Integrating Digiquartz® MET3 and MET3A Broadband Meteorological Systems with a Thales (Ashtech) GPS Receiver

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"The standard by which other standards are measured"

Integrating Digiquartz® MET3 and MET3A Broadband Meteorological Systems with a Thales (Ashtech) GPS Receiver

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1. Introduction

Paroscientific is the leader in the high precision pressure measurement field where high resolution, accuracy, reliability, ruggedness, long-term stability, and low cost of ownership are important requirements. The high performance of Digiquartz® Instruments is a result of careful design, meticulous manufacturing, and extensive calibration and testing.

Paroscientific's MET3 and MET3A Broadband Meteorological Measurement Systems were specially designed for GPS-Meteorology and geophysical applications. For both of these applications, an intermediary goal is to calculate the amount of precipitable water vapor (PWV) in the atmosphere either to make very accurate position measurements or to forecast short-term weather very precisely. For these applications, precision, accuracy, reliability, and long-term stability of the MET stations correspond to low total cost of ownership in the long run. The broadband feature of these instruments also enables scientists to measure other atmospheric and geophysical signals with a network of GPS receivers co-located with Digiquartz® MET3 and MET3A Meteorological Measurement Systems.

Since surface pressure and temperature measurements are important parameters for PWV calculations, the data reliability and integrity from the MET stations are of paramount importance.

The MET3 and MET3A precision measurement instruments provide high accuracy data from barometric pressure, temperature, and relative humidity sensors. Pressure resolution is better than 1 microbar with a total accuracy of 0.08 hPa over the extended barometric range of 620 to 1100 hPa. Temperature resolution is 0.01 degree C. The fan-aspirated MET3A has a total temperature accuracy of 0.1 degree C over the full temperature range of –50 to +60 degrees C. Relative humidity performance is better than 2% at 25 degrees C, and humidity recovery time for the MET3A after 100% water saturation is less than 2 minutes.

These fully integrated systems are housed in environmental enclosures allowing stand-alone, indoor or outdoor mounting. Installation hardware and software are included, and optional interface cabling is available for easy system integration. The MET3 radiation shield protects the temperature and humidity sensors from precipitation and solar radiation. The MET3A utilizes a high performance, tuned barometric pressure port to reduce dynamic pressure errors caused by wind.

Microprocessor-based electronics provide fully temperature compensated and linearized outputs via a two-way RS-232 interface. The serial interface allows complete remote configuration and control of all operating parameters including resolution, sample rates, choice of engineering units, integration time, and sampling commands. Individual measurement parameters or a "unified" data word with all sensor outputs are easily interfaced with computer systems, GPS receivers, and data loggers.

The purpose of this document is to provide specific integration and diagnostics information, additional to the MET3 and MET3A Installation, Operation and Maintenance Guides, to facilitate the integration of a MET station with a Thales (Ashtech) CGRS™ or iCGRS™ GPS receiver. Once the MET stations are set up properly in the field, these instruments are designed to work under rugged environmental conditions for years without problems. The operating principle of a MET station with a GPS receiver is simple and relies on a few critical parameters. This technical paper elaborates on these critical parameters and provides a technical recipe to integrate a Thales iCGRS™ GPS receiver with a MET station.

2. What do you need for GPS-MET Integration?

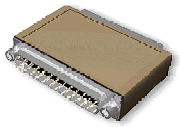
Upon your purchase of Thales iCGRS™ and a Broadband Digiquartz® MET3 or MET3A Meteorological packages, you receive the following items from each vendor. If any of these items are missing from your package, please contact Thales (Ashtech) or Paroscientific, Inc.

GPS Receiver

GPS Antenna

MET and PC Cable

Ethernet Cable



Micro-Manager Software & Software Key

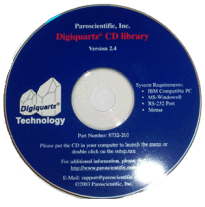
Power Adapter

Table 1. Items provided by Thales

MET Station

MET Cable (optional)

Power Adapter, PC Cable and Connector (optional)



Digiquartz® Software CD

Table 2. Items provided by Paroscientific

3. Operating Principle of MET Stations

MET stations include the world's most accurate, stable, and reliable **Broadband Digiquartz® Barometers**, packaged with a precision temperature and humidity probe. Integral electronics and packaging make installation and communication with these instruments an easy task.

In order for a MET station to work with a GPS receiver, regardless of the GPS receiver manufacturer, the following conditions **must** be met.

a. The MET instrument must be powered up.

MET stations are powered via pin 9 of its RS-232 connector. Please check the operating manual of your receiver to review if your receiver is capable of providing power to MET stations. If your GPS receiver is not capable of providing a voltage output of +7 to +16 VDC through pin 9 of its RS-232 connector, please contact Paroscientific Sales and Application engineers to get the power breakout/ supply kit (Part Number 1727-00X, X=1 for 110 VAC, for 220 VAC X=2). You may order this kit during your purchase of the MET station as well.

