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Installation and Operating Instructions

DM231 Series
Magnetostrictive
Total Level, Interface Level, & Temperature System

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EDO #06-08-108
DM231-LM
ISSUE #3

DM231 Series
Magnetostrictive
Total Level, Interface Level, & Temperature System

AMETEK®
DREXELBROOK
An ISO 9001 Certified Company

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Section 1

Section 1: Introduction

1.1 Product Description

The AMETEK Drexelbrook DM231 Series Level System is an integral assembly that measures Liquid Level, Interface Level, and Temperature using magnetostrictive technology.

Modbus communications are used to receive information from the level, Interface and temperature sensors.

A variety of floats and mounting accessories are available to fit nearly all applications.

1.2 Terminology

Magnetostriction: A magnetic field produces small change in the physical dimension of ferromagnetic materials on the order of several parts per million in carbon steel and conversely, a physical deformation or stain (torsion) produces a change of magnetization in the material.

1.3 Technology

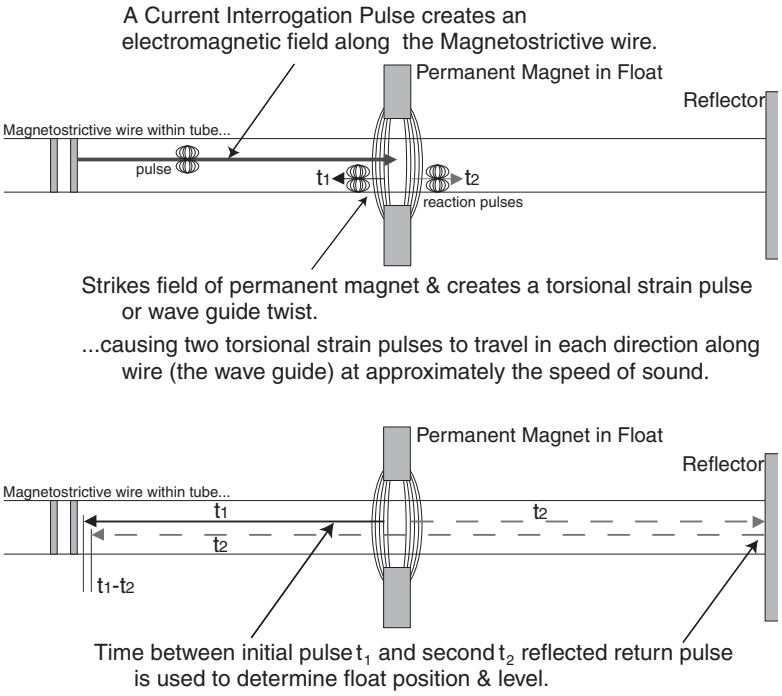


Figure 1-1
Magnetostrictive Theory

1.3 Technology (Continued)

In a magnetostrictive level sensor a current pulse is sent down a wave guide made of a special nickel alloy wire designed to enhance magnetostrictive properties. A permanent magnet within a float is used to indicate the position or level being measured. The interaction of the current pulse with the magnetic field created by a float (with magnet) produces a torsional strain pulse that travels at approximately the speed of sound along the wire. A small induction pickup coil senses the strain pulse. The position of the float is determined with high precision by measuring the time between the launching of the current pulse and the arrival of the torsional strain pulse.

The magnetostrictive wire is linearized during manufacture and the speed of the torsional pulse is determined for the specific sensor. Inherently, magnetostrictive sensors have very high resolution and repeatability.

Magnetostrictive technology is excellent for applications where the dielectric constant is very low or is changing. The technology has been used quite successfully for the detection of leaks in underground storage tanks, for example. The measurement of a 0.1 gallon leak out of a 10,000 gallon tank over a period of one hour is the standard for EPA mandated leak detection.

1.4 Model Number

Magnetostrictive Level Measurement System with Modbus RTU Output
DM23

Protocol
1 Modbus RTU / ASCII

Style / Material
X 316SS

Style Connector
S Single 3/4" NPT - for housing attachment
D Dual 3/4" NPT - For both housing and process connection

Fittings
E English - Supplies a 3/4" NPT electrical connection
M Metric - Supplies an adaptor to M20 electrical connection (ATEX Version Only)

Maximum Span
XXX Maximum Span in Inches

Temperature Points
R1 1 Temperature Sensor
R5 5 Temperature Sensors Evenly Spaced Over Span Length

Output Signals - Order Floats Separately
F1 Output Signal 1 - (For Total Level)
F2 Output Signal 2 - (For Total Level and Interface Level)

Overall Length
XXX Overall Length of Sensor

Style / Mounting
H Condulet

Special Mounting
EX Explosion proof Class I Div. 1, (FM & FM-C)
ED Flame proof for Zone 1 (ATEX) pending

Float Kit 1
0 No Float Kit
1 Float Kit, 316SS, 2.05" Diameter w/ E-Clip and spacer, 0.54 sp.gr.
2 Float Kit, Nitrophyl, 2.02" Diameter w/ E-Clip and spacer. 0.40 sp.gr.
3 Interrface Float Kit, 316 SS, 2.05" Diameter w E-Clip, 0.96sp. gr.

Float Kit 2
0 No Float Kit
1 316SS, 2.05" Diameter 0.96 sg for use with "Nitrophly Level" only
2 316SS, 2.05" Diameter 0.96 sg for use with "316SS Level" only

