



DXD Series - Precision Digital Pressure Transducer

Installation and Operating Instructions

I&M 002-10106 DXD

Revision 1.6.1 2/28/06

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Section 1.0 Introduction

Congratulations on your purchase of a DXD Series Digital Pressure Transducer. This transducer provides unmatched performance and value. Innovative modeling and processing firmware assures extremely high precision over a broad temperature range as well as extremely fast response. Please read the following cautions and instructions carefully in order to take full advantage of the product's capabilities.

Section 2.0 Cautions

Pressure instruments must be selected in accordance with industry codes and safety practices to avoid the possibility of misuse or misapplication, which could result in personal injury or property damage. Personnel responsible for selection and installation should also be familiar with the safety recommendations of ASME B40.1, that apply to elastic pressure elements and their application in general and specific services. ASME B40.1 is available from:

ASME
345 47th Street
New York, NY 10017

- Select a range so that the maximum applied pressure will never exceed the upper range limit.
- Excessive vibration could cause loosening of components resulting in loss of instrument accuracy or failure to provide valid data.
- Excessive pressure pulsation could result in fatigue failure of the pressure element.
- Operation of the instrument in an environment where temperatures are in excess of design ratings may result in loss of accuracy and failure.
- Pressure boundary materials must be resistant to the process media. Failure to assure compatibility may result in pressure sensing element deterioration or failure. Instruments used on high-pressure gas, or potentially hazardous service, such as oxygen should be carefully selected in accordance with the recommendations of ASME B40.1.
- Only approved explosion proof or intrinsically safe instruments should be used in hazardous locations.

- Instruments used in locations where EMI/RFI conditions exist may exhibit erroneous performance.
- These instruments are not explosion proof or intrinsically safe. Power levels present preclude use in hazardous locations.

Section 3.0 Theory of Operation

The DXD transducer design employs a piezo resistive strain gauge, a 24 bit A/D converter, microprocessor and a 20 MHz clock. The A/D resolution is internally reduced to 50,000 counts to optimize signal to noise ratio. The raw data is processed with a proprietary algorithm which employs a fourth order polynomial. The math package fits both temperature and pressure signals from the transducer using coefficients calculated from the outputs of pressure and temperature standards during the calibration process. The internal update rate can be set to 27.7mS or 12.6 mS. The DXD responds to a simple ASCII command protocol. The total transmit/ receive time for fully corrected pressure data is 30 mS (when set to 27.7 mS) and 15 mS (when set to 12.6 mS) at 115,200 bps. There may be a slight reduction in signal stability (1 to 3 counts) when operated at 15 mS as the difference in signal processing time is gained at the expense of filtering in the processor. The firmware supports addressable, multi-drop operation. Electrical communications are via full duplex RS232 or RS485 standards. The maximum resolution is 50,000 counts.

Section 4.0 Unpacking

Please note: When handling connectors care should be taken to avoid electrostatic discharge to prevent damage to the electronics. The power pins are reverse polarity protected. Use caution if fabricating connector and cable assemblies because the digital I/O lines are not protected from the inadvertent application of power. Following is a description of material included in shipment.

4.1 DXD Transducer(s)

The DXD is available in a variety of standard pressure ranges and types as specified at time of order placement. **It is configured for either RS232 or RS485 operation at the factory as specified at time of purchase.** The output is not field configurable. Please check the product label to ensure that the pressure range and output signal type are correct.

4.2 Certificate of Calibration

Each DXD is provided with a report of calibration traceable to NIST. The report is packaged with the transducer.

4.3 Utility Software

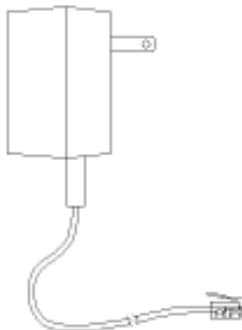
Software is provided on three 3 1/2-inch disks or CD rom. The Windows compatible software simplifies the setup and installation of the DXD. It also provides powerful data logging and pressure display capabilities. It includes an ".OCX" compatible com driver which can be utilized through Active X compliant software.

4.4 Accessories (RS232 Configurations only)

The following accessory items are available individually or in kit form at time of order. These accessories are designed for use with the RS232 version of the product. The DXD with complete kit option includes the following items:

4.41 Modular power supply. The AC Adapter supplies 12 VDC power (500 mA) to the Serial Port Converter and the DXD transducer(s) which are interconnected forming a "network". The DXD has its own regulated power supply (internal DC to DC converter) and is protected against spikes and supply reversals. Each DXD consumes approximately 300 milliwatts or 15ma at 20 volts. The power supply can be plugged in anywhere along the network, it does not have to be near the Serial Port Converter. The contact rating of the RJ11/4 (telephone-type) connector is 1.5 amps which provides a fast, economical, and reliable method of interconnection.

Figure 1. Modular Power Supply with RJ11/4 Connector



4.42 Serial port converter. The Serial port converter consists of electronics housed in a standard DB25 connector's shell assembly. It has a standard DB25 female RS-232C socket on one end and two RJ11/4 jacks on the other. The DB25 side plugs into an RS-232C port and the RJ11/4 jack connects to the transducer(s). Its function is to amplify and buffer standard RS-232C signals so that up to 99 DXD transducers can be connected in parallel in any configuration, Daisy Chain or Star. One converter is required per 99 units. The converter can drive extension cables up to 1000 feet (total cable length) and still maintain data integrity while communicating at high speed with each transducer.

Figure 2. Serial Port Adapter Assembly

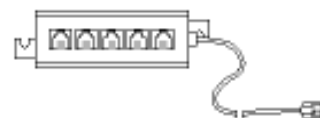


4.43 25 to 9 pin adapter. A 25 pin to nine pin adapter is provided to facilitate connecting the serial port converter's DB25 pin connector to a computer or terminal serial port having a DB9 pin connector.

4.44 25 foot cable. The 25-foot cable connects the DXD to an expander module or directly to a serial port converter. The cable is provided with a Switchcraft or Cannon connector on one end and an RJ11/4 (telephone-type plug) on the other. Pushing the female connector onto the male socket and then securing the connector with the sleeve by turning the sleeve until it locks in place makes connection to the DXD.

4.45 Five-port expander module. A five-port expander module consists of a block with five female RJ11/4 jacks and a six-inch pigtail with a male RJ11/4 connector. The DXD cable plug(s) and the modular power supply plug are inserted into the available jacks and the male plug on the pigtail of the five port expander is inserted into the female jack on the serial port converter.

Figure 3. Five-Port Expander Module



Section 5.0 Installation

The Installation of the product has three basic steps, which include making pressure connections, system wiring (connecting communication and power cables to the transducers and a PC or PLC and installing and running software to communicate with and set up the DXD transducer.

5.1 Pressure Connections

The standard pressure inlet fitting is a 1/4 inch NPTM type connector unless an optional fitting was specified at time of purchase.

IMPORTANT NOTE: The standard vented housing is recommended for gauge pressure types with ranges less than or equal to 500 PSI. This is because changes in ambient temperature will increase or decrease the pressure of the gas volume within the housing producing an undesirable effect on the performance of the unit. The housing is vented through the Switchcraft or Cannon electrical connector by removal of one of the unused connector pins at the factory (see Table 1 and 2). A sealed housing (no connector pin removed) can be specified at time of purchase if required. The effect is approximately ± 0.027 PSI per degree Fahrenheit change in ambient temperature.

This is not a factor on absolute pressure ranges because the reference side of the sensor is evacuated and sealed.

5.2 System Wiring

5.2.1 RS232 Cables. The RS232 configuration requires four conductors for signal in, signal out, power positive, and power negative. Prefabricated telephone type cables with RJ11 modular connectors and Switchcraft or ITT Cannon connectors can be purchased from the factory as a kit for RS232 configurations. Other cable and connector combinations can be fabricated using user supplied, multiconductor wire and connectors per the following pin function tables. Minimum 26 AWG wire is recommended.

