemini 4100 has four "Output Termination Modes", which control the way the output will terminate or reset. In all modes, the output will terminate immediately when Counter B is reset.

A reverse phase mode is available on the Gemini 4100. This refers to the complementing of the logic state of the output. With normal phase operation, when the display value reaches the Preset the output will turn on. The reset condition of the output is output off. In reverse phase operation, the output turns off when the Preset is reached. The reset condition of the output is output on. (Note: The state of the relay, if used, is also reversed.) A "-" sign in front of the mode identifier will provide for reverse phase operation. The absence of a "-" sign will indicate normal phase operation.

[52 3] TERMINATE AT MANUAL RESET - The output activates when Counter B is greater than or equal to the Preset Value. In this mode, once the output is activated, it does not deactivate until the moment a reset occurs. The output is set for normal phase operation.

[52 4] TERMINATE AT MANUAL RESET END - This mode is like the preceding, except the output deactivates when reset ends. The output is set for normal phase operation.

[52 5] TERMINATE AFTER TIMED OUTPUT - Once the output has been activated, it will deactivate after the predetermined length of time (code 53) has expired. Manual reset will override the timed output and reset the output. The output is set for normal phase operation.

[52 6] BOUNDARY MODE - When in boundary mode the Preset Value serves as the boundary point. When the Counter B Value is less than the Preset, the output is not activated (normal phase). When the Counter B Value is greater than or equal to the Preset, the output is activated. If the Counter B Value were to drop below the Preset, the output would then deactivate. For negative Preset points, the output is not activated when the Counter B Value is more positive that the Preset Value. When the count is more negative than or equal to the Preset, the output is activated. If the count becomes more positive than the Preset, the output again deactivates. Upon power up, the output will "remember" its power down boundary condition and go to that state. The output is set for normal phase operation.

[52 -3] [52 -4] [52 -5] [52 -6]	These modes are the same as above with the exception that the output is set for reverse phase operation.

CODE 53 - TIMED OUTPUT VALUE

The Gemini 4100 has the capability of varying the timed output from 0.01 second to 599.99 seconds. When the code is entered, instead of a single mode identifier digit being displayed, six digits will be shown. Refer to "Programming the Preset, Scale Factors, Timed Output & Counter Load Values" section for more details about entering. The timed output will be terminated if the unit is manually reset.

NOTE: A Timed Output Value of zero cannot be programmed into the Gemini 4100. If a value of 0 is entered into the display the "E" key is pressed, the unit will not enter the 0, but will stay in the data entry mode. If a new value is not entered it will time out and the unit will continue to use it's previous setting.

CODE 56 - COUNTER (B) RESET MODES

The Gemini 4100 has six different Counter B reset modes. There are also two methods by which manual reset can act on the counter (reset must be enabled, see function code 66 and dip switch set-up). The first is a "maintained" reset action, where the unit is held at reset for as long as the reset terminal or reset button is activated. The second is a "momentary" reset, in which the unit resets, when reset is activated, and starts counting even though the terminal or reset button may still be active. A "-" sign in front of the mode identifier indicates "momentary" reset action, the absence of the "-" sign indicates "maintained" reset action.

In reset to zero modes the output activates at the Preset Value. In reset to Preset modes the output activates at zero.

In the "Reset to Preset" modes, for proper operation, the counter normally counts down. In the "Count with Inhibit" and "Separate Inputs" input response modes, [43 1,or 4], the unit will automatically count down if a Reset to Preset mode is selected. In the other input response modes, proper input phasing is required for down counting. See "CODE 43 - INPUTS 1 & 2 RESPONSE MODES" section for details.

The activation and de-activation response time for reset is 10msec.

[56 1] MANUAL RESET TO ZERO (RTZ) - Manual reset to zero is accomplished by pulling the "RST." terminal to "COMMON" or, if the front panel reset is enabled, by pressing the front panel reset button. Reset is "maintained".

[56 2] MANUAL RESET TO PRESET (RTP) - Manual reset to Preset is accomplished by pulling the "RST." terminal to "COMMON" or, if the front panel reset is enabled, by pressing the front panel reset button. Reset is "maintained".

[56 3] AUTOMATIC RESET TO ZERO AFTER TIMED OUTPUT - The counter automatically resets to zero when the timed output ends. Manual reset is "maintained" and will override automatic reset.

[56 4] AUTOMATIC RESET TO PRESET AFTER TIMED OUTPUT - The counter automatically resets to Preset when the timed output ends. Manual reset is "maintained" and will override automatic reset.

[56 5] AUTOMATIC RESET TO ZERO AT BEGINNING OF TIMED OUTPUT (AT PRESET) - In this reset mode, the counter will automatically reset to zero at the beginning of the timed output (at Preset). The Timed Output Value (code 53) must be shorter than the time required for the counter to count to the Preset Value, otherwise, the output will appear to be latched on. Manual reset is "maintained" and will override automatic reset.

[56 6] AUTOMATIC RESET TO PRESET AT BEGINNING OF TIMED OUTPUT (AT ZERO) - In this reset mode, the counter will automatically reset to Preset at the beginning of the timed output (at zero). The Timed Output Value (code 53) must be shorter than the time required for the counter to count to zero, otherwise, the output will appear to be latched on. Manual reset is "maintained" and will override automatic reset.

[56 -1]
[56 -2]
[56 -3]
[56 -4]
[56 -5]
[56 -6]

These modes are the same as above with the exception that manual reset is set for "momentary" operation.

CODE 61 - COUNTER (A) RESET MODES

Counter A is set to Reset to zero, since the output is assigned to Counter B. There are two ways to reset Counter A. The reset button or "RST." terminal can be used, if the appropriate "Reset Button & Terminal Activation Mode" is programmed. The second way is the use of the "RST.A" terminal. If it is necessary to reset Counter A & B independently, the "Reset Button & Terminal Activation Mode" should be programmed to Reset Counter B, and the "RST.A" terminal should then be used to reset Counter A.

There are two methods by which manual reset can act on Counter A (reset must be enabled - see function code 66 and dip switch set-up). The first is a "maintained" reset action, where the unit is held at reset for as long as the reset terminal or reset button is activated. The second is a "momentary" reset, in which the unit resets, when reset is activated, and starts counting even though the terminal or reset button may still be active. A "-" sign in front of the mode identifier indicates "momentary" reset action, the absence of the "-" sign indicates "maintained" reset action.

The activation and de-activation response time for reset is 10msec.

[61 1] MANUAL RESET TO ZERO (RTZ) - Manual reset to zero is accomplished by activating the appropriate reset button or terminal. Reset is "maintained".

[61 -1] Same as above, except Reset is "momentary".

CODE 64 - COUNTER (A) SCALE MULTIPLIER

There are four counter scale multipliers that are available. They effectively divide the internal Counter A Value by 1, 10, 100, and 1000 respectively, to yield the displayed Counter A Value. Note: Use of a small scale multiplier in conjunction with a small Scale Factor could cause the internal Counter A Value to have exceeded before the 6-digit display value is exceeded.

[64 1] X1
[64 2] X0.1
[64 3] X0.01
[64 4] X0.001

CODE 65 - COUNTER (A) DECIMAL POINT & LEADING ZERO BLANKING

There are six basic modes of decimal point placement for Counter A of the Gemini 4100. The decimal point is placed to the right of the display digit that corresponds to the mode identifier. (The right most decimal point, digit 1, is never turned on.) A "-" sign in front of the mode identifier will inhibit leading zero blanking. The absence of a "-" sign will enable leading zero blanking.

[65 1]	0	LEADING ZERO BLANKING
[65 2]	0.0	
[65 3]	0.0 0	
[65 4]	0.0 0 0	
[65 5]	0.0 0 0 0	
[65 6]	0.0 0 0 0 0	
[65 -1]	0 0 0 0 0 0	LEADING ZERO BLANKING INHIBITED
[65 -2]	0 0 0 0 0.0	
[65 -3]	0 0 0 0.0 0	
[65 -4]	0 0 0.0 0 0	
[65 -5]	0 0.0 0 0 0	
[65 -6]	0.0 0 0 0 0	

CODE 66 - "OPERATOR ACCESSIBLE FUNCTIONS" MODES

The Gemini 4100 has six basic levels of "Operator Accessible Functions". Each of these levels can be modified to enable or disable manual reset. When the "PGM. DIS." (program disable) terminal is connected to "COMMON", access to all functions is disabled except for those listed below which will remain enabled. All of the function codes and parameters can be interrogated, regardless of the "Operator Accessible Functions" mode selected.

A "-" sign in front of the mode identifier will disable the front panel Reset button and the "RST." terminal.

NOTE: The front panel reset button can be independently disabled by using the disable reset DIP switch.

[66 1] NO FUNCTIONS ENABLED EXCEPT RESET - In this mode, manual reset is enabled, but none of the programming functions can be changed.

[66 2] PRESET PROGRAMMING AND RESET ENABLED - In this mode, manual reset and the programming of the Preset Value are enabled.

[66 3] SCALE FACTOR PROGRAMMING AND RESET ENABLED - In this mode, manual reset and the programming of the Scale Factor Values are enabled.

[66 4] SCALE FACTOR, PRESET PROGRAMMING AND RESET ENABLED - In this mode, manual reset and the programming of the Scale Factor and Preset Values are enabled.

[66 5] PRESET AND COUNTER LOAD PROGRAMMING ENABLED - In this mode, manual reset and the programming of the Preset and Counter Value are enabled.

[66 6] PRESET, SCALE FACTOR AND COUNTER LOAD PROGRAMMING ENABLED - In this mode, manual reset and the programming of the Preset, Scale Factor and Counter Value are enabled.

[66 -1]
[66 -2]
[66 -3]
[66 -4]
[66 -5]
[66 -6]

These modes are the same as above with the exception that reset is disabled.

PRESET VALUE

Whenever the display value equals the Preset Value, an output action will occur. This action depends on the previously programmed modes. The Preset Value may vary from -999,999 to 999,999. (Refer to "Programming the Preset, Scale Factors, Timed Output & Counter Load Values" for instructions on entering the Preset Value.)

The Scale Factor will have a direct effect on the Preset Value being entered. For a Scale Factor Value greater than one, the Preset Value should be an integer multiple of the Scale Factor. If it is not, the Gemini will automatically adjust the Preset Value up or down to force it to be evenly divisible by the Scale Factor.

"P"(1) - PRESET VALUE

SCALE FACTOR A & B

"SF"(3) SCALE FACTOR - The Scale Factor, for the Value (Counter A or Counter B) that is currently being displayed, is accessed by pressing the "SF"(3) key. To access the Scale Factor of the "other" display value, the "DISP" key would be pushed (to change the display to the other value), then the "SF"(3) key would be pushed.

The number of pulses counted (internal count value) is multiplied by the Scale Factor, which changes the displayed value accordingly. A Scale Factor Value of 1.0000 would result in a display of the actual number of input pulses that have been counted. The Scale Factor is used primarily for conversion from existing pulses per unit of measure to the required displayed units. This includes conversion from different units of measure (i.e feet to meters, etc.). The Scale Factor Value may range from -5.9999 to +5.9999. Refer to "Programming the Preset, Scale Factors, Timed Output & Counter Load Values" for entering instructions.

It is important to note that the precision of a counter application cannot be improved by using a Scale Factor greater than one. To accomplish greater precision, more pulse information must be generated per measuring unit. For example, if 5 pulses are being received per foot of material, the precision of 10th of feet cannot be attained by simply programming a Scale Factor of 2.0000, even though the display is reading in 10ths. In this case, the display will increment by two for each count input. Thus if an odd Preset Value was entered, such as 6.7ft., the Gemini will alter the Preset to read in even tenths of feet.

NOTE: Use of a small Scale Factor in conjunction with a small scale multiplier could cause the internal count value to be exceeded before the 6-digit display value is exceeded.

COUNTER LOAD VALUE

The Counter Load Value is provided to allow the user to modify the count value. The Counter Load Value is reset to zero when the Gemini is powered up. Once the Counter Load Value has been changed, it will remain set to that value until the unit is powered down and up. Accessing the Counter Load Value for the counter that is currently being displayed is done by pushing the "E" button and while being held down also pushing the "DISP" button.

"E" & "DISP" - Counter Load Value for the currently displayed counter.

DUAL COUNTER APPLICATION

A leading cloth manufacturer would like to measure production output in both English and metric units. The production workers were accustomed to working with English units, however, certain foreign orders called for the measurements in metric. By applying the Gemini 4100, both measurements and a cut-off control can be accomplished.

A PSAC proximity sensor, sensing an existing 48-tooth gear mounted on a 1 foot circumference feed roll, will provide the input to the Gemini 4100.

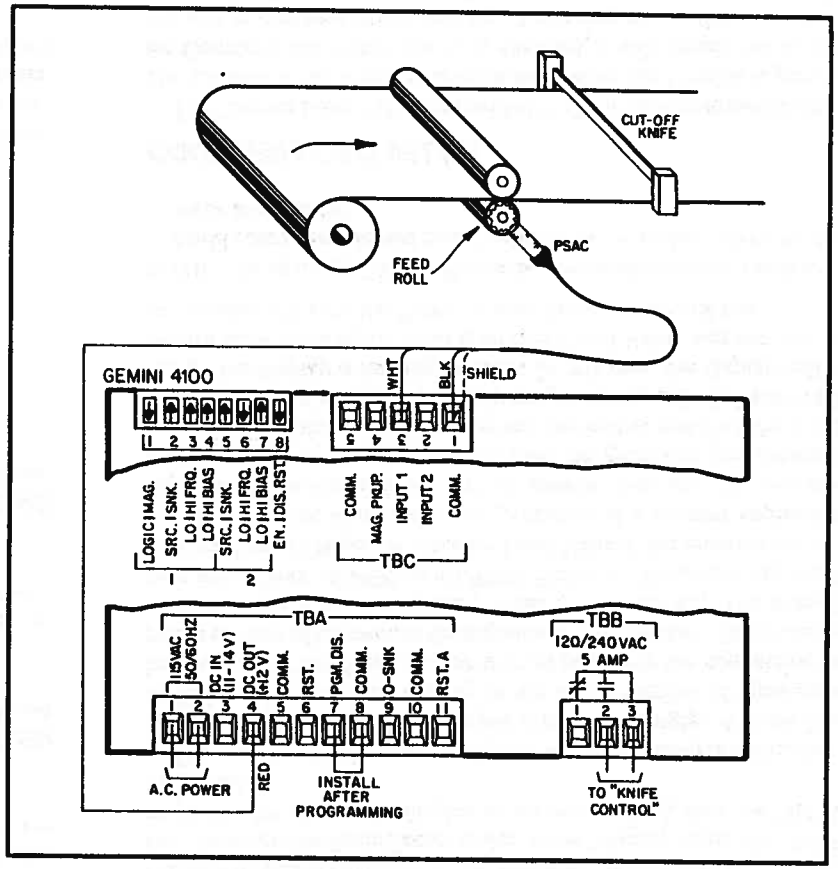
Programming the Gemini for a Dual Counter personality [41 2] will enable us to monitor both measurements at the same time. Counter A will be used to readout the English measurement and Counter B the metric measurement. The accompanying drawing shows the PSAC sensing the 48 tooth gear mounted to the feed roller.

HARDWARE SET-UP

The application drawing shows how the hardware for this system is to be connected. The red, black, and white wires of the PSAC are connected to the "DC OUT", "COMM", and "INPUT 1" terminals of the Gemini 4100, respectively. The shield of the PSAC cable is also connected to "COMM". After the programming is completed, a jumper should be installed between the "PGM. DIS." and "COMM" terminals. This, in conjunction with the "Operator Accessible Functions" mode, will prevent accidental changes in the units operating modes. The normally open contact of the relay is connected to the cut-off control.

In order to set-up the input Dip switches, "Inputs 1 & 2 Response Mode" must be selected. For this application, the most appropriate one would be either mode 1, Count with Inhibit, or mode 2, Count with Up/Dn control. In both of these modes a pulse applied to Input 1 will be counted on both counters. Both of these modes also have a higher maximum count rate than the other response modes. The "Inputs 1 & 2 Response Mode" is selected to be mode 1, Count with Inhibit.

