

Paroscientific, Inc.
Digiquartz® Pressure Instrumentation

User's Manual

For

**MET4 and MET4A Meteorological
Measurement Systems**



“The standard by which other standards are measured”



USER'S MANUAL

FOR

**MET4 and MET4A Meteorological
Measurement Systems**

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1 Introduction

Thank you for your purchase of a Digiquartz[®] MET4 or MET4A Meteorological Measurement System.

1.1 Conventions

The following conventions are used throughout this manual:

Digiquartz[®] Intelligent Device – Any Digiquartz[®] Intelligent Instrument or Transmitter with one or more serial data interfaces. Serial data interfaces include RS-232, RS-485 and USB.

Digiquartz[®] Pressure Transducer – Any Digiquartz[®] pressure transducer with frequency outputs.

CAUTION is used to draw your attention to a situation that may result in an undesirable outcome, but will not damage the unit.

WARNING is used to draw your attention to a situation that may result in permanent damage to the unit or will void the warranty.

DANGER is used to draw your attention to a situation that may result in injury.

Serial commands are shown in bold type. Example: **P3** is the command that returns a single pressure value.

1.2 Warnings and Safety Precautions

The MET4 and MET4A are precision instruments, and as such, should be operated with a certain degree of care to ensure optimum performance.

WARNING The MET4 and MET4A are rugged field instruments. However, excessive mechanical shock may cause irreparable damage.

WARNING There are no user-serviceable components inside the MET4 and MET4A electronic enclosure. Breaking the warranty seal will void the warranty.

WARNING The MET4 and MET4A are housed in a weather-resistant enclosure. Do not submerge the unit.

2 Getting Familiar

2.1 Physical Inspection

You should have received the following items with your MET4 or MET4A:

- MET4 or MET4A Meteorological Measurement System
- User's manual
- DigiQuartz® CD Library
- Specification Control Drawing (SCD) for the MET4 or MET4A
- Certificate of Calibration
- Certificate of Conformance (NIST traceable)
- Status Report

NOTE: The Certificate of Calibration and Certificate of Conformance are original documents. Do not discard.

2.2 Performance, Features and Configurations

PERFORMANCE

Range: Pressure: 500 – 1100 hPa (7.25 – 16 psia)
 Temperature: -50 to 60°C
 Humidity: 0 – 100%

Resolution: Better than 0.0001% of full scale

Accuracy: Pressure: ± 0.08 hPa
 Temperature: MET4 – ± 0.5°C
 MET4A – ± 0.2°C
 Humidity: ± 2% RH @ 25°C

Supply voltage: MET4: 5 - 16VDC
 MET4A: 11 – 14VDC

Nominal current: MET4: 35mA
 MET4A: 225mA

NOTE: Specifications subject to change at any time without notice. Where specifications listed herein differ from the SCD, the SCD takes precedence.

FEATURES

- Integrated barometric pressure, temperature, and humidity sensors
- High-performance DigiPort pressure port for accurate barometric pressure measurements even in the presence of wind.
- Rugged, weather-resistant enclosure
- RS-232 and RS-485 remote operation
- Powerful command set
- Optional barometric functions
- Optional data logging features
- Firmware may be updated via RS-232
- PC software for configuration, data acquisition, downloading of logged data, and diagnostics.

QUALITY AND STANDARDS

- CE certified
- NIST traceable
- ISO 9001:2000 quality system

2.3 Physical Description

The MET4 and MET4A are precision meteorological measurement systems housed in rugged, weather-resistant enclosures. An internal DigiQuartz[®] pressure transducer, precision temperature/humidity probe, and microprocessor-based electronics provide the measurement and communication capabilities. Measurement data is accessed via RS-232 or RS-485 serial ports. An external status panel monitors power status and RS-232/RS-485 communication.

The MET4/MET4A features the DigiPort high-performance barometric pressure port. It is designed to dramatically reduce barometric pressure measurement errors in the presence of wind.

The air temperature/humidity probe is housed within a solar radiation shield. The purpose of the solar radiation shield is to minimize air temperature measurement errors caused by exposure to direct sunlight. The MET4 features a simple yet effective passive solar radiation shield. The MET4A features a multi-chamber fan-aspirated solar radiation shield for superior immunity to temperature measurement errors caused by solar radiation.

The MET4/MET4A is designed for easy and convenient mounting to masts, tubing, and other structures and surfaces.

3 Features and Functions

3.1 Barometric Pressure

3.1.1 Barometer basics

The outputs from the DIGIQUARTZ® barometer are two square wave signals whose period is proportional to applied pressure and internal transducer temperature. The internal transducer temperature is used to perform a temperature compensation of the pressure output. The MET4/MET4A measures these signals using a technique similar to that of a common laboratory frequency counter. Like the frequency counter, a signal must be integrated, or sampled, for a specified period of time to measure its period. The time over which the signal is sampled determines the resolution of the measurement. Longer sampling times increase resolution, but result in a slower sampling rate.

The MET4/MET4A allows you to set the integration time between 0.001 and 270 seconds in 0.001 second increments. Pressure and temperature integration times can be set independently. Measurements can be continuously taken in the background, or can be initiated when a measurement command is received. You can use these features to configure the MET4/MET4A according to the data acquisition and resolution requirements of your application. Refer to paragraph 10.5 for more information about integration time, resolution, and sampling rate.

The MET4/MET4A features the DigiPort high-performance barometric pressure port. It is designed to dramatically reduce barometric pressure measurement errors in the presence of wind.

3.1.2 Barometer measurement descriptions

One or both of the barometer pressure and temperature signals are sampled, or integrated, depending on the type of measurement requested.

PRESSURE MEASUREMENTS

Pressure measurements are by far the most common. Pressure measurements are fully temperature-compensated, and therefore require an internal temperature measurement.

When a pressure measurement is made, the following sequence occurs:

1. The temperature signal period is measured
2. A temperature value is calculated using the temperature period and the calibration coefficients
3. The pressure signal period is measured

4. A temperature-compensated pressure value is calculated using the pressure period, temperature value, and the calibration coefficients
5. The pressure value is output

NOTE: The description above assumes Sequential Integration. The barometer outputs can now be integrated simultaneously, resulting in faster data rates without sacrificing measurement resolution. Refer to paragraph 3.1.4 for more information.

INTERNAL SENSOR TEMPERATURE MEASUREMENTS

Internal sensor temperature is normally only used for temperature compensation of pressure, but can be requested independently for diagnostic purposes.

When an internal sensor temperature measurement is made, the following sequence occurs:

1. The temperature signal period is measured
2. A temperature value is calculated using the temperature period and the calibration coefficients
3. The temperature value is output

PRESSURE / TEMPERATURE PERIOD MEASUREMENTS

Period measurements are used mainly for calibration and diagnostic purposes, but may be useful in high-speed sampling applications.

When a period measurement is made, the following sequence occurs:

1. The pressure or temperature signal period is measured
2. The period value is output

Refer to paragraph 6.3 for detailed measurement command descriptions.

3.1.3 Pressure measurement modes

TRIGGER MODE

In Trigger Mode, pressure measurements are initiated when a measurement command is received. Data is output when the new measurement is complete. This is the mode in which DIGIQUARTZ® intelligent devices have traditionally operated.

FETCH MODE

In Fetch Mode, pressure measurements are continuously taken in the background. When a measurement command is received, the most recently acquired measurement value is immediately output. Fetch Mode also allows limited simultaneous access to

measurement data from both RS-232 and RS-485 ports. Refer to paragraph 6.6 for more information.

3.1.4 Pressure integration methods

SEQUENTIAL INTEGRATION

During Sequential Integration, the barometer temperature period is sampled first, followed by the pressure period. This is the method used exclusively by previous-generation DIGIQUARTZ® intelligent devices, and is the default integration method to provide compatibility with older units.

SIMULTANEOUS INTEGRATION

When Simultaneous Integration is selected, the barometer pressure and temperature periods are integrated simultaneously, resulting in increased data rates without sacrificing measurement resolution. Refer to paragraph 3.1.4 for more information.

3.1.5 Pressure sampling types

SINGLE MEASUREMENT SAMPLING

Single measurement sampling commands output a single measurement value each time the command is received.

CONTINUOUS MEASUREMENT SAMPLING

Continuous measurement sampling commands repeatedly output measurement data until commanded to stop.

HIGH-SPEED CONTINUOUS MEASUREMENT SAMPLING

Similar to regular continuous measurement commands, but internal temperature measurements are taken only occasionally. This type of sampling is useful when sampling rates must be as high as possible, and is particularly effective when internal temperature is not expected to change significantly.

NOTE: High-speed continuous sampling was rendered obsolete by Simultaneous Integration, but remains available to provide compatibility with older DIGIQUARTZ® intelligent devices.

SAMPLE AND HOLD MEASUREMENT SAMPLING

Similar to single measurement sampling, but the measurement value is not output until a separate command is sent. This type of sampling is useful when you need to simultaneously trigger measurements from multiple units, and then read them one by one in a particular order.

Refer to paragraph 6.3 for detailed measurement command descriptions.

3.1.6 Barometer engineering units

Pressure values can be expressed in the following engineering units. Refer to the UN command in paragraph 6.9 for details.

- psi
- hPa (mbar)
- bar
- kPa
- MPa
- in Hg
- mm Hg (Torr)
- m H₂O
- User-defined units

Internal barometer temperature values can be expressed in the following units. Refer to the TU command in paragraph 6.9 for details.

- °C
- °F

3.1.7 Tare

You can configure the MET4/MET4A to subtract a value from each subsequent pressure measurement. This process is referred to as taring. You can tare to the current pressure value, or to any value you specify. Taring is initiated by a serial command. A special character in the measurement data can be used to indicate whether taring is in effect. Refer to paragraphs 6.10 and 6.11 for details.

3.1.8 Minimum and maximum pressure measurements

Minimum and maximum measured pressure values are automatically stored, and can be retrieved or reset at any time. Refer to paragraph 6.7 for details.

3.2 Air Temperature and Relative Humidity

3.2.1 Air temperature and relative humidity basics

Air temperature and relative humidity measurements are provided by a single precision probe. The probe is fully calibrated and self-contained, providing easy plug and play interchangeability. The probe is easily accessed by the user for field replacement.

The air temperature and humidity probe are housed within a solar radiation shield. The purpose of the solar radiation shield is to minimize air temperature measurement errors caused by exposure to direct sunlight. The MET4 features a simple yet effective passive solar radiation shield. The MET4A features a multi-chamber fan-aspirated solar radiation shield for superior immunity to solar radiation.

Air temperature is expressed in °C, and relative humidity is expressed as a percentage.

3.2.2 Air temperature and relative humidity sampling

Air temperature and relative humidity measurements are sampled continuously in the background approximately every .6 seconds. When an air temperature or relative humidity measurement is requested, the most recent measurement value is output.

3.3 RS-232 and RS-485 Serial Communications

3.3.1 RS-232 and RS-485 basics

The MET4/MET4A is equipped with both RS-232 and RS-485 serial ports. Commands can be sent to either port. Response data, if any, will be output from the port that received the command. Common baud rates between 300 and 115,200 baud are supported. The serial protocol is fixed at 8 data bits, no parity, and 1 stop bit. An external status panel monitors power status and RS-232/RS-485 communication for diagnostic purposes.

3.3.2 Networking

Up to 98 DIGIQUARTZ® Intelligent devices and an RS-232 serial host can be interconnected to form a serial loop network. Up to 98 DIGIQUARTZ® Intelligent devices and an RS-485 serial host can be interconnected to form a 2-wire or 4-wire RS-485 multi-drop network. Refer to Section 9 for details.

Commands are sent to a specific DIGIQUARTZ® Intelligent device by using its unique ID number. You can also send certain commands to all devices on a network by sending the command to the global address. Refer to paragraphs 5.5 and 6.2 for details.

3.3.3 Differences between the RS-232 and RS-485 ports

Generally, the MET4/MET4A responds identically to commands received on either port, with the following exceptions:

- Global commands received by the RS-232 port are re-transmitted. This enables a global command to be relayed to each device in an RS-232 serial loop network. Refer to paragraph 9.4 for more information about RS-232 serial loop networking.
- Commands received by the RS-232 port that are addressed for other devices are re-transmitted. This behavior is necessary to support RS-232 serial loop networking. Refer to paragraph 9.4 for more information about RS-232 serial loop networking.
- Global commands received by the RS-485 port never generate a response. This prevents the data collision that would occur if all devices on a multi-drop network were to respond simultaneously.

3.4 Serial Data Output Modes

In addition to the sampling types described in paragraph 3.1.5, the MET4/MET4A can also be configured to provide continuous measurement data whenever power is applied. Refer to paragraph 6.8 for details.

3.5 Measurement Data Formatting

Several serial data formatting options have been provided, and are listed below. Refer to paragraph 6.11 for details.

- **User-Defined Commands:** Lets you create your own custom measurement commands, containing any combination of measurement values and text strings. See the **OF** and **OM** commands in paragraph 6.4 for details.
- **Engineering Unit Suffix:** Appends the engineering unit to pressure and temperature measurement data. See the **US** command for details
- **Underscore Separator:** Adds underscore characters to pressure and temperature measurement data to separate the measurement value from the address header and optional engineering unit. See the **SU** command for details.
- **Tare Indicator:** Adds an uppercase ‘T’ character to pressure measurement data to indicate a tared value. See the **ZI** command for details.
- **Data Logger Format:** Converts measurement data to a predictable fixed-length and fixed-position format to simplify parsing by data loggers and other programmable serial hosts. See the **DL** command for details.
- **User-Defined Unit Label:** Lets you define the 4-character unit label to be used when the user-defined pressure unit is selected. See the **UM** command for details.

3.6 Data Logging

The optional Data Logging feature enables the MET4/MET4A to acquire and store measurement data for later retrieval. You can begin logging immediately, or use the real-time clock to start and stop the data logging process at a predetermined time and date. Windows PC software is provided to retrieve the stored data and save it to a file for easy import into popular analysis software such as Microsoft Excel. Refer to Section 7 for details.

3.7 Barometric Functions

The optional Barometric Functions feature enables the following industry-standard barometric functions: Field Pressure, Station Pressure, Sea-Level Pressure, Altimeter Setting, Density Altitude, Pressure Altitude, and Pressure Tendency Code. Refer to Section 8 for details.

3.8 Power Management

You can configure the MET4 to automatically switch to a low power “sleep” state after a user-defined period of serial inactivity, thus conserving power. When serial activity resumes, the unit will “awaken”, allowing normal operation. Refer to paragraph 6.16 for details.

3.9 Calibration

The MET4/MET4A is shipped fully calibrated. Pressure calibration data are shipped with the unit in printed form, and are stored within the device in non-volatile memory. These values should not be modified unless it is absolutely necessary, and then only with extreme caution. See Section 14 for details.

3.10 Model 715 Display

The MET4/MET4A can be used with the optional Model 715 Display to display pressure, air temperature, humidity, and user-defined alphanumeric information. The Model 715 can communicate with the MET4/MET4A via either RS-232 or RS-485. User-defined alphanumeric display information can be stored in the MET4/MET4A, or can be sent directly from the serial host to the Model 715 display. The MET4/MET4A supports several commands that control the Model 715 display. Refer to paragraphs 6.13 and 12.5 for details.

The MET4/MET4A is not compatible with the Model 710 display.

3.11 Real-time Clock

The MET4/MET4A features an on-board real-time clock. See paragraph 6.14 for details.

4 Quick Start

This section will help you to quickly set up the MET4/MET4A and take measurements to verify operation. We strongly recommend that MET4/MET4A system operation be verified prior to installation.

NOTE: The following instructions apply to Digiquartz® Interactive 2.0 version 1.2.0 or later.

1. INSTALL DIGIQUARTZ® INTERACTIVE (DQI) SOFTWARE

Using the Digiquartz® CD Library disk, install Digiquartz® Interactive software (DQI) on a Windows PC equipped with at least one RS-232 serial port.

2. CONNECT MET4/MET4A TO A PC RS-232 SERIAL PORT

Connect the MET4 serial cable to the MET4 or MET4A. Connect the serial cable to an RS-232 port of the Windows PC. Refer to paragraphs 12.3, 12.4, and 12.5 for more information about serial data connections.

NOTE: The optional cable and power adaptor kit (P/N 2367-0XX) will enable you to quickly and easily connect a Windows PC to the MET4/MET4A.

3. POWER THE UNIT

Apply DC power to the unit per the supplied Specification Control Drawing (SCD). Verify that power has been correctly applied by checking the power indicator on the status panel – it should be lit. If it is not lit, check applied voltage and wiring.

NOTE: The optional cable and power adaptor kit (P/N 2367-0XX) will enable you to quickly and easily power the MET4/MET4A.

4. ESTABLISH COMMUNICATIONS AND TAKE MEASUREMENTS

Run Digiquartz® Interactive (DQI) software. Select Configuration and Monitoring and click Next. Set the Search Type to RS-232/USB. If the RS-232 COM port number is known, set COM Port to that value; if the COM port number is unknown, set COM Port to All. Set Baud Rate to All. Click Begin Search. DQI will attempt to detect the MET4/MET4A, and if successful, will display its serial number and communications parameters. Click Next to proceed. Select the Numerical Display tab. Click Start to begin acquiring and displaying barometric pressure, temperature, and humidity measurements.

NOTE: If DQI fails to detect the MET4/MET4A, check for correct power and wiring. RS-232 communications can be monitored using the Status Panel. When the

PC sends data to the MET4/MET4A, the RS-232 RX indicator should flicker. When the MET4/MET4A sends data to the PC, the RS-232 TX indicator should flicker.

5 Operation

5.1 Overview

ASCII text commands are used to communicate with the MET4/META via RS-232 or RS-485. Commands generally generate an ASCII text response. Please refer to paragraphs 5.4, 5.5, and Section 6 for detailed information about commands and command responses.

Each command is sent with a Unit ID to specify the unit that is to carry out the command. A MET4/MET4A can operate alone, or multiple units can be connected together to form RS-232 and RS-485 networks. Each unit on a network must be set to a unique Unit ID. Refer to Section 9 for more information about networking, and paragraph 6.2 for more information about Unit ID.

The MET4/MET4A supports standard baud rates between 300 and 115,200 baud. The serial protocol is fixed at 8 data bits, no parity, and 1 stop bit. Refer to paragraph 6.2 for more information about serial communication parameters.

5.2 RS-232 Operation

The MET4/MET4A does not require special configuration is to communicate via the RS-232 port. Simply connect its RS-232 lines to the RS-232 port of your host device, set your host software or device to match the MET4/MET4A baud rate, set the serial protocol to 8 data bits, 1 stop bit, and no parity, and you are ready to begin sending commands. If you are using a generic terminal program, you must ensure that it is configured to output a carriage return and line feed when the Enter key is pressed. See Section 12 for wiring details.

Multiple MET4/MET4A units may be connected to a single RS-232 serial host via an RS-232 serial loop network. See Section 12 for network wiring details.

NOTE: The optional cable and power adaptor kit (P/N 2367-0XX) will enable you to quickly and easily connect a Windows PC or other standard RS-232 serial host to the MET4/MET4A.

5.3 RS-485 Operation

The MET4/MET4A does not require special configuration is to communicate via the RS-485 port. Simply connect its RS-485 lines to the RS-485 port of your host device, set your host software or device to match the MET4/MET4A baud rate, set the serial protocol to 8 data bits, 1 stop bit, and no parity, and you are ready to begin sending commands. If you are using a generic terminal program, you must ensure that it is configured to output a carriage return and line feed when the Enter key is pressed. Both two-wire and four-wire configurations are supported. See Section 12 for wiring details.

Multiple MET4/MET4A units may be connected to a single RS-485 serial host via an RS-485 multi-drop network. See Section 12 for network wiring details.

NOTE: The optional cable and power adaptor kit (P/N 2367-0XX) will enable you to quickly and easily connect a Windows PC or other standard RS-485 serial host to the MET4/MET4A.

CAUTION Extreme caution must be observed when configuring any device on a 2-wire RS-485 network for continuous data output from the RS-485 port (**P2, P4, P7, PP, Q2, Q4, MD=2, 3, 6, 7, 8, 10, or 12**). This is due to the half-duplex nature of 2-wire RS-485, which does not allow data to be simultaneously transmitted and received. If the baud rate is sufficiently low and the integration time is sufficiently short, no gaps will be present between the continuous transmissions, making it impossible for the serial host to transmit a command to the device. Recovery depends on the command issued. If **P2, P4, P7, PP, Q2, Q4** is issued, power can be cycled to regain control of the device. If **MD** was issued, it may be necessary to remove the device from the network and reconfigure it individually via the RS-232 port. As a precaution, always keep the baud rate as high as possible and the integration time as long as possible when setting up a 2-wire RS-485 network, and run tests to ensure that you will be able to regain control of the device should it be commanded to produce continuous data output.

5.4 Command and Response Basics

ASCII text commands are used to communicate remotely with the MET4/MET4A. The following basic tasks can be performed by sending the appropriate command:

- Take a measurement
- Perform a control function, such as changing the baud rate
- Set or read the value of an operating parameter, such as integration time

Measurement commands typically generate a response that contains the measurement data. Parameter-set commands typically generate a response that reports the updated parameter value. Parameter-read commands report the current parameter value.

When setting virtually all parameter values, you must precede the command with an **EW** command. This reduces the likelihood of accidental alteration of stored parameter values. Please refer to paragraph 6.1 for more information about the **EW** command.

In general, when a command is being processed and another command is received, the MET4/MET4A will abort the command in process and begin processing the second command, regardless of whether the commands are received via RS-232 or RS-485. However, when Fetch Mode is selected, measurement commands can

typically be received simultaneously on the RS-232 and RS-485 ports, allowing asynchronous access to measurement data from two serial hosts. Refer to paragraph 3.1.3 for more information about Fetch Mode.

NOTE: Due to internal resource limitations, commands sent simultaneously to both RS-232 and RS-485 ports may occasionally not generate a response. It is recommended that the serial host retry the command if this should occur.

5.5 Command and Response Format

Commands sent to and responses received from the MET4/MET4A are very similar, and are made up of the following:

START CHARACTER

The start character is an asterisk (ASCII 42).

DESTINATION ID

The destination ID is the Unit ID number of the device that is to receive the command or response. It is a two-digit integer between 00 and 99. ID 00 is reserved for the serial host, usually a PC.

SOURCE ID

The source ID is the Unit ID number of device that is sending the command or the response. It is a two-digit integer between 00 and 98. ID 00 is reserved for the serial host, usually a PC.

COMMAND OR RESPONSE DATA

A wide variety of commands and resulting response data are possible, depending on the particular command used. Refer to Section 6 for detailed information.

TERMINATION CHARACTERS

All commands must terminate with a carriage return (ASCII 13 decimal) followed by a linefeed (ASCII 10 decimal). All command responses are terminated in the same manner.

COMMAND FORMAT

Commands are typically sent in the following format. The **P3** command will be used in this example.