5.2.2 RS485 Cables. The RS485 configuration requires six conductors two for signal in, two for signal out, one for power positive, and one for power negative. The user can fabricate similar telephone type cable and modular connectors for RS485 configurations. This configuration uses eight conductor RJ45 plugs and sockets and cable such as Alpha

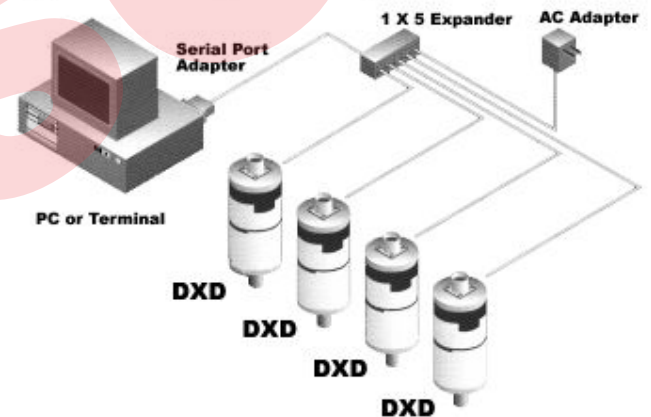
9314C 24 AWG. Other cables and connector combinations can be fabricated using user supplied, multiconductor wire and connectors. Minimum 26 AWG wire is recommended.

5.2.3 Cable length and transmission speed. Total cable length, wire gage and total number of transducers connected to the system have an effect on maximum communication speed. This is due to the effects of cumulative resistance and capacitance on the signals. The tables in appendix B illustrate the relationship between cable length, number of DXD transducers and communication speed.

5.2.4 Transducer Connectors. The DXD is available with a standard Switchcraft EN3 electrical connector or an optional ITT Cannon KPT03 (Bendix PTX compatible) electrical connector. Both configurations operate in full duplex (simultaneous send and receive) mode.

5.3 Installation Wiring for RS232 Systems with Accessory Kit

Typical RS232 System Configuration



5.3.1 Pin Functions and Cable Fabrication for RS232 Compatible Systems

The following information is provided for reference if you wish to fabricate your own cables. The Switchcraft EN3 connector has eight pins. The RS232 configuration utilizes four pins with the following assignments and functions:

Table 1. Switchcraft EN3 Pin Assignments for RS232 Configuration.

SWITCHCRAFT CONNECTOR PIN ID.	PIN FUNCTION FOR RS-232 APPLICATION
1	NA
2	SUPPLY (+)
3	NA
4	DIGITAL OUTPUT
5	NA
6	DIGITAL INPUT
7	SUPPLY COMMON
8	NA

IMPORTANT:
REQUIRES USE OF SERIAL PORT CONVERTER, (PART #629009-01) FOR RS-232 FUNCTIONALITY.

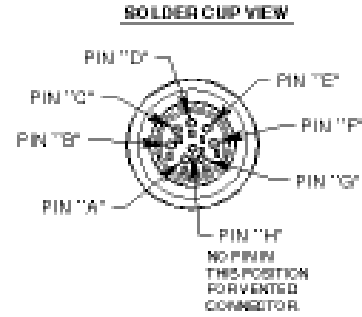


Table 3. RJ11 Connector Functions for RS232 Systems

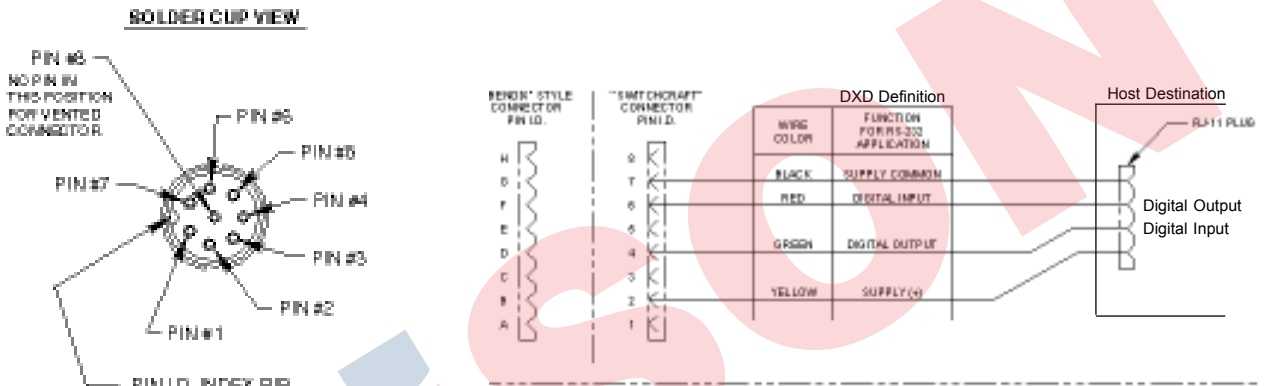
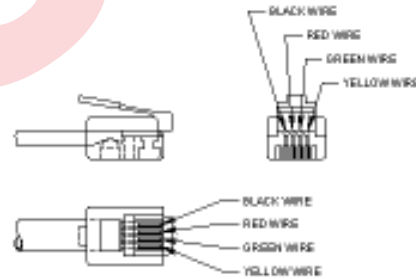


Table 2. ITT Cannon KPT03 Pin Assignments for RS232 Configuration.

BENDIX STYLE CONNECTOR PIN ID.	PIN FUNCTION FOR RS-232 APPLICATION
A	NA
B	SUPPLY (+)
C	NA
D	DIGITAL OUTPUT
E	NA
F	DIGITAL INPUT
G	SUPPLY COMMON
H	NA

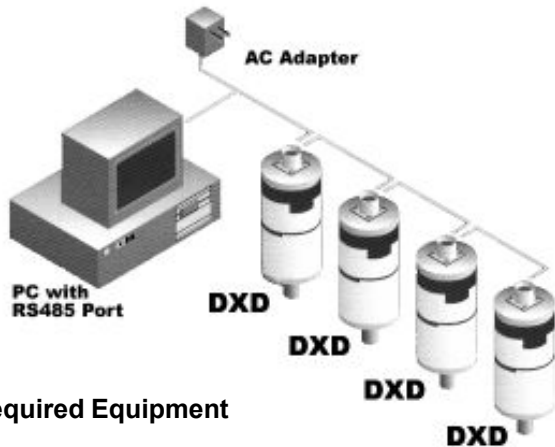
IMPORTANT:
REQUIRES USE OF SERIAL PORT CONVERTER, (PART #629009-01) FOR RS-232 FUNCTIONALITY.



RS232 CUSTOMER CONNECTOR WIRE COLOR & CONNECTOR PIN FUNCTION DETAIL

5.4 Wiring Installation for RS485 Systems

Typical RS485 System Configuration



Required Equipment

RS485 card. A full duplex RS485 card is required for setting up an RS485 system. This type of card is available from a wide variety of manufactures. Factory experience is limited to National Instruments P/N AT485/2 although any fully compliant card should work. An RS485 system can also be connected to a standard RS232 port using a powered RS232 to 485 adapter such as those supplied by Black Box (model 485PS).

Power supply. A DC power supply capable of providing 12 to 24 VDC and 15mA per transducer is required.

Wiring: According to the RS485 standard six conductor, shielded, twisted pair 24 AWG is recommended for interconnecting RS485 systems. However, modular telephone cable and hardware (RJ45 six conductor) can be employed depending on the application (distance, EMI, RFI, speed). Daisy chain interconnection is recommended with minimum drop lengths. See RS485 schematic, appendix C.

5.4.1 Pin Functions and Cable Fabrication for RS485 Compatible Systems

Connectors: The DXD is supplied with either Switchcraft or Cannon (Bendix Compatible) connectors as specified at time of purchase. The pin identification and assignments are shown in Tables 4 and 5.

