Paroscientific, Inc.
Digiquartz® Pressure Instrumentation

Digiquartz® Broadband Pressure Transducers And Depth Sensors With Frequency Outputs

User Manual

"The standard by which other standards are measured"

Technology

Digiquartz® Broadband Pressure Transducers And Depth Sensors With Frequency Outputs

User Manual

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Please visit www.paroscientific.com for the latest manual revisions.

Contents

1 Introduction

This manual is intended to offer installation and start up information for Paroscientific Digiquartz® Broadband Pressure Transducers and Depth Sensors with frequency outputs.

Digiquartz Broadband Pressure Transducers are precision instruments and, as such, must be used with a certain degree of care. To ensure optimum performance, please follow the installation and handling recommendations presented in this manual.

The latest manual revision, along with additional product, installation, and operating information is available on the Paroscientific website at www.paroscientific.com.

1.1 Conventions

The following conventions are used throughout this manual:

Digiquartz Broadband Pressure Transducer – Any Digiquartz Broadband Pressure Transducer with frequency outputs.

Digiquartz Broadband Depth Sensor – Any Digiquartz Broadband Pressure Transducer with frequency outputs that is specially packaged for depth sensing applications.

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

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

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2 Getting Familiar

2.1 Features

General descriptions and feature summaries for Digiquartz Broadband Pressure Transducers can be found on the Paroscientific website at www.paroscientific.com. Additional details are shown on the Specification Control Drawing that is shipped with the transducer.

2.2 Physical Inspection

You should have received the following items with your Digiquartz Broadband Pressure Transducer purchase:

- Digiquartz Broadband Pressure Transducer or Depth Sensor
- User's manual
- Specification Control Drawing (SCD) for the Digiquartz Broadband Pressure Transducer or Depth Sensor
- Calibration Coefficient Sheet
- Certificate of Calibration
- Certificate of Conformance

2.3 Handling Precautions

Digiquartz Broadband Pressure Transducers 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 the specified limit. Calibration can be affected if this limit is exceeded, and permanent damage can result if the unit is sufficiently overpressured.

WARNING

Excessive mechanical shock may cause irreparable damage. Do not drop a Digiquartz Broadband Pressure Transducer, or allow tools or other hard objects to fall on the unit or its pressure port. If so equipped, the nylon or stainless steel buffer tube is an integral part of the transducer's shock isolation system, and should not be removed.

2.4 Documents

The following documents are supplied with each Digiquartz Broadband Pressure Transducer.

SPECIFICATION CONTROL DRAWING (SCD)

The SCD is a drawing that contains information about the performance, characteristics, environmental specifications, and physical dimensions of the unit.

CALIBRATION COEFFICIENT SHEET

The Calibration Coefficient Sheet contains the calibration coefficient values and the associated modeling equations (see Section 5). The calibration coefficients are derived from a calibration test run, and are unique to each Digiquartz Broadband Pressure Transducer.

CERTIFICATE OF CALIBRATION

The Certificate of Calibration identifies the primary pressure standard(s) used to calibrate the Digiquartz Broadband Pressure Transducer.

CERTIFICATE OF CONFORMANCE

The Certificate of Conformance certifies that the Digiquartz Broadband Pressure Transducer was manufactured in accordance with the applicable engineering drawings, process specifications, procedures, and specification control drawing. It also certifies that the Digiquartz Broadband Pressure Transducer was tested against NIST-traceable primary pressure standards, temperature standards, and pressure transfer standards that are regularly checked and calibrated per documented Paroscientific procedures in accordance with ISO 9001 requirements.

3 Installation

Digiquartz Broadband Pressure Transducers can generally be mounted in any orientation. Mounting hole patterns for units so equipped can be found on the Specification Control Drawing (SCD) supplied with the unit.

CAUTION

Pressure head effects vary with transducer orientation, and result in zero offsets. These effects are more pronounced when liquid-filled pressure lines are being used. These effects can be minimized by keeping the transducer pressure port and the pressure source at the same elevation, or by making an offset correction to compensate for the pressure head.

3.1 Pressure Ports and Buffer Tubes

Digiquartz Broadband Pressure Transducers typically include a nylon or stainless steel buffer tube. The buffer tube is an integral part of the mechanical shock protection system of the transducer.