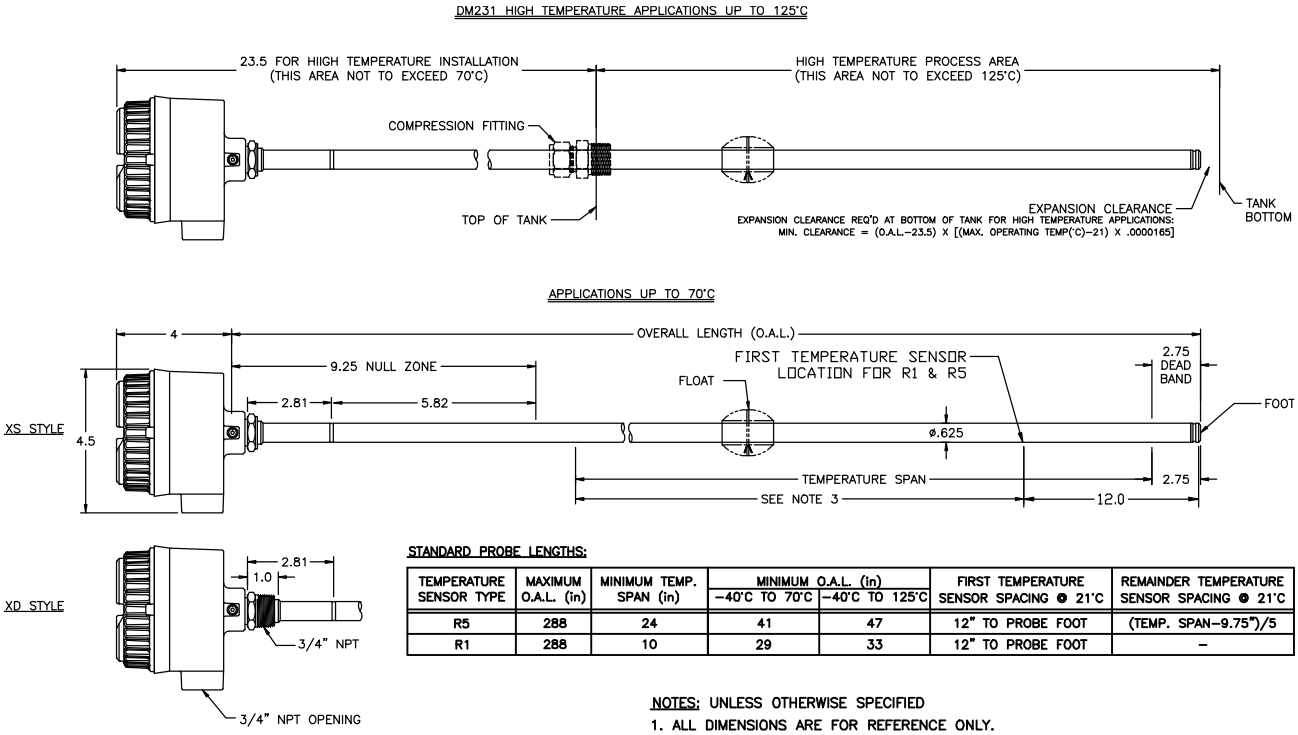
Mounting 1
0 No Mounting
1 Compression fitting 5/8" X ¾" NPT

Mounting 2
0 No Mounting
1 Reducer Bushing, 316SS, ¾" NPT X 2" NPT

Accessory 1
0 No Accessory
1 Modbus RTU to Analog Converter

DM23	1	X							H						

1.5 Probe Dimensions - Inches (mm)



STANDARD PROBE LENGTHS:

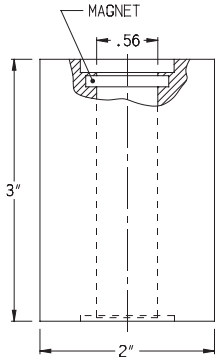
TEMPERATURE SENSOR TYPE	MAXIMUM O.A.L. (in)	MINIMUM TEMP. SPAN (in)	MINIMUM O.A.L. (in)		FIRST TEMPERATURE SENSOR SPACING @ 21°C	REMAINDER TEMPERATURE SENSOR SPACING @ 21°C
			–40°C TO 70°C	–40°C TO 125°C		
R5	288	24	41	47	12" TO PROBE FOOT	(TEMP. SPAN–9.75")/5
R1	288	10	29	33	12" TO PROBE FOOT	–

NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL DIMENSIONS ARE FOR REFERENCE ONLY.
2. ENSURE MAGNET DOES NOT ENTER NULL ZONE AND DEAD BAND AREAS.
3. REMAINING 4 TEMPERATURE SENSORS ARE SPACED EQUALLY OVER RANGE SPECIFIED.
4. FOR FIVE TEMPERATURE SENSOR PROBES, SENSORS ARE NUMBERED R1 TO R5 WITH R1 BEING NEAREST TO FOOT OF PROBE AND R5 NEAREST TO ENCLOSURE.

1.6 Float Dimensions & Types - Inches (mm)

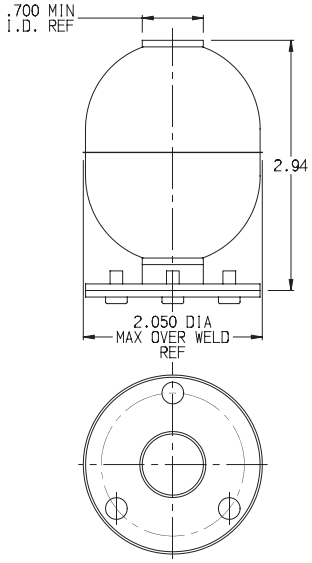
LEVEL FLOAT



SPECIFIC GRAVITY: 0.40
MAXIMUM PRESSURE: 300 psi
WETTED MATERIAL: NITROPHYL

P/N 04535095

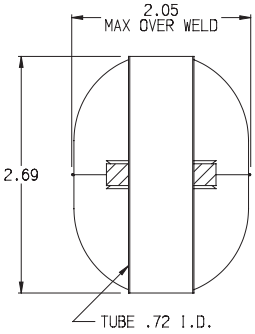
INTERFACE FLOAT



SPECIFIC GRAVITY: 0.96
MAXIMUM PRESSURE: 300 psi
WETTED MATERIAL: 316 SS

P/N SD0437901 & SD0556900

LEVEL FLOAT



SPECIFIC GRAVITY: 0.54
MAXIMUM PRESSURE: 300 psi
WETTED MATERIAL: 316 SS

P/N 14020002

Section 2: Installation

IMPORTANT
Be sure to read & understand all of the Installation Instructions before beginning the procedure!

2.1 Unpacking

Carefully remove the contents of the shipping carton and check each item against the packing list before destroying any packing materials. If there is any shortage or damage, report to the factory at 1-800-527-6297.

2.1.1 Storage

DM231 systems should be stored in their original shipping containers until ready for installation.
Damage that occurs in storage is not covered under manufacturers system warranty.