*0100P3CrLf

Where:	* = Start character	Asterisk, ASCII 42
	01 = Destination ID	Unit ID of the MET4/MET4A that is to receive the command.
	00 = Source ID	Unit ID of the device that is sending the command (Serial host is ID 00)
	P3 = Command	P3 is an example. Refer to Section 6 for descriptions of the entire command set.
	Cr = Carriage return	ASCII 13 decimal
	Lf = Linefeed character	ASCII 10 decimal

RESPONSE FORMAT

Responses are typically received in the following format:

*000114.4567CrLf

Where:	* = Start character	Asterisk, ASCII 42
	00 = Destination ID	Unit ID of the serial host that is to receive the response.
	01 = Source ID	Unit ID of MET4/MET4A that is responding
	14.4567 = Data	Data sent in response to the prior command
	Cr = Carriage return	ASCII 13 decimal
	Lf = Linefeed character	ASCII 10 decimal

These examples are typical, but other response forms exist. Refer to Section 6 for specific details regarding each available command.

5.6 Establishing RS-232/RS-485 Communications

The following are two methods of establishing and verifying RS-232 or RS-485 communications between the MET4/MET4A and a PC running Microsoft Windows[®].

USING DIGIQUARTZ[®] INTERACTIVE 2.0 SOFTWARE

The easiest way to establish RS-232 or RS-485 communications is by using DigiQuartz[®] Interactive 2.0 (DQI) software.

Step 1. Install DQI 2.0

Insert the DigiQuartz[®] CD Library CD into your PC CD-ROM drive, and follow the installation instructions to install DQI 2.0.

Step 2. Connect the MET4/MET4A to the PC

RS-232: Connect the MET4/MET4A RS-232 port to the PC RS-232 port. Refer to Section 12 for details.

RS-485: Connect the MET4/MET4A RS-RS-485 port to the PC RS-485 port using the four-wire method. Refer to Section 12 for details.

NOTE: The optional cable and power adaptor kit (P/N 2367-0XX) will enable you to quickly and easily connect a Windows PC or other standard RS-232/RS-485 serial host to the MET4/MET4A.

Step 3. Apply power to MET4/MET4A

Apply DC power to the MET4/MET4A per the supplied Specification Control Drawing (SCD). Verify that power has been correctly applied by checking the power indicator on the status panel – it should be lit. If it is not lit, check applied voltage and wiring.

NOTE: The optional cable and power adaptor kit (P/N 2367-0XX) will enable you to quickly and easily power the MET4/MET4A.

Step 4. Run DQI 2.0

Run DQI 2.0 software. Select Configuration and Monitoring and click Next. Set the Search Type to RS-232/USB or RS-485, depending on the type of serial connection being used. If the COM port number is known, set COM Port to that value; if the COM port number is unknown, set COM Port to All. Set Baud Rate to All. Click Begin Search. DQI will attempt to detect the MET4/MET4A, and if successful, will display its serial number and communications parameters. Click Next to proceed. Select the Numerical Display tab. Click Start to begin acquiring and displaying barometric pressure, temperature, and humidity measurements.

Refer to the DQI help feature for more information about using DQI.

NOTE: If DQI fails to detect the MET4/MET4A, check for correct power and wiring. RS-232 communications can be monitored using the Status Panel. When the PC sends data to the MET4/MET4A, the RS-232 RX indicator should flicker. When the MET4/MET4A sends data to the PC, the RS-232 TX indicator should flicker.

USING A TERMINAL PROGRAM

A standard terminal program can also be used to establish RS-232 or RS-485 communications with the MET4/MET4A. Digiquartz[®] Interactive 2.0 (DQI) includes a terminal program that is designed especially for communication with Digiquartz[®] Intelligent Devices. DQI is provided on the Digiquartz[®] CD Library disk.

Step 1. Install DQI 2.0

If you plan to use the DQI 2.0 terminal, and DQI 2.0 is not already installed, insert the Digiquartz® CD Library CD into your PC CD-ROM drive, and follow the installation instructions to install DQI 2.0.

Step 2. Connect the MET4/MET4A to the PC

RS-232: Connect the MET4/MET4A RS-232 port to the PC RS-232 port. Refer to Section 12 for details.

RS-485: Connect the MET4/MET4A RS-RS-485 port to the PC RS-485 port. Either the two-wire or four-wire method may be used. Refer to Section 12 for details.

NOTE: The optional cable and power adaptor kit (P/N 2367-0XX) will enable you to quickly and easily connect a Windows PC or other standard RS-232/RS-485 serial host to the MET4/MET4A.

Step 3. Configure the terminal program

If using a generic terminal program:

Set the COM port to the PC COM port number that you are using. Set the baud rate to match the MET4/MET4A. Set the communications protocol to 8 data bits, no parity, and 1 stop bit. If DQT is not being used, it is often necessary to configure the terminal program to append a line feed character to each carriage return character.

If using DQI 2.0:

Run DQI 2.0. Select Digiquartz Terminal, and click Next>>. Select Com Port from the Communications menu, and select the desired com port number. Select Baud Rate from the Communications menu, and select the current MET4/MET4A baud rate. Select Parity from the Communications menu, and select No parity, 8 data bits.

At this point, the terminal program should be able to communicate with the unit. Refer to Section 6 for detailed command and command response information. Refer to the DQT reference feature for detailed information about using DQT.

5.7 Setting and Reading Parameter Values

The behavior of the MET4/MET4A is controlled by several operating parameters. The values of these parameters are stored in non-volatile memory. Serial commands are provided to set and read the parameters values. Refer to Section 6 for detailed information about the various parameter commands.

SETTING PARAMETER VALUES

Most parameter-set commands must be preceded with the **EW** enable write command. The purpose of this is to reduce the chance of changing a parameter value by mistake. Parameter set commands will usually be ignored unless they are

preceded with an **EW** command. See paragraph 6.1 for more information about the **EW** command.

The following is an example of a parameter-set command preceded with the **EW** command. For this example, the **UN** (pressure unit) parameter will be set to a value of 1.

Command: *0100EW*0100UN=1CrLf
Response: *0001UN=1CrLf

Other writable parameters are typically set in the same way. Some parameters are read-only, and cannot be set.

READING PARAMETER VALUES

The following is an example of a parameter-read command. For this example, the **UN** (pressure unit) parameter will be read.

Command: *0100UNCrLf
Response: *0001UN=1CrLf

CAUTION Repeatedly setting or reading parameter values may temporarily prevent the optional Model 715 display from being updated.

5.8 Digiquartz[®] Software

Paroscientific provides several software programs that simplify common measurement and configuration tasks. These programs can be installed from the Digiquartz[®] CD Library disk provided with the MET4/MET4A. The latest versions of these and other software programs are also available at the Paroscientific web site at www.paroscientific.com.

5.8.1 Digiquartz[®] Interactive 2.0 (DQI)

OVERVIEW

Digiquartz[®] Interactive 2.0 (DQI) is a Windows program that makes it easy to communicate with and configure Digiquartz[®] Intelligent Devices. We encourage you to install and use DQI 2.0 to verify proper operation, configure your MET4/MET4A, take measurements, and experiment with its functions.

DQI 2.0 consists of two main sections, Configuration and Monitoring and Digiquartz[®] Terminal.

CONFIGURATION AND MONITORING SECTION

The Configuration and Monitoring section allows you to set up the MET4/MET4A and display measurement values without any knowledge of MET4/MET4A commands. With Configuration and Monitoring, you can:

- Establish communications MET4/MET4A on any available com port, at any supported Unit ID and baud rate value.
- Perform the most needed configuration functions.
- Store configuration data so that you can later restore the MET4/MET4A to the current configuration.
- Save or print a configuration report.
- Take measurements and display measurement data.
- Plot measurement data, and print graphs
- Log time-stamped measurement data to a file for analysis.

DIGIQUARTZ[®] TERMINAL SECTION

The DigiQuartz[®] Terminal section allows you to communicate directly with the MET4/MET4A at the most fundamental level using native commands. All possible configuration and measurement functions are available via the terminal interface. DigiQuartz Terminal is designed especially for communication with DigiQuartz[®] Intelligent Devices such as the MET4/MET4A.

HOW TO USE DQI 2.0

Refer to Section 4 for basic instructions. Refer to the help function in DQI for more information.

5.8.2 DigiQuartz[®] Assistant (DQA)

OVERVIEW

DigiQuartz[®] Assistant is a Windows data logging program. With DQA, you can log time-stamped measurement data from up to 8 DigiQuartz[®] Intelligent Devices. Measurement data can also be displayed in real time in an automatically scaled graph. Data is stored to a text file in a format that can easily be imported into popular PC programs such as Microsoft Word or Excel.

HOW TO USE DQA

Refer to the help function in DQA for more information.

5.8.3 Digiquartz[®] Data Download

NOTE: Digiquartz[®] Data Download can be used only if the MET4/MET4A was purchased with the Data Logging option.

OVERVIEW

Digiquartz[®] Data Download provides access to the logged data stored in the MET4/MET4A. The logged data may be transferred to a PC, and stored in a comma-separated value (CSV) format that can be easily imported into Microsoft Excel or other common software programs.

HOW TO USE DIGIQUARTZ[®] DATA DOWNLOAD

1. Connect the MET4/MET4A to the Windows PC via RS-232.
2. Apply power to the MET4/MET4A.
3. Set the Unit ID and baud rate values to match the MET4/MET4A. Set the COM port value to the Windows PC COM port being used.
4. Click the Start Download button, and specify the desired filename. Click the Ok button to begin the download. The download process can take several minutes, depending on the amount of data being downloaded and the baud rate. The Cancel Download button can be clicked at any time during the download to abort the process.

5.8.4 Digiquartz[®] SLP Configuration

NOTE: Digiquartz[®] SLP Configuration software can be used only if the MET4/MET4A was purchased with the Barometric Functions option.

OVERVIEW

Digiquartz[®] SLP Configuration provides the functions necessary to configure the unit to use the optional Sea-Level Pressure function.

Digiquartz[®] SLP Configuration performs the following functions:

- Transfer a pressure reduction ratio table from a PC text file to a MET4/MET4A .
- Transfer a pressure reduction ratio table from a MET4/MET4A to a PC text file.
- Set the temperature unit of the temperature values stored in a pressure reduction ratio table.
- Set the 12-hour average temperature value.
- Set the pressure reduction constant value.

HOW TO USE DIGIQUARTZ[®] SLP CONFIGURATION

To transfer a pressure reduction ratio table from a PC text file to a MET4/MET4A:

1. Connect the MET4/MET4A to the Windows PC via RS-232.
2. Apply power to the MET4/MET4A.
3. Set the Unit ID and baud rate values to match the MET4/MET4A. Set the COM port value to the Windows PC COM port being used.
4. Click the Detect Unit button to establish communications with the MET4/MET4A.
5. Click the Select File button, specify the desired file, and click Ok.
6. Click Get Table from PC File to read the pressure reduction ratio table from the specified file.
7. Click Save Table to Unit to save the pressure reduction ratio table to the MET4/MET4A.

To transfer a pressure reduction ratio table from the MET4/MET4A to a PC text file:

1. Connect the MET4/MET4A to the Windows PC via RS-232.
2. Apply power to the MET4/MET4A.
3. Set the Unit ID and baud rate values to match the MET4/MET4A. Set the COM port value to the Windows PC COM port being used.
4. Click the Detect Unit button to establish communications with the MET4/MET4A.
5. Click the Select File button, specify the desired file, and click Ok.
6. Click the Get Table From Unit button to read the pressure reduction table from the unit.
7. Click the Save Table to PC File button to save the pressure reduction table to the specified file.

To set the pressure reduction ratio table temperature unit, 12-hour temperature value, or pressure reduction constant value:

1. Connect the MET4/MET4A to the Windows PC via RS-232.
2. Apply power to the MET4/MET4A.
3. Set the Unit ID and baud rate values to match the MET4/MET4A. Set the COM port value to the Windows PC COM port being used.
4. Click the Detect Unit button to establish communications with the MET4/MET4A.
5. Change the Unit Configuration value(s) as desired.
6. Click the Save Displayed Values To Unit button to update the unit with the displayed configuration values.
7. You may optionally click the Get Current Values From Unit button to verify that the proper values were stored.

6 Command Reference

6.1 Enable Write Command

When setting virtually all parameter values, you must precede the parameter set command with an **EW** (enable write) command. Parameter set commands will usually be ignored unless they are preceded with an **EW** command.

EW Enables the next parameter set command to write a new value into non-volatile memory. You can issue **EW** as a separate command by terminating it with a carriage return/line feed, or you can string the **EW** and parameter set commands together, as shown below.

Typical syntax:	*0100EW *0100TR=800
Alternate syntax:	*0100EW *0100TR=800

NOTE: **EW** is only necessary when using commands to set a parameter value. It is not necessary to use **EW** to read a parameter value, or when using measurement commands.

6.2 Serial Communications Commands

The serial communications commands enable the baud rate and device ID to be set via the RS-232 or RS-485 ports.

BR Set the baud rate.

Typical command:	*9900BR=19200
Typical response:	*9900BR=19200 *9900BR=19200

BR is a set-only command. It is not possible to read the value of **BR**. **BR** must be sent to the global Unit ID 99. **BR** cannot be sent to an individual Unit ID. If the command was successful, two identical responses are received on the RS-232 port due to the nature of the serial loop networking protocol. If the command was unsuccessful, the response will only be the command sent. Supported baud rates are 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200 baud.

NOTE: Since **BR** is a global command, it produces no response on the RS-485 port.

BL Lock or unlock the baud rate.

Typical command: *9900EW*9900BL=1
Typical response: *9900EW
*0001BL=1
*9900BL=1

BL is a set-only command. It is not possible to read the value of **BL**. **BL** must be sent to the global ID 99. **BL** cannot be sent to an individual unit ID. If the command was successful, the responses on the RS-232 port include the **EW** command echo and a **BL** command response for each unit - this is due to the nature of the serial loop networking protocol. If the command was unsuccessful, the response will only be the command sent. Supported baud rates are 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200 baud.

NOTE: Since **BL** is a global command, it produces no response on the RS-485 port.

ID Set the Unit ID.

Typical command: *9900ID
Typical response: *9901ID

ID must be sent to the global ID 99.

RS-232 USAGE

With a single unit, **ID** sets the Unit ID of the unit to the source ID + 1. When used with a serial loop network, **ID** sets the Unit ID of the first unit to the source ID + 1. The unit then responds by incrementing the source ID. This behavior enables **ID** to set all units on the serial loop network to unique Unit ID values in ascending order, starting with the command source ID + 1. See paragraph 9.4 for more information regarding serial loop networking.

RS-485 USAGE

Use of the **ID** command is not recommended in RS-485 multi-drop networks, since all the units on the network would be set to the same Unit ID. To set a unique Unit ID for each unit to be used in a multi-drop network, set them one at a time prior to installing them in the network.

6.3 Measurement Commands

The following commands are used to initiate measurements, and to control measurement integration time.

6.3.1 Single Measurement Commands

The following commands are used to initiate single measurements. They return the resulting measurement value as soon as it is available.

P3 Sample and send one pressure measurement

Action: Measure pressure sensor temperature period and pressure period, calculate temperature-compensated pressure, send pressure value, and await next command.

Unit: As specified by **UN**

Typical command: *0100P3

Typical response: *000114.71234 (Value: 14.71234)

RH Send the most recent relative humidity measurement

Action: Relative humidity is sampled in the background every .6 seconds. **RH** returns the most recent relative humidity value.

Unit: Percent

Typical command: *0100RH

Typical response: *000123.45 (Value: 23.45)

NOTE: The **A2** command is the same as the **RH** command, and is included for backward compatibility with the MET3/MET3A.

TT Send the most recent air temperature measurement

Action: Air temperature is sampled in the background every .6 seconds. **TT** returns the most recent air temperature value.

Unit: °C

Typical command: *0100TT

Typical response: *000112.34 (Value: 12.34)

NOTE: The MET4/MET4A temperature measurement range is -50 to +60° C. Temperatures below -50°C will be reported as -50°C.

NOTE: The **A1** command is the same as the **TT** command, and is included for backward compatibility with the MET3/MET3A.

P9 Sample and send pressure, air temperature, and relative humidity measurement values.

NOTE: The MET4/MET4A will not respond to the **P9** command unless **UN** is set to 3 (bar).

Action: Measure pressure, get most recent air temperature and relative humidity measurements, send measurement data in a unified data string per NMEA specification, and await next command.

Unit: Pressure in bar, air temperature in °C, relative humidity in percent RH

Typical command: *0100P9

Typical response:

\$WIXDR,P,<P>,B,<SN>,C,<T>,C,<SN>,H,<H>,P,<SN>

The **P9** response is divided into a header and three measurement sections, one each for pressure, temperature, and humidity. Each measurement section consists of an identifier, a measurement value, a unit, and a transducer serial number, separated by commas. Each measurement section is separated from the previous section by a comma.

Header: Current value of **NH** (\$WI in the example) and XDR. See paragraph 6.11 for more details about the **NH** command.

Pressure:	Identifier:	P
	Value:	<P> in the example
	Unit:	bar (B)
	Serial number:	Pressure transducer serial number
Temperature:	Identifier:	C
	Value:	<T> in the example
	Unit:	°C
	Serial number:	Temp/humidity probe serial number
Humidity:	Identifier:	H
	Value:	<H> in the example
	Unit:	%RH
	Serial number:	Pressure transducer serial number

NOTE: The **P9** command is designed for use with individual MET4/MET4A units, and is not intended for use with RS-232 or RS-485 networks.

L1 Send measurement data, serial number, and fan status indication in a fixed format, comma delimited string. This format simplifies parsing of the returned data and enhances compatibility with commercial data loggers and similar equipment.

Action: Measure pressure, get most recent air temperature and relative humidity measurements, send measurement data, serial number, and fan status in a fixed format, comma delimited string.

Unit: Current pressure unit per UN, °C, %RH

Typical command: *0100L1

Typical response: *123456,+14.123456,+24.12,+46.6,1

Field	Position
Start Character "*" (asterisk)	1
Serial Number (SN)	2-7
Comma	8
Pressure data (P3)	9-18
Comma	19
Air Temperature data (TT)	20-25
Comma	26
Relative Humidity (RH) data	27-31
Comma	32
Fan Status (FS)	33
Carriage return/Line feed	34-35

Explicit signs are always returned for pressure, air temperature, and relative humidity measurement values. Pressure, air temperature, and relative humidity values are padded with leading and trailing zeros as required to maintain fixed field widths. The decimal point always appears in the same position within each field.

NOTE: The **L1** command may not be used in RS-232 serial loop networks.

**THE FOLLOWING ARE LOW-LEVEL MEASUREMENT COMMANDS
GENERALLY USED FOR DIAGNOSTIC PURPOSES:**

Q3 Sample and send one pressure sensor temperature measurement.

Action: Measure pressure sensor temperature period, calculate pressure sensor temperature, send pressure sensor temperature value, and await next command.

Unit: °F or °C, as selected by TU

Typical command: *0100Q3

Typical response: *000122.345 (Value: 22.345)

NOTE: Q3 is the pressure sensor temperature, and is mainly used for diagnostic purposes. Use **TT** or **A1** for air temperature measurements.

NOTE: Repeatedly issuing the **Q3** command will temporarily prevent the optional Model 715 display from being updated.

P1 Sample and send one pressure period measurement.

Action: Measure pressure period, send pressure period value, and await next command.

Typical command: *0100P1

Typical response: *000128.123456 (Value: 28.123456)

NOTE: Repeatedly issuing the **P1** command will temporarily prevent the optional Model 715 display from being updated.

Q1 Sample and send one pressure sensor temperature period measurement.

Action: Measure pressure sensor temperature period, send pressure sensor temperature period value, and await next command.

Unit: Microseconds

Typical command: *0100Q1

Typical response: *00015.1234567 (Value: 5.1234567)

NOTE: Repeatedly issuing the **Q3** command will temporarily prevent the optional Model 715 display from being updated.

6.3.2 Sample and Hold Measurement Commands

The following commands are used to initiate and send single sample and hold measurements. Measurement values are held until the next command is received. If the next command is a **DB** or **DS** command, the measurement value is sent; if it is any other command, the measurement value is lost. If a **DB** or **DS** command is received before the measurement command is complete, the measurement value will be sent as soon as it is available.

CAUTION Sample and hold commands will temporarily prevent the optional Model 715 display from being updated until the **DB** or **DS** command is received or the sample and hold command is cancelled by the next valid command.

P5 Sample and hold one pressure measurement.
Action: Measure temperature period, measure pressure period, calculate temperature-compensated pressure, save pressure value, and await **DB** or **DS** command.
Unit: As specified by **UN**
Typical command: *0100P5
Typical response: No response until **DB** or **DS** command is received

DB Dump Buffer. Send a held measurement value.
Action: If a measurement value is being held, send it - otherwise do nothing.
Typical command: *0100DB
Typical response: *000114.12345 (Value: 14.12345)

NOTE: The **DB** command can also be used globally on the RS-232 port. The MET4/MET4A will not respond to a global **DS** command on the RS-485 port.

DS Dump Sequential. Sequentially send a held measurement value.
Action: If a measurement value is being held, send it - otherwise do nothing.
Typical command: *9900DS
Typical response: *000114.12345 (From unit 1)
*000214.54321 (From unit 2)
*9900DS (Echoed **DS** command)

DS is useful only when acquiring measurement data from two or more units in an RS-232 serial loop network. **DS** ensures that measurements are returned in the order that units appear in the serial loop network. See paragraph 9.4 for more information about RS-232 serial loop networking.

NOTE: The MET4/MET4A will not respond to a global **DS** command on the RS-485 port.

**THE FOLLOWING ARE LOW-LEVEL MEASUREMENT COMMANDS
GENERALLY USED FOR DIAGNOSTIC PURPOSES:**

P6 Sample and hold one pressure period measurement.

Action: Measure pressure period, save pressure period value, and await **DB** or **DS** command.

Unit: Microseconds

Typical command: *0100P6

Typical response: No response until **DB** or **DS** command is received

Q5 Sample and hold one pressure sensor temperature measurement.

Action: Measure pressure sensor temperature period, calculate pressure sensor temperature, save value, and await **DB** or **DS** command.

Unit: °F or °C, as selected by **TU**

Typical command: *0100Q5

Typical response: No response until **DB** or **DS** command is received

Q6 Sample and hold one pressure sensor temperature period measurement.

Action: Measure pressure sensor temperature period, save value, and await **DB** or **DS** command.

Unit: Microseconds

Typical command: *0100Q6

Typical response: No response until **DB** or **DS** command is received

6.3.3 Continuous Measurement Commands

The following commands are used to initiate and control continuous measurements. Continuous measurement commands repeatedly take measurement samples and return measurement values until commanded to stop.

Continuous measurements are cancelled by sending any valid command.

P4 Continuously sample and send pressure measurement values.

Action: Continuously sample and send pressure measurement values, and repeat until commanded to stop.

Unit: As specified by **UN**

Typical command: *0100P4

Typical response: *000114.71234 (Value: 14.71234)

*000114.71235 (Value: 14.71235)

*000114.71234 ... (Value: 14.71234)

P7 Continuously send high-speed continuous pressure measurements.