Parker A-Lok or equivalent nut and ferrule compression tube fittings are used on most Digiquartz Broadband Pressure Transducers. Series 2000 devices require 1/8” diameter tubing fittings for installation, while Series 3000 and 4000 use 1/16” diameter tube fittings.

Two 7/16" wrenches are required when making or breaking any 1/8-inch pressure fitting. The first wrench is used to stabilize the stationary fitting, and the second wrench is used to turn the other fitting.

High-pressure transducers (Series 3000 and Series 4000) use the 1/16" Parker A-Lok or equivalent fittings. Two 5/16" wrenches are required to make and break these connections.

CAUTION

It is recommended that pressure fittings be installed finger tight, then tightened an additional ¾ turn to complete the pressure seal.

WARNING

Removing the buffer tube is NOT recommended, as it is an integral part of the mechanical shock protection of the transducer. Connections made directly to the transducer pressure fitting without using the buffer tube may result in irreversible damage to the unit. If damage occurs, it will be necessary to return the unit to Paroscientific for repairs or replacement not covered under warranty.

3.2 Oil Filled vs. Non-Oil Filled Units

OIL FILLED TRANSDUCERS

Transducers that are to be used to measure liquid media pressures are oil filled at Paroscientific. Transducers that are oil filled should never be used in gas media applications.

Oil fill and bleed all pressure lines that are to be connected to an oil filled transducer. The same oil used to fill the transducer should be used to fill the pressure lines; consult the transducer Specification Control Drawing for details.

CAUTION

If your transducer and buffer tube are oil filled, do not pull a vacuum or apply pressurized gas to the unit. Doing so could allow bubbles to form in the pressure lines and transducer, which will adversely affect the accuracy of the unit.

CAUTION

Pressure head effects result in zero offsets. These effects are more pronounced when liquid filled pressure lines are being used. These effects can be minimized by keeping the transducer pressure port and the pressure source at the same elevation, or by making an offset correction to compensate for the pressure head.

NON-OIL FILLED TRANSDUCERS

Non-oil filled transducers are intended for use in gas media applications, and should never be used in liquid media applications.

WARNING

If your transducer and buffer tube are not oil-filled, do not apply pressurized liquid media to the unit. Liquid may contaminate the unit, and may adversely affect the accuracy of the unit. It is not possible to completely remove most liquids from the transducer once they have been introduced.

4 Electrical

4.1 Characteristics

PRESSURE SIGNAL

Signal Type:	AC coupled nominal square wave
Amplitude:	Nominal 4V peak to peak
Source Impedance:	Less than 750 Ohms
Range:	Nominal 10% frequency change within the band of 30 kHz to 42 kHz.

TEMPERATURE SIGNAL

Signal Type:	AC coupled nominal square wave
Amplitude:	Nominal 4V peak to peak
Source Impedance:	Less than 750 Ohms
Range:	Nominal 45 ppm/°C sensitivity within the band of 168 kHz to 174 kHz.

SUPPLY VOLTAGE

Refer to Specification Control Drawing supplied with transducer.

CURRENT CONSUMPTION

Refer to Specification Control Drawing supplied with transducer.

WARNING

Power/signal ground are connected to the transducer pressure fitting (and in some cases, the transducer housing) through a 0.1µF 50V capacitor. To prevent damage to the transducer electronics, ensure that the potential between power/signal ground and the pressure fitting does not exceed 50V.

CAUTION

Current consumption increases when driving long lines or low impedances. Refer to the Specification Control Drawing supplied with the transducer for output loading recommendations.

TRANSDUCER WIRES

Most Digiquartz Broadband Pressure Transducers bring out their output and power connections on flying wire leads. The pressure and temperature signals are typically brought out separately as twisted pairs with power/signal ground. The wires are color-coded per following table:

TABLE 4-1: Transducer Wire Color-Coding

Wire Color	Signal
Red	Power
Blue / Black twisted	Pressure Signal / Ground
White / Black twisted	Temperature Signal / Ground

⚠ CAUTION

Do not bundle pressure and temperature wires together. Doing so can cause the temperature signal to couple into the pressure signal, which may result in pressure signal noise and diminished sensor performance.

⚠ CAUTION

If pressure and temperature wires are to be extended, also extend the associated black ground wires, and ensure that the extension wires are also twisted at a rate of at least 4 to 5 twists per inch. Failure to do so can cause the temperature signal to couple into the pressure signal, which may result in pressure signal noise and diminished sensor performance.