2.2 Mounting Conditions

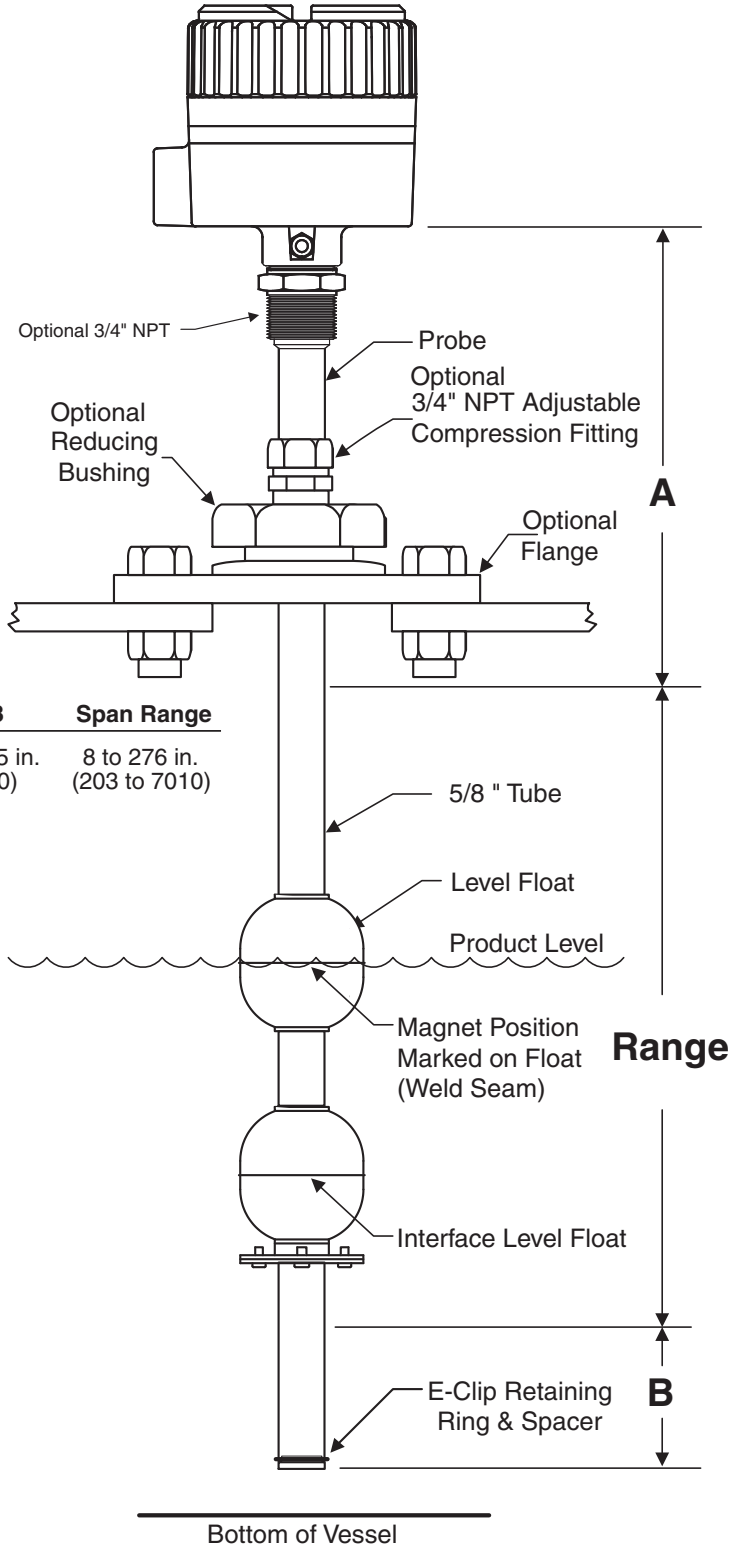
⚠ *CAUTION*

- **When installing probes, do not bend rigid probes, permanent damage may result.**
- **Longer rigid probes need to be supported at both ends while handling.**

  Probes are sealed at the factory and have electronic circuits inside. Do not attempt to open probe or weld the tube.

- DM231 Series level system is designed for industrial applications, but should be mounted in a location as free as possible from vibration, corrosive atmospheres, or any possibility of mechanical damage.
- Place the level gauge in a reasonably accessible location. Ambient temperature should be between -40°F and 158°F (-40°C to 70°C).
- Mount the probe perpendicular with gravity. See Figure 2-1.
- Float should have free movement along probe. Float dimensions are shown in Section 1.5.
- Float Retention Clip should be in place at base of probe.

2.2 Mounting Conditions (Continued)



Probe Type	A	B	Span Range
316SS	9.25 in.	2.75 in.	8 to 276 in.
inches	(235)	(70)	(203 to 7010)
(mm)			

Figure 2-1
Installation Diagram

2.3 Mounting Considerations

Mounting considerations may vary (Flanges, Compression Fitting, etc.) depending on the application. For underground tanks, the probe is generally mounted in the riser, resting on the bottom of the tank. Spacers are used to hold the sensor in the riser and a cable is suspended from the tank cap.

While most underground tanks are horizontal and fairly standard in design, above ground tanks vary considerably. The requirements for mounting these probes are fairly simple.

Since the sensor requires a float to provide level position, there is a minimum size required for insertion of the float into the tank. It is recommended that a minimum of 2" diameter be used for the most reliable system.

The size and material of the float being used will have a slight impact on the overall accuracy of the measuring system. In general, the larger the float the easier it is to provide a high accuracy measurement.

2.4 Stainless Steel Probe Mounting

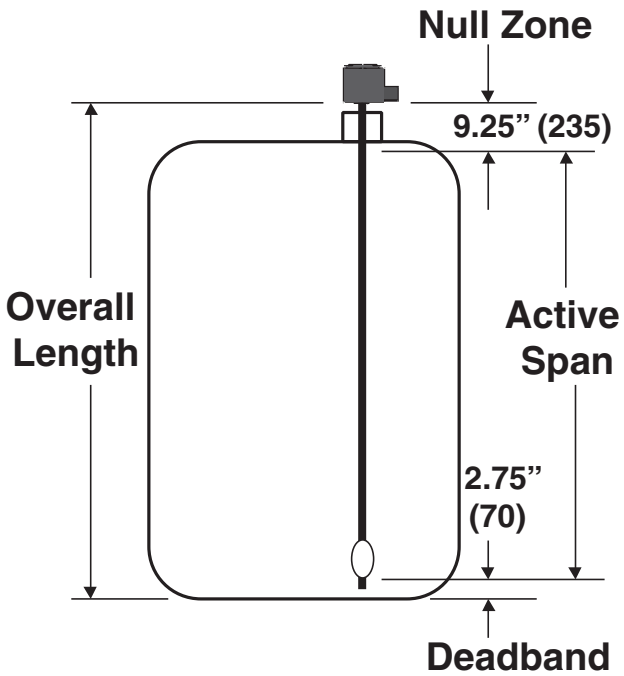


Figure 2-2
SS Probe up to 288" (7315mm)

2.4.1 Sizing of Stainless Steel Probe

Insertion Length is: Actual length from mounting point to bottom of probe.

Overall length of probe is: Insertion Length plus 2 inches (51mm) for Flange mounted probe, and Insertion Length plus 6 inches (152mm) for Compression Fitting mounted probe.

If the probe rests on the bottom of the tank, then the Active Range of the probe is the Overall Length minus 12" (305mm) **[2.75" (70mm) Dead Band at bottom of the probe and 9.25" (235mm) for the Null Zone at the top of the probe]**.