The input set-up switches are selected as follows. Dip switch 1 is set to the "LOGIC" position. Dip switch 2 should be set to "SNK" (current sinking), and dip switch position 3 should be set to the "HI FRQ" position, due to the count speeds involved. Dip switch 4 is set to "HI BIAS" for higher noise immunity. Input 2 is the Inhibit input. The application does not require the use of this terminal, so dip switch 5 is set to the "SNK" position, which provides a pull-up resistor that will put the input in the non-inhibited state. Dip switch 6 is set to "LO FRQ" and dip switch 7 is set to "HI BIAS" to provide maximum noise immunity. Switch position 8 is set to the "RST. EN." position to allow the front panel reset of the Gemini 4100 to operate.



SCALING FOR COUNTER A

The unit of measure desired on Counter A is in tenths of feet. To calculate the number of pulses per foot the following formula is used.

$$\text{Pulses/Ft.} = \frac{48 \text{ Pulses/Rev.}}{1 \text{ Ft./Rev.}} = 48 \text{ Pulses/Ft.}$$

In this application, the basic unit of display will be tenths of feet. The number of "Display Units" (tenths of feet) that will be displayed after 48 pulses have been counted will be 10.

The following procedure and Formulae are taken from Appendix "E" - Scaling for Counter.

STEP 1 - Calculate the Total Scaling Factor required, "K_T", using Formula #1 of Appendix "E", Scaling for Counter.

$$K_T = \text{Display Units/Number of Pulses}$$
$$K_T = 10/48 = 0.208334$$

STEP 2 - Choose the "Number of Count Edges" required, and calculate the Remaining Scaling needed, "K_R", using Formula #2 in the Appendix.

In this application, there are 48 pulses per foot of measurement which is adequate to obtain a readout in 10ths of feet. Therefore, the "Number of Count Edges" is chosen to be 1.

$$K_R = K_T/\text{Number of Count Edges}$$
$$K_R = 0.208334/1 = 0.208334$$

STEP 3 - Determine the "Counter A Scale Multiplier" value and calculate the "Counter A Scale Factor" value using Formula #3 in the Appendix.

In order to obtain maximum conversion accuracy a "Counter A Scale Multiplier" value of 0.1 is chosen. This will give us a "Counter A Scale Factor" value of 2.0833.

$$SF = K_R/SCM$$
$$SF = 0.208334/0.1 = 2.0833$$

SCALING FOR COUNTER B

The display reading Counter B is to be in hundredths of a meter. The following formula is used to calculate the "Number of Pulses" per meter.

$$1 \text{ Foot} = 0.3048 \text{ Meters}$$

$$\text{Pulses/Meter} = \frac{48 \text{ Pulses/Rev.}}{0.3048 \text{ Meters/Rev.}} = 157.48 \text{ Pulses/Meter}$$

The desired reading on the display, after 157.48 pulses have been counted, would be 1.00. Since the basic display unit is 1 hundredth of a meter, the number of "Display Units" is 100.

The following procedure and Formulae are taken from "Appendix E - Scaling for Counter".

STEP 1 - Calculate the Total Scaling Factor required, "K_T" using Formula #1 of Appendix "E".

$$K_T = \text{Display Units/Number of Pulses}$$
$$K_T = 100/157.48 = 0.63500$$

STEP 2 - Choose the "Number of Count Edges" required, and calculate "K_R" using Formula #2 in the Appendix.

The "Number of Count Edges" has already been chosen to be 1, when Counter A was scaled. A value of 1 is also adequate for Counter B since we have 157.48 pulses per meter and only 100 pulses/meter is necessary to obtain resolution in hundredths of a meter.

$$K_R = K_T/\text{Number of Count Edges}$$
$$K_R = 0.6350/1 = 0.6350$$

STEP 3 - Determine the "Counter B Scale Multiplier" value and calculate the "Counter B Scale Factor" value using Formula #3 in the Appendix.

Since the "K_R" value is already in the range of the Scale Factor, a "Counter B Scale Multiplier" value of 1 is chosen. This will give us a "Counter B Scale Factor" value of 0.6350.

$$SF = K_R/SCM$$
$$SF = 0.6350/1 = 0.6350$$

The Preset and Output will be controlled by Counter B so that the rolls of cloth can be cut to the exact metric measurement per each order.

STEP BY STEP PROGRAMMING OF THE GEMINI 4100

STEP 1 - Enter code 41 (Unit Personality). Select and enter mode 2 to set the Unit Personality to Dual Counter.

STEP 2 - Enter code 42 ("Reset Button & Terminal Actuation Mode"). Select and enter mode 3 so reset will reset Counter A & B.

STEP 3 - Enter code 43 ("Inputs 1 & 2 Response Modes"). Select and enter mode 1 for Count with Inhibit (Input 1 = CNT. A & B, Input 2 = Inhibit).

STEP 4 - Enter code 44 ("Counters A & B Number of Count Edges"). Select and enter mode 1 for single edge counting.

STEP 5 - Enter code 45 (Counter B Scale Multiplier). Select and enter mode 1 for a scale multiplier of 1.

STEP 6 - Enter code 46 (Counter B Decimal Point & Lead Zero Blanking). Select and enter mode 3 for a decimal point in the hundredths position.
NOTE: Code 51 (Output Assignment) is factory set to [51 2], Output to Counter B.

STEP 7 - Enter code 52 (Output Termination Modes). Select and enter mode 5 for termination after timed output.

STEP 8 - Enter code 53 (Timed Output Value). The display will read the timed output value. Adjust the display for the desired output time of 0.2 seconds.

STEP 9 - Enter code 56 (Counter B Reset Modes). Select and enter mode 1 for manual reset to zero.
NOTE: Code 61 (Counter A Reset Modes) is factory set to [61 1], Manual Reset to Zero.

STEP 10 - Enter code 64 (Counter A Scale Multiplier). Select and enter mode 2 for a scale multiplier of 0.1.

STEP 11 - Enter code 65 (Counter A Decimal Point & Leading Zero Blanking). Select and enter mode 2 for a decimal point in the tenths position.

STEP 12 - Enter code 66 (Operator Accessible Functions Modes). Select and enter mode 2 for Preset programming and reset enabled. When the "PGM.DIS." terminal is connected to "COMM.", the only changes that will be possible are resetting the unit and changing the Preset.

STEP 13 - Press the "SF" key when the unit is displaying Counter A. (Pressing the "DISP" key changes the display from Counter A to Counter B and vice-versa.) Enter a Counter A Scale Factor value of 2.0833.

STEP 14 - Press the "SF" key when the unit is displaying Counter B. Enter a Counter B Scale Factor value of 0.6350.

The Gemini 4100 in now fully programmed. Jumper the "PGM.DIS." terminal to "COMM." to prevent accidental program changes and to enable the "Operator Accessible Functions". The unit is now ready to accept a Preset value for the desired length of cloth.

20MA CURRENT LOOP COMMUNICATIONS

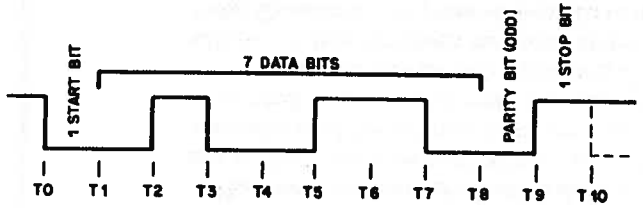
The Gemini 4100's 20mA Current Loop Communications Option allows a 'two-way" serial communications link to be established in order to monitor the count, rate, Preset and Scale Factors from a remote location. Some typical devices hat can be connected with the Gemini 4100 are: a printer, terminal, programmable controller, or host computer. For devices that use RS232, a GCM Serial Converter Module is available to convert the 20mA Current Loop signals to RS232 and rice-versa. Also, a BCD Converter is available to convert the 20mA Current Loop ignals to full parallel BCD, to enable the Gemini to operate with programmable ogic controllers, etc.

There are two loops that must be established. One for sending commands to he Gemini 4100 and one for receiving the data values from the Gemini 4100. Up o sixteen Geminis or other RLC units with 20mA Serial Communications can be connected together in the "loop". These units are assigned unit addresses by etting the Serial Dip Switch on each unit. The applications can be as simple as ttaching a printer to obtain hard copy of the count information or as involved as sing a host computer to automatically set up Preset and Scale Factors of a number f Gemini units.

With the Communications Option, the following functions can be performed:

. Interrogation of the Count, Rate, Presets, and Scale Factors.
. Changing of the Count values, Presets and Scale Factors.
. Resetting of the Count values.
. Automatic print-out when using a printer and the "Print Request" Terminal.
. Change viewed display channel.

FIG. 1: DATA FORMAT-10 BIT FRAME [300, 600, 1200, 2400 Baud]



COMMUNICATION FORMAT

Data is sent by switching off and on the current in the 20mA current loop. Data i received by monitoring the switching action and interpreting the codes that are ansmitted. In order for data to be interpreted correctly, there must be identical formats and Baud Rates. The format that the Gemini 4100 will accept is: 1 start bit, 7 data bits, 1 odd parity bit, and 1 stop bit. The Baud Rates that are available are: 300, 600, 1200, and 2400.

The selection of the Baud Rate is done by setting DIP switches. Refer to the "Current Loop Installation" section, for set-up instructions.

SENDING COMMANDS & DATA TO THE GEMINI 4100

When sending commands to the Gemini 4100, a command string must be constructed. The command string may consist of command codes, value identifiers, and numerical data. Below is a list of commands and value identifiers that are used when communicating with the Gemini 4100.

The command string is constructed by using the above commands and value identifiers along with the data values that are required. Data values may or may not contain the decimal point if a decimal point is programmed into the Gemini 4100. The Gemini 4100 will accept the decimal points, however, it does not interpret them in any way. Leading zeros can be eliminated, however, all trailing zeros must be present. For example, if a Scale Factor of 1.0000 is to be sent, the data value can be transmitted as 1.0000 or 10000. If a "1" is transmitted, the Scale Factor will be changed to 0.0001.

COMMAND	DESCRIPTION
N (4EH)	Address command; followed by a unit address number 1-15 and one of the following commands.
P (50H)	Transmit per Print Options command.
R (52H)	Reset command: operates on Count valuesand output
T (54H)	Transmit Value command; operates on Rate or Count values, Preset and Scale Factors.
V (56H)	Change Value command; operates on Count values, Scale Factors, and the Preset.
D (44H)	Change Display command; operates on Display values E & F.

VALUE IDENTIFIER	DESCRIPTION	MNEMONIC
A (41H)	Preset	(PS1)
C (43H)	Scale Factor A	(SFA)
D (44H)	Scale Factor B	(SFB)
E (45H)	Rate or Count A	(CTA)
F (46H)	Count B	(CTB)

SENDING COMMANDS & DATA TO THE GEMINI 4100 (Cont'd)

The Address command is used to allow a command to be directed to a specific unit in the Serial Communications Loop. Whenever the unit address is zero, transmission of the Address command is not required. This is done for applications which do not require more than one Gemini. For applications that require several units, it is recommended that each Gemini in the loop be given a separate address. If they are given the same address, a command such as the Transmit Value Command, will cause all the units to respond at the same time, resulting in erroneous data.

The command string is constructed in a specific logical sequence. The Gemini 4100 will not accept command strings that do not follow this sequence. Only one operation can be performed per command string. Below is the procedure to be used when constructing a command string.

1. If the Gemini 4100, to which the command is to be sent, is assigned an address other than zero, the first two characters of the command string must consist of the Address Command (N) and the address number of the unit (1-15).
2. The next character/s in the command string is the actual command that the Gemini 4100 is to perform and the value identifier if it pertains to the command. (A command such as the Transmit per Print Options, "P", command does not require a Value Identifier.)
3. If the "Change Value" command is being used, the next characters in the command string is the numerical data value.
4. The last character in the command string is the command terminator (•). This character must be sent in order to tell the Geminis that the command string is complete, so that they can begin processing the command.

Below are some typical examples of properly constructed command strings.

(EX. 1) Change Preset on the Gemini 4100 with address of 2 to 00123.4.
COMMAND STRING: N2VA1234•

(EX. 2) Have the Gemini 4100 with address of 3 transmit the Count (B) value.
COMMAND STRING: N3TF•

(EX. 3) Reset Counter B of the Gemini 4100 with address of 0.
COMMAND STRING: RF•

As shown, all commands must be terminated with a "Command Terminator" (• or 2AH). The Gemini 4100 will not process the command until the terminator is sent. If illegal commands or characters are sent to the Gemini 4100, they still would need to be terminated by an (•). If they are not terminated, the next command will not be accepted.

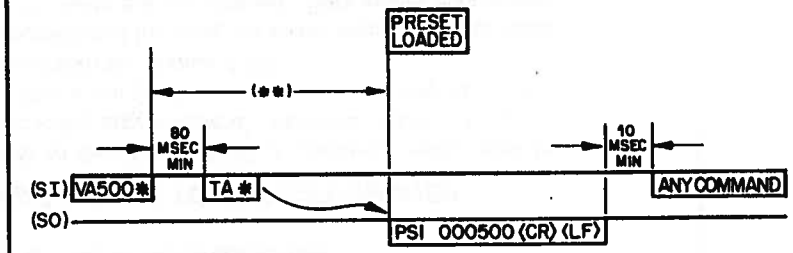
When writing applications programs in Basic, the transmission of spaces or carriage return and line feed should be inhibited by using the semicolon delimiter with the "PRINT" statement. The Gemini 4100 will not accept a carriage return or line feed as valid characters. See "Terminal Emulation Program" section for a listing of an IBM* PC Basic terminal emulation program.

When a "Change Value" command is sent to the Gemini 4100, a short amount of time is required for the unit to process the data. This time increases with the count rate. During this time, only one additional command may be sent to the Gemini 4100. This may be done 80msec after the transmission of the "Change Value" command. After the second command has been transmitted, the unit will ignore any further commands until 10msec after both the "Change Value" and second command have been processed. It is recommended that a "Transmit Value" command follow a "Change Value" Command. If this is done, the reception of the data can provide a timing reference for sending another command and will insure that the change has occurred.

The timing diagrams show the timing considerations that need to be made.

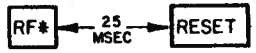
* *This is a registered trademark of International Business Machines.*

FIG. 2: TIMING FOR SENDING COMMANDS



(**) *This is the time that it takes the Gemini 4100 to process the preset. It varies with the Count Rate and Scale Factor Value.*

FIG. 3: RESET COMMAND TIMING

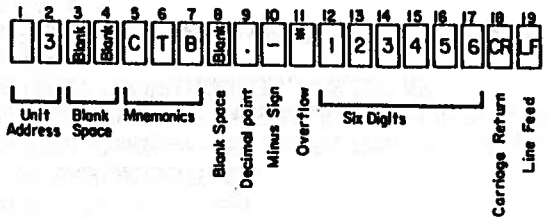


RECEIVING DATA FROM THE GEMINI 4100

Data is transmitted from the Gemini 4100 when a "Transmit Value" or "Transmit per Print Options" command is sent to the unit, or when the "PRINT REQ." terminal is activated. The Gemini 4100 can transmit 5 values: display channel A, display channel B, , Preset, Scale Factor A, and Scale Factor B. A list of the abbreviations used when the Gemini 4100 transmits the values are shown below.

CTA - Counter A or Rate A Value
CTB - Counter B Value
PS1 - Preset
SFA - Scale Factor A
SFB - Scale Factor B

A typical transmission, with the *"PRJD" (Print ID)* switch in the up position, is shown below.



The first two digits transmitted are the unit address followed by two blank spaces. If the unit address is 0, the first locations will be left blank. The next three letters are the abbreviation for the mnemonic value followed by one blank space. The actual values are transmitted last. Negative values are indicated by a "-" sign. For positive values, the "+" sign is not transmitted. Overflowed count values are shown by an asterisk preceding the most significant digit of the value. The decimal point position will *"float"* within the data field depending on the actual value it represents.

