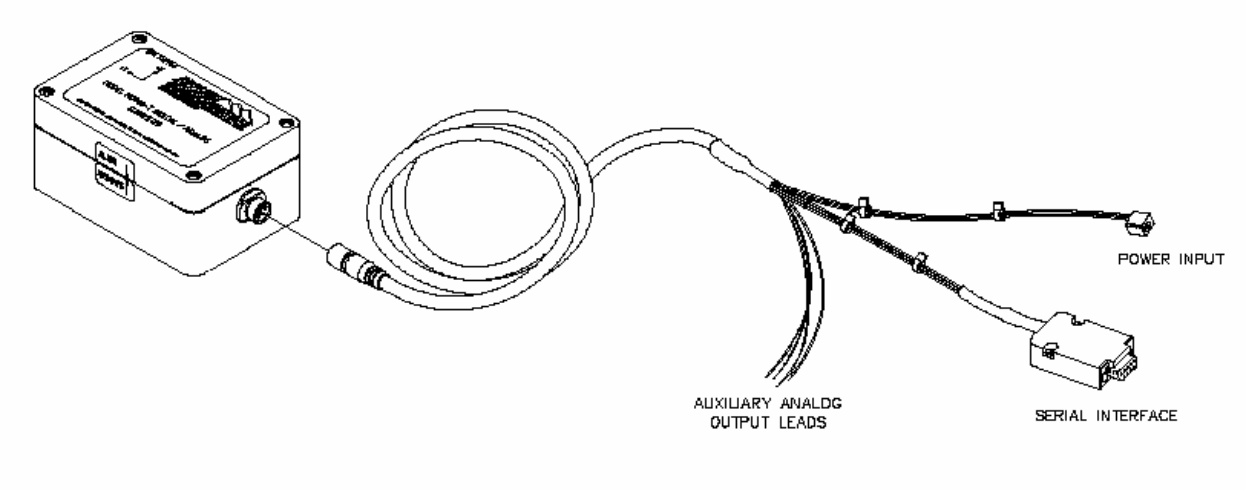
WinFrog Device Group:	**INS**
Device Name/Model:	**MD 900T**
Device Manufacturer:	Applied Geomechanics Incorporated 1336 Brommer Street Santa Cruz, CA 95062 USA Phone: (831) 462-2801; Fax: (831)462-4418 applied@geomechanics.com
Device Data String(s) Output to WinFrog:	NMEA $YXXDR (Pitch, Roll and Temperature)
WinFrog Data String(s) Output to Device:	For update rate of 1 per second, the following code is sent to the device: "*0100XYC2\r\n" For update rate of 4 times per second, the following code is sent to the device: "*0100XYC1\r\n"
WinFrog Data Item(s) and their RAW record:	Type 413 (Attitude): Time, Pitch, Roll, Status

DEVICE DESCRIPTION:

The MD 900T is a bi-axial clinometer with analogue and digital output capabilities. A liquid-filled electrolytic transducer comprises the sensing element. The MD-900T provides an RS-232 serial interface via a 6 pin NEMA 4X connector. The MD 900T has factory calibration values stored in non-volatile memory. The MD900-T operates on + 9 to +16 VDC @100MA. Output data (x, y, temperature and serial number) are provided in NMEA format and 2 other selectable formats. Each unit is shipped with Applied Geomechanics' ZAGI graphing and logging software (not required for use with WinFrog).



MD-900T Digital / Analog Clinometer

There are three different versions of the MD-900T: a High-Gain version (model Md-900 TH) that has an angular range of +- 10 degrees (at 0.004 degree resolution), a Standard version (model Md-900 TS) with an angular range of +- 25 degrees (at 0.01 degree resolution), and a Wide-Angle version (model Md-900 TW) with an angular range of +- 50 degrees (at 0.02 degree resolution).

The unit is small (120 mm x 80mm x 60mm) and can be mounted directly to the required surface using the mounting screws provided. When mounting small inclination units such as the MD 900T, it is sometimes difficult to orient the device's axis parallel to the vehicle's axis. To minimize these errors, it is good practice to mount the device precisely to a larger hard surface or plate, and then mount the plate to the vehicle. Winfrog allows for entry of calibration values to correct for differences in pitch and roll that may exist due to installation misalignment.

