Paroscientific, Inc.

OPERATION MANUAL

FOR

INTELLIGENT INSTRUMENTS WITH DUAL RS-232 AND RS-485 INTERFACES

SERIES 1000 / 6000 / 9000
INTELLIGENT PRESSURE TRANSMITTER

SERIES 8CDP / 8CB
INTELLIGENT DEPTH SENSOR

MODEL 715 DISPLAY

RS-232 / RS-485 SERIAL INTERFACE BOARD

DOCUMENT NO. 8819-001
REVISION C
FEBRUARY 2002

WWW.PAROSCIENTIFIC.COM

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1. Introduction

1.1. About this manual

Thank you for your recent DIGIQUARTZ® Intelligent Transmitter or Depth Sensor purchase. This manual describes the operation of the entire line of Paroscientific DIGIQUARTZ® Intelligent Transmitters and Depth Sensors equipped with dual RS-232 and RS-485 serial interfaces. DIGIQUARTZ® Intelligent devices that support RS-232 only are covered by a separate manual, Paroscientific Document Number 8107-001.

1.2. Conventions used in this manual

The following conventions are used throughout this manual:

DIGIQUARTZ® Intelligent Device – Any Series 1000, 6000, or 9000 Intelligent Transmitter, or Series 8000 Intelligent Depth Sensor with dual RS-232 and RS-485 ports.

DIGIQUARTZ® Intelligent Transmitter – Any model from the Series 1000, 6000, or 9000 product lines with dual RS-232 and RS-485 ports.

DIGIQUARTZ® Intelligent Depth Sensor – Any model from the Series 8000 product line with dual RS-232 and RS-485 ports.

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

WARNING is used to draw your attention to a situation that may result in permanent damage to an Intelligent device.

1.3. Safety precautions

DIGIQUARTZ® Pressure Transmitters and Depth Sensors are precision devices, and as such, they should be operated with a certain degree of care to ensure optimum performance.

WARNING It is recommended that the input pressure not exceed 1.2 times the rated full-scale pressure. Calibration can be affected if this limit is exceeded, and permanent damage can result if the unit is sufficiently over-pressured.

WARNING Excessive mechanical shock may cause irreparable damage. Do not drop an Intelligent device, or allow tools to fall on the unit or its pressure port.

1.4. Manual summary

This manual is organized as follows:

Section 1	Introduction to this manual.
Section 2	Descriptions of the hardware covered in this manual.
Section 3	Description of the features and functions common to all DIGIQUARTZ® Transmitters and Depth Sensors.
Section 4	Information needed to quickly connect a DIGIQUARTZ® Intelligent device to a serial host and take pressure measurements.
Section 5	Information about interconnection, serial communications, command and response data format, measurement options, device configuration, and the DIGIQUARTZ® application software.
Section 6	Detailed command descriptions.
Section 7	Explanation of the relationship between resolution, integration time, and sampling rate.
Section 8	Recommendations for maximizing sampling rate.
Section 9	Information regarding the operation of Intelligent devices in RS232 serial loop and RS485 multi-drop networks.
Section 10	Information about interconnecting and operating the Model 715 display with DIGIQUARTZ® Intelligent devices.
Section 11	A functional description of the Tare Input, Tare Output, and Overpressure I/O lines.
Section 12	Connector pin-out diagrams for Intelligent devices, Model 715 Display, power adapter module, and PC RS-232 serial port.
Section 13	Wiring diagrams for simple RS232, simple RS485, RS232 serial loop network, and RS485 multi-drop network systems.
Section 14	Troubleshooting tips.
Section 15	Descriptions of the formulas used by DIGIQUARTZ® Intelligent devices to calculate pressure and temperature.
Section 16	Information about zero and span calibration adjustments.
Section 17	A quick reference list of the commands supported by DIGIQUARTZ® Intelligent devices.

2. Hardware Descriptions

2.1. Intelligent Transmitters (Series 1000 / 6000 / 9000)

DIGIQUARTZ® Intelligent Transmitters consist of a pressure transducer and a serial interface board in an integral package. Commands are sent and measurement data are received via one RS-232 and one RS-485 serial port. Measurement data are provided directly in user-selectable engineering units with a typical total accuracy of 0.01% or better over a wide temperature range. Pressure measurements are fully temperature compensated using a precision quartz crystal temperature sensor. Each intelligent transmitter is preprogrammed with calibration coefficients for full plug-in interchangeability.

2.2. Intelligent Depth Sensors (Series 8CDP, 8CB)

DIGIQUARTZ® Intelligent Depth Sensors consist of a pressure transducer and a serial interface board in a rugged waterproof package. Commands are sent and measurement data are received via one RS-232 and one RS-485 serial port. Measurement data are provided directly in user-selectable engineering units with a typical total accuracy of 0.01% or better over a wide temperature range. Pressure measurements are fully temperature compensated using a precision quartz crystal temperature sensor. Each intelligent depth sensor is preprogrammed with calibration coefficients for full plug-in interchangeability.

2.3. Model 715 Display

The Model 715 is an LCD display unit that can be used with DIGIQUARTZ® Intelligent devices that are equipped with dual RS-232 and RS-485 serial interfaces. It features a two-line, 16 character alphanumeric LCD display that is backlit to ensure readability even in low light conditions. The Model 715 can communicate with an Intelligent device via either RS-232 or RS-485.

The Model 715 is housed in a sturdy metal enclosure that conforms to DIN specifications. It is designed for easy panel mounting, but can also function as a tabletop instrument when used with the optional bench stand.

3. Universal Features and Functions

The following features and capabilities are common to all DIGIQUARTZ® Intelligent Transmitters and Depth Sensors with dual RS-232 and RS-485 ports, except as noted.

3.1. Measurement basics

The outputs from DIGIQUARTZ® pressure transducers are two square wave signals whose period is proportional to applied pressure and internal transducer temperature. The Intelligent electronics 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.

DIGIQUARTZ® Intelligent devices allow you to set the integration time between 0.001 and 65.535 seconds in 0.001 second increments. Pressure and temperature integration times can be set independently. You can use these features to configure the intelligent device according to the data acquisition and resolution requirements of your application.

Refer to Section 7 for more information about integration time, resolution, and sampling rate.

3.2. Measurement types

The outputs from DIGIQUARTZ® pressure transducers are two square wave signals whose period is proportional to applied pressure and internal transducer temperature. One or both of these 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

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

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:

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 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:

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

Refer to Section 6.1 for detailed measurement command descriptions.

3.3. Sampling types

Four sampling types are available:

- 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 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.

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 Section 6.1 for detailed measurement command descriptions.

3.4. Engineering units

Pressure values can be expressed in the following engineering units. Refer to the **UN** command in Section 6.2.3 for details.

- psi
- hPa (mbar)
- bar
- kPa
- MPa
- in Hg
- mm Hg (torr)
- m H_2O
- User-defined units

Temperature values can be expressed in the following units. Refer to the **TU** command in Section 6.2.3 for details.

- °C
- °F

3.5. Serial data output modes

In addition to the sampling types described in Section 3.3, DIGIQUARTZ® Intelligent devices can also be configured to provide continuous pressure measurement data whenever power is applied. Refer to Section 6.3 for details.

3.6. Power management

You can configure a DIGIQUARTZ® Intelligent device to 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 Section 6.2.4 for details.

3.7. Tare and overpressure

You can configure the DIGIQUARTZ® Intelligent device 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 can be initiated by contact closure via a dedicated digital input line, or by serial command. A dedicated digital output and/or a special character in the measurement data can be used to indicate whether taring is in effect. Refer to Sections 6.2.5 and 11 for details.

You can configure the DIGIQUARTZ® Intelligent device to indicate whether the measured pressure exceeds a user-specified setpoint. This indication is provided via a dedicated digital output line. Refer to Sections 6.2.5 and 11 for details.

NOTE: Tare and overpressure I/O lines are not available with DIGIQUARTZ® Intelligent Depth Sensors.

3.8. Measurement data formatting

Several serial data formatting options have been provided, and are listed below. Refer to Section 6.2.6 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(s) 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.

3.9. RS-232 and RS-485 serial communications

DIGIQUARTZ® Intelligent devices are 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. Both ports share the same baud rate. 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.

Up to 98 units and an RS-232 serial host can be interconnected to form a serial loop network. Refer to Sections 6.2.2, 9.4, and 13 for details. Additionally, up to 98 units and an RS-485 serial host can be interconnected to form a 2-wire or 4-wire RS-485 multi-drop network. Refer to Sections 6.2.2, 9.3, and 13 for details.

You communicate with a specific DIGIQUARTZ® Intelligent device by sending commands to its ID number. You can also send certain commands to all devices on a network by sending the command to the global address. Refer to Sections 5.3, 5.4, and 6.6 for details.

3.10. Differences between the RS-232 and RS-485 ports

Generally, DIGIQUARTZ® Intelligent devices respond 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 Section 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 Section 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. Refer to Section 9.3 for details.

