QUARTZDYNE ®

OPERATING MANUAL
for
QUARTZDYNE®
SERIES I
TRANSDUCER INTERFACE AND DISPLAY

QUARTZDYNE, INC.

Series I Transducer Interface and Display Operating Manual

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1. Transducer Connection

1.1 Standard Configuration

The transducer interface is directly compatible with most Quartzdyne transducers. A female DB9 connector located in the center of the back panel is standard. The table below shows the pinout which is consistent with Series QS and QU cables. The frequency input signals are designed to withstand reasonable static discharges. However, care should be taken to prevent excessive voltages on these lines. Properly discharge potential static sources before connecting. The input sensitivity allows detection of frequencies in the ranges shown in the table, with amplitudes as low as 1 Vpp.

Power is supplied to Quartzdyne transducers on pin 6 (5V $\pm$ 5% or 9-15 VDC unregulated). The maximum load on this line should be less than 50 mA. The supply is protected with a 200 mA solid state fuse. The ground and shield leads are referenced to the power supply (-) pin and to the interface chassis. Prior to December 1999, the default output voltage was set to 9-15VDC. Beginning December 1999, the default output is set to the regulated 5 VDC, and a "5V" sticker is affixed to the back panel. See **Section 2.2** for details on setting the output voltage option.

Warning! Series QL and LV transducers may be damaged if supplied with more than 5.5 Volts. Verify that the Series I has been set to 5 Volts prior to connecting any transducer that is specified for 5 Volt use only.

Warning! In order to comply with radiated emissions standards the transducer cable must be fully shielded with 360$°$ termination. Failure to provide adequate shielding is likely to result in emissions which will exceed national and international RF standards.

Table 1. Transducer Connection Pinout

Pin #	Label	Range
1	Ground	
2	Frequency 1	1-100 kHz 1-5 Vpp
3	Shield	
4	TCXO Input/Output	10.000 MHz 1-5 Vpp
5	Reference Frequency	5-10 MHz 1-5 Vpp (7.200 MHz Nominal)
6	Supply Output	5 VDC $\pm$5% 0-100 mA (9-15 VDC optional)
7	No Connection	
8	Frequency 2	1-100 kHz 1-5 Vpp
9	No Connection	

1.2 TCXO Option

The TCXO option is available for use with transducers such as the Series QD that do not have a reference frequency output. The output of the TCXO is available on pin 4 of the Series I's transducer connector. This output can be used to verify the actual frequency of the TCXO for calibration purposes. Because the TCXO output is not buffered it should not be used to drive long cables or multiple transducer interfaces. If the TCXO option is not installed, pin 4 can be used as an input for an external 10 MHz timebase. The input amplitude should be HCMOS compatible 5 Vpp. The TCXO provides no advantage over using the transducer reference frequency if the reference frequency is available. See **Sections 7.3** and **8.1** for more information on using the TCXO option.

2. User Serviceable Parts

Warning! The Series I Transducer Interface contains static sensitive devices. Use static prevention measures when accessing the inside of the case. Work only in an ESD safe work area.

2.1 Case Assembly/Disassembly
To open the case, remove the eight Phillips head screws from the perimeter of the back case. Carefully slide the back panel and electronics assembly out of the front portion of the case. Avoid damaging the EMI gasketing materials on the back panel. To re-assemble the case, first verify that all ribbon cable connectors are fully seated in their correct positions. Slide the bottom board into the bottom slot, and position the extensions from the upper board into the first slot above the center screw holes. Rest the device on the display and tighten the screws in a "plus-ex" pattern so as not to damage the EMI gasketing: first install all screws loosely, then tighten the screws on the center of each side before tightening the screws in the corners.

2.2 Transducer Supply Voltage Select
The Series I can supply the transducer with either unregulated 9-15 VDC (prior to December 1999) or regulated 5 VDC (Standard beginning December 1999). This is selected via a jumper block on the transducer input buffer board which is the smaller of the two boards mounted to the back panel. Position the shorting bar so as to short the center pin to the appropriate supply voltage as shown in **Figure 1**. Series I's that have been set at the factory to supply 5 Volts will have a "5V" sticker affixed to the back panel to indicate the selection.

2.3 Lithium Battery Replacement
The Lithium battery in the Series I is designed to last for approximately one year. Actual lifetime will vary from device to device and depending on operating conditions such as temperature, humidity, and usage patterns. During the boot sequence, the battery voltage is checked and if the voltage is shown to be low, an ERROR 20 is reported on the display and at the beginning of each reply. To eliminate this error message issue an EM20 command. This will suppress the reporting of the low battery condition but will not change the status reported by the ES command. The battery should be replaced as soon as possible since the device configuration and data logging features are dependent on it. Before replacing the battery, make sure you have copies of coefficient files and other relevant settings (units, span, zero) so that these can be restored after the battery is replaced. See ROMREAD.EXE and ROMWRITE.EXE on the software disk for a convenient way to retrieve and upload Series I ROM data. The battery is located on the CPU board as shown in **Figure 1**. To remove the battery, insert a screwdriver or coin in the slot on the battery holder, and gently pry the battery up until it can be slid out if its socket. Insert the new battery with the "**+**" sign on the top. Use only Panasonic type BR2330 or equivalent batteries.
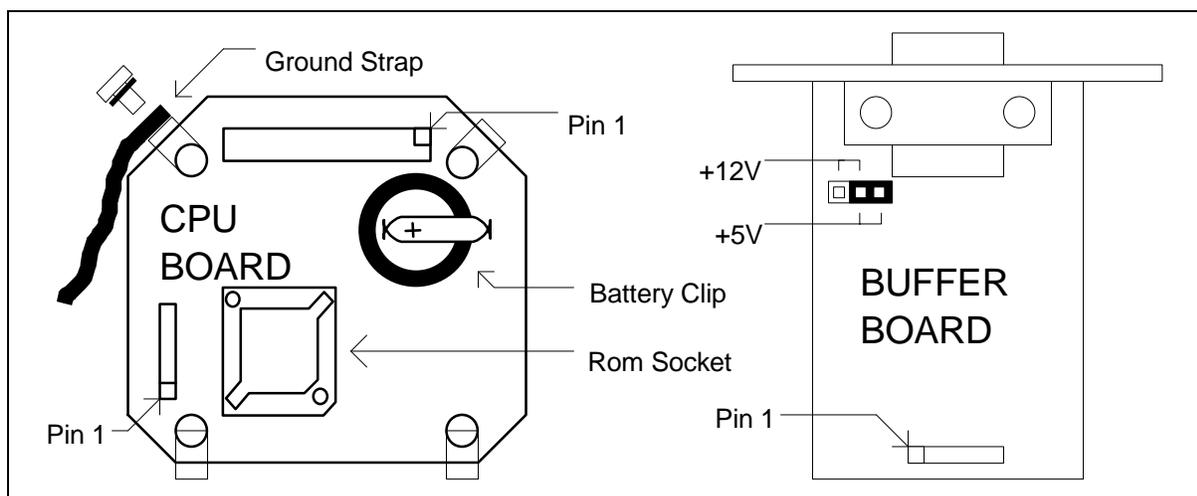
Figure 1. User Serviceable Parts Locations