Action: Continuously sample and send pressure measurement values, using temperature measurement interval specified by the current value of **PS**. **P7** automatically performs the following sequence:

1. Initially measure temperature period.
2. Measure pressure period.
3. Calculate temperature-compensated pressure using last temperature period measurement.
4. Send pressure value.
5. Do steps 2-4 the number of times specified by **PS**, then measure temperature period.
6. Repeat steps 2-5 until commanded to stop.

Unit: As specified by **UN**

Typical command: *0100P7

Typical response: *000114.71234 (Value: 14.71234)

*000114.71235 (Value: 14.71235)

*000114.71234 ... (Value: 14.71234)

NOTE: **P7** allows you to maximize the pressure sampling rate by taking temperature measurements at the interval specified by the **PS** command. Each subsequent pressure value is temperature-compensated using the currently stored temperature value. You can take a single initial temperature measurement, or you can take periodic temperature measurements at the interval you select with the **PS** command. Please refer to the **PS** command for more information.

NOTE: **P7** offers a performance advantage over **P4** only when in Sequential Integration Mode (**OI=1**). When in Simultaneous Integration Mode (**OI=0**), **P7** and **P4** are equivalent in terms of performance.

Refer to the P9 command for response format details.

PS Set or read the temperature measurement interval used by the P7 command.

Range: 1 to 65535

Default: 0

Unit: Pressure measurements

Typical command: *0100EW*0100PS=4

Typical response: *0001PS=4

Controls how often temperature measurements are taken during a **P7** pressure measurement sequence.

If **PS=0**, an initial temperature measurement is taken, and all subsequent pressure measurements are compensated using that value.

If **PS=1**, a temperature measurement is taken before each pressure measurement (same as **P4**).

If **PS=n** and $n > 1$, an initial temperature measurement is taken, and subsequent temperature measurements are taken after every n pressure measurements.

NOTE: When setting virtually all parameter values, you must precede the command with an **EW** (Enable Write) command. Please refer to paragraph 6.1 for more information.

PP Continuously sample and send pressure, air temperature, and relative humidity measurement values. **PP** produces the same output as **P9**, but does so in a continuous manner.

NOTE: The MET4/MET4A will not respond to the **PP** command unless **UN** is set to 3 (bar).

Action: Measure pressure, get most recent air temperature and relative humidity measurements, send measurement data in **P9** format, and repeat until commanded to stop.

Unit: Pressure in bar, air temperature in °C, relative humidity in percent

Typical command: *0100PP

Typical response: *000114.71234 (Value: 14.71234)

*000114.71235 (Value: 14.71235)

*000114.71234 ... (Value: 14.71234)

THE FOLLOWING ARE LOW-LEVEL MEASUREMENT COMMANDS GENERALLY USED FOR DIAGNOSTIC PURPOSES:

P2 Continuously sample and send pressure period measurement values.

Action: Measure pressure period, send pressure period value, and repeat until commanded to stop.

Unit: Microseconds

Typical command: *0100P2

Typical response: *000128.123456 (Value: 28.123456)

*000128.123457 (Value: 28.123457)

*000128.123456 ... (Value: 28.123456) (Cont.)

NOTE: The **P2** command will temporarily prevent the Model 715 display from being updated.

Q2 Continuously sample and send temperature period measurement values.

Action: Measure temperature period, send temperature period value, and repeat until commanded to stop.

Unit: Microseconds

Typical command: *0100Q2

Typical response: *00015.1234567 (Value: 5.1234567)

*00015.1234568 (Value: 5.1234568)

*00015.1234567 ... (Value: 5.1234567)

NOTE: The **Q2** command will temporarily prevent the Model 715 display from being updated.

Q4 Continuously sample and send temperature measurement values.

Action: Measure temperature period, calculate temperature, send temperature value, and repeat until commanded to stop.

Unit: °F or °C, as selected by **TU**

Typical command: *0100Q4

Typical response: *000122.345 (Value: 22.345)

*000122.346 (Value: 22.346)

*000122.345 ... (Value: 22.345)

NOTE: The **Q4** command will temporarily prevent the Model 715 display from being updated.

6.4 User-Defined Commands

The user-defined commands enable the user to define custom commands. All measurement options supported by the MET4/MET4A are available. Any combination of measurement options and text can be specified, and measurement values can be formatted per your specifications.

User-defined commands consist of an output mask command to define the command behavior, and an associated command to execute the output mask. Three independent user-defined commands are available. To use a user-defined command, the output mask must be defined using the **OM** command. The output mask typically contains some combination of command codes, text strings, and numeric

format specifiers, each separated by a comma. The **OF** command is used to execute the command defined by **OM**.

COMMAND CODES

Command codes are used in the output mask to produce measurement or text output when executed. The available command codes are listed in Figure 1 below.

Command Code	Description	Format Specifier?
P	Pressure	Y
TEMP	Air temperature	Y
RH	Relative humidity	Y
MINP	Minimum pressure	Y
MAXP	Maximum pressure	Y
MINPT	Minimum pressure time stamp	N
MINPD	Minimum pressure date stamp	N
MAXPT	Maximum pressure time stamp	N
MAXPD	Maximum pressure date stamp	N
TV	Tare value	N
TSA	Pressure measurement time reference	N
FSTAT	Fan status (valid for MET4A only)	N
FSPD	Fan RPM (valid for MET4A only)	N
PTEND	Pressure tendency code *	N
AS	Altimeter setting *	N
SP	Station pressure *	N
SLP	Sea-Level pressure *	N
PA	Pressure altitude *	N
FP	Field pressure *	N
DA	Density altitude *	N
ST	Sensor temperature	Y
PPER	Pressure period	Y
TPER	Temperature period	Y
PU	Pressure unit	N
TU	Sensor temperature unit	N
UA	Destination ID	N
HA	Source ID	N
DATE	Current date	N
TIME	Current time	N
HEAD	Same as STAR,UA,HA	N
CR	Carriage return	N
LF	Line feed	N
CRLF	Carriage return/line feed	N
STAR	Asterisk	N
SPACE	Space character	N
COMMA	Comma character	N
RESET	Set mask to default – must be used alone	N

* Available with Barometric Functions option only

Figure 1. Command Codes for User-Defined Commands

TEXT STRINGS

Text strings are literal text delimited by quote characters. They can be inserted at any location within the output mask. The most common use of text strings is to annotate command code outputs.

Example: “This is my text” will output “This is my text” (less the quote characters) when executed.

NUMERIC FORMAT SPECIFIERS

Numeric format specifiers are used to control the format of measurement value outputs. The command codes that can be used with numeric format specifiers are identified as such in Figure 2. Numeric format specifiers are placed immediately after the command code to which they apply.

Numeric format specifiers have the syntax x.y, where x and y are any number between 0 and 9.

The x value specifies the number of digits to the left of the decimal point that will be output. All digits to the left of the decimal point are always output regardless of the x value. If the x value is greater than the number of digits to the left of the decimal point, the output will be padded with leading zeros.

The y value specifies the number of digits to the right of the decimal point that will be output. If the y value is less than the number of digits to the right of the decimal point, the output will be rounded to the number of digits specified. If the y value is greater than the number of digits to the right of the decimal point, the output will be padded with trailing zeros.

Refer to Figure 2 for examples.

Value	Format specifier	Output
14.56789	1.5	14.56789
14.56789	5.5	00014.56789
14.56789	2.2	14.57
14.56789	2.7	14.5678900
14.56789	5.7	00014.5678900

Figure 2. User-defined numeric formatting examples

COMMANDS

OM Set or read the user-defined command output mask. Three output masks can be defined - **OM1**, **OM2**, and **OM3**. The number is optional - if no number is specified, **OM1** is assumed.

Range: 200 characters maximum.

Default: OM1 - STAR,HA,UA,P,CRLF

OM2 - STAR,HA,UA"“,P,”““,PU,CRLF

OM3 - STAR,"",P,"",PU,"",TIME:",TIME," DATE:",
DATE,CRLF

Typ. set command: *0100EW*0100OM="Pressure:",P,CRLF

Typ. set response: *0001OM="Pressure:",P,CRLF

Typ. read command: *0100OM

Typ. read response: *0001OM="Pressure:",P,CRLF

When the **OM** command is sent, the output mask is checked for syntax errors. If a syntax error is detected, an error code is returned, along with the output mask up to the point where the error was detected. The syntax error will be between the last comma and the end of the returned output mask. Refer to Figure 3 for the list of **OM** error codes and their descriptions.

OM Error Code	Description
O1	Unrecognized command
O2	Missing quote character
O3	Output mask too long
O4	RESET mixed with other command codes
O5	Bad format specifier

Figure 3. OM command error codes

OF Executes the associated user-defined command output mask. **OF1**, **OF2**, and **OF3** execute output masks defined by **OM1**, **OM2**, and **OM3**, respectively. The number is optional - if no number is specified, **OF1** is assumed.

Typical command: *0100OF

Typical response: Pressure: 14.12345

The **OF** command processes command codes in the order that they appear in the output mask. The output for each command code is sent as it is processed.

6.5 Pressure Measurement Integration Time Commands

The MET4/MET4A supports two pressure integration modes: time-based and period-based. Time-based integration samples the transducer pressure and temperature signals for a specified time, and is the recommended integration mode. Period-based integration samples the signals for a specified number of periods of the measured signal, and is included to provide compatibility with earlier Digiquartz® Intelligent Devices that do not support time-based integration. See paragraph 10.5 for information regarding the relationships between integration time, resolution, and sampling rate.

The desired integration mode is automatically selected depending on which integration time set command is issued. For example, when a **PI** or **TI** set command is received, the MET4/MET4A is configured for time-based integration mode; when a **PR** or **TR** set command is received, it is configured for period-based integration. The selected mode remains in effect until it is changed.

TIME-BASED INTEGRATION

PI and **TI** are the time-based integration time commands for pressure and temperature signal integration. The advantage of **PI** and **TI** is that the integration time is not a function of measured period, and is consistent from unit to unit. This allows you to synchronize measurements from two or more Digiquartz® Intelligent Devices that support time-based integration. The resolution of **PI** and **TI** is approximately 1ms.

PERIOD-BASED INTEGRATION

PR and **TR** are the period-based integration time commands for pressure and temperature signal integration. **PR** and **TR** have been made obsolete by **PI** and **TI**, but remain available for compatibility with older units. The resolution of **PR** is approximately 3ms, and **TR** is approximately 1ms.

TIME-BASED INTEGRATION TIME COMMANDS

PI Set or read the time-based pressure measurement integration time.

Units: Milliseconds

Range: 1 to 290000. Resolution is 1 millisecond.

Default: 666

Typical set command: *0100EW*0100PI=1000

Typical set response: *0001PI=1000

Typical read command: *0100PI

Typical read response: *0001PI=1000

NOTE: Whenever the value of **PI** is changed, **TI** is automatically updated with the same value.

TI Set or read time-based temperature measurement integration time
Units: Milliseconds
Range: 1 to 290000. Resolution is 1 millisecond.
Default: 666
Typical set command: *0100EW*0100TI=1000
Typical set response: *0001TI=1000
Typical read command: *0100TI
Typical read response: *0001TI=1000

NOTE: Whenever the value of **PI** is changed, **TI** is automatically updated with the same value. Changing **TI** has no effect on **PI**. **TI** should be set to the value as **PI** for optimum performance in most applications.

PERIOD-BASED INTEGRATION TIME COMMANDS

PR Set or read period-based pressure measurement integration time
Range: 1 to 16383
Default: 238
Typical set command: *0100EW*0100PR=200
Typical set response: *0001PR=200
Typical read command: *0100PR
Typical read response: *0001PR=200

NOTE: Whenever the value of **PR** is changed, **TR** is automatically updated with the value of **PR** times 4.

TR Set or read period-based temperature measurement integration time
Range: 1 to 65535
Default: 952
Typical set command: *0100EW*0100TR=800
Typical set response: *0001TR=800
Typical read command: *0100TR
Typical read response: *0001TR=800

NOTE: Whenever the value of **PR** is changed, **TR** is automatically updated with the value of **PR** times 4. Changing **TR** has no effect on **PR**. **TR** should be set to the value as **PR** times 4 for optimum performance in most applications.

6.6 Pressure Measurement Mode Commands

Pressure measurement mode commands control the way the MET4/MET4A acquires pressure measurements.

OI Select Sequential or Simultaneous pressure integration

Action: The **OI** command is used to select Sequential or Simultaneous pressure integration. When Simultaneous Integration is selected, the pressure and temperature periods are integrated simultaneously, resulting in increased data rates without sacrificing measurement resolution. When Sequential Integration is selected, the temperature period is integrated first, followed by the pressure period. This is the measurement scheme traditionally used in DIGIQUARTZ® intelligent devices. **OI** has no effect on air temperature or relative humidity measurements.

Pressure measurements.

Values: 0 = Simultaneous Integration
1 = Sequential Integration

Default: 1

Typical set command: *0100EW*0100OI=1

Typical set response: *0001OI=1

Typical read command: *0100OI

Typical read response: *0001OI=1

NOTE: When Simultaneous Integration is selected, the time needed to acquire a pressure measurement is controlled by the greater of the pressure and temperature integration times.

FM Set or read pressure measurement mode

Action: The **FM** command is used to select Trigger Mode or Fetch Mode. When in Trigger Mode, the unit initiates a new pressure measurement when the measurement command is received. This is the mode in which DIGIQUARTZ® Intelligent devices have traditionally operated. In Fetch Mode, pressure measurement data is continuously acquired in the background, and the unit responds immediately to pressure measurement commands with the most recent measurement value.

Fetch Mode also enables measurement commands to be processed simultaneously on both RS-232 and RS-485 ports. Refer to paragraph 3.1.3 for more information.

Values: 0 = Unit operates in Trigger Mode
1 = Unit operates in Fetch Mode

Default: 0

Typical set command: *0100EW*0100FM=1
Typical set response: *0001FM=1
Typical read command: *0100FM
Typical read response: *0001FM=1

NOTE: Due to internal resource limitations, commands sent simultaneously to both RS-232 and RS-485 ports may occasionally not generate a response. It is recommended that the serial host retry the command if this should occur.

6.7 Minimum/Maximum Pressure Commands

The Minimum/Maximum Pressure Commands return the minimum and maximum pressure measurement values. The time and date at which the minimum and maximum pressure measurements were taken is also available.

M1 Return minimum pressure measurement value

Units: Current pressure unit

Typical read command: *0100M1

Typical read response: *0001M1=14.12345 (Value: 14.54321)

M2 Return the time and date stamp for the minimum pressure measurement

Units: Date and time

Typical read command: *0100M2

Typical read response: *0001M2=02/10/04 03:48:19 PM

NOTE: The date and time formats are controlled by the **GD** and **GT** commands. Refer to paragraph 6.14 for more information.

M3 Return minimum pressure measurement value

Units: Current pressure unit

Typical read command: *0100M3

Typical read response: *0001M3=14.12345 (Value: 14.54321)

M4 Return the time and date stamp for the minimum pressure measurement

Units: Date and time

Typical read command: *0100M4

Typical read response: *0001M4=02/10/04 03:48:19 PM

NOTE: The date and time formats are controlled by the **GD** and **GT** commands, respectively. Refer to paragraph 6.14 for more information.

MR Reset the minimum and maximum pressure measurement values

Units: Current pressure unit

Typical command: *0100MR

Typical response: *0001MR>OK

When the **MR** command is received, the minimum and maximum pressure values will be set to the next pressure measurement value.

NOTE: **M1** and **M3** are reset to the next pressure measurement value whenever power is cycled, tare is initiated or disabled, or coefficients/parameters that effect the pressure value are changed (**C1, C2, C3, D1, D2, PA, PM, TC, T1, T2, T3, T4, T5, U0, Y1, Y2, Y3**).

6.8 Data Output Mode Command

The data output mode command controls the continuous serial output of pressure measurement data.

MD Set or read the data output mode.

Action: **MD** configures the MET4/MET4A for continuous measurement data, Model 715 display data output, and fan status indication.

Once **MD** is set, the specified function will remain in effect until **MD** is set to a different value, even through a power cycle. Therefore, the MET4/MET4A will generally perform the specified function whenever power is applied.

FUNCTIONS

Display Output – Transmits Model 715 display data from the RS-232 or RS-485 port, depending on the value of **DO**.

Serial Data Output – Transmits the specified serial data type from the RS-232 or RS-485 port, depending on the value of **DO**.

Fan Status – Appends a plus sign (+) to **TT** (or **A1**) response data if the fan is not operating properly.

Range: See table.

MD value	Display output	Serial data output	Serial data type	Fan Status
0	OFF	OFF	-	N
1	ON	OFF	-	N
2	OFF	ON	Pressure	N
3	ON	ON	Pressure	N
4	OFF	OFF	-	Y
5	ON	OFF	-	Y
6	OFF	ON	Pressure	Y
7	ON	ON	Pressure	Y
8	OFF	ON	OM (OM1)	N
10	OFF	ON	OM2	N
12	OFF	ON	OM3	N

Default: 1

Typical set command: *0100EW*0100MD=1

Typical set response: *0001MD=1

Typical read command: *0100MD

Typical read response: *0001MD=1

Under the following circumstances, continuous serial data will be temporarily suspended:

- Whenever a measurement command is received. Continuous data output resumes when the measurement command is complete.
- While a continuous measurement command (**P2**, **P4**, **P7**, **Q2**, **Q4**) is in effect. Continuous pressure data output resumes when the measurement command is cancelled.

6.9 Unit Commands

Unit commands are used to specify the unit to be used when calculating pressure or sensor temperature values, and to configure the user-defined pressure unit.

UN Set or read the pressure unit.

Action: Sets or reads the unit of all pressure values displayed and output via the serial ports.

Range: 0 to 8. See Figure 4 for available pressure units

Default: 1

Typical set command: *0100EW*0100UN=2

Typical set response: *0001UN=2

Typical read command: *0100UN

Typical read response: *0001UN=2

UN value	Pressure unit	Conversion factor
0	User-defined pressure unit	Value of UF
1	psi	1.0000000
2	hPa (mbar)	68.94757
3	bar	0.06894757
4	kPa	6.894757
5	MPa	0.00689476
6	in Hg	2.036021
7	mm Hg (Torr)	51.71493
8	m H ₂ O	0.7030696

Figure 4. Pressure units and conversion factors

Setting **UN** to a non-zero value selects one of eight standard pressure units. Setting **UN** to 0 selects a user-defined unit whose conversion factor is specified by the **UF** command.

The native pressure unit of the MET4/MET4A is psi. When a different pressure unit is specified, the pressure value in psi is first calculated, and then converted to the desired unit by multiplying by the appropriate conversion factor.

UF Set or read the user-defined pressure unit conversion factor.

Action: When **UN**=0, calculated pressure values in psi are multiplied by the value of **UF** before being output, thus scaling pressure values in the desired user-defined pressure unit.

Range: -9999999 to 9999999

Default: 1.000000

Typical set command: *0100EW*0100UF=2

Typical set response: *0001UF=2.000000

Typical read command: *0100UF

Typical read response: *0001UF=2.000000

TU Set or read the sensor temperature unit.

Action: Specifies the temperature units for **Q3**, **Q4**, **Q5**, and displayed sensor temperature data.

Range: 0 = °C
1 = °F

Default: 0

Typical set command: *0100EW*0100TU=1

Typical set response: *0001TU=1

Typical read command: *0100TU

Typical read response: *0001TU=1

NOTE: The native sensor temperature unit of the MET4/MET4A is °C, and is converted to °F if **TU**=1.

6.10 Tare Commands

Tare is the process of subtracting a specified value from pressure measurements. You may use the current measured pressure as the tare value, or you may specify any desired value. Tare can also be enabled, disabled, and locked out through the use of serial commands. Serial pressure measurement data can be formatted to include an indication when tare is in effect. Refer to the **ZI** command for more information.

ZS Set or read the tare state parameter value.

Action: The three states of **ZS** are as follows:

- ZS**=0 Tare function is off.
- ZS**=1 Tare has been requested, but is not yet in effect.
- ZS**=2 Tare is in effect

(Cont.)

ZS is set to 0 on power-up. If **ZL**=0 (tare is not locked out), tare can be requested by setting the **ZS** to 1. At the first pressure measurement following a tare request, the following sequence occurs:

- The pressure value is stored in the **ZV** parameter.
- The value of **ZS** is set to 2 to indicate that tare is in effect.
- The value of **ZV** is subtracted from all subsequent pressure values until tare is turned off.

If tare is already in effect when a **ZS**=1 command is issued, the sequence described above occurs at the next pressure measurement, and tare continues using a new value of **ZV**.

Tare can be turned off by issuing a **ZS**=0 command.

Range: 0 to 2

Default: 0

Typical set command: *0100EW*0100ZS=1

Typical set response: *0001ZS=1

Typical read command: *0100ZS

Typical read response: *0001ZS=1

ZV Set or read the tare value.

Action: Sets or reads the value that is subtracted from pressure measurements when tare is activated. **ZV** can be set to any desired value when tare is in effect (**ZS**=2). Note, however, that if tare is subsequently requested, a new value will overwrite the **ZV** value you have set. The value of **ZV** is set to 0 on power-up.

Range: -9999999 to 9999999

Default: 0

Typical set command: *0100EW*0100ZV=14.7123

Typical set response: *0001ZV=14.7123

Typical read command: *0100ZV

Typical read response: *0001ZV=14.7123

ZL Set or read the tare lockout parameter value.

Action: When **ZL**=0, **ZS** can be set to enable and disable tare. When **ZL**=1, tare is locked, and the value of **ZS** cannot be modified via serial commands or the Tare Input I/O line. However, if **ZS**=1 and a **ZL**=1 command is issued, tare will be in effect when the next

pressure measurement is taken, but you cannot turn tare off until **ZL** is set to 0. The value of **ZL** is set to 0 on power-up.

Range: 0 or 1

Default: 0

Typical set command: *0100EW*0100ZL=1

Typical set response: *0001ZL=1

Typical read command: *0100ZL

Typical read response: *0001ZV=1

6.11 Measurement Data Formatting Commands

These commands are used to alter the format of serial measurement data. The following data formatting functions are available:

- Append engineering unit label to measurement data.
- Append a tare indication to tare pressure measurement data.
- Add underscores to separate the measurement data from the rest of the serial output data string to improve readability.
- Add trailing zeroes to the measurement data to create a fixed-length data string to simplify parsing.

Formatting commands can be used separately or in any combination.

US Set or read the engineering units suffix parameter value.

Action: When **US**=1, a unit label is appended to measurement data. When **US**=0, no unit label is appended.

Range: 0 or 1

Default: 0

Typical set command: *0100EW*0100US=1

Typical set response: *0001US =1

Typical read command: *0100US

Typical read response: *0001US =1

Examples:

*000114.71234psia (Pressure measurement, **US**=1)

*000121.123C (Temp measurement, **US**=1)

*0001.00015psia/sec (Pressure rate measurement, **US**=1)

When **US**=1, a pressure unit label is appended to pressure measurement values according to the value of **UN**: (Cont.)