3.11. Calibration

DIGIQUARTZ® Intelligent devices are shipped fully calibrated. 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 to do so, and then only with extreme caution. See Section 6.5 for details.

3.12. Unit identification

DIGIQUARTZ® Intelligent devices are shipped with several unit identification values stored in non-volatile memory. These read-only values include:

- Serial and model numbers
- Full-scale pressure
- Transducer type.

Refer to Section 6.2.7 for details.

3.13. Model 715 Display

DIGIQUARTZ® Intelligent devices can be used with the Model 715 Display to display pressure, temperature, and user-defined alphanumeric information. The Model 715 can communicate with DIGIQUARTZ® Intelligent devices via either RS-232 or RS-485. User-defined alphanumeric display information can be stored in the DIGIQUARTZ® Intelligent device, or can be sent directly from the serial host to the Model 715 display. Intelligent devices support several commands that control the Model 715 display. Refer to Section 6.2.8 for details.

DIGIQUARTZ® Intelligent devices with dual RS-232 and RS-485 ports are not compatible with the Model 710 display. Older Intelligent devices with RS-232 only are not compatible with the Model 715 display.

4. Quick Start

This section will help you to quickly connect your DIGIQUARTZ® Intelligent device to the RS-232 serial port of a standard PC, establish communications, and take your first pressure measurements.

This process will be much simpler and easier if you have purchased the RS232/RS485 Power Module Kit (110V p/n 1294-001, 220V p/n 1294-002. The kit includes the following items:

- Power adapter module, p/n 6671-003
- 110 or 220 VAC wall power supply, p/n 6024-001 or 6024-002
- 9-pin serial cable, p/n 6409-003

Step 1. Connect up the system

If you have the Power Module Kit:

- Connect up the system as shown in Figure 2 in Section 13.
- Plug in the wall power supply.

If you don't have the Power Module Kit:

- Connect up the system as shown in Figure 3 in Section 13.

Step 2. Run DIGIQUARTZ® Interactive (DQI)

- Install DIGIQUARTZ® Interactive (DQI) software on your PC. See Section 5.6 for more information.
- Run DQI. When the program starts, the Startup window is displayed.
- Set the Port ID to match the PC COM port you are using, and click Start. DQI will search for your device at various baud rates.
- If your device is not detected, exit DQI, check your power and serial connections, re-run DQI and try again.
- If your device is detected, DQI will display your device's ID, parity setting, and software version. Click OK to proceed. DQI will then display its main window.
- Click the Sampling tab and click Start. DQI will read and display the device's serial number and software version.
- Click Sample and Send Pressure, and click Send. DQI will then send the pressure measurement command to your Intelligent device. When the pressure measurement is complete, the response from your device will be displayed. Refer to Section 5.5 for detailed information about the response data format.

Congratulations! You have taken your first pressure measurement! We encourage you to use DQI and DIGIQUARTZ® Terminal to explore the remaining functions of your DIGIQUARTZ® Intelligent device. Refer to the Help function in DQI and DIGIQUARTZ® Terminal for more information.

5. Getting Started

5.1. Compatible serial hardware

DIGIQUARTZ® Intelligent devices are compatible with any equipment that conforms to the EIA RS-232 and/or RS-485 specifications. They are also backward compatible with earlier Intelligent devices that support RS-232 only, and can be used together in RS-232 serial loop networks.

DIGIQUARTZ® Intelligent devices with dual RS-232 and RS-485 ports are not compatible with the Model 710 display, and DIGIQUARTZ® Intelligent devices with RS-232 only are not compatible with the Model 715 display.

5.2. Serial and power connections

Serial and power connections are made via a male 15-pin high-density D-subminiature connector. Refer to Section 12 for connector pin details.

Refer to section 13 for detailed system wiring diagrams.

It is recommended that you establish communications and verify transmitter operation prior to permanently installing the device. The RS232/RS485 Power Module Kit (110V p/n 1294-001, 220V p/n 1294-002) simplifies the task of powering the transmitter and making RS-232 serial connections to a PC or other serial host.

NOTE: The RS232/RS485 Power Module Kit is intended for use with DIGIQUARTZ® Intelligent transmitters, and is not compatible with Intelligent depth sensor products.

5.3. Communications

DIGIQUARTZ® Intelligent devices are initially configured for RS232/RS485 communications at 9,600 baud. Both ports operate at the same baud rate. The serial protocol is fixed at 8 data bits, no parity, and 1 stop bit. Each Intelligent device has an ID number, and will only respond to commands sent to its ID number or 99. ID number 99 is reserved as a global address, which can be used to send a single command to multiple devices at once. The ID number is initially configured to 01, but you can set the ID number to any value between 01 and 98.

It is recommended that DIGIQUARTZ® Interactive (DQI) software be used to establish initial communications with your transmitter. Refer to the DIGIQUARTZ® CD library and Section 5.6 for details.

You may also use any terminal program that is configured for the proper baud rate and serial protocol. Your terminal program must also send a line-feed character (ASCII 10) with each carriage return.

5.4. Command basics

DIGIQUARTZ® Intelligent devices are controlled by serial ASCII command strings. The following basic tasks can be accomplished by sending the appropriate command:

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

When setting virtually all parameter values, you must precede the command with an **EW** command. This prevents accidental alteration of stored parameter values. Please refer to Section 6.2.1 for more information about the **EW** command.

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.

5.5. Command and response format

Commands are typically sent in the following form: *0100P3CrLf

Where:	* = start character	(ASCII 42)
	01 = Destination ID	(ID of intelligent device that is to respond to the command)
	00 = Source ID	(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)
	Lf = Linefeed character	(ASCII 10)

Responses are typically received in the following form: *000114.4567CrLf

Where:	* = start character	(ASCII 42)
	00 = Destination ID	(ID of serial host)
	01 = Source ID	(ID of device that is responding)
	14.4567 = Data	(Data sent in response to a measurement command)
	Cr = Carriage return	(ASCII 13)
	Lf = Linefeed character	(ASCII 10)

These examples are typical. Refer to Section 6 for specific details regarding each supported command.

5.6. DIGIQUARTZ® Software Programs

Paroscientific provides several software programs that simplify common measurement and configuration tasks. These programs can be found on the DIGIQUARTZ® CD Library, which is provided free of charge with each Intelligent device purchase. The latest versions of these and other software programs are also available at the Paroscientific web site, at www.paroscientific.com.

5.6.1. DIGIQUARTZ® Interactive (DQI)

DIGIQUARTZ® Interactive (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 to verify proper device operation, configure your device, take measurements, and experiment with its functions. Refer to the help function in DQI for more information.

5.6.2. DIGIQUARTZ® Assistant (DQA)

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. Refer to the help function in DQA for more information.

5.6.3. DIGIQUARTZ® Terminal (DQT)

DIGIQUARTZ® Terminal is a Windows terminal program that was developed specifically for use with DIGIQUARTZ® Intelligent devices. Like traditional terminal programs, DIGIQUARTZ® Terminal lets you interactively communicate with Intelligent devices. In addition, DIGIQUARTZ® Terminal can log time-stamped measurement data to a text file in a format that can easily be imported into popular PC programs such as Microsoft Word or Excel. Refer to the help function in DIGIQUARTZ® Terminal for more information.

6. Command Descriptions

6.1. Measurement commands

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

6.1.1. Single measurement commands

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

P1 Sample and send one pressure period measurement in microseconds.

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

Typical command: *0100P1

Typical response: *000128.123456 (Value: 28.123456)

P3 Sample and send one pressure measurement in selected engineering units.

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

Typical command: *0100P3

Typical response: *000114.71234 (Value: 14.71234)

Q1 Sample and send one temperature period measurement in microseconds).

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

Typical command: *0100Q1

Typical response: *00015.1234567 (Value: 5.1234567)

Q3 Sample and send one temperature measurement in selected engineering units.

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

Typical command: *0100Q3

Typical response: *000122.345 (Value: 22.34)

6.1.2. 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** command, the measurement value is sent; if it is any other command, the measurement value is lost. If a **DB** command is received before the measurement command is complete, the measurement value will be sent as soon as it is available.

P5 Sample and hold one pressure measurement in selected engineering units.

Action: Measure temperature period, measure pressure period, calculate temperature-compensated pressure, save pressure value, and await DB command.

Typical command: *0100P5

Typical response: No response until DB command is received

P6 Sample and hold one pressure period measurement in microseconds.

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

Typical command: *0100P6

Typical response: No response until DB command is received

Q5 Sample and hold one temperature measurement in selected engineering units.

Action: Measure temperature period, calculate temperature, save temperature value, and await DB command.

Typical command: *0100Q5

Typical response: No response until DB command is received

Q6 Sample and hold one temperature period measurement in microseconds.

Action: Measure temperature period, save temperature period value, and await DB command.

Typical command: *0100Q6

Typical response: No response until DB 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)

6.1.3. 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 measurement can be stopped by sending any valid command.