Note: MET stations shipped after 8/02 have Power & Status LEDs, which indicate the instrument is powered up and/or transmitting/receiving data.

b. The MET station must be set to transmit pressure data in units of "bar" (UN=3).

The MET stations only respond to a GPS receiver when the pressure unit is set to "bar". Broadband MET3 and MET3A Meteorological Measurement Systems' pressure units are set to "bar" in the factory before shipment. This corresponds to UN parameter (set to) "3" in the configuration. If your instrument is set to a different pressure unit, you can use the Digiquartz® Interactive (DQI) software (provided with the MET station) to change the pressure unit as illustrated in Figure 1. To download the most recent version of the DQI software, please visit our web site.

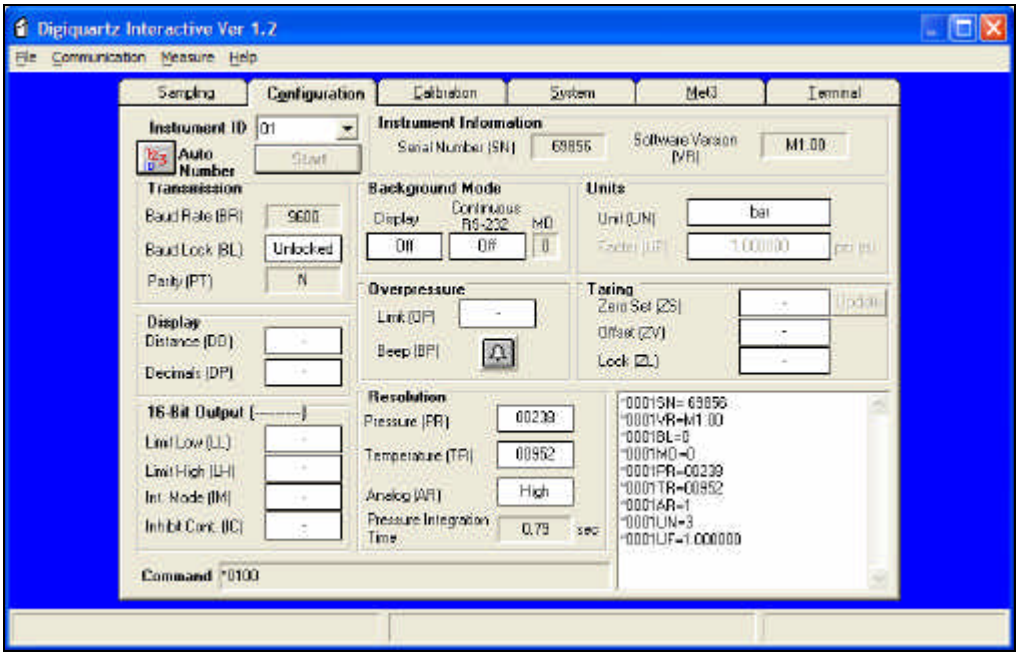


Figure 1. MET Station pressure unit must be set to UN=3 (bar)

c. Correct cable type between the GPS receiver and MET station must be used.

Paroscientific provides (optionally available) GPS to MET interface cables. This cable connects the MET station directly to the GPS, or to another GPS interface cable provided by the GPS receiver manufacturer. If you are using a custom made cable or don't have the right GPS cable to interface with the MET cable, you may experience communication problems. If you are using a custom-made MET cable, please check MET manual to see the pin connections.

d. The GPS receiver must be configured to send a P9 command to the MET station.

Once the GPS receiver and MET station is connected and powered up, the MET station is ready to respond to a P9 command issued from the GPS receiver. The GPS receiver must be configured to send a P9 command to the MET station. The MET station returns the pressure, temperature and humidity in standard NMEA[1] format.

Please refer to related section in this document to configure your receiver to issue a P9 command every time position data is acquired. The P9 command must be in the following format.

***(Two-digit address of the MET Station)00P9 <cr><lf>**

In this format, (Two-digit address of the MET Station) corresponds to the address of your MET station. By default, it is "01". If you changed this address, please use the correct address in the format above. If you did not change the address of the MET station, *0100P9<cr><lf> command should be issued by the GPS receiver to get a response from the MET station. The <cr> and <lf> correspond to carriage return (Character 13) and line feed (Character 11).

The MET station P9 command only works with a single device. It will not work in an RS-232 loop.

A typical response to a P9 command is as below.