UN value	Label
0	Defined by UM
1	psia, psig, or psid
2	hPa
3	bar
4	kPa
5	MPa
6	inHg
7	mmHg
8	mH2O

When **US=1**, a temperature unit label is appended to temperature measurement values according to the value of **TU**:

TU value	Label
0	C
1	F

SU Set or read the underscore separator parameter value.

Action: When **SU=1**, an underscore separates the measurement data from the address header and the optional unit suffix. When **SU=0**, no underscore separators appear.

Range: 0 or 1

Default: 0

Typical set command: *0100EW*0100SU=1

Typical set response: *0001SU=1

Typical read command: *0100SU

Typical read response: *0001SU=1

Examples: *000114.71234 (SU=0)
 *0001_14.71234 (SU=1)
 *0001_14.71234_psia (SU=1, US=1)

ZI Set or read the tare indication parameter value.

Action: When **ZI=1**, a “T” is appended to pressure measurement values when tare is in effect. When **ZI=0**, no tare indication appears, whether tare is in effect or not.

Range: 0 or 1
 Default: 0
 Typical set command: *0100EW*0100ZI=1
 Typical set response: *0001ZI=1
 Typical read command: *0100ZI
 Typical read response: *0001ZI=1

Examples: *000114.71234 (ZI=0)
 *000114.71234T (ZI=1)
 *0001_14.71234T (ZI=1, SU=1)
 *000114.71234Tpsia (ZI=1, US=1)
 *0001_14.71234T_psia (ZI=1, US=1, SU=1)

DL Set or read the fixed field data format parameter.

Action: When **DL**=1, measurement data is formatted in a fixed field format. When **DL**=0, measurement data is given in the standard format.

The fixed field format is specified as follows:

*AAAASDDDDDDDDDD, where

- * = the asterisk character
- A = destination and source address characters
- S = sign of pressure data, either + or -
- D = numeric representation of pressure data, either digits or a decimal point

Range: 0 or 1
 Default: 0
 Typical set command: *0100EW*0100DL=1
 Typical set response: *0001DL=1
 Typical read command: *0100DL
 Typical read response: *0001DL=1

Examples: *000114.71234 (Pressure, **DO**=0)
 *0001+14.7123400 (Pressure, **DO**=1)
 *000121. 123 (Temperature, **DO**=0)
 *0001+21.1230000 (Temperature, **DO**=1)

(Cont.)

NOTE: The format specification and examples shown above assume that the other formatting commands are disabled. If other formatting commands are used in combination with **DL**, a fixed field format will still result, but the format will vary slightly from the one described above.

UM Set or read the user-defined unit label parameter.

Action: When **UN**=0 and **US**=1, the text value of **UM** is appended to pressure measurements.

Range: Any text up to four characters, consisting of ASCII 32 to ASCII 127.

Default: user

Typical set command: *0100EW*0100UM=test

Typical set response: *0001UM=test

Typical read command: *0100UM

Typical read response: *0001UM=test

Examples: *000114.71234 (UN=0, US=0)
*000114.71234user (UN=0, US=1, UM=user)

NH Set or read the NMEA header used by the **P9** and **PP** commands.

Range: Any text up to seven characters, consisting of ASCII 32 to ASCII 90, except "*" and "=".

Default: \$WI

Typical set command: *0100EW*0100NH=\$PASHS,

Typical set response: *0100NH=\$PASHS,

Typical read command: *0100NH

Typical read response: *0100NH=\$PASHS,

Examples: *000114.71234 (UN=0, US=0)
*000114.71234user (UN=0, US=1, UM=user)

NOTE: In the example above, the resulting P9 and PP header will be \$PASHS,XDR.

NOTE: Unused characters are nulls, not spaces.

6.12 Unit Identification Commands

The Unit Identification commands read various unit-specific parameters. These parameters are factory-set, and cannot be modified.

SN Read the serial number.

Action: The **SN** parameter contains the device serial number. **SN** is a read-only command.

Typical read command: *0100SN

Typical read response: *0001SN=12345

VR Read the firmware version number.

Action: The **VR** parameter contains the device firmware version number. **VR** is a read-only command.

Typical read command: *0100VR

Typical read response: *0001VR=D1.02

MN Read the model number.

Action: The **MN** parameter contains the device model number as a text string. The value of **MN** always contains 16 characters. If the model number is less than 16 characters, the string will be padded with trailing spaces to a length of 16 characters. **MN** is a read-only command.

Typical read command: *0100MN

Typical read response: *0001MN=MET4A

H1 Read the temperature/humidity probe serial number.

Action: Return the temperature/humidity probe serial number.

Typical read command: *0100H1

Typical read response: *0001H1=1234567

PF Read the full-scale pressure value.

Action: The **PF** parameter contains the full-scale pressure value in the current pressure units. If the units are changed, the value of **PF** is scaled accordingly. **PF** is a read-only command.

Typical read command: *0100PF

Typical read response: *0001PF=30.00000

PO Read the pressure transducer type.

Action: The **PO** parameter contains the pressure transducer type. **PO** is a read-only command.

PO value	Transducer type
0	Absolute

Typical read command: *0100PO

Typical read response: *0001PO=0

6.13 Model 715 Display Configuration Commands

The Display Configuration commands allow you to alter the information shown on the optional Model 715 display.

DM Set or read the display mode value. The display mode determines what information, if any, is shown on the second line of the Model 715 display.

Action: **DM** sets the second line of the Model 715 display to the desired mode. Refer to Figure 5 for the available display modes and associated **DM** values.

Range: 0 to 18

Default: 0

Typical set command: *0100EW*0100DM=6

Typical set response: *0001DM=6

Typical read command: *0100DM

Typical read response: *0001DM=6

DM Value	Second Line Display Mode
0	Bar Graph
1	Sensor Temperature
2	Stored Text (UL)
3	No second Line
4	External Text (DT)
5	Current Tare Value
9	Minimum Pressure
10	Maximum Pressure
11	Altimeter Setting
12	Field Pressure
13	Station Pressure
14	Sea-Level Pressure
15	Density Altitude
16	Pressure Altitude

DM Value	Second Line Display Mode
17	QNH
18	QFE
19	Pressure Tendency
20	Relative Humidity / Air Temperature

Figure 5. Display modes

DO Set or read the display output port.

Action: **DO** selects which serial port (RS-232 or RS-485) will produce data for the Model 715 display. The other serial port is normally used for communication with a host device, such as a PC.

Range: 0 or 1

Default: 0

Typical set command: *0100EW*0100DO=1

Typical set response: *0001DO=1

Typical read command: *0100DO

Typical read response: *0001DO=1

DO Value	RS-232 port	RS-485 port
0	Measurement data	715 Display data
1	715 Display data	Measurement data

DP Set or read the maximum number of decimal places in the displayed pressure value.

Action: **DP** sets the maximum number of decimal places in the displayed pressure value. Fewer decimal places will be displayed if the pressure resolution and/or pressure unit will not provide the specified number of decimal places. When **DP** is set to 6, the maximum number of decimal places is always displayed, according to current pressure resolution.

Range: 0 to 6

Default: 6

Typical set command: *0100EW*0100DP=6

Typical set response: *0001DP=6

Typical read command: *0100DP

Typical read response: *0001DP=6

DT Set the text to be displayed on the second line when the External Text display option (**DM=4**) is selected. Use **DT** when the MET4/MET4A is to be controlled by an RS-232 serial host, and the text must be updated frequently.

Action: **DT** allows a serial host (such as a PC) to send text to be displayed on the bottom line. The text sent using **DT** is not stored by the MET4/MET4A; it is simply transferred to the Model 715 display. **DT** cannot be queried, and it is not necessary to precede **DT** with an **EW** command. The text is lost when the MET4/MET4A is powered off.

Range: 16 characters maximum. Any characters in the range of ASCII 32 to ASCII 127 are legal.

Typical set command: *0100DT=This is my text

Typical set response: *0001DT=This is my text

PL Read the overpressure indication setpoint. This setpoint is used to determine the pressure at which the overpressure indication is displayed. **PL** is a factory-set, read-only command.

Action: When the MET4/MET4A measures a pressure greater than the value of **PL**, an overpressure indication is displayed.

Typical read command: *0100PL

Typical read response: *0001PL=120.0000

NOTE: **PL** is typically factory-set to the overpressure limit as specified in the Specification Control Drawing for the Digiquartz[®] transducer.

UL Set or read the text to be displayed on the second line when the Stored Text display option (**DM=2**) is selected.

Action: **UL** defines the text to be displayed on the bottom line. The value of **UL** is stored in non-volatile memory, and will therefore be retained even if power is lost.

Range: 11 characters maximum. Any characters in the range of ASCII 32 to ASCII 127 are legal.

Default: 11 space characters

Typical set command: *0100EW*0100UL=My label

Typical set response: *0001UL=My label

Typical read command: *0100UL

Typical read response: *0001UL=My label

CAUTION Do not use **UL** if it is necessary to update the displayed text often; use the External Text display option and the **DT** command instead. The nonvolatile memory used to store the text data can be written approximately 100,000 times; excessive use of **UL** will eventually result in the inability to change its value.

6.14 Date and Time Commands

The date and time commands set, read, and format the date and time. The formatting commands apply to all date and time outputs and displays.

NOTE: The time and date settings will be retained for up to two weeks after power is lost. If the unit is un-powered for two weeks or more, the time and date settings may need to be updated.

GD Set and read the date format

Action: Sets and reads the date format.

Range: **GD=0** MM/DD/YY
GD=1 DD/MM/YY

Typical set command: *0100EW*0100GD=1

Typical set response: *0001GD=1

Typical read command: *0100GD

Typical read response: *0001GD=1

GT Set and read the time format

Action: Sets and reads the time format.

Range: **GT=0** HH/MM/SS XX, where XX=AM or PM
GT=1 HH/MM/SS (24 hour format)

Typical set command: *0100EW*0100GT=1

Typical set response: *0001GT=1

Typical read command: *0100GT

Typical read response: *0001GT=1

GR Set and read the date and time. Date and time are set and read according to the current format settings.

Action: Sets and reads the current date and time.

The following examples assume **GD=0** and **GT=0**. (Cont.)

Typical set command: *0100EW*0100GR=04/05/04 03:53:00 PM
Typical set response: *0001GR=04/05/04 03:53:00 PM
Typical read command: *0100GR
Typical read response: *0001GR=04/05/04 03:53:00 PM

NOTE: **GR** set commands must be sent per the current date and time format settings. All punctuation and space characters must be included as shown. Improperly formatted **GR** set commands will not be carried out.

6.15 Fan Monitor Commands (MET4A only)

Fan monitor commands allow you to determine the operational status of the fan within the solar radiation shield of the MET4A. The commands are functional in the MET4, but are meaningless.

FS Read the current fan status.

Action: Reads the fan RPM, compares it to a factory-set limit, and returns a pass/fail status.

Range: 0 = Fan running below acceptable speed
1 = Fan running at or above acceptable speed

Typical read command: *0100FS
Typical read response: *0001FS=1

FR Read the current fan speed.

Action: Reads and returns the fan RPM.
Unit: RPM

Typical read command: *0100FR
Typical read response: *0001FS=3200

FL Read the factory-set fan RPM limit.

Action: Reads and returns the fan RPM.
Unit: RPM

Typical read command: *0100FL
Typical read response: *0001FL=3000

6.16 Power Management Commands

The MET4 can be commanded to enter a reduced-power Sleep Mode during periods of serial port inactivity. The unit “awakens” 0.6 seconds after a single serial character is received on either port. Since the unit is “asleep” when the wake-up character is received, that character will be lost, and will not be interpreted as being part of a command. It is therefore necessary to send a character and wait at least 0.6 seconds before sending a command to an intelligent device that is in Sleep Mode.

CAUTION Power management features are not available if **MD** is set for continuous pressure data output or display data output, or Fetch Mode is enabled (**FM=1**).

NOTE: The power management commands are available in the MET4A, but are not particularly useful since its fan continues to run and consume considerable current.

SL Set or read the sleep mode enable state.

Action: Allows sleep mode to be enabled or disabled. When sleep mode is enabled, the device will enter sleep mode when both serial ports have received no characters for the number of seconds specified by the value of **ST**. When sleep mode is disabled, the device cannot enter sleep mode.

Range: 0 = sleep mode disabled
1 = sleep mode enabled

Default: 0

Typical set command: *0100EW*0100SL=1

Typical set response: *0001SL=1

Typical read command: *0100SL

Typical read response: *0001SL=1

NOTE: If **MD** is set for continuous pressure data output or display data output, or Fetch Mode is enabled (**FM=1**), the device will never enter sleep mode regardless of the values of **SL** or **ST**.

ST Set or read the sleep mode timeout length.

Action: When **SL=1**, the device enters sleep mode if both serial ports have received no characters for **ST** seconds.

Units: Seconds

Range: 5 to 255, integer values only.

Default: 10

Typical set command: *0100EW*0100ST=5 (Cont.)

Typical set response: *0001ST=5
Typical read command: *0100ST
Typical read response: *0001ST=5

6.17 Time Reference Stamp Command

The MET4/MET4A can include a time reference stamp to help you determine when the pressure or period measurement was taken, relative to the transmission of the measurement command response. The time reference value reported is the time interval between the midpoint of the integration period and the start of the transmission of the first ASCII character of the response data.

TS Enables and disables the time reference stamp feature. The **TS** command affects the following measurement commands: **P1, P2, P3, P4, P5, P6, P7, Q1, Q2, Q3, Q4, Q5, and Q6**.

Action: When is enabled, a comma delimited time reference stamp is appended to the measurement values returned by the aforementioned commands, expressed in microseconds.

Range: 0 = Time reference stamp disabled
1 = Time reference stamp enabled

Typical set command: *0100EW*0100TS=1
Typical set response: *0001TS=1
Typical read command: *0100TS
Typical read response: *0001TS=1

The time reference value reported is the time interval between the midpoint of the integration period and the start of the transmission of the first ASCII character of the response data, expressed in microseconds. **DL=1** pads the time reference stamp value to 9 digits.

NOTE: The time reference stamp feature is not compatible with fetch mode. If **FM=1** (fetch mode active), >ERR:S1 is returned instead of the time reference stamp value.

Examples:

(Pressure = 14.74638, time reference stamp = 500637 microseconds)

P3 response, **DL=0**: *000114.74638,500637
P3 response, **DL=1**: *0001+14.746380000,000500637

Transmission delay

The response data as seen by the serial host is delayed by the time it takes to transmit the data. For high accuracy applications, it is necessary to

compensate for this delay. The formula for calculating the transmission delay time is as follows:

$$T = (N * 10) (1E6/BR)$$

Where: T = transmission delay in microseconds

N = number of characters transmitted

BR = baud rate

Don't forget to consider the carriage return and line feed characters when determining the number of characters transmitted.

Processing delay

For high accuracy applications, it is also necessary to compensate for any delay by the serial host in acknowledging the first character of the response data.

6.18 Barometric Commands

Barometric commands are available only if the MET4/MET4A was purchased with the Barometric Measurement Functions option.

6.18.1 Barometric Function Commands

J1 Output a Field Pressure value.

Action: Take a pressure measurement, use the pressure value to calculate a Field Pressure value, and output the Field Pressure value.

Unit: Current pressure unit

Typical command: *010J1

Typical response: *0001 14.71234 (Value: 14.71234)

The Field Pressure calculation is dependent on the Field Elevation (**JF**) and Sensor Elevation (**JD**) values. These values must be set properly for Field Pressure to be calculated accurately.

J2 Output a Station Pressure (QFE) value.

Action: Take a pressure measurement, use the pressure value to calculate a Station Pressure value, and output the Station Pressure value.

Unit: Current pressure unit

Typical command: *010J2

Typical response: *0001 14.71234 (Value: 14.71234)

(Cont.)

The Station Pressure calculation is dependent on the Station Elevation (**JS**) and the Sensor Elevation (**JD**) values. These values must be set properly for Station Pressure to be calculated accurately.

J3 Output a Sea-Level Pressure value.

Action: Take a pressure measurement, use the pressure value to calculate a Sea-Level Pressure value, and output the Sea-Level Pressure value.

Unit: Current pressure unit

Typical command: *010J3

Typical response: *0001 14.71234 (Value: 14.71234)

The Sea-Level Pressure calculation is dependent on the Station Elevation (**JS**) and Sensor Elevation (**JD**) values. These values must be set properly for Sea-Level Pressure to be calculated accurately.

The Sea-Level Pressure calculation is also dependent on either a Pressure Reduction Ratio or a Pressure Reduction Constant (**JC**) value. See paragraph 8.4 for detailed information regarding Pressure Reduction Ratio and Pressure Reduction Constant.

J4 Output an Altimeter Setting (QNH) value.

Action: Take a pressure measurement, use the pressure value to calculate an Altimeter Setting value, and output the Altimeter Setting value.

Unit: Current pressure unit

Typical command: *010J4

Typical response: *0001 14.71234 (Value: 14.71234)

The Altimeter Setting calculation is dependent on the Field Elevation (**JF**) and Sensor Elevation (**JD**) values. These values must be set properly for Altimeter Setting to be calculated accurately.

J5 Output a Density Altitude value, rounded to 100 feet.

Action: Take a pressure measurement, use the pressure value to calculate a Density Altitude value, and output the Density Altitude value.

Unit: Feet or meters, selected by the **JK** command

Typical command: *010J5

Typical response: *0001 1300 (Value: 1300)

The Density Altitude calculation is dependent on the Field Elevation (**JF**) and Sensor Elevation (**JD**) values. These values must be set properly for Density Altitude to be calculated accurately.

J6 Output a Pressure Altitude value, rounded to 10 feet.

Action: Take a pressure measurement, use the pressure value to calculate a Pressure Altitude value, and output the Pressure Altitude value.

Unit: Feet or meters, selected by the **JJ** command

Typical command: *010J6

Typical response: *0001 1300 (Value: 1300)

The Pressure Altitude calculation is dependent on the Field Elevation (**JF**) and Sensor Elevation (**JD**) values. These values must be set properly for Pressure Altitude to be calculated accurately.

J7 Output a Pressure Tendency Code value.

Action: Output the current Pressure Tendency Code.

Typical command: *010J7

Typical response: *00013 (Value: 3)

NOTE: Fetch Mode must be enabled (**FM**=1) to provide the background pressure measurements needed to calculate the Pressure Tendency Code. If Fetch Mode is not enabled (**FM**=0), the Pressure Tendency Code will never be calculated.

Pressure Tendency Code is calculated using the four most recent pressure readings taken at one-hour intervals. The initial pressure reading is taken on power up. Subsequent pressure readings are taken at one-hour intervals from the time of the initial reading. When four readings have been taken, the Pressure Tendency Code is calculated, and is available to be output. The Pressure Tendency Code is subsequently updated when the next hourly pressure reading is taken.

If **J7** is sent before the required four hourly pressure readings have been taken, the message ">DATA NOT READY" is returned.

6.18.2 Barometric Configuration Commands

Barometric configuration commands set and read the parameter values that are required by the barometric functions.

PRESSURE REDUCTION CONSTANT

JC Set or read the Pressure Reduction Constant.

Range: -9999999 to 9999999

Unit: inHg

Default: 0.0

Typical set command: *0100EW*0100JC=1.234567 (Cont.)

Typical set response: *0001JC=1.234567
Typical read command: *0100JC
Typical read response: *0001JC=1.234567

If **JC** is non-zero, it will be used to calculate Sea-Level Pressure. If **JC** is set to zero, the Pressure Reduction Ratio will be used instead. See Section 8 for more information about Pressure Reduction Constant and Pressure Reduction Ratio.

SENSOR ELEVATION

JD Set or read the Sensor Elevation.

Range: -9999999 to 9999999

Unit: Feet or meters, according to the current value of **JE**.

Default: 0.0

Typical set command: *0100EW*0100JD=123

Typical set response: *0001JD=123

Typical read command: *0100JD

Typical read response: *0001JD=123

JE Set or read the Sensor Elevation unit.

Range: 0 = feet

1 = meters

Default: 0

Typical set command: *0100EW*0100JE=0

Typical set response: *0100JE=0

Typical read command: *0100JE

Typical read response: *0100JE=0

FIELD ELEVATION

JF Set or read the Field Elevation.

Range: -9999999 to 9999999

Unit: Feet or meters, according to the current value of **JG**.

Default: 0.0

Typical set command: *0100EW*0100JF=123

Typical set response: *0001JF=123

Typical read command: *0100JF

Typical read response: *0001JF=123

JG Set or read the Field Elevation unit.
Range: 0 = feet
1 = meters
Default: 0
Typical set command: *0100EW*0100JG=0
Typical set response: *0100JG=0
Typical read command: *0100JG
Typical read response: *0100JG=0

STATION ELEVATION

JS Set or read the Station Elevation.
Range: -9999999 to 9999999
Unit: Feet or meters, according to the current value of **JU**.
Default: 0.0
Typical set command: *0100EW*0100JS=123
Typical set response: *0001JS=123
Typical read command: *0100JS
Typical read response: *0001JS=123

JU Set or read the Station Elevation unit.
Range: 0 = feet
1 = meters
Default: 0
Typical set command: *0100EW*0100JU=0
Typical set response: *0100JU=0
Typical read command: *0100JU
Typical read response: *0100JU=0

ALTITUDE UNITS

JJ Set or read the Pressure Altitude unit.
Range: 0 = feet
1 = meters
Default: 0
Typical set command: *0100EW*0100JJ=0
Typical set response: *0100JJ=0
Typical read command: *0100JJ
Typical read response: *0100JJ=0

JK Set or read the Density Altitude unit.
Range: 0 = feet
1 = meters
Default: 0
Typical set command: *0100EW*0100JK=0
Typical set response: *0100JK=0
Typical read command: *0100JK
Typical read response: *0100JK=0

TEMPERATURE PARAMETERS

JH Set or read the 12-hour Temperature value.
Range: -9999999 to 9999999, integers only.
Unit: °F, °C, or °R, according to the current value of **JL**.
Default: 0
Typical set command: *0100EW*0100JH=23
Typical set response: *0001JH=23
Typical read command: *0100JH
Typical read response: *0001JH=23

JH is used to select the associated value from the Pressure Reduction Ratio table if **JC** is set to zero.

JI Read the 12-hour Temperature unit.
Action: **JL** returns the Density Altitude unit.
Range: 0 = °F
1 = °C
2 = °R
Default: 0
Typical read command: *0100JK
Typical read response: *0100JK=0

JL is a read-only command. The 12-hour Temperature unit can only be set when the Pressure Reduction Ratio table is loaded into memory. Refer to paragraph 8.4 for more information.

JM Set or read the 5-minute Temperature value.
Range: -9999999 to 9999999.
Unit: °F, °C, or °R, according to the current value of **JN**.

Default: 0.0

Typical set command: *0100EW*0100JM=2.3

Typical set response: *0001JM=2.3

Typical read command: *0100JM

Typical read response: *0001JM=2.3

JM is set automatically by the MET4/MET4A at 5-minute intervals, starting 5 minutes after the unit is powered.

JN Set or read the 5-minute Temperature unit.