P2 Continuously sample and send pressure period measurement values in microseconds.

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

Typical command:	*0100P2	
Typical response:	*000128.123456	(Value: 28.123456)
	*000128.123457	(Value: 28.123457)
	*000128.123456 …	(Value: 28.123456)

P4 Continuously sample and send pressure measurement values in selected engineering units.

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

Typical command:	*0100P4	
Typical response:	*000114.71234	(Value: 14.71234)
	*000114.71235	(Value: 14.71235)
	*000114.71234 …	(Value: 14.71234)

P7 High-speed continuous pressure measurement in selected engineering units.

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.

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.

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

Action: 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.

Typical command: *0100EW*0100PS=4

Typical response: *0001PS=4

Note: When setting virtually all parameter values, you must precede the command with an **EW** (**E**nable **W**rite) command. Please refer to Section 6.2.1 for more information.

Q2 Continuously sample and send temperature period measurement values in microseconds.

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

Typical command: *0100Q2

Typical response:	*00015.1234567	(Value: 5.1234567)
	*00015.1234568	(Value: 5.1234568)
	*00015.1234567 …	(Value: 5.1234567)

Q4 Continuously sample and send temperature measurement values in selected engineering units.

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

Typical command: *0100Q4

Typical response:	*000122.345	(Value: 22.345)
	*000122.346	(Value: 22.346)
	*000122.345 …	(Value: 22.345)

6.1.4. Measurement integration time commands

DIGIQUARTZ® Intelligent devices support two measurement integration modes: time-based and period-based. Time-based integration samples the transducer's pressure and temperature signals for a specified time, and period-based integration samples the signals for a specified number of periods of the measured signal. See Section 7 for the relationships between integration time, resolution, and sampling rate.

The desired integration mode is automatically selected whenever an integration time set command is issued. For example, when a **PI** or **TI** set command is received, the intelligent device is configured for time-based integration mode; when a **PR** or **TR** set command is received, the intelligent device is configured for period-based integration. The selected integration mode remains in effect until it is changed.

PI and **TI** are new commands that set the integration time in increments of 0.001 second. The resulting integration times are independent of measured period, and will therefore be consistent from unit to unit. If you are controlling multiple devices in an RS-485 multi-drop network and require synchronized pressure measurements, it is recommended that **PI** and **TI** be used instead of **PR** and **TR**.

Time-based integration time commands

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

Units: Milliseconds

Range: 1-65535

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: 1-65535

Default: 666

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

Typical set response: *0001TI=1000

Typical read command: *0100TI

Typical read response: *0001TI=1000

Note: Changing TI has no effect on PI.

Period-based integration time commands

PR Set or read period-based pressure measurement integration time

Units: None

Range: 1-16383

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

Units: None

Range: 1-65535

Default: 952

Typical set command: *0100EW*0100TR=800

Typical set response: *0001TR=800

Typical read command: *0100TR

Typical read response: *0001TR=800

Note: Changing TR has no effect on PR.

6.2. Configuration commands

6.2.1. Enable write command

When setting virtually all parameter values, you must precede the parameter set command with an **EW** (**E**nable **W**rite) command. Parameter set commands will 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

6.2.2. Communications commands

The following commands are used to configure DIGIQUARTZ® Intelligent devices for serial communications. These commands affect both the RS-232 and RS-485 ports, regardless of which port receives the command.

BR Set the RS-232 and RS-485 baud rate.

Action: The **BR** command is used to set the baud rate of the RS-232 and RS-485 ports. The BR command must be addressed to 99, the global ID; this ensures that all units on a network are set to the same baud rate. It is not possible to read the baud rate value.

BR is unique in that it does not need to be preceded by an EW command.

Values: 300, 600, 1200, 4800, 9600, 19200, 38400, 57600, and 115200

Default: 9600

Typical set command: *9900BR=19200

Typical set response: *9900BR=19200

CAUTION Be careful to only set the baud rate to a value supported by your serial host! If you accidentally set the baud rate to an unsupported value and subsequently lose serial communications, use the DIGIQUARTZ® Terminal program to establish communications and restore the baud rate to the original value.

BL Set or read the Baud Lock parameter.

Action: The **BL** command is used to prevent an accidental change of baud rate. The **BL** command must be preceded with an **EW** command. The **BL** set command must be addressed to 99, the global ID; this ensures that all units on a network are set to the same baud lock state.

Values: 0 = Baud rate can be changed with **BR** command.
1 = **BR** command is ignored.

Default: 0

Typical set command: *9900EW*9900BL=1

Typical set response: *9900EW (Echoed **EW** command)
*0001BL=1 (Response from device)
*9900BL=1 (Echoed command)

Typical read command: *0100BL

Typical read response: *0001BL=1

Note: The response shown above assumes that the RS-232 port is being used. If the RS-485 port were being used, no response would have been sent. Refer to section 9.3 for more information.

ID Set the device ID.

Action: The ID command is used to set the device ID. The **ID** command must be addressed to 99, the global address. The device ID is set to the destination ID + 1. For example, if the command *9900ID were sent, the device would be set to ID=1 (00 + 1).

Range: 01 - 97

Default: 01

Typical set command: *9903ID (to set device ID to 04)

Typical set response: *9904ID (Indicates device ID was set to 04)

Note: The response shown above assumes that the RS-232 port is being used. If the RS-485 port were being used, no response would have been sent. CAUTION Do not send the ID command when multiple devices are connected together in an RS-485 multi-drop network. Doing so will set all devices on the network to the same ID. Refer to Section 9.3 for more information about using the ID command in an RS-485 multi-drop network.

6.2.3. Engineering units commands

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

UN Set or read the pressure engineering units.

Action: Sets or queries the conversion factor by which all calculated pressure values are multiplied before being output. Setting **UN** to a non-zero value selects one of eight standard pressure units; 0 selects a user-defined unit whose conversion factor is specified by the **UF** command. **UN** also sets the units of the pressure data displayed by an optional Model 715 display.

Range: 0-8

UN value	Pressure units	psi multiplied by…
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_2O	0.7030696

Default: 1

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

Typical set response: *0001UN=2

Typical read command: *0100UN

Typical read response: *0001UN=2

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

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

Range: -9999999 - 9999999

Default: 1.0000000

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

Typical set response: *0001UF=2

Typical read command: *0100UF

Typical read response: *0001UF=2

TU Set or read the temperature engineering units.

Action: Specifies the temperature units for **Q3**, **Q4**, **Q5**, and temperature data displayed by an optional Model 715 display.

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: Temperature is always calculated in °C, but it is converted to °F if TU=1.

6.2.4. Power management commands

DIGIQUARTZ® intelligent devices can be commanded to enter a low-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 "asleep".

CAUTION Power management features are not available if **MD** is set for continuous pressure data output or display data output.

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, 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 – 255, integer values only.

Default: 10

Typical set command: *0100EW*0100ST=5

Typical set response: *0001ST=5

Typical read command: *0100ST

Typical read response: *0001ST=5

6.2.5. Tare and overpressure commands

Taring is the process of subtracting a specified value from pressure measurements. You may use a measured pressure as the tare value, or you may specify any desired value. Taring can be enabled, disabled, and locked out through the use of serial commands. Taring can also be controlled and monitored using I/O lines; please refer to Section 11 for more information. Pressure measurement data can be formatted to include an indication when taring is in effect. Refer to the **ZI** command for more information.

The overpressure command can be used to specify the overpressure alarm setpoint. When the overpressure setpoint is exceeded, the overpressure I/O line changes from logic low (0 VDC) to logic high (3.3 VDC). Refer to Section 11 for more information.

ZS Set or read the tare state parameter value.

Action: The three states of ZS are as follows:

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

ZS is set to 0 on power-up. If **ZL**=0 (taring is not locked out), taring can be requested by sending the ZS=1 command. 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 taring is in effect.
- The value of **ZV** is subtracted from all subsequent pressure values until taring is turned off.

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

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

Range: 0-2

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 queries the value that is subtracted from pressure measurements when taring is activated. You can set **ZV** to any desired value when taring is in effect (**ZS**=2). Note, however, that if taring 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 - 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 taring. When **ZL**=1, 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, taring will be in effect when the next pressure measurement is taken, but you cannot turn taring off until **ZL** is set to 0.

The value of **ZL** is set to 0 on power-up.

Range: 0-1

Default: 0

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

Typical set response: *0001ZL=1

Typical read command: *0100ZL

Typical read response: *0001ZV=1

OP Set or read the overpressure alarm setpoint value.

Action: When a pressure measurement value is less than the value of **OP**, the Overpressure I/O line is at logic low (0 VDC); if it is greater or equal to the value of **OP**, the Overpressure I/O line is set to logic high (3.3 VDC). Refer to Section 11 for more information.

OP is set in the current pressure units, and is scaled accordingly if the engineering units are changed.