$WIXDR,P,<Pres Value>,B,<SN>,C,<Temp value>,C,<SN>,H,<Hum value>,P,<SN><CR><LF>
+- - Pressure - - + +- Temperature - + +- - Humidity - - +

Transducer	Field	Units
Pressure	P	B=Bar
Temperature	C	C=Celsius
Humidity	H	P=Percent

<SN> = Transducer Serial Number (Typically - DQ#####)

This response will be parsed out by your GPS receiver and stored in your GPS receiver.

4. Integration Procedure

After the introductory information above, we are now ready to integrate a Thales GPS receiver with a Paroscientific MET station. Please follow these steps:

1. Unpack the GPS receiver. Review the contents of your order. You need the receiver, antenna, antenna cable, PC and MET station cable, software dongle, Micro Manager™ software and power adapter. These contents are listed in Table 1.

[1] The NMEA 0183 (National Marine Electronics Association) Standard for Interfacing Marine Electronics Devices is a voluntary industry standard, first released in March of 1983. The NMEA has become a standard protocol for interfacing navigational devices such as GPS and DGPS receivers. It defines electrical signal requirements, data transmission protocol, timing and specific sentence formats.

2. Unpack the MET station. Review the contents of your order. You need all of the MET station items in Table 2.
3. Connect the power (to PWR port), GPS antenna (GPS port) and Ethernet (ETH port) cables as illustrated in Figure 2.

Figure 2. Thales GPS Receiver Back Panel

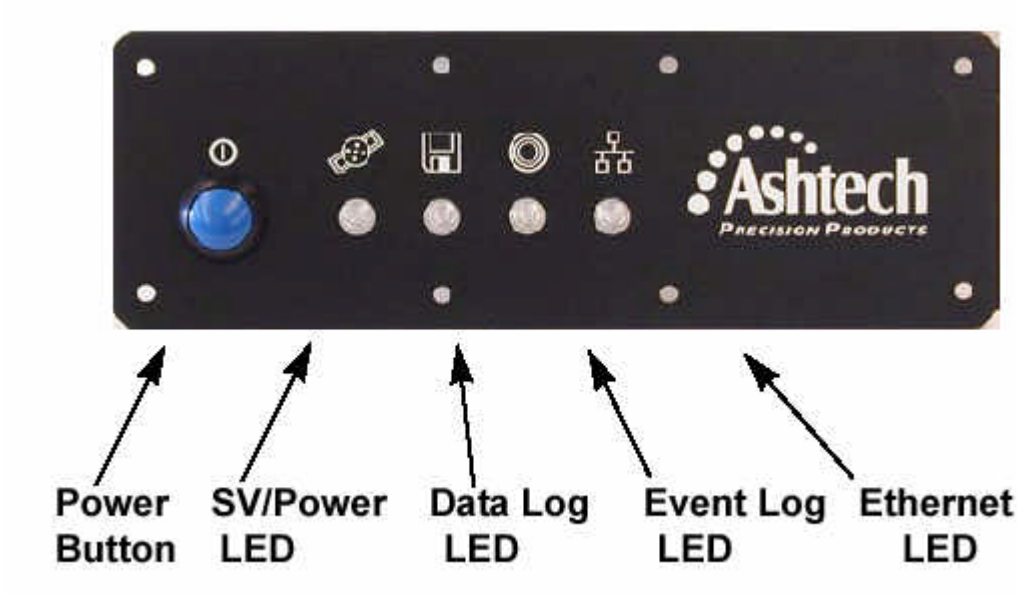


Figure 3. Thales GPS Receiver Front Panel

4. Power up the unit. See the S/V Power LED blinking (red means powered up, green means tracking satellites) as in Figure 3.

Caution: YOU WILL NOT BE ABLE TO LOG METEOROLOGICAL DATA UNLESS YOU ARE TRACKING SATELLITES.

5. Connect the Y-shape GPS cable (P/N 730417) to Port A/C on the back panel of the GPS receiver. Connect the Port A/B end of the same cable to the RS-232 port of your computer, and the C/D end of the cable to the MET cable provided by Paroscientific. When you connect the Port C/D end of the cable to the MET station, the MET station power LED (red) should turn on as in Figure 4. At this point the MET station is ready to respond.

Figure 4. MET Station LEDs (Power –ON)

6. At the factory, Thales receivers are configured to talk to Paroscientific instruments after the logging feature is turned on. The trigger string (*0100P9) is embedded into the firmware as a default. If the MET station power LED is not ON, use the PC kit to bench test the MET station as explained in the troubleshooting section.
7. At this point, your GPS receiver must be tracking satellites, and the power LED on the MET station must be "ON" in order to start logging MET data.
8. To configure the GPS receiver to start logging MET data, install the Micro Manager™ software on your computer that came with the GPS receiver. Connect the software key (dongle) on the parallel port of your computer. Launch the Micro Manager™ software.
9. In the Micro Manager™ interface, under the "Configuration" menu, select the "Port Settings" option.
10. As in Figure 5, change the baud rate to "115200". Click on OK. (Note: For the uZ CGRS model, the default baud rate on Port A/B is 9,600).