3. Serial Communications Hardware

3.1 Overview

The interface can communicate with standard RS232, RS422, or RS485 ports available on most computers. Communication may occur at baud rates ranging from 1200 to 9600 baud, with 8 data bits, 1 stop bit, and no parity. Multiple devices may be connected to the RS422 and RS485 ports in a daisy chain fashion with total cable lengths up to 1 kilometer. Any one of these devices may be used as an RS232 to RS422 translator eliminating the need for stand alone translators or special RS422 serial ports. **Figure 2** and **Figure 3** show typical wiring configurations for multiple devices.
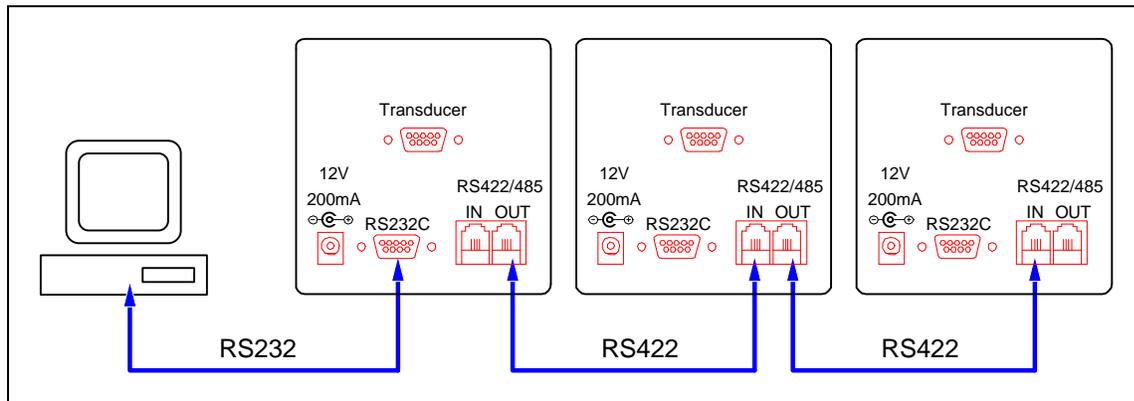
Figure 2. Typical Wiring Using an RS232 Host (PC)
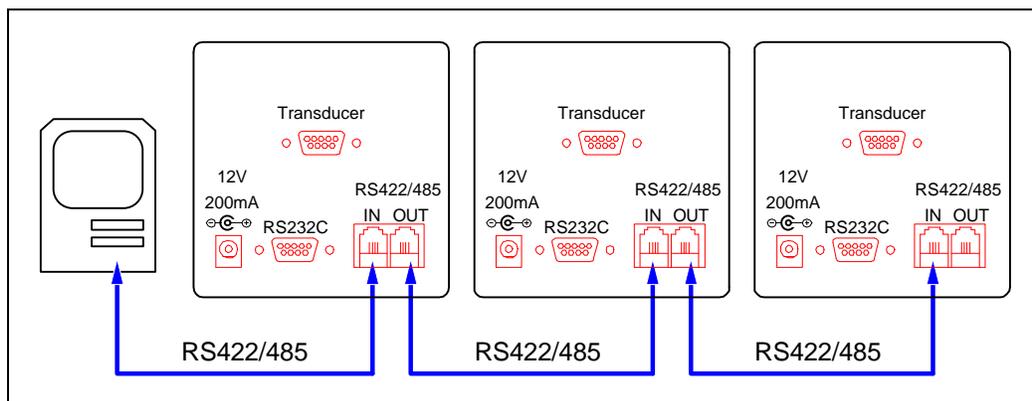
Figure 3. Typical Wiring Using an RS422/485 Host (MAC)

In the operation configuration shown in **Figure 2**, the first transducer interface is operating as an RS232 to RS422 translator.   **Figure 4** shows in block diagram form how the protocol translation is done. Multiple transducers are connected in parallel on the RS422 ports. If a signal is detected on the RS232 receive port, it is echoed to the RS422 receive port where it is heard by all of the units. Any signal which is detected on the RS422 transmit line is also echoed to the RS232 transmit port so that an RS232 Host can detect it. The transducer interface always listens to both of its RS422 ports and replies on the RS422 transmit port. In an RS485 implementation the host must be able to disable its line driver during a reply sequence. In this case only the transmit lines are used.
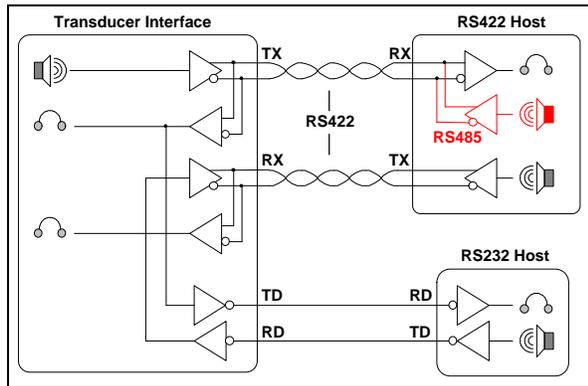
Figure 4. Translation of RS232 and RS422/485 signals.