Range: -9999999 - 9999999

Default: Maximum rated device pressure

Typical set command: *0100EW*0100OP=15

Typical set response: *0001OP=15

Typical read command: *0100OP

Typical read response: *0001OP=15

6.2.6. 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 units to pressure and temperature measurement data
- Append a taring indication to tared 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, an engineering units label is appended to pressure and temperature measurement data. When **US**=0, no engineering units label is appended.

Examples:	*000114.71234	(Pressure measurement, **US**=0)
	*000114.71234psia	(Pressure measurement, **US**=1)
	*000121. 123	(Temp measurement, **US**=0)
	*000121. 123C	(Temp measurement, **US**=1)

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

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

Range: 0-1

Default: 0

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

Typical set response: *0001US =1

Typical read command: *0100US

Typical read response: *0001US =1

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 engineering units suffix. When **SU**=0, no underscore separators appear.

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

Range: 0-1

Default: 0

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

Typical set response: *0001SU=1

Typical read command: *0100SU

Typical read response: *0001SU=1

ZI Set or read the taring indication parameter value.

Action: When **ZI**=1, an "T" is appended to pressure measurement values when taring is in effect. When **ZI**=0, no taring indication appears, whether taring is in effect or not.

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)

Range: 0-1

Default: 0

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

Typical set response: *0001ZI=1

Typical read command: *0100ZI

Typical read response: *0001ZI=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

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

Range: 0-1

Default: 0

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

Typical set response: *0001DL=1

Typical read command: *0100DL

Typical read response: *0001DL=1

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 specification will vary slightly from the one described above.

UM Set or read the user-defined engineering units label parameter.

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

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

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

Default: user

Typical set command:	*0100EW*0100UM=test
Typical set response:	*0001UM=test
Typical read command:	*0100UM
Typical read response:	*0001UM=test

6.2.7. Unit identification commands

The Unit Identification commands read various device-specific parameters. These commands 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=R1.00

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=6030A

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

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
1	Gauge
2	Differential

Typical read command: *0100PO

Typical read response: *0001PO=0

6.2.8. Model 715 display configuration commands

The Display Configuration commands configure the DIGIQUARTZ® intelligent device for use with an optional Model 715 display.

DM Set or read the display mode.

Action: The display mode determines which data (if any) is displayed on the second line of an optional Model 715 display. The following table describes the supported display modes:

DM	Display mode
0	Horizontal bar graph indicating measured pressure as a percentage of full-scale pressure.
1	Internal transducer temperature.
2	User-defined text defined by the UL parameter.
3	No data is displayed on second line.
4	User-defined text received with the DT command.

Range: 0 - 4

Default: 0

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

Typical set response: *0001DM=1

Typical read command: *0100DM

Typical read response: *0001DM=1

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. When **DO**=0, the RS-485 port is used for Model 715 display data; when **DO**=1, the RS-232 port is used.

Range: 0 - 1

Default: 0

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

Typical set response: *0001DO=1

Typical read command: *0100DO

Typical read response: *0001DO=1

DP Set or read the number of decimal places in the pressure data sent to the Model 715 display.

Action: **DP** sets the maximum number of decimal places in the pressure display data. Fewer decimal places will be displayed if the pressure resolution is not sufficient to provide the specified number of decimal places. When DP is set to 6, the maximum number of decimal places is always displayed.

Range: 0 - 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 line 2 of the Model 715 display when DM=4.

Action: **DT** allows a serial host (such as a PC) to send text to the second line of an optional Model 715 display when **DM**=4. The text sent with **DT** is not stored by the intelligent device; it is simply transferred to the display. Since the text sent with **DT** is not stored, it cannot be queried, and it is not necessary to precede **DT** with an **EW** command.

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

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

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

PL Read the display overpressure indication setpoint. This setpoint is used to determine the pressure at which the intelligent device sends an overpressure indication to an optional Model 715 display.

Action: **PL** is a factory-set, read-only command. The value of the **PL** parameter is used as the overpressure indication setpoint for the Model 715 display.

Typical read command: *0100PL

Typical read response: *0001PL=120.0000

Note: **PL** is typically factory-set to 1.2 times full-scale pressure.

UL Set or read the text to be displayed on line 2 of the Model 715 display when **DM**=2.

Action: **UL** defines the text to be displayed on line 2 of an optional Model 715 display when **DM**=2. The value of **UL** is stored in non-volatile memory, and will therefore be retained even if power is lost. The value of **UL** is sent to the optional Model 715 display each time the pressure data is updated.

Range: 11 characters maximum. Any characters in the range of ASCII 32 – 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

6.3. Serial data output mode command

The following command controls whether pressure data is continuously output, and whether display data are produced.

MD Set or read the serial data output mode.

Action: **MD** configures the intelligent device for continuous pressure measurement output and/or display data output whenever power is applied.

MD value	Model 715 display data output	Continuous pressure data output
0	Off	Off
1	On	Off
2	Off	On
3	On	On

Once **MD** is set, the specified serial data output mode will remain in effect until **MD** is set to a different value, even through a power cycle. Therefore, the device will perform the specified serial data output function whenever power is applied.

Range: 0-3

Default: 0

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

Typical set response: *0001MD=1

Typical read command: *0100MD

Typical read response: *0001MD=1

Note: When **MD** is set to a non-zero value, the specified serial data output mode will be preempted under the following conditions:

- When the intelligent device is running in a continuous pressure data output mode, continuous data output is suspended when a measurement command is received. Continuous data output resumes when the measurement command is complete.

- When the intelligent device is running in a display data output mode, display data output is suspended when a period measurement command (**P1**, **P2**, **P6**, **Q1**, **Q2**, **Q6**) is received. Display data output resumes when the period measurement command is complete.

- Continuous pressure data output is suspended when a continuous measurement command (**P2**, **P4**, **P7**, **Q2**, **Q4**) is received, and resumes when the continuous measurement command is cancelled.

6.4. Diagnostic commands

In the unlikely event of a hardware failure, the Diagnostic commands can assist in the troubleshooting process.

CS Read the number of unused bytes on the stack since power-up.

Action: **CS** is read-only; it cannot be set. It can be used to determine whether a stack overflow may have occurred.

Typical read command: *0100CS

Typical read response: *0001CS=8

CX Check timebase crystal frequency.

Action: Puts the timebase frequency divided by 480 on the Tare Output I/O line. The timebase signal is removed from the Tare Output I/O line when the next valid command is received. CX cannot be queried. The **CX** set command does not produce a response.

Typical set command: *0100CX

Typical set response: No response

6.5. Calibration commands

The calibration commands set and read several parameters that directly affect the measurement accuracy of the device. Refer to Sections 15 and 16 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.

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.

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

P_{output} = PM * (P + PA), where

PM = the value of the **PM** parameter
P = the pressure value calculated using the original calibration data
PA = the value of the **PA** parameter

Range: -9999999 - 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. See the formula in the **PA** command description.

Range: -9999999 - 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.

TC Read the crystal timebase correction factor.

Action: **TC** is used to normalize the nominal 14.7456 MHz reference crystal frequency to 10 MHz to compensate for the natural variation in crystal resonant frequency. **TC** is read-only command.

Typical read command: *0100TC

Typical read response: *0001TC=.6666667

C1 **C2** **C3** **D1** **D2** **T1** **T2** **T3** **T4** **T5** **U0** **Y1** **Y2** **Y3**	Set or read the calibration coefficients.

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

6.6. Global Commands

Under certain circumstances, it may be necessary to send a single command to multiple Intelligent devices on a serial loop or multi-drop network. The ID 99 has been reserved for such global addressing. When an Intelligent device receives a legal command addressed to ID 99, the device reacts to that command regardless of its assigned ID value.

To support the unique requirements of RS-232 serial loop and RS-485 multi-drop networking, Intelligent devices react to global commands differently depending on which port received the command. When a global command is received via RS-232, the global command is re-transmitted before acting on the command. This ensures that all devices on a serial loop will receive the global command. When a global command is received via RS-485, the Intelligent device acts on the command but does not send a response. This prevents multiple devices on a multi-drop network from transmitting simultaneously, which would result in data collisions and unintelligible data.

Some commands can only be sent with global addressing:

BR
BL
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 and **P6**
Q5 and **Q6**

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

P1 through **P7**
Q1 through **Q6**
DB
VR
EW

The remaining commands should not be sent as global commands

7. Resolution, Integration Time, and Sampling Rate

The outputs from DIGIQUARTZ® pressure transducers are two square wave signals whose period is proportional to applied pressure and internal transducer temperature. The Intelligent electronics measures these signals using a technique similar to that of a common laboratory frequency counter. Like the frequency counter, a signal must be integrated for a specified period of time to measure its period.

The time over which the signal is integrated determines the resolution of the measurement. Longer integration times increase resolution, but reduce the sampling rate. Conversely, shorter integration times decrease resolution, but increase the sampling rate.