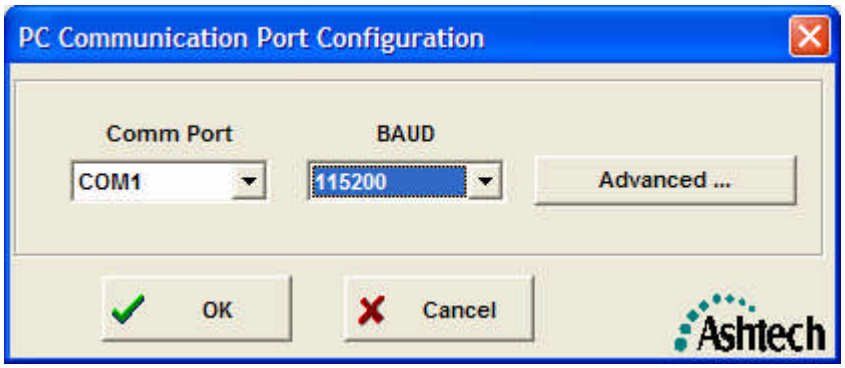


Figure 5. Adjusting GPS Receiver Baud Rate

11. Click on the "File" then the "Terminal" menu. From the "Command" drop down box, select the "$PASHQ, RAW" command and then click on the "Send" button.

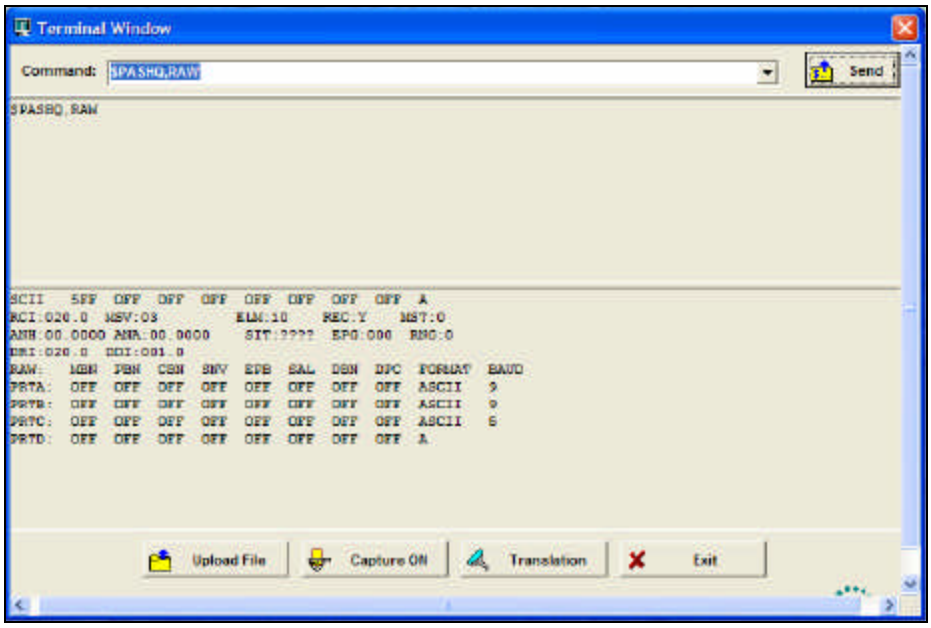


Figure 6. Review the RAW command output

Verify that all data output in the lower section of the window are listed as OFF, as in Figure 6. If any raw data output is listed as ON, issue the command $PASHS,OUT,C <Enter> where C is the raw data output port.

12. Issue the query command $PASHQ,PAR <Enter> via port A as in Figure 7.
13. Look at the $PASHQ,PAR response message and verify that all NMEA message output is listed as OFF. If any NMEA messages are listed as ON, issue the command $PASHS,NME,ALL,C,OFF <Enter> .