Range: 0 = °F

1 = °C

2 = °R

Default: 0

Typical set command: *0100EW*0100JN=0

Typical set response: *0001JN=0

Typical read command: *0100JN

Typical read response: *0100JN=0

6.19 Data Logging Commands

The data logging commands control the data logging feature. They are available only if the MET4/MET4A was purchased with the Data Logging option. See Section 7 for more information about the data logging feature.

Each logged data point consists of a pressure, air temperature, and relative humidity measurement, tare status, pressure unit, fan status, and date and time.

Two data logging modes are available: Immediate Mode and Programmed Mode. Immediate mode begins data logging immediately when commanded to do so. Programmed mode enables data logging to begin and end at predetermined dates and times.

When data logging is underway, the MET4/MET4A will not carry out most commands, and will respond to most commands with the message “BUSY LOGGING...” The exception is the **LK** command, which is used to abort data logging.

Logged data is retrieved by using the Digiquartz[®] Data Download software. See paragraph 7.3 for more information.

DATA LOGGING CONTROL COMMANDS

LM Start Immediate Model data logging.

Action: Data logging begins immediately when **LM** is received.

Typical command: *0100LM

Typical response: *0001LM>OK

LP Start Programmed Model data logging.

Action: Enables data logging to begin when the start date and time occur.

Typical command: *0100LP

Typical response: *0001LP>OK

The start date and time (**LB**) and stop date and time (**LC**) must be set before the **LP** command is issued. The **LP** command will not be carried out and the following error codes will be returned under the following conditions:

Error L1: Memory is full

Error L2: Start date and time is earlier than current date and time

Error L3: Stop date and time is earlier than start date and time

Typical error response: *0001LM>ERR:L3

LK Abort data logging.

Action: Data logging stops immediately when **LK** is received.

Typical command: *0100LK

Typical response: *0001LK>LOGGING OFF

LK aborts data logging in both Immediate Mode and Programmed Mode.

LK returns no response unless data logging was in progress.

DATA LOGGING CONFIGURATION COMMANDS

LB Data logging start date and time.

Typical set command: *0100EW*0100LB=11/23/04 12:57:19 PM

Typical set response: *0001LB=11/23/04 12:57:19 PM

Typ. read command: *0100LB

Typ. read response: *0001LB=11/23/04 12:57:19 PM

LB must be set according to the current date (**GD**) and time (**GT**) formats.

LC Data logging stop date and time.

Typical set command: *0100EW*0100LC=11/23/04 12:57:19 PM

Typical set response: *0001LC=11/23/04 12:57:19 PM

Typ. read command: *0100LC

Typ. read response: *0001LC=11/23/04 12:57:19 PM

LC must be set according to the current date (**GD**) and time (**GT**) formats.

LV Data logging interval.

Range: 00:00:00 to 24:59:59

Default: 00:00:00

Typical set command: *0100EW*0100LV=00:01:00

Typical read response: *0001LV=00:01:00

Typical read command: *0100LV

Typical read response: *0001LC=00:01:00

LV must be set according to the current time (**GT**) format. If **LV** is set to 00:00:00, data logging will occur at the fastest possible rate, governed by the current sampling rate.

DATA LOGGING MEMORY COMMANDS

LE Erase the data in the data logging memory.

Typical command: *0100EW*0100LE=1

Typical response: *0001LE>OK

LE erases all data stored in the data logging memory. There is no way to recover logged data once it has been erased. If the **LE** command syntax is not correct, the following error will be returned: ERR>L1.

LW Memory wraparound enable/disable.

Range: 0 = Memory wraparound disabled

1 = Memory wraparound enabled

Default: 0

Typical set command: *0100EW*0100LW=1

Typical set response: *0001LW=1

Typical read command: *0100LW

Typical read response: *0001LW=1

(Cont.)

When memory wraparound is disabled, the MET4/MET4A stops logging data when memory is full. When memory wraparound is enabled, the MET4/MET4A begins overwriting the oldest data with new data when memory is full.

LA Return the number of data logging records available.

Typical read command: *0100LA

Typical read response: *0001LB=393216

LA is a read-only command.

A data logging record is defined as a single pressure measurement and its associated timestamp and configuration data. The maximum number of data logging records that can be stored in the MET4/MET4A is 221184. **LS** returns the number of data logging records that are currently used.

LS Return the number of data logging records used.

Typical read command: *0100LS

Typical read response: *0001LS=12345

LS is a read-only command.

A data logging record is defined as a pressure measurement and its associated timestamp and configuration data. The maximum number of data logging records that can be stored in the MET4/MET4A is 221184. **LA** returns the number of data logging records that are currently available.

DATA LOGGING BURST MODE COMMANDS

See paragraph 7.4 for more information about Burst Mode.

LN Burst Mode enable/disable.

Range: 0 = Burst Mode disabled

1 = Burst Mode enabled

Default: 0

Typical set command: *0100EW*0100LN=1

Typical set response: *0001LN=1

Typical read command: *0100LN

Typical read response: *0001LN=1

LT Burst Mode trigger rate.
Range: 0.0 - 9999999
Units: Current pressure unit/minute
Default: 0.0
Typical set command: *0100EW*0100LT=1.000000
Typical set response: *0001LN=1.000000
Typical read command: *0100LN
Typical read response: *0001LN=1.000000

LO Burst Mode timeout interval.
Range: 00:00:00 to 24:59:59
Default: 00:00:00
Typical set command: *0100EW*0100LV=00:01:00
Typical read response: *0001LV=00:01:00
Typical read command: *0100LV
Typical read response: *0001LC=00:01:00

6.20 Calibration Commands

The calibration commands set and read several parameters that directly affect the measurement accuracy of the device. Refer to Section 14 for more information regarding the use of the calibration parameters.

CAUTION Calibration values should be modified only when absolutely necessary, and then with extreme caution. Calibration value adjustments should only be performed by a qualified metrology lab.

DIGIQUARTZ® BAROMETER ZERO AND SPAN ADJUSTMENT COMMANDS

The **PA** command is used to make zero offset adjustments to the indicated pressure value. The **PM** command is used to make span adjustments to the indicated pressure value.

PA and **PM** are used in the following formula to calculate final output pressure:

$$P_{\text{adjusted}} = PM * (P + PA)$$

Where: P = Pressure calculated using original calibration coefficients, in the current pressure unit
PM = the current value of the **PM** parameter
PA = the current value of the **PA** parameter

PA Set or read the pressure adder parameter.

Action: The pressure adder parameter is used to make zero adjustments to the calibration. PA can also be used to offset absolute pressure measurements by atmospheric pressure to obtain gauge pressure.

Range: -9999999 to 9999999

Default: 0.0

Typical set command: *0100EW*0100PA=.0000123

Typical set response: *0001PA=.0000123

Typical read command: *0100PA

Typical read response: *0001PA=.0000123

NOTE: The value of **PA** is entered in the current pressure units, but is converted to psi prior to being stored. When **PA** is queried, it returns the value scaled to the current pressure units.

PM Set or read the pressure multiplier parameter.

Action: The pressure multiplier parameter is used to make span adjustments to the calibration.

Range: -9999999 to 9999999

Default: 1

Typical set command: *0100EW*0100PM=1.000123

Typical set response: *0001PM=1.000123

Typical read command: *0100PM

Typical read response: *0001PM=1.000123

NOTE: The value of **PM** is dimensionless, and is therefore not scaled if the units are changed.

BAROMETER CALIBRATION COEFFICIENT COMMANDS

These commands contain the calibration coefficients for the Digiquartz[®] pressure transducer within the MET4/MET4A.

- C1** Set or read the calibration coefficients. See Section 14 for more
- C2** information about calibration and calibration coefficients.
- C3**
- D1**
- D2**
- T1**
- T2**
- T3**
- T4**
- T5**
- U0**
- Y1**
- Y2**
- Y3**

Default: Device-specific

Typical set command: *0100EW*0100C1=228.1234

Typical set response: *0001C1=228.1234

Typical read command: *0100C1

Typical read response: *0001C1=228.1234

AIR TEMPERATURE ZERO AND SPAN ADJUSTMENT COMMANDS

The **S1** and **Z1** commands make span and zero offset corrections to the air temperature sensor output, using the following formula:

$$T_{\text{corrected}} = S1 * (T_{\text{sensor}} + Z1)$$

- S1** Set or read the air temperature sensor span adjustment.

Range: -9999999 to 9999999

Default: 1.0000000

Typical set command: *0100EW*0100S1=1.000000

Typical set response: *0001S1=1.000000

Typical read command: *0100S1

Typical read response: *0001S1=1.000000

Z1 Set or read the air temperature sensor zero offset adjustment.
Range: -9999999 to 9999999
Default: 0.0000000
Typical set command: *0100EW*0100Z1=0.000000
Typical set response: *0001Z1=0.000000
Typical read command: *0100Z1
Typical read response: *0001Z1=0.000000

RELATIVE HUMIDITY ZERO AND SPAN ADJUSTMENT COMMANDS

The **S2** and **Z2** commands make span and zero offset corrections to the relative humidity sensor output, using the following formula:

$$RH_{\text{corrected}} = S2 * (RH_{\text{sensor}} + Z2)$$

S2 Set or read the relative humidity sensor span adjustment.
Range: -9999999 to 9999999
Default: 1.0000000
Typical set command: *0100EW*0100S2=1.000000
Typical set response: *0001S2=1.000000
Typical read command: *0100S2
Typical read response: *0001S2=1.000000

Z2 Set or read the relative humidity sensor zero offset adjustment.
Range: -9999999 to 9999999
Default: 0.0000000
Typical set command: *0100EW*0100Z2=0.000000
Typical set response: *0001Z2=0.000000
Typical read command: *0100Z2
Typical read response: *0001Z2=0.000000

TIMEBASE CALIBRATION COMMANDS

TC is used to normalize the nominal 14.7456 MHz reference crystal frequency to 10 MHz to compensate for the natural variation in reference crystal frequency.

TC Read the factory-set crystal timebase correction factor.
Action: Read the **TC** value. **TC** is a read-only command.

Typical read command: *0100TC

Typical read response: *0001TC=.6666667

6.21 Global Commands

Under certain circumstances, it may be desirable to send a single command to multiple units on a serial loop network. The ID 99 has been reserved for such global addressing. When a MET4/MET4A receives a supported command addressed to ID 99, it reacts to that command regardless of its assigned ID value.

When the MET4/MET4A receives a global command via RS-232, it retransmits the global command before acting on it. This ensures that all units on a serial loop will receive the global command. Eventually, the global command is retransmitted by the last unit in the serial loop and is received by the serial host. The serial host must be able to disregard the retransmitted command.

SUPPORTED GLOBAL COMMANDS

All serial communications commands must be globally addressed: **BR**, **BL**, and **ID**.

Global addressing is often used with sample and hold measurement commands to synchronize measurements from multiple devices. The sample and hold measurement commands are:

P5 P6, Q5 and Q6

Most sampling commands and certain other commands may be either individually or globally addressed:

P1 through P7, Q1 through Q6, TT (A1), RH (A2), DB, DS, VR, and EW

The remaining commands should not be sent as global commands.

7 Data Logging (Optional)

7.1 Data logging basics

The optional data logging feature enables the MET4/MET4A to acquire and store measurement data. Each logged data point consists of a barometric pressure, air temperature, and relative humidity measurement, tare status, pressure unit, fan status, and date and time. Data can be logged at a user-specified time interval, or may be logged as quickly as measurements can be made. Logged data may be retrieved using the DigiQuartz[®] Data Download software supplied with your MET4/MET4A.

The data logging is controlled by a set of serial commands. See paragraph 6.19 for specific information about the data logging commands.

Two data logging modes are available: Immediate Mode and Programmed Mode. Immediate mode begins data logging immediately when commanded to do so. Programmed mode enables data logging to begin and end at predetermined dates and times.

When data logging is enabled or underway, the MET4/MET4A will not carry out most commands, and will respond to most commands with the message “BUSY LOGGING...” The exception is the **LK** command, which is used to abort data logging.

Memory management commands let you monitor the number of records logged and remaining, and erase previously logged data. You can also choose whether to stop logging if data logging memory is filled, or overwrite the oldest data.

7.2 Logging data

IMMEDIATE MODE

Immediate Mode is used when you want data logging to begin and end on a serial command.

Step 1. Configure MET4/MET4A

- Set up the MET4/MET4A pressure measurement parameters according to your application.
- Use **LS** to determine the number of data records available. If necessary, use **LE** to erase previously logged data, thus freeing up memory space.
- Set **LV** to the desired time interval between logged data records.
- Set **LW** to choose the behavior if data logging memory is filled.

Step 2. Begin data logging

- Use **LM** to begin data logging immediately.

Step 3. End data logging

- When sufficient data has been logged, issue the LK command to end data logging.

PROGRAMMED MODE

Programmed Mode is used when you want data logging to begin and end at a predetermined time and date.

Step 1. Configure MET4/MET4A

- Set up the MET4/MET4A pressure measurement parameters according to your application.
- Use **LS** to determine the number of data records available. If necessary, use **LE** to erase previously logged data, thus freeing up memory space.
- Set **LV** to the desired time interval between logged data records.
- Set **LW** to choose the behavior if data logging memory is filled.
- Use **GR** to check the accuracy of the real-time clock. If it needs to be set, use the **GR** command to set the current time and date.
- Set **LB** to the time/date to start logging.
- Set **LC** to the time/date to end logging.

Step 2. Begin data logging

- Use **LP** to begin data logging at the start time/date. Data logging will end automatically at the end time/date. Data logging can be aborted at any time with the **LK** command.

7.3 Retrieving logged data

Step 1. Install Digiquartz[®] Data Download software

- Install Digiquartz[®] Data Download software on a Windows PC with an available RS-232 serial port. The software can be found on the Digiquartz[®] CD Library disk included with the MET4/MET4A.

Step 2. Run Digiquartz[®] Data Download and retrieve logged data

- Connect the MET4/MET4A to the Windows PC RS-232 serial port, and apply DC power.
- Run Digiquartz[®] Data Download.
- Set the Com Port to the RS-232 port being used. Set Baud Rate and Unit ID to match the MET4/MET4A.
- Click Start Download. Specify the filename of the file where the logged data is to be stored. The logged data will be retrieved and stored in the specified file. The file can then be imported into standard Windows programs such as Microsoft Excel.

7.4 Burst Mode

Burst mode enables you to log data at a shorter interval for a specified duration whenever a measured pressure change equals or exceeds a specified limit.

When burst mode is enabled with the **LN** command, data is initially logged at the interval specified by the **LV** command. If a measured pressure change equals or exceeds the limit specified by the **LT** command, data will be logged at the rate specified by the pressure integration time for the duration specified by the **LO** command. Logging will then return to the interval specified by the **LV** command. Refer to paragraph 6.19 for detailed information about the **LN**, **LO**, **LT**, and **LV** commands.

8 Barometric Functions (Optional)

8.1 Overview

The optional barometric functions output the results of various standard computations using barometric pressure measurements and user-specified parameter values as input. The supported barometric functions and their definitions are as follows:

Field Pressure – The atmospheric pressure computed for a specific airport elevation.

Station Pressure (QFE) – The atmospheric pressure computed for a specific station location and elevation.

Sea-Level Pressure – The pressure value obtained by the theoretical reduction or increase of station pressure to sea level.

Altimeter Setting (QNH) – The pressure value to which an aircraft altimeter is set so that it will indicate the altitude above mean sea level on the ground at the location for which the pressure value was determined.

Density Altitude – The altitude in the standard atmosphere where air density is the equivalent to that at the airport.

Pressure Altitude – The altitude in the standard atmosphere at which a given pressure will be observed.

Pressure Tendency Code – A World Meteorological Organization (WMO) code describing the character and amount of atmospheric pressure change during the past three hours.

8.2 Barometric Functions

FIELD PRESSURE

Function: Outputs the Field Pressure value.

Command: **J1**

Field Pressure is calculated using Field Elevation, Sensor Elevation, and 5-Minute Average Temperature values. Field Elevation and Sensor Elevation must be set properly in order to accurately calculate Field Pressure. See paragraph 6.18.2 for information about barometric settings.

STATION PRESSURE (QFE)

Function: Outputs the Station Pressure (QFE) value.

Command: **J2**

Station Pressure (QFE) is calculated using Station Elevation, Sensor Elevation, and 5-Minute Average Temperature values. Station Elevation and Sensor Elevation must be set properly in order to accurately calculate Station Pressure. See paragraph 6.18.2 for information about barometric settings.

SEA-LEVEL PRESSURE

Function: Outputs the Sea-Level Pressure value.

Command: **J3**

Sea-Level Pressure is calculated using Station Elevation, Sensor Elevation, and 5-Minute Average Temperature values. Station Elevation and Sensor Elevation must be set properly in order to accurately calculate Sea-Level Pressure. See paragraph 6.18.2 for information about barometric settings.

The Sea-Level Pressure calculation also requires either a Pressure Reduction Constant or a Pressure Reduction Ratio. If the Pressure Reduction Constant value is non-zero, it will be used to calculate Sea-Level Pressure; if the value is zero, the Pressure Reduction Ratio table will be used to calculate Sea-Level Pressure. The Pressure Reduction Ratio is selected from a user-supplied table that pairs a Pressure Reduction Ratio values with 12-Hour Average Temperature values. The 12-Hour Average Temperature is used to look up the associated Pressure Reduction Ratio value from the table.

The MET4/MET4A has the ability to store a Pressure Reduction Ratio table in non-volatile memory, and to look up the proper Pressure Reduction Ratio value for the 12-Hour Average Temperature value entered by the user. Please refer to paragraph 8.4 for more information regarding the Pressure Reduction Ratio table.

ALTIMETER SETTING (QNH)

Function: Outputs the Altimeter Setting (QNH) value.

Command: **J4**

Altimeter Setting (QNH) is calculated using Field Elevation, Sensor Elevation, and 5-Minute Average Temperature values. Field Elevation and Sensor Elevation must be set properly in order to accurately calculate Altimeter Setting. See paragraph 6.18.2 for information about barometric settings.

DENSITY ALTITUDE

Function: Outputs the Density Altitude value, rounded to 100 feet.

Command: **J5**

Density Altitude is calculated using Field Elevation, Sensor Elevation, and 5-Minute Average Temperature values. Field Elevation and Sensor Elevation must be set properly in order to accurately calculate Density Altitude. See paragraph 6.18.2 for information about barometric settings.

PRESSURE ALTITUDE

Function: Outputs the Pressure Altitude value, rounded to 10 feet.

Command: **J6**

Pressure Altitude is calculated using Field Elevation, Sensor Elevation, and 5-Minute Temperature values. Field Elevation and Sensor Elevation must be set properly in order to accurately calculate Pressure Altitude. See paragraph 6.18.2 for information about barometric settings.

PRESSURE TENDENCY CODE

Function: Outputs the pressure tendency code value.

Command: **J7**

The Pressure Tendency Code is calculated using the four most recent pressure readings taken at one-hour intervals. The MET4/MET4A must be configured for continuous pressure measurements for the Pressure Tendency Code feature to function. The initial pressure reading is taken on power up if the unit is configured for continuous pressure measurements, or when the unit is configured for continuous pressure measurements. Subsequent pressure readings are stored at one-hour intervals from the time of the initial reading. When four readings have been taken, the Pressure Tendency Code is calculated and can be output when requested. The Pressure Tendency Code value is subsequently updated when the next hourly pressure reading is taken.

8.3 Barometric Settings

FIELD ELEVATION

Function: Enter the Field Elevation value. The value can be entered in feet or meters.

Command: **JF**

SENSOR ELEVATION

Function: Enter the Sensor Elevation value. The value can be entered in feet or meters.

Command: **JD**

STATION ELEVATION

Function: Enter the Station Elevation value. The value can be entered in feet or meters.

Command: **JS**

5-MINUTE AVERAGE TEMPERATURE

Function: Enter the 5-minute average temperature value. The value can be entered in °F, °C, or °R. It is generally not necessary to enter the 5-minute temperature value as it is updated automatically.

Command: **JM**

12-HOUR AVERAGE TEMPERATURE

Function: The value is entered in the same unit as the temperature values in the Pressure Reduction Ratio table. The entered value must be an integer, and must exactly match a temperature value in the Pressure Reduction Ratio table. It is generally not necessary to enter the 12-Hour Average Temperature value as it is updated automatically. Please refer to paragraph 8.4 for more information regarding the Pressure Reduction Ratio table.

Command: **JH**

PRESSURE REDUCTION CONSTANT

Function: Enter the Pressure Reduction Constant value. If the entered value is non-zero, the Pressure Reduction Constant is used to calculate Sea-Level Pressure. If the value is zero, the Pressure Reduction Ratio table is used to calculate Sea-Level Pressure. Please refer to paragraph 8.4 for more information regarding the Pressure Reduction Ratio table.

Command: **JC**

8.4 Pressure Reduction Ratio Table

In most cases, it is necessary to use a Pressure Reduction Ratio to calculate Sea-Level Pressure. Pressure Reduction Ratios are normally provided at one-degree temperature intervals throughout the typical temperature range at a particular location. A 12-Hour Average Temperature value is then used to look up the proper Pressure Reduction Ratio for that temperature.

The MET4/MET4A has the ability to store and reference a table of Pressure Reduction Ratios and associated temperatures in non-volatile memory. When Sea-Level Pressure is calculated, the current 12-Hour Temperature Value is used to look up the associated Pressure Reduction Ratio value, and that value is used in the calculation.

A Pressure Reduction Ratio table is entered into the MET4/MET4A in the form of an ASCII text file. The Digiquartz® SLP Configuration software is provided for this purpose. Please refer to paragraph 5.8.4 for explicit instructions about using Digiquartz® SLP Configuration to load a Pressure Reduction Ratio table into the MET4/MET4A.

9 Networking

The MET4/MET4A supports RS-232 serial loop and RS-485 multi-drop networking. Networking allows you to communicate with up to 98 Digiquartz[®] Intelligent Devices from a single RS-232 or RS-485 serial host.

9.1 Networking Basics

When setting up a network, the following must be observed.

- Verify proper operation of each Digiquartz[®] Intelligent Device before installing it in a network.
- If your network includes older Digiquartz[®] Intelligent Devices, set the older devices to **PT = N** to assure compatibility with the MET4/MET4A.
- Set all Digiquartz[®] Intelligent Devices to the same baud rate before installing them in a network. Baud rates should be limited to 9600 or 19200 baud.
- Set each Digiquartz[®] Intelligent Device on the network to a unique Unit ID.

9.2 Choosing a Network Type

RS-232 and RS-485 networks have unique benefits, as described below. Carefully consider your system requirements before selecting a network type.

BENEFITS OF RS-485 MULTI-DROP NETWORKS:

- RS-485 transmission distance is up to 4,000 feet, compared to 50 feet for RS-232 serial loop networking.
- Improved data integrity in electrically noisy environments, as compared to RS-232 serial loop networks.
- Can take synchronized measurements from any or all devices on the network. This is not possible with RS-232 serial loop network due to the delays that occur as the measurement command propagates through the network.
- Can wake up all sleeping devices with a single character. Each device must be awakened individually on an RS-232 serial loop network.
- Improved system reliability. It is less likely that a failure in a single unit will affect the entire network, as compared to RS-232 serial loop networks.