Another factor that influences sampling rate is the serial baud rate. For short integration times, faster baud rates enable faster sampling. As integration times increase, the benefit of faster baud rates quickly diminishes.

Tables 1, 2, and 3 illustrate the relationship between integration time, resolution, and sampling rate for the **P2**, **P4**, and **P7** commands at various baud rates. Integration time is given using both time-based (**PI**) and period-based (**PR**) methods.

NOTE: When using the period-based integration method (**PR**/**TR**), sampling rates and sample times are estimates, and may vary by up to 20% from unit to unit.

NOTE: Baud rates higher than those shown do not increase sampling rate.

P2 Command (Continuous Pressure Period Output)

Integration Time		Pressure Resolution	Sampling Rate and Sample Time					
			9600 Baud		19200 Baud		57600 Baud	
PI (ms)	PR	(ppm)	(Hz)	(s)	(Hz)	(s)	(Hz)	(s)
3	1	242.203	68.00	0.015	137.00	0.007	340.00	0.003
8	3	80.734	68.00	0.015	105.00	0.010	116.00	0.009
11	4	60.551	64.00	0.016	87.00	0.011	87.00	0.011
17	6	40.367	58.00	0.017	58.00	0.017	58.00	0.017
34	12	20.184	29.00	0.034	29.00	0.034	29.00	0.034
67	24	10.092	14.60	0.068	14.60	0.068	14.60	0.068
134	48	5.046	7.30	0.137	7.30	0.137	7.30	0.137
333	119	2.035	2.90	0.345	2.90	0.345	2.90	0.345
666	238	1.018	1.46	0.685	1.46	0.685	1.46	0.685
1333	476	0.509	0.73	1.368	0.73	1.368	0.73	1.368
3332	1190	0.204	0.29	3.425	0.29	3.425	0.29	3.425
6664	2380	0.102	0.15	6.803	0.15	6.803	0.15	6.803
13328	4760	0.051	0.07	13.605	0.07	13.605	0.07	13.605
26656	9520	0.025	0.04	27.300	0.04	27.300	0.04	27.300
45872	16383	0.015	0.02	47.201	0.02	47.201	0.02	47.201

Table 1. Relationship of Integration Time, Resolution, and Sampling Rate for P2 Command

P4 Command (Continuous Pressure Output)

Integration Time		Pressure Resolution	Sampling Rate and Sample Time			
			9600 Baud		19200 Baud	
PI (ms)	PR	(ppm)	(Hz)	(s)	(Hz)	(s)
3	1	242.203	74.00	0.014	121.00	0.008
8	3	80.734	64.00	0.016	64.00	0.016
11	4	60.551	48.00	0.021	48.00	0.021
17	6	40.367	32.00	0.031	32.00	0.031
34	12	20.184	16.00	0.063	16.00	0.063
67	24	10.092	8.00	0.125	8.00	0.125
134	48	5.046	4.00	0.250	4.00	0.250
333	119	2.035	1.60	0.625	1.60	0.625
666	238	1.018	0.81	1.235	0.81	1.235
1333	476	0.509	0.40	2.481	0.40	2.481
3332	1190	0.204	0.16	6.211	0.16	6.211
6664	2380	0.102	0.08	12.361	0.08	12.361
13328	4760	0.051	0.04	24.600	0.04	24.600
26656	9520	0.025	0.02	49.603	0.02	49.603
45872	16383	0.015	0.01	85.600	0.01	85.600

Table 2. Relationship of Integration Time, Resolution, and Sampling Rate for P4 Command

P7 Command (Fast Continuous Pressure Output)

Integration Time		Pressure Resolution	Sampling Rate and Sample Time			
			9600 Baud		19200 Baud	
PI (ms)	PR	(ppm)	(Hz)	(s)	(Hz)	(s)
3	1	242.203	74.00	0.014	147.00	0.007
8	3	80.734	74.00	0.014	104.00	0.010
11	4	60.551	68.00	0.015	80.00	0.013
17	6	40.367	55.00	0.018	55.00	0.018
34	12	20.184	28.00	0.036	28.00	0.036
67	24	10.092	14.30	0.070	14.30	0.070
134	48	5.046	7.20	0.139	7.20	0.139
333	119	2.035	2.90	0.345	2.90	0.345
666	238	1.018	1.46	0.685	1.46	0.685
1333	476	0.509	0.73	1.368	0.73	1.368
3332	1190	0.204	0.29	3.425	0.29	3.425
6664	2380	0.102	0.15	6.803	0.15	6.803
13328	4760	0.051	0.07	13.721	0.07	13.721
26656	9520	0.025	0.04	27.405	0.04	27.405
45872	16383	0.015	0.02	47.601	0.02	47.601

Table 3. Relationship of Integration Time, Resolution, and Sampling Rate for P7 Command, PS=0

8. High-Speed Sampling

Use one or more of the following techniques to increase sampling rate:

- Turn off any data being sent to the Model 715 display. Refer to the **MD** command in Section 6.3.
- Increase the baud rate. Refer to the **BR** command in Section 6.2.2.
- Reduce integration time. Refer to **PI**, **TI**, **PR**, and **TR** commands in Section 6.1.4.
- Use a continuous pressure measurement command, such as **P4** or **P7**. See section 6.1.3.
- Use the continuous pressure period command (**P2**), and post-process data to convert to pressure. Refer to Section 15 for detailed information about converting period measurements into pressure values.

9. Networking Multiple Intelligent Devices

DIGIQUARTZ® Intelligent devices support RS485 multi-drop and RS-232 serial loop networking. Both types of networking allow you to address up to 98 DIGIQUARTZ® Intelligent devices from a single serial host.

9.1. Networking basics

When setting up a network, the following points must be observed, regardless of whether you choose RS-485 multi-drop or RS-232 serial loop networking.

- If your network includes older Intelligent devices that support RS-232 only, set the older devices to **PT** = N to assure compatibility with newer devices.
- Verify proper operation of each Intelligent device before installing it in a network.
- Set all Intelligent devices to the same baud rate before installing them in a network. Once your network is up and running, you can change the baud rate to any supported value.
- Each Intelligent device on the network needs to be set to a unique ID.
  - If you are setting up an RS-232 serial loop network, you can automatically set all devices to a unique ID value by issuing a single ID command.
  - If you are setting up an RS-485 multi-drop network, you must isolate each device from the network, and set the ID of each device individually.

See Section 6.2.2 for more information about the ID command.

9.2. Choosing a networking type

Both types of networking have unique benefits, as described below. Carefully consider your system requirements before selecting a networking type.

Benefits of RS-485 multi-drop networking:

- 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 networking 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 networking:

- RS-232 serial loop networking is 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 multi-drop networking

As shown in Section 9.2, RS-485 multi-drop offers several significant benefits over RS-232 serial loop networking. It is recommended that RS-485 multi-drop networking 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 Section 13.4 for multi-drop wiring diagrams.

9.3.1. Characteristics unique to RS-485 multi-drop networking

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 ID values over a multi-drop network. Doing so will set all devices on the network to the same ID value. To set each device to a unique ID, isolate each device from the network, and individually set its ID value.
- **CAUTION** Do not send continuous measurement commands (**P2**, **P4**, **P7**, **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** Do not configure any device on a 2 -wire network for continuous pressure data output on power-up (**MD** = 2 or **MD**=3). If you do this, it is unlikely that you will be able to reconfigure the unit over the network, since any command is likely to collide with the pressure data being continuously sent. To recover, you will need to isolate the errant device from the network and reconfigure it individually.

9.3.2. 2-wire RS-485 multi-drop networking

DIGIQUARTZ® Intelligent devices support half-duplex, master-slave communications with serial hosts. This means that the Intelligent device, or slave, will only transmit if it has been commanded to do so by the serial host, or master. This feature enables Intelligent devices to be used in 2-wire RS-485 systems, where commands sent from the host and responses sent by the Intelligent device are sent on the same pair of wires.

Figure 7 in Section 13.4 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 configuration can reduce wiring costs, but the system designer must take precautions as described below to ensure reliable communications.

Data collisions occur on 2-wire RS-485 systems when two or more devices 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.

9.3.3. 4-wire RS-485 multi-drop networking

Figure 8 in Section 13.4 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.

9.4. RS-232 serial loop networking

RS-232 serial loop networking can be used when RS-485 communications are not available or are impractical, and provides network compatibility with previous DIGIQUARTZ® Intelligent devices that do not support RS-485.

Refer to Figure 1 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.

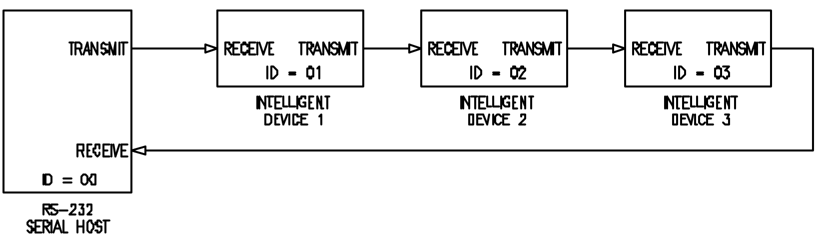


Figure 1. Serial loop network block diagram

There are several points to keep 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

- Serial loop networking is limited to baud rates of 19,200 and below.