For peripheral control purposes, a single line transmission will have a <CR> attached to the end of the above string. For a *"T"* command or each line of a block transmission, only the above character string is sent. For the last line of a block transmission, a <SP> <CR> <LF> is attached to the end of the above character string. An example of a typical serial transmission:

3 CTB -1234.56 < CR> < LF>

If the *"Print Request"* terminal initiates the transmission, a 400msec delay is inserted before the transmission to keep multiple transmissions from overrunning the printer.

When the Print ID switch is in the down position, the unit will not transmit the characters before the data value *(address, Value ID, spaces)* or the 400msec printer delay. The same above value when transmitted with the *"PRJD"* switch in the down position, is transmitted as: -1234.56 < CR> < LF>

NOTE: When using the Gemini with a printer, with the "Print ID" switch in the down position, some printers (other than the RLC DMPC) may not work, since the printer delay is not transmitted.

PRINT OPTIONS

The various Print Options are used mainly in conjunction with a printer and the Print Request Terminal. They provide a choice of Gemini 4100 data values to be printed when either the Print Request Terminal is activated or the "Transmit per Print Options" (P) command is sent to the Gemini 4100. The various Print Options available are:

A. Print Display A Count or Rate value
B. Print Display B Count Value
C. Print Display A & B Values
D. Print Preset, and Scale Factors A & B
E. Print Display B, Preset, and Scale Factors A & B
F. Print Display A, Preset, and Scale Factors A & B
G. Print Display A & B, Preset, and Scale Factors A & B

A typical print-out is shown below. The Print Options are selected by setting S3, S4 and S5 on the Serial DIP Switch. See "Current Loop Installation" section for the various switch settings.

1	CTA	000054
1	PS1	000100
1	SFA	01.0000
1	SFB	02.5000

TERMINAL EMULATION PROGRAM FOR IBM PC*

Listed below is a basic program that will emulate a terminal. It is written using the IBM* PC Basic. The program may need to be modified if using a different basic interpreter. Set-up the Gemini 4100 for a baud rate of 1200. When the program is running, commands can be typed in from the keyboard as shown in the examples above. Do not use the carriage return to end the command.

* *This is a registered trademark of International Business Machines.*

```
10 REM  RED LION CONTROLS GEMINI COMMUNICATIONS
15 REM  PROGRAM FOR THE IBM* PC
20 REM
25 REM  This Program allows the IBM* PC to function as a
30 REM  video terminal
35 REM
40 REM  Clear Screen; make sure all files are closed
45 CLS:CLOSE
50 REM Turn cursor on
55 LOCATE 1,1,1
60 REM  Set Error pointer
70 ON ERROR GOTO 330
100 REM  Configure serial port for 1200 baud; odd parity;
110 REM  7 data bits; 1 stop bit; handshake lines disabled
120 OPEN  "COM1:1200,O,7,1,CS,DS" AS #1
130 REM
140 REM  ***** TRANSMIT DATA FROM COMPUTER *****
150 REM
155 REM  Send all keyboard input to serial port
156 REM  Use semicolon after PRINT statement to
157 REM  suppress < CR > < LF >
160 B$=INKEY$:IF B$ < > ""THEN PRINT B$;:PRINT #1,B$;
170 REM  Skip to next screen line when command terminator is
175 REM  entered
180 IF B$="*" THEN PRINT
190 REM
200 REM  *****  RECEIVE DATA FROM GEMINI *****
210 REM
220 REM  Check serial input buffer and display any
230 REM  information received from the Gemini
240 WHILE NOT EOF(1)
250 A$=INPUT$(1,#1)
260 REM  Suppress < CR >  input to avoid double spacing on
270 REM  screen
280 IF A$=CHR$(13) GOTO 300
290 PRINT A$;
300 WEND
310 REM  Check for keyboard input again
320 GOTO 160
330 PRINT "ERROR NO.";ERR:RESUME
```

CURRENT LOOP INSTALLATION

WIRING CONNECTIONS

When wiring the 20mA current loop, remove the 7-position terminal block (TBD), located on the right side of the top board. Refer to the numbers listed with the terminal descriptions below or on the top label, and install each wire in its proper location on the terminal block. When all connections are made, replace the terminal block into its proper location.

TERMINAL DESCRIPTIONS FOR TERMINAL BLOCK TBD

1. COMM. - Common
2. PRINT REQUEST - The Print Request Terminal is pulled low to request the Gemini 4100 to transmit according to the Print Options mode that has been selected. (Minimum Activation time = 25msec.)
3. 20mA SRC - The 20mA SRC terminal provides the source current for one of the loops.
4. SO- (Serial Out-) -
5. SO+ (Serial Out+) -
   The Gemini 4100 transmits the requested data on these terminals. They are connected in series to the receive input of the device to be connected.
6. SI- (Serial In-) -
7. SI+ (Serial In+) -
   The Gemini 4100 receives commands on these terminals. They are connected in series with the transmit or output terminals of the device to be connected.

NOTE: The serial input terminals must be held in the mark condition (current on) in order for the Gemini 4100 to respond to a Print Request terminal activation.

SERIAL DIP SWITCH SET-UP

The Serial DIP switch is accessible through the side of the Gemini 4100. A list of the DIP switch positions and their functions are shown in Figure 4.

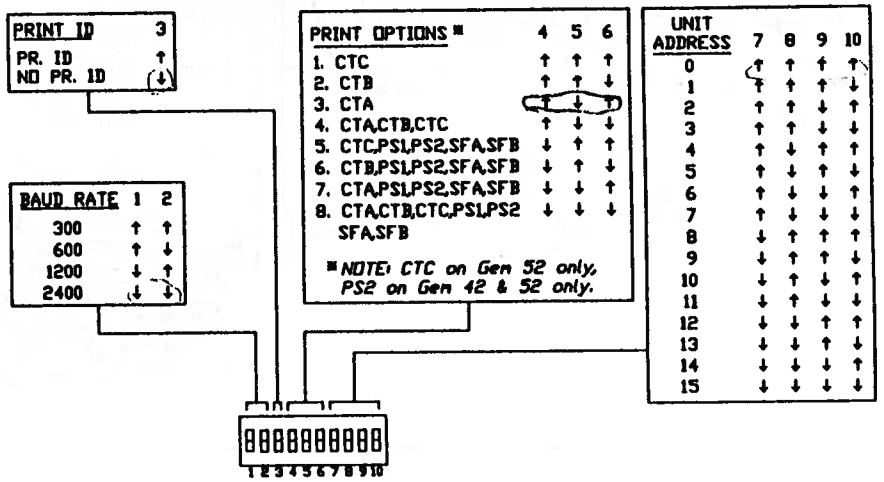
BR0 & BR1, BAUD RATE - Set-up is shown in Figure 4. When changing the Baud Rate, the unit should be powered-down and then powered back up again. The unit will only recognize a baud rate change upon power-up, after activating the *"Print Request"* terminal or after a few characters have been sent at the new baud rate *(If the two previous conditions have not occurred, the Gemini will see the characters as erroneous and it will check the baud rate and set itself to operate at the new rate).*

PR.ID - PRINT ID. - When this switch is in the up position, the Gemini 4100 will print the unit address, data value ID and the data value when a transmission is requested. The unit will also insert a 400msec delay between transmissions when the *"P"* command or Print Request terminal is used. This switch position is generally used when the unit is connected with a printer.
When the switch is in the down position, the Gemini 4100 will transmit only the data value, without the unit address and data ID. The 400msec delay, described above, will not be inserted. This switch position usage is intended for applications where the Gemini is communicating with a computer. In these circumstances printing the address and value ID and inserting a 400msec print delay is usually unnecessary and needlessly slows down communication throughput.

PC0, PC1, & PC2, PRINT OPTIONS - Used to control which values are transmitted when the Print Request terminal is activated or when the Transmit per Print Options command "P" is sent to the Gemini 4100.

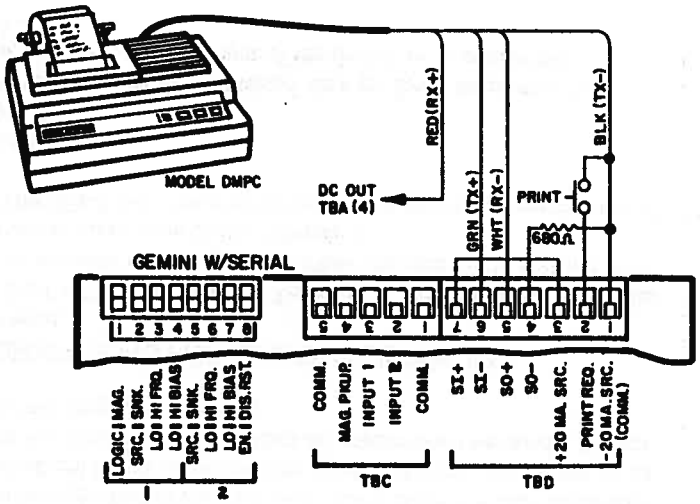
AD0, AD1, AD2, & AD3, UNIT ADDRESS - These switches are used to give each unit a separate address when more than one unit is connected in the Loop. See Figure 4, below, for Switch Set-up.

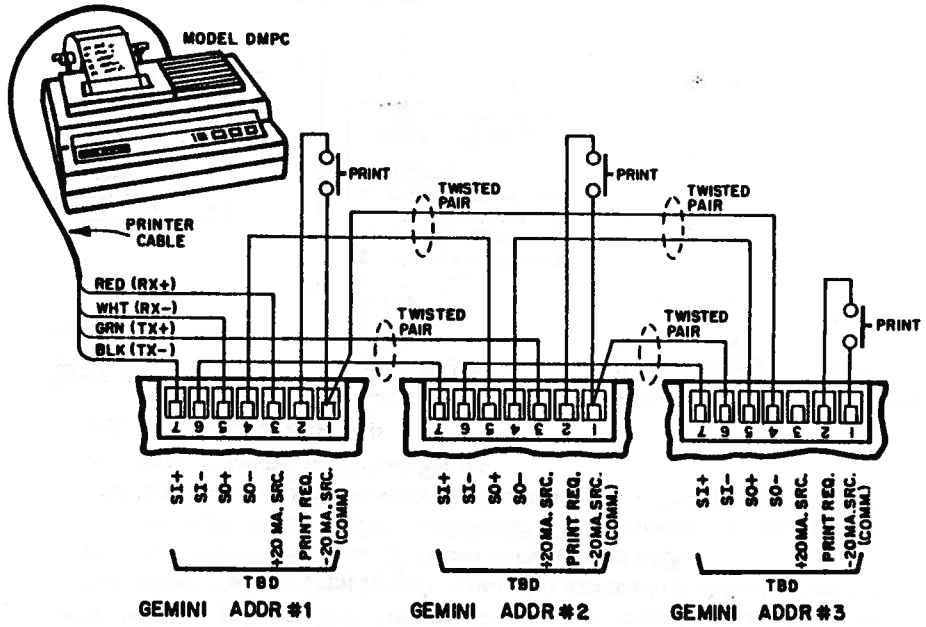
FIG. 4: DIP SWITCH SET-UP



CONNECTING TO AN RLC PRINTER

One or several Gemini 4100's (with Serial Communications option) can be set up to operate with an RLC Model DMPC printer. The two applications show the wiring diagrams for single and multiple Gemini hookups to the printer. Both loops (transmit and receive) are used with the Model DMPC printer. The printer sends a busy signal on the Gemini's receive loop, which prevents the Gemini from overrunning the printer. In the single Gemini hookup, the "DC OUT" terminal, current limited with a 680 ohm resistor (provided with the printer), is used to obtain the source current for the Gemini Serial Output loop. The Gemini's "20mA SRC" terminal provides the current for the Serial Input Loop.





In multiple Gemini hookups, the "20mA SRC" terminal of two Geminis provide the 20mA source current for both the Serial Input loop and Serial Output loop. When more than one unit is connected to a printer, only one Gemini can transmit data at any given time. If another Print Request terminal is activated while the printer is still printing, two Geminis will transmit to the one printer at the same time, resulting in a "garbled" print-out.

In both configurations, the Baud rate switches of the Gemini(s) are to be set to 1200 baud. Refer to "Current Loop Installation" section to set up the Baud Rate, Print Options, and Unit Address. The DMPC printer has been factory set to operate with the Gemini 4100 and does not require any set-up.

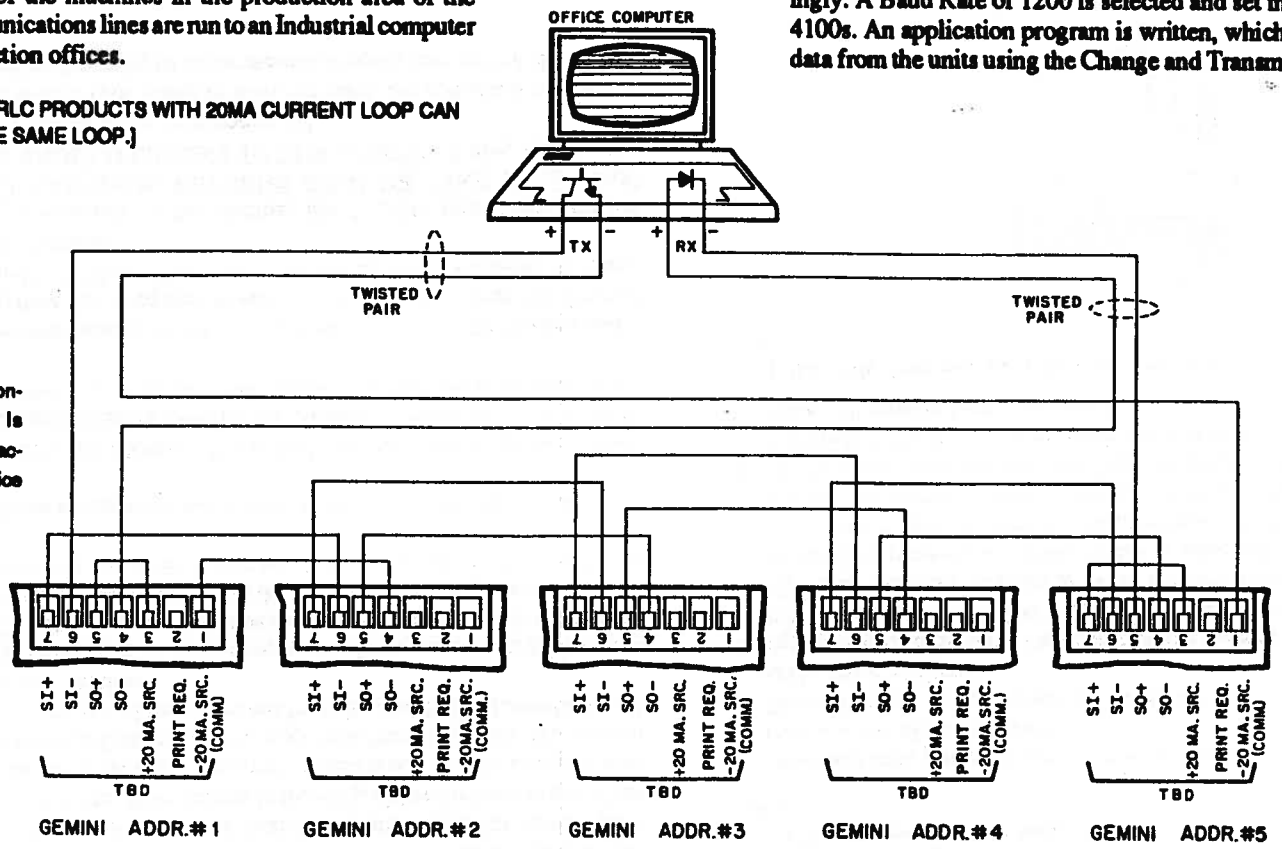
PROCESS MONITORING SYSTEM

Five Gemini 4100s with 20mA Current Loop Option, are used to monitor and control parts packaging machines in a plant. The units are located at each of the machines in the production area of the building. The communications lines are run to an Industrial computer located in the production offices.