BENEFITS OF RS-232 SERIAL LOOP NETWORKS:

- RS-232 serial loop networks are compatible with all standard PCs, and most other control devices. RS-485 may not be available or may require additional hardware, depending on the serial host you have selected.
- Unique device IDs can be assigned to all devices on the network with a single command. With an RS-485 multi-drop network, you must isolate each unit and assign its unique ID individually.

- Can directly communicate with up to 98 devices. You can address up to 98 devices with RS-485, but you must use a repeater if you have more than 32 devices (including the host) on the network.

9.3 RS-485 Networks

As described in paragraph 9.2, RS-485 multi-drop offers several significant benefits over RS-232 serial loop networking. It is recommended that RS-485 multi-drop networks be used whenever possible.

RS-485 multi-drop networks can be wired as a 2-wire or 4-wire system. DIGIQUARTZ® Intelligent devices are compatible with either system. Refer to paragraph 12.5 for multi-drop network wiring diagrams.

RS-485 MULTI-DROP NETWORK CONSIDERATIONS

When setting up and operating an RS-485 multi-drop network, please be aware of the following:

- Up to 98 devices can be addressed on an RS-485 multi-drop network, but a maximum of 31 devices can be driven by any single transmitter. If you intend to build a network that exceeds 31 DIGIQUARTZ® Intelligent devices, you must use one or more RS-485 repeaters to ensure that no device is driving more than a maximum of 31 receivers.
- **CAUTION** Do not attempt to set Unit ID values over a multi-drop network. Doing so will set all devices on the network to the same Unit ID value. To set each device to a unique Unit ID, isolate each device from the network, and individually set its Unit ID value.
- **CAUTION** Do not send continuous measurement commands (**P2**, **P4**, **P7**, **PP**, **Q2**, **Q4**) to any device on a 2-wire multi-drop network. If you do this, you may need to cycle power to stop the continuous transmission of measurement data, since the command from the host to stop continuous measurement will likely collide with the measurement data coming from the device. This is especially true if your device is set for a short integration time.

- **CAUTION** Extreme caution must be observed when configuring any device on a 2-wire RS-485 network for continuous data output from the RS-485 port (**P2, P4, P7, PP, Q2, Q4, MD=2, 3, 6, 7, 8, 10, or 12**). This is due to the half-duplex nature of 2-wire RS-485, which does not allow data to be simultaneously transmitted and received. If the baud rate is sufficiently low and the integration time is sufficiently short, no gaps will be present between the device transmissions, making it impossible for the serial host to transmit a command to the device. Recovery depends on the command issued. If **P2, P4, P7, PP, Q2, Q4** is issued, power can be cycled to regain control of the device. If **MD** was issued, it may be necessary to remove the device from the network and reconfigure it individually via the RS-232 port. As a precaution, always keep the baud rate as high as possible and the integration time as long as possible when setting up a 2-wire RS-485 network, and run tests to ensure that you will be able to regain control of the device should it be commanded to produce continuous data output.

2-WIRE RS-485 MULTI-DROP NETWORKS

The MET4/MET4A supports half-duplex, master-slave communications with serial hosts. This means that the MET4/MET4A (slave) will only transmit if it has been commanded to do so by the serial host, or master. This feature enables the MET4/MET4A to be used in 2-wire RS-485 systems, where commands sent from the host and responses sent by the MET4/MET4A are sent on the same pair of wires.

Figure 21 in paragraph 12.5 illustrates a two-wire RS-485 multi-drop network consisting of a host and multiple DIGIQUARTZ® Intelligent devices. Notice that the TX+ and RX+ signals and the TX- and RX- signals are tied together at each device, forming a 2-wire interface. The 2-wire half duplex configuration can reduce wiring costs, but the system designer must take precautions as described above to ensure reliable communications.

Data collisions occur on 2-wire RS-485 systems when two or more slaves transmit simultaneously, or when the master and one or more slaves transmit simultaneously. The result of a data collision is that both transmissions become unintelligible and are lost. In a master-slave network, it is the responsibility of the serial host to ensure that data collisions do not occur. Normally, this requires that the host wait an appropriate length of time for a response before sending another command.

Since multiple transmitters share common wiring in 2-wire RS-485 multi-drop systems, it is necessary that all devices on a network have the ability to disable their transmitters when not actively transmitting. DIGIQUARTZ® Intelligent devices perform this task automatically, but the serial host must also enable its transmitter only when transmitting. Some RS-485 devices, particularly low-cost RS-232 to RS-485 converters, tend to leave their transmitters enabled for a period of time after RS-485 data has been transmitted. If this time is sufficiently long, some or all of the

response data from a DIGIQUARTZ® Intelligent device will not be received by the serial host, since the host will still be in the transmit mode when the response is being sent. If you plan to use such a device, reliable two-wire RS-485 communications may not be possible, and you will need to use a 4-wire system instead.

4-WIRE RS-485 MULTI-DROP NETWORKS

Figure 20 in paragraph 12.5 illustrates a 4-wire RS-485 multi-drop network consisting of a host and three DIGIQUARTZ® Intelligent devices. In this system, there is no need for the host to disable its transmitter, since it is connected to the receive lines of the Intelligent devices via a dedicated pair of wires, enabling full-duplex operation.

9.4 RS-232 Serial Loop Networks

Refer to the figure below. In an RS-232 serial loop network, the transmit output of the RS-232 host is connected to the receive input of the first device in the loop. The transmit output of the first device is connected to the receive input of the next device. The remaining devices are connected similarly, with their receive input connected to the transmit output of the previous device, and their transmit output connected to the receive input of the next device. The transmit output of the last device is connected to the receive input of the RS-232 host.

The host sends commands to the first device in the loop. If a command is addressed to that device, the command is carried out; if not, the command is resent to the next device. Globally addressed commands are carried out by each device, and are also resent to the next device. When a device responds to a command, the response is addressed to the host, and is therefore resent by each device that receives it until it eventually makes it way to the serial host.

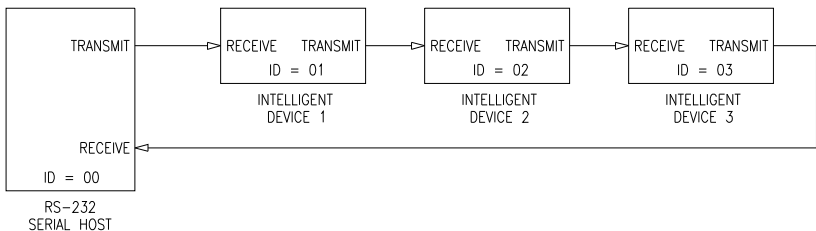


Figure 6. Serial loop network block diagram

Keep these points in mind when designing an RS-232 serial loop network:

- As previously described, each device resends any command or response that is addressed to another device. Since each device considers resending to be a higher priority than sending its own response, it is possible that a device can spend all its time resending, and never have an opportunity to send its own response. This occurs only when one or more upstream devices are continuously transmitting. To prevent this situation:
 - Operate your network at 9,600 baud or above
 - Avoid continuous transmission (P2, P4, P7, Q2, and Q4 commands) at extremely low integration times
- Do not operate a serial loop network above 19,200 baud.
- It is not possible to precisely synchronize measurements from two or more devices by sending a global measurement command. This is a result of the delay that occurs as the measurement command propagates through the serial loop.
- When a global command is sent, it propagates through the serial loop, eventually making its way back to the host. Therefore, the data received by the host in response to a global command includes the command itself, followed by the individual responses from all devices on the network.

10 Pressure Measurement Concepts

10.1 Measurement Basics

At the heart of all Digiquartz® Intelligent Instruments is a precision Digiquartz® pressure transducer. The outputs from a Digiquartz® pressure transducer are two square wave signals whose period is proportional to applied pressure and internal transducer temperature. The MET4/MET4A measures these signals using a technique similar to that of a common laboratory frequency counter. Like the frequency counter, a signal must be integrated, or sampled, for a specified period of time to measure its period. The time over which the signal is sampled determines the resolution of the measurement. Longer sampling times increase resolution, but result in a slower sampling rate.

The MET4/MET4A allows you to set the sampling time between 0.02 to 131.06 seconds in 0.02-second increments. Pressure and temperature sampling times can be set independently via the serial ports. You can use these features to configure the unit according to the data acquisition and resolution requirements of your application.

Refer to paragraph 10.5 for more information about integration time, resolution, and sampling rate.

10.2 Measurement Types

One or both of the Digiquartz® pressure transducer output signals are sampled, depending on the type of measurement requested.

Four types of measurements can be taken:

- Pressure
- Internal sensor temperature
- Pressure period
- Temperature period

Period measurements data can only be accessed via the serial ports.

PRESSURE MEASUREMENTS

Pressure measurements are the most common. Pressure measurements are fully temperature-compensated, and therefore require an internal temperature measurement.

When a pressure measurement is made, the following sequence occurs:

- The temperature signal period is measured

- An internal transducer temperature value is calculated using the temperature period and the calibration coefficients
- The pressure signal period is measured
- A temperature-compensated pressure value is calculated using the pressure period, temperature value, and the calibration coefficients
- The pressure value is output via RS-232 or RS-485

INTERNAL SENSOR TEMPERATURE MEASUREMENTS

Internal sensor temperature is normally only used for temperature compensation of pressure, but can be requested independently for diagnostic and other purposes.

When an internal sensor temperature measurement is made, the following sequence occurs:

- The temperature signal period is measured
- A temperature value is calculated using the temperature period and the calibration coefficients
- The pressure value is output via RS-232 or RS-485

PRESSURE AND TEMPERATURE PERIOD MEASUREMENTS

Period measurements are used mainly for calibration and diagnostic purposes, but may be useful in high-speed sampling applications.

When a period measurement is made, the following sequence occurs:

- The pressure or temperature signal period is measured
- The pressure value is output via RS-232 or RS-485

Refer to paragraph 6.3 for measurement command descriptions.

10.3 Sampling Types

Measurement data can be sampled via the RS-232 and RS-485 ports by the following methods:

- Single measurement
- Continuous measurement
- High-speed continuous measurement
- Sample and hold measurement

SINGLE MEASUREMENT SAMPLING

Single measurement sampling commands output a single measurement value each time the command is received.

CONTINUOUS MEASUREMENT SAMPLING

Continuous measurement sampling commands repeatedly output measurement data until commanded to stop.

HIGH-SPEED CONTINUOUS MEASUREMENT SAMPLING

Similar to regular continuous measurement commands, but internal transducer temperature measurements are taken only occasionally. This type of sampling is useful when sampling rates must be as high as possible, and is particularly appropriate when internal transducer temperature is not expected to change significantly.

SAMPLE AND HOLD MEASUREMENT SAMPLING

Similar to single measurement sampling, but the measurement value is not output until a separate command is sent. This type of sampling is useful when you need to simultaneously trigger measurements from multiple units, and then read them one by one in a particular order.

Refer to paragraph 6.3 for serial measurement command descriptions.

10.4 Tare Function

You can configure the MET4/MET4A to subtract a value from each subsequent pressure measurement. This process is referred to as tare. You can tare subsequent pressure measurements to the current pressure value, or to any value you specify. Tare can be enabled and disabled through the TARE key or by serial command.

An indicator on the display and/or a special character in the serial measurement data indicates when tare is in effect. Refer to paragraph 6.10 and/or 6.11 for details.

10.5 Resolution, Sampling Time and Sampling Rate

10.5.1 Definitions

RESOLUTION

Resolution is defined as the smallest change in a measured quantity that can be detected.

SAMPLING TIME

Sampling time is defined as the length of time that a Digiquartz[®] pressure transducer output signal is sampled to produce a single measurement value.

SAMPLING RATE

Sampling rate is defined as the number of measurements that can be taken in a given period of time.

10.5.2 Interdependencies

Resolution, sampling time, and sampling rate are interdependent. This is due to the method by which the MET4/MET4A measures the outputs from the Digiquartz[®] pressure transducer.

The sampling time determines the resolution of the measurement. Longer sampling times increase resolution, but reduce the sampling rate. Conversely, shorter sampling times decrease resolution, but increase the sampling rate.

Another factor that can influence sampling rate is the serial baud rate. For short sampling times, faster baud rates enable faster sampling. As sampling times increase, the benefit of faster baud rates quickly diminishes. Baud rate has no effect on sampling time, and therefore has no effect on resolution.

Figure 7, Figure 8, and Figure 9 illustrate the relationship between sampling time, resolution, and sampling rate for the **P2**, **P4**, and **P7** commands at common baud rates.

P2 Command (Continuous Pressure Period Output)

P2 Command (Continuous Pressure Period Output)					
PI (ms)	Pressure Resolution (ppm)	Sampling Rate and Sampling Time			
		9600 Baud		19200 Baud	
		(Hz)	(s)	(Hz)	(s)
1	678.168	73.964	0.0135	147.929	0.0068
5	135.634	73.964	0.0135	137.363	0.0073
10	67.817	68.493	0.0146	90.580	0.0110
20	33.908	47.847	0.0209	47.847	0.0209
30	22.606	32.154	0.0311	32.154	0.0311
40	16.954	24.450	0.0409	24.450	0.0409
50	13.563	19.531	0.0512	19.531	0.0512
100	6.782	9.960	0.1004	9.960	0.1004
200	3.391	4.998	0.2001	4.998	0.2001
250	2.713	4.000	0.2500	4.000	0.2500
500	1.356	2.000	0.5000	2.000	0.5000
1000	0.678	1.000	1.0000	1.000	1.0000
2000	0.339	0.500	2.0000	0.500	2.0000
5000	0.136	0.200	5.0000	0.200	5.0000
10000	0.068	0.100	10.0000	0.100	10.0000
20000	0.034	0.050	20.0000	0.050	20.0000
50000	0.014	0.020	50.0000	0.020	50.0000

Figure 7. Relationship of Sampling Time, Resolution, and Sampling Rate for P2 Command

The values in Figure 7 assume a MET4/MET4A configured as follows. Other configuration conditions can result in different sampling rates.

SU=0, US=0, UN=1, MD=0, OI=0, FM=0, and DL=0

P4 Command (Continuous Pressure Output)

P4 Command (Continuous Pressure Output)					
PI (ms)	Pressure Resolution (ppm)	Sampling Rate and Sampling Time			
		9600 Baud		19200 Baud	
		(Hz)	(s)	(Hz)	(s)
1	678.168	80.128	0.0125	160.256	0.0062
5	135.634	73.746	0.0136	147.929	0.0068
10	67.817	73.746	0.0136	86.207	0.0116
20	33.908	46.083	0.0217	46.083	0.0217
30	22.606	31.447	0.0318	31.447	0.0318
40	16.954	23.923	0.0418	23.923	0.0418
50	13.563	19.380	0.0516	19.380	0.0516
100	6.782	9.881	0.1012	9.881	0.1012
200	3.391	4.995	0.2002	4.995	0.2002
250	2.713	3.984	0.2510	3.984	0.2510
500	1.356	2.000	0.5000	2.000	0.5000
1000	0.678	1.000	1.0000	1.000	1.0000
2000	0.339	0.500	2.0000	0.500	2.0000
5000	0.136	0.200	5.0000	0.200	5.0000
10000	0.068	0.100	10.0000	0.100	10.0000
20000	0.034	0.050	20.0000	0.050	20.0000
50000	0.014	0.020	50.0000	0.020	50.0000

Figure 8. Relationship of Sampling Time, Resolution, and Sampling Rate for P4 Command

The values in Figure 8 assume a MET4/MET4A configured as follows. Other configuration conditions can result in different sampling rates.

SU=0, US=0, UN=1, MD=0, OI=0, FM=0, and DL=0

P7 Command (Fast Continuous Pressure Output)

P7 Command (Fast Continuous Pressure Output)					
PI (ms)	Pressure Resolution (ppm)	Sampling Rate and Sampling Time			
		9600 Baud		19200 Baud	
		(Hz)	(s)	(Hz)	(s)
1	678.168	80.128	0.0125	160.256	0.0062
5	135.634	73.746	0.0136	147.929	0.0068
10	67.817	73.746	0.0136	88.968	0.0112
20	33.908	46.729	0.0214	46.729	0.0214
30	22.606	31.646	0.0316	31.646	0.0316
40	16.954	24.331	0.0411	24.331	0.0411
50	13.563	19.531	0.0512	19.531	0.0512
100	6.782	9.881	0.1012	9.881	0.1012
200	3.391	4.995	0.2002	4.995	0.2002
250	2.713	4.000	0.2500	4.000	0.2500
500	1.356	2.000	0.5000	2.000	0.5000
1000	0.678	1.000	1.0000	1.000	1.0000
2000	0.339	0.500	2.0000	0.500	2.0000
5000	0.136	0.200	5.0000	0.200	5.0000
10000	0.068	0.100	10.0000	0.100	10.0000
20000	0.034	0.050	20.0000	0.050	20.0000
50000	0.014	0.020	50.0000	0.020	50.0000

Figure 9. Relationship of Sampling Time, Resolution, and Sampling Rate for P7 Command, PS=0

The values in Figure 9 assume a MET4/MET4A configured as follows. Other configuration conditions can result in different sampling rates.

SU=0, US=0, UN=1, MD=0, OI=0, FM=0, and DL=0

Optimizing Pressure Data Rate

Use one or more of the following techniques to increase the pressure measurement data rate.

- Reduce integration time. Refer to **PI**, **TI**, **PR**, and **TR** commands in paragraph 6.5.
- Use Simultaneous Integration (**OI=0**). See paragraph 6.6 for details
- Use a continuous pressure measurement command, such as **P4** or **P7**. See paragraph 6.3.3 for details.
- Increase the baud rate. Refer to paragraph 6.2.
- Disable any functions that increase the length of serial responses, such as **US** and **SU**.
- Use the continuous pressure period command (**P2**), and post-process data to convert to pressure. Refer to paragraph 10.6 for detailed information about converting period measurements into pressure values.

10.6 Calculations and Formulas

The MET4/MET4A calculates internal sensor temperature and temperature-compensated pressure from period measurements of the Digiquartz[®] pressure transducer output signals. The equations and coefficients used to perform these calculations are given below. The MET4/MET4A is initialized with its transducer coefficients at the factory.

TEMPERATURE CALCULATION

The following equation is used to calculate internal sensor temperature:

$$T = Y_1U + Y_2U^2 + Y_3U^3$$

Where: T = Temperature (°C)

U = temperature period (microseconds) – U₀ (microseconds)

Temperature coefficients: U₀ Y₁ Y₂ Y₃

PRESSURE CALCULATION

The following equation is used to calculate pressure:

$$P = C(1 - \tau_0^2 / \tau^2)[1 - D(1 - \tau_0^2 / \tau^2)]$$

Where: P = pressure (psi)

τ = pressure period (microseconds)

$$C = C_1 + C_2U + C_3U^2$$

$$D = D_1 + D_2U$$

$$\tau_0 = T_1 + T_2U + T_3U^2 + T_4U^3 + T_5U^4$$

U = temperature period (microseconds) – U₀ (microseconds)

Pressure coefficients: C₁ C₂ C₃ D₁ D₂ T₁ T₂ T₃ T₄ T₅

Temperature coefficient: U₀

FINAL OUTPUT PRESSURE CALCULATION

The following equation is used with the pressure value calculated above to calculate the final output pressure value:

$$P_{\text{output}} = \text{PM} * (\text{units conversion factor}) * [P + \text{PA}]$$

Where: P_{output} = Final output pressure value

P = raw pressure value (from pressure equation above)

PM = Value stored in the **PM** parameter

PA = Value stored in the **PA** parameter

Units conversion factor = Value used to convert psi to the current pressure unit.

The **PM** and **PA** parameters allow you to make minor zero and span adjustments to the raw pressure value. Initially, **PM** (pressure multiplier) is set to 1.0, and **PA** (pressure adder) is set to 0.0. Refer to paragraph 6.20 for more information.

11 Optional Accessories

CABLE & POWER ADAPTER KIT

Paroscientific part number 2367-0XX

The Cable & Power Adapter Kit simplifies the task of providing power to the MET4/MET4A, and making the necessary RS-232 or RS-485 connections to a serial host. The cable is suitable for outdoor installations, and can be ordered in lengths ranging from 3 to 30 meters. The wall mount power supply and adapter are intended for indoor use only.

MODEL 715 REMOTE DISPLAY

Paroscientific part number 1554-00X

The Model 715 displays measurement data, text, and diagnostic information on an easy to read backlit LDC display. The Model 715 is suitable for desktop and panel-mount applications, and can interface to the MET4/MET4A via RS-232 or RS-485.

DATA LOGGING

The MET4/MET4A data logging option enables time-stamped pressure, air temperature, and relative humidity measurements to be stored within the unit for later retrieval and analysis. See Section 7 for more information.

BAROMETRIC FUNCTIONS

The MET4/MET4A barometric functions option enables several industry-standard barometric functions. See Section 8 for more information.

MODEL 765-16B PORTABLE PRESSURE STANDARD AND DIGIPORT HIGH-PERFORMANCE PRESSURE PORT

Model 765-16B - Paroscientific part number 1100-010

DigiPort - Paroscientific part number 1745-0XX

When paired with the DigiPort high-accuracy pressure port, the Model 765-16B is an ideal pressure transfer standard for assessing the accuracy of the MET4/MET4A barometer in the field. For more information about field assessment of barometer accuracy, refer to paragraph 14.3.

12 Installation

We strongly recommend that MET4/MET4A system operation be verified prior to installation. Please refer to Section 4 for details.

This section covers the physical installation of the MET4/MET4A. For information about connecting the MET4/MET4A to a GPS receiver, please refer to our GPS-MET support document, “Integrating DigiQuartz® MET4 and MET4A Broadband Meteorological Measurement Systems with a GPS Receiver.” It can be found on our website at www.paroscientific.com/pdf/GPSMETIntegration.pdf.

12.1 Locating the MET4/MET4A

Please observe the following when locating the MET4/MET4A:

- The MET4/MET4A must be installed vertically with the DigiPort oriented upward. This position will assure optimum performance of the sensors.
- Whenever possible, mount the MET4/MET4A such that the DigiPort extends above the mounting structure.
- For optimum barometer performance, the distance from MET4/MET4A to adjacent objects should be at least ten times the width of the object. For example, the MET4/MET4A should be at least 100 feet away from a 10 foot wide obstruction.
- Avoid mounting the MET4/MET4A near sources of heat or humidity, such as HVAC vents or objects that accumulate and radiate heat.
- Avoid mounting the MET4/MET4A in a location where heat may be reflected into the solar shield by a nearby object.

12.2 Mounting the MET4/MET4A

The MET4/MET4A is packaged to withstand adverse field conditions and no additional shielding or protection is required

Install the mounting bracket on a pole of not more than 2 inches in diameter. (An optional flat monument mounting plate is available.) Be sure the mounting fixture and structure are capable of supporting the weight of the MET4/MET4A under adverse weather conditions.