NOTICE ***The amount of Active Range in a tank will vary, depending on the mounting style.***

Stainless Steel probes are available in lengths up to 24 feet (7.3m) allowing Active Span Range of 22 feet (6.7m) up to maximum temperature of 257° F (125° C).

Most of the SS Probes are mounted with probe end resting on bottom of the tank (for non pressurized tanks) or about ½" (12.7mm) from bottom (for pressurized tanks) and held in position with compression fitting at top of tank. A 5/8" x ¾" adjustable fitting is used to mount probe to a flange or adapter. Minimum process connection depends on the diameter of float, but it is suggested to use 2" NPT or larger.

If a compression fitting is used, fitting should be should be positioned below "crimp" in tube or a minimum of 4 inches (102mm) from the top of probe. Hand tighten fitting in a non-pressurized tank. This will allow for a slight movement of probe when tank expands or contracts. If tank is pressurized, fitting must be tightened.

If a flange is being used, a "D" style connector can be specified to thread probe directly into flange. This requires more accuracy in specifying overall length of probe, but eliminates need for compression fitting or adapter bushing. Contact factory if Welded Flange connection is required.

2.4.2 Assembly of Stainless Steel Probe

1. Standard SS Float Kit should contain a 2 inch 316 stainless steel float, spacer and retainer to hold float on to probe. The standard retainer is a 316 SS "E-Clip". Optionally, if the probe is to rest on the bottom of a metal tank, an ECTFE End-Cap may be supplied With either, a spacer is required to insure SS float is positioned in active area of span.

2. Two people are recommended for assembly of probe, one to hold the probe and the other to assemble components.

3. Slide compression fitting if it is being used on probe.

4. Slide reducing bushing or flange on to probe.

5. Slide float onto probe. Use a single float for the F1 option and 2 floats for the F2 option. Refer to the Float Installation Instructions (Section 6) for details.

6. Slide spacer onto probe.

7. Capture all of these parts with E-Clip or ECTFE foot.

NOTICE

At this point, if probe span is to be set outside the vessel, then go to Section 2-9 Setting Span before continuing.

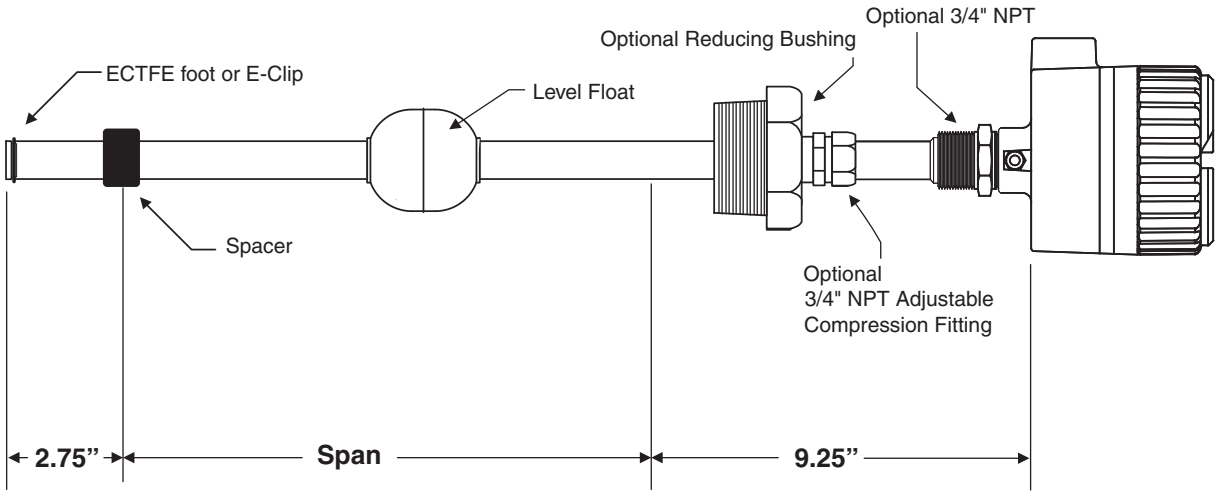


Figure 2-3
Stainless Steel Probe Assembly Sequence

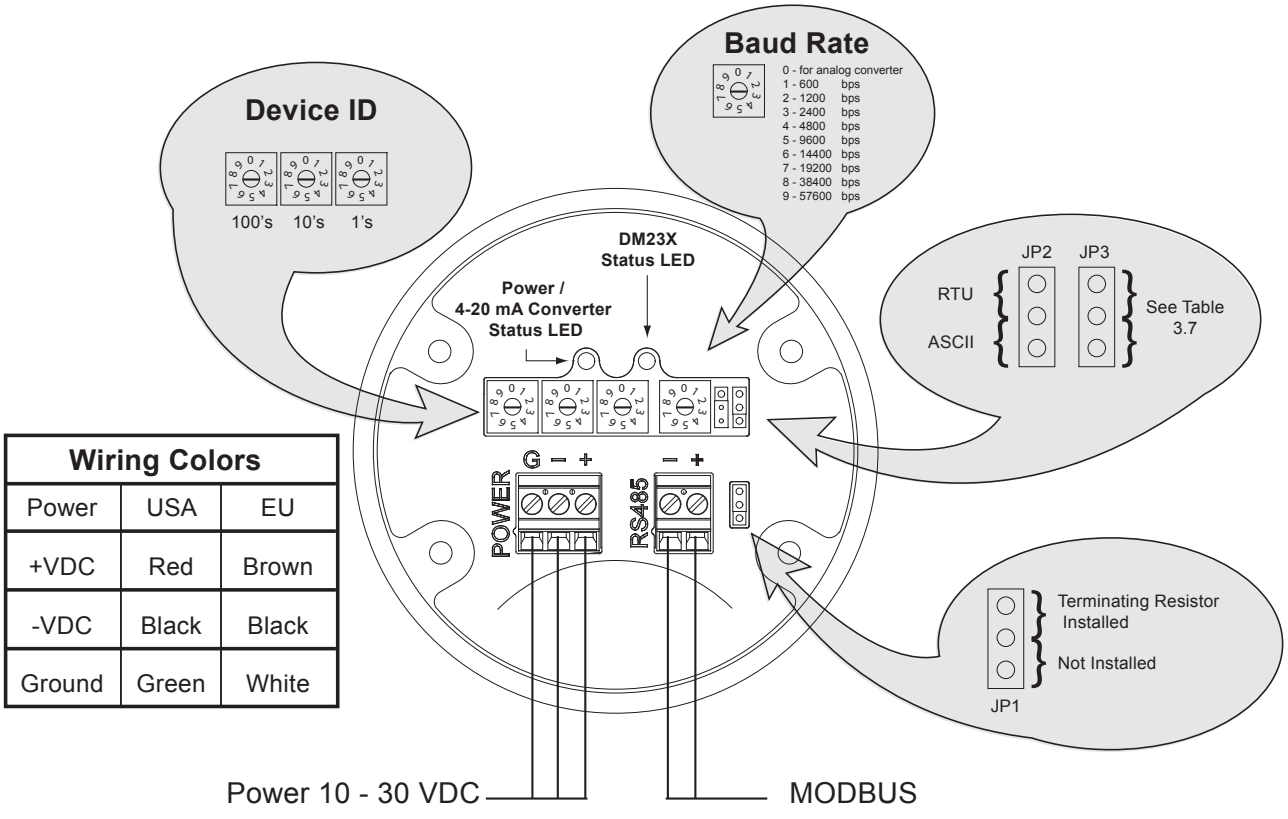
2.4.3 Insertion of Stainless Steel Probe

CAUTION:
Do not allow float to drop suddenly since it can damage retainer at end of probe.

