Product Manual

"IRIS" MODEL MD900-T

DIGITAL/ANALOG CLINOMETER

Serial Number:_____

☐ MD900-TH High-Gain Version

☐ MD900-TS Standard Version

☐ MD900-TW Wide-Angle Version

850 Perimeter Road
Manchester, NH 03103
Phone: 603–669-6400
Fax: 603–669-5962
www.jewellinstruments.com
sales@jewellinstruments.com

REVISION HISTORY

Revision	Date	Change Description
L	03/06/18	Added information for models using RS-422.
M	03/06/18	Red & Red/White “Auxiliary Power” output was “Auxiliary Analog”.
N	08/15/18	Updated format, NMEA and Jewell contact info.

TABLE OF CONTENTS

TABLE OF FIGURES

MANUAL ACRONYMS & NOTATIONS

ASH	Ashtech (acquired by Trimble)
BAE	BAE Systems
GPS	Global Positioning System
NEMA	National Electrical Manufacturers Association
NMEA	National Marine Electronics Association
TCM	Terrain Compensation Module
XDR	NMEA 0183 Protocol Cross Track Error – Dead Reckoning

1 OVERVIEW

The biaxial model MD900-T “IRIS” is an economical digital clinometer with powerful firmware features, designed for a variety of industrial and scientific applications, such as industrial pitch and roll measurement, marine piling, dredging and construction systems, platform leveling, geotechnical monitoring and more.

User programmable settings include AUTO-zero (tare), baud and output rate, sample averaging, and more. Available serial interfaces are RS-232 or RS-422 (RS-485 full duplex). The MD900-T easily integrates with a variety of GPS receivers, and supports Trimble TCM, NMEA XDR, BAE, and Ashtech output protocols. Factory calibration values are stored in non-volatile memory.

A liquid-filled electrolytic transducer comprises the sensing element and is excited and read by stable, low-noise electronics. The clinometer is housed in an easily mountable enclosure and provides an RS-232 or RS-422 serial interface via a 6-pin NEMA 4X connector (Figure 1). Units ship standard with a 6-ft. hook-up cable and 100-240VAC power transformer.

Figure 1: Example MD900

2 TECHNICAL DATA

Refer to the Model MD 900-T Digital and Analog Clinometer datasheet at http://www.jewellinstruments.com specifications and the latest data sheet.

3 INSTALLATION

Your clinometer includes the following accessories: P/N 84033 (or P/N 84080-01) Cable Assembly, P/N 00254-02 Transformer (100-240 VAC to 12 VDC), and four 8-32 machine screws. You will use these accessories during the installation and operation steps described below.

For best results, the MD900-T should be fastened to a rigid metal or concrete base using four machine screws (no. 8 or M4 size). To access the four mounting holes, first remove the lid of the clinometer (Figure 3). Mounting hole locations and dimensions are shown in Figure 4. The base to which you will attach the clinometer should be drilled in advance with four threaded or through holes. Use a bolt anchoring system if the base is concrete. The hole pattern must match the 107 x 67 mm hole mounting hole pattern of the clinometer. For stable readings, the mounting screws should hold the clinometer tightly against the base so that it cannot shift or wobble. Replace the lid when installation is complete.

Figure 5 illustrates the directions and polarities of the two orthogonal tilt directions. The N(orth) and Y directions are the same and parallel the long dimension of the box. Downward rotation of the N or Y arrowhead is positive (+) tilt. The E(ast) and X directions are the same and parallel the short dimension of the box. Downward rotation of the E or X arrowhead is positive (+) tilt.

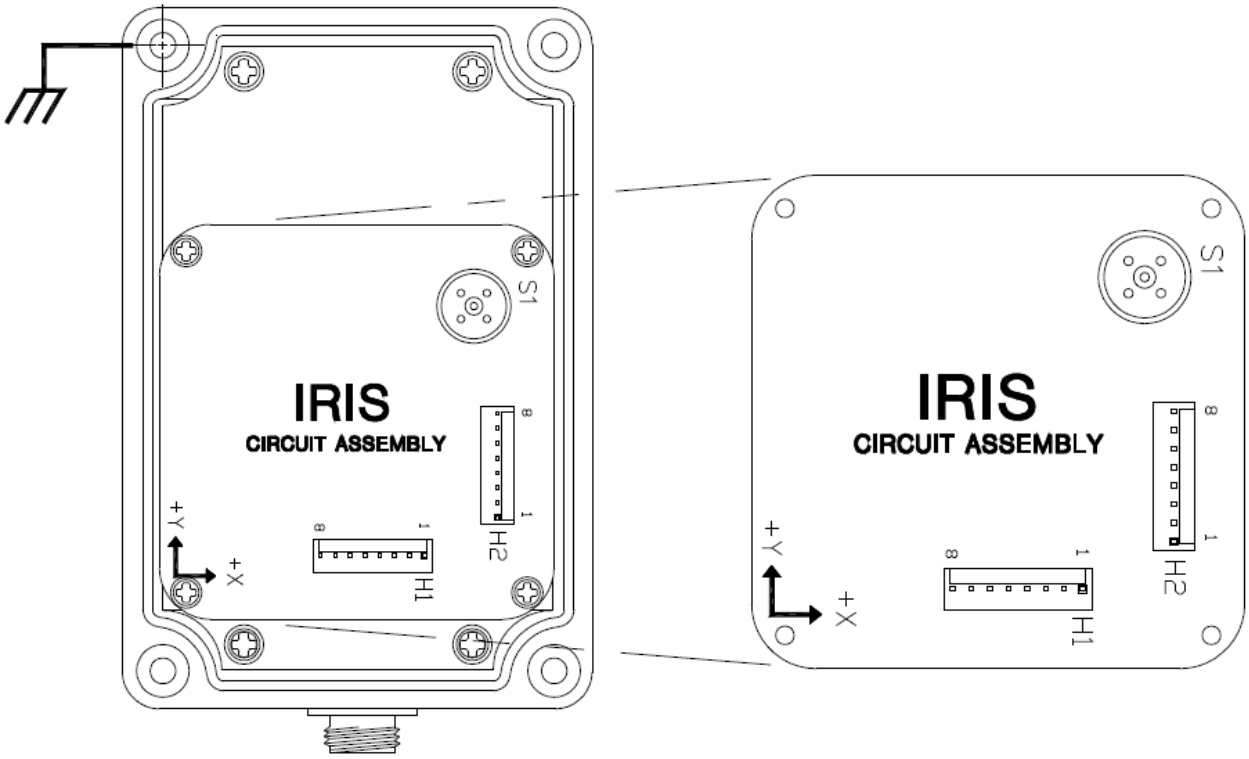
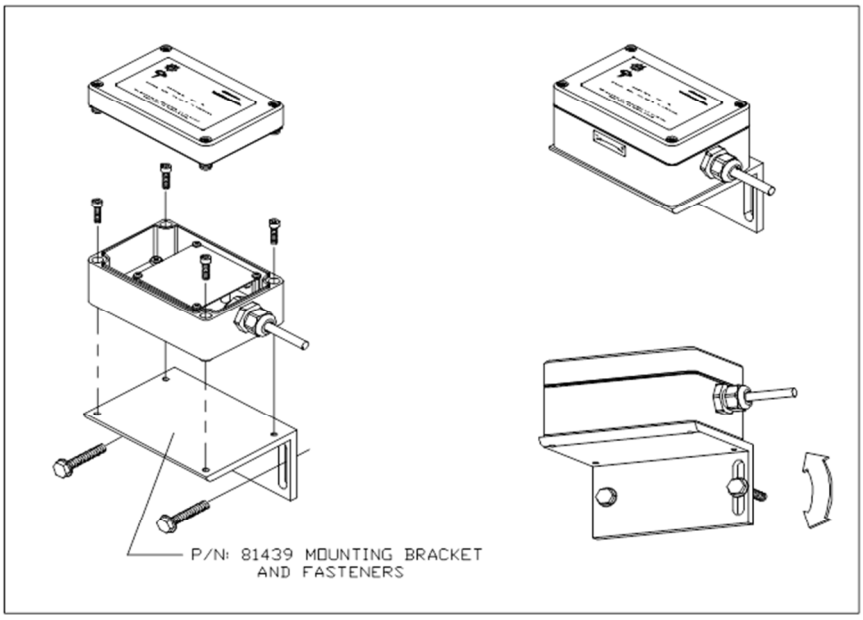
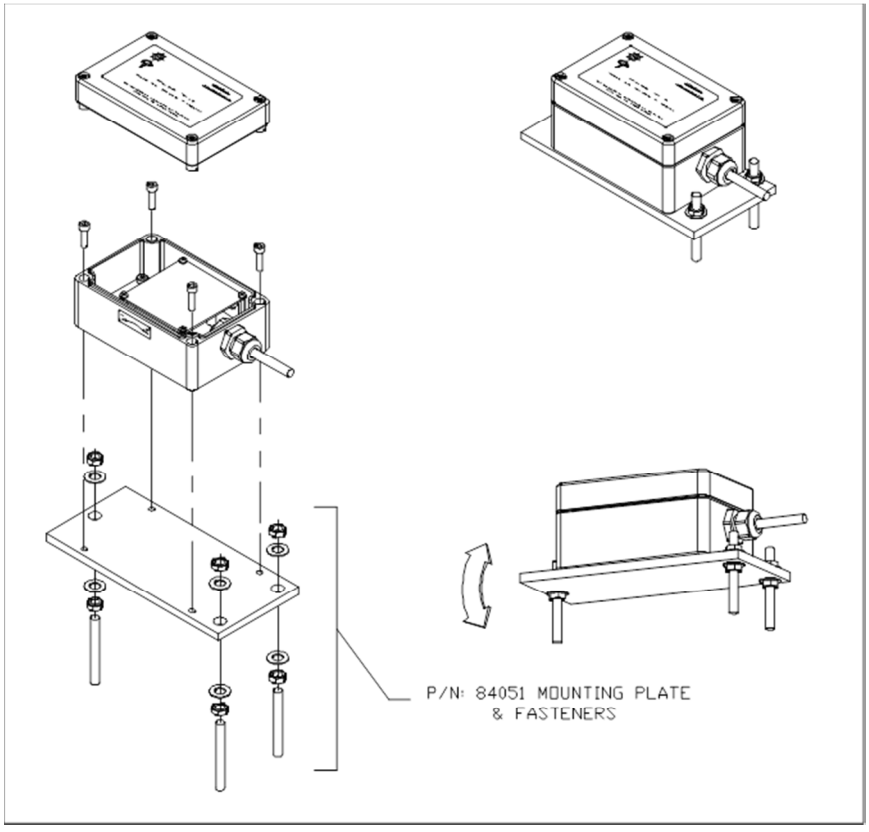