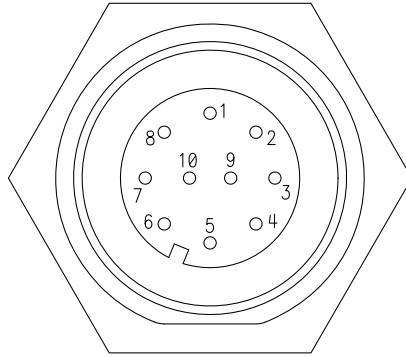
12.3 Electrical Connections

The MET4/MET4A is packaged to withstand adverse field conditions and no additional shielding or protection is required. The mounting hardware supplied with the MET4/MET4A provides ground isolation from the mounting pole. No other ground connection should be made except at the recording device through the cable shield and connector shells (as shown in Connector Diagram section).

We recommend that the MET4/MET4A interface cable be protected from long-term exposure to the elements. A typical installation will include placing the cable in conduit to ensure extended cable life and reliable data transmission. Proper cable strain relief and cable bend radii will minimize the risk of cable and connector damage.

12.4 Connector Diagrams

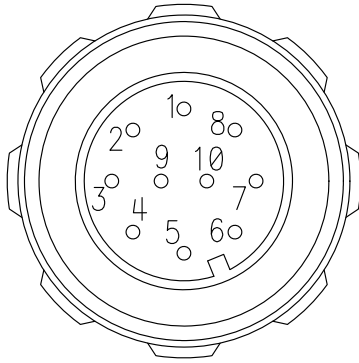
MET4/MET4A CONNECTOR



Pin	Connection
1	RS-485 TX+
2	RS-485 TX-
3	RS-485 RX+
4	RS-485 RX-
5	RS-232 TX
6	RS-232 RX
7	Power
8	Chassis ground
9	Ground (power/signal)
10	Ground (power/signal)

Figure 10. MET4/MET4A (Bulgin PX0413/10P) connector pin-out

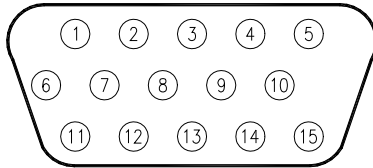
MET4/MET4A CABLE (PN 6059-XXX) CONNECTORS



Pin	Connection
1	RS-485 TX+
2	RS-485 TX-
3	RS-485 RX+
4	RS-485 RX-
5	RS-232 TX
6	RS-232 RX
7	Power
8	Not used
9	Ground (power/signal)
10	Not used

Figure 11. MET4/MET4A cable (PN 6059-XXX) Bulgin PX0410/10S connector pin-out

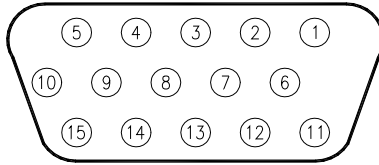
MET4/MET4A CABLE (PN 6059-XXX) CONNECTORS (CONT.)



Pin	Connection
1	Not used
2	RS-232 TX
3	RS-232 RX
4	Not used
5	Ground (power/signal)
6	Not used
7	Not used
8	Not used
9	Power (consult SCD)
10	Not used
11	Not used
12	RS-485 RX+
13	RS-485 RX-
14	RS-485 TX+
15	RS-485 TX-

Figure 12. MET4/MET4A cable (PN 6059-XXX) DB15M-HD connector pin-out

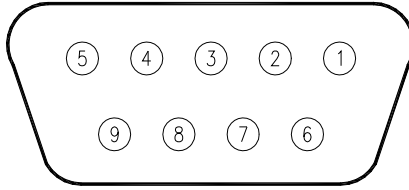
POWER ADAPTER (PN 6671-003) CONNECTORS



Pin	Connection
1	Not used
2	RS-232 TX
3	RS-232 RX
4	Not used
5	Ground (power/signal)
6	Not used
7	Not used
8	Not used
9	Power (consult SCD)
10	Not used
11	Not used
12	RS-485 RX+
13	RS-485 RX-
14	RS-485 TX+
15	RS-485 TX-

Figure 13. Power adapter (PN 6671-003) DB15F-HD connector pin-out

POWER ADAPTER (PN 6671-003) CONNECTORS (CONT.)



Pin	Connection
1	Not used
2	RS-232 TX
3	RS-232 RX
4	Not used
5	Ground (power/signal)
6	Not used
7	Not used
8	Not used
9	Power (consult SCD)

Figure 14. Power adapter (PN 6671-003) DB9-F connector pin-out

12.5 Wiring Diagrams

The diagrams in this section show the various ways in which the MET4/MET4A (and other DIGIQUARTZ® Intelligent devices) can be connected to RS-232 and RS-485 serial hosts and the Model 715 display. The MET4/MET4A pin numbers given are for the MET4/MET4A connector. PC RS-232 serial port pin numbers assume a typical 9-pin connector. Consult the documentation that came with your PC to verify your RS-232 port pin assignments.

RS-232

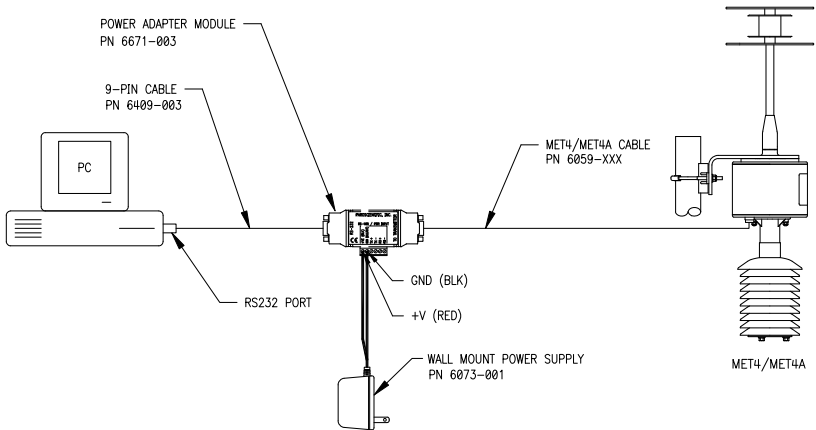


Figure 15. RS-232 wiring diagram using optional Cable and Power Adapter Kit

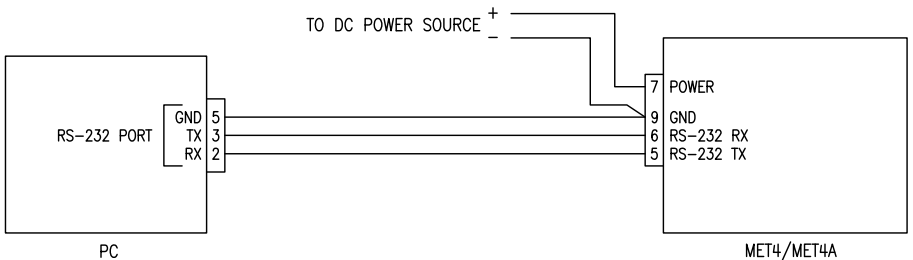


Figure 16. Simple RS-232 wiring diagram

RS-232 SERIAL LOOP NETWORK

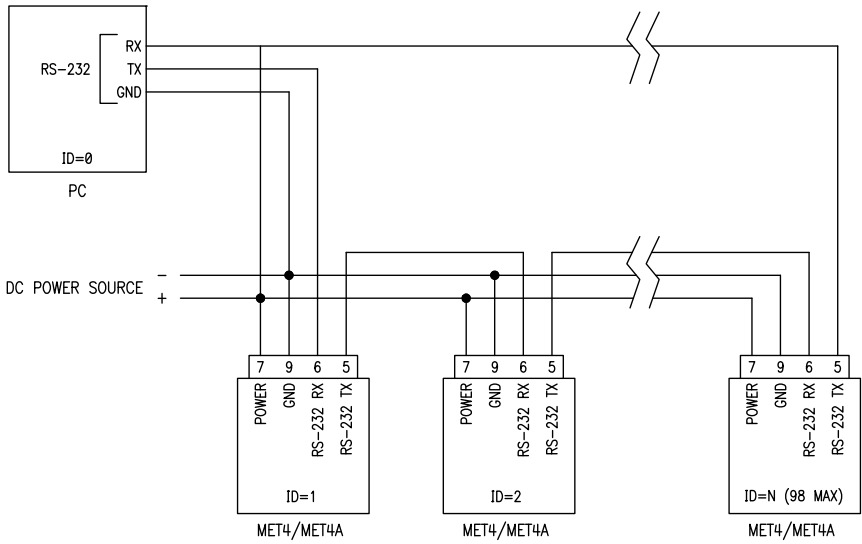


Figure 17. RS-232 serial loop network

RS-485

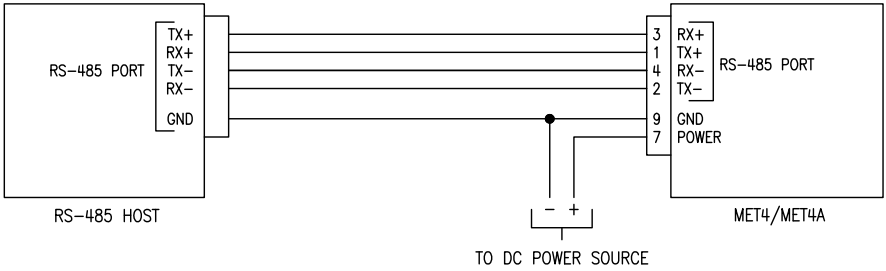


Figure 18. Simple 4-wire RS-485

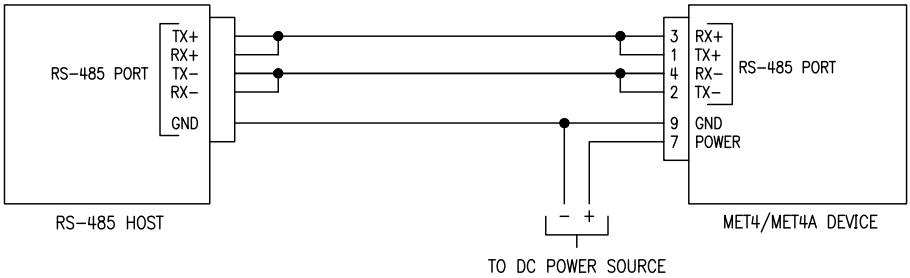


Figure 19. Simple 2-wire RS-485

RS-485 MULTI-DROP NETWORK

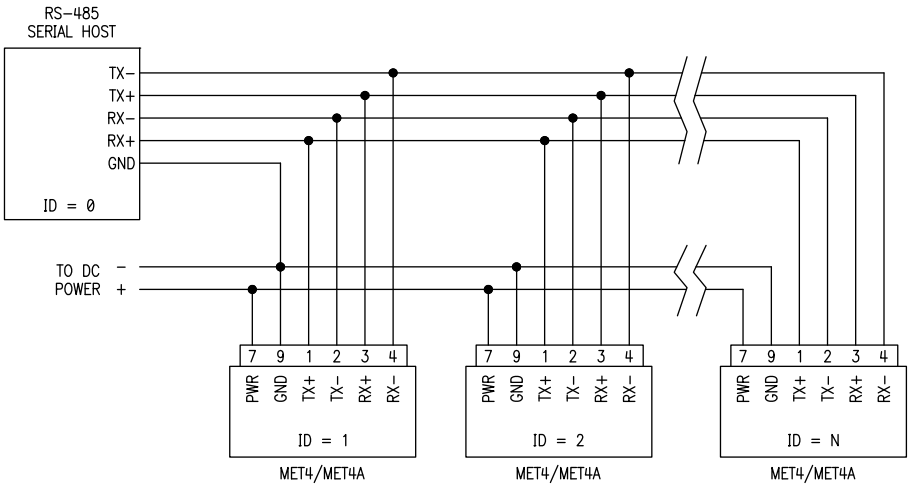


Figure 20. Simple 4-wire RS-485 multidrop network

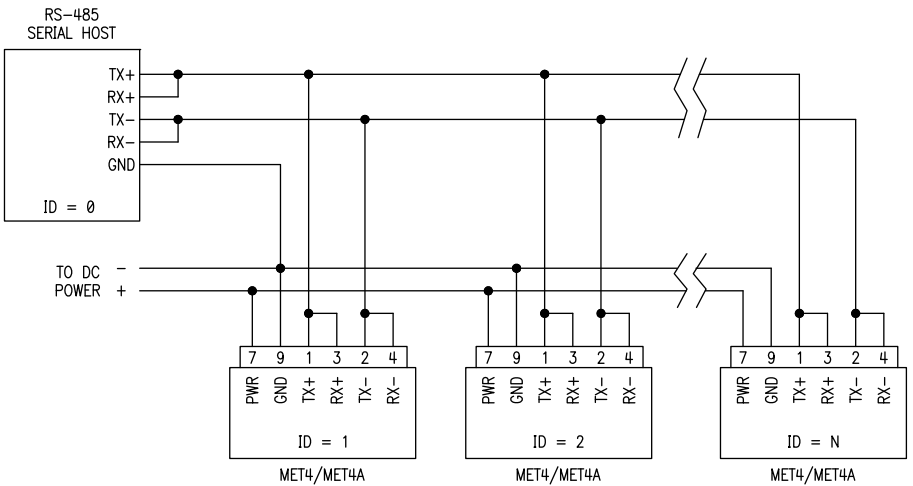


Figure 21. Simple 2-wire RS-485 multi-drop network

MODEL 715 DISPLAY

The diagrams in this section illustrate a few typical MET4/MET4A systems incorporating the Model 715 display, Paroscientific part number 1554-00X. The Model 715 can be powered with an external DC power source, or by an optional wall-mount DC power supply. Both power sources are shown on each diagram, but only one is needed. Either can be selected depending on your application.

The Model 715 display can supply power to the MET4 when connected per Figure 22. The Model 715 cannot supply adequate power to run the MET4A. A separate DC power source should always be used to power the MET4A.

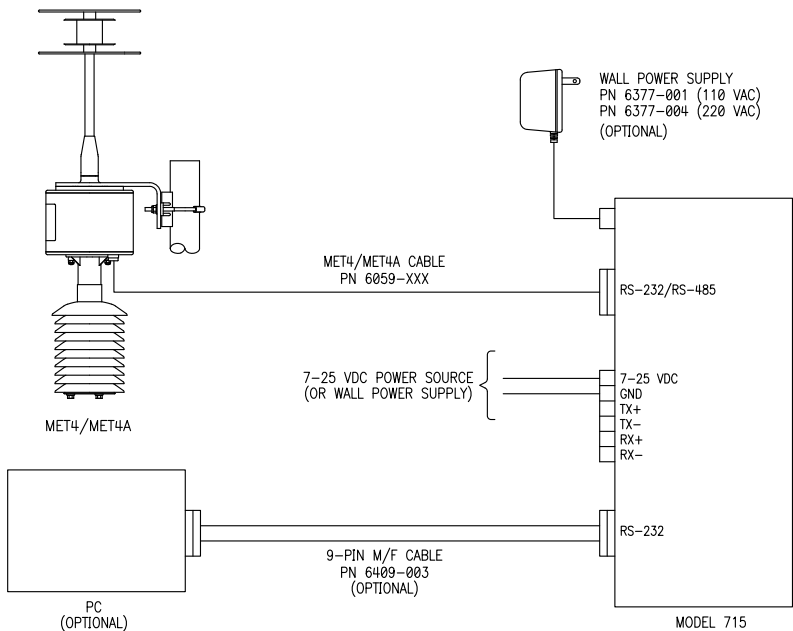


Figure 22. Simple MET4 / Model 715 Display system

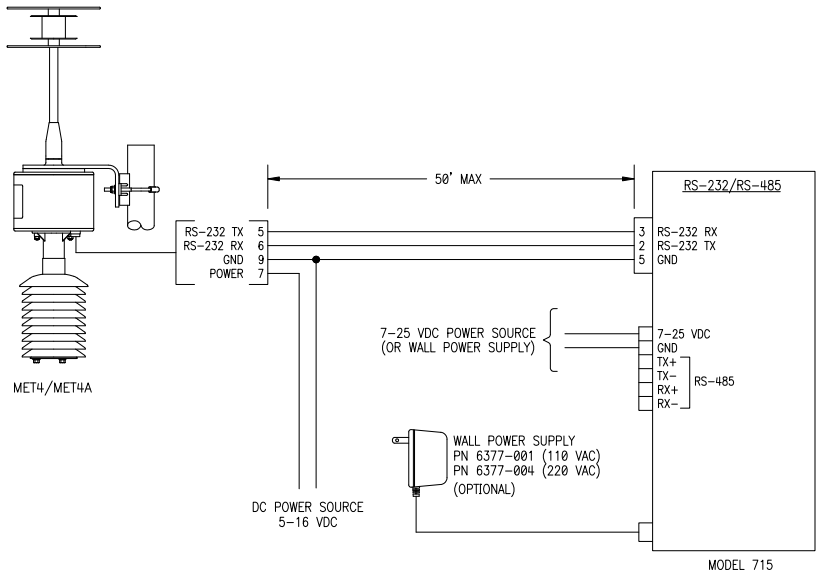


Figure 23. MET4/MET4A with Model 715 Display - RS-232 communication

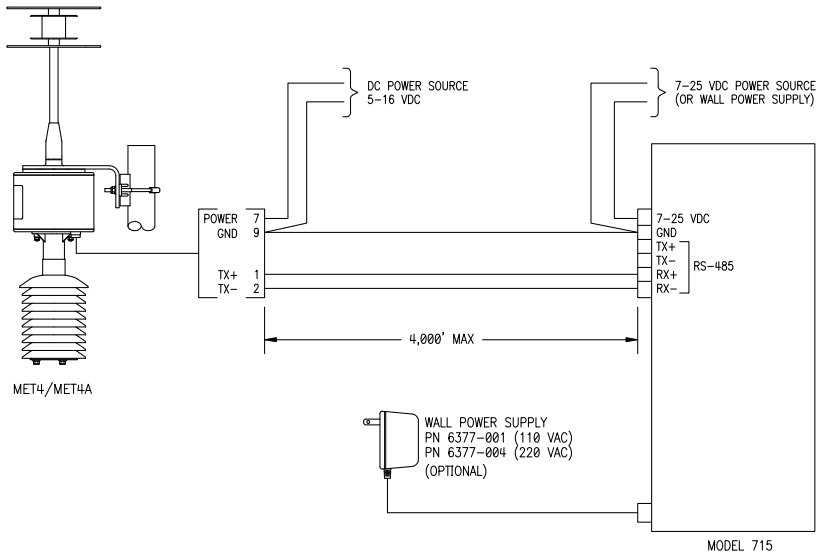


Figure 24. MET4/MET4A with Model 715 Display - RS-485 communication

13 Maintenance

The MET4/MET4A user maintenance tasks are described in this section. No other maintenance is required. If the unit becomes soiled, it may be cleaned using a soft cloth lightly moistened with plain water.

WARNING Do not open the electronics enclosure. No user serviceable parts are located inside. Breaking the warranty seal will void your warranty.

13.1 Cleaning the Temperature/Humidity Probe Screen

In certain environments where particulate and/or animal matter is present, it may be necessary to periodically clean the temperature/humidity probe screen to ensure accurate temperature and humidity measurements.

MET4 TEMPERATURE/HUMIDITY PROBE SCREEN CLEANING PROCEDURE

1. Remove power from the MET4.
2. Refer to Figure 25. Remove the two hex nuts and lock washers securing the solar shield to the bottom of the electronics enclosure.
3. Carefully pull the solar shield downward and away from the electronics enclosure until the solar shield clears the temperature/humidity probe.
4. The temperature/humidity probe screen assembly screws onto the end of the probe. Grasp the body of the probe, and turn the screen assembly counterclockwise until it is free, then carefully pull it straight out until it clears the sensing elements, taking care not to disturb them.
5. Remove any particulate matter from the screen using a brush or compressed air. Blow out the inside of the screen assembly to ensure that it is clean and free of particulate matter.
6. Carefully position the screen assembly over the probe sensing elements, taking care not to disturb them. Grasp the body of the probe, and turn the screen assembly clockwise until it is secured finger-tight.
7. Carefully position the solar shield over the probe and onto the mounting studs. Reinstall the lock washers and nuts, taking care not to damage the solar shield by over-tightening the nuts.
8. Test the MET4 to ensure that the temperature/humidity probe is working properly.

MET4A TEMPERATURE/HUMIDITY PROBE SCREEN CLEANING PROCEDURE

1. Remove power from the MET4A.
2. Refer to Figure 26. Remove the two uppermost screws on the side of the aspirated solar shield.

3. Carefully pull the solar shield downward and away from the fan enclosure until it clears the temperature/humidity probe.
4. The temperature/humidity probe screen assembly screws onto the end of the probe. Grasp the body of the probe, and turn the screen assembly counterclockwise until it is free, then carefully pull it straight out until it clears the sensing elements, taking care not to disturb them.
5. Remove any particulate matter from the screen using a brush or compressed air. Blow out the inside of the screen assembly to ensure that it is clean and free of particulate matter. **WARNING** Keep compressed air away from the barometric pressure port to prevent possible damage to the Digiquartz[®] pressure transducer.
6. Carefully position the screen assembly over the probe sensing elements, taking care not to disturb them. Grasp the body of the probe, and turn the screen assembly clockwise until it is secured finger-tight.
7. Carefully position the solar shield over the probe and onto the fan enclosure. Reinstall the two screws, taking care not to damage them by over-tightening.
8. Test the MET4A to ensure that the newly installed temperature/humidity probe is working properly.

13.2 Cleaning the MET4A Aspirated Solar Shield

In certain environments where particulate and/or animal matter is present, it may be necessary to periodically clean the MET4 aspirated solar shield to ensure accurate temperature measurements.

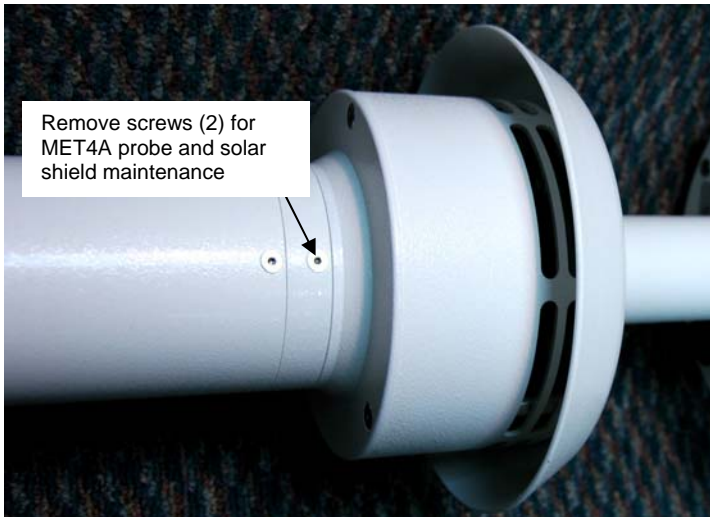
MET4A ASPIRATED SOLAR SHIELD CLEANING PROCEDURE

1. Remove power from the MET4A.
2. Refer to Figure 26. Remove the two uppermost screws on the side of the aspirated solar shield.
3. Carefully pull the solar shield downward and away from the fan enclosure until it clears the temperature/humidity probe.
4. Remove the remaining three screws to remove the outer shield.
5. Using a brush and/or compressed air, loosen and remove any debris on the solar shield parts and the bottom of the fan enclosure. Ensure that all air passages are free of debris.
6. Install the outer shield onto the inner shield, and secure with three screws, taking care not to damage them by over-tightening.
7. Carefully position the solar shield over the probe and onto the fan enclosure. Reinstall the two screws, taking care not to damage them by over-tightening.
8. Test that the **FS** command returns 1, indicating that the fan is operating at the correct speed. Test that the **TT** and **RH** commands return temperature and relative humidity values, respectively.