1. Insert bottom end of probe into tank.
2. Thread bushing into tank or flange. Bolt flange into position.
3. Thread compression fitting into bushing or flange.
4. Hand tighten. To insure compression fitting is sealed, turn fitting 1 ¼ turns after hand tightening.
5. Make final check to see that all of bolts and screws are in proper position and probe is securely tightened.

2.5 Wiring

WARNING! If the DM231 is located in a hazardous environment, do not open the enclosure cover or make / break any electrical connections without first disconnecting electrical power at the source. Ensure that wiring, electrical fittings and conduit connections conform to electrical codes and Approval Agency Control Drawings for specific location and environment.



Wiring Colors		
Power	USA	EU
+VDC	Red	Brown
-VDC	Black	Black
Ground	Green	White

Section 3: Communications

3.1 Description

The DM231 uses the Modbus protocol for communicating with a PC or devices such as a programmable logic controller. Modbus is a master-slave protocol that is openly published. Many PC programs currently exist for communicating with Modbus supported devices. The DM231 supports the RTU / ASCII transmission mode over RS-485 or RS-232.

3.2 Compatibility

The DM231 supports all the required specifications and is conditionally complaint.

3.3 Implementation Class

The DM231 uses the Basic Implementation Class of the Modbus protocol. The table below shows configurations capabilities of the basic implementation class.

	Basic
Addressing	Configurable address from 1 to 247
Broadcast	Yes
Baud Rate	9600, 19200 (19200 is default)
Mode	RTU, ASCII
Parity	EVEN, NONE
Electrical Interface	RS485 2W-cabling
Connector Type	3 wire terminal (Adapter Cable Required for RS232)

3.4 Wiring for RS485

RS485 is designed for cable lengths of to 4,000 feet. As many as 32 Modbus devices may be multi-dropped on the same bus. A twisted pair is used to connector the DM231 to a host such as a PC with a RS485 converter or PC card. It is recommended that the twisted pair be shielded and at least 24 AWG. The shield should be connected to common only at one end.

If the RS485 bus already has terminating resistors installed, the jumper JP1 on the motherboard must be set to position 2-3. This will remove the built-in terminating resistor that is connected by default.

3.5 Configuration

Refer to the illustration for switch and jumper positions.

3.5.1 Baud Rate

The Baud Rate may be adjusted by changing the position of the boud rate switch. The default baud rate is 19200 bps.

Baud Rate Switch Position

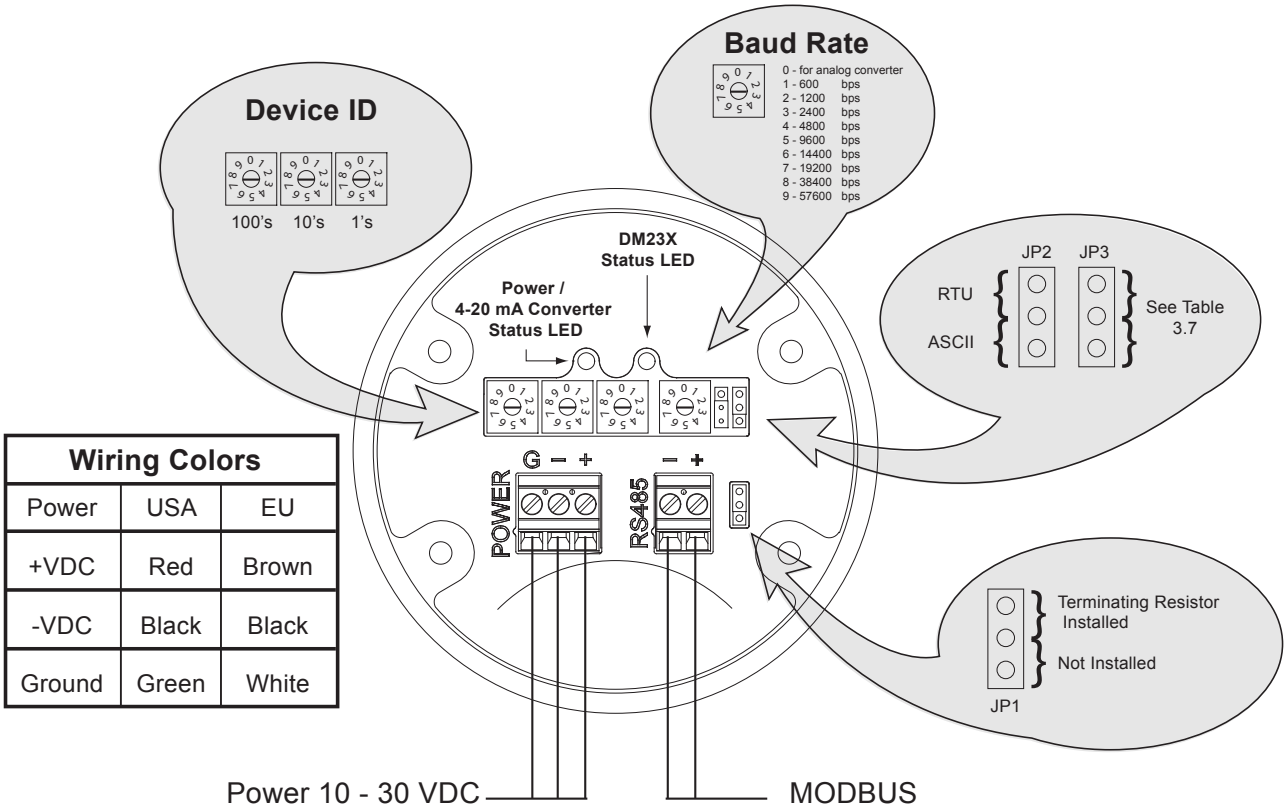
0 - For Use with Modbus RTU to Analog Converter **Only**

1 - 600 bps	4 - 4800 bps	7 - 19200 bps
2 - 1200 bps	5 - 9600 bps	8 - 38400 bps
3 - 2400 bps	6 - 14400 bps	9 - 57600 bps

3.5.2 Device ID

The Device ID is a unique address used to multi-drop the DM231 with up to 32 Modbus devices using the RS485 Interface.