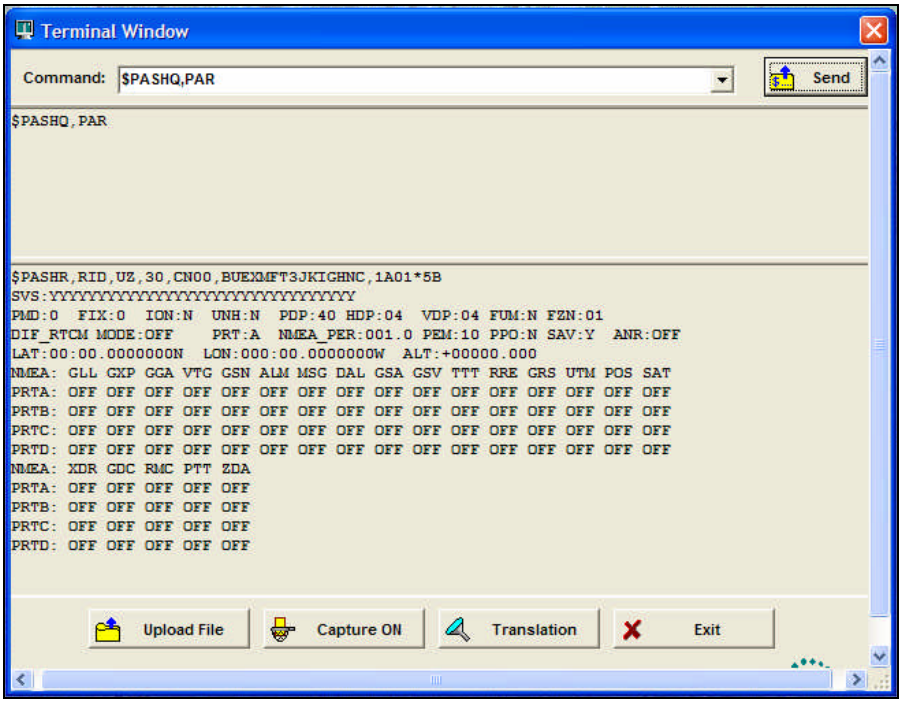


Figure 7. Review the PAR command output

14. Issue the command $PASHS,OUT,C,MET,ON <Enter> to connect the MET station via port C as in Figure 8. The receiver should now start logging MET information in the D-file if data recording is enabled.

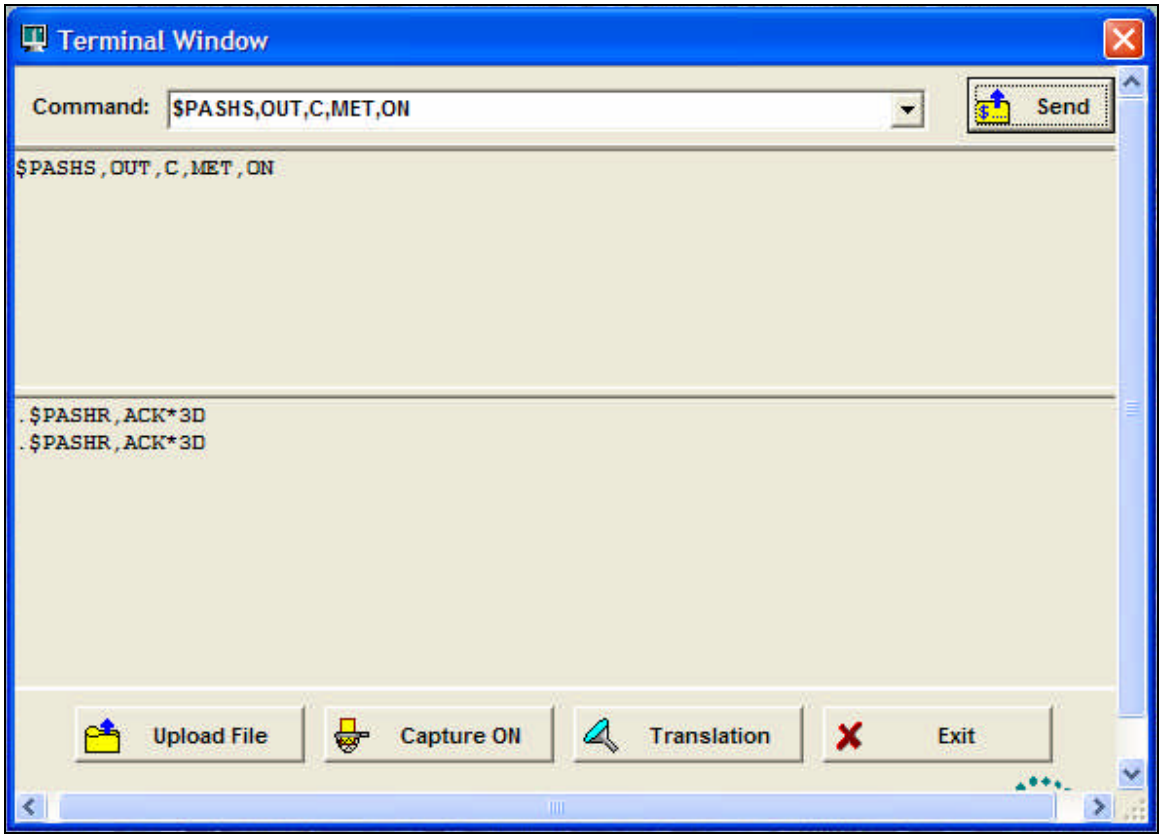


Figure 8. Turn on logging

NOTE: To turn off MET information logging, issue the command $PASHS,OUT,C,MET,OFF

15. You will see the Event and Data log LEDs blinking on the front panel of the GPS receiver. You should also watch the TX and RX LEDs on the MET station and see them blinking every time a data string is sent and received to/from the MET station.
16. The GPS receiver will start logging the MET data. You can access these files from Micro-manager under the “Receiver” menu and “Files” option. When this option is selected, you will see the dialog box in Figure 9.