Figure 2: Model MD900-T Digital Clinometer Layout (Exploded View)



Installing Models 801, 904-T and MD900-T on Vertical Surfaces



Installing Models 801, 904-T and MD900-T on Horizontal Surfaces

Note: The tiltmeter enclosure may also be screwed directly to the mounting surface without use of the P/N 84051 Mounting Plate

Figure 3: Installation Diagrams

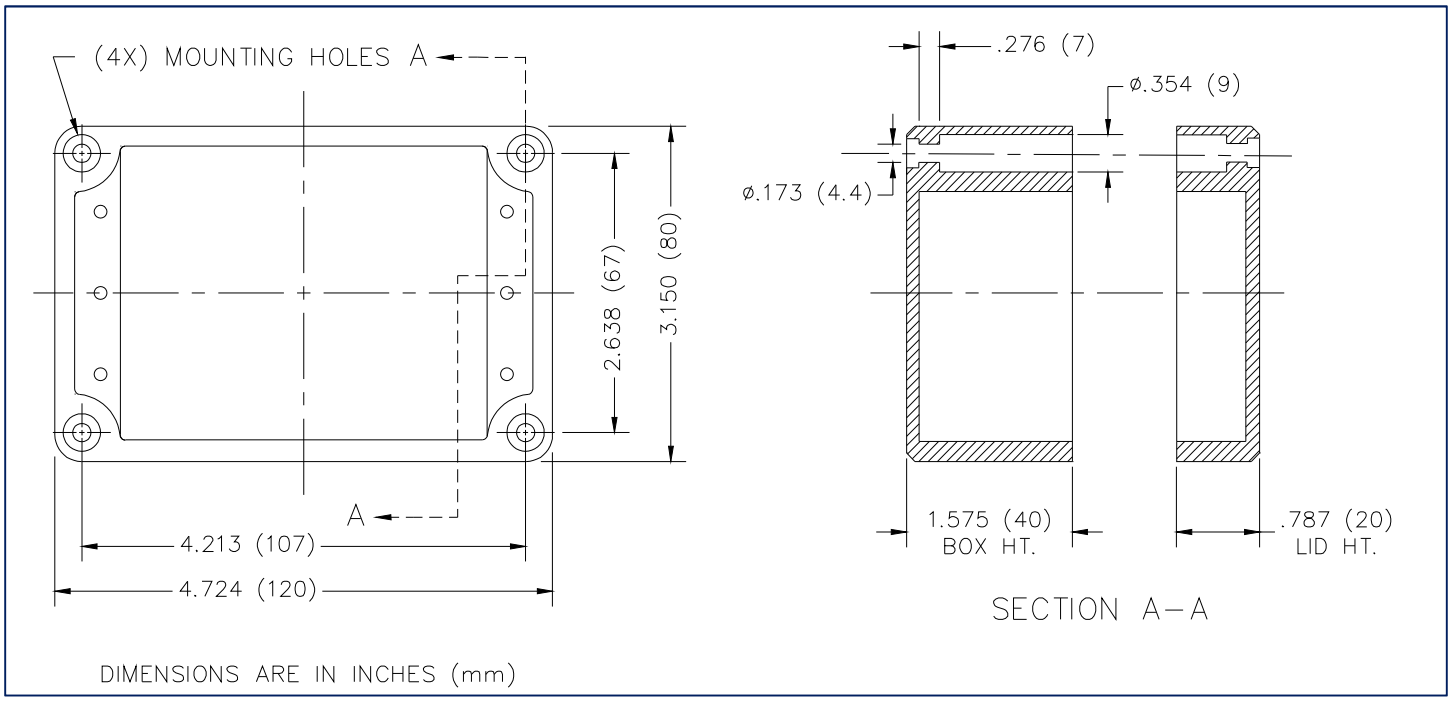


Figure 4: Model MD900-T Digital Clinometer Mounting Detail

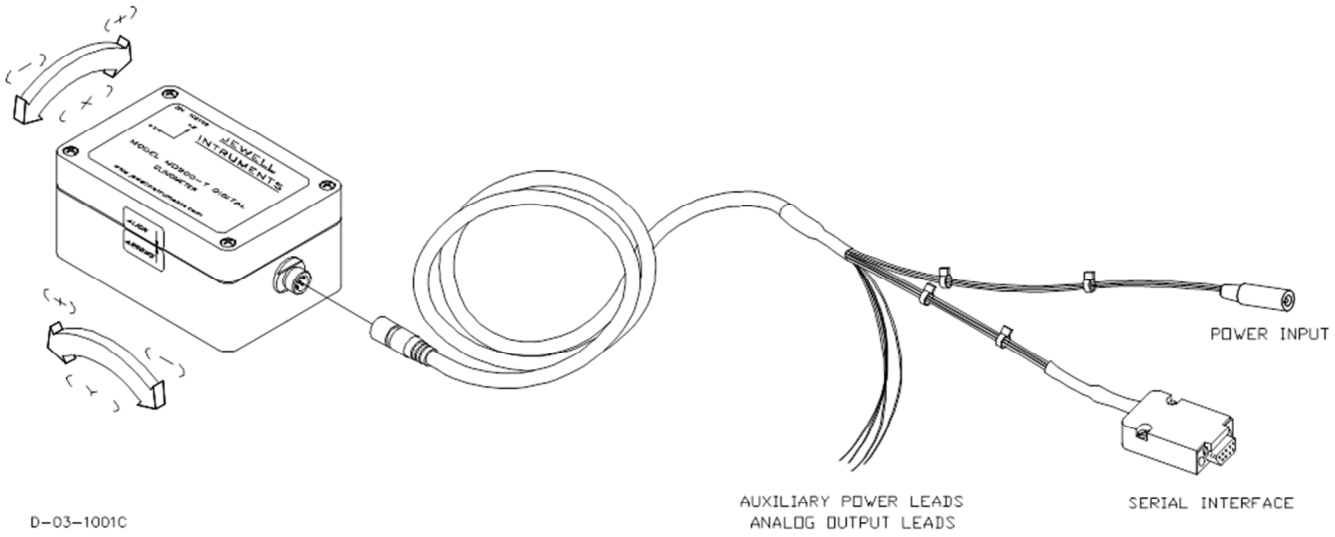


Figure 5: Model MD900-T Digital Clinometer with P/N 84033 Cable Assembly

4 PHYSICAL CONNECTIONS