[OTHER GEMINIS OR RLC PRODUCTS WITH 20MA CURRENT LOOP CAN BE CONNECTED IN THE SAME LOOP.]

The drawing below shows the Current Loop set-up. Each Gemini 4100 is given an address and the Serial DIP switches are set accordingly. A Baud Rate of 1200 is selected and set in each of the Gemini 4100s. An application program is written, which sends and retrieves data from the units using the Change and Transmit Value commands.

NOTE: A Serial Converter Module is available for interfacing an RS232 device to Geminis.



TROUBLESHOOTING GEMINI SERIAL COMMUNICATIONS

If problems are encountered when trying to get the Gemini*(s)* and host device or printer to communicate, the following checklist can be used to help find the solution.

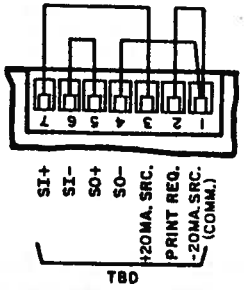
1. Check all wiring. Refer to the previous application examples and use them as a guide to check your serial communication wiring. Proper polarity of all Geminis and other peripherals must be observed. If a multimeter or ammeter is available, insert it in series in each Serial loop and check for current flow with all units powered up. If no current is flowing, either the loop is not wired correctly, or some other fault has occurred. If too much current has been sent through a Serial Input or Output, the unit may have been damaged. If a Gemini is suspected, it can be tested for operation by using the Serial Loop-back test described in the next section.
2. If the Gemini is set-up with a *"host computer"*, device or printer *(other than the RLC DMPC)*, check to make sure that the computer or device is configured with the same communication format as the Gemini. The only communication format the Gemini will accept is; 1 start bit, 7 data bits, odd parity, and 1 stop bit.
3. Check the baud rate settings and make sure all devices in the loop are set to the same baud rate.
4. Check the Gemini's unit address. If the Address command is not used when transmitting a command to the Gemini, the Gemini's address must be set to 0. See *"Sending Commands & Data to the Gemini"* section for command structure.
5. If two-way communications are to be established between the Gemini and a computer, try getting the computer to receive transmissions from the Gemini first. The Gemini's *"PRINT REQ."* terminal can be used to initiate the transmissions from the Gemini.
6. When sending commands to the Gemini, the * *(2Ah)* must terminate the command. NO CARRIAGE RETURNS *(0Dh)* OR LINE FEED *(0Ah)* CHARACTERS SHOULD BE SENT TO THE GEMINI. If they are sent, the Gemini will not respond to the next command.
7. For applications where 1200 Baud or lower is used, the command terminator (*) can be sent before the string to eliminate any illegally transmitted characters.

SERIAL LOOP-BACK SELF-TEST

The Gemini 4100 has a Serial Loop-back Self-test feature. This test enables the user to verify the operation of the Gemini when problems are encountered trying to get the Gemini and *"Host device"* communicating. In this test, the Gemini's Serial Input and Output Loops are connected together with the 20mA source supplying the loop current. The Gemini then transmits data *"to itself"*. If the data is received properly, the Gemini 4100 will change its Scale Factor B value to 0.1111. To perform the loop-back test, follow the test sequence as described below.

1. With the unit powered down, wire up the serial terminal block, *"TBD"*, as shown in the diagram below.
2. Set the Gemini's unit address to 15 *(set switches 7-10 of the Serial DIP Switch to the down position)*.
3. Apply power to the unit. On power-up the Gemini will perform the loop-back test. To check the results: Call up the Scale Factor B value by pressing the *"SF"* key while the Counter B value is being displayed. If the Serial loop is functioning properly the Scale Factor B value will be 0.1111. If this result is not obtained, double check the connections with those shown in the diagram, and the unit address switch positions and repeat step 3.
4. If the connection between the Print Request terminal, *"PRINT REQ."* and *"COMMON"* is disconnected while the unit is under power, the Scale Factor B value will change back to its previous setting.

If the unit does not pass this test, contact your local Red Lion Controls distributor.

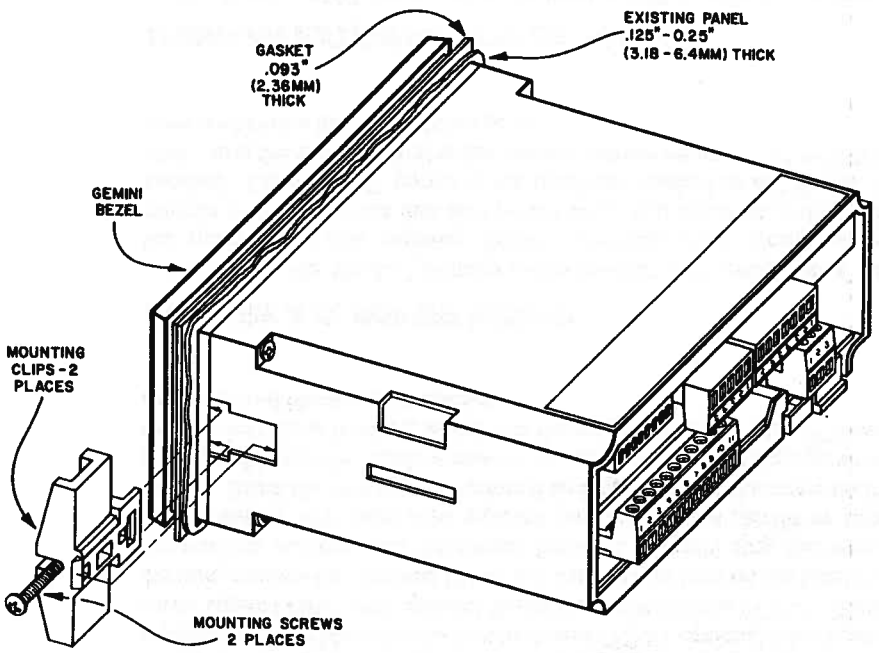


APPENDIX "A" - INSTALLATION & INPUT CONFIGURATION SWITCH SET-UP

Before installing the Gemini 4100 into the panel, the user should first become familiar with the unit. It may also be desirable to program the unit and appropriate DIP switches for the application at hand (Refer to the "Programming and Applications" sections). Once the unit is programmed, the settings will be saved in memory. The Program Disable "PGM. DIS." terminal should be connected to "COMM." to prevent accidental or unauthorized programming changes. The Gemini 4100 should be installed in a location which provides good air circulation. Placing the unit near devices that generate excessive heat should be avoided.

The Gemini 4100 is designed with a high degree of noise immunity. However, consideration should also be given to installing the unit away from noise sources such as relays, solenoids, motors, etc.

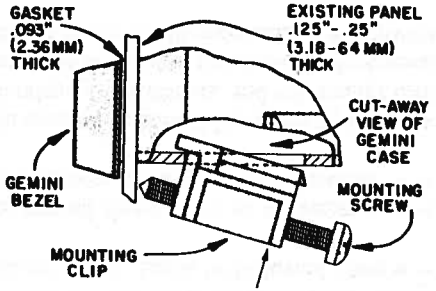
PANEL MOUNTING {Note: See Appendix "B" for dimensions}



The Gemini 4100 is designed to be panel-mounted with a gasket to provide a water-tight seal. Two mounting clips and screws are provided for easy installation. Consideration should be given to the thickness of the panel. A panel which is too thin may distort and not provide a water-tight seal. (Recommended minimum panel thickness is 1/8".)

After the panel cut-out has been completed and deburred, remove the backing from the adhesive side of the gasket, and carefully apply the gasket to the panel. DO NOT APPLY THE ADHESIVE SIDE OF THE GASKET TO THE COUNTER BEZEL. Insert the unit into the panel. Install the screws into the narrow ends of the mounting clips as shown in the drawing to the left. Thread the screws into the clips until the pointed end just protrudes through the other side.

Install each of the two mounting clips by inserting the wide lip of the clips into the wide end of the holes located on either side of the case. Tighten the screws evenly, applying uniform compression, thus providing a water-tight seal. CAUTION: Only minimum pressure is required to seal panel. Do NOT over tighten mounting screws.



WIRING CONNECTIONS

After the unit has been mechanically mounted, it is ready to be wired. All wiring connections are made on removable plug-in terminal blocks. There is a separate terminal block for the bottom board (TBA), optional relay board (TBB), count inputs (TBC), and optional Serial Communications (TBD). When wiring the unit, remove the terminal block and use the numbers on the label to identify the position number with the proper function. Simply strip the wire, leaving approximately 1/4" bare wire exposed (stranded wires should be tinned with solder). Insert the wire into the terminal and tighten down the screw until the wire is clamped in tightly. Each terminal can accept up to two 18-gauge wires. After the terminal block is wired, install it in the proper location on the PC board. Wire each terminal block in this manner.

PRIMARY A.C. POWER WIRING

For best results, the A.C. primary power should be relatively "clean" and within the specified +/-10% variation limits. Drawing power from heavily loaded circuits or from circuits that also power loads that cycle on and off, should be avoided. Connect A.C. power to the terminals marked as AC Power, 50/60Hz. Make sure the Gemini 4100 is the correct voltage version (115 or 230VAC) for your application before applying power.

USING AN EXTERNAL POWER SOURCE

The Gemini 4100 can be operated from a D.C. power source that provides 11-14VDC at the unit's rated power consumption (700mA). The power source can be a 12V battery or an external power supply that is capable of supplying the unit's rated current. It is not necessary to provide battery backup to retain count information. The Gemini 4100 has an internal non-volatile memory in which the count and programming information are stored at power-down. Refer to the "Block Diagram".

SIGNAL WIRING

There are certain considerations that should be given when running the cour and control signal wires. A length of wire can act like an antenna and the clos it is to a source of electrical noise, the more it becomes susceptible to the nois There are a few simple rules that should be followed when running these wires.

1. Never run count or control signal wires in the same conduit or raceway wit A.C. power lines, conductors feeding motors, solenoids, SCR controls, heater etc.
2. Signal wires within enclosures should be routed as far away as possible fro contactors, control relays, transformers, and other noisy components.
3. When shielded wire is used, connect the shield to the common of the counte and leave the other end of the shield unconnected and insulated from machin ground.
4. Connect common of Gemini 4100 to machine ground. Attach common t machine ground only at one point.

SERIAL COMMUNICATIONS

The Gemini 4100 can be purchased with a 20mA Current Loop Commu nications Option. On these units, refer to the "Current Loop Communication section of the manual, for wiring and operational procedures of the Serial Loop

INPUT 1 & MAGNETIC PICKUP INPUT

The Magnetic Pickup Input and Input 1 utilize some common circuitry. F this reason the Input 1 switches are used to set up both the Magnetic and Logi Input 1. S1 selects between Magnetic Pickup Input and Logic Input 1. WHE A MAGNETIC PICKUP IS BEING USED, S2 MUST BE IN THE "SNK POSITION or the unit will not count.

INPUT 1 & MAGNETIC PICKUP INPUT [Cont'd]

S3 (HI/LO FRQ) and S4 (HI/LO BIAS) do not effect the Magnetic Pickup Input and their settings are inconsequential. When S1 is in the Logic position, the Magnetic Pickup Input is disabled and Input 1 can be used as a logic input.

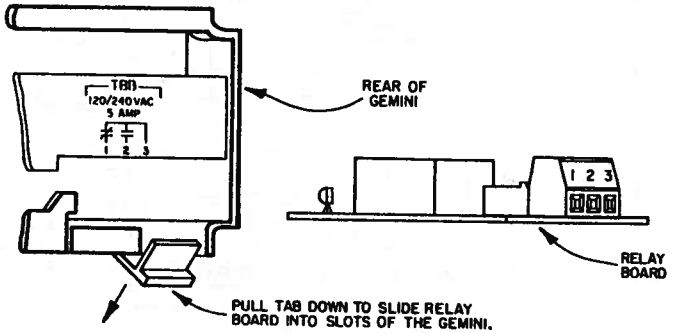
NOTE: A Magnetic Pickup type sensor should not be used unless a large enough signal is provided at all speeds of operation.

INPUT 2

Input 2 is designed specifically for Logic type inputs. It is identical to the count input of SC Series counters. When Input 1 is set up for Logic operation, both Inputs 1 and 2 operate identically. DIP switch positions S5, S6, and S7 function the same as S2, S3, and S4.

INSTALLATION & REMOVAL OF THE RELAY BOARD

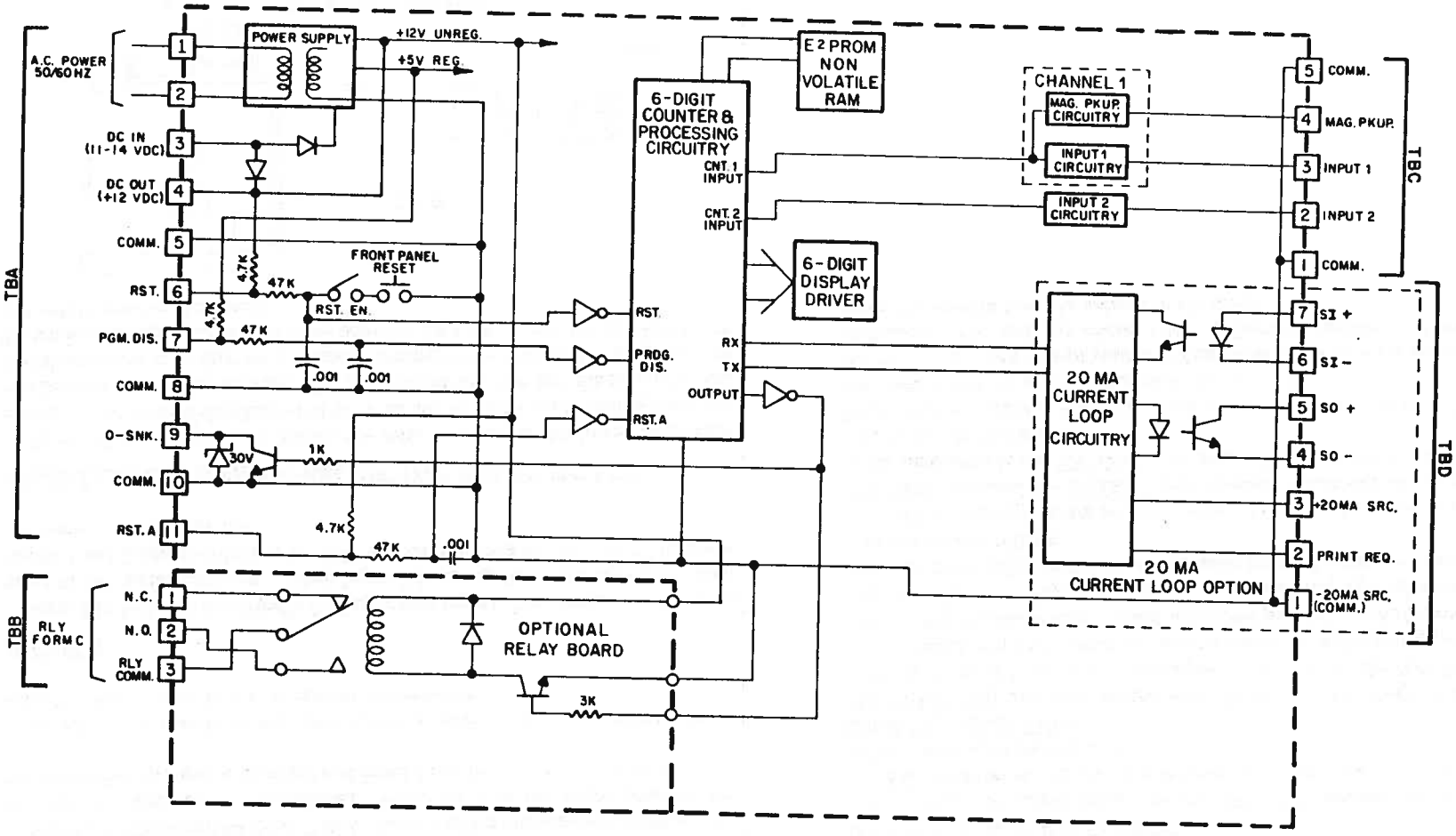
To install the relay board, locate the relay opening at the lower right-hand corner, on the back of the Gemini 4100. Pull the tab down while sliding the board into the two slots in the housing. The relay board will seat into the unit, allowing the tab to return to its original position. To remove the relay board, pull down on the tab just enough to allow the relay board to slide out. Grasp the terminal block and pull to remove the board.