Table 4. Switchcraft EN3 Pin Assignments for RS485 Configuration

SWITCHCRAFT CONNECTOR PIN I.D.	PIN FUNCTION FOR RS485 APPLICATION
1	+5V (OUT)
2	SUPPLY (+)
3	TXD+
4	TXD-
5	RXD+
6	RXD-
7	SUPPLY COMMON
8	N/A

SOLDER CUP VIEW

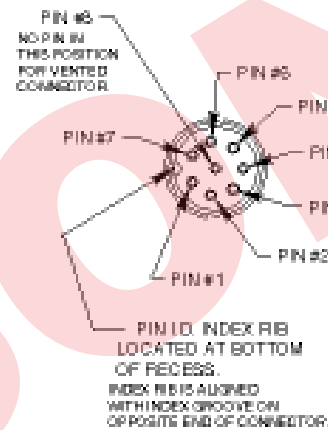
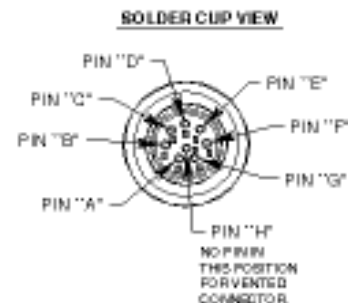


Table 5. ITT Cannon - Bendix Compatible Pin Assignments for RS485 Operation

"BENDIX" STYLE CONNECTOR PIN I.D.	PIN FUNCTION FOR RS485 APPLICATION
A	+5V (OUT)
B	SUPPLY (+)
C	TXD+
D	TXD-
E	RXD+
F	RXD-
G	SUPPLY COMMON
H	N/A

SOLDER CUP VIEW



Section 6.0 Installing and Running Utility Software

Computer Requirements. A Pentium class PC is recommended to take full advantage of the high speed capabilities of the DXD digital pressure transducer, however, any PC capable of running Windows 95 can be used.

Software. Three Disks and/or a CD rom are available for the DXD transducer that provide a program called DXDSetup. This optional software provides an easy means of setting up the user configurable features of the DXD along with data logging and display capabilities. It includes an "OCX" compatible com driver which can be utilized through Active X compliant software. See the software supplement for details.

Section 7.0 Using Hyperterminal with the DXD

Windows 95 includes a utility terminal emulation program called Hyperterminal. Hyperterminal can be used to communicate with the DXD in order to setup user preferences such as address, label, etc. and to read pressure. The following section will guide you through the steps required to accomplish this. This tutorial in DXD command structure can also be used with the Windows 3.1 Terminal.exe application or any terminal emulation software provided you are familiar with the setup characteristics of those programs. The command syntax illustrated in the following section will familiarize you with how they are implemented if you wish to write your own software.

Basic Setup Information

Each DXD transducer is configured for address value 01 and bit rate 19,200 bits per second as shipped from the factory. These values can be changed, however, the following instructions assume that you are using the DXD in the factory configuration.

Signal and Power Connections

Make all electrical and power connections as described in Section 5.0. **IMPORTANT: Be sure to connect only one DXD until you are familiar with its addressing conventions.**

7.1 Configuring HyperTerminal

The Hyperterminal application prompts you through the process of setting up communication parameters that include assigning a file name and icon and setting the com port, data format, bps (bit per sec-

ond). After this is done, you can save the configuration using a name like "DXD" and simply open it by name without need to re-configure it each time it is used. This application will work with RS232 ports, RS232 ports with a RS232 to RS485 adapter, or an RS485 port.

1. Click the start button on the task bar and drag up to Run...
2. Type hypertrm in the text box and click OK. This will launch the Hyperterminal configuration program.
3. You will be prompted for a name so use something easy to remember like DXD. Type the name and select an icon. Click on the OK button.
4. The next box will prompt you for a phone number. Pull down the Connect using: box and choose the appropriate com port and click OK (a phone number isn't utilized in this type of setup).
5. Next you will be prompted for com port setup which should be configured as follows: Bits per second: 19200, Data bits: 7, Parity: Even, Stop bits: 1, Flow control: None.
6. Next click on the settings tab and click on ASCII setup button.
7. Click in the check boxes labeled Send line ends with line feeds and Echo typed characters locally. Click OK to close this box and OK to close the next box.
8. You have now configured HyperTerminal to communicate with the DXD. Open the File drop box in the upper left hand corner of the window and select save. This will save the com port configuration for later use.
9. Open the File drop box in the upper left hand corner of the HyperTerminal window and select Exit. You will be prompted by an alert message stating that you are currently connected and asking if you want to terminate now. Click Yes and HyperTerminal will close.

7.2 Basic Communications with the DXD

The command library in Section 9 contains a detailed description of all of the DXD commands, responses and data formats. It also outlines the command syntax required to read from or write to the DXD. The following section describes how to use these commands via HyperTerminal.

7.2.1 Communication and Command Basics

There are some basic conventions and characteristics which must be observed in order to communicate with the DXD.

- The data format is 7 data bits, 1 stop bit, even parity
- All commands are prefaced with the pound sign character (#, ASCII 35) which serves as an attention character.
- All responses are alphanumeric and include a carriage return (CR) and line feed (LF) ASCII 13 and 10.
- The pound sign is followed by a two character numeric address (01 through 99). Note that with one DXD connected you can substitute a double asterisk (*, ASCII 42) if you don't know the current address value.
- The DXD has two categories of commands which are read (get data from) or write (send data to) the DXD. All read commands are issued as uppercase characters and corresponding write commands are issued using lower case characters followed by the data to be written.
- The format of data used in write commands is critical so please review the command library if you encounter problems in the following section.
- NOTE: The [CR] in the following examples means hit the enter key. A carriage return (ASCII13) is required to terminate a read or write command.

7.3 Launching the Previously Configured HyperTerminal Application

1. Ensure that only one DXD is connected to the computer and that power is applied.
2. Click the Start button on the task bar, select programs, then accessories and then click on HyperTerminal. This will open a folder on the desk top that contains the HyperTerminal setup you created in the preceding section. Double click the file icon to launch HyperTerminal. When the program opens it will be properly configured to communicate with the DXD set to its factory defaults.

7.4 Talking to the DXD with HyperTerminal

7.4.1 Determine and Set the Current Address

The value retrieved with the AD (Address) command is comprised of 7 alphanumeric characters (including CR/LF) that can be modified by the user to set a desired address value. The address value of the DXD is user configurable and the default factory value is 01.

Note: There may be circumstances where the address is unknown. To simplify the task of determining the current address setting, the DXD can recognize a "wild card" value comprised of double asterisks (**). Substitute it in the address position of a read command. For example, #01AD can be sent as #**AD (provided only one DXD is connected to the system).

1. To determine the DXD's current address type the following command:
#**AD[CR]
2. The DXD will respond with the following message:
AD=01 indicating that the address is currently configured to the value 01.
3. To change the DXD's address from 01 to 02 type the following command:
#01ad02[CR]
4. To verify that the address has been changed, send the following command:
#**AD[CR]
5. The DXD will respond with the following message:
AD=02
6. To change the DXD's address back to 01 type the following command:
#01ad01[CR]
7. To verify that the address has been changed, type the following command:
#01AD[CR]
8. The DXD will respond with the following message:
AD=01

7.4.2 Determine and Set Baud Rate

The value retrieved with the BR (Baud Rate) command is comprised of 11 alphanumeric characters (including CR/LF) which can be modified by the user to set the desired system baud rate.

1. To read the current baud rate, type the following

command in the HyperTerminal window:

```
#01BR[CR]
```

2. The DXD will respond with the following message:
BR= 19200

3. To change the current baud rate you first must change the DXD's setting then change the com port setting for HyperTerminal. To change the DXD baud rate from 19200 to 9600, type the following command:

```
#01br= 9600[CR]
```

4. You will be unable to communicate with the DXD until the com port settings are changed in HyperTerminal.

5. To do this click the File button and select Properties. Click on "Configure" then click the arrow box next to Bits per Second then select 9600. Click OK for the com properties box and OK for the file properties box.

6. Next click on the Call button and select Disconnect then Connect (this activates any changes made to HyperTerminal's communications properties).