All connections to the MD900-T are made using the 6-pin connector on the exterior of the unit. Pin assignments are shown in Figure 7 and Figure 8.

To operate your clinometer, connect the cable assembly as shown in Figure 5. Provide power by connecting the transformer to the power input connector, or use the auxiliary power leads and a separate power supply. Connect the DB9 serial interface connector (Figure 5, Figure 7, or Figure 8) to a PC or terminal and then follow the instructions in Section 5.

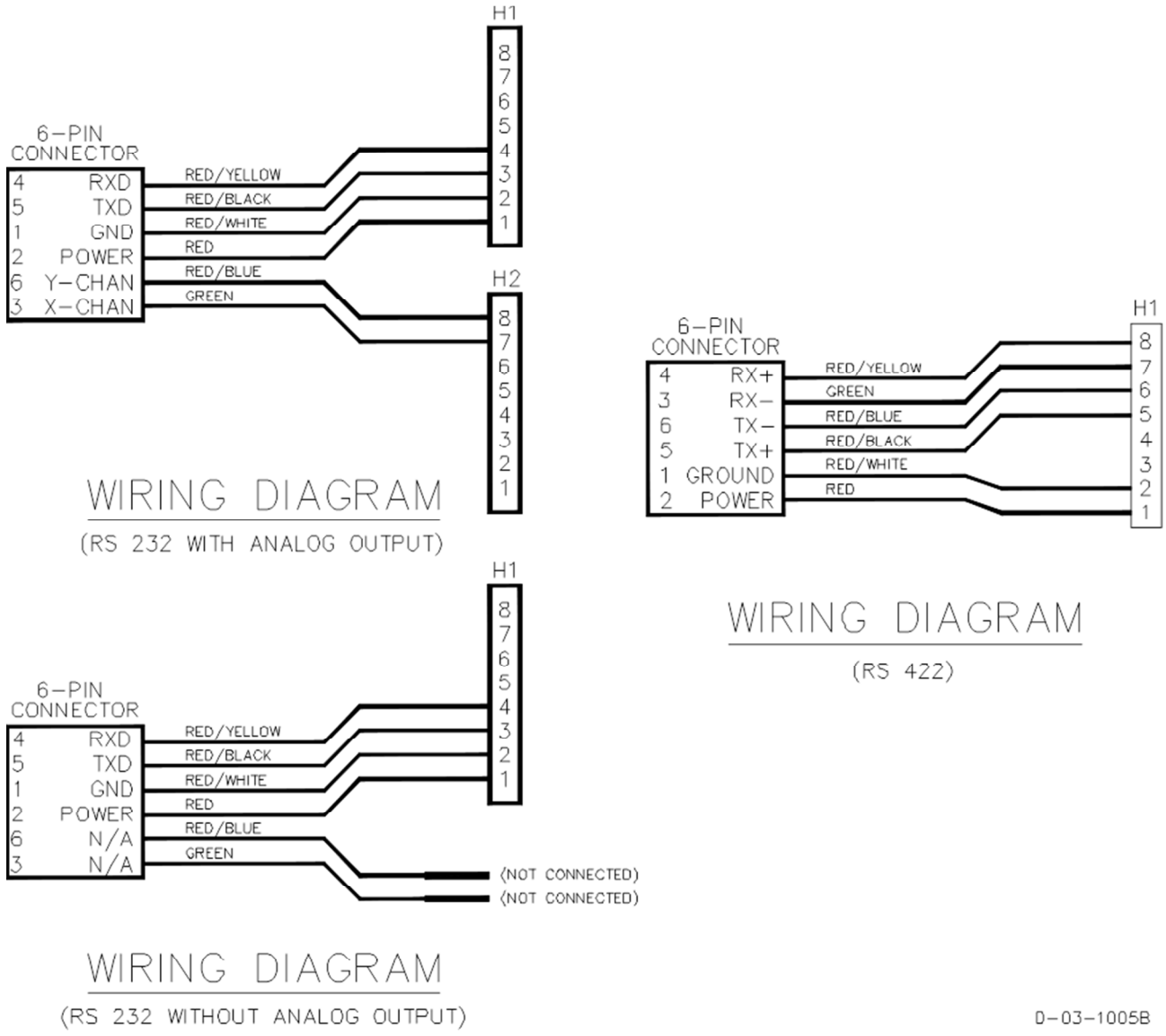
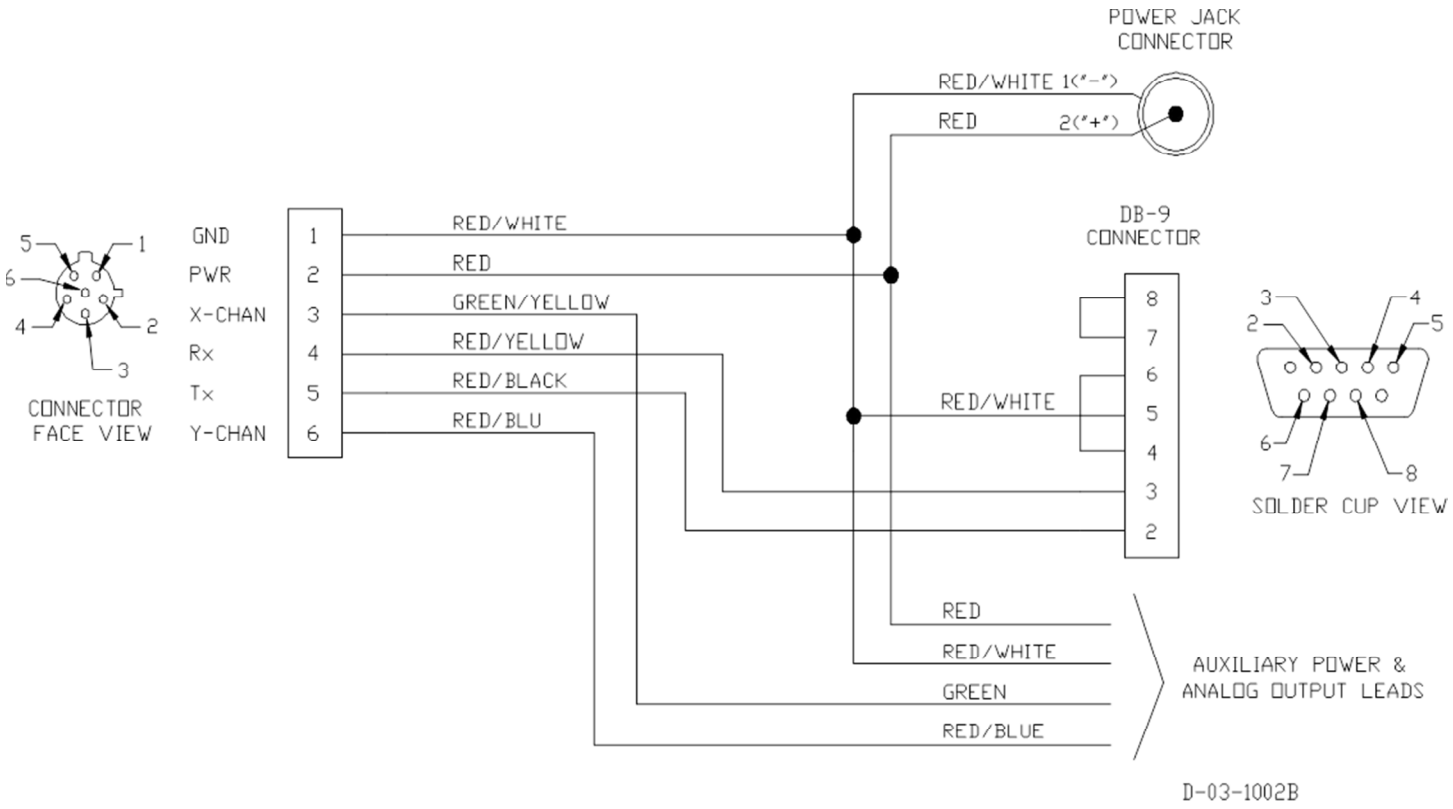
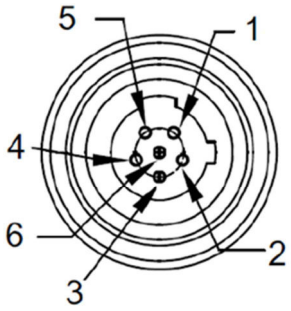