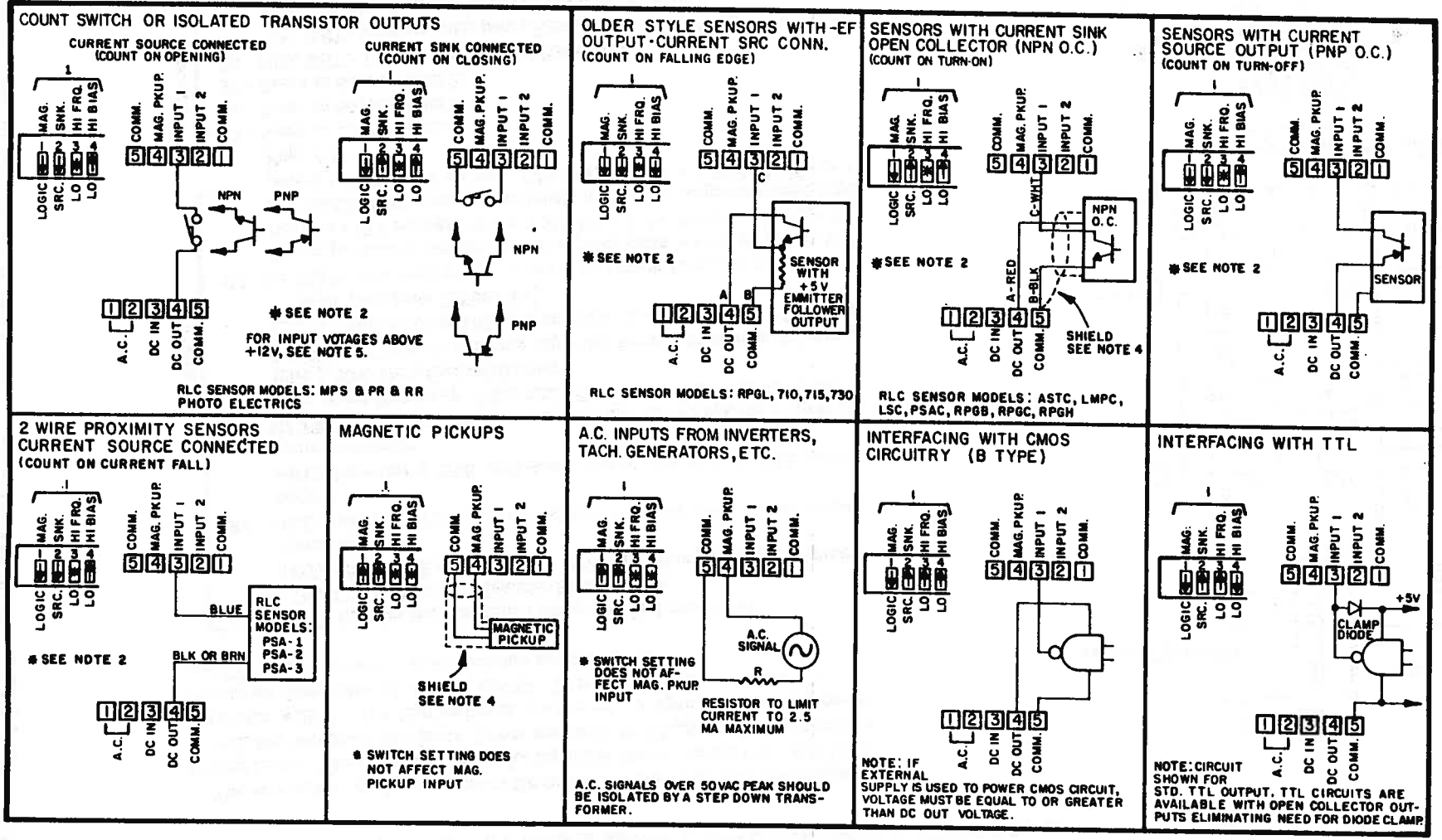
NOTES:

1. *SENSOR VOLTAGE AND CURRENT*
   The +12V sensor supply voltage on the "DC OUT" terminal is nominal with +/-25% variation due to line and internal load variations. All RLC sensors will accommodate this variation.
2. *HI/LO FRQ SELECTION*
   The HI/LO FRQ selection switch must be set on "LO FRQ" when switch contacts are used to generate count input signals. Since the "LO FRQ" mode also provides very high immunity against electrical noise pickup, it is recommended that this mode also be used, whenever possible, with electronic sensor outputs. The "LO FRQ" mode can be used with any type of sensor output, provided count pulse widths never decrease below 5 msec, and the count rate does not exceed 100cps.
3. *V_{IL} and V_{IH} levels given are nominal values +/-10% when counter voltage on "DC OUT" terminal is +12VDC. These nominal values will vary in proportion to the variations in the "DC OUT" terminal voltage, which are caused by line voltage and load changes.*
4. *When shielded cable is used, the shield should be connected to "COMM." at the counter and left unconnected at the sensor end.*
5. *Inputs 1 and 2 can accept source pulses from other circuits up to +28V in amplitude. For voltages above +28V, a limiting resistor and zener diode should be used to limit the voltage at the input.*

BLOCK DIAGRAM



CONNECTIONS & CONFIGURATION SWITCH SET-UPS FOR VARIOUS SENSOR OUTPUTS (SEE NOTE 5)



SENSOR INPUT CONNECTIONS & INPUT CONFIGURATION SWITCH SET-UP

The accompanying diagram shows the details of Input 1, Input 2, and Magnetic Pickup circuit. The schematic circuit for Input 2 is almost identical to that of Input 1, with the exception that Input 2 does not have the Magnetic Pickup circuitry paralleled with it. The four switches used to set up Input 1 and the Magnetic Pickup are designated S1, S2, S3, and S4. To set up Input 2, use switches S5, S6, and S7. The functions of these switches are as follows:

CHANNEL A

S1 - MAG: Enables the Magnetic Pickup terminal to be used.
LOGIC: Disables the Magnetic Pickup Input.
NOTE: Switch S2 must be in the "SNK" position for magnetic pickup operation.

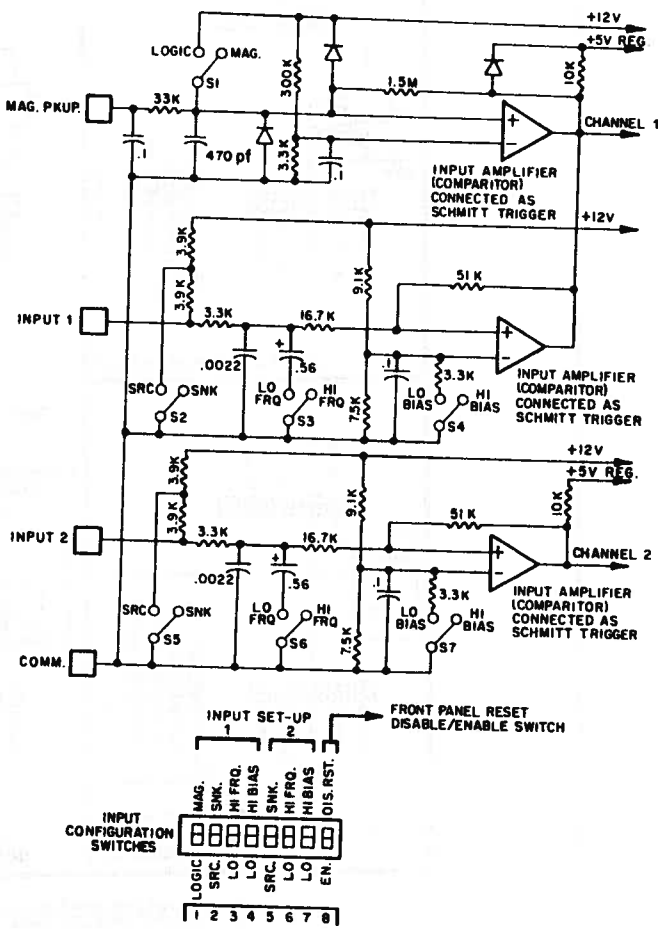
S2 - SNK: Provides a 7.8K pull-up resistor for sensors with current sinking outputs.
SRC: Provides a 3.9K pull-down resistor for sensors with current sourcing outputs.

S3 - HI FRQ: Removes damping capacitor and allows operation up to the max. count frequency. Min. count ON or OFF time - 50usec (U/D or INH.), 50% Duty Cycle (all other).
LO FRQ: Connects damping capacitor for switch contact debounce. Limits count speed to 100cps max. Min. count pulse ON or OFF time - 5msec. (See Note 2, Page 40.)

S4 - HI BIAS: Sets input trigger levels at mid-range to accept outputs from 2-wire proximity sensors, resistive photo-cells, and logic pulses with full 0 to +12V swings. (V_{IL} = 5.5V, V_{IH} = 7.5V, See Note 3, Page 40.)
LO BIAS: Sets input trigger levels to the low range to accept logic pulses with 0 to 5V swings. (V_{IL} = 1.5V, V_{IH} = 3.75V, See Note 3, Page 40.)

CHAN. B

S5 - Same as S2, for Input 2.
S6 - Same as S3, for Input 2.
S7 - Same as S4, for Input 2.
S8 - DIS. RST.: Disables front panel Reset button, "R".
EN. RST: Enables front panel Reset button "R", if "Operator Accessible Functions" mode (code 66) has reset enabled.



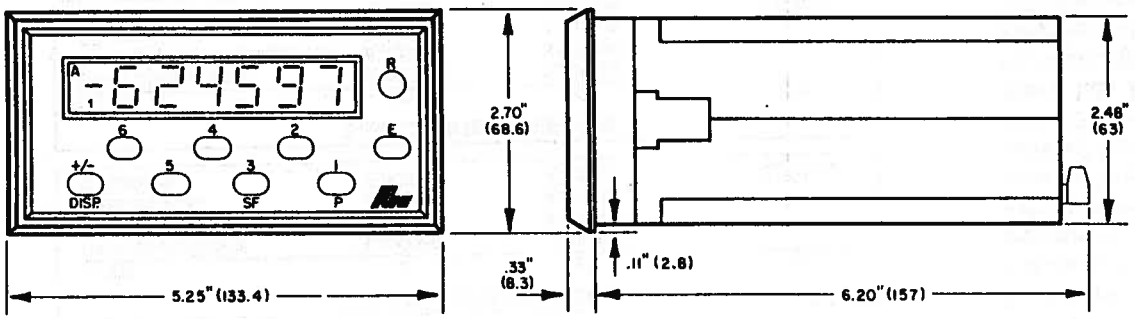
APPENDIX "B" - SPECIFICATIONS & DIMENSIONS

1. **DISPLAY:** 6-digit 0.56" (14.2mm) High LED display.
2. **POWER REQUIREMENTS:**
   AC Operation: GEM41X0X; 115VAC (+/-10%), 50/60Hz, 20VA
   GEM41X1X; 230VAC (+/-10%), 50/60Hz, 20VA
   DC Operation: 11 to 14VDC @ 0.7amp maximum
3. **SENSOR POWER:** +12VDC (+/-25%) @ 100mA.
4. **MEMORY:** Non-volatile E^2Prom memory retains all programming information and count values (except Counter Load Values) when power is removed or interrupted.
   Power Cycles (ON/OFF): 100,000 minimum
   Data Retention: 10 yrs. minimum
5. **INPUTS 1 AND 2:** Switch selectable to accept count pulses from a variety of sources including switch contacts, outputs from CMOS or TTL circuits, and all standard RLC sensors.
   Current Sourcing - Unit provides pull-down for sensor with current sourcing outputs. (Max. input voltage 28VDC @ 7mA.)
   Current Sinking - Unit provides pull-up load for sensors with current sinking outputs. (Max. sensor current 1.6mA.)
   Debounce - Damping capacitor provided for switch contact debounce. Limits count speed to 100cps maximum and input pulse widths to 5msec. minimum.
   Lo Bias - Input trigger levels V_{IL} = 1.5V, V_{IH} = 3.75V
   Hi Bias - Input trigger levels V_{IL} = 5.5V, V_{IH} = 7.5V
   NOTE: Bias levels given are +/-10% @ 12VDC. They vary proportionally with sensor supply voltage at "DC OUT" terminal.
6. **MAGNETIC PICKUP INPUT:**
   Sensitivity - 150mV peak (typical @ 12VDC)
   Hysteresis - 100mV
   Input Impedance - 26.5Kohm @ 60Hz
   Maximum Input Voltage - +/-50Vp
7. **RATE ACCURACY AND REPEATABILITY:** +0.012%
8. **RATE MINIMUM INPUT FREQUENCY:** 0.03cps
   NOTE: At frequencies below 0.03cps (1 pulse every 32 sec.) the rate display will go to zero.

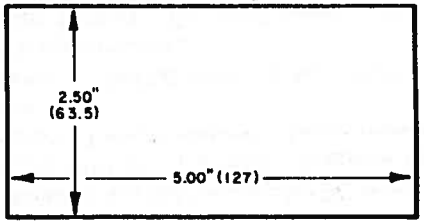
2,282

DIMENSIONS "In Inches (mm)"

NOTE: Mounted units require a clearance of 6.8" (W) behind the panel.



PANEL CUT-OUT



APPENDIX "B" - SPECIFICATIONS & DIMENSIONS (Cont'd)

9. MAXIMUM COUNT RATES:

COUNTER/RATE MODE [41 1]

MODE	X1	X2	X4
Uni or Bi-directional	10,000cps	6,000cps	
Anti-Coincidence Add/Subtract	5,000cps	3,500cps	
Separate Input	9,000cps	4,500cps	
Quadrature	5,500cps	4,500cps	3,000cps

DUAL COUNTER MODE [41 2]

MODE	X1	X2	X4
Uni or Bi-directional	10,000cps	5,500cps	
Anti-Coincidence Add/Subtract	6,000cps	3,000cps	
Separate Input	8,500cps	4,000cps	
Quadrature	5,000cps	4,500cps	3,000cps

10. CONTROL INPUTS:

Reset - Active low (V_{IL} = 1.5V max.), internally pulled up to +12VDC (I_{SNK} = 3mA), activation and de-activation response time = 10msec.

Program Disable - Active low (V_{IL} = 1.5V max.), internally pulled up to +5VDC (I_{SNK} = 1mA).

Print Request - (GEM411XX only) Active low, (V_{IL} = 1.5V max.), internally pulled up to +5VDC (I_{SNK} = 1mA).

11. SERIAL COMMUNICATIONS:

Type - Bi-directional 20mA current loop, 20mA source provided. (Powers up to 7 units in a loop with internal current source.)

Baud Rate - Programmable 300 to 2400.

Maximum Address - 16 units. *(Actual number in a single loop is limited by serial hardware specifications.)*

Data Format - 10 bit frame, Odd parity *(one start bit, 7 data bits, one odd parity bit, and one stop bit.)*

Serial Hardware Specifications -

SO - Output Transistor Rating: V_{max} = 30VDC, V_{SAT} = 1V_{max} at 20mA.

SI - Input Diode Rating: V_F = 1.25V_{TYP}; 1.5V_{max}

NOTE: The compliance voltage rating of the source must be greater than the sum of the voltage drops around the loop.

12. OUTPUT:

Solid-State - Current sinking NPN open collector transistor. I_{SNK} = 100mA maximum @ VCE = 1V. V_{OH} = 30VDC maximum (Internal Zener diode protection).

Relay (optional) - Mounted on a field replaceable PC board. Form C contacts rated at 5amps @ 120/240VAC or 28VDC (resistive load), 1/8 H.P. @ 120VAC (inductive load). The operate time is 5msec. nominal and the release time is 3msec. nominal.