7. To read the revised baud rate, type the following command:

```
#01BR[CR]
```

8. The DXD will respond with the following message:
BR= 9600

9. To change the baud rate back to 19200 type the following command:

```
#01br=19200[CR]
```

10. Remember that you will be unable to communicate with the DXD until the com port settings are changed in HyperTerminal.

11. To do this click the File button and select Properties. Click on "Configure" then click the arrow box next to Bits per Second then select 19200. Click OK for the com properties box and OK for the file properties box.

12. Next click on the Call button and select Disconnect then Connect (this activates any changes made to HyperTerminal's communications properties).

13. To read the revised baud rate, type the following command:

```
#01BR[CR]
```

14. The DXD will respond with the following message:

```
BR= 19200
```

7.4.3 Determine the Pressure Type

1. The value retrieved with the PT (Pressure Type) command is the pressure type of the unit. It is comprised of 6 alpha numeric characters (including CR/LF) and specifies the pressure type of the transducer. It is assigned during manufacturing and can not be changed. To read the pressure type (gauge, absolute, vacuum, compound), type the following command:
#01PT [CR]

2. The DXD will respond by transmitting the following message to the Hyper Terminal window.

```
PT=G (G for Gauge, A for absolute, V for vacuum, C for compound)
```

7.4.4 Determine the Full Scale Pressure Range

1. The value retrieved with the FS (Full Scale) command is the fullscale pressure range of the unit. It is comprised of 13 alpha numeric characters (including CR/LF) and specifies the pressure range of the transducer. It is assigned during manufacturing and can not be changed. To read the current FS value, type the following command in the Hyper Terminal window:
#01FS [CR]

2. The DXD will respond by transmitting the following message to the Hyper Terminal window.

```
FS=+030.000 (Note that the decimal position is range dependent see Appendix A for details)
```

7.4.5 Get a Pressure Reading

1. To read the current pressure in PSI, type the following command in the Hyper Terminal window:
#01PS [CR] (or ##PS[CR])

2. The DXD will respond by transmitting the following message to the Hyper Terminal window.

```
PS=+000.000 (or the value of the existing pressure)
```

7.4.6 Get the Heise Label

1. The value retrieved with the HL (Heise Label) command is the serial number assigned to the unit during manufacturing and can not be changed. To read the value stored in the HL location, type the following command:

```
#01HL[CR]
```

2. The DXD will respond by transmitting the following message:
HL=000XXX (where X represents your DXD's actual serial number)

7.4.7 Get and Change the Current User Label

1. The value retrieved with the UL (User Label) command is comprised of up to 16 alphanumeric characters which can be modified by the user to form a descriptive tag or identification name. To read the current user label value, type the following command:
#01UL[CR]

2. The DXD will respond by transmitting the following message:
UL=User Label Here (this is the factory default value)

3. To change the current user label to "Test Point 01", type the following command:
#01ulTest Point 01[CR]

7.4.8 Get and Change the Current User Tare Value

1. The value retrieved with the UT (User Tare) command is comprised of 11 alphanumeric characters which can be modified by the user to remove or "tare out" a pressure preload from the displayed pressure value. To read the current user tare value, type the following command:
#01UT[CR]

2. The DXD will respond by transmitting the following message:
UT=+000.000 (note: This is the factory default value and that the decimal position will depend on the full scale range of the unit)

3. To change the current user tare to 1 PSI, type the following command:
#01ut+001.000[CR]

Section 8.0 Field Calibration

Calibration adjustments on the DXD are limited to adjusting zero and span. A high precision primary standard (50 ppm or better) is required for the span adjustment on gauge, vacuum and compound pressure types and a precision absolute standard is required for absolute pressure types

8.1 Zero Adjustment

1. Zero adjustment. This example will guide you through the process of adjusting zero for a gauge, compound or vacuum pressure type unit. Absolute pressure types require that you connect the DXD to a vacuum source capable of achieving 0.05 torr for ranges from 15 to 50 PSIA or .5 torr for ranges from 60 to 500 PSIA.

2. Be sure that the DXD is at zero pressure (vented to atmosphere for gauge, vacuum or compound pressure types) or full vacuum for absolute pressure types.

3. Send the following command: #01uz+000.000[CR]. This will reset the user zero offset value to zero.

4. Send the following command: #01PS and note the result which will be something like PS=+000.002

5. Send the opposite sign of the PS value received in step 4 above (-000.002) with the following command: #01uz-000.002 [CR]

6. Confirm that the zero adjustment is complete by sending the following command: #01PS[CR] which should result in a display of PS=+000.000

8.2 Span Adjustment

1. This procedure requires a primary pressure standard of suitable accuracy. The following example is based on a DXD with a full span rating of 30 PSI. The value that will be adjusted is US (user span).

2. The first step is to connect the transducer to a pressure standard and apply full span pressure (30 PSI in this example).

3. Next, retrieve the current pressure reading by sending the following command: #01PS[CR]

4. The result will be something like this: PS=+030.002

5. Next retrieve the current value of user span (US)

by sending the following command: #01US[CR]

6. Next calculate the new value for US by dividing the known pressure generated with the pressure standard by the displayed value, for example, $30 / 30.002 = 0.99993$.

7. Multiply the current US value retrieved in step 5 by 0.99993 to calculate the new US value.

8. To write the new US value to the DXD, send the following command: #01uz+0.99993[CR]

9. Confirm that the span has been properly adjusted by applying full span pressure and retrieving the current pressure reading with the following command: #01PS[CR]

10. The result should be PS=+030.000 ($\pm 0.005\%$ of full span). If not, repeat steps 3 through 9 as required.

Section 9.0 DXD Command Library

The DXD digital pressure transducer employs a simple ASCII character based protocol for communications. A DXD UNIT cannot initiate this communication process. A host device, i.e. a computer, terminal or PLC device must be used to initiate communications by querying the DXD. Multiple DXD's on the same communication bus are addressed sequentially so each unit must have a unique, two digit address between 01 and 99.

For applications where only one DXD is on the communications bus, wildcard characters "***" (double asterisks) can be used to address a single unit. **Note: When using wildcard addressing for communications care should be taken to ensure only one unit is being addressed. To avoid problems that may arise from it's use, wildcard addressing should be used primarily for testing or troubleshooting purposes.**

Commands issued to a DXD UNIT can be classified as one of two types.

1. Read Commands: These always return a value
2. Write Commands: Normally do not return a value, however, if the command issued syntax is incorrect an error code value will be returned (see error codes section 9.3).

9.1 Communications Settings

The DXD Transducer uses the following communications settings

Bits Per Second Rates: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200

Data Bits: 7
Stop Bits: 1
Parity: Even
Flow Control: None

9.2 Communications Protocol

9.21 Read Commands

Each read command is initiated with a pound sign (#, ASCII 35). Following the pound sign is a two character numeric address (from 01 to 99). The address is followed by a two character, upper case alpha command mnemonic representing the command being issued. A carriage return (ASCII 13) is used to terminate the command.

9.22 Write Commands

Each write command is initiated with a pound sign (#, ASCII 35). Following the pound sign is a two character numeric address (from 01 to 99). The address is followed by a two character, lower case alpha command mnemonic representing the command being issued. Following the mnemonic is the value to be written. A carriage return (ASCII 13) is used to terminate the command. there is usually an input value to set.

Start Character	DXD Address	Command Mnemonic	Input Value (for write only)	Termination Character
#	01 through 99	2 Character Alpha	Alphanumeric	CR

Example 1. Read pressure command: #01PS[CR]

This command is directed to DXD UNIT address '01' and a PSI pressure reading is being requested.

Example 2. Write Command: #01uUNIT 100[CR]

This command is directed to DXD UNIT address '01' and it's User Label is being set to UNIT 100.

9.3 Command Library Mnemonics

The same command mnemonic is used for both read and write functions. The distinction between read and write commands is that read commands use uppercase characters and all write commands use lowercase characters.