Note that the MD-900T is not submersible, and so must be protected from exposure to moisture.

WinFrog can be configured to apply the attitude data to remove device and tracking offsets caused by the vehicle's pitching and rolling motion. These calculations include reducing the GPS antenna position to the Z datum zero reference, removing apparent vehicle wandering due to the vehicle's pitch and roll.

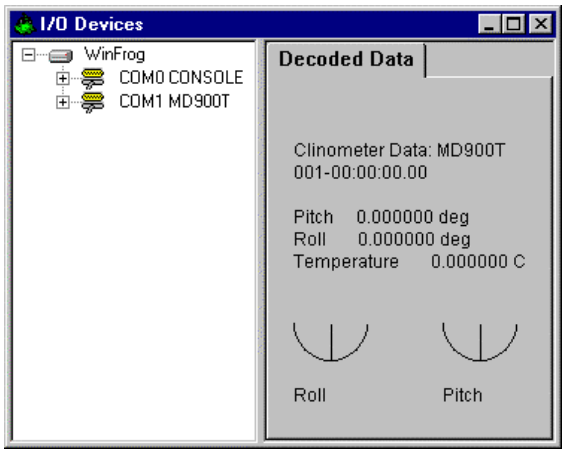
DEVICE CONFIGURATION INSTRUCTIONS

WINFROG I/O DEVICES > EDIT I/O:

Baud Rate:	9600	
Data Bits:	8	(programmable between 5 and 8)
Stop Bits:	1	(configurable: 1 or 2)
Parity :	none	(configurable)
Flow Control:	Configurable	

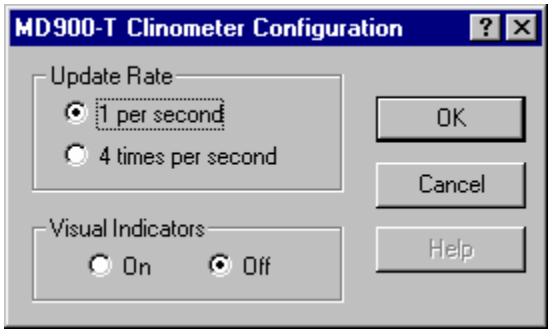
WINFROG I/O DEVICES > CONFIGURE DEVICE:

The MD 900T is added to WinFrog from the INS device category. Adding the MD900-T creates an Attitude data item, which contains device pitch, roll and temperature data. As seen below, the pitch and roll values are depicted both numerically and graphically in the I/O Devices window.



I/O Devices Window - MD 900T (Optional visual indicators enabled)

The MD-900T must be edited at the “generic” I/O Device level. In the I/O Device window, highlight the MD-900T device then right-click and select Config device. The MD900-T Clinometer Configuration dialog box appears as seen below.