3.2 RS232

The RS232 port on the Series I is directly compatible with the standard IBM AT style (9-pin) serial port. Table 2 shows the function of each of the pins. Note that the labeling of the RX and TX pins is relative to the device in question; thus RX on the host is connected to TX on the Series I. The RS232 Cable supplied by Quartzdyne is a standard straight-through DB-9P to DB-9P cable. Beware of commercially available RS232 "null modem" cables where several of the pins are swapped.

Hardware handshaking is not required by the protocol, but since most AT type computers require DTR and CTS to be active, these lines are supported. The DSR and CTS handshake lines are driven high (ACTIVE) when the transducer interface is ready for data. Communications are half duplex (only one device may talk at a time). For convenience, power (9-15 VDC) may be supplied to the transducer interface via pin 9 (RI) of the RS232 port. Some serial port interfaces provide external power on this pin.

Table 2. RS232 Pin Numbers and Functions

Pin Number	RS232 DTE (IBM AT)	Transducer Interface (DCE)
1	Receive Line Signal Detect	Shield
2	* Receive Data (RXD)	* Transmit Data
3	* Transmit Data (TXD)	* Receive Data
4	* Data Terminal Ready (DTR)	N/A
5	* Signal Ground	* Signal Ground
6	* Data Set Ready (DSR)	DSR
7	Request to Send (RTS)	N/A
8	* Clear to Send (CTS)	CTS
9	Ring Indicator (RI)	Auxiliary Power

* These lines required for communication.

3.3 RS422 and RS485

RS422 and RS485 use differential drivers and receivers to enhance noise immunity and increase transmission distance. RS422 uses two wires for transmitting (TX+/-), and two more for receiving data (RX+/-). RS485 uses only two wires (TX+/-). The transducer interface output driver is only enabled during transmission of data, allowing multiple devices to be connected on the same wires. A maximum of 31 devices (including the host) may be connected in the RS422/RS485 system.

Line terminations are recommended in the RS422 and RS485 standards, but are not required with the Series I because of the relatively low baud rates. If data errors occur with long transmission lines, a termination pod may be placed in the empty RS422/485 jack at each end of a string of devices. The termination is a 110 Ω resistor in series with a 0.01 µF capacitor between the +/- leads of each RS422 wire pair.

Two RJ11 jacks are located on the bottom of the rear panel. The pinout of each is the same and is shown in the table below. Signaling is non-inverted; during idle periods the "+" input should be high and the "-" input should be low. A start bit is the reverse of this; the "+" input should be low and the "-" input should be high.

The RS422 cables supplied by Quartzdyne are straight-through with pins 2 thru 5 connected. Pins 1 and 6 may be used for an optional shield, but shielded cables are neither required for communications nor supplied by Quartzdyne. The RJ11 jack used in the Series I is the same jack used commonly in phone systems in the United States. The standard phone cable is not straight-thru however; each of the pins are reversed (2 to 5 and 3 to 4) resulting in a polarity reversal of the transmit and receive lines. Table 3 shows the pin numbers and function for the RJ11 connectors as well as the pin numbers of the MINI-DIN 8 Apple Macintosh serial port. Note the difference in naming convention between the Macintosh RS422 port and the Series I. See **Figure 5** for pin number locations.

Table 3. RS422 Pin Numbers and Functions

RJ11 Pin Number	RS422 Function	RS485 Function	Translate Function	MINI-DIN 8 (Mac) Pin Number	
1	* Case Ground	* Case Ground	* Case Ground		
2	TX-	RX/TX-	RX/TX- to RS232 TXD	8	RD
3	RX+	Not Used	RS232 RXD to TX+	3	TD-
4	RX-	Not Used	RS232 RXD to TX-	6	TD
5	TX+	RX/TX+	RX/TX+ to RS232 TXD	5	RD-
6	* Case Ground	* Case Ground	* Case Ground		

* Ground wires are not required, nor provided with standard cables supplied by Quartzdyne.
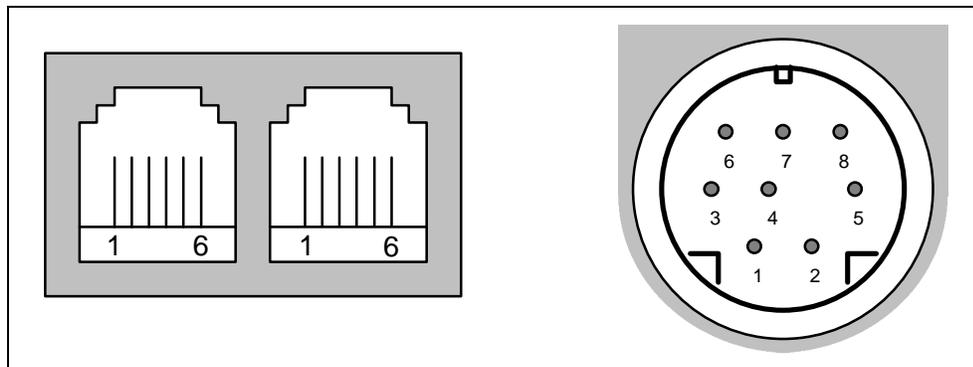

Figure 5. RJ11 (Series I) and MINI-DIN 8 (Macintosh) Pin Numbers

4. Serial Communications Protocol - Overview

Any commercially available terminal emulator can be used to communicate with the Series I. The program "LTALK" on the Series I program disk is tailored for this. Also included on the disk are demonstration programs, including source code, showing how to interface with the Series I. See the README.TXT file on the program disk for more information.

In the command documentation square brackets ([]) indicate optional parameters; a vertical bar (|) indicates alternate parameters. Uppercase letters indicate literal expressions, lowercase letters indicate data formats and italics represent data values and descriptions. The "¬" character indicates a CR-LF sequence.