Remove nuts (2) for
MET4 probe maintenance

Figure 25. Gaining access to MET4 probe for maintenance



Remove screws (2) for
MET4A probe and solar
shield maintenance

Figure 26. Gaining access to MET4A probe and solar shield for maintenance

13.3 Replacing the MET4A Fan

The MET4A aspirated solar shield incorporates a fan to provide superior immunity to air temperature measurement errors due to direct solar radiation. Any fan operated in an outdoor environment is subject to wear due to dust, dirt, debris, salt, and other airborne contaminants. It is therefore necessary to monitor the fan status periodically to ensure continued optimum performance. The **FS** command reports the status of the MET4A solar shield fan. If the **FS** command returns 0, the fan is not rotating fast enough to provide adequate immunity from air temperature measurement errors due to solar radiation, and generally must be replaced. Replacement fan assemblies are available from Paroscientific.

To perform a field fan replacement, purchase the MET4A Fan Replacement Kit, Paroscientific part number 1776-001.

13.4 Replacing the Air Temperature/Humidity Probe

The MET4/MET4A air temperature/humidity probe is fully calibrated, certified, and self-contained, providing easy plug and play interchangeability. It is not possible for the end user to calibrate the probe itself. To return a MET4/MET4A to the published air temperature and humidity accuracy specifications, the probe must be replaced with a calibrated unit. Fully calibrated and certified replacement probes are available from Paroscientific.

To perform a field fan replacement, purchase the MET4/MET4A Temperature/Humidity Probe Replacement Kit, Paroscientific part number 1777-001.

14 Calibration

14.1 Pressure Calibration Procedure

OVERVIEW

Paroscientific transducers measure pressure with a force sensitive quartz crystal whose output period (or frequency) changes with applied load. For a given temperature, true applied pressure will generate a specific crystal period. Therefore, a measure of the crystal period will indicate what pressure is applied, provided the relationship between crystal period and pressure is known. This relationship is usually expressed as the C, D, T_0 equation. C, D, and T_0 are coefficients that are unique to Paroscientific transducers, and are different for each transducer. In addition, these coefficients are characterized for thermal effects. For each temperature, they are expressed as polynomial expansions with coefficients C1, C2, C3, D1, D2, T1, T2, T3, T4, and T5. Typically, it takes between 7 and 10 coefficients to fully describe the relationship, also called the "CD thermal model", between crystal output, temperature, and pressure.

Recalibration is necessary if a user decides that the agreement between true and indicated pressure is outside tolerances set for the particular application. Please see the documents entitled "Recalibration of Paroscientific Transducers - Doc 8140-001" and "Calibration of Digiquartz[®] Sensors" at www.paroscientific.com for recalibration procedures and calibration software support.

ZERO AND SPAN ADJUSTMENTS

The Paroscientific pressure transducer measures a force that is generated by external pressure. Since the quartz crystal is extremely sensitive, any other small force that is transmitted to the sensing element will be added to the pressure measurement. A pressure offset generated in this way is purely additive and is the same at all pressure values. In principle, checking accuracy at a single applied pressure is sufficient to determine an offset. Of course, the offset can be calculated as the average offset of many pressure points.

Span is defined here as the pressure difference from minimum pressure to full-scale pressure. A span error is the difference between the indicated pressure span as measured by the transducer and the true pressure span. If a transducer is carefully adjusted at minimum pressure, the span error is simply the difference between indicated and true applied pressure at full scale.

The span of a Paroscientific transducer is rarely adjusted since the scale factor of the sensing element is very stable. Differences are sometimes due to different calibration standards. The span of a dead weight tester used as a primary standard depends directly on the piston area and the value of local gravity. Any apparent

change of span in a Paroscientific transducer should be carefully checked to ascertain that the pressure is correctly applied and calculated with the correct piston area and gravity constant, and that the piston is vertical. We recommend recording several pressure points over the entire pressure range to establish any span error. The Paroscientific calibration software program RECAL calculates the best span by a least-squares fit optimization.

Please refer to the document entitled "Recalibration of Paroscientific Transducers - Doc 8140-001" at www.paroscientific.com for details regarding offset and span adjustment.

Calibration should only be performed by a skilled metrologist.

The **PA** and **PM** commands allow you to make zero and span adjustments. Normally, **PA** (pressure adder) is set to 0.0, and **PM** (pressure multiplier) is set to 1.0.

Adjusted pressure is calculated using the following equation:

$$P_{\text{adjusted}} = \text{PM} * (P + \text{PA})$$

Where:

- P = Pressure calculated using original calibration coefficients, in the current pressure units
- PM = the current value of **PM**
- PA = the current value of **PA**

Refer to paragraphs 6.20 and 10.6 for more information regarding **PA** and **PM**.

CAUTION **PA** and **PM** directly affect calibration. Use extreme caution when modifying **PA** or **PM**. Improper **PA** and/or **PM** values will result in inaccurate pressure measurements.

14.2 Temperature and Humidity Calibration Procedure

The MET4/MET4A temperature/humidity probe is fully calibrated, certified, and self-contained, providing easy plug and play interchangeability. It is not possible for the end user to calibrate the probe itself. To return a MET4/MET4A to the published temperature and humidity accuracy specifications, the temperature/humidity probe must be replaced with a calibrated unit. Fully calibrated and certified replacement probes are available from Paroscientific. Order the MET4/MET4A Temperature/Humidity Probe Replacement Kit, part number 1777-001.

14.3 Field Assessment of Barometer Accuracy

14.3.1 Overview

The intent of performing a field assessment of MET4/MET4A barometer accuracy is to potentially reduce unnecessary expenses related to returning the instrument to Paroscientific for service or re-calibration.

The purpose of the field assessment is to determine whether the unit should be removed from service for further laboratory evaluation or calibration. It is not possible to precisely calibrate the MET4/MET4A in the field due to uncontrolled environmental conditions. Paroscientific appreciates the importance of being able to assess barometer accuracy in the field. This capability will reduce overall ownership cost by minimizing system down time, shipping costs and in the case of international customers, potential duties associated with returning the product to Paroscientific.

In the event the field assessment reveals that the accuracy of the MET4/MET4A barometer may be out of tolerance, our recommendation is to perform another comparison in a controlled laboratory environment. If testing in the laboratory environment yields the same or a similar result, you could either offset adjust the MET4/MET4A based on your reference Model 765-16B, send the unit to a local calibration lab or return the unit to Paroscientific for calibration. Your final decision should be based on your accuracy requirement for the application.

The MET4/MET4A is designed to operate for extended periods in adverse weather conditions. This Field Assessment of Barometer Accuracy is not a substitute for a regular calibration program. Paroscientific highly recommends that customers establish their own calibration interval based on the requirements of their application.

14.3.2 Equipment

Paroscientific recommends that a Model 765-16B equipped with a DigiPort High Performance Pressure Port be used as the pressure reference for the assessment. It is important to note that since this is your reference equipment for field and possible laboratory comparisons that the Model 765-16B should be calibrated on a regular basis at either a local calibration laboratory or at Paroscientific. Records of the calibration should be maintained.

14.3.3 Field Assessment

The Field Assessment is intended as a gross check of barometer accuracy. Whether a measured pressure deviation is considered significant is highly dependant on the needs of your particular application. In general, in a controlled field test the difference between the measured pressure from the reference barometer (Model 765-16B) and the MET4/MET4A should be no greater than 0.3 hPa. (1) Depending on

the environment and the care you exercise in setting up the field test, your field results could vary significantly from this number.

FIELD ASSESSMENT RESULTS

In the field, the uncertainty of the MET4/4A and reference pressure measurements can be affected by a number of potential error sources. The degree to which these error sources affect your ability to assess the MET4/MET4A performance must be factored into your decision to perform the field assessment and/or to remove the MET4/MET4A from service.

MINIMIZING POTENTIAL ERROR SOURCES

Potential error sources and recommendations for minimizing their error contributions are listed below:

Pressure Instability

Fluctuating barometric pressure in the field may contribute to pressure measurement errors of a magnitude many times the specified accuracy of the MET4/MET4A barometer.

- Only attempt an assessment of barometer accuracy when barometric pressure measurements are consistent and stable.
- Synchronize the pressure measurements wherever possible to minimize the error contribution of fluctuating barometric pressure.
- Take a group of measurements over time, discard any unstable measurements, and average the remaining stable measurements.

Hydrostatic (Head) Pressure

It is imperative that you vertically align the Model 765 and MET4/MET4A barometers to minimize the effects of head pressure during the field assessment.

Refer to Figure 27 for alignment details.

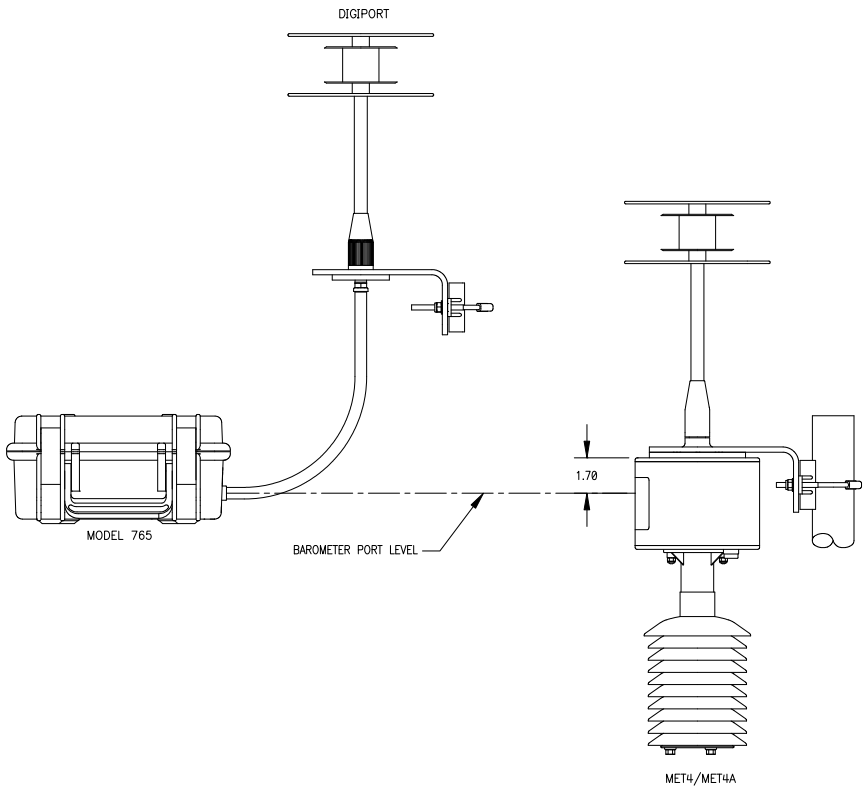


Figure 27. Aligning Model 765 and MET4/MET4A to minimize pressure head effects.

Air Movement Effects

The presence of moving air can compromise outdoor pressure measurements.

- The pressure reference should be connected to a pressure port that minimizes errors caused by moving air, such as the Paroscientific High Performance DigiPort. The MET4/MET4A features an integral DigiPort.

Temperature Effects

Unstable temperature of the reference device or the MET4/MET4A can contribute to pressure measurement errors.

- The reference and the MET4/MET4A should be allowed to reach thermal equilibrium prior to any accuracy assessment. The barometer temperature command (Q3) can be used to monitor internal barometer temperature.

14.3.4 Laboratory Comparison

Based on the results of your field test, you may determine that further testing in a laboratory environment is required. If you choose to perform the test in a laboratory,

there are several factors that can influence your results. These include heating and ventilation and movement of objects or people around or near the test set up. Care should also be taken to make sure that the pressure ports of the reference barometer (Model 765-16B) and the MET4/MET4A are at the same vertical level to minimize hydrostatic (head) pressure effects. Multiple measurements of both units should be taken over time.

In a highly controlled laboratory test the maximum pressure difference between the reference barometer (Model 765-16B) and the MET4/4A should be no greater than 0.16 hPa. However, there is a possibility that your results will not reflect this difference due to the test environment or the accuracy uncertainty of the Model 765-16B and/or the MET4/MET4A. Whether or not the pressure difference measured is significant is highly dependant on the needs of your application.

14.3.5 Calibration Options

After completing your Laboratory Comparison you may conclude that the pressure difference does not meet the needs of your application. At this point you have three options:

1. Offset adjust the MET4/4A against the 765-16B reference barometer. This can be accomplished by changing the PA value stored in the MET4/4A. See paragraph 14.1 for details. Be advised that due to the uncertainty in accuracy of the 765-16B Offset adjusting the MET4/MET 4A is no guarantee that the MET4/4A will meet the specification published by Paroscientific.
2. Have the MET4/4A calibrated at a local certified calibration laboratory.
3. Return the unit to Paroscientific for calibration.

Recommended Equipment:

1. Model 765-16B Portable Barometric Field Standard, Paroscientific part number 1100-010
2. High Performance DigiPort, Paroscientific part number 1745-0XX

(1) Allocated error budget of pressure measurement to achieve 1mm. measurement accuracy of Precipitable Water Vapor in GPS-MET Systems. Bevis et al., "GPS Meteorology: Remote Sensing of Atmospheric Water Vapor Using the Global Positioning System," Vol. 97, No. D14, pp 15,787-15,801, October, 1992,

15 Warranty

Paroscientific highly values our customers. A Quality Management System that is certified to the requirements of the ISO 9001:2000 International Quality Standard provides consistency in our products and processes from design and development through production, calibration, test, and servicing. Our quality system and commitment to excellence ensure customers of outstanding products and services. As a result, we offer a one-year warranty on all instrumentation systems, and a full five-year limited warranty on all Digiquartz[®] transducers that is unmatched in the industry.

This policy applies to all Digiquartz[®] transducers manufactured by Paroscientific, and includes the repair and/or replacement of parts that are required to maintain the unit to the “as purchased” configuration. Excluded from this policy are the following: conversions, product modification, zero adjustments, recalibration, and service analysis charges. This “Extended Limited Warranty” is a supplement to Paroscientific, Inc.’s “Terms and Conditions of Sale”. Shipping charges are the responsibility of the customer.

Months From Shipment	Discount From List Price
0 - 24	100%
25 - 36	75%
37 - 48	50%
49 - 60	25%

CONDITIONS:

- The warranty period is from the date of shipment from Paroscientific to date of receipt at Paroscientific.
- The customer must authorize the repair or replacement of the warranty claim within 45 days of notification by our Service Department.
- No exceptions to the discount schedule or terms of this policy are allowed.
- This warranty does not apply to units broken due to overpressure or excessive shock.
- Warranty returned units become the property of Paroscientific upon replacement.
- All barometers also have a three year limited warranty on long-term stability. Years 4 and 5 are covered by the above schedule.

16 Service and Support

Support is available via the Paroscientific web site at www.paroscientific.com. Technical information, application notes, software and product manuals are available on our web site. Please check the troubleshooting section of this manual if you are having problems with your instrument. If you need assistance, contact our sales and application engineers at support@paroscientific.com or (425) 883-8700.

If you are sending an instrument to us for service, please check our web site under the service section for detailed instructions for shipping a unit to us for service.

17 Troubleshooting

This section will help you to diagnose common problems related to the MET4/MET4A. If you have taken the recommended action and you are still experiencing difficulty, please contact a Paroscientific Application Engineer at support@paroscientific.com or (425) 883-8700.

CANNOT COMMUNICATE WITH MET4/MET4A

- Check that power is being applied to the MET4/MET4A. If the red PWR LED on the indicator panel is lit, the unit is being powered.
- Check that the MET4/MET4A is connected to the specified COM port.
- Check that the serial connections between the MET4/MET4A and the serial host are correct.
- Ensure that the serial host is configured for the correct baud rate, and is set to 8 data bits, 1 stop bit, and no parity. Digiquartz[®] Interactive (DQI) software can be used to scan the supported baud rates to determine the baud rate of the MET4/MET4A.
- Ensure that the serial host is sending a carriage return and line feed character at the end of each command.
- Ensure that commands are addressed to the proper Unit ID. If the Unit ID is unknown, Digiquartz[®] Interactive (DQI) software can be used to determine the current setting.

MET4/MET4A REPORTS INCORRECT PRESSURE VALUES

- Check that the calibration coefficients are correct. Digiquartz[®] Interactive (DQI) software can be used for this purpose. The proper calibration coefficients are listed in the calibration data sheet that was provided with your MET4/MET4A. If you are unable to locate the calibration data sheet, contact Paroscientific for the calibration coefficients.

DIGIQUARTZ[®] INTERACTIVE (DQI) CANNOT DETECT MET4/MET4A

- Check that power is being applied to the MET4/MET4A. If the red PWR LED on the indicator panel is lit, the unit is being powered.
- Check that the MET4/MET4A is connected to the specified COM port.
- Check that the serial connections between the MET4/MET4A and the PC are correct.

18 Pressure Unit Conversion Table

To use this table:

- Determine original pressure unit and desired pressure unit.
- Using the table, identify the appropriate pressure conversion factor.
- Multiply the original pressure value by the conversion factor to convert it to the desired pressure unit.

Original Pressure Unit	Desired Pressure Unit						
	Meters H ₂ O (density = 1.0 gm/cm ³)	psi	Inches of mercury (in Hg)	mm of Hg or Torr (mm Hg)	Gram/cm ² (gm/cm ²)	Millibar (mbar) (hPa)	Newton/m ² (Pascal) (Pa)
Meters H ₂ O	1	1.422334	2.895903	73.5592	100.0000	98.06650	9806.650
psi	.7030696	1	2.036021	51.71493	70.30696	68.94757	6894.757
Inches of Hg	.3453155	.4911541	1	25.40000	34.53155	33.86388	3386.388
mm of Hg, Torr	.01359510	.01933678	.03937008	1	1.359510	1.333224	133.3224
Gram/cm ²	.01000000	.01422334	.02895903	.7355592	1	.9806650	98.06650
Millibar	.01019716	.01450377	.02952999	.75000617	1.019716	1	100.0000
Newton/m ²	1.019716 X10 ⁻⁴	1.450377 X10 ⁻⁴	2.952999 X10 ⁻⁴	7.500617 X10 ⁻³	.01019716	.01000000	1

19 Glossary

The following is a list of definitions related to the MET4/MET4A

5-minute Temperature – The air temperature measured at 5-minute intervals. Used to calculate Field Pressure, Station Pressure, Sea-Level Pressure, Altimeter Setting, Density Altitude, and Pressure Altitude.

12-hour Temperature – The air temperature measured at 12 hour-intervals. Used to select the appropriate Pressure Reduction Ratio when calculating Sea-Level Pressure.

Altimeter Setting – The pressure value to which an aircraft altimeter is set so that it will indicate the altitude above mean sea level on the ground at the location for which the pressure value was determined.

Data Logging – Accumulating measurement data within the MET4/MET4A for later retrieval.

Density Altitude – The altitude in the standard atmosphere where air density is the equivalent to that at the airport.

Digiquartz® Intelligent Device – A Digiquartz® Intelligent Instrument or Transmitter with RS-232 and RS-485 serial interfaces.

Digiquartz® Pressure Transducer – A Digiquartz® pressure transducer with frequency outputs.

Field Elevation – The elevation from mean sea level of the airfield.

Field Pressure – The atmospheric pressure computed for a specific airport elevation.

Integration Time – The time over which the Digiquartz® pressure transducer output signals are measured. Also referred to as sampling time.

Pressure Altitude – The altitude in the standard atmosphere at which a given pressure will be observed.

Pressure Reduction Constant – A constant used to calculate Sea-Level Pressure. Can be used in lieu of Pressure Reduction Ratios at certain low-elevation locations.

Pressure Signal – The output of a Digiquartz® pressure transducer whose frequency is related to applied pressure.

Pressure Tendency Code – A standardized code describing the character and amount of atmospheric pressure change during a specified period of time.

QFE – Same as Station Pressure.

QNH – Same as Altimeter Setting.

Resolution – The smallest change in measured quantity that can be resolved.

Sampling Rate – The number of pressure measurements taken per a given time unit, often expressed in Hertz (Hz).

Sampling Time – The time over which the Digiquartz® pressure transducer output signals are measured. Also referred to as integration time.

Sea-Level Pressure – The pressure value obtained by the theoretical reduction or increase of station pressure to sea level.

Sensor Elevation – The elevation from mean sea level of the sensor used to provide barometric pressure measurement data.

Station Elevation – The elevation from mean sea level of the reporting station.

Station Pressure – The atmospheric pressure computed for a specific station location and elevation.

Temperature Signal – The output of a Digiquartz® pressure transducer whose frequency is proportional to internal sensor temperature.

User-defined Command – A command whose function is defined by the user to suit a particular application.

20 Frequently Asked Questions

1. How do I communicate with the instrument via RS-232 or RS-485?

Refer to paragraphs 5.2 and 5.3.

2. How do I change the RS-232 / RS-485 baud rate?

Refer to paragraph 6.2.

3. How do I configure my instrument?

Refer to Sections 5 and 6.

4. How do I change the pressure unit?

Refer to paragraph 6.9.

5. How do I change the pressure sampling rate?

Refer to paragraph 6.5.

6. What are the RS-232 and RS-485 commands?

Refer to Section 6.

7. How do I tare the unit?

Refer to paragraph 6.10.

8. How do I change the information on the Model 715 display?

Refer to paragraph 6.13.

9. How do I change the Unit ID?

Refer to paragraph 6.2.

21 Command and Parameter Reference

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A1 Output air temperature measurement value.....	6-3
A2 Output relative humidity measurement value.....	6-3
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BR Set baud rate.....	6-1
DB Dump buffer.....	6-8
DS Dump buffer sequential.....	6-7
DT Display text on second line.....	6-31
EW Enable write.....	6-1
FR Fan speed.....	6-33
FS Fan operational status.....	6-33
ID Set unit ID.....	6-2
J1 Output Field Pressure value.....	6-36
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J3 Output Sea-Level Pressure value.....	6-37
J4 Output Altimeter Setting (QNH) value.....	6-37
J5 Output Density Altitude value.....	6-37
J6 Output Pressure Altitude value.....	6-37
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L1 Output fixed format pressure, air temperature, and humidity.....	6-5
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M2 Output timestamp for minimum pressure value.....	6-18
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Q5	Sample and hold a temperature value.....	6-8
Q6	Sample and hold a temperature period value.....	6-8
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VR	Output firmware version.....	6-28

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US	Serial data unit suffix enable/disable.....	6-24
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ZI	Tare serial indication enable/disable.....	6-25
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