- A single **ID** command will automatically set all devices on the serial loop to unique sequential IDs.

- 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. If precise measurement synchronization is required, consider an RS-485 multi-drop network instead.

- 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.

- Sleeping devices on a serial loop network must be awakened individually, and in sequence, by sending a complete command to each device, starting with the first device. Keep in mind that a serial loop network will not be fully operational unless all devices on the network are awake, since response data will not be resent by sleeping devices downstream.

- DIGIQUARTZ® Interactive software (DQI) is not capable of waking multiple sleeping devices on a serial loop network. If you intend to use DQI to communicate with units on a serial loop network, please ensure that all devices have the sleep mode disabled.

9.5. Other networking methods

Multiple serial ports

PC expansion boards are available which provide up to 32 individual RS-232 serial ports. Using such a board, it would be possible to design a system whereby each Intelligent device would be connected to the serial host via its own RS-232 port. This type of a system would ensure that any communications port, cable, or transmitter failure would not affect the rest of the system.

Relay Multiplexer System

For high-reliability applications with a large number of transmitters, it may be desirable to use a custom relay multiplexer as a switching hub to select separate data lines running out to the individual transmitters or serial loops in the system. Loss of any one data line through accident or failure will affect only those transmitters on that data line.

10. Using the Model 715 Display

The Model 715 is extremely simple and easy to use. There are no controls to set or configure. Simply connect the display to an appropriately configured DIGIQUARTZ® Intelligent device and a DC power source, and the Model 715 will display the desired information.

The Model 715 can communicate with a DIGIQUARTZ® Intelligent device via either RS-232 or RS-485. You can therefore use either port to communicate with the Model 715. The Model 715 automatically sets its baud rate to match that of the DIGIQUARTZ® Intelligent device.

The Model 715 provides a regulated 6.0 VDC output for powering a DIGIQUARTZ® Intelligent device, eliminating the need to power the Intelligent device separately.

10.1. Serial and power connections

DC power (7 – 25VDC, 270 mA max.) can be applied to a terminal block on the rear panel, or can be supplied by a 110VAC or 220 VAC wall power supply (part numbers 6377-001 or 6377-004).

Refer to Section 13.5 for Model 715 interconnection options.

10.2. Configuring an Intelligent device for use with the Model 715

DIGIQUARTZ® Intelligent devices must be configured to be used with the Model 715 display. The following commands are available for this purpose:

MD Enables output of display data. Refer to Section 6.3 for details.

DM Selects the type of information to be displayed on the second line of the Model 715 display.
DO Selects either RS-232 or RS-485 communication with the Model 715
DP Selects the number of decimal points in displayed pressure measurements.

Refer to Section 6.2.8 for details on the **DM**, **DO**, and **DP** commands.

11. I/O Lines

DIGIQUARTZ® Intelligent Transmitters feature discrete digital I/O lines that may be used to control and monitor tare and overpressure alarm functions. See Section 6.2.5 for more information regarding tare and overpressure functions.

NOTE: DIGIQUARTZ® Intelligent Depth Sensors do not support the I/O lines described in this section.

INPUT

Tare Input – Activated by a momentary contact closure to ground. When taring is not in effect and Tare Input is activated, taring is enabled on the next pressure measurement. When taring is in effect and Tare Input is activated, taring is disabled, and the next pressure measurement taken will not be tared.

WARNING To prevent possible damage, do not connect any voltage source other than DC power ground to the Tare Input.

OUTPUTS

Tare Output – Indicates whether the most recent pressure measurement was tared. The tare output is set to logic high when taring is in effect, is set to logic low when taring is not in effect.

Overpressure Output – Indicates whether the most recent pressure measurement exceeds the user-specified overpressure setpoint. The overpressure output is set to logic high if overpressure setpoint is exceeded, and is set to logic low otherwise. See the **OP** command in Section 6.2.5 for more information.

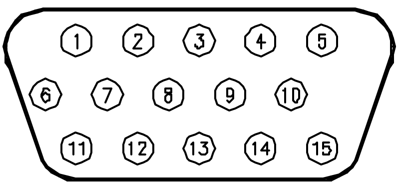
Logic low: < 0.1 VDC
Logic high: 3.3 VDC
Maximum output drive current: 300 microamps

12. Connector Diagrams

This section provides pin assignment diagrams for DIGIQUARTZ® Intelligent devices and standard PCs. PC pin assignments are typical; if in doubt, consult the hardware manual that came with your PC.

Note: All connector diagrams are as viewed from the mating end.

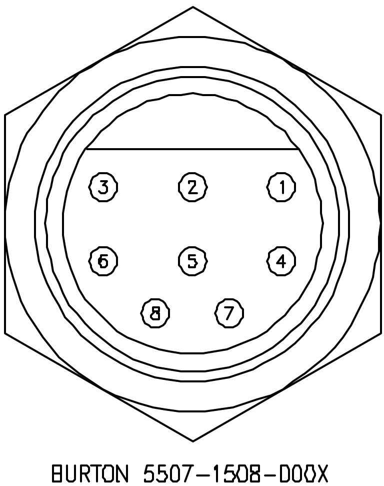
12.1. Intelligent transmitters: 15-pin male high-density D-sub



DB15M-HD

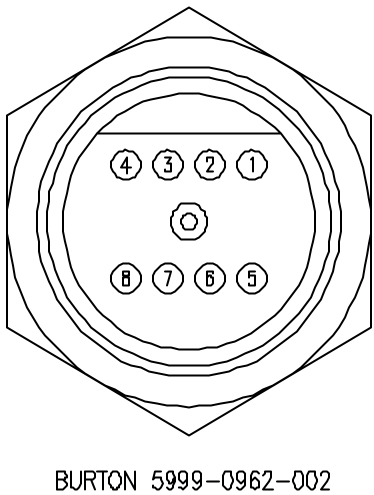
PIN	INTELLIGENT TRANSMITTER SIGNAL
1	Chassis ground or Not used (consult SCD)
2	RS-232 TX
3	RS-232 RX
4	Not used
5	Power/signal ground
6	Tare output
7	Tare switch input
8	Overpressure output
9	Power (consult SCD)
10	Not used
11	Not used
12	RS-485 RX+
13	RS-485 RX-
14	RS-485 TX+
15	RS-485 TX-

12.2. Intelligent absolute depth sensors: Burton 5507-1508-000X



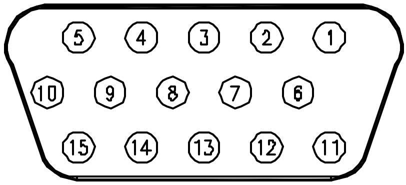
PIN	DEPTH SENSOR SIGNAL
1	RS-232 TX
2	RS-232 RX
3	Power/signal ground
4	Power (consult SCD)
5	RS-485 RX+
6	RS-485 RX-
7	RS-485 TX+
8	RS-485 TX-

12.3. Intelligent gauge depth sensors: Burton 5999-0962-002



PIN	DEPTH SENSOR SIGNAL
1	RS-232 TX
2	RS-232 RX
3	Power/signal ground
4	Power (consult SCD)
5	RS-485 RX+
6	RS-485 RX-
7	RS-485 TX+
8	RS-485 TX-

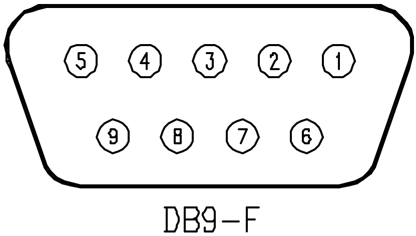
12.4. Model 715: 15-pin female high-density D-sub



DB15F-HD

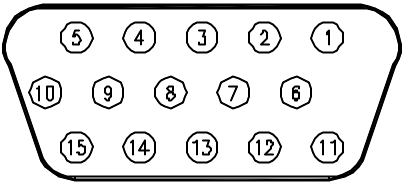
PIN	MODEL 715 RS-232/RS-485 SIGNAL
1	Chassis ground
2	RS-232 TX
3	RS-232 RX
4	Not used
5	Power/signal ground
6	Tare output
7	Tare switch input
8	Overpressure output
9	Power (consult SCD)
10	Not used
11	Not used
12	RS-485 TX+
13	RS-485 TX-
14	RS-485 RX+
15	RS-485 RX-

12.5. Model 715: 9-pin female D-sub



PIN	MODEL 715 RS-232 SIGNAL
1	Chassis ground
2	RS-232 TX
3	RS-232 RX
4	Not used
5	Signal ground
6	Not used
7	Not used
8	Not used
9	Not used