All command lines are preceded by a three character address sequence. The first of these is the hash character (#), followed by two numeric digits which are unique to each transducer on the bus. The address #00 is an all-call, or global command; all transducers on the bus will interpret the command, but none will respond. Each device is initially programmed to address #01. If multiple devices are installed, the logical addresses must be changed with the AD command (**Section 9.1**) before they are physically connected together.

Commands may be terminated by a CR, LF or both. Responses are terminated by a CR-LF (¬) sequence. The null command (#nn¬) can be used to repeat the previous command. The equal sign (=) is used to program a value. Data items within a command or response are separated by commas (,). Multiple commands may be sent in a single command line with each command separated by a semicolon (;). The responses will be comma separated (see example). Braces ({}) are used to enclose commands that include CR-LF sequences such as the contents of a calibration file or multiple line data log dumps. Tab and space characters are generally ignored. Invalid commands or data respond with "ERROR nn¬", where nn indicates the particular error. A typical command/response sequence is shown.

> #01D1;D2¬
> 4522.45,120.24¬
> #01¬
> 4522.47,120.22¬

A copy of all programmable data is stored in nonvolatile memory (EEPROM). On power-up, defaults are assigned based on the contents of this memory. The contents of this memory are accessed using EEPROM commands (See **Section 10.1**).

5. Data Commands

5.1 Read Data

D[1]¬	±nnnnn.nnn	*Primary Output (Pressure)*
D2¬	±nnnnn.nnn	*Secondary Output (Temperature)*
D3¬	nnnnnn.nnn	*Frequency 1*
D4¬	nnnnnn.nnn	*Frequency 2*

Data commands are used to read the transducer interface. If data is available, the response will be immediate. If the current data has already been read, the response will be delayed by up to 1 gate time. If data is not available for any other reason, an appropriate error indicator will be sent. The precision returned is automatically adjusted to what is justifiable based upon the gate time, units, and calibration coefficients. It may be useful to combine multiple data statements in the same command line so that one request for data will return all of the data needed. The data commands can be used in the global mode to set up a command format as illustrated below.

Command	Response	Comments
#00D3;D4¬		*global command for F1 and F2*
#01¬	12234.55,45000.12¬	*#01's response*
#02¬	23456.78,33453.12¬	*#02's response*

6. Units Commands

6.1   Select Units

UN[1][=n|*name*]¬	*name*¬	*Primary Units (Pressure)*
UN2[=n|*name*]¬	*name*¬	*Secondary Units (Temperature)*

UN selects the units to be used from the programmed units table. The units may be selected by name or number. The name of the currently programmed units is returned. The name search is not case sensitive. If the number is out of range [1-8] or the name cannot be found, an error is returned.

#01UN1=BAR¬	bar¬	*Pressure Units to bar*
#01UN2=C¬	C¬	*Temperature Units to °C*

6.2 Program Units

UP[1][=*name*[,*scale*[,*offset*]]]¬	*name*,*scale*,*offset*¬	Units Program 1
UPn[=*name*[,*scale*[,*offset*]]]¬	*name*,*scale*,*offset*¬	Units Programs 2-8

The UPn command is used to program each of the eight available units programs. If n is not specified, 1 is assumed.   The units program includes a name by which the units are referred (maximum 5 characters), a scale factor, and an offset. The scale factor defaults to 1.0 and the offset to 0.0. The output is computed based on the following equation where the units of each term is shown in parentheses.

$$D_{out}\ (units)\ =\ scale\ (units\,/\,CU)\ \times\ D_{calc}\ (CU)\ +\ offset\ (units).$$

CU is the calibrated unit as specified in the coefficient file (See **Section 7.4**). For Quartzdyne pressure transducers, the calibrated units are psi for D1 (primary output) and °C for D2 (secondary output). It is the user's responsibility to verify that the scale factors are appropriate for the calibration type. **Note**: Programming a unit does not select it! The Series I is initially programmed with the units conversion factors shown below. Any of these may be changed by the user. Each program can be used with either D1 or D2. Use the EW command (**Section 10.1**) to store the changes permanently.

Program	Name	Scale	Offset
UP1	psi	1.0	0.0
UP2	bar	0.0689476	0.0
UP3	MPa	0.00689476	0.0
UP4	mH$_2$O	0.70307	10.335
UP5	C	1.0	0.0
UP6	K	1.0	273.15
UP7	F	1.8	32
UP8	R	1.8	523.67

Example:

#01UP8=Atm,0.0680272¬	Atm,0.0680272,0¬	*Units Program 8 to Atmospheres*
#01UN1=8¬	Atm¬	*Select Atm as Pressure units*

7. Calibration Commands

7.1 Span and Zero

S[1|2][=*span*[,*range*]]¬	*span*¬	*Span Adjust*
Z[1|2][=*zero*]¬	*zero*¬	*Zero Adjust*

The S and Z commands set the span and zero for two point calibrations. S[1] and Z[1] refer to the primary output (pressure). S2 and Z2 refer to the secondary output (temperature). Zero and span are input in the current units. They are adjusted automatically when units are changed. The span adjustment is the desired change at full scale. If a value other than full scale is used to calculate the span adjustment, include that value in the range argument. The following equation is used to calculate the interface output.

$$D_{out} = \left(1 + \frac{span}{D_{\max}} \right) \times (D_{calc} + zero).$$

In a typical two point calibration, the span and zero are initially set to zero. Data is taken at the zero point and zero is calculated as:

$$zero = D_{actual} - D_{measured}.$$

Enter the zero using the Z command.

    #01Z1=*zero*¬   *zero*¬

Next, data is taken at a known point near full scale. Span is calculated as:

$$span = D_{actual} - D_{measured}.$$

Enter the span adjustment using the S command.

    #01S1=*span*, $D_{measured}$ ¬   *span*¬

The returned span will have been adjusted for the calibrated full scale load. Use the EW command (**Section 10.1**) to store the changes permanently.