Relay Life Expectancy - 100,000 cycles at Max. Rating. *(As load level decreases, life expectancy increases.)*

Programmable Timed Output - The timed output can be set from 0.01 to 599.99 seconds, +/-(0.01% + 10msec.).

13. PHYSICAL:

Construction - Metal die-cast bezel, plastic case.

Weight - 2.1 lbs *(.9kg)*

14. OPERATING TEMPERATURE: 0° to 50° C

15. STORAGE TEMPERATURE RANGE: -40° to 70° C

APPENDIX "C" - TROUBLE SHOOTING GUIDE

The majority of difficulties arising with the Gemini 4100 are related to incorrect hook-up and programming set-up. Always check all connections, function codes, Scale Factors, and preset as a first step in troubleshooting.

Before applying power, double check all wiring. Improper AC voltage or AC connections may result in permanent damage to the unit.

PROBLEM	*POSSIBLE CAUSE*	*REMEDIES*
NO DISPLAY	1. Power off, improperly connected, or power brown-out.	1. Check all wiring, verify power.
P ON DISPLAY	1. Data error on power-up.	1a. Press "E" key. b. Check all function codes.
E ON THE DISPLAY	1. Data error detected by processor.	1a. Press "E" or "R" button. b. Check all function codes. c. Check signal lines for possible noise sources.
NO RESPONSE TO FRONT PANEL	1. Panel disabled.	1. Consult manual on "Operator Accessible Functions" modes.
UNIT DOES NOT COUNT	1. No input. 2. Input selected incorrectly. 3. Count inhibited. 4. Scale factor/multiplier too small.	1. Check sensors/connections. 2. Check rear panel DIP switches. 3. Check function code 43, "Input 1 and 2 Response" modes. 4. Check scale factor value & scale multiplier values.
UNIT WILL NOT ACCEPT THE DESIRED PRESET	1. When counter scale factors greater than 1 are used, the preset value must be evenly divisible by the scale factor.	1. Unit automatically adjusts preset to be evenly divisible by the scale factor.

APPENDIX "C" - TROUBLE SHOOTING GUIDE (Cont'd)

PROBLEM	*POSSIBLE CAUSE*	*REMEDIES*
UNIT COUNTS INCORRECTLY	1. Input type incorrectly selected. 2. Inputs incorrectly connected or loose connections. 3. Electrical interference. 4. Wrong counting mode. 5. Scale factor incorrect.	1. Check rear panel DIP switches. Turn on LO FRQ. switch for count speed of less than 100cps. 2. Check sensors/input connections. 3. Check connections and wiring for noise sources. 4. Verify functions and modes. 5. Change scale factor value.
UNIT WILL NOT RESET	1. Front panel reset disabled. 2. Reset disabled.	1. Check rear panel DIP switch. 2. Check function code 42 or 66.
DATA VALUES AND FUNCTIONS WILL NOT CHANGE OR NOT RECORDED	1. Front panel locked out. 2. Incorrect programming procedure ("E" not pressed).	1. Consult manual on "Operator Accessible Functions" mode (66). 2. Consult section on programming functions in sequential order.
UNIT COUNTS WHILE RESET IS ACTIVATED	1. Reset mode set for "momentary reset".	1. Change reset mode to "Maintained" reset (56).

APPENDIX "D" - GEMINI 4100 COUNTER/RATE MODE FUNCTION COMMAND CODE SUMMARY

CODE	MODE	DESCRIPTION	COMMENTS
41		UNIT PERSONALITY	(-)Loads factory set code values*
	+/-1	Counter/Rate*	Rate → Display value (A)/Counter → Display value (B)
42		RESET BUTTON & TERMINAL ACTUATION MODES	
	1	Reset Rate Output	For Rate, reset only affects the output and does not
	2	Reset Counter	change the displayed value. For Counter, reset affects the
	3	Reset Rate Output & Counter	output as well as the count value.
43		INPUTS 1 & 2 RESPONSE MODES	
	1	Count With Inhibit	Input 1 = Cnt & Rate, Input 2 = Inh for Cnt.
	2	Count With Up/Down Control	Input 1 = Cnt & Rate, Input 2 = Up/Dn for Cnt.
	3	Add/Subtract	Input 1 = Add & Rate, Input 2 = Subtract
	4	Separate Inputs	Input 1 = Rate, Input 2 = Counter
	5	Quadrature	Input 1 = Cnt & Rate, Input 2 = Quadrature
	6	Quadrature X4	Input 1 = Cnt, Quad. & Rate, Input 2 = Cnt & Quad
44		COUNTER NUMBER OF COUNT EDGES	Cannot be programmed in quadrature X4.
	1	Single Edge Counting (X1)	Count on falling edge of count input.
	2	Double Edge Counting (X2)	Count on both edges of count input.
45		COUNTER SCALE MULTIPLIER	
	1	1	
	2	0.1	
	3	0.01	
	4	0.001	
46		CNTR DECIMAL POINT & LEAD ZERO BLANKING	
		(+) Leading Zero Blanking Enabled	
		(-) Leading Zero Blanking Disabled*	
	+/-1	No Decimal Point	
	+/-2	Decimal Point Right of Digit 2	
	+/-3	Decimal Point Right of Digit 3	
	+/-4	Decimal Point Right of Digit 4	
	+/-5	Decimal Point Right of Digit 5	
	+/-6	Decimal Point Right of Digit 6	

**Polarity sign is displayed in front of the identifier, a (-) sign is displayed, a (+) sign is not.*

APPENDIX "D" - GEMINI 4100 COUNTER/RATE MODE FUNCTION COMMAND CODE SUMMARY

CODE	MODE	DESCRIPTION	COMMENTS
51		OUTPUT CONFIGURATION	
	2	Output to Counter	
	3	Output to Rate	Automatically selects code [56.1].
52		OUTPUT TERMINATION MODES	
		(+) Normal Phase	Output normally "OFF", turns "ON" at preset .
		(-) Reverse Phase*	Output normally "ON", turns "OFF" at preset.
	+/-3	Terminate at Manual Reset	
	+/-4	Terminate at Manual Reset End	
	+/-5	Terminate after Timed Output	
	+/-6	Boundary	Automatically selects code [56.1].
53		TIMED OUTPUT VALUE	Range 0.01 to 599.99sec.
56		COUNTER RESET MODES	
		(+) Maintained	Unit remains reset as long as reset is activated
		(-) Momentary*	Unit will reset instantly and will start counting again even if reset is still activated.
	+/-1	Manual Reset to Zero	Automatically selected when output is configured for rate [51.3] or when boundary mode is used. [52.6].
	+/-2	Manual Reset to Preset	
	+/-3	Automatically Reset to Zero after Timed Output	
	+/-4	Automatically Reset to Preset after Timed Output	
	+/-5	Automatically Reset to Zero at Preset	Counter resets as soon as the output is activated
	+/-6	Automatically Reset to Preset at Zero	
61		RATE RIGHT-HAND DUMMY ZEROS	
	1	1 Dummy Zero	
	2	2 Dummy Zeros	
	3	3 Dummy Zeros	
	4	No Dummy Zeros	
62		RATE CONVERSION FACTOR	
	1	Rate Per Second (X1)	
	2	Rate Per Minute (X60)	
	3	Rate Per Hour (X3600)	

* Polarity sign is displayed in front of the identifier, A (-) sign is displayed, A (+) sign is not.

APPENDIX "D" - GEMINI 4100 COUNTER/RATE MODE FUNCTION COMMAND CODE SUMMARY

CODE	MODE	DESCRIPTION	COMMENTS
63		RATE MINIMUM UPDATE TIME	
	1	0.5 Sec. minimum/1 Sec. maximum	
	2	1 Sec. minimum/2 Sec. maximum	
	3	2 Sec. minimum/4 Sec. maximum	
	4	4 Sec. minimum/8 Sec. maximum	
	5	8 Sec. minimum/16 Sec. maximum	
	6	16 Sec. minimum/32 Sec. maximum	Maximum rate = 7500cps.
64		RATE SCALE MULTIPLIER	Maximum rate = 3250cps.
	1	1000	
	2	100	
	3	10	
	4	1	
	5	0.1	
	6	0.01	
65		RATE DECIMAL POINT & LEAD ZERO BLANKING	
		(+) Leading Zero Blanking Enabled	
		(-) Leading Zero Blanking Disabled*	
	+/-1	No Decimal Point	
	+/-2	Decimal Point Right of Digit 2	
	+/-3	Decimal Point Right of Digit 3	
	+/-4	Decimal Point Right of Digit 4	
	+/-5	Decimal Point Right of Digit 5	
	+/-6	Decimal Point Right of Digit 6	

** Polarity sign is displayed in front of the identifier, a (-) sign is displayed, a (+) sign is not.*

APPENDIX "D" - GEMINI 4100 COUNTER/RATE MODE FUNCTION COMMAND CODE SUMMARY

CODE	MODE	DESCRIPTION	COMMENTS
66		"OPERATOR ACCESSIBLE FUNCTIONS" MODES	"PGM DIS" Terminal connected to "Comm"
		(+) Reset Button & "RST" Terminal Enabled	Front panel reset can be independently disabled by using DIP switch.
		(-) Reset Button & "RST" Terminal Disabled*	This mode has no affect on the"RST A" terminal which is always enabled.
	+/-1		No Functions Enabled
	+/-2		Preset Programming Enabled
	+/-3		Scale Factor Programming Enabled
	+/-4		Preset & Scale Factor Programming Enabled
	+/-5		Preset & Counter Load Programming Enabled
	+/-6		Preset, Scale Factor & Counter Load Programming Enabled
P(1)		PRESET	Up to +/-999999
SF(A)	Display A	RATE SCALE FACTOR	Up to 5.9999
SF(B)	Display B	COUNTER SCALE FACTOR	Up to +/-5.9999
E & DISP	Display B	COUNTER LOAD VALUE	Up to +/-999999. Counter load value is NOT saved in memory when power is removed.

* Polarity sign is displayed in front of the identifier, A (-) sign is displayed, A (+) sign is not.

APPENDIX "D" - GEMINI 4100 DUAL COUNTER MODE FUNCTION COMMAND CODE SUMMARY

CODE	MODE	DESCRIPTION	COMMENTS
41		UNIT PERSONALITY	(-)Loads factory set code values*
	+/-2	Dual Counter*	Counter A|Display value (A)/Counter B|Display value (B)
42		RESET BUTTON & TERMINAL ACTUATION MODES	
	1	Reset Counter A	Reset affects the output as well as the displayed value.
	2	Reset Counter B	
	3	Reset Counter A & B	
43		INPUTS 1 & 2 RESPONSE MODES	
	1	Count With Inhibit	Input 1 = Cnt A & Cnt B, Input 2 = Inh.
	2	Count With Up/Down Control	Input 1 = Cnt A & Cnt B, Input 2 = Up/Dn.
	3	Add/Subtract	Input 1 = Add, Input 2 = Subtract
	4	Separate Inputs	Input 1 = Counter A, Input 2 = Counter B
	5	Quadrature	Input 1 = Cnt A & Cnt B, Input 2 = Quadrature
	6	Quadrature X4	Input 1 = Cnt & Quad, Input 2 = Cnt & Quad.
44		COUNTER A & B NUMBER OF COUNT EDGES	Cannot be programmed in quadrature X4.
	1	Single Edge Counting (X1)	Count on falling edge of count input.
	2	Double Edge Counting (X2)	Count on both edges of count input.
45		COUNTER B SCALE MULTIPLIER	
	1	1	
	2	0.1	
	3	0.01	
	4	0.001	
46		CNTR B DECIMAL POINT & LEAD ZERO BLANKING	
		(+) Leading Zero Blanking Enabled	
		(-) Leading Zero Blanking Disabled*	
	+/-1	No Decimal Point	
	+/-2	Decimal Point Right of Digit 2	
	+/-3	Decimal Point Right of Digit 3	
	+/-4	Decimal Point Right of Digit 4	
	+/-5	Decimal Point Right of Digit 5	
	+/-6	Decimal Point Right of Digit 6	

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APPENDIX "D" - GEMINI 4100 DUAL COUNTER MODE FUNCTION COMMAND CODE SUMMARY

CODE	MODE	DESCRIPTION	COMMENTS
51		OUTPUT CONFIGURATION	
	2	Output to Counter B	
52		OUTPUT TERMINATION MODES	
		(+) Normal Phase	Output normally "OFF", turns "ON" at preset.
		(-) Reverse Phase*	Output normally "ON", turns "OFF" at preset.
	+/-3	Terminate at Manual Reset	
	+/-4	Terminate at Manual Reset End	
	+/-5	Terminate after Timed Output	
	+/-6	Boundary	Automatically selects code [56.1]
53		TIMED OUTPUT VALUE	Range 0.01 to 599.99sec.
56		COUNTER B RESET MODES	
		(+) Maintained	Unit remains reset as long as reset is activated.
		(-) Momentary*	Unit will reset and start counting again, even if reset is still activated.
	+/-1	Manual Reset to Zero	Automatically selected when boundary mode is used [52.6].
	+/-2	Manual Reset to Preset	
	+/-3	Automatically Reset to Zero after Timed Output	
	+/-4	Automatically Reset to Preset after Timed Output	
	+/-5	Automatically Reset to Zero at Preset	Counter resets as soon as the output is activated.
	+/-6	Automatically Reset to Preset at Zero	
61		COUNTER A RESET MODES	
		(+) Maintained	Unit remains reset as long as reset is activated.
		(-) Momentary*	Unit will reset and start counting again, even if reset is still activated.
	+/-1	Manual Reset to Zero	
64		COUNTER A SCALE MULTIPLIER	
	1	1	
	2	0.1	
	3	0.01	
	4	0.001	

* Polarity sign is displayed in front of the identifier, A (-) sign is displayed, A (+) sign is not.

APPENDIX "D" - GEMINI 4100 DUAL COUNTER MODE FUNCTION COMMAND CODE SUMMARY

CODE	MODE	DESCRIPTION	COMMENTS
65		CNTR A DECIMAL POINT & LEAD ZERO BLANKING	
		(+) Leading Zero Blanking Enabled	
		(-) Leading Zero Blanking Disabled*	
	+/-1	No Decimal Point	
	+/-2	Decimal Point Right of Digit 2	
	+/-3	Decimal Point Right of Digit 3	
	+/-4	Decimal Point Right of Digit 4	
	+/-5	Decimal Point Right of Digit 5	
	+/-6	Decimal Point Right of Digit 6	
66		"OPERATOR ACCESSIBLE FUNCTIONS" MODES	"PGM DIS" Terminal connected to "Comm"
		(+) Reset Button & "RST" Terminal Enabled	Front panel reset can be independently disabled by using DIP switch.
		(-) Reset Button & "RST" Terminal Disabled*	This mode has no affect on the"RST A" terminal which is always enabled.
	+/-1	No Functions Enabled	
	+/-2	Preset Programming Enabled	
	+/-3	Scale Factor Programming Enabled	
	+/-4	Preset & Scale Factor Programming Enabled	
	+/-5	Preset & Counter Load Programming Enabled	
	+/-6	Preset, Scale Factor & Cnter Load Programming Enabled	
P(1)		PRESET	Up to +/-999999
SF(A)	Display A	COUNTER A SCALE FACTOR	Up to +/-5.9999
SF(B)	Display B	COUNTER B SCALE FACTOR	
E & DISP	Display A	COUNTER A COUNTER LOAD VALUE	Up to +/-999999. Counter Load value is NOT saved in memory when power is removed.
E & DISP	Display B	COUNTER B COUNTER LOAD VALUE	Up to +/-999999. Counter Load value is NOT saved in memory when power is removed.
* Polarity sign is displayed in front of the identifier, A (-) sign is displayed, A (+) sign is not.			

APPENDIX "E" - SCALING FOR COUNTING

The Gemini 4100 is factory set to provide 1 count on the display for each pulse that is input to the unit. In many applications, there will not be a one to one correspondence between input pulses and display units. In these applications it will be necessary for the Gemini 4100 to scale or multiply the input pulses by a scaling factor to achieve the proper display units (feet, meters, gallons, widgets, etc.). There are three different function codes that are used in scaling the input pulses to the desired reading. They are: The "Counter Scale Factor", the "Counter Scale Multiplier", and the "Counter Number of Count Edges", function code 44. All three are factored together to provide the Total Scaling that is necessary.