Figure 6: Model MD900-T Internal Wiring Diagrams



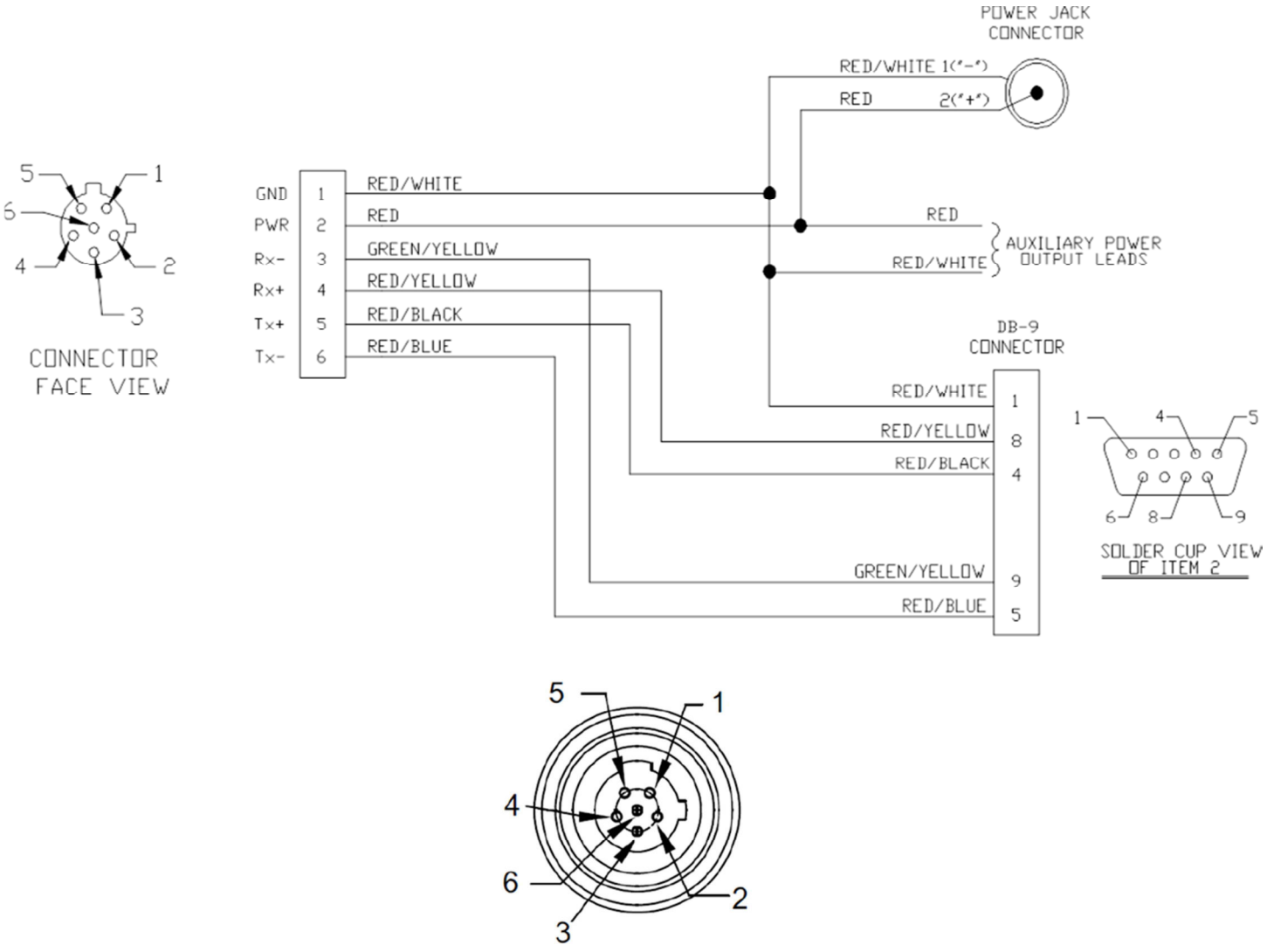


6-Socket Female Connector Face View

RS232 Wiring

6-socket female	Wire Color	Function	DB9 Pin-out
1	Red-White	GND	5
2	Red	V+ (Power)	--
3	Green-Yellow	Analog X Out	--
4	Red-Yellow	RxD (RS232)	3
5	Red-Black	TxD (RS232)	2
6	Red-Blue	Analog Y Out	--

Figure 7: P/N 84033 Cable and Connector Wiring (RS-232)



6-Socket Female Connector Face View

RS422 Wiring

6-socket female	Wire Color	Function	DB9 Pin-out
1	Red-White	GND	1
2	Red	V+ (Power)	--
3	Green-Yellow	Rx-(RS422)	9
4	Red-Yellow	Rx+ (RS422)	8
5	Red-Black	Tx+ (RS422)	4
6	Red-Blue	Tx- (RS422)	5

Figure 8: P/N 84080 Cable and Connector Wiring (RS-422)

5 COMMUNICATION

Basic Requirements and Settings

You may communicate with the Model MD900-T tiltmeter using:

1. A terminal emulator program (e.g. RealTerm, HyperTerminal, Tera Term, etc.).
2. A GPS receiver that is capable of sending and receiving terminal commands.