    #01EW¬   0¬

Note: Two point calibration trimming is not generally recommended for Quartzdyne Transducers.

7.2 Full Calibration

CAL[1|2][={*file contents*}]¬   {*file contents*}¬   *Full Calibration*

CAL accepts and echoes coefficient files in the format provided by Quartzdyne. The format of these files is described in the transducer user's manual and documentation disk. The file contents are sent with surrounding braces ({}). Extra carriage returns and line feeds are ignored. CAL[1] will set the primary coefficients which are used to calculate D1 (typically Pressure - .CRF or .CRT files). CAL2 will set the secondary coefficients which are used to calculate D2 (typically Temperature - .CRT or .CFT files).

Send an EW command (**Section 10.1**) after programming coefficients to make the changes permanent. In the example, the full command is sent before any response is received. Be sure to use the correct coefficient file as described in **Section 7.3**. An "R" in the serial number line indicates Reference-based coefficients. CAL will automatically select the transducer reference frequency (FR) as the timebase (**Section 8.1**) if there is an "R" in serial number. Otherwise, the internal timebase (TCXO) will be selected. If the selected timebase is not available, an Error 18 will occur.

COMMAND	RESPONSE	MEANING
#01CAL2={¬	{¬	*Secondary Calibration*
023995R¬	023995R¬	*Serial Number (R for ref).*
Temperature¬	Temperature¬	*Type*
°C¬	°C¬	*Units*
3¬	3¬	*Fit order in F2*
1¬	1¬	*F2 prescale algorithm*
0.01¬	0.01¬	*F2 prescale factor*
50061¬	50061¬	*F2 prescale offset*
0¬	0¬	*Fit order in F1*
1¬	1¬	*F1 prescale algorithm*
0.01¬	0.01¬	*F1 prescale factor*
20161¬	20161¬	*F1 prescale offset*
-19.7130934982¬	-19.7130934982¬	*Cf(0)*
-0.872692993263¬	-0.872692993263¬	*Cf(1)*
-0.00161158992916¬	-0.00161158992916¬	*Cf(2)*
-3.41566295992E-06¬	-3.41566295992E-06¬	*Cf(3)*
1¬	1¬	*Span scale factor*
0¬	0¬	*Zero offset*
25¬	25¬	*Secondary (Temperature) Min*
150¬	150¬	*Secondary Max*
0¬	0¬	*Primary (Pressure) Min*
10000¬	10000¬	*Primary Max*
26 Dec 1995¬	26 Dec 1995¬	*Calibration Date*
QGX10K/A0¬	QGX10K/A0¬	*Model/Rev*
}¬	}¬	
#01EW¬	0¬	*Store Permanently*

The program CALIBRAT.EXE provided on the program disk will download coefficients for both outputs and store them in EEPROM using a single DOS command. See the README.TXT file on the program disk for more information.

7.3   Reference Based Coefficients

Two sets of coefficient files are provided with Quartzdyne transducers that have a reference frequency output. These are referred to as standard and reference-based coefficients. The files are distinguished by the DOS file extensions. CFF and CFT are standard coefficient files for pressure and temperature respectively.   CRF and CRT are the respective reference-based coefficient files.   The standard coefficients assume that an external frequency counter with its own calibrated time base (ovenized or TCXO) is used to count frequency. Frequency errors in the time base will directly affect the transducer frequency readings and consequently the calibrated transducer output.

The reference based coefficients assume that the frequency counter uses the reference frequency of the transducer as its time base. By using temperature information from the transducer output frequencies, the coefficients provide digital temperature compensation of the reference frequency. The computed output is a function of the ratio of the sensor and reference frequencies. This ratio does not depend on any external reference, making the transducer a true self-contained transfer standard. Note that the displayed frequency (D3 or D4) does not reflect the digital compensation. The true frequency can be computed by the following equation:

$$F_{actual} = F_{display} \times \frac{F_{reference}}{7.2e6}$$

$F_{reference}$ may vary from 7.200 MHz by several kHz depending on the transducer and operating temperature (see the Series QR Specification Sheet). Consequently, F_{actual} and $F_{display}$ may differ by $\pm$ 0.1% or by as much as $\pm$64 Hz at 64 kHz. $F_{display}$ should be used when computing coefficients during recalibration.

The transducer interface automatically selects the Series I's optional TCXO when standard coefficient files are downloaded to the transducer interface. The transducer's reference frequency is automatically selected when reference based coefficients are downloaded. See the TB command (**Section 8.1**) for more information on selecting the TCXO.

7.4 Calibration Information

CD[1|2]¬	dd mmm yyyy¬	*Calibration Date*
CU[1|2]¬	*units*¬	*Calibrated Units*
CR[1|2]¬	*Pmax,Pmin,Smax,Smin*¬	*Calibration Range*
CT[1|2]¬	Pressure|Temperature|*Other*¬	*Calibration Type*

The CD, CU, CR, and CT commands return specific information from the programmed calibration files. CR will return the primary range (*Pmax* and *Pmin*) in the current units for D1 and the secondary range (*Smax* and *Smin*) in the current units for D2. The calibration type returned by CT is the name of the parameter being measured as specified in the coefficient file. CU returns the calibrated units from which the user programmable units are calculated. For Quartzdyne pressure transducers, the calibration types are Pressure and Temperature; standard units are psi and °C.

7.5 Transducer Information

M[1|2]¬	nnnnn-nnnn¬	*Model Number*
ID[1|2]¬	nnnnnnnn¬	*Serial Number*

The M and ID commands return the model and serial number as downloaded in the coefficient file. Note that an R at the end of the serial number indicates to the Series I that the coefficients are reference-based. See the TB command (**Section 8.1**) for more information on selecting the TCXO.