5 Calculating Pressure and Temperature

Internal sensor temperature and applied pressure are calculated from period measurements of the two transducer output signals. The equations and coefficients used to perform these calculations are described below. Refer to the Calibration Coefficient Sheet for the actual coefficient values for your transducer.

5.1 Temperature Calculation

The following equation is used to calculate internal sensor temperature:

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

Where: T = Temperature (°C)
U_0 = temperature signal period (microseconds) at 25° C
U = temperature signal period (microseconds) – U_0 (microseconds)
Temperature coefficients: U_0 Y_1 Y_2 Y_3

5.2 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 signal period (microseconds)
U = temperature signal 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

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6 Digiquartz Data Storage (DDS)

Most Digiquartz Broadband Pressure Transducers include the Digiquartz Data Storage (DDS) feature. Transducers with DDS can be identified by the presence of the wires described in Section 6.1.

Digiquartz Data Storage (DDS) is an onboard serial EEPROM that contains calibration and transducer information. This information can be accessed electronically to provide plug and play pressure transducer interchangeability. An additional 4k bytes of DDS EEPROM memory has been allocated for customer use.

NOTE: The sole purpose of DDS is to store transducer configuration information. Use of DDS is optional, and does not affect pressure measurement. A minimum wire length of 6 inches is required to program DDS. If one chooses to remove the DDS wires, the recommended method is to cut the DDS wires to the desired length and protect the exposed leads with heat shrink.

WARNING

Voltages outside the range of -0.3 to 4.3 volts must not be applied to the SDA (Serial Data) and SCL (Serial Clock) signal lines. Doing so will damage the DDS serial EEPROM.

CAUTION

The maximum recommended length of the SDA and SCL wires is 18 inches. Serial communication with the serial EEPROM may become unreliable at longer wire lengths.

6.1 DDS Wires

TABLE 6-1: DDS Wire Color-Coding

Wire Color	Signal
White / Brown	SCL
White / Violet	SDA
Black	Ground

6.2 EEPROM Type

The DDS serial EEPROM is a Microchip Technology 24LC64 or equivalent. For interface information, please consult the manufacturer's data sheet for this device, which can be obtained at the Microchip Technology website at www.microchip.com.

6.3 Chip Address

The chip address of the DDS serial EEPROM is fixed at binary 101. Any device used to communicate with DDS must be able to select the proper chip address.

6.4 Memory Map

The information stored in DDS memory is organized as shown in the table below. All data are stored in fixed length fields in ASCII format. All used fields are padded from the end of the data to the end of the field with space characters (ASCII 32 decimal).

256 bytes of data storage starting at address 1000 hex has been reserved for your use.

CAUTION

Do not store data at addresses below 1000 hex. This memory space is reserved for Paroscientific use.

Table 6-2: DDS Memory Map

Field No	Address (Hex)	Description	Field Length (Bytes)
General Information			
1	0000-000F	EEPROM Revision	16
2 - 6	0010-005F	Customer Information	80
7 - 11	0060-00AF	Reserved	80
Sensor Information			
12	00B0-00BF	Serial Number	16
13	00C0-00CF	Part Number	16
14-15	00D0-00EF	Model Description	32
16-17	00F0-010F	Pressure Range	32
18-19	0110-012F	Temperature Range	32
20	0130-013F	Report Date	16
21	0140-014F	Pressure Medium	16
22	0150-015F	Sensor Type	16
23 - 27	0160-01AF	Reserved	80
Calibration Data			
28	01B0-01BF	Calibration Date	16
29	01C0-01CF	Pressure Units	16
30	01D0-01DF	Temperature Units	16
31	01E0-01EF	U0 Coefficient	16
32	01F0-01FF	Y1 Coefficient	16
33	0200-020F	Y2 Coefficient	16
34	0210-021F	Y3 Coefficient	16
35	0220-022F	C1 Coefficient	16
36	0230-023F	C2 Coefficient	16
37	0240-024F	C3 Coefficient	16
38	0250-025F	D1 Coefficient	16
39	0260-026F	D2 Coefficient	16
40	0270-027F	T1 Coefficient	16
41	0280-028F	T2 Coefficient	16