All communication to the tiltmeter is performed through the send (transmit) and receive wires of the serial port. The default parameters for the serial port are set to no parity, 8 bits and 1 stop bit (8N1) with no hardware or software flow control. The baud rate is the only parameter that is user-selectable. The default baud rate is 9600. Baud rates up to 230400 are supported.

Firmware Command Format

The format of commands issued by the host is: *9900<command><CR><LF>

Valid commands are listed in Appendix A.

The input/output processing on the serial port of the MD900-T is as follows:

1. Input is read until a <CR> or <LF> (carriage return or line feed) is received. (On a PC, this usually means pressing the 'Enter' or 'Return' key.)
2. When a line is received, it is parsed to see if it is a command of the device. If it is not, then it is echoed back out, terminated with a <CR> <LF> and we go back to step (1). All strings that are not commands for the unit are echoed. If the command is for the device, we then go to step (3).
3. The command is processed and we return to step (1). All incoming characters are buffered (up to 1000) while the command is being processed. If the command is for ID 99 and echoing of 99 commands is enabled, the command is echoed after the command result is transmitted.

Default output of the MD900-T running firmware version 5 is a simple ("SIM") comma-delimited string consisting of X tilt in degrees, Y tilt in degrees, temperature in °C, and the serial number of the device.

Optional outputs consist of a Trimble Navigation proprietary ASCII string with X (Roll) and Y (Pitch) tilts in degrees, and two output formats that follow NMEA Standard 0183, version 2.1, October 15, 1995. This standard may be obtained from:

National Marine Electronics Association (NMEA)
692 Ritchie Highway, Suite 104
Severna Park, MD 21146 USA
www.nmea.org
info@nmea.org
Tel: 410-975-9425
Fax: 410-975-9450

Firmware Command Summary

The list below summarizes the most important user-accessible firmware commands. **Precede these commands with the string *9900.** See Appendix A for additional details.

XY	Outputs a single tilt and temperature measurement. The format of the output depends on the setting of the SO command.
SO-xxx	Selects the output format for the XY command. "xxx" selects format as follows: ASH: Ashtech compatible NMEA format SIM: Simple x,y,t,sn output string (default) XDR: NMEA XDR format TCM: Trimble Navigation proprietary pitch (Y) and roll (X) string BAE: BAE Systems encoded 11-byte string containing a sync packet, x, y, t, SN, and checksum information. Advanced users only—typically for embedded system integration.
XY-MEMS	Stores tiltmeter readings at selected output rate in nonvolatile memory. (Versions 5.1 and higher)
XY-MEMD	Downloads data from nonvolatile memory. (Versions 5.1 and higher)
XY-M1	Sets the tiltmeter to Mode-1 operation.
XYVR	Displays the sign-on string.
ID	Sets the ID of units in the daisy chain (not currently implemented).
XY-TR-PASH-ON	Translates the Paros provided $PASHS,XDR,P sentences to standard NMEA XDR format.
XY-TR-PASH-OFF	Turns off translation of $PASHS,XDR,P sentences.
XY-EP	Enables power on message.
XY-SP	Disables power on message.
XY-EE	Enables echoing of global 99 commands.
XY-SE	Disables echoing of global 99 commands.
XY-SET-BAUDRATE,x	Sets baud rate to value of x in bits per second. Selectable values include: 9600, 19200, 28800, 57600, 115200 and 230400 baud.
XY-SET-N-SAMP,x	Sets number of samples that are averaged before a reading is transmitted; x may have any value from 1 to 1000. Changing this value may also change the output rate.
XY-SET-RSMODE,x	Selects serial output mode: x = 0 RS232 x = 1 RS485 (RS422)
XY-AUTOZ	Turns on auto zero function.
XY-AUTOZOFF	Turns off auto zero function.
XYCx	Continuously sends XY data where x determines output rate as follows: x = 0: 8-10 outputs per second x = 1: 4 outputs per second x = 2: 1 output per second (default) x = 3: 1 output every 10 seconds x = 4: 1 output every 60 seconds

	x = 5: 1 output every hour x = 6: 1 output every 12 hours x = 7: 1 output every 24 hours x = 0A: Averaging of the 8-10 outputs per second data x = 1A: Averaging of the 4 outputs per second data x = 2A or x = A: Averaging of the 1 output per second data Once initiated, continuous output remains in effect until turned off with the XYC-OFF command (see below).
XYC-OFF	Turns off XYC mode.
XY-SET-CTRL-ON	Enables control feature.
XY-SET-CTRL-OFF	Disables control feature.
XY-SET-CTRLTEST-ON	Sets the control pin high (+5 VDC).
XY-SET-CTRLTEST-OFF	Sets the control pin low (0 VDC).
XY-SET-THRESHOLD,x+,x-,y+,y-	Sets the control thresholds.
XY-SET-HYST,k	Sets the control hysteresis.
XY-DUMP-SETTINGS	Dumps settings of device.
XY-DUMP2	Dumps extended settings of device.

Sample Data Using the XY Command

The most commonly used command is the XY command, which returns the X and Y tilt angles in degrees and the internal temperature of the MD900-T in °C. The format of the returned data depends on the setting of the SO command. The returned data are averages of a series of readings. The number of samples used in the average is set by the XY-SET-N-SAMP command. The following lines illustrate the format of the data returned by the XY command for the range of possible SO settings:

SO = "ASH." Ashtech compatible NMEA output string which returns the North-South (Y) and East-West (X) tilt angle in degrees and the internal temperature of the MD-900-T in °C:

```
$PASHS,XDR,A,004.261,D,N,A,004.280,D,E,C,021.288,C,T-N1346
$PASHS,XDR,A,004.261,D,N,A,004.280,D,E,C,021.306,C,T-N1346
$PASHS,XDR,A,004.261,D,N,A,004.280,D,E,C,021.298,C,T-N1346
$PASHS,XDR,A,004.261,D,N,A,004.280,D,E,C,021.332,C,T-N1346
```

SO = "SIM" (default). Simple X,Y,T,SN output which returns the X and Y tilt angle in degrees and the internal temperature of the MD-900-T in °C:

```
$-00.619,000.023,018.910,N0000
$-00.619,000.023,018.923,N0000
$-00.620,000.024,018.932,N0000
$-00.620,000.023,018.951,N0000
```

SO = "XDR." Standard NMEA XDR output string which returns the North-South (Y) and East-West (X) tilt angle in degrees and the internal temperature of the MD-900-T in °C:

```
$YXXDR,A,000.034,D,N,A,-00.625,D,E,C,021.651,C,T-N0000*47
$YXXDR,A,000.034,D,N,A,-00.624,D,E,C,021.675,C,T-N0000*40
$YXXDR,A,000.034,D,N,A,-00.624,D,E,C,021.686,C,T-N0000*4C
$YXXDR,A,000.034,D,N,A,-00.625,D,E,C,021.707,C,T-N0000*45
```

SO = "TCM." Proprietary Trimble Navigation pitch (Y-tilt) and roll (X-tilt) output string which returns the tilt angle in degrees and a checksum:

```
$P-00.907R002.186*1C
$P-00.906R002.183*18
$P-00.908R002.191*15
$P-00.908R002.191*15
$P-00.905R002.190*19
```

SO = "BAE." Advanced users only, using the D711-2A(4X). BAE Systems encoded 11-byte output which returns two synchronization bytes, the X (2 bytes) and Y (2 bytes) tilt angle, the internal temperature of the tiltmeter (2 bytes), the serial number (2 bytes), and a checksum byte:

```
Uª Ä$é TæUª Ä$ä TáUª Ä$ß TÜUª Ä$é Tæ
```

The BAE output string is not clearly decipherable by HyperTerminal which sometimes hides characters that it has received and cannot understand. Because of this, it is difficult, if not impossible, to interpret data in this format. The above output string shows four outputs taken from HyperTerminal.