8.   Frequency Counter Commands

8.1   Timebase

TB[=FR|TCXO[,*freq*]]¬   FR|TCXO,*freq*¬   *Select Timebase*

The timebase command is used to select either the transducer reference frequency FR (pin 5) or a TCXO (pin 4 or internal). The default frequencies for these are 7.2 MHz and 10.0 MHz respectively. The actual value used in frequency calculations may be set with the *freq* parameter of this command to allow for calibration of a TCXO or for non-standard reference configurations. A separate frequency value is stored for FR and TCXO. If TCXO is selected and a TCXO is not present or if FR is selected when FR is not present, a frequency error will occur (Error 18). When coefficients are downloaded using the CAL command, FR or TCXO is automatically selected based on the transducer serial number as listed in the first line of the coefficient file. An "R" at the end of the first line indicates that it is a reference based coefficient file, so FR is selected. Otherwise TCXO is selected. The TB command can be used to override this default condition after the coefficients have been downloaded. See **Section 7.3** for a discussion of which time base option is appropriate.

8.2   Gatetime

GA[=*gatetime*]¬   n.nn¬   *Gatetime in seconds*

The gatetime command (ROM Rev 2.01 and greater) allows variable gatetimes for the counters ranging from 0.13 seconds to 9.99 seconds. Communications protocols and internal processing capabilities may limit throughput at faster gatetimes to 0.20 seconds. The frequency counter resolution and therefore the calculated output resolution will be affected by the gatetime. Shorter gatetimes will yield proportionately less resolution than longer gatetimes. Both displayed and transmitted data resolution will be adjusted automatically based on the gatetime. When a gatetime command is received, the gatetime will be displayed momentarily on the display. A 1.00 second gatetime would be displayed as **[G 1.00]**.

8.3   Trigger

TR¬   TR¬   *Trigger Counters*

The trigger command synchronizes the frequency counter gate with the software command. The command is most useful when several transducers are monitoring a process which is changing rapidly. In this case the command should be sent in the global mode. All transducer interfaces will delay the next gate closing for a period of one gate time after the trigger command is received. Synchronized data will be available after the gate closes and calculations are completed. Once synchronized, the transducers should remain synchronized for several minutes or until an LD or CAL command is received.

9. Communications Protocol Commands

9.1 Device Address

AD[=nn]   nn¬   *Device address*

The address command sets the transducer interface response address. The response will be the new address. The address of a device is shown on the front panel in response to this command and during the startup sequence as the last two digits of the initial screen **[2.01 01]**. The response address digits are limited to numbers between 01 and 99 allowing for up to 99 logical interfaces on the same serial port. Initially, the response address is set to 01. Before connecting multiple devices together, the addresses must be reprogrammed. The following example assigns the address 02 to a device. The example assumes that only one device is connected and that its address is unknown.

#00AD=02¬		*Global command*
#02AD¬	*02¬*	*Verify new address*
#02EW¬	*0¬*	*Permanently store new address*

9.2 Baud Rate

BR[=*baud*]¬   *baud*¬   *Set Baud Rate*

The baud rate command (ROM Ver. 2.01 and greater) allows communications at baud rates ranging from 1200 to 9600. This feature was added to accommodate the higher throughput needs of systems using faster gatetimes, and systems with several transducer interfaces on a single port. The command will reply at the old baud rate to allow verification that the baud rate has been changed. It is recommended that an EW command be issued (at the new baud rate) after setting this command. The baud rate will be displayed momentarily upon receipt of this command in the format **[1200-]**. The baud rate is also displayed during the startup sequence right after the ROM version and address are displayed. The demo programs accompanying the Series I have been updated to allow communications at standard baud rates within this range.

#01BR¬	*1200¬*	*Communicating at 1200 Baud*
#01BR=9600¬	*9600¬*	*Set 9600 Baud (reply still at 1200)*
		Change Baud rate of host to 9600
#01EW¬	*0¬*	*Store new baud rate at 9600 Baud*

10. Miscellaneous Commands

10.1 EEPROM Read, Write

ER¬	*status*¬	*Read EEPROM*
EW¬	*status*¬	*Write EEPROM*

All of the programmable variables are stored in battery-backed memory. On power up, defaults are obtained from this memory and subsequently can be changed by the user. The EW command saves the current settings as the power-on default. The ER command restores the transducer interface to its power-on state. In each case, the status of the hardware flags is returned (see **Section 11.2**). The user should record all of the transducer interface variables (i.e. units programs, coefficient files, display mode) in case the EEPROM checksum fails. If an EEPROM checksum error occurs, all variables will be set to safe factory presets (AD=01, Coefficients Invalid, etc.). To restore the EEPROM contents, first clear the error by re-writing the EEPROM. Then restore the variable contents and execute another EW command. The programs ROMREAD.EXE and ROMLOAD.EXE are useful for archiving and restoring the EEPROM contents. If other devices are on the interface, it may be necessary to disconnect them until the address is restored.

#01EW¬	Error 19, 0	*Clear Error State*
#01CAL1={*cffile*}¬	{*cffile*}¬	*Download Coefficient File*
#01CAL2={ . . . }	.	
.	.	
.	.	
#01EW¬	0¬	*Save settings in EEPROM*

10.2 Software Version

VER¬	*revision message*¬	*Software Revision*

The VER command reports the software version of the transducer interface ROM. It is the default command on power up. The ROM revision is reported on the display in response to this command and during the startup sequence as the first three digits of the initial screen **[2.01 01]**.

    #01VER¬   Ver 2.01 05/02/96 (c) 1996 Quartzdyne, Inc.¬

10.3 Display Mode

DM[=1|2|3|4|5|6|7]¬	1|2|3|4|5|6|7¬	*Display Mode*

Sets the LCD display mode. Modes 1 through 4 display the corresponding data item D1 to D4. Mode 5 alternately displays D1 and D2. Mode 6 displays the two frequencies D3 and D4. Mode 7 displays all of the data (D1, D2, D3 and D4) in sequence. The display is updated once each gatetime except for long gatetimes where the entire sequence is repeated each gatetime. If a calibration coefficient file is not valid for D1 or D2, the corresponding display will be bypassed in the rotation. In any of the alternating modes, the display flashes momentarily before displaying the first data item of the sequence.