This section applies to Counter A (if Dual Counter personality) and Counter B. There are separate Scale Factors and Scale Multipliers associated with each counter.

The "Number of Count Edges", function code 44 or code 43 (Quad X4), will apply to both counters. In other words, if one counter requires that 2 count edges be used per input pulse, programming that mode will cause both counters to use both count edges. In the Quadrature X4, Inputs 1 & 2 Response mode, both the rising and falling edges of both Inputs, 1 & 2, are counted. In this mode the "Number of Count Edges" is 4.

The first step in scaling the counter requires that the "Number of Pulses" per "Display Unit" or "Display Units" be obtained. This may require a small amount of deductive reasoning. For example: A 48 tooth gear is mounted to a 2.5 ft circumference feed roll in a paper processing plant. It is desired to totalize the total footage of paper processed. In this example the units of display will be in feet. A sensor sensing the gear teeth will provide 48 pulses for each revolution of the feed roll. Each revolution will equate to a linear distance of 2.5 feet. The number of "Display Units" will be 2.5. Even though the application only requires indication in "whole" feet, the decimal information (0.5ft) is kept to maintain conversion accuracy. The "Number of Pulses" per "Display Units" (2.5 feet) would naturally be 48.

Once the number of "Display Units" and the "Number of Pulses" have been obtained, the Total Scaling Factor can be calculated. The "Total Scaling Factor", denoted as "KT", is simply the total amount of scaling required. It is obtained by dividing the "Display Units" by the "Number of Pulses" as shown in Formula #1 below.

FORMULA #1: K_T = Display Units/Number of Pulses

WHERE:

DISPLAY UNITS - The number of units (revolutions, feet, 10ths of feet, meter etc.) that would be acquired after the "Number of Pulses" has occurred.

NUMBER OF PULSES - The Number of pulses required to achieve the numb of "Display Units".

For the preceding example, the Total Scaling Factor, "K_T", is calculated b plugging in 2.5 and 48 in the formula. K_T = Display Units/Number of Pulses 2.5/48 = 0.052083.

As previously stated, the Total Scaling Factor, "K_T", is the combination of th Scale Factor, Scale Multiplier, and Number of Count edges. In many applicatior the Total Scale Factor, "K_T", can be programmed directly into the Scale Facto "SF", and the Scale Multiplier and Number of Count Edges factory settings, X1, would be used.

In some applications, more display resolution may be required. Whenever th Total Scaling Factor is greater than 1.0000 and when utilizing only one edge p count pulse, there may not be enough display resolution. For example; with Total Scaling Factor of 2.000, when an input pulse is generated, the display wi increment by 2. If the display units is in feet, when 3 feet has gone by, the displ will still only read 2. It will not increment again until 4 feet has been accumulate With this amount of display resolution it would be impossible to set the Preset ar have the output respond at odd feet intervals (1, 3, 5, etc.). To increase resolutio the Number of Count edges will have to be increased. This can be achieved b programming Function code 44 to mode 2, 2 edges, or Function code 43 to mo 6, Quad X4, if quadrature counting is being used.

If enough resolution still has not been attained, more input pulses will need be generated per display unit.

The amount of resolution required will vary depending on the particul application. In cut-to-length applications, a high amount of resolution is oft necessary. However, in totalizing applications, display resolution may not important. It should be noted that whenever the number of count edges increased to 2 or 4 (Quad X4), the maximum count frequency will decrease. (S Appendix "B" for maximum count frequency specification.)

NOTE: When using 2 or 4 edge counting for length sensor, on/off duty cycle mu be 50% to maintain max. accuracy (mag. pickup will not work).

Once the Number of Count Edges (NCE) to be used has been determined, t Remaining Scaling factor required, "K_R", can be calculated. This is simply t Total Scaling Factor, "K_T", divided by the Number of Count edges.

FORMULA #2: $K_R = K_T/NCE$

WHERE: KR - Remaining Scaling required

In our original example, the Total Scaling Factor, "K_T" was determined to be 0.052083. Since this value is less than one, sufficient pulse information is being generated, i.e., there is enough resolution for the units selected. The Number of Count edges can be left at the factory set value of 1. The Total Scaling Factor, "K_T", effectively becomes the Total Scaling Remaining, "K_R". ($K_R = 0.052083/1 = 0.052083$)

If the scaling remaining is between 0.6000 and 5.9999, it can be programmed directly into the Scale Factor value and the X1 factory setting for the Scale Multiplier, "SCM", can be used.

The general rule for choosing an SCM value is, when the Remaining Scaling Required, "K_R", is less than 0.6000, an SCM value of 0.1 or 0.01 can be used to get a Scale Factor value between 0.6 and 5.9999 or to the point where the maximum number of significant digits is obtained.

FORMULA #3: $SF = K_R/SCM$

Following our continuing example, it is easy to see that the Scaling Remaining, "K_R" (0.052083), cannot fit into the Scale Factor Value without losing significant digits. Using the Formula above and a Scale Multiplier value of 0.01, will allow us to get the maximum number of significant digits possible ($SF = K_R/SCM = 0.052083/0.01 = 5.2083$).

COUNTER SCALING EXAMPLE:

EXAMPLE #1:

A flow sensor provides 62 pulses per gallon. Calculate the scaling required to provide a display reading in gallons.

In this example the number of "Display Units" is the same as the desired reading, since there are no decimal points involved.

The number of "Display Units" displayed after 62 pulses have been counted should be 1.

STEP 1 - Calculate the Total Scaling Factor, "K_T", using Formula #1.

K_T = Display Units/Number of Pulses (Formula #1)

$K_T = 1/62 = 0.016129$

STEP 2 - In this application 62 pulses per gallon provides more than enough resolution, so the "Number of Count Edges" is left set to the factory configured value of 1. With a "NCE" value of 1, the remaining amount of scaling necessary is still 0.016129.

KR = KT/NCE (Formula #2)

KR = 0.016129/1 = 0.016129

STEP 3 - In order to provide maximum scaling accuracy, a "Scale Multiplier" value is chosen that will give the maximum amount of significant digits in the Scale Factor. A value of 0.01 will result in a Scale Factor Value of 1.6129.

$SF = K_R/SCM$ (Formula #3)

$SF = 0.016129/0.01 = 1.6129$

EXAMPLE #2:

A quadrature Rotary Pulse Generator that provides 100 pulses per revolution is coupled to a feed roll that is 2.5 feet in circumference. It is desired to read in feet with display resolution to the nearest hundredth of feet.

In this application, the requirement is for the display to read in hundredths of a foot. A 2.5 ft. distance will equate to 250 "Display Units". The "Number of Pulses" for 2.5 ft. (250 hundredths) is 100, as stated.

From the information obtained, the Total Scaling Factor, "K_T", can be calculated, using Formula #1.

K_T = Display Units/Number of Pulses

$K_T = 250/100 = 2.5$

With a Total Scaling Factor, "K_T", of 2.5, it can easily be seen that for every pulse that is input, the display will increment by 2.5 display units. The application requires resolution to the nearest hundredth of a foot. In order to get higher resolution, Quadrature X4 Input Response Mode is selected. This will provide four times more resolution. Using Formula #2, and 4 for the "Number of Count Edges", the Remaining Scaling, "K_R", is calculated.

$K_R = K_T$/Number of Count Edges

$K_R = 2.5/4 = 0.625$

At this point, it can be seen that the Remaining Scaling value of 0.625 will fit into the Scale Factor value range without losing any significant digits or scaling it any further. Because of this, the Scale Multiplier (SCM) factory set value of X1 is used, and 0.6250 is programmed directly into the Scale Factor, "SF".

$SF = K_R/SCM$

$SF = 0.6250/1 = 0.6250$

APPENDIX "F" - SCALING FOR RATE

The Gemini 4100 offers a simplified method for scaling the rate indicator. The method does not require time unit conversions. The desired time format (Rate Per Second, Rate Per Minute, Rate Per Hour) is simply selected as part of the programming procedure.

Due to the way the rate is calculated (See "General Description" section), high resolution and accuracy can be realized at all input rates, slow or fast. It is not necessary to increase the pulse information to obtain higher resolution.

The Rate Minimum Update Time, function code 63, can be increased (from 0.5sec. up to 16sec.) to provide averaging in applications where the input pulse spacing is not stable. The Update time selected, however, will not affect the scaling in any manner.

Scaling the Rate channel simply involves programming the Gemini 4100 so that pulse units inputted to the unit will be scaled to the desired display units (revolutions, feet, meters, etc.) in the desired time format (Rate Per Second, Rate per Minute, Rate Per Hour).

There are two basic types of rate scaling applications for the Gemini 4100. The first is when the rate indicator is to display the rate at which the counter is counting (count and rate using the same sensor). In this case, the rate indicator can be programmed with the same scaling parameters as the counter. The only other requirement is that the desired "Rate Conversion Factor", function code 62, be selected to provide the rate display in the desired time format, i.e., Rate per Second, Rate per Minute or Rate per Hour. This will automatically scale the rate by X1, X60 or X3600 (1 pulse per second = 60 pulses per minute = 3600 pulses per hour).

NOTE: If the number of Count Edges for Counter B is 2 or 4, the rate must be scaled by the same amount using the Rate Scale Factor and Scale Multiplier. This is due to the fact that the rate indicator only uses 1 edge.

The second basic type of rate application is when the rate indicator and counter are using two separate sensors. In this case, both the rate and count channels must be scaled separately.

Scaling for the count channel is discussed in Appendix "E" - Scaling for Counter.

In order to scale the rate, it is only necessary to know the number of pulses per display unit or units (feet, revolutions, etc.). For example; if a 48 tooth gear, which is coupled to a shaft, is being sensed and it is desired to indicate the shaft speed in revolutions, the display units would be revolutions. It is obvious that 48 pulses will occur in one revolution.

In order to convert the pulse units to revolutions, it is necessary for the Gemi 4100 to multiply the number of pulses by a scaling factor to convert the pulse uni to revolution units. The Gemini 4100 has two programming codes that serve scale pulse units to desired display units. They are: the Scale Factor and the Sca Multiplier. Both are used to attain the Total Scaling Factor, "K_T".

To calculate the Total Scaling Factor, "KT", for the application, the followin formula is used.

FORMULA #1: K_T = Display units/Number of pulses

WHERE:

DISPLAY UNITS - The number of units (revolutions, feet, 10ths of feet, meter etc.) that would be acquired after the "Number of Pulses" has occurred.

NUMBER OF PULSES - The Number of pulses required to achieve the numb of "Display Units".

Using the example previously discussed, the display unit would be 1 revolutio and the number of pulses per display unit would be 48. Therefore, the Total Scal Factor would be 0.020833 (KT = Display Units/Number of Pulses = 1 rev/4 pulses per rev = 0.020833). In many applications the Total Scale Factor, "K_T" can be programmed as the Scale Factor, "SF", and the Scale Multiplier, "SCM" factory setting, X1, would be used. However, in some applications, such as th one above, it may be desired to obtain more significant digits in the Scale Facto "SF". These situations occur when the "K_T" factor does not calculate to an eve number that will be fit into the four decimal places available to the Scale Facto The following formula can be used to calculate the Scale Factor when an SC value other than X1 is needed.

FORMULA #2: $SF = K_T/SCM$

In this formula, the Total Scaling Factor, previously calculated, is divided b the Scale Multiplier Value, "SCM", to obtain the Scale Factor, "SF".

The general rule for choosing an SCM value is, when the Total Scale Facto "K_T", is less than 0.6000, an SCM value of 0.1 or 0.01 can be used to get a Scal Factor value between 0.6 and 5.9999, or to the point where the maximum numb of significant digits is obtained. If the Total Scaling Factor, "K_T", is greater tha 5.9999, then an SCM value of 10, 100, or 1000 can be used to obtain a Scale Facto Value between 0.6 and 5.9999.

In our initial example, the Total Scaling Factor, "K_T" was determined to b 0.020833. It is easy to see that this number cannot be programmed into the Scal Factor, "SF", without losing significant digits. Using formula #2 and the gener

rules stated above, a Scale Multiplier Value of 0.01 is chosen and the Scale Factor is calculated as shown below. This will provide maximum amount of conversion accuracy possible.

$$SF = KT/SCM$$
$$SF = 0.020833/SCM$$
$$SF = 0.020833/0.01 = 2.0833$$

In situations where the Total Scale Factor is already in range of the Scale Factor (0.0001 to 5.9999) and when there are no significant digits that are lost, the Total Scaling Factor, "K_T", can be programmed directly into the Scale Factor Value and a Scale Multiplier value of 1 (the factory set value) used. For example; if the display units are in feet and there are 100 pulses per foot, the Total Scaling Factor,"K_T", would be 0.01 (K_T = Display units/pulses per display units = 1 / 100 = 0.01). Since the Total Scaling Factor, "K_T", is exactly 0.01, it can be programmed into the Scale Factor Value, "SF", and the Scale Multiplier Value, "SCM", can be left at, or programmed to, its factory setting of x1.

After the Scale Factor and Scale Multiplier values are selected, all that is necessary to complete the scaling is to choose the Rate Conversion Factor. The Rate Conversion Factor can be selected to provide indication in Rate per Second, Rate Per Minute, or Rate per Hour.

NOTE: There may be situations where there are many more pulses per display unit than needed. In these situations the minimum SCM value (0.01) may not provide enough significant digits in the Scale Factor. To achieve more significant digits, the Rate Conversion Factor should be set to mode 1, Rate per Second and the following formula be used.

$$SF = \frac{K_T \times CF}{SCM}$$

Where: CF = 60 for display reading in Rate Per Minute, or
CF = 3600 for display reading in Rate Per Hour

RATE SCALING EXAMPLE:

EXAMPLE #1:

A 60 tooth gear is mounted to a web that has a circumference of 2 feet. It is desired to have a rate readout in 10ths of feet per minute. Calculate the Scale Factor and Scale Multiplier values necessary to provide the desired readout.

In this example one revolution of the web will provide 60 pulses for 2 feet of linear travel. Since the desired display units are to be in tenths of feet, it is necessary to convert 2 feet to tenths, giving us 20 tenths (display units). The Total Scaling Factor, "K_T", is calculated by simply plugging in the two numbers into formula #1.

$$KT = \text{Display Units/Number of Pulses}$$
$$KT = 20/60 = 0.333333$$

In order to get the maximum number of significant digits in the Scale Factor we use formula #2 and a Scale Multiplier value of 0.1 as shown below.

$$SF = K_T/SCM \qquad SF = 0.333333/0.1 = 3.3333$$

To obtain rate indication in Feet Per Minute, the Rate Conversion Factor is programmed for Rate per Minute mode. A decimal point is also added to provide for a display of feet in 10ths.

EXAMPLE #2:

The shaft of a positive displacement pump has a 14 tooth sprocket that is being sensed by a magnetic pickup. It is known that when the unit is pumping 810 liters of water per minute, the shaft is turning 400 RPM. It is desired to have a display readout in liters per minute.

With the Gemini 4100, it is not necessary to deal with time unit conversions. From the information given, we know that when the shaft has turned 400 revolutions, 810 liters of water will have been pumped. The first step we need to take, is to calculate the number of pulses that occur when 810 liters have been pumped.

NUMBER OF PULSES = # of Revolutions x Pulses per Rev.
NUMBER OF PULSES = 400 Rev x 14 Pulses per Rev = 5600 pulses.

We now have all the information necessary to scale the rate. The Total Scaling Factor, "K_T", is calculated using Formula #1 as shown below.

$$K_T = \text{Display Units/Number of Pulses}$$
$$K_T = 810/5600 = 0.144643$$

It is noticed that there are more significant digits in the Total Scale Factor, "K_T", than there are available for the Scale Factor, "SF". In order to acquire the maximum amount of significant digits for the Scale Factor, Formula #2 is used and a Scale Multiplier value of 0.1 is selected.