This encoded output command is typically used to communicate with embedded systems, as they can view raw data and perform fast translations.

The first synchronization byte is 0x55, the second is 0xAA. The X and Y bytes use 0.0000277 angular degrees per LSB, hence the total output range of this output mode is limited to the model D711-2A(4X). The temperature uses 0.004 degrees Celsius per LSB. The serial number is a two byte integer. The checksum byte is the result of ANDing bytes 2-7 with 255 (0xFF).

BAE output mode reduces the total number of characters per output to 11 bytes, while transferring the same data as the SIM output mode, which requires 33 bytes. BAE mode also includes checksum and frame synchronization bytes. Refer to Appendix A, Firmware Commands, to decode the output.

6 MAINTENANCE & TROUBLESHOOTING

The Model MD900-T is packaged in a rugged aluminum box and should provide many years of trouble-free operation. Best results are achieved by keeping the unit clean, dry and within the stated operating and storage temperature ranges.

Problems most commonly result from lack of power, or a broken wire or connection. If the unit does not respond when queried by the host, first verify that it is receiving power. If it still does not respond, remove the lid and check for loose broken wires or a loose or detached internal connector. If these checks still do not reveal the problem, contact Jewell Instruments LLC in New Hampshire for assistance at:

Telephone: 603-669-6400 or 800-227-5955

Fax: 603-669-5962

E-mail: sales@jewellinstruments.com

APPENDIX A: FIRMWARE COMMANDS

Valid commands are listed below. Some commands have more than one string to trigger the command. “tt” stands for the target ID (99) and “ss” stands for the source ID (00). Settings stored in nonvolatile memory remain in effect until disabled, even after a power cycle.

XY	Outputs a single tilt measurement. The format of the output depends on the setting of the SO command. Syntax: *ttssXY<CR><LF> Error Strings: None. Default: N/A Persistence: N/A Example: command: *9900XY<CR><LF> response: $YXXDR,A,-00.920,D,N,A,-00.210,D,E,C,030.045,C,T-N1212*57
XY-MEMS	Stores the tiltmeter readings in simple format (SO-SIM) at selected output rate in nonvolatile memory. Syntax: *ttssXY-MEMS<CR><LF> Error Strings: None. Default: N/A Persistence: Subsequent tiltmeter readings stored in nonvolatile memory until memory is full. Maximum of approximately 150 lines of data. Example: command: *9900XY-MEMS<CR><LF> response: <none>
XY-MEMD	Downloads the tiltmeter readings in nonvolatile memory to PC. Syntax: *ttssXY-MEMD<CR><LF> Error Strings: None. Default: N/A Persistence: Stored tiltmeter readings downloaded at rate of 1 per second to PC in ASCII comma-delimited string. Example: command: *9900XY-MEMD<CR><LF> response: $start:11-11-1997 18:43:09 4/sec $000.699,-01.022,025.116,N1028 $000.699,-01.022,025.116,N1028 $000.698,-01.021,025.110,N1028 $000.698,-01.022,025.122,N1028

XY-M1	Sets the operation to Mode 1. This command groups several other commands together for convenience. The commands that are issued are: XY-TR-PASH-ON XY-SO-XDR XY-SE XY-SP Syntax: *ttssXY-M1<CR><LF> Error Strings: None. Default: N/A Persistence: Setting is stored in nonvolatile memory. Example: command: *9900XY-M1<CR><LF> response: AGI Model D711-2A(4X) Firmware V2.2 SN-N1212 ID01
XYVR	Displays the sign-on string. Syntax: *ttssXYVR<CR><LF> Error Strings: None. Default: N/A Persistence: N/A Example: command: *9900XYVR<CR><LF> response: AGI Model D711-2A(4X) Firmware V5.2 SN-N1212 ID01
XY-TR-PASH-ON	Translates the Paros provided $PASHS,XDR,P sentences to standard NMEA XDR format. An example input PASH string would be: $PASHS,XDR,P,1.000123,B,SN123,C,22.12,C,SN123,H,32.11,P,SN123<CR><LF> The translated string would then be: $WIXDR,P,1.000123,B,SN123,C,22.12,C,SN123,H,32.11,P,SN123*hh<CR><LF> Syntax: *ttssXY-TR-PASH-ON<CR><LF> Error Strings: None. Default: Off. Persistence: Setting is stored in nonvolatile memory. Example: command: *9900XY-TR-PASH-ON<CR><LF> response: <none>

XY-TR-PASH-OFF	Turns off translation of $PASHS,XDR,P sentences. Syntax: *ttssXY-TR-PASH-OFF<CR><LF> Error Strings: None. Default: N/A Persistence: Setting is stored in nonvolatile memory. Example: command: *9900XY-TR-PASH-OFF<CR><LF> response: <none>
XY-EP	Enables power on message. Power on message is: AGI Tiltmeter Firmware V5.2 SN-N1212 ID01 Where: V5.2 is the firmware version SN-N1212 is the serial number of the device ID01 is the target's ID Syntax: *ttssXY-EP<CR><LF> Error Strings: None. Default: On. Persistence: Setting is stored in nonvolatile memory. Example: command: *0100XY-EP<CR><LF> response: <none>
XY-SP	Disables power on message. Syntax: *ttssXY-SP<CR><LF> Error Strings: None. Default: N/A Persistence: Setting is stored in nonvolatile memory. Example: command: *9900TR-SP<CR><LF> response: <none>
XY-EE	Enables echoing of global 99 commands. If the unit receives a command for ID 99, then the unit will respond to the command and echo the command when it is done. Syntax: *ttssXY-EE<CR><LF> Error Strings: None. Default: On. Persistence: Setting is stored in nonvolatile memory. Example: command: *0100XY-EE<CR><LF> response: <none>

XY-SE	Disables echoing of global 99 commands. If the unit receives a command for ID 99, then the unit will respond, but the unit will NOT echo the command when it is done. Syntax: *ttssXY-SE<CR><LF> Error Strings: None. Default: N/A Persistence: Setting is stored in nonvolatile memory. Example: command: *0100XY-SE<CR><LF> response: <none>
XY-SET-BAUDRATE,x	Changes communications baud rate. Valid baud rates (x) are (only): 9600, 19200, 28800, 57600, 115200, and 230400. Syntax: *ttssXY-SET-BAUDRATE,x<CR><LF> Error Strings: ERR XY-SET-BAUDRATE,x PARSE ERROR. Default: 9600 Persistence: Setting is stored in nonvolatile memory. Example: command: *9900XY-SET-BAUDRATE,57600<CR><LF> response: <none>

XY-SET-N-SAMP,x	Sets the number of samples that are averaged before a reading is transmitted. The parameter x is an integer between 1 and 1000 equal to the number of samples that are averaged. Syntax: *ttssXY-SET-N-SAMP,x<CR><LF> Error Strings: None. Default: Depends on data output rate, as specified by the XYCx command. The default numbers of samples averaged for each data rate are: XYC0: 28 XYC1: 100 XYC2: 460 XYC3: 500 XYC4: 500 XYC5: 500 XYC6: 500 XYC7: 500 If the number of samples specified exceeds the number listed above for XYC0, XYC1 or XYC2, the microprocessor reduces the data output rate until it has enough time to collect and average all of the samples. Persistence: Once initiated, the same averaging remains in effect even with power cycle. (Setting is stored in nonvolatile memory). Can be changed by reissuing the command with a different value for x, or by changing the output rate with the XYCx command. Example: command: *9900XY-SET-N-SAMP,250<CR><LF> response: <none>
XY-SET-RSMODE,x	Sets output protocol to RS232 or RS485(RS422), as follows: x = 0: RS232 x = 1: RS485(RS422) Syntax: *ttss XY-SET-RSMODE,x<CR><LF> Error Strings: None. Default: Set in factory to customer specification. Persistence: Once initiated, remains in effect even with power cycle. (Setting is stored in nonvolatile memory.) Example: command: *9900XY-SET-RSMODE,0<CR><LF> response: <none> CAUTION: If you change the output protocol, you will no longer be able to communicate with the tiltmeter unless you have the correct interconnect cable.