AD UNIT ADDRESS

Command Description: Reads or writes the DXD Unit's address (valid address values are from 01 through 99)

Command Type: Dual (READ/WRITE) Command

Read Command Syntax: #01AD[CR]

Typical Read Command Response: The DXD transmits the address as a 7-Character string as shown below.

Char. Position	1	2	3	4	5	6	7
Response Char	A	D	=	0	1	CR	LF

Write Command Syntax: #01ad03[CR]

Typical Write Command Response: None

BR BAUD RATE

Command Description: Reads or writes the DXD Unit's Bits Per Second Rate. Valid Baud Rate values include: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200

Command Type: Dual (READ/WRITE) Command

Read Command Syntax: #01BR[CR]

Typical Read Command Response: The DXD transmits the Bits Per Second Rate as a 11-Character string as shown below.

Char. Position	1	2	3	4	5	6	7	8	9	10	11
Response Char.	B	R	=			9	6	0	0	CR	LF

Write Command Syntax #01br38400[CR]

Typical Write Command Response: None

ED EEPROM MEMORY MAP DUMP

Command Description: Returns the first 160 bytes of EEPROM memory as decimal values. The values returned are formatted 16 bytes per line with carriage return/line feeds appended at ends.

Command Type: READ Command

Read Command Syntax: #01ED[CR]

Typical Read Command Response: Each line contains 65 characters including CR/LF.

```
005 000 000 000 000 000 001 000 000 000 000 000 000 000 000 003 006[CR][LF]
003 000 000 032 000 000 128 000 000 089 000 000 000 000 000 007[CR][LF]
003 000 000 064 002 000 128 000 000 089 000 000 000 000 000 007[CR][LF]
000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 025[CR][LF]
000 000 000 000 000 000 000 000 016 000 000 000 000 000 000 000[CR][LF]
000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000[CR][LF]
000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000[CR][LF]
000 000 000 000 000 001 000 000 000 000 039 016 002 000 000 093[CR][LF]
000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000[CR][LF]
000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000[CR][LF]
```


ER READ FROM EEPROM ADDRESS

Command Description: Returns a specified EEPROM location's value in decimal format, as a 3 digit value ranging from 000 to 255.

Command Type: READ Only Command

Read Command Syntax: #01ER005[CR]Read from EE location 005

Typical Read Command Response: Displays the EEPROM location contents as a 5-character string as shown below:

Char. Position	1	2	3	4	5
Response Char.	0	0	1	CR	LF

EW WRITE TO EEPROM ADDRESS

Command Description: Writes a value to the current EEPROM address. The current EEPROM address is set using the ER command above. To change an EEPROM address content the ER and EW commands must be used in conjunction with each other. The ew command sets a flag to cause the pressure and temperature coefficients to be reloaded from the EEPROM to RAM.

Command Type: Write Only Command

Write Command Syntax: #01ew005[CR]Write "005", to current EE location.

Typical Write Command Response: Echoes back the characters written as 5-character string shown below.

Char. Position	1	2	3	4	5
Response Char.	0	0	5	CR	LF

IMPORTANT NOTE: This command echoes back the characters written. This is the only write command that always sends back a response. All other write commands only send back a response in cases of an error. Valid values for writing to the EEPROM using the "EW" command are 3 character decimal values, 000 through 255.

FS FULL SCALE VALUE

Command Description: Returns the unit's full scale pressure rating value

Command Type: READ Only Command

Read Command Syntax: #01FS[CR]

Typical Read Command Response: Outputs the Full Scale Value as a 13-character string as shown below.

Char. Position	1	2	3	4	5	6	7	8	9	10	11	12	13
Response Char.	F	S	=	+	0	1	0	0	.	0	0	CR	LF

FV FIRMWARE VERSION

Command Description: Returns the unit's current Firmware version.

Command Type: READ Only Command

Read Command Syntax #01FV[CR]

Typical Read Command Response: Outputs the Full Scale Value as a 7-character string as shown below.

Char. Position	1	2	3	4	5	6	7
Response Char.	V	2	.	1	5	CR	LF

HL HEISE LABEL (SERIAL NUMBER)

Command Description: Returns the unit's Heise Label

Command Type: READ Only Command

Read Command Syntax: #01HL[CR]

Typical Read Command Response: Outputs the Heise Label as a 11-character string as shown below

Char. Position	1	2	3	4	5	6	7	8	9	10	11
Response Char.	H	L	=	0	0	0	3	0	4	CR	LF

PS PSI READING

Command Description: Returns the unit's current pressure reading in PSI.

Command Type: READ Only Command

Read Command Syntax: #01PS[CR]

Typical Read Command Response: Outputs the PSI Reading as a 13-character string as shown below

Char. Position	1	2	3	4	5	6	7	8	9	10	11	12	13
Response Char.	P	S	=	+	0	0	0	1	.	0	2	CR	LF

PT PRESSURE TYPE

Command Description: Returns the unit's Pressure Type as a single character alpha value. Valid Pressure Type values returned by the PT command include A for Absolute, C for Compound, G for Gauge, and V for Vacuum.

Command Type: READ Only Command

Read Command Syntax: #01PT[CR]

Typical Read Command Response: Outputs the Pressure Type as a 6-character string as shown below.

Char. Position	1	2	3	4	5	6
Response Char.	P	T	=	G	CR	LF

RC RAW COUNTS

Command Description: Returns the unit's raw ADC values, calculated temperature feedback signal, and the corrected pressure and corrected temperature values.

Command Type: READ Only Command

Read Command Syntax: #01RC[CR]

Typical Read Command Response: Outputs the Raw Counts as a 54-Character string as shown below.

Char. Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Response Char.	V	P	=	-	0	0	0	0	4	9		V	I	=	+	0	4	4
Char. Position	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Response Char.	1	9	2		V	B	=	+	0	0	0	2	2	9		P	=	+
Char. Position	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Response Char.	0	0	0	0	0	4		T	=	+	0	0	2	1	7	3	CR	LF

ST SENSOR TEMPERATURE

Command Description: Returns the unit's current temperature reading in °C

Command Type: READ Only Command

Read Command Syntax: #01ST[CR]

Typical Read Command Response: Outputs the Sensor Temperature Reading as a 13-Character string as shown below.

Char. Position	1	2	3	4	5	6	7	8	9	10	11	12	13
Response Char.	S	T	=	+	0	0	2	.	1	4	2	CR	LF

UL USER LABEL

Command Description Reads or writes the DXD Unit's Alpha Numeric User Label. The User Label string for the Write command must be of a Maximum length 16 characters. Any User Label greater than 16 characters entered to be written is ignored. If the User Label written is less than 16 characters then trailing space (SPC), characters are appended to the User Label written to memory and hence returned by the UL read command.

Command Type: Dual (READ/WRITE) Command

Read Command Syntax: #01UL[CR]

Typical Read Command Response: Output's the User Label Setting as a 18-Character string as shown below.

Char. Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Response Char.	D	X	D		T	r	a	n	s	d	u	c	e	r		1	CR	LF

Write Command Syntax: #01ulDXD Transducer 2[CR]

Typical Write Command Response: *None*

US USER SPAN

Command Description: Reads or writes the DXD's user span value. The User Span value to write to the device has to be in exactly in the same format as shown below, i.e., a 5 decimal point floating point value. The value is determined by applying full span pressure to the DXD and reading the PS output. The US value is determined by dividing the known pressure of the calibration standard by the displayed value (PS)

Command Type: Dual (READ/WRITE) Command

Read Command Syntax: #01US[CR]

Typical Read Command Response: Output's the User Span Value as a 13-Character string as shown below.

Char. Position	1	2	3	4	5	6	7	8	9	10	11	12	13
Response Char.	U	S	=	+	0	.	9	9	9	4	8	CR	LF

Write Command Syntax: #01us1.00004 [CR]

Typical Write Command Response: *None*

UT USER TARE

Command Description: Reads or writes the DXD Unit's User Tare Value. The value written to the device has to be in exactly the same format as returned when the User Tare value is read. The value to be written to Tare out the pressure reading from the Device is the inverse of the current pressure reading from the PS command added to the current User Tare value. For the following example, a User Tare value of +0000.12 would be written to tare a PS reading of -0000.12 if the current User Tare value was +0000.00.