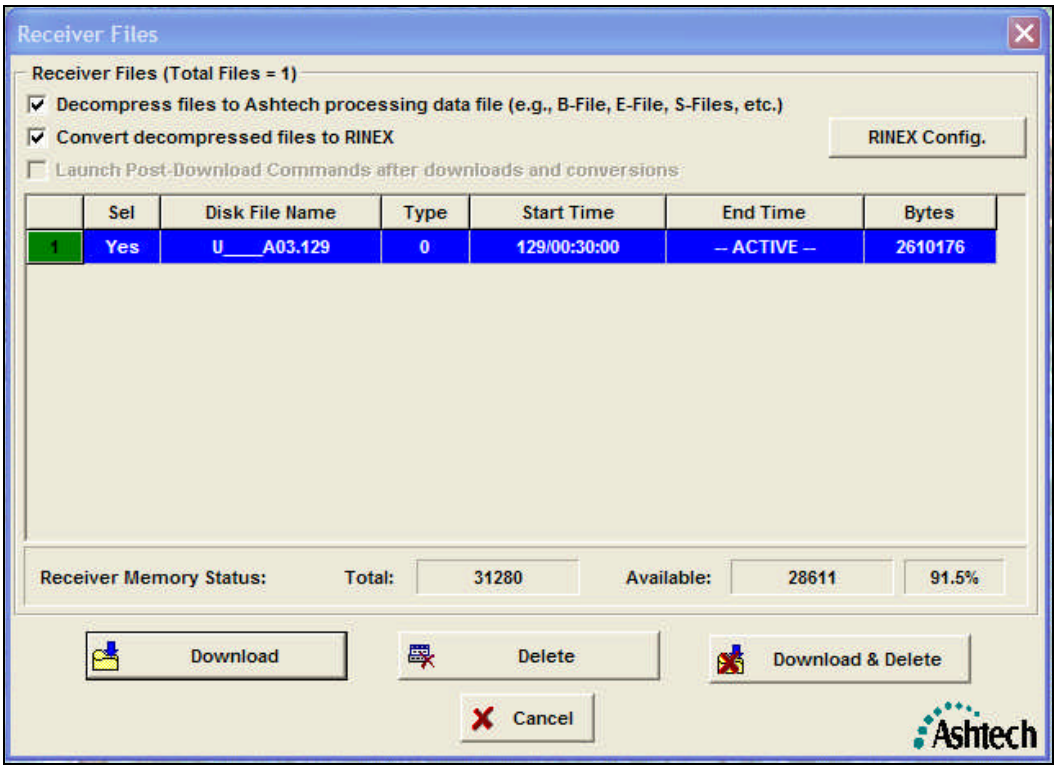


Figure 9. Downloading data file from the GPS receiver

17. The GPS file downloaded must be converted to RINEX format to be processed. You will need the Micro Manager Pro™ to make this conversion and see the file contents.

5. GPS Receiver Network Operations

Thales iCGRS™ receiver is the pioneer in the field of Internet-enabled receivers. Once connected to a network, you can access the functionality of the receiver via any browser.

You must assign a valid IP address to the receiver before communicating with it over a network or the Internet. Please use Micro Manager™ software and talk to your network administrator to assign an IP address to your receiver. After assigning an address to your receiver, connect the compatible end of the Ethernet cable to the "ETH" port on the back panel of the GPS receiver and the other end to a hub or network node. If the GPS receiver Ethernet interface is configured properly, you should be able to ping your receiver from an MS-DOS window. Once the interface is configured properly, you can use any telnet program to communicate with the iCGRS™.

There is also a terminal program (java applet) in the iCGRS™ to send commands to the instrument from anywhere in the world. The GPS receiver can be configured by issuing the same command sequence from the browser via the Internet. You can also use the different menu options along the left side of the screen in the browser. You can issue the same commands from the telnet window to configure and log data from the MET station as in Figure 10.

Receiver files can be accessed over the Internet and downloaded to a local computer for post-processing as in Figure 11. Use the "Receiver Files" option in your browser to download a data file. The files can later be converted to RINEX format by using the Micro Manager Pro™ software. Please contact Thales to receive a copy of this package if not provided.