XY-AUTOZ	Turns autozero function on, causing tiltmeter to subtract current X and Y readings from all subsequent X and Y readings. Syntax: *ttssXY-AUTOZ <CR><LF> Error Strings: None. Default: Off. Persistence: Setting is stored in nonvolatile memory. Example: command: *9900XY-AUTOZ<CR><LF> response: <none>
XY-AUTOZOFF	Turns autozero function off, causing tiltmeter to display non-biased (unshifted) position readings. Syntax: *ttssXY-AUTOZOFF<CR><LF> Error Strings: None. Default: Off. Persistence: Setting is stored in nonvolatile memory. Example: command: *9900XY-AUTOZOFF<CR><LF> response: <none>

XYCx

Continuously sends XY data - even after power has been turned off and then on again. Timing is determined by the microprocessor's crystal and is approximate. The parameter x is an integer between 1 and 7, the letter A, or 0A, 1A, or 2A.
An A indicates the use of the moving average function, in which the moving average of the data is output. When the moving average function is used, the first output is delayed until the first n readings have been taken, where n is the number of readings to be averaged. After that, the outputs occur at the same rate as the readings. For example, the command XYC2A outputs the moving average of the same data that would be output if the user issued the command XYC2. Since XYC2 outputs data once per second, XYC2A also outputs once per second. However, the first output occurs after a four-second delay, in which the first four readings (at a rate of 1 per second) are averaged. The second output is the average of readings 2-5, the third output is the average of readings 3-6, and so on, creating an output rate equal to that of XYC2.
The parameter x determines rate of continuous output as follows:

x = 0: 8-10 per second
1: 4 per second
2: 1 per second
3: 1 every 10 seconds
4: 1 every 60 seconds
5: 1 every 60 minutes
6: 1 every 12 hours
7: 1 every 24 hours
0A: Average of 8-10 outputs/sec data. 10 readings are averaged.
1A: Average of 4 outputs/second data. 4 readings are averaged.
2A or A: Average of 1 output/second data. 4 readings are averaged.

Syntax: *ttssXYCx<CR><LF>
Error Strings: None.
Default: Off.
Persistence: Once initiated, continuous output remains in effect even with power cycle. (Setting is stored in nonvolatile memory.) Must be turned off using the XYC-OFF command (see below).
Example (with SO="SIM"):
command: *9900XYC1<CR><LF>
response: $-00.699,000.070,020.290,N0000
$-00.699,000.071,020.309,N0000
$-00.699,000.071,020.313,N0000
$-00.699,000.071,020.330,N0000
$-00.699,000.071,020.348,N0000
$-00.700,000.070,020.360,N0000

XYC-OFF	Turns off XYC mode. Syntax: *ttssXYC-OFF<CR><LF> Error Strings: None. Default: N/A. Persistence: Setting is stored in nonvolatile memory. Example: command: *0100XYC-OFF<CR><LF> response: *0100XYC-OFF<CR><LF>
XY-SET-CTRL-ON	Enables control feature. If the tilt exceeds either threshold in any direction, the control pin will go high (+5 VDC) until the tilt falls below the positive threshold value minus the hysteresis value, or falls above the negative threshold value plus the hysteresis value. Syntax: *ttssXY-SET-CTRL-ON<CR><LF> Error Strings: None. Default: On. Persistence: Setting is stored in nonvolatile memory. Example: command: *9900XY-SET-CTRL-ON<CR><LF> response: <none>
XY-SET-CTRL-OFF	Disables control feature. The control pin will remain at ground potential (0 VDC) unless the user issues the command XY-SET-CTRLTEST-ON or turns the control feature on again by issuing the command XY-SET-CTRL-ON. Syntax: *ttssXY-SET-CTRL-OFF<CR><LF> Error Strings: None. Default: On. Persistence: Setting is stored in nonvolatile memory. Example: command: *9900XY-SET-CTRL-OFF<CR><LF> response: <none>
XY-SET-CTRLTEST-ON	Sets the control pin high (+5 VDC), regardless of whether control feature is on or off. Convenient for testing control functionality regardless of tilt. Syntax: *ttssXY-SET-CTRLTEST-ON<CR><LF> Error Strings: None. Default: Off. Persistence: Control pin stays high until the user issues the command XY-SET-CTRLTEST-OFF or disconnects power. Example: command: *9900XY-SET-CTRLTEST-ON<CR><LF> response: <none>

XY-SET-CTRLTEST-OFF	Sets the control pin low (0 VDC). If the control feature is on and the tilt falls above the positive threshold value minus the hysteresis value, or falls below the negative threshold value plus the hysteresis value, the control pin may go high again immediately. XY-SET-CTRL-OFF turns off the control feature altogether. Syntax: *ttssXY-SET-CTRLTEST-OFF<CR><LF> Error Strings: None. Default: Off. Persistence: None. If the control feature is on and the tilt exceeds the hysteresis value, the control pin may go high again immediately. Example: command: *9900XY-SET-CTRLTEST-OFF<CR><LF> response: <none>
XY-SET-THRESHOLD,x+,x-,y+,y-	Sets the control thresholds. The parameter x+ is the positive threshold for the x axis in the current output units (default is degrees), and so on for parameters x-, y+, and y-. If the tilt exceeds either threshold on either axis, and the control feature is on, the control pin goes high (+5 VDC) until the tilt falls below the positive threshold value minus the hysteresis value, or falls above the negative threshold value plus the hysteresis value. Syntax: *ttssXY-SET-THRESHOLD,x+,x-,y+,y-<CR><LF> Error Strings: ERR XY-SET-THRESHOLD PARSE ERROR. Default: x+ = 1 x- = -1 y+ = 1 y- = -1 Persistence: Setting is stored in nonvolatile memory. Example: command: *9900XY-SET-THRESHOLD,5,-3.244,4.0,0<CR><LF> response: <none>
XY-SET-HYST,x	Sets the control hysteresis, where the parameter x is the hysteresis value in the current output units (default is degrees). If the tilt exceeds either threshold on either axis, and the control feature is on, the control pin remains high (+5 VDC) until the tilt falls below the positive threshold value minus the hysteresis value, or falls above the negative threshold value plus the hysteresis value. Syntax: *ttssXY-SET-HYST,x<CR><LF> Error Strings: ERR XY-SET-HYST PARSE ERROR. Default: 0 Persistence: Setting is stored in nonvolatile memory. Example: command: *9900XY-SET-HYST,0.5<CR><LF> response: <none>

XY-DUMP-SETTINGS	Dumps settings of device. Syntax: *ttssXY-DUMP-SETTINGS<CR><LF> Error Strings: None. Default: N/A Persistence: N/A Example: command: *9900XY-DUMP-SETTINGS response: JEWELL INSTRUMENTS Tiltmeter Firmware V5.0 SN-N2144 ID01 01: Vbias= 2047.000000000 2047.000000000 NaN NaN 01: Vgain= 0.005000000 0.005000000 0.000610350 0.000610350 01: Vmin: -2.50 -2.50 2.50 2.50 01: Vmax: 2.50 2.50 2.50 2.50 01: a0= 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 01: a1= 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 01: a2= 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 01: a3= 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 01: Tcoef 0: Ks= 0.0003 Kz= 0 Tcal= 25 01: Tcoef 1: Ks= 0.0003 Kz= 0 Tcal= 25 01: N_SAMP=1000 Xzero= 0.00 Yzero= 0.00 01: TR-PASH-OFF E99-ON SO-NMEA-SIM XY-EP 9600 baud FV