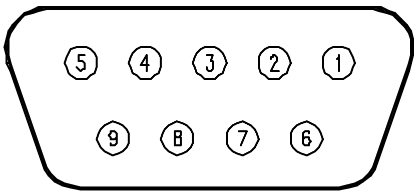
12.6. Power Adapter Module: 15-pin female high-density D-sub



DB15F-HD

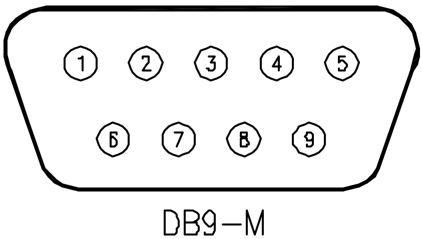
PIN	SIGNAL
1	Not used
2	RS-232 TX
3	RS-232 RX
4	Not used
5	Power / signal ground
6	Not used
7	Not used
8	Not used
9	Power (consult SCD)
10	Not used
11	Not used
12	RS-485 RX+
13	RS-485 RX-
14	RS-485 TX+
15	RS-485 TX-

12.7. Power Adapter Module: 9-pin female D-sub



PIN	SIGNAL
1	Not used
2	RS-232 TX
3	RS-232 RX
4	Not used
5	Power / signal ground
6	Not used
7	Not used
8	Not used
9	Power (consult SCD)

12.8. PC RS-232 port: 9-pin male D-sub connector



PIN	PC RS-232 SIGNAL
1	Data Carrier detect (DCD)
2	RS-232 RX
3	RS-232 TX
4	Data Terminal Ready (DTR)
5	Signal ground
6	Data Set Ready (DSR)
7	Request To Send (RTS)
8	Clear To Send (CTS)
9	Ring Indicator (RI)

13. Serial Wiring Diagrams

The diagrams in this section show the various ways in which DIGIQUARTZ® Intelligent devices can be connected to RS-232 and RS-485 serial hosts and the Model 715 display. The pin numbers given are for DIGIQUARTZ® Intelligent devices with 15-pin high-density D-subminiature connectors. Refer to Section 12 for pin assignments of other connectors. PC serial port pin numbers assume a typical 9-pin RS-232 port; consult the documentation that came with your PC to verify your RS-232 port pin assignments.

13.1. RS-232 wiring diagrams

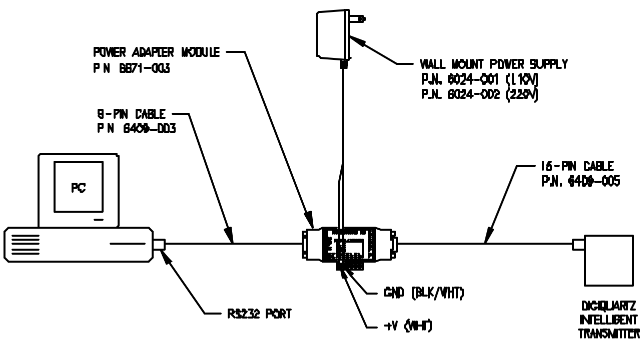


Figure 2. RS-232 wiring diagram using optional RS232/RS485 Power Module Kit

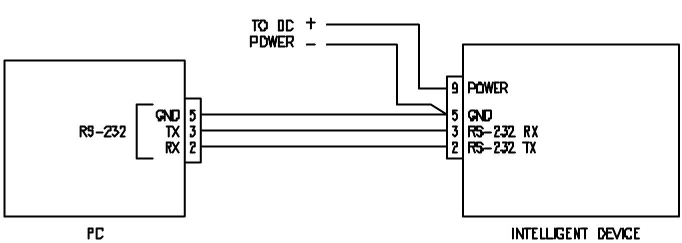


Figure 3. Simple RS-232 wiring diagram

13.2. RS-232 serial loop network wiring diagram

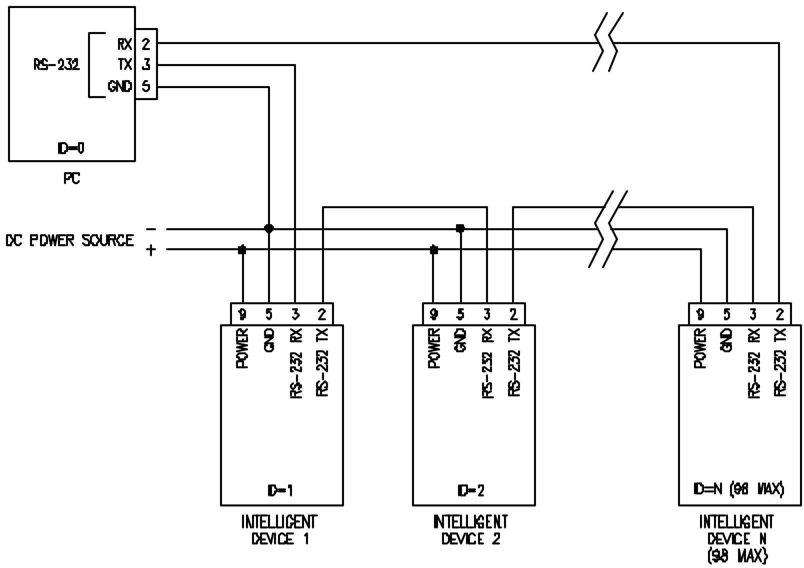


Figure 4. RS-232 serial loop network

13.3. RS-485 wiring diagrams

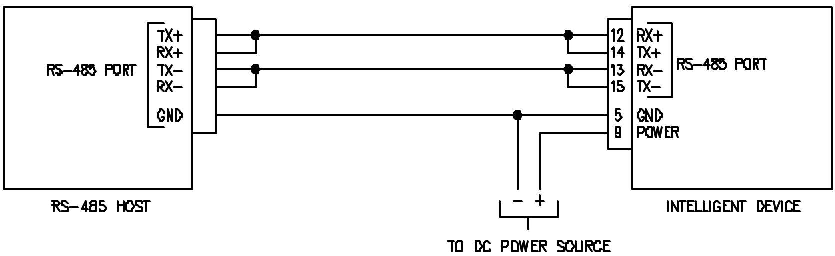


Figure 5. 2-wire RS-485 system, single device

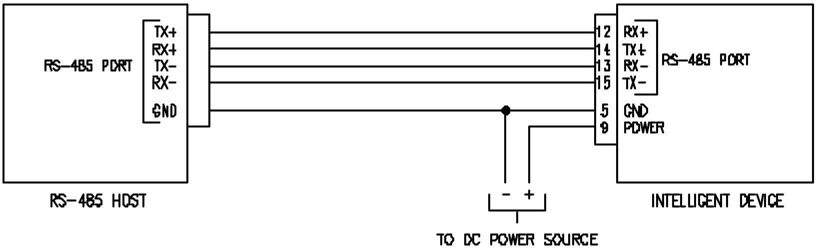


Figure 6. 4-wire RS-485 system, single device

13.4. RS-485 multi-drop network wiring diagrams

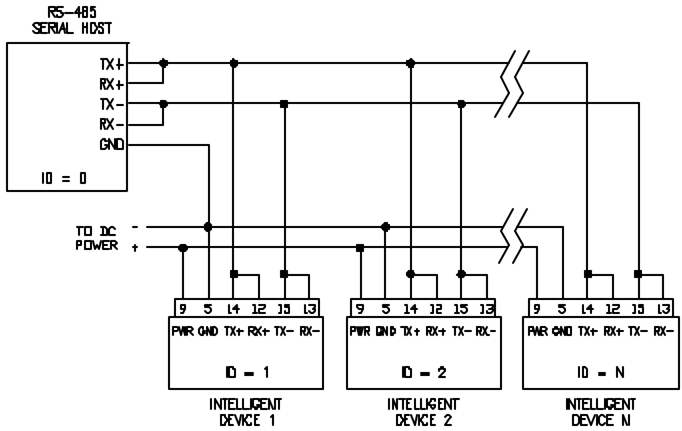


Figure 7. 2-wire RS-485 multi-drop network

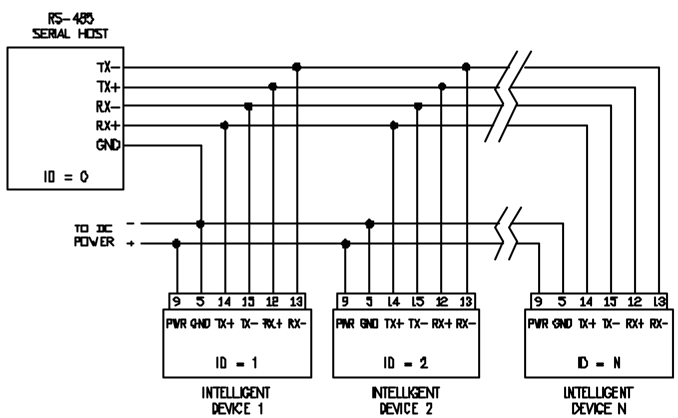


Figure 8. 4-wire RS-485 multi-drop network

13.5. Model 715 Display wiring diagrams

The following diagrams illustrate a few typical Model 715 systems. There are two ways to power the Model 715: using an optional wall power supply or via screw terminal blocks. Both methods are shown on each diagram, but only one power option is needed, and either can be selected depending on your application.