The DM231 may me configured for a Device ID of 1 to 247. The Device ID may be adjusted by changing the position of the baud rate switches. The default Device ID is 1 (switch position 0).



Wiring Colors		
Power	USA	EU
+VDC	Red	Brown
-VDC	Black	Black
Ground	Green	White

3.6 Modbus

The DM231 has 2 modes: it can act as a Modbus slave, responding to data requests from a Modbus master in RTU or ASCII Modbus, or it can act as a Modbus master for interfacing to an optional Modbus to 4-20 mA converter. The mode is determined by the Baud Rate switch. Position 0 configures the DM231 as a Modbus Master. Positions 1- 9 configure the DM231 as a Modbus Slave, and also sets the baud rate at which it will communicate with the master.

3.7 Modbus Slave Operation

When configured as slave, the DM231 responds to requests for data from a Modbus master. The data available is the product, interface, total covered temperature, product temperature, interface temperature, span (probe length), max temperature, and the individual values of the 5 temperature sensors from the probe as well as the status of the probe.

The DM231 is capable of communicating using the Modbus RTU or ASCII format. The format is selected by the on board jumper JP2. The serial communication parameters are selected by the on board jumper JP3. The baud rate and Modbus device number are selected by on board switches. Refer to the table below for the jumper settings.

Individual data items (product, average temperature, etc.) are obtained by issuing a Modbus request with a specific register number, as per the Modbus protocol specification. Multiple values can be obtained by specifying a starting register and the number of registers desired.

The data returned from a Modbus request can be in many formats: 16 bit integer, 32 bit integer (long), or floating point. The DM231 has a unique feature which allows the user to specify the data format desired by the selecting the correct register. For example, the value for the product reading can be obtained as an integer (16 bits), a long word (32 bits), or a floating point value (32 bits) by simply choosing different registers.

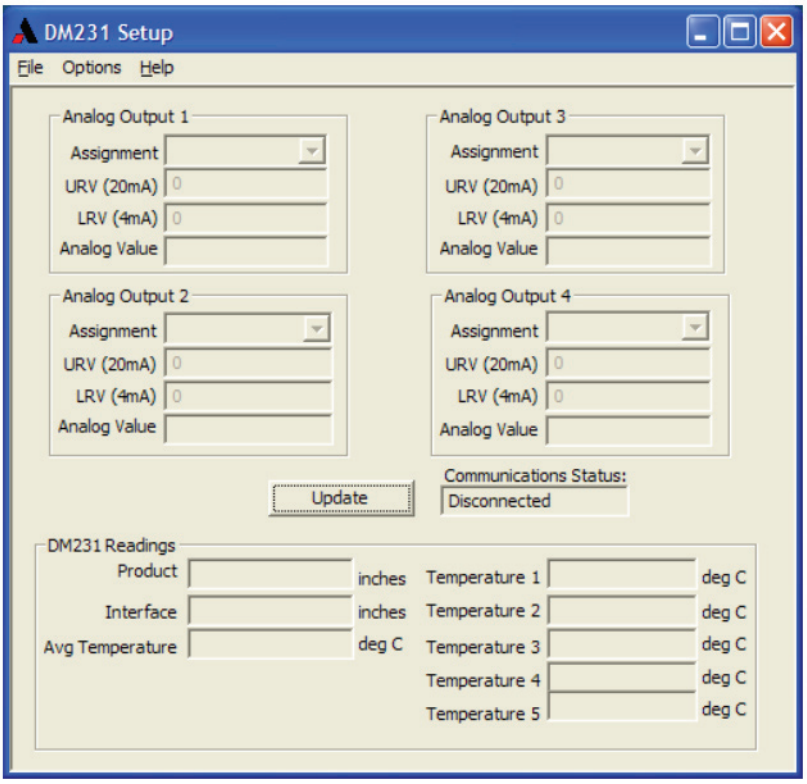
In addition to the length of the data, the order of the bytes in the returned data must be known by the Modbus master in order to assemble the data correctly. The DM231 allows for all byte ordering combinations by specification of the correct register number.

In traditional Modbus, 1 register represented 16 bits of data. To obtain a 32 bit value, the master requested 2 registers to get the 32 bits. A variant of Modbus called Enron Modbus allows for 32 bits of data to be returned with 1 register request. The DM231 will work with either type of Modbus master. Again, the format type is controlled by the register number requested.

All of the Modbus formats available are shown in Section 3.19

3.8 Modbus Master Operation

When configured as a Modbus master, the communications settings are internally fixed, and all other jumpers and switches are not used. The DM231 connects to PC Windows based software used to set the configuration, and to a Modbus to 4-20mA converter to drive 4-20mA outputs. The PC software shows the current values for the data points (product, average temperature, etc.) It also allows the user to select one of the variables to represent a 4-20mA analog output. After selecting the desired variable, the user sets the LRV (Lower Range Value) and URV (Upper Range Value), which determines the output current. 4 channels are available for outputs.



Screen shot of PC configuration program used to configure the DM231 when configured as a Modbus master.

3.9 Master Slave Configuration

The mode (Modbus master or slave) is controlled by the baud rate switch. Setting the switch to position 0 will configure the DM231 as a Modbus master. Settings 1 – 9 will configure the DM231 as a Modbus slave, and set the baud rate.

When configured as a Modbus master, the Device Id switches and communication jumpers are not used.

3.10 Data Points

The data points available are:

Product – position of top float
Interface – position of bottom float
Average Temperature – average temperature of covered product and interface
Product temperature – average temperature of product only
Interface temperature – average temperature of interface only
Individual Temperature sensors – 5 total, 1 is closest to the bottom of the probe, 5 is closest to the top.
Maximum temperature - recorded by any of the sensors, saved through power cycles
Temperature sensor locations- 5 total, indicates sensor location from bottom of tank.

All temperatures are available in both degrees F and C.
All positions are available in inches and centimeters.

A value of 2000 for product or -2000 for interface indicates a float error condition.
A value of 2000 for a temperature sensor indicates a sensor error condition.
A value of 1000 for product or -1000 for interface indicates a communication problem between the DM231 and the probe.

3.11 Scaling

All integer formats are scaled X 100 so that the last 2 digits represent the decimal portion of the number.