Command Type: Dual (READ/WRITE) Command

Read Command Syntax: #01UT[CR]

Typical Read Command Response: Output's the User Tare Value as a 13-Character string as shown below.

Char. Position	1	2	3	4	5	6	7	8	9	10	11	12	13
Response Char.	U	T	=	+	0	0	0	0	.	0	0	CR	LF

Write Command Syntax: #01ut+0000.12[CR]

Typical Write Command Response: *None*

UZ USER ZERO

Command Description: Reads or writes the DXD's User Zero value. The value written to the device has to be in exactly the same format as returned when the User Zero value is read. The value to be written to zero out the pressure reading from the device is the inverse of the current pressure reading from the PS command added to the current User Zero value. For the following example a User Zero value of +0000.12 would be written to Zero a PS reading of -0000.12 if the current User Zero value was +0000.00. The DXD can also be zeroed by first writing a value of zero to UZ then getting the PS value and writing the inverse of the PS value to UZ.

Command Type: Dual (READ/WRITE) Command

Read Command Syntax: #01UZ[CR]

Typical Read Command Response: Output's the User Zero Value as a 13-Character string as shown above.

Char. Position	1	2	3	4	5	6	7	8	9	10	11	12	13
Response Char.	U	Z	=	+	0	0	0	0	.	0	0	CR	LF

Write Command Syntax: #01uz+0000.12[CR]

Typical Write Command Response: *None*

ERROR CODES

The DXD Transducer will return error codes in certain situations for example, where a user issues an incorrect command syntax, and when measurement values are out of specifications due to sensor damage, electrical problems, etc. The following list includes all error responses and their meanings.

- Err01* ADC no response within 300 ms.
- Err02* EEPROM write error. Write timeout set to 20 ms.
- Err03* Incorrect numerical format for command.
- Err04* Calculated pressure output over range (approximately 5% of full span).
- Err05* ADC over range, could be either channel 1 or channel 2.
- Err06* Bad pressure type value.
- Err07* Illegal scale factor could be either channel 1 or channel 2.
- Err08* ADC Reference Voltage Unstable or Not Present.

Error codes in the message string

Using error code 04 (over range)for an example, if the DXD is subjected to a pressure greater than 5% of it's full span rating and pressure is requested using the PS command "Err04[CR][LF] will be appended to the data string for as long as the error condition exists as shown below. If more than one error condition occurs it will be appended to the preceding error as shown below.

Char. Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Response Char.	P	S	=	+	0	0	0	1	.	0	2	CR	LF	E	r	r	0	4	CR	LF

Section 10.0 DXD Command Summary

10.1 Read Command Summary

Cmd	Description	Syntax	Response	String Length (Includes CR/LF)
AD	Read Address	#01AD[CR]	AD=01[CR][LF]	7
BR	Bit Per Second Rate	#01BR[CR]	BR= 19200[CR][LF]	11
ED	EEPROM Dump	#01ED[CR]	1 st 160 Bytes of EEPROM Mem	65 X 10 lines*
ER	Read from EE	#01ER005[CR]	010[CR][LF]	5
FS	Full Scale Value	#01FS[CR]	FS=+0250.00[CR][LF]	13
FV	Firmware Version	#01FV[CR]	V2.15[CR][LF]	7
HL	Heise Label	#01HL[CR]	HL=000304[CR][LF]	11
PS	PSI Reading	#01PS[CR]	PS=+000.040[CR][LF]	13
PT	Pressure Type	#01PT[CR]	PT=V[CR][LF]	6
RC	Raw Counts	#01RC[CR]		54
ST	Sensor Temperature	#01ST[CR]	ST=+002.142[CR][LF]	13
UL	User Label	#01UL[CR]	UL=DEMO[CR][LF]	18
US	User Span	#01US[CR]	US=+1.00001[CR][LF]	13
UT	User Tare	#01UT[CR]	UT=+0000.00[CR][LF]	13
UZ	User Zero	#01UZ[CR]	UZ=-0000.01[CR][LF]	13

10.2 Write Command Summary

Cmd	Description	Syntax	Response
ad	Write Address	#01ad05[CR]	None
br	Bit Per Second Rate	#01br38400[CR]	None
ew	Write to EE	#01ew005[CR]	005[CR][LF]
ez	Initialize EEPROM	#01ez[CR]	None
ul	User Label	#01ulDXD 1[CR]	None
us	User Span	#01us0.99996[CR]	None
ut	User Tare	#01ut+0001.00[CR]	None
uz	User Zero	#01uz+0000.01[CR]	None

10.3 Error Code Summary

Code	Description
Err01	ADC No Response within 300 ms
Err02	EEPROM write error
Err03	Incorrect numerical format for command
Err04	Calculated output over range
Err05	ADC over range. Either channel 1 or 2.
Err06	Bad Pressure Type value
Err07	Illegal scale factor. Either channel 1 or 2
Err08	ADC Reference Voltage Unstable or Not Present.

* Data presented in decimal format

Section 11.0 DXD Product Specification

Accuracy: ±0.02% F.S. total error band from 10°-30°C (50°-86°F)
 ±0.04% F.S. 0°-50°C (32°-122°F)
 ±0.05% F.S. -10°-70°C (14°-158°F)

Temperature Effects:

Corrected: -10 to 70°C (14 to 158°F)
 Operating: -10 to 70°C (14 to 158°F)
 Storage: -40 to 80°C (-40 to 176°F)

Update Rate: from 12.6mS or 27.7mS processing time for fully corrected pressure information.

Turnaround Time: 15 mS or 30mS @ 115.2k baud

Resolution: 1 part in 50,000 maximum (range dependent)

Signal Stability: ±1 count in 50,000 counts @ 27.7 mS update rate, ±3 counts in 50,000 counts @ 12.6 mS update rate.

Functional Characteristics

Sensor Type: Piezo resistive strain gauge

Pressure Ranges:

0/5	0/100
0/10	0/150
0/15	0/200
0/20	0/250
0/30	0/300
0/50	0/500
0/60	0/1000

Overpressure Capability:

0/5 psi through 1000 psi: 2X range
 Above 1000 psi: 1.5X range

Pressure Types: Gauge, absolute, vacuum and compound.

Pressure Inlet Type:

Standard – 1/4NPTM 0/5 to 0/1000 psi
 Optional – VCR, MS-33656-4

Housing Dimensions: 1.5. x 5.78.
 cylindrical

Housing Materials: 304 stainless steel

Wetted Materials: 316 stainless steel

Electrical Connector: Standard – Switchcraft EN3 8 pin weather-tight connector. Optional – ITTCannon KPT03 (Bendix PT07 compatible).

Power Requirement: 12 to 24 Vdc 15mA maximum

A/D Resolution: 23 bit plus sign Sigma/Delta internally reduced to 50,000 counts.

Output Signal: ASCII digital

Output Electrical: RS485 full duplex – asynchronous serial interface up to 32 units or RS232 full duplex – asynchronous serial interface up to 99 units. 9 pin “D” type Com port adapter included.

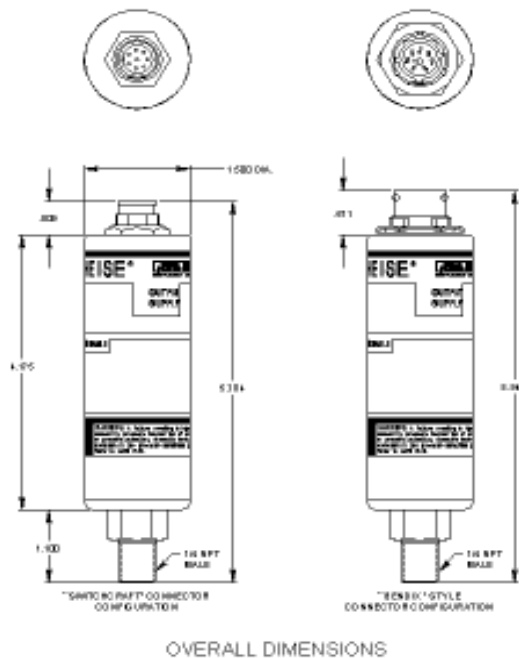
ASCII Data Format: 7 data bits, 1 stop bit, even parity

BPS: 1200, 2400, 4800, 9600, 19.2K, 38.4k, 57.6k, 115.2k

User Accessible Features:

- Address
- BPS Select
- Zero
- Span
- Tare
- Pressure Type (G, A, V, C)
- User Label
- Error Flag
- Wild Card Address
- PSI Reading
- Serial Number
- A/D Filter
- Full Scale Value
- Firmware Revision I.D.