11. Error Commands

11.1 Error Message

EM[nn]¬   *message*¬   *Error Message*

If a command is not recognized, data is out of range, or the transducer is not operating properly, the text "ERROR n" will be sent instead of the normal response to a command. The display will also show an error indicator such as **[E   11]**. To receive a full message rather than a number, issue the EM[n] command where n is the number of the message you want to receive. If [n] is omitted, the message corresponding to the most recent error will be sent. The error messages and likely causes and remedies are listed in **Section 14**.

Some error states are persistent, causing them to be reported at the beginning of each reply. These error messages may be suppressed by issuing an EM[n] command where n is either explicitly set to the persistent error message number or defaults to it because it was the last error reported. Once an error has been suppressed in this fashion, it will not be reported until the condition corrects itself and then fails again or the power is cycled off then on. The ES command will continue to report the suppressed error condition as long as it persists.

11.2 Hardware Status Command

ES¬   *status*¬   *Hardware Status*

The status of certain hardware conditions can be read. If this value is non-zero, an error state exists. The hardware status flags are bit mapped into a 16 bit integer. The bit fields are shown in **Table 4**. Conditions other than those shown indicate hardware failure and should be recorded and reported to Quartzdyne.

Table 4. Hardware Error Status Bits

Bit	Value	Meaning
0	1	No Pressure Frequency Signal
1	2	No Temperature Frequency Signal
2	4	No Reference Frequency Signal
3	8	
4	16	EEPROM Checksum Error
5	32	Backup Battery Low
6	64	
7	128	
8-15	>255	Software Errors

12. Data Logging

The Series I Transducer Interface is supplied with 98K of battery backed memory and a real time clock for data logging. This allows logging of up to 12288 data points. The data logger requires the power to be on for data to be logged. Configuration and data are retained when power is removed. If power is removed during an active logging session, data logging will resume when power is restored. The Data Log data and configuration are stored separately from EEPROM data. The EW and ER commands do not affect the data logger.

12.1 Time Commands

TM[=[yy]yy:mm:dd:hh:mm:[ss]]¬   yyyy:mm:dd:hh:mm:ss¬   *Time*
TS[=*ts*]¬   *ts*¬   *Time in seconds*

TM and TS set or report the setting of the real time clock. TM uses an international 24 hour time format. TS reports/sets time in seconds since 12:00 Midnight on Jan. 1, 1970 (1970:01:01:00:00:00). The TM and TS commands are also used to determine the format of the LD command. The range of the TM format is as follows:

[yy]yy   [19]70-[20]69   *Year*
mm   1-12   *Month*
dd   1-31   *Day of Month*
hh   0-23   *Hours*
mm   0-59   *Minutes*
ss   0-59   *Seconds*

12.2 Log Initialize/Delete

LI[=dd[,dd][,dd][,dd][,dd]]¬   TM|TS[,D1] ... [,D4]¬   *Initialize Log*

LI initializes the data logging functions (deleting any previously stored data) and programs which data items will be stored. The data in the log is stored as 4 byte floating point numbers. Time must be stored in addition to at least one of the data items D1-D4. The data log has room for 24576 data items. Storing only time and D1, for example, will allow up to 12288 data points to be stored. If D2, D3, and D4 are also recorded, the number of samples that can be stored will decrease accordingly. After the log is initialized, the log rate and start/stop time must be set for logging to commence. **Note**: The LI= command deletes all points currently stored in the log. Power must be on for data to be logged. The log settings and logged data are preserved during power down. (See example in **Section 12.6.**)

12.3 Log Rate

LR[=*nsec*[AND|OR Dn=*step*]]¬   *nsec*[AND|OR Dn = *step*]¬   *Logging rate*

Data is stored at time intervals specified in seconds. Optionally a condition may be included based on one of the logged data items. In the AND mode, data will be logged at the time interval only if the data Dn has changed by at least the value of *step*. In the OR mode data will be logged at the time interval OR if the data has changed by at least *step* since it was last logged. If the number of seconds is set to zero, all data points will be logged as they become available (at the gatetime rate). The logging rate may be changed while data is being logged. (See example in **Section 12.6.**)

12.4 Log Start/Stop

      LS[=START|*start*[,*stop*]|STOP]¬   *start*[,*stop*]|STOPPED¬   *Start/Stop times*

Data logging will commence when the time programmed by *start* is reached and continue until the time specified in *stop*. If no stop time is specified, logging will continue until the log is full. To start/stop data logging immediately, use the words START or STOP instead of the actual times. The times will be reported as in TM or TS depending on the last format used. Logging may be stopped and started at will without destroying previously logged data. Only the most recently programmed start and stop times are reported. (See example in **Section 12.6.**)

12.5 Log Length

      LL¬   nnnnn¬   *Log Length*

Reports the number of data sets currently stored in the log.

12.6 Log Dump

      LD[n1[,n2]]¬   *time*,nnnn.nn[,nn ...]¬| {¬   *Dump Log*
                                       time,nnnn.nn[,nn ...]¬
                                       .
                                       }¬

Dumps data from the log in the format specified above. When more than one line of data is returned, braces will enclose the response. Time will be reported in the most recently used format (LI, TM or TS). All other items will be dumped in the currently programmed units and with currently programmed scale and offset. Units may be changed during the data logging. If only n1 is specified, a single data set will be dumped. If both n1 and n2 are specified, data sets ranging from n1 through n2 will be dumped. n1 can range from 1 to the number returned by LL. n2 can range from n2 to the number returned by LL. If neither n1 nor n2 are specified, the entire data log will be dumped. Display updates and data logging functions will be suspended during log dumps.

The following example programs the data log to store Time, D1 and D2 if D1 changes by at least 1.0, but no more than once every 10 seconds. Data logging is started immediately and continues until 7:00 a.m. on Christmas morning or until the log memory is full. Commands and responses are on alternating lines. Comments are in italics.