For example:

Product reading:	1790 = 17.90 inches
Interface reading:	563 = 5.63 inches
Average Temperature:	2382 = 23.82 degrees Celsius

3.12 Byte Ordering

In the Modbus slave configuration, data can be accessed as integers (16 bits), long integers (32 bits), and floating point value (32 bits). The order that the bytes are sent must be known by the master in order to assembly the bytes into the correct value. Byte ordering can have a few different terminologies.

1) Big/Little Endian
2) Byte order by number, with 1 indicating the most significant part of the value, and 4 the least significant,
3) Word/Byte, indicating which word (16 bits, high or low) is sent first, and which byte of the word (high or low) come first in that byte.

See the following example for accessing a product reading of 46.60 inches. The integer value will be 4660, which translates to the hex number 0x00001234. The individual bytes, 0x00, 0x00, 0x12, and 0x34 can be sent the following 4 ways for 32 bits values:

1) Big Endian, Byte order 1234, High Word High Byte (HWHB)
   Order sent: 0x00, 0x00, 0x12, 0x34

2) Little Endian, Byte order 4321, Low Word Low Byte (LWLB)
   Order sent: 0x34, 0x12, 0x00, 0x00

3) Big Endian Byte Swapped, Byte order 2143, High Word Low Byte (HWLB)
   Order sent: 0x00, 0x00, 0x34, 0x12

4) Little Endian Byte Swapped, Byte order 3412, Low Word High Byte (LWHB)
   Order sent: 0x12, 0x34, 0x00, 0x00

The individual bytes 0x12, and 0x34 can be sent the following 2 ways for 16 bits values:

1) Big Endian, Byte order 12, High Byte first (HB)
   Order sent: 0x12, 0x34

2) Little Endian, Byte order 21, Low Byte first (LB)
   Order sent: 0x34, 0x12

3.13 Enron Modbus

Enron Modbus has a few differences from Traditional Modbus. One difference is the register offsets follow a different numbering scheme, with integer values residing in the 3XXX range, long integers in the 5XXX range, and floating points in the 7XXX range. The second difference is that 32 bits of data can be returned in one register.

The DM231 supports both of these features, by selection of the proper register value.

3.14 Jumper Settings

In the Modbus slave configuration, jumpers JP2 and JP3 control the Modbus format (RTU or ASCII) and the communication settings, according to the chart below.

The Data bits for the Down position of JP3 depend upon the setting of JP2 (RTU or ASCII format).

NOTICE These jumpers have no effect when the DM231 is configured as a Modbus master.

JP2	JP3	Mode	Data bits	Stop bits	Parity
Up	Up	RTU	8	1	None
Up	Down	RTU	8	1	Even
Down	Up	ASCII	8	1	None
Down	Down	ASCII	7	1	Even

3.15 Baud Rate

The baud rate for a Modbus slave configuration is determined by the Baud rate switch, summarized in the following table:

Switch position	Baud (in bps)
0	Sets DM231 as a Modbus master
1	600
2	1200
3	2400
4	4800
5	9600
6	14400
7	19200
8	38400
9	57600

3.16 Holding and input registers

All data points can be accessed as either a holding or an input register. Holding registers start with a 3XXXX and Input registers start with a 4XXXX. For example, product can be obtained at both registers 30203 and 40203.

3.17 Maximum registers

The maximum number of registers that can be accessed in a single Modbus request depends on the mode (RTU or ASCII) and the register size of the data (i.e Enron uses 4 data bytes per register for floats and longs)

- For ASCII setting , accessing Enron floats or long integers, the maximum number of registers that can be requested is 30.
- For all other modes, the maximum number is 36, which will retrieve all the data points in a single message.

3.18 Examples of Accessing Data in the DM231

For the following examples, suppose we have these values:

Product (level) reading: 200.74 inches, 509.88 cm
Interface reading: 120.39 inches, 305.79 cm
Average Temperature: 26.94 degrees C, 80.49 F

1) To access Product as an integer, Big Endian order, in inches:
   Request register 31803, length 1, value returned = 20074

2) To access Interface as a Floating Point, Little Endian order, in cm :
   Request register 30905, length 2, value returned = 305.79

3) To access Avg Temperature as a long integer, Big Endian Byte Swapped, in C:
   Request register 31511, length 2, value returned = 2694

4) To access product as an integer, Big Endian, in Enron addressing, in inches:
   Request register 3002, length 1, value returned = 20074

5) To access Interface as a Floating Point, Big Endian, in Enron addressing, in cm:
   Request register 7104, length 1, value returned = 305.79

6) To access Avg Temperature as a long integer, Little Endian in Enron addressing, in F:
   Request register 5610, length 1, value returned = 8049

7) To access all of the data points in Floating point, Big Endian, English units:
   Request register 30203, length 36

8) To access Product, Interface, and product temperature points in Floating point, Big Endian, English units:
   Request register 30203, length 6

3.19 Modbus Map

Use the following tables to find the register number for the desired format. First, go to the section for the number format you desire (integer, long integer, or floating point). Then find the table with the desired units, English or metric. Then find the value (product, interface, average temperature, etc) in the left hand column. Next, find the desired byte ordering across the top row. The corresponding entry at the intersection of these 2 items gives the register that should be specified in the Modbus master request message. The number of registers needed to obtain the value is also specified for each format.

NOTICE

HWHB = High Word. High byte
LWHB = Low Word High Byte,
HWLB = High word low byte
LWLB = Low Word low byte

3.19.1 Integer (16 bit Signed) formats

Signed 16 bit Integer, 16 bits of data per register

1 register needed to get value English Units, inches & degrees F

Data	Big Endian Hi Byte first	Little Endian Low Byte first
Product	31803	32003
Interface	31805	32005
product temperature	31807	32007
interface temperature	31809	32009
average temperature	31811	32011
status	31813	32013
Span	31815	32015
temperature 1	31817	32017
temperature 2	31819	32019
temperature 3	31821	32021
temperature 4	31823	32023
temperature 5	31825	32025
max temperature	31827	32027
temperature sensor 1 location (closest to bottom)	31829	32029
temperature sensor 2 location	31831	32031
temperature sensor 3 location	31833	32033
temperature sensor 4 location	31835	32035
temperature sensor 5 location (closest to top)	31837	32037
Software version	31899	32099

3.19.2 Signed 16 bit Integer, 16 bits of data per register

1 register needed to get value Metric Units, centimeters & degrees C

Data	Big Endian Hi Byte first	Little Endian Low Byte first
Product	31903	32103
Interface	31905	32105
product temperature	31907	32107
interface temperature	31909	32109
average temperature	31911	32111
status	31913	32113
Span	31915	32115
temperature 1	31917	32117
temperature 2	31919	32119
temperature 3	31921	32121
temperature 4	31923	32123
temperature 5	31925	32125
max temperature	31927	32127
temperature sensor 1 location (closest to bottom)	31929	32129
temperature sensor 2 location	31931	32131
temperature sensor 3 location	31933	32133
temperature sensor 4 location	31935	32135
temperature sensor 5 location (closest to top)	31937	32137
Software version	31999	32199