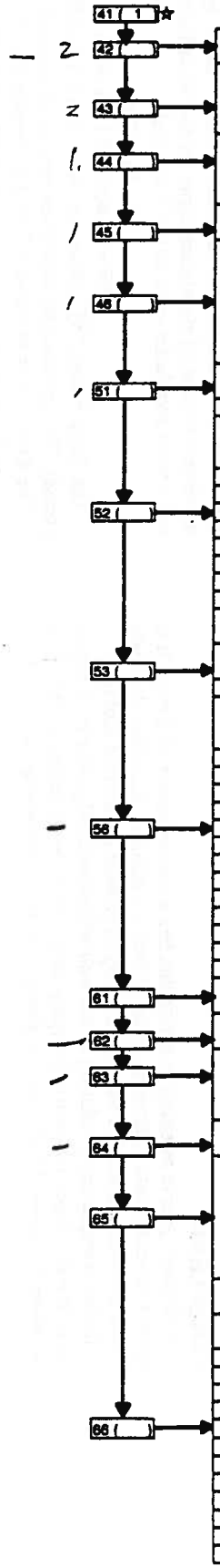
$$SF = K_T/SCM$$
$$SF = 0.144643/0.1 = 1.4464$$

The Scale Factor, "SF", then becomes 1.4464 (1.44643 rounded to 4 decimal places). This provides the maximum amount of conversion accuracy possible.

The final step is to select a Rate Conversion Factor. The Rate Conversion Factor is chosen to be Rate Per Minute as was required.

APPENDIS "G" - GEMINI 4100 COUNTER/RATE PROGRAMMING CHART

FEATURE & MODE SELECTION (See Programming Procedure)



DETAILED MODE MENUS

RESET BUTTON & TERMINAL ACTUATION MODES

(1) RST RATE OUTPUT (2) RST COUNTER (3) RST RATE OUTPUT & COUNTER

INPUTS 1 & 2 RESPONSE MODES

(1) 1 = CNT. & RATE, 2 = INH.(CNT.)
(2) 1 = CNT. & RATE, 2 = UP/DN
(3) 1 = CNT. UP & RATE, 2 = CNT. DN
(4) 1 = RATE, 2 = CNT.
(5) QUADRATURE X1 (1 = RATE)
(6) QUADRATURE X4 (1 = RATE)

INPUT PULSE EDGES REGISTERING COUNTS (Counter B)*

(1) NEG. GOING EDGES ONLY (1 count/pulse)
(2) BOTH + & - EDGES (2 counts/pulse)

* Not accessible with Quadrature X4 Input Response Mode

COUNTER SCALE MULTIPLIER

(1) x1 (2) x0.1 (3) x0.01 (4) x0.001

COUNTER DECIMAL POINT & LEADING ZERO BLANKING

(1)	0	(-1)	000000 (NO L.Z.B.)
(2)	0.0	(-2)	00000.0
(3)	0.00	(-3)	0000.00
(4)	0.000	(-4)	000.000
(5)	0.0000	(-5)	00.0000
(6)	0.00000	(-6)	0.00000

OUTPUT ASSIGNMENT

(2) OUTPUT TO COUNTER (3) OUTPUT TO RATE

OUTPUT TERMINATION MODES

MODE	AT RESET START	AT RESET END	AFTER TIMED OUTPUT	BOUNDARY MODE	OUTPUT NORMALLY "OFF"	OUTPUT NORMALLY "ON"
(3)	●				●	
(-3)	●					●
(4)		●			●	
(-4)		●				●
(5)			●		●	
(-5)			●			●
• (6)				●	●	
(-6)				●		●

*BOUNDARY MODE: Output goes "OFF" when count or rate < Preset and goes "ON" when count or rate is ≥ Preset as the value goes up and down through the Preset.

TIMED OUTPUT VALUE

Timed Output Value range: 0.01 to 599.99Sec

COUNTER RESET MODES

MODE	RESET TO ZERO	RESET TO PRESET	AUTO RST AFTER TIMED OUT.	AUTO RST AT TIMED OUT.	MAINTAINED MANUAL RST	MOMENTARY MANUAL RST
• (1)	●				●	
• (-1)	●					●
(2)		●			●	
(-2)		●				●
(3)	●		●		●	
(-3)	●		●			●
(4)		●	●		●	
(-4)		●	●			●
(5)	●			●	●	
(-5)	●			●		●
(6)		●		●	●	
(-6)		●		●		●

*Automatically selected when [51 3] or [52 6] is programmed.

RATE RIGHT HAND DUMMY ZEROS

(1) 0 (2) 00 (3) 000 (4) NONE

RATE CONVERSION FACTOR

(1) RATE/SEC (x1) (2) RATE/MINUTE (x60) (3) RATE/HR. (x3600)

RATE MINIMUM UPDATE TIME*

(1) 0.5Sec (2) 1Sec (3) 2Sec
(4) 4Sec (5) 8Sec (6) 16Sec

*Maximum update time varies with each minimum update time.

RATE SCALE MULTIPLIER

(1) x1000 (2) x100 (3) x10 (4) x1 (5) x0.1 (6) x0.01

RATE DECIMAL POINT & LEADING ZERO BLANKING

(1)	0	(-1)	000000 (NO L.Z.B.)
(2)	0.0	(-2)	00000.0
(3)	0.00	(-3)	0000.00
(4)	0.000	(-4)	000.000
(5)	0.0000	(-5)	00.0000
(6)	0.00000	(-6)	0.00000

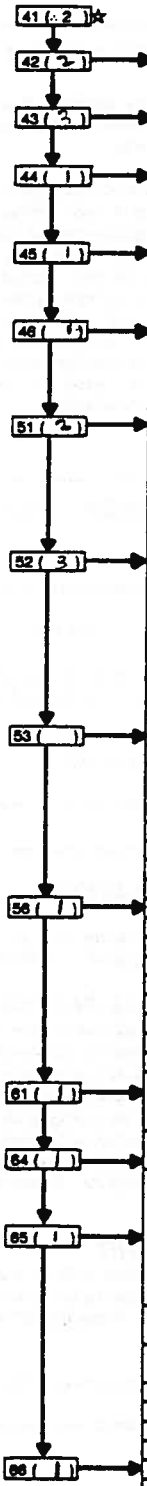
"OPERATOR ACCESSIBLE FUNCTIONS" MODES (With "PGM. DIS." terminal to "COMM")

MODE	PRESET VALUE	SCALE FACTORS	COUNTER LOAD VALUE	RESET BUTTON & TERMINAL
(1)				●
(-1)				
(2)	●			●
(-2)	●			
(3)		●		●
(-3)		●		
(4)	●	●		●
(-4)	●	●		
(5)	●		●	●
(-5)	●		●	
(6)	●	●	●	●
(-6)	●	●	●	

☆Entering a [41 -1], at any time will load factory settings for all modes.

APPENDIS "G" - GEMINI 4100 DUAL COUNTER PROGRAMMING CHART

FEATURE & MODE SELECTION (See Programming Procedure)



DETAILED MODE MENUS

RESET BUTTON & TERMINAL ACTUATION MODES (42 [2])

(1) RST COUNTER A — (2) RST COUNTER B — (3) RST COUNTER A & B

INPUTS 1 & 2 RESPONSE MODES (43 [2])

(1) 1 = CNT. (A & B), 2 = INH. — (2) 1 = CNT. (A & B), 2 = UP/DN
(3) 1 = CNT. UP (A & B), 2 = CNT. DN (A & B) — (4) 1 = CNT. A, 2 = CNT. B
(5) QUADRATURE X1 (A & B) — (6) QUADRATURE X4 (A & B)

INPUT PULSE EDGES REGISTERING COUNTS (Counter A & B)* (44 [1])

(1) NEG. GOING EDGES ONLY (1 count/pulse) — (2) BOTH + & - EDGES (2 COUNTS/PULSE)

* Not accessible with Quadrature X4 Input Response Mode

COUNTER B SCALE MULTIPLIER (45 [1])

(1) x1 — (2) x0.1 — (3) x0.01 — (4) x0.001

COUNTER B DECIMAL POINT & LEADING ZERO BLANKING (46 [1])

(1)	0	(-1) 0 0 0 0 0 0 (NO L.Z.B.)
(2)	0.0	(-2) 0 0 0 0 0.0
(3)	0.0 0	(-3) 0 0 0 0.0 0
(4)	0.0 0 0	(-4) 0 0 0.0 0 0
(5)	0.0 0 0 0	(-5) 0 0.0 0 0 0
(6)	0.0 0 0 0 0	(-6) 0.0 0 0 0 0

OUTPUT ASSIGNMENT (51 [2])

(2) OUTPUT TO COUNTER B

OUTPUT TERMINATION MODES (52 [3])

MODE	AT RESET START	AT RESET END	AFTER TIMED OUTPUT	BOUNDARY MODE	OUTPUT NORMALLY "OFF"	OUTPUT NORMALLY "ON"
(3)	●				●	
(-3)	●					●
(4)		●			●	
(-4)		●				●
(5)			●		●	
(-5)			●			●
* (6)				●	●	
(-6)				●		●

*BOUNDARY MODE: Output goes "OFF" when count or rate < Preset and goes "ON" when count or rate is ≥ Preset as the value goes up and down through the Preset.

TIMED OUTPUT VALUE (53 [ ])

Timed Output Value range: 0.01 to 599.99Sec

COUNTER B RESET MODES (56 [1])

MODE	RESET TO ZERO	RESET TO PRESET	AUTO RST AFTER TIMED OUT.	AUTO RST AT TIMED OUT.	MAINTAINED MANUAL RST	MOMENTARY MANUAL RST
* (1)	●				●	
* (-1)	●					●
(2)		●			●	
(-2)		●				●
(3)	●		●		●	
(-3)	●		●			●
(4)		●	●		●	
(-4)		●	●			●
(5)	●			●	●	
(-5)	●			●		●
(6)		●		●	●	
(-6)		●		●		●

*Automatically selected when [52 6] is programmed.

COUNTER A RESET MODES (61 [ ])

(1) MANUAL RESET TO ZERO MAINTAINED RESET — (-1) MANUAL RESET TO ZERO MOMENTARY RESET

COUNTER A SCALE MULTIPLIER (64 [ ])

(1) x1 — (2) x0.1 — (3) x0.01 — (4) x0.001

COUNTER A DECIMAL POINT & LEADING ZERO BLANKING (65 [1])

(1)	0	(-1)	0 0 0 0 0 0 (NO L.Z.B.)
(2)	0.0	(-2)	0 0 0 0 0.0
(3)	0.0 0	(-3)	0 0 0 0.0 0
(4)	0.0 0 0	(-4)	0 0 0.0 0 0
(5)	0.0 0 0 0	(-5)	0 0.0 0 0 0
(6)	0.0 0 0 0 0	(-6)	0.0 0 0 0 0

"OPERATOR ACCESSIBLE FUNCTIONS" MODES (66 [ ])
(With "PGM. DIS." terminal to "COMM")

MODE	PRESET VALUE	SCALE FACTORS	COUNTER LOAD VALUE	RESET BUTTON & TERMINAL
(1)				●
(-1)				
(2)	●			●
(-2)	●			
(3)		●		●
(-3)		●		
(4)	●	●		●
(-4)	●	●		
(5)	●		●	●
(-5)	●		●	
(6)	●	●	●	●
(-6)	●	●	●	

☆ Entering a [41 -2], at any time will load factory settings for all modes.

GEMINI 4100 PROGRAMMING

SOME NOTES & HINTS ON PROGRAMMING THE GEMINI 4100

1. Be systematic about programming! Plan out the exact features & functions you need for your application. Write out the code entries you need from start to finish, and then enter the codes completely. Don't start in the middle of the program codes and make arbitrary entries to "see what it will do". This is a sure way to create confusing results. Finally, after you are done, record your program & file it where you can find it later if you want to make changes. You can use this card to write in your codes in the program ladder on the reverse side, together with any fixed data entries, for convenient future reference.

2. Watch out for conflicting modes! The programs in the GEMINI 4100 have been written to prevent illegal code entry. However, to provide optimum flexibility, some reliance must be placed on the programmer to avoid conflicting codes.

3. The GEMINI 4100 can be interrogated at any time to see what modes & data entries have been made. Such interrogation can be made during a counting cycle without interrupting the normal counting process. In the lockout mode, all functions can also be interrogated, but those functions locked out cannot be changed. Making changes in program modes or data during a run is not recommended since mid-cycle changes can result in unanticipated outputs for that particular cycle.

PROGRAMMING PROCEDURE FOR FUNCTION & MODE SELECTION☆ (Applies to Programming Chart)

To enter a programmable function or mode, enter the function selector code desired and then select the particular mode identifier required.

For example, to set up a decimal point to display a reading in 1/100ths with leading zero blanking, function selector code #46 must be entered. (See codes on reverse side.)

Press button #4, then button #6. The display will temporarily interrupt its normal readout (without interfering with the normal operation of the unit).

It will then display the entered code on the L.H. side.

[46] (DISPLAY READOUT)

Next, enter the mode identifier (button #3) that defines the decimal point location & LZB condition. This code is displayed on the right.

[46 3] (DISPLAY READOUT)

Now, enter this new selection by pressing the "E" button.

PROGRAMMING PROCEDURE FOR DATA ENTRY

In data entry, the front panel pushbuttons are identified by two different sets of references and will cause two different reactions in the course of making a data entry.

In the first phase of a data entry cycle, the particular data entry mode is called up by pushing the buttons identified by their panel markings (i.e. Buttons "5", "3", "P", or "SF"). Once the data entry mode has been entered, the existing data appears on the display and the buttons below the display reference themselves to the digits directly above each button. The data can then be changed a digit at a time by depressing the button directly below the digits to be changed.

After the new data value is obtained , the "E" button is depressed to enter the new value.

[53] TIMED OUTPUT VALUE☆

Entering Code "53" will call up the Timed Output Value in seconds & hundredths. The value can be set to new value by incrementing each digit with the button underneath that digit.

Press the "E" button to enter the new Timed Output value. (Max. Timed Output value = 599.99sec.)

[S.F.] SCALE FACTOR

One stroke of the "S.F." (3) button calls up the existing Scale Factor for the currently displayed count or rate value. (The Scale Factor is the multiplier used to convert the actual count or rate to the direct readout display.) The value can be changed by incrementing each digit with the button below it. Pressing the "E" key enters the new S.F. The S.F. can be set at any value from +/-0.0001 to +/-5.9999. (Positive only for Rate Scale Factor A.)

[P] PRESET

One stroke of the "P" button calls up the preset value, which can then be changed by incrementing each digit with the button below it. Press the "E" button to enter the new Preset.

☆Program before connecting "PGM. DIS." to "COMMON".

SELF-TEST ROUTINE 6, +/-

Depressing "6" & then "+/-" starts the self-test routine by lighting all decimal points, then all 9's, all 8's, all 7's, etc., until alternate 8's & 9's are displayed. At this time, the output can be manually activated for testing by pressing the "P" button. (The Output test is disabled when "PGM. DIS." terminal is pulled to "COMMON".) An automatic exit will occur six (6) seconds after the Test Mode is completed. Test Mode can be run at any time and will not interfere with the normal operation of the Gemini 4100.

APPENDIX "I" - ORDERING INFORMATION

MODEL NO.	DESCRIPTION	OPTIONS		PART NUMBERS FOR AVAILABLE SUPPLY VOLTAGES		
		W/Relay Board	W/20mA Current Loop	24VDC	230VAC	115VAC
GEM41	Gemini 4100	Yes	No	GEM41030	GEM41010	GEM41000
		No	No	GEM41031	GEM41011	GEM41001
		Yes	Yes	GEM41130	GEM41110	GEM41100
		No	Yes	GEM41131	GEM41111	GEM41101
----	Gemini 4100 Relay Board			RLYBD001		

For Information & Pricing on NEMA Enclosures, Base Mount Kits, & Panel Adapter Kits, see the Red Lion Controls Catalog or contact your local RLC distributor.