      #01LI=TM,D1,D2¬   *Initialize Logging for time, D1 and D2*
      TM,D1,D2¬
      #01LR=10 AND D1=1.0   *Set Logging Rate and Conditions*
      10 AND D1=1.0¬
      #01LS=START,1992:12:25:07:00:00¬   *Start logging and set stop time.*
      1992:12:24:16:59:59,1992:12:25:05:00:00¬   *Start and Stop times confirmed.*
      #01LL¬   *Some time later log length is checked.*
      15¬
      #01LD 11,15¬   *Read last 5 log entries.*
      {¬
      1992:12:24:23:59:45, 1012.21, 1.512¬
      1992:12:24:23:59:55, 1018.32, 1.513¬
      1992:12:25:00:00:10, 1017.31, 1.514¬
      1992:12:25:00:05:23, 1016.31, 1.515¬
      1992:12:25:00:05:33, 1013.15, 1.516¬
      }¬

13. Command Summary

D[1]¬	±nnnnn.nnn	*Pressure*
D2¬	±nnnnn.nnn	*Temperature*
D3¬	nnnnn.nnn	*Frequency 1*
D4¬	nnnnn.nnn	*Frequency 2*
UN[1][=n|*name*]¬	*name*¬	*Pressure Units*
UN2[=n|*name*]¬	*name*¬	*Temperature Units*
UP[1][=*name*[,*scale*[,*offset*]]]¬	name,scale,offset¬	*Unit Program 1*
UPn[=*name*[,*scale*[,*offset*]]]¬	name,scale,offset¬	*Unit Program 2-8*
S[1|2][=*span*[,*range*]]¬	*span*¬	*Span Adjust*
Z[1|2][=*zero*]¬	*zero*¬	*Zero Adjust*
CAL[1|2][={*file contents*}]¬	{¬*cffile contents*}¬	*Full Calibration*
CD[1|2]¬	dd mmm yyyy¬	*Calibration Date*
CU[1|2]¬	*units*¬	*Calibrated Units*
CR[1|2]¬	*Pmax,Pmin,Smax,Smin*¬	*Calibration Range*
CT[1|2]¬	Pressure|Temperature|*Other*¬	*Calibration Type*
M[1|2]¬	nnnnn-nnnn¬	*Model Number*
ID[1|2]¬	nnnnnnnn¬	*Serial Number*
TB[=FR|TCXO[,*freq*]]¬	FR|TCXO,*freq*¬	*Select/Trim Timebase*
GA[=*gatetime*]¬	n.nn¬	*Gatetime*
TR¬	TR¬	*Trigger Counters*
DM[=1|2|3|4|5|6|7]¬	1|2|3|4|5|6|7¬	*Display Mode*
VER¬	*revision message*¬	*Software Revision*
AD[=*address*] ¬	nn¬	*Response Address*
BR[=*baud*]¬	nnnn¬	*Baud Rate*
EM[nn]¬	message¬	*Error Message*
ES¬	*status*¬	*Hardware Status*
ER¬	*status*¬	*Read EEPROM*
EW	*status*¬	*Write EEPROM*
TM[=[yy]yy:mm:dd:hh:mm:[ss]]¬	yyyy:mm:dd:hh:mm:ss¬	*Time*
TS[=*ts*]¬	nnnnnnnnnn¬	*Time in seconds*
LI[=dd[,dd][,dd][,dd][,dd]]¬	TM|TS[,D1] ... [,D4]¬	*Initialize Log*
LR[=*nsec*[AND|OR Dn=*step*]]¬	*nsec*[AND|OR Dn = *step*]¬	*Logging rate*
LS[=START|*start*[,*stop*]|STOP]¬	*start*[,*stop*]|STOPPED¬	*Start/Stop times*
LL¬	nnnnn¬	*Log Length*
LD[n1[,n2]]¬	time,nnnn.nn[,nn ...]¬ | {¬	*Dump Log*
	time,nnnn.nn[,nn ...]¬	
	.	
	}¬	

14. Error Messages

Error	Description	*Possible Causes/Relevant Commands*
Error 0	No Error	
Error 1	Bad Pressure Coefficients	*Download using* CAL1={*file contents*}
Error 2	Bad Temperature Coefficients	*Download using* CAL2={*file contents*}
Error 3	Unrecognized Command	*Semicolon instead of comma* *Missing characters in host serial software*
Error 4	Invalid Data	*Numeric data out of range* *String data contains too many characters*
Error 5	Named Units Not Found	UN[1|2]=*name - name not found in units table* *Use* UPn *to program units into the units table*
Error 6	Numeric Overflow	*Inappropriate Coefficients* (CAL) *Inappropriate Units* (UN,UP) *Inappropriate Span or Zero adjust* (S,Z) *Input frequency out of range*
Error 7	Command Too Long	*Maximum 1024 characters*
Error 8	Response Too Long	*N/A*
Error 9	Serial Port Overrun Error	*Try shorter commands, slower baud rate* (BR)
Error 10	Serial Port Parity Error	*N/A*
Error 11	Serial Port Framing Error	*Incorrect Baud Rate* (BR) *Polarity Reversal on RS422 lines* *ESD Event* *Break Character Sent*
Error 12	Log Hardware Not Installed	*N/A*
Error 13	Log Initialization Error	*Check format of* LI= *command* *Use* LI= *before* LL,LR,LS
Error 14	Data Log is Full	*Use* LI= *command to delete old data*
Error 15	Data Log is Empty	*Check log length* LL *before using* LD
Error 16	Protocol Overrun	*Characters sent by host or other device before addressed device responded-* *Host time-out shorter than gatetime* (GA) *Multiple devices set to same address* (AD) *Too much time between CR and LF*
Error 17	Hardware Error - Check Status (ES)	*Consult Factory*
Error 18	Sensor Frequency or Timebase Error	*Check timebase and coefficients* (TB,CAL) *Note that* TB *will be automatically changed when coefficients are downloaded with* CAL *command.* *Check transducer Cable*
Error 19	Memory Checksum Error	*EEPROM Data corrupt* *Check Lithium Battery (Ver < 1.02)* *Must download coefficients, units, etc.*
Error 20	Battery Low Error	*Replace Lithium Battery (Ver >= 1.02)*
Error 21	Software Error	*Consult Factory*