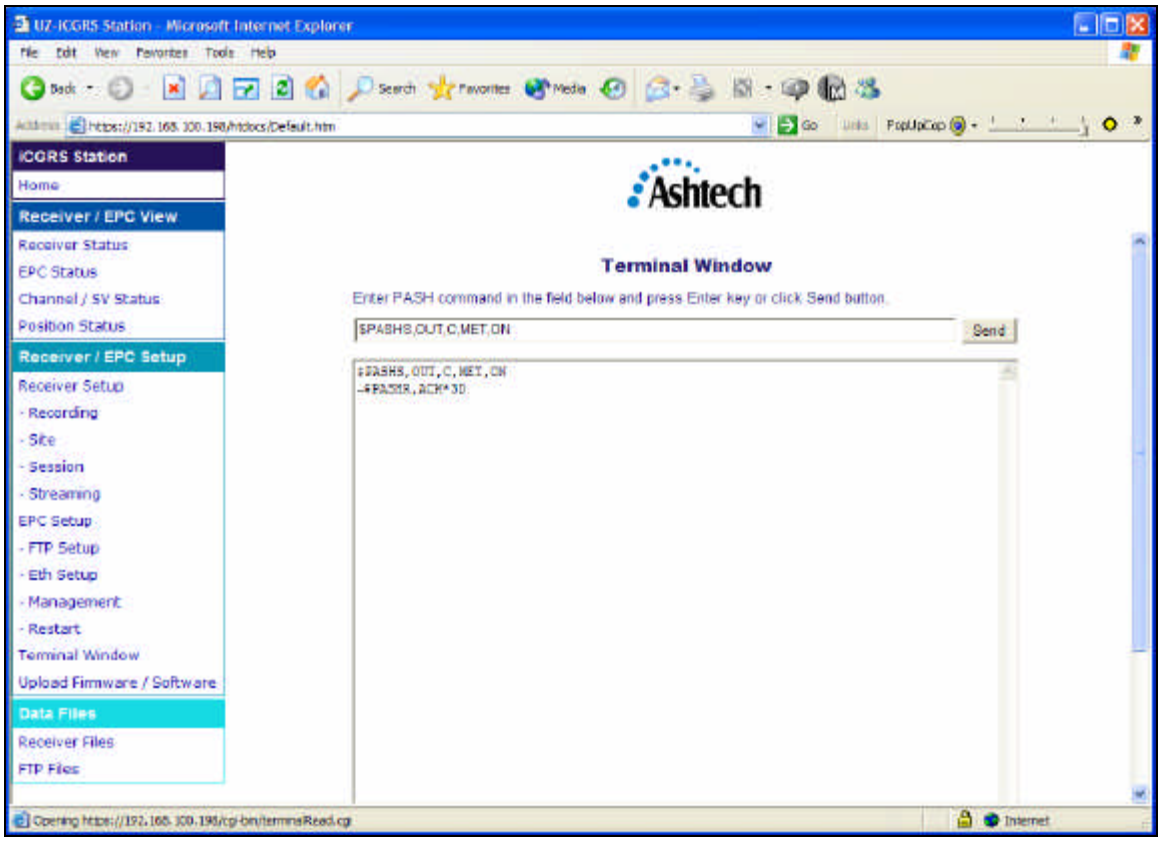


Figure 10. Network access to iCGRS via a browser

Access to your files via the browser

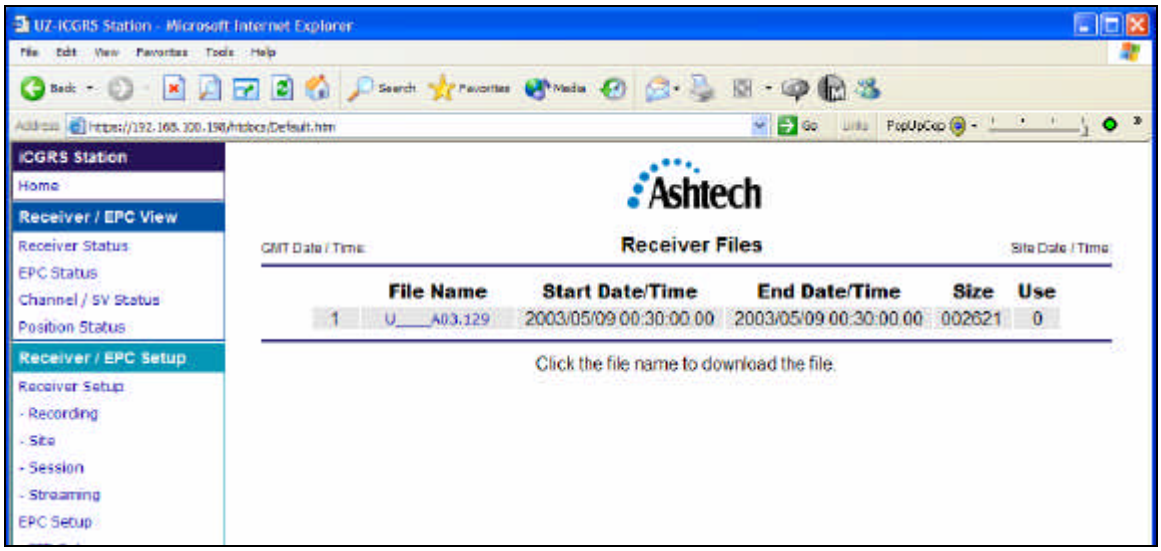


Figure 11. Accessing log files via a browser

6. Troubleshooting

Before integrating your GPS and MET station, or in the event of communication loss between a GPS receiver and a MET station, the MET station should be tested separate from the GPS receiver. To perform this test, please follow these steps.

Figure 12. MET to PC Connection

1. Connect the MET station to a laptop computer via the MET station interface cable and the power breakout as in Figure 12. Since PC's are not equipped to power up a MET station, a power breakout must be used. The power breakout must be connected to the PC's serial port and plugged into the MET station RS-232 cable. If your MET station has LEDs, you should see the red power light ON. The power for the MET unit is +7 to 16 VDC.
2. Download our FREE setup and configuration software Digiquartz® Interactive (DQI) from www.paroscientific.com/software.htm or load it from the Digiquartz® CD Library that was shipped to you with the purchase of your MET station.
3. Start the DQI program. Select the Communication Port to which the MET station is connected and press "Start". The communication baud rate of the unit has been pre-set to 9600 baud, 8 data bits, and 1 stop bit. DQI will try to communicate with an Intelligent Instrument on the selected Communication Port by using a succession of baud rates. The screen will display a baud rate and instrument identification numbers upon successful communication.
4. If your instrument is powered up (see the LED) and DQI cannot detect your MET station, there is either a problem with the interface cable or the MET station. Please make sure to use the original MET station cable and power breakout (Part Number 1727-00X, X=1 for 110 VAC, X=2 for 220VAC) supplied by Paroscientific. If the problem continues, and you are sure you are not having a cabling problem, please contact us at (425) 883-8700 or at support@paroscientific.com.
5. If DQI detects your instrument, click on the "OK" button. You should now see the DQI "Configuration" screen. On this screen, click on the "Start" button to read the configuration parameters of your MET station. Check the "Pressure Unit (UN)" parameter. Make sure that it is set to bar (factory default). If it is not in bar, click on the pressure unit field and select "bar", then click on the "OK" button. Make sure that the pressure unit field is changed to "bar".