XY-DUMP2	Dumps extended settings of device. Syntax: *ttssXY-DUMP2<CR><LF> Error Strings: None. Default: N/A Persistence: N/A Example: command: *9900XY-DUMP2 response: 01: TBias: 8.95 Above 0.00(KZMinTemp): kz[0]= 0, kz[1]= 0.0011 Below 0.00(KZMinTemp): kz[2]= 0, kz[3]= 0.0011 01: ADCDelay: 310 01: PCA Model: 84833-13 01: Firmware Version: 5.10 Rev D 01: X Ch Gain= 1.0000, Y Ch Gain= 1.0000, Temperature Gain= 1.0000 01: Output Mode: Degrees 01: Using RS232 01: Real Time Clock: Not Installed 01: External Flash Capacity: 0 Bytes(Not Installed) 01: Relay Thresholds: 01: Xpositive=1.0000 Xnegative=-1.0000 01: Ypositive=1.0000 Ynegative=-1.0000 01: Calibration method: Dynamic 01: Positive Limit=1.5000 Negative Limit=-1.5000 01: Calibration Points:041 X: Disabled Y: Enabled 01: Uniaxial (x2) Sensor Type (2) 01: ADC Channels: Two

SO-

Selects the output format for the XY command.
Syntax: *ttssSO-<output format><CR><LF>
Valid output formats are: SIM, XDR, ASH, TCM, BAE.
Error Strings:
ERR XY-SO BAD PARAMETER <output format> was invalid.
ERR XY-SO PARSE ERROR Could not parse <output format>.
Default output format: SIM
Persistence: Setting is stored in nonvolatile memory.

SIM

Output format: $x.x,y.y,t.t,sn<CR><LF> where:
x.x X-tilt value in degrees
y.y Y-tilt value in degrees
t.t Temperature of tiltmeter
sn Serial number
Example:
command: *9900SO-SIM<CR><LF>
response: $ -1.2216, -0.9476,38.53,N6091

XDR

Selects the XDR output format for the XY command.
Output format: $YXXDR,A,x.x,D,N,A,x.x,D,E,C,x.x,C,T-sn*hh<CR><LF> where:
A Data Type (A = Angular)
x.x Y (N)-tilt value
D Units (M=microradians, D=degrees)
N Comment, N for North/South (Y) direction
A Data Type (A = Angular)
x.x X (E)-tilt value
D Units (M = microradians, D = degrees)
E Comment (E for East/West (X) direction)
C Data Type (C=Temperature)
x.x Temperature of tiltmeter
C Units (C = degrees C)
T Comment (T for temperature)
sn Serial number
hh Checksum
Example:
command: *9900SO-XDR
response: $YXXDR,A,-00.940,D,N,A,-01.229,D,E,C,38.62,C,T-N6091*59

ASH

Selects the ASH output format for the XY command.

Output format: $PASHS,XDR,A,x.x,D,N,A,x.x,D,E,C,x.x,C,T-sn<CR><LF> where:

- A Data Type (A = Angular)
- x.x Y (N)-tilt value
- D Units (M=microradians, D=degrees)
- N Comment, N for North/South direction
- A Data Type (A = Angular)
- x.x X (E)-tilt value
- D Units (M=microradians, D=degrees)
- E Comment (E for East/West (X) direction)
- C Data Type (C=Temperature)
- x.x Temperature of tiltmeter
- C Units (C = degrees C)
- T Comment (T for temperature)
- sn Serial number

Example:

command: *9900SO-ASH

response: $PASHS,XDR,A,-00.941,D,N,A,-01.226,D,E,C,38.60,C,T-N6091

TCM

Selects the TCM output format for the XY command.

Output format: $Py.y,Rx.x*hh<CR><LF> where:

- Py.y Pitch= Y-tilt value in degrees
- Rx.x Roll= X-tilt value in degrees
- hh Checksum

Example:

command: *9900SO-TCM<CR><LF>

response: $P-00.946R-01.225*0D

BAE

Selects the BAE output format for the XY command.

Output format: abcdefghijk where:

- a (byte 0): 0x55, 1st Synchronization Byte
- b (byte 1): 0xAA, 2nd Synchronization Byte
- cd (bytes 2,3): X Axis Level Data (bits 14–0 = magn, bit 15 = sign, LSB = 0.0000277°)
- ef (bytes 4,5): Y Axis Level Data (bits 14–0 = magn, bit 15 = sign, LSB = 0.0000277°)
- gh (bytes 6,7): Temperature in °C (bits 14–0 = magn, bit 15 = sign, LSB = 0.004°C)
- ij (bytes 8,9): Serial number in hexadecimal format
- k (byte 10): Checksum of bytes 2-7 ANDed with decimal 255 (0xFF)

Example:

command: *9900SO-BAE<CR><LF>

response: Uªñ ô %™ Ë5

APPENDIX B: WARRANTY & LIMITATION OF LIABILITY

Standard goods (those listed in Jewell Instruments' published sales literature, excluding software) manufactured by Jewell Instruments LLC are warranted against defects in materials and workmanship for twelve (12) months from the date of shipment from Jewells' premises with the following exceptions: Series 900 analog or digital clinometers are warranted against defects in materials and workmanship for 90 days from the delivery date. Jewell will repair or replace (at its option) goods that prove to be defective during the warranty period provided that they are returned prepaid to Jewell and:

(a) that the goods were used at all times for the purpose for which they were designed and in accordance with any instructions given by Jewell in respect of them,

(b) that notice is received by Jewell within 30 days of the defects becoming apparent, and

(c) that return authorization is received from Jewell prior to the goods being sent back.

Should goods be damaged in transit to the Purchaser, Jewell will accept no liability unless the Purchaser can show that such damage arose solely from Jewell's failure to pack the goods properly for shipment.

Software products are warranted to perform substantially in accordance with their documentation for 90 days following your receipt of the software. Jewell and its suppliers do not and cannot warrant the performance or results you may obtain by using the software or its documentation.

In respect of goods or parts thereof manufactured by others and resold by Jewell, Jewell will pass on to the customer the benefit of any guarantee or warranty received by Jewell from the original manufacturer insofar as such guarantee or warranty is assignable.

ANY OTHER CONDITIONS OR WARRANTIES WHETHER EXPRESS OR IMPLIED BY STATUTE OR OTHERWISE ARE EXCLUDED. THE REMEDIES PROVIDED HEREIN ARE THE BUYER'S SOLE AND EXCLUSIVE REMEDIES. JEWELL INSTRUMBENTS LLC SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING LOST PROFITS OR LOST SAVINGS, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY. THIS WARRANTY EXTENDS ONLY TO THE ORIGINAL PURCHASER AND IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, WHETHER OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR USE, AND OF ALL OTHER OBLIGATIONS AND LIABILITIES OF ANY KIND AND CHARACTER. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF.

Jewell's liability arising out of the sale of its goods is expressly limited to the repair and/or replacement of defective parts or the cost of such repair and/or replacement.

If software does not perform substantially in accordance with the documentation, the entire and exclusive liability and remedy shall be limited to either, at Jewell's option, the replacement of the software or the refund of the license fee you paid for the software.

Liability for any other form of loss or damage is hereby expressly excluded.

Customer shall indemnify Jewell against any third party claim arising out of the use of goods and/or services supplied by Jewell, including any claim arising directly or indirectly out of alleged negligence on the part of Jewell, its employees, servants, representatives or agents