General Dimensions (inches)



OVERALL DIMENSIONS

Appendix A - Resolution by Pressure Range

RANGES & PRESSURE TYPES:

GAUGE (PSI)	ABSOLUTE (PSI)	VACUUM (PSI)	COMPOUND (PSI)
05.0000			
010.000	010.000	010.000	-010.000/+010.000
015.000	015.000	015.000	-015.000/+015.000
020.000	020.000		-015.000/+030.000
025.000	025.000		-0015.00/+0060.00
030.000	030.000		
050.000	050.000		
0060.00	0060.00		
0100.00	0100.00		
0150.00	0150.00		
0200.00	0200.00		
0250.00	0250.00		
0300.00	0300.00		
0500.00	0500.00		
00600.0	00600.0		
01000.0	01000.0		

Appendix B - System Performance Response Time

RS-232 COMPATIBLE BUS

BAUD RATE (bps)	NUMBER OF ADDRESSABLE UNITS (AS A FUNCTION OF DISTANCE & BAUD RATE)					
	25 FT.	100 FT.	250 FT.	500 FT.	750 FT.	1000 FT.
1,200 bps	99	99	99	99	99	99
2,400 bps	99	99	99	99	99	99
4,800 bps	99	99	99	99	99	99
9,600 bps	99	99	99	99	99	99
19,200 bps	99	99	99	99	75	50
38,400 bps	85	70	55	40	30	20
57,600 bps	60	40	30	20	10	5
115,200 bps	40	30	20	15		

RS-485 BUS

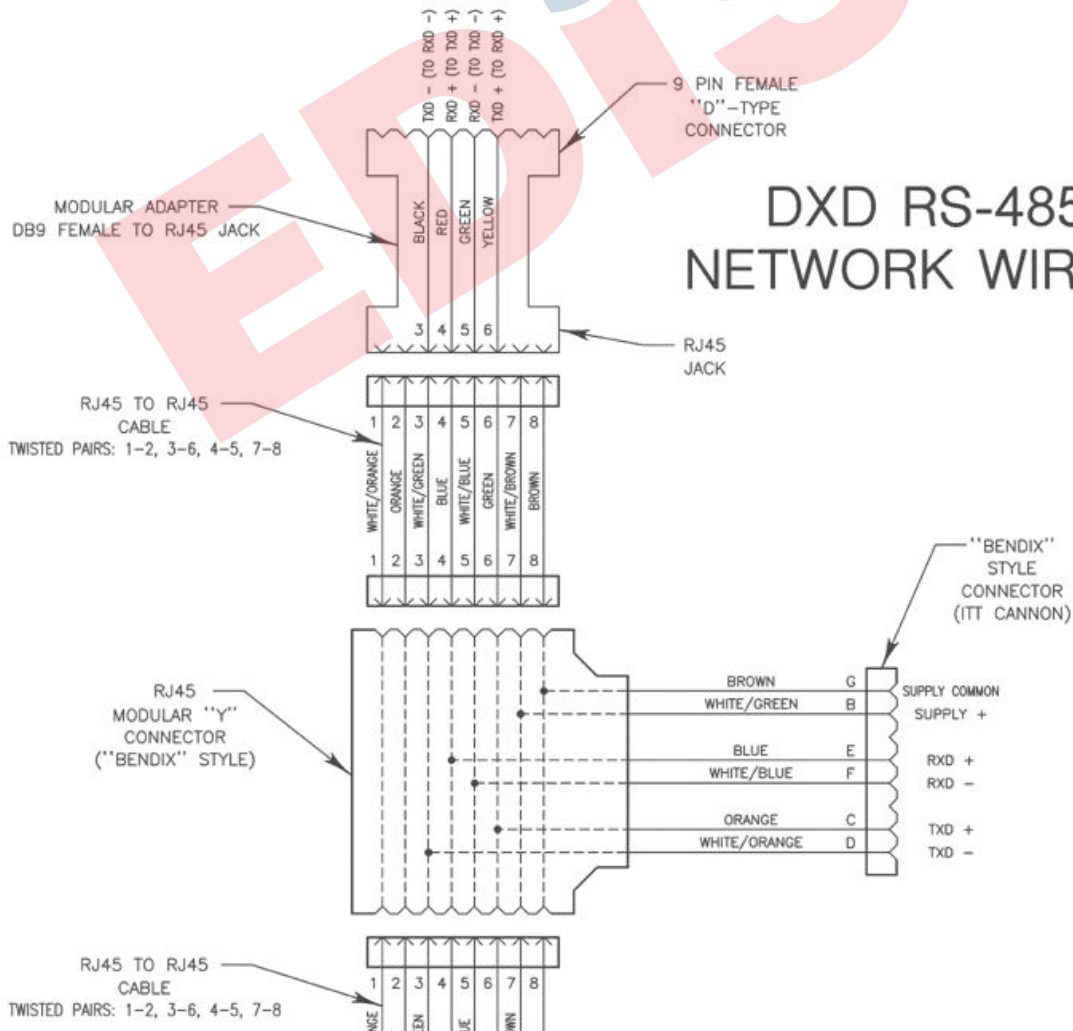
BAUD RATE (bps)	NUMBER OF ADDRESSABLE UNITS (AS A FUNCTION OF DISTANCE & BAUD RATE)										
	25 FT.	100 FT.	250 FT.	500 FT.	750 FT.	1000 FT.	1250 FT.	1500 FT.	2000 FT.	3000 FT.	4000 FT.
1,200 bps	∞	∞	32	32	32	32	∞	∞	∞	32	32
2,400 bps	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
4,800 bps											
9,600 bps											
19,200 bps											
38,400 bps											
57,600 bps	↓	↓	↓	↓	32	32					
115,200 bps	32	32	32	32							

BAUD RATE (bps)	TRANSMIT/RECEIVE *** TIME (ms)	SIGNAL PROCESSING TIME * STANDARD MODE (ms)	TOTAL RESPONSE TIME (ms)
1,200 bps	154.5 ms	27.7 ms	182.2 ms
2,400 bps	77.8 ms	↑	105.5 ms
4,800 bps	39.1 ms		66.8 ms
9,600 bps	19.79 ms		47.49 ms
19,200 bps	9.89 ms		37.59 ms
38,400 bps	5.07 ms		32.77 ms
57,600 bps	3.52 ms	↓	31.22 ms
115,200 bps	1.82 ms	27.7 ms	29.52 ms

CUSTOM CONFIGURATION

BAUD RATE (bps)	TRANSMIT/RECEIVE *** TIME (ms)	SIGNAL PROCESSING TIME ** FAST MODE (ms)	TOTAL RESPONSE TIME (ms)
1,200 bps	154.5 ms	12.6 ms	167.1 ms
2,400 bps	77.8 ms	↑	90.4 ms
4,800 bps	39.1 ms		51.7 ms
9,600 bps	19.79 ms		32.39 ms
19,200 bps	9.89 ms		22.49 ms
38,400 bps	5.07 ms		17.67 ms
57,600 bps	3.52 ms	↓	16.12 ms
115,200 bps	1.82 ms	12.6 ms	14.42 ms