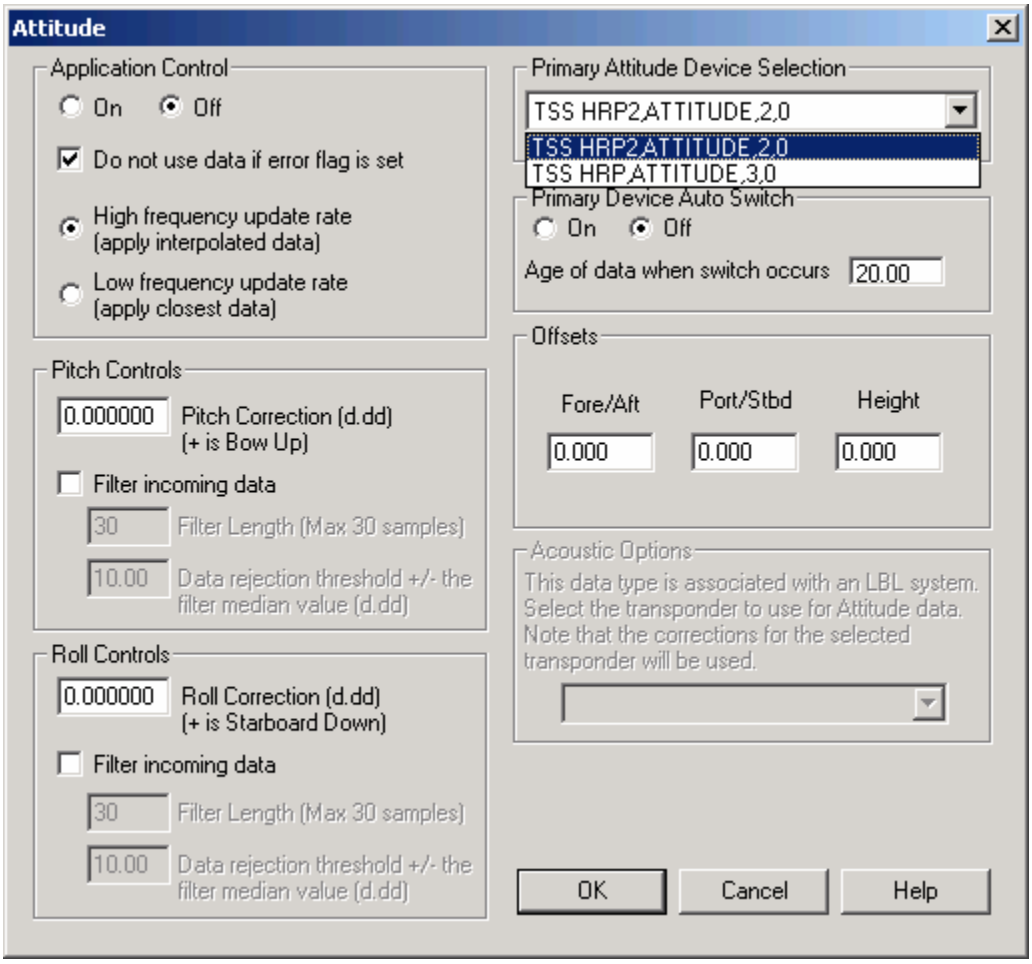


Update Rate
You can select the rate at which the MD-900T will output data to WinFrog. Select either the 1 per second or 4 per second update rate. Upon clicking OK to close this dialog box, WinFrog will send a configuration message to the MD900-T through the serial connection.

Visual Indicators
You can enable or disable the graphical pitch and roll indicators seen in the I/O Devices window. Select On or Off as desired.

WINFROG VEHICLE - DEVICES > EDIT OPTIONS:

When the MD 900T is added to a vehicle’s device list, it must be edited to suit the application. In the vehicle’s device list, highlight the device and click the Edit button. The Attitude dialog box appears as seen below.



Attitude

By default, the sensor mode is off, meaning that data from the attitude device will not be used in the vehicle's calculations. To turn the sensor on, and begin using the inclination corrections in the position output, click the 'On' radio button.

Error flag testing

The error flag check box is applicable to those devices that output a code indicating the data is either good or bad. If checked and the device supports such a code in its telegram, WinFrog will look at the code and if the data is indicated as bad, WinFrog will not use the data.

Sensor Update Frequency Rate

If the associated attitude sensor has a high frequency update rate (e.g. 10Hz and higher) it is appropriate to extract attitude data for application by either interpolating or extrapolating for a given epoch. In this case, the *High frequency update* option should be selected. Some attitude sensors have slow update rates, in particular those installed in acoustic transponders that require interrogation. For these sensors interpolation/extrapolation can produce a bad value as there is insufficient information to determine the correct shape of the curve (aliasing). Thus the most current attitude needs to be used. In this case, select the *Low Frequency update* option. This option applies to the use of the attitude data by the following data items:

- POSITION
- ELEVATION
- ALTITUDE
- XPONDER
- LBL TRANSCEIVER
- PROFILE

Pitch and Roll
There are two control groups, one for each of pitch and roll. Correction values can be added in this section of the window. The correction values (entered in units of degrees-decimal degrees) are added to the raw pitch and roll values received from the device before the data is applied to the vehicle's calculations. Ensure that entered values adhere to the sign convention used by WinFrog. You can verify that the corrections are entered properly by viewing the pitch and roll values in the I/O Device window and the Vehicle Text window.