Table 6-2: DDS Memory Map

Field No	Address (Hex)	Description	Field Length (Bytes)
Calibration Data			
42	0290-029F	T3 Coefficient	16
43	02A0-02AF	T4 Coefficient	16
44	02B0-02BF	T5 Coefficient	16
45	02C0-02CF	Pressure Adder	16
46	02D0-02DF	Pressure Multiplier	16
47 - 51	02E0-032F	Reserved	80
Common-Mode Calibration			
52	0330-033F	Common-Mode Coefficient Units	10
53	0340-034F	A1 Coefficient	16
54	0350-035F	A2 Coefficient	16
55	0360-036F	B1 Coefficient	16
56	0370-037F	P0 Coefficient	16
Reserved			
57 - 256	0380-05CF	Paroscientific Reserved	592
257 - 512	1000-1FFF	User Reserved	4096

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7 Accessories and Software

7.1 Model 735 Intelligent Display

If your application requires RS-232 interface, a display, or transducer control and monitoring without a computer, the Model 735 can be the best choice for you. The Model 735 Intelligent Display performs all of the functions of the Model 745 High Accuracy Portable Standard when connected to a single external Digiquartz Transducer. It features an intuitive front panel menu system, two-line display, RS-232 communication port, tare capability, and transducer connection terminals.

The Model 735 can be powered from its AC adapter, or for up to 20 hours from AA alkaline batteries. Configuration and data logging software provided by Paroscientific allows the user to configure and log data from Model 735 via RS-232.

7.2 Digiquartz Intelligent Interface Board

The Digiquartz Intelligent Interface Board is a microprocessor-based interface that processes the frequency outputs from a single Digiquartz transducer. It provides fully temperature-compensated pressure measurement values in the user's choice of engineering units. Dual RS-232 and RS-485 serial interfaces are provided. The user may program the sample rate, integration time, engineering units, and communication parameters via the serial interfaces. Multiple transducer/board combinations can be connected together to form an RS-232 serial loop or RS-485 multi-drop network.

Set-up and data acquisition software provided by Paroscientific can be used with the Digiquartz Intelligent Interface Board.

The Digiquartz Intelligent Interface Board is compatible with the Model 715 display.

7.3 Model 715 Display

The Model 715 displays pressure and temperature data from all Paroscientific Intelligent Transmitters with firmware versions R1.00 and later. The two-line, 16-character backlit alphanumeric liquid crystal display is set up with transmitter commands. Display functions include pressure and temperature values with engineering units, overpressure warning, tare indicator, user defined text messages, and a horizontal analog bar graph showing pressure as a percentage of full-scale pressure.

The Model 715 will respond to display commands from a Digiquartz transmitter, a computer, or other serial host on either the RS-232 or RS-485 port. For stand-alone operation, it can display data whenever power is applied to the transmitter.

7.4 Digiquartz Software Programs

Paroscientific provides software programs that simplify common measurement and configuration tasks. The latest versions of these and other software programs are available at the Paroscientific web site www.paroscientific.com.

Digiquartz Broadband Pressure Transducers require an intelligent board or Model 735 Intelligent Display to interface with PC-based Digiquartz Software.

A transducer can also interface directly with third-party data acquisition systems that measure frequency signals. In this case, the user would need to develop their own software to acquire and process the signal output from the transducer.

7.4.1 Digiquartz Interactive 2.0 (DQI 2.0)

Digiquartz Interactive 2.0 is a Windows program that makes it easy to communicate with and configure DIGIQUARTZ Intelligent devices. We encourage you to install DQI 2.0 and use it to verify proper device operation, configure your device, take measurements, and experiment with its functions.

DQI 2.0 is separated into two main sections: Configuration and Monitoring, and Digiquartz Terminal.

The Configuration and Monitoring section provides a means of viewing, changing, storing, and retrieving the configuration parameters of your instrument. It also allows you to take measurements and display them numerically and in a real-time graph. Measurement data may also be logged to a text file in a format that can be easily imported into popular PC programs such as Microsoft Excel® or Word®.

The Digiquartz Terminal section allows you to interactively communicate with your instrument using text-based commands. Measurement data may be logged to a text file in a format that can be easily imported into popular PC programs such as Microsoft Excel or Word.

7.4.2 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.