Appendix C - RS485 System Schematic



Appendix D - ASCII Character Code Table

Dec	Binary	Hex	ASCII	Dec	Binary	Hex	ASCII	Dec	Binary	Hex	ASCII	Dec	Binary	Hex	ASCII
0	00000000	00	(NUL)	64	01000000	40	@	128	10000000	80		192	11000000	C0	
1	00000001	01	(SOH)	65	01000001	41	A	129	10000001	81		193	11000001	C1	
2	00000010	02	(STX)	66	01000010	42	B	130	10000010	82		194	11000010	C2	
3	00000011	03	(ETX)	67	01000011	43	C	131	10000011	83		195	11000011	C3	
4	00000100	04	(EOT)	68	01000100	44	D	132	10000100	84		196	11000100	C4	
5	00000101	05	(ENQ)	69	01000101	45	E	133	10000101	85		197	11000101	C5	
6	00000110	06	(ACK)	70	01000110	46	F	134	10000110	86		198	11000110	C6	
7	00000111	07	(BEL)	71	01000111	47	G	135	10000111	87		199	11000111	C7	
8	00001000	08	(BS)	72	01001000	48	H	136	10001000	88		200	11001000	C8	
9	00001001	09	(T)	73	01001001	49	I	137	10001001	89		201	11001001	C9	
10	00001010	0A	(LF)	74	01001010	4A	J	138	10001010	8A		202	11001010	CA	
11	00001011	0B	(VT)	75	01001011	4B	K	139	10001011	8B		203	11001011	CB	
12	00001100	0C	(FF)	76	01001100	4C	L	140	10001100	8C		204	11001100	CC	
13	00001101	0D	(CR)	77	01001101	4D	M	141	10001101	8D		205	11001101	CD	
14	00001110	0E	(SO)	78	01001110	4E	N	142	10001110	8E		206	11001110	CD	
15	00001111	0F	(SI)	79	01001111	4F	O	143	10001111	8F		207	11001111	CF	
16	00010000	10	(DLE)	80	01010000	50	P	144	10010000	90		208	11010000	D0	
17	00010001	11	(DC1)	81	01010001	51	Q	145	10010001	91		209	11010001	D1	
18	00010010	12	(DE2)	82	01010010	52	R	146	10010010	92		210	11010010	D2	
19	00010011	13	(DC3)	83	01010011	53	S	147	10010011	93		211	11000011	D3	
20	00010100	14	(DC4)	84	01010100	54	T	148	10010100	94		212	11010100	D4	
21	00010101	15	(NAK)	85	01010101	55	U	149	10010101	95		213	11010101	D5	
22	00010110	16	(SYN)	86	01010110	56	V	150	10010110	96		214	11010110	D6	
23	00010111	17	(ETB)	87	01010111	57	W	151	10010111	97		215	11010111	D7	
24	00011000	18	(CAN)	88	01011000	58	X	152	10011000	98		216	11011000	D8	
25	00011001	19	(EM)	89	01011001	59	Y	153	10011001	99		217	11011001	D9	
26	00011010	1A	(SUB)	90	01011010	5A	Z	154	10011010	9A		218	11011010	DA	
27	00011011	1B	(ESC)	91	01011011	5B	[155	10011011	9B		219	11011011	DB	
28	00011100	1C	(FS)	92	01011100	5C	\	156	10011100	9C		220	11011100	DC	
29	00011101	1D	(GS)	93	01011101	5D]	157	10011101	9D		221	11011101	DD	
30	00011110	1E	(RS)	94	01011110	5E	^	158	10011110	9E		222	11011110	DE	
31	00011111	1F	(US)	95	01011111	5F	_	159	10011111	9F		223	11011111	DF	
32	00100000	20	(SP)	96	01100000	60	`	160	10100000	A0		224	11100000	E0	
33	00100001	21	!	97	01100001	61	a	161	10100001	A1		225	11100001	E1	
34	00100010	22	"	98	01100010	62	b	162	10100010	A2		226	11100010	E2	
35	00100011	23	#	99	01100011	63	c	163	10100011	A3		227	11100011	E3	
36	00100100	24	\$	100	01100100	64	d	164	10100100	A4		228	11100100	E4	
37	00100101	25	%	101	01100101	65	e	165	10100101	A5		229	11100101	E5	
38	00100110	26	&	102	01100110	66	f	166	10100110	A6		230	11100110	E6	
39	00100111	27	'	103	01100111	67	g	167	10100111	A7		231	11100111	E7	
40	00101000	28	(104	01101000	68	h	168	10101000	A8		232	11101000	E8	
41	00101001	29)	105	01101001	69	i	169	10101001	A9		233	11101001	E9	
42	00101010	2A	*	106	01101010	6A	j	170	10101010	AA		234	11101010	EA	
43	00101011	2B	+	107	01101011	6B	k	171	10101011	AB		235	11101011	EB	
44	00101100	2C	,	108	01101100	6C	l	172	10101100	AC		236	11101100	EC	
45	00101101	2D	-	109	01101101	6D	m	173	10101101	AD		237	11101101	ED	
46	00101110	2E	.	110	01101110	6E	n	174	10101110	AE		238	11101110	EE	
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Appendix D - Warranty and Limitation of Liability

All Heise Products and Parts carry a warranty against defective material and workmanship for a period of one (1) year from date of shipment.

A. Seller warrants that its products and parts, when shipped, and its work (including installation, construction and start up), when performed, will meet all applicable specifications and other specific product and work requirements (including those of performance), if any, of this agreement, will be of good quality and will be free from defects in material and workmanship. All claims under this warranty must be made in writing immediately upon discovery and, in any event, within one (1) year from shipment of the applicable item unless Seller specifically assumes installation, construction or start-up responsibility. All claims when Seller specifically assumes installation, construction or start up responsibility, must be made in writing immediately upon discovery and, in any event, within one (1) year from completion of the applicable work by Seller, provided, however all claims must be made in writing no later than eighteen (18) months after shipment. Defective items must be held for Seller's inspection and returned to the original f.o.b. point upon request. THE FOREGOING IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES WHATSOEVER, EXPRESS, IMPLIED AND STATUTORY, INCLUDING, WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS.

B. Upon Buyer's submission of a claim as provided above and its substantiation, Seller shall at its option either (i) repair or replace its product, part of work at the original f.o.b. point of delivery or (ii) refund an equitable portion of the purchase price.

C. THE FOREGOING IS SELLER'S ONLY OBLIGATION AND BUYER'S EXCLUSIVE REMEDY FOR BREACH OF WARRANTY AND, EXCEPT FOR GROSS NEGLIGENCE OR WILLFUL MISCONDUCT. THE FOREGOING IS BUYER'S EXCLUSIVE REMEDY AGAINST SELLER FOR ALL CLAIMS ARISING HEREUNDER OR RELATING HERETO WHETHER SUCH CLAIMS ARE BASED ON BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE AND STRICT LIABILITY) OR OTHER THEORIES. BUYER'S FAILURE TO SUBMIT A CLAIM AS PROVIDED ABOVE SHALL SPECIFICALLY WAIVE ALL CLAIMS FOR DAMAGES OTHER THAN RELIEF, INCLUDING BUT NOT LIMITED TO CLAIMS BASED ON LATENT DEFECTS. IN NO EVENT SHALL BUYER BE ENTITLED TO INCIDENTAL OR CONSEQUENTIAL DAMAGES. ANY ACTION BY BUYER ARISING HERE UNDER OR RELATING HERETO, WHETHER BASED ON BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE AND STRICT LIABILITY) OR OTHER THEORIES, MUST BE COMMENCED WITHIN ONE (1) YEAR AFTER THE CAUSE OF ACTION ACCRUES OR IT SHALL BE BARRED.

D. In the event certifications are required, certifications are based on adherence to rigid fabrication, assembly and test procedures during production at our manufacturing facility and attest to the condition of the product at the time of shipment. Any disassembly, modifications, testing, tampering or inadequate storage of products covered by the certifications will void the certifications. Should disassembly or resetting of this product be necessary, such work must be conducted in the presence of, and under procedures approved by Seller in order to maintain validity of the certifications.

EDISON

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