Filtering
Additionally you may filter the incoming values to remove extraneous noise or spikes – check boxes are provided to switch this feature on or off. A filter length (up to 30 samples) and a threshold value (applied to the median of the samples in the filter to obtain lower and upper bounds) can be entered. Any pitch or roll values outside of the bounds are rejected and not used in the vehicle calculations, but will be recorded in the RAW files. If either one of pitch or roll is rejected, both values are ignored, although you may set up the filtering parameters for them separately. The status of the filters, including the current valid range for each of pitch and roll, and the percentage of values rejected, can be viewed in the calculations window, selecting the appropriate ATTITUDE data item.

> ***Important:***
> Do not enable filtering unless there is a high enough data rate (say 10hz) to correctly determine the shape of the curve. Essentially, if the low frequency update rate is selected above, do not enable filtering.

Primary Attitude Device Selection
If more than one attitude device is present, you may select one of them to be primary and the others to be secondary and allow WinFrog to automatically switch between them should the primary system stop sending data or has bad data. There must be at least two attitude data items added to the vehicle to use this feature. (Note: The attitude and offset data displayed in this dialog is for the attitude device corresponding to the data item that is being edited. Selecting a Primary Attitude Device from the drop down list does not affect these values for any attitude device in the list. Every attitude device needs to be set up for its own corrections and offsets.)

Primary Device Auto Switch
Select the On radio button to turn on this feature. Then enter the time out time in the edit box. If WinFrog does not receive data from the primary attitude device, or if it

receives bad data for this length of time, it will switch to the next secondary that is enabled and has good data.

Auto Switch Feature Usage
To use this feature first turn the sensor on as described in the Attitude section above. Next, select the attitude device that you wish to be primary from the drop down list box. Then turn the primary device auto switch on and enter the time out time. Then edit all the other attitude data items and enable them in the Attitude group box. Note that the same selected primary will be displayed for all attitude data items; similarly, the automatic feature will be turned on and the time out time will be the same. However, you must individually enable each attitude device in the Attitude group box.

Offsets
These offsets are used to calculate remote heave (leaver arm). It is expected that these values are the offset from the center of gravity of the sensor. Then using the observed pitch, roll, and heave, the heave at the center of gravity will be calculated and assigned to the vehicle, which may then be output using the INSIX output device. However, it is recommended that the sensor be placed at the center of gravity. If this is not possible, it is better to enter the lever arm offsets into the sensor and have the sensor make the correction, then have the sensor output the corrected values with respect to the center of gravity. The INSIX output device expects that the heave assigned to the vehicle is with respect to the center of gravity.

WinFrog records the attitude data to a type 413 raw data record. This record contains observed Heave, Pitch, Roll, status, accuracy, and a time stamp to indicate precisely when the data was observed. See Appendix B: WinFrog File Formats in the WinFrog User's Guide for details on the Type 413 raw data record.

Acoustic Options
This applies to long base line acoustic transponders that have inclinometers. See chapter 17 for more information.

CONFIGURATION DETAILS:

The MD-900T interfaces to the WinFrog PC using standard RS-232 protocol through a "DB" type 9 pin connector.

Output String:

The MD900-T outputs the NMEA "XDR" string ($YXXDR) which includes the North/South (Y) and East/West (X) tilt angle in degrees and the internal temperature in ^{o}C. An example of the string is shown below:

$YXXDR,A,000.034,D,N,A,-00.625,D,E,C,021.651,C,T-N0000*47
N/S angle E/W angle Temp. ^{o}C

ZAGI version 2.0 Software:

Applied Geomechanics provides its proprietary ZAGI software with all MD900-T purchases. The software will allow the user to set up the communication parameters using either **Windows 3.1 or 95** operating systems. The data output rate can be set via the software, however it will also be set in Winfrog. The ZAGI software will also allow graphing and plotting of real-time output of Pitch, Roll and Temperature data.