8 Calibration

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

Calibration is performed by applying known pressures from primary standards to manifolds of transducers mounted in temperature chambers. Two frequency (or period) output signals are sent from each transducer. Pressure is measured with a force-sensitive quartz crystal whose output period changes with applied load. A second period output comes from a quartz crystal temperature sensor used for thermal compensation. The manifold of transducer signals are multiplexed, measured, and the data fit to derive coefficients for the standard equation that characterizes the transducers. The calibration coefficients provided with each transducer and the indicated pressure (calculated) will agree with the "true" applied pressure with a typical accuracy of 0.01 percent or better of transducer full scale over the full operational range of pressures and temperatures. Digiquartz Intelligent Transmitters store the calibration coefficients in non-volatile EEPROM to provide fully temperature-compensated and linearized outputs on the bi-directional RS-232 and RS-485 interfaces.

Because the recalibration period of Digiquartz Instruments depends on specific applications and user requirements, we do not recommend a typical interval between calibrations. Some customers never recalibrate their instruments, while others recalibrate periodically every 1 to 3 years. A test report on long-term stability of Digiquartz Barometers can be found on our web site.

Equally amazing stability has been shown with high-pressure depth sensors in oceanographic deployments. After 30 years and 100,000 transducers, we have not detected a change in span (scale factor) with time. Therefore, the only correction made to instruments during recalibration is usually a small offset adjustment. With no pressure applied to gauge or differential transducers, the adjustment equals the indicated value. For absolute instruments, an effective adjustment (especially on higher pressure ranges) can simply be the difference between the indicated value and a single "true" pressure. The calibration adjustments may be done via the PA (Pressure Adder) and PM (Pressure Multiplier) parameters on the Intelligent Instruments or via the C1 and T1 calibration coefficients for frequency output transducers.

Paroscientific's Quality Assurance System is certified to the requirements of the ISO 9001 International Quality Standard and provides consistency in our products and processes from design and development through production, calibration, test, and servicing. Our calibration system meets MIL-STD 45662A and is traceable to NIST.

Digiquartz absolute transducers, transmitters, and portable standards, with full scale pressure ranges of 500 psia or less, come with a certificate for one FREE inspection, calibration check, zero adjustment, and new Certificate of NIST Traceability within the first two years of shipment.

9 Warranty and Technical Support

9.1 Warranty Information

DIGIQUARTZ TRANSDUCERS

5-YEAR EXTENDED LIMITED WARRANTY

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

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

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

CONDITIONS:

- The warranty period is from the date of shipment from Paroscientific to date of receipt at Paroscientific.
- The customer must authorize the repair or replacement of the warranty claim within 45 days of notification by our Service Department.
- No exceptions to the discount schedule or terms of this policy are allowed.
- This warranty does not apply to units broken due to overpressure or excessive shock.
- Warranty returned units become the property of Paroscientific upon replacement.

All barometers also have a three year limited warranty on long-term stability. Years 4 and 5 are covered by the above schedule.

9.2 Technical Support and Service

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

For information on returning an instrument to us for disposal (Waste Electrical and Electronic Equipment - WEEE), please see the Disposal section of our web site for documentation requirements and packaging instructions.

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

10 Pressure Unit Conversion Table

To use this table:

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

TABLE 10-1: Pressure Unit Conversion Table

Original Pressure Unit	Desired Pressure Unit						
	Meters H2O	Pounds/in^2	Inches of mercury	Millimeters of mercury or Torr	Gram/cm^2	Millibar or Hectopascal	Pascal or Newton/m^2
	g/cm^3	psi	in Hg	mm Hg or Torr	g/cm^2	mbar or hPa	Pa or N/m^2
g/cm^3	1	1.422334	2.895903	73.5592	100.0000	98.06650	9806.650
psi	.7030696	1	2.036021	51.71493	70.30696	68.94757	6894.757
in Hg	.3453155	.4911541	1	25.40000	34.53155	33.86388	3386.388
mm Hg or Torr	.01359510	.01933678	.03937008	1	1.359510	1.333224	133.3224
g/cm^2	.01000000	.01422334	.02895903	.7355592	1	.9806650	98.06650
mbar or hPa	.01019716	.01450377	.02952999	.75000617	1.019716	1	100.0000
Pa or N/m^2	1.019716x10-4	1.450377x10-4	2.952999x10-4	7.500617x10-3	.01019716	.01000000	1

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