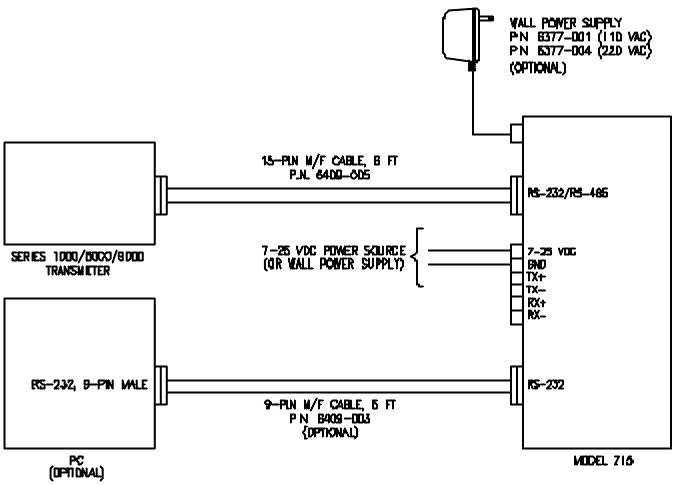


Figure 9. Simple Model 715 / Intelligent transmitter system, w/ optional PC shown

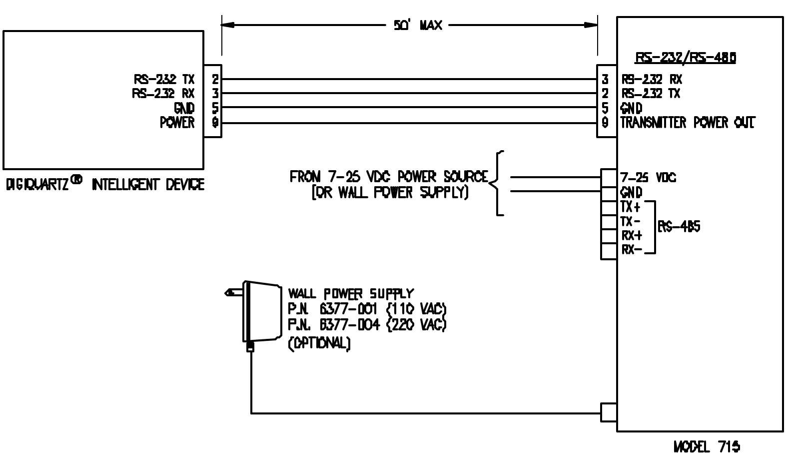


Figure 10. Model 715, RS-232 connection to an Intelligent device

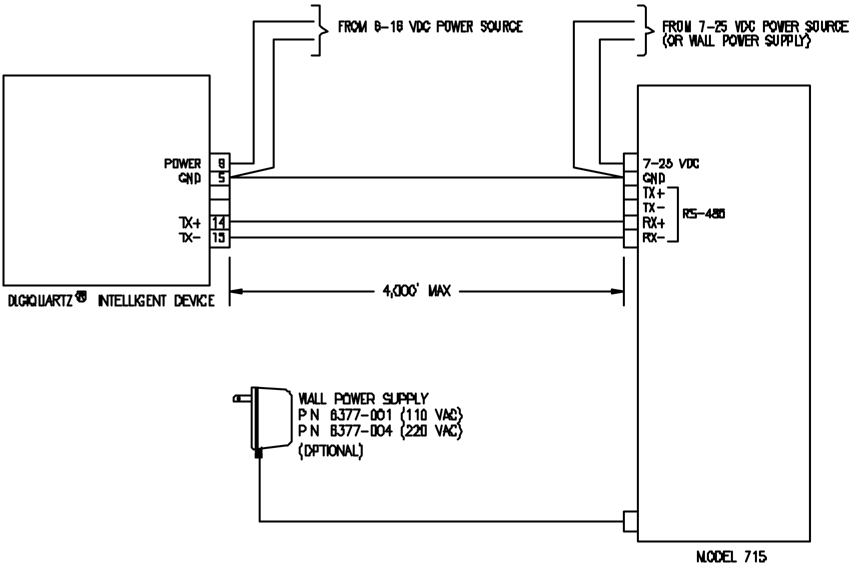


Figure 11. Model 715, RS-485 connection to an Intelligent device

14. Troubleshooting

The following are solutions to frequently encountered problems. If you are experiencing difficulty with a DIGIQUARTZ® Intelligent device, it is likely that the solution can be found below.

PROBLEM: NO RESPONSE FROM DEVICE

1. Check your connections

- Check your connections to ensure that your system is hooked up properly.
- Check your power source to ensure that the proper voltage is supplied to the device.
- If you believe that your system is wired and powered properly, but you still cannot communicate with your device(s), try using a PC and DIGIQUARTZ® Interactive software (DQI) to verify operation and configuration of each device individually. To do this, you will need to connect each device one at a time to the PC RS-232 port. DQI will allow you to establish communications with DIGIQUARTZ® Intelligent devices regardless of baud rate or ID settings.

  If you are networking your devices, make sure that all are set to the same baud rate, and that any earlier-generation (RS-232 only) devices are set to **PT**=N (8 data bits, no parity, 1 stop bit). Also ensure that each device is set to a unique ID value.

  If your device(s) work properly with DQI, but you are still unable to communicate with them in your system, the problem is almost certainly caused by your serial host hardware/software settings or your connections.

2. Check your serial host

- Make sure your serial host is configured for the proper baud rate, and 8 data bits, no parity, and 1 stop bit.
- Make sure your commands are terminated with a carriage return and line feed (ASCII 13 and 10). Your serial host hardware or software may need to be configured to provide proper command termination.
- Make sure that you are sending commands to the proper ID. If you are unsure which ID to use, try sending a global **SN** command (*9900SN), and check the response(s) to see which ID(s) responded.

PROBLEM: INTELLIGENT DEVICE DOES NOT RESPOND TO A COMMAND, BUT RESPONDS TO SUBSEQUENT COMMANDS

- The Intelligent device is probably asleep when the first command is received, but is awake when the second command arrives. Therefore, the first command is ignored, and the second command is acted upon. To avoid this, either wake up the device before attempting a command, or disable sleep mode. Refer to the **SL** command for more information.

15. Internal Calculations and Formulas

DIGIQUARTZ® Intelligent devices calculate internal sensor temperature and applied pressure from period measurements of two frequency signals. The equations and coefficients used to perform these calculations are given below. The coefficients are factory-set, and are stored in non-volatile EEPROM. Refer to Section 6.5 for more information.

TEMPERATURE CALCULATION

The following equation is used to calculate internal sensor temperature:

$$T = Y_1 U + Y_2 U^2 + Y_3 U^3$$

Where: T = Temperature (°C)
U_0 = temperature period (microseconds) at 25° C
U = temperature period (microseconds) – U_0 (microseconds)

Temperature coefficients: U_0 Y_1 Y_2 Y_3

PRESSURE CALCULATION

The following equation is used to calculate pressure:

$$P = C(1 - T_0^2/Tau^2)[1 - D(1 - T_0^2/Tau^2)]$$

Where: P = pressure
Tau = pressure period (microseconds)
U = temperature period (microseconds) – U_0 (microseconds)
$C = C_1 + C_2U + C_3U^2$
$D = D_1 + D_2U$
$T_0 = T_1 + T_2U + T_3U^2 + T_4U^3 + T_5U^4$

Pressure coefficients: C_1 C_2 C_3 D_1 D_2 T_1 T_2 T_3 T_4 T_5

FINAL OUTPUT PRESSURE CALCULATION

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

P_{output} = **PM**[(units multiplier) x P + **PA**]

Where: P_{output} = Final output pressure value (psi)
P = raw pressure value (from pressure equation above)
PM = Value stored in the **PM** parameter
PA = Value stored in the **PA** parameter
Units multiplier = Value used to convert psi to the current pressure unit. Refer to Section 6.2.3 for more information.

The **PM** and **PA** parameters allow you to make minor zero and span adjustments to the raw pressure value. Normally, **PM** (pressure multiplier) is set to 1.0, and **PA** (pressure adder) is set to 0.0. Refer to Sections 6.5 and 16 for more information.

16. Zero and Span Adjustments

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

Adjusted pressure is calculated using the following equation:

$P_{adjusted}$ = **PM** x (P + **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 Sections 6.5 and 15 for more information regarding **PA** and **PM**.

CAUTION Use extreme caution when modifying **PA** or **PM** because they directly affect calibration. Inaccurate values will result in inaccurate pressure measurements.

17. Command and Parameter Reference

PARAMETERS (CONTINUED) **PAGE**