

7.0 Communicating with the Model D711 Tiltmeter

7.1 Basic Requirements and Settings

You may communicate with the Model D711 tiltmeter using:

1. A terminal emulator program (e.g. Terminal in Windows 3.1, or HyperTerminal in Windows 95 and later); or
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 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.

7.2 Firmware Command Format

The format of commands issued by the host is:

*9900<command><CR><LF>

Valid commands are summarized in Section 7.3 and described in detail in Appendix C.

The input/output processing on the serial port of the D711 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 D711 tiltmeter running firmware version 5 and above is a simple ("SIM") comma-delimited string consisting of X tilt in degrees or microradians, Y tilt in degrees or microradians, 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)
National Office
P.O. Box 3435
New Bern, NC 28564-3435 USA
Tel: 919/638-2626
Fax: 919/638-4885

7.3 Firmware Command Summary

The list below summarizes the most important user-accessible firmware commands. Precede these commands with the string*9900. See Appendix C 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 tilt meter to Mode-1 operation.
XYVR	Displays the sign-on string.
ID	Sets the ID of units in the daisy chain.
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.
EE	Enables echoing of global 99 commands.
SE	Disables echoing of global 99 commands.
XY-SET-BAUDRATE, <i>x</i>	Sets baud rate to value of <i>x</i> in bits per second. Selectable values include 9600, 19200, 28800, 57600, 115200 and 230400 baud.
XY-SET-N-SAMP, <i>x</i>	Sets number of samples that are averaged before a reading is transmitted; <i>x</i> may have any value from 1 to 1000. Changing this value may also change the output rate.

XY-SET-RSMODE, <i>x</i>	Selects serial output mode: <i>x</i> = 0 RS232 <i>x</i> = 1: RS485 (RS422)
XY-AUTOZ	Turns on auto zero function.
XY-AUTOZOFF	Turns off auto zero function.
XYC <i>x</i>	Continuously sends XY data where <i>x</i> determines output rate as follows: <div style="margin-left: 40px;"> <i>x</i> = 0 8-10 outputs per second <i>x</i> = 1: 4 outputs per second. <i>x</i> = 2: 1 output per second (default). <i>x</i> = 3: 1 output every 10 seconds. <i>x</i> = 4: 1 output every 60 seconds. <i>x</i> = 5: 1 output every hour <i>x</i> = 6: 1 output every 12 hours <i>x</i> = 7: 1 output every 24 hours <i>x</i> = 0A: Averaging of the 8-10 outputs per second data <i>x</i> = 1A: Averaging of the 4 outputs per second data <i>x</i> = 2A or <i>x</i> = A: Averaging of the 1 output per second data </div> Once initiated, continuous output remains in effect until turned off with the XYC-OFF command (see below).
XYC-OFF	Turns off XYC mode.
XY-DUMP-SETTINGS	Dumps settings of device.
XY-DUMP2	Dumps extended settings of device.

7.4 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 or microradians, and the internal temperature of the tiltmeter 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 or microradians and the internal temperature of the tiltmeter 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 or microradians and the internal temperature of the tiltmeter in °C:

```
$-0.619,0.023,18.910,N0000  
$-0.619,0.023,18.923,N0000  
$-0.620,0.024,18.932,N0000  
$-0.620,0.023,18.951,N0000
```

SO = “XDR.” Standard NMEA XDR output string which returns the North-South (Y) and East-West (X) tilt angle in degrees or microradians and the internal temperature of the tiltmeter 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-A. 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 a scale factor that can be found by issuing the *9900XY-DUMP2<CR> command. This scale factor is in arc seconds per LSB and changes automatically with the range of each instrument (the scale factor is different for the D711-A and D711-B). 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.

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 C, Firmware Commands, to decode the output.

7.5 Recording Data in Internal Memory or on a PC; Data File Size

You can log data from your model D711 tiltmeter in tow easy ways:

1. Use a serial communication program to log ASCII data to a storage device on your personal computer.
2. Use the XY-MEMS command to store ASCII data in the tiltmeter's nonvolatile FLASH memory.

The sizes of the data files stored to a PC are approximately:

Format

ASH	16.5 lines =	1 kilobyte
SIM	29.8 lines =	1 kilobyte
XDR	16.6 lines =	1 kilobyte
TCM	42.3 lines =	1 kilobyte

Data stored to FLASH memory must be stored in simple (SIM) format. Approximately 150 lines of data may be stored at any sample rate..

7.6 Switching between RS 232 and RS485 (RS422) Output

You may switch the tiltmeter's output from RS232 to RS485 (RS422) or back again by issuing the *9900XY-SET-RSMODE firmware command. After switching to RS485, the RS232 test cable (Figure 5) cannot be used to communicate with the tiltmeter. Similarly, after a switch to RS232, the RS485 cable can no longer be used (Figure 6). An additional test cable may be ordered from Jewell Instruments by



specifying P/N 89063 for the RS232 cable or P/N 89062 for the RS485 (RS422) cable.

***Be sure you have the proper interconnect cable before switching to a new output protocol.
Without it, you will lose the ability to communicate with the tiltmeter!***

8.0 Maintenance and Troubleshooting

Model D711 Digital Tiltmeters are rugged and require no maintenance other than normal cleaning. Apart from the procedures described below, the tiltmeters are not field-serviceable. If you encounter problems not described here, please contact Jewell Instruments LLC at (603) 669-6400 in New Hampshire. A sales representative will assist you in determining the cause of any problem.

8.1 Routine Maintenance

Keep all tiltmeters away from extremes of heat and cold. Extreme temperatures shorten the life of the seals and unnecessarily stress the electronic components. Keep tiltmeters out of direct sun because the internal temperature can reach levels considerably greater than the ambient temperature.

Your Model D711 tiltmeter has been sealed at the factory to protect it against splashes and wet weather. However, it should NEVER BE SUBMERGED in water or any other liquid. WATER DAMAGE TO INTERNAL COMPONENTS VOIDS THE WARRANTY!