6. On the top menu bar, click on "Measure" and select MET3 from the drop-down list. The MET measurement panel will appear on the screen. Each measurement parameter has its own window. Verify that the pressure, temperature, and humidity fields have a reasonable data value. If any field displays "------" characters, there may be a program or instrument problem. Try increasing the time-out value on this screen to see if it will solve the problem. If it does not, contact our support department. The program Help file also has troubleshooting suggestions.

7. In early 2002, a status indicator panel (LEDs) was added to the MET stations. These status indicators allow you to determine whether input power is applied to the unit and to monitor RS-232 serial activity. The status indicator panel is located on the bottom surface of the unit, adjacent to the electrical connector.

   The following table explains the function of the status indicators:

Indicator color	Function
Red	ON: Input power on OFF: Input power off
Green	FLICKERING: Activity on RS-232 receive line OFF: No activity on RS-232 receive line
Yellow	FLICKERING: Activity on RS-232 transmit line OFF: No activity on RS-232 transmit line

Table 3. MET LED Status

8. The RS-232 interface is capable of driving signals over distances of up to 30 meters with good quality shielded cable. It is recommended that you bench test your unit with the installation cable, especially if you are driving the signal a long distance.
9. If your MET station seems to be operating properly and you can make the GPS receiver communicate with the MET station, this means there is either a problem with the connection between the GPS receiver and MET station or a configuration problem with the GPS receiver.
10. Please make sure that when the GPS receiver cable is connected to the RS-232 cable of the MET station, the Power LED on the MET station must be “ON”.
11. As stated before, the GPS receiver must track satellites in order to log MET data. Please check the front panel of your GPS receiver and look at the SV/Power LED. If this LED is blinking green, this means you are tracking satellites.
12. If you still can’t log data, make sure that the logging feature is on and enabled. Review the steps in section 4 of this document. When you issue a $PASHS,OUT,C,MET,ON command to turn on data logging, make sure that the MET station is connected to port C.
13. If you still can’t log data from the GPS receiver and your MET station has passed the stand-alone communication test explained in steps 1-6 of this section, please contact Thales technical support.
14. If you are still having problems with the MET station, please contact Paroscientific’s Application Support Engineers either at (425) 883-8700 or send a description of your problem including the serial number of your instrument via e-mail to support@paroscientific.com.