3.19.3 Enron Modbus, Signed 16 bit Integer, 16 bits of data per register

1 register needed to get value. English Units, inches & degrees F

Data	Big Endian Hi Byte first	Little Endian Low Byte first
Product	3002	3202
Interface	3004	3204
product temperature	3006	3206
interface temperature	3008	3208
average temperature	3010	3210
status	3012	3212
Span	3014	3214
temperature 1	3016	3216
temperature 2	3018	3218
temperature 3	3020	3220
temperature 4	3022	3222
temperature 5	3024	3224
max temperature	3026	3226
temperature sensor 1 location (closest to bottom)	3028	3228
temperature sensor 2 location	3030	3230
temperature sensor 3 location	3032	3232
temperature sensor 4 location	3034	3234
temperature sensor 5 location (closest to top)	3036	3236
Software version	3098	3298

3.19.4 Enron Modbus, Signed 16 bit Integer, 16 bits of data per register

1 register needed to get value. Metric Units, centimeters & degrees C

Data	Big Endian Hi Byte first	Little Endian Low Byte first
Product	3102	3302
Interface	3104	3304
product temperature	3106	3306
interface temperature	3108	3308
average temperature	3110	3310
status	3112	3312
Span	3114	3314
temperature 1	3116	3316
temperature 2	3118	3318
temperature 3	3120	3320
temperature 4	3122	3322
temperature 5	3124	3324
max temperature	3126	3326
temperature sensor 1 location (closest to bottom)	3128	3328
temperature sensor 2 location	3130	3330
temperature sensor 3 location	3132	3332
temperature sensor 4 location	3134	3334
temperature sensor 5 location (closest to top)	3136	3336
Software version	3198	3398

3.20 Floating point formats

3.20.1 Floating Point, 32 bit, 16 bits of data per register

2 registers needed to get value. English Units, inches and degrees F

Data	Big Endian HWHB/ 1234	Little Endian Byte Swapped LWHB / 3412	Big Endian Byte Swapped HWLB / 2143	Little Endian LWLB / 4321
Product	30203	30403	30603	30803
Interface	30205	30405	30605	30805
product temperature	30207	30407	30607	30807
interface temperature	30209	30409	30609	30809
average temperature	30211	30411	30611	30811
status	30213	30413	30613	30813
Span	30215	30415	30615	30815
temperature 1	30217	30417	30617	30817
temperature 2	30219	30419	30619	30819
temperature 3	30221	30421	30621	30821
temperature 4	30223	30423	30623	30823
temperature 5	30225	30425	30625	30825
max temperature	30227	30427	30627	30827
temperature sensor 1 location (closest to bottom)	30229	30429	30629	30829
temperature sensor 2 location	30231	30431	30631	30831
temperature sensor 3 location	30233	30433	30633	30833
temperature sensor 4 location	30235	30435	30635	30835
temperature sensor 5 location (closest to top)	30237	30437	30637	30837
Software version	30299	30499	30699	30899

3.20.2 Floating Point, 32 bit, 16 bits of data per register

2 registers needed to get value. Metric Units, centimeters & degrees C

Data	Big Endian HWHB/ 1234	Little Endian Byte Swapped LWHB/ 3412	Big Endian Byte swapped HWLB/ 2143	Little Endian LWLB/ 4321
Product	30303	30503	30703	30903
Interface	30305	30505	30705	30905
product temperature	30307	30507	30707	30907
interface temperature	30309	30509	30709	30909
average temperature	30311	30511	30711	30911
status	30313	30513	30713	30913
Span	30315	30515	30715	30915
temperature 1	30317	30517	30717	30917
temperature 2	30319	30519	30719	30919
temperature 3	30321	30521	30721	30921
temperature 4	30323	30523	30723	30923
temperature 5	30325	30525	30725	30925
max temperature	30327	30527	30727	30927
temperature sensor 1 location (closest to bottom)	30329	30529	30729	30929
temperature sensor 2 location	30331	30531	30731	30931
temperature sensor 3 location	30333	30533	30733	30933
temperature sensor 4 location	30335	30535	30735	30935
temperature sensor 5 location (closest to top)	30337	30537	30737	30937
Software version	30399	30599	30799	30999

3.20.3 Enron Modbus, Floating Point, 32 bit, 32 bits of data per register

1 register needed to get value. English Units, inches and degrees F

Data	Big Endian HWHB/ 1234	Little Endian Byte Swapped LWHB/ 3412	Big Endian Byte swapped HWLB/ 2143	Little Endian LWLB/ 4321
Product	7002	7202	7402	7602
Interface	7004	7204	7404	7604
product temperature	7006	7206	7406	7606
interface temperature	7008	7208	7408	7608
average temperature	7010	7210	7410	7610
status	7012	7212	7412	7612
Span	7014	7214	7414	7614
temperature 1	7016	7216	7416	7616
temperature 2	7018	7218	7418	7618
temperature 3	7020	7220	7420	7620
temperature 4	7022	7222	7422	7622
temperature 5	7024	7224	7424	7624
max temperature	7026	7226	7426	7626
temperature sensor 1 location (closest to bottom)	7028	7228	7428	7628
temperature sensor 2 location	7030	7230	7430	7630
temperature sensor 3 location	7032	7232	7432	7632
temperature sensor 4 location	7034	7234	7434	7634
temperature sensor 5 location (closest to top)	7036	7236	7436	7636
Software version	7098	7298	7498	7698

3.20.4 Enron Modbus, Floating Point, 32 bit, 32 bits of data per register

1 register needed to get value. Metric Units, centimeters & degrees C

Data	Big Endian HWHB/ 1234	Little Endian Byte Swapped LWHB/ 3412	Big Endian Byte swapped HWLB/ 2143	Little Endian LWLB/ 4321
Product	7102	7302	7502	7702
Interface	7104	7304	7504	7704
product temperature	7106	7306	7506	7706
interface temperature	7108	7308	7508	7708
average temperature	7110	7310	7510	7710
status	7112	7312	7512	7712
Span	7114	7314	7514	7714
temperature 1	7116	7316	7516	7716
temperature 2	7118	7318	7518	7718
temperature 3	7120	7320	7520	7720
temperature 4	7122	7322	7522	7722
temperature 5	7124	7324	7524	7724
max temperature	7126	7326	7526	7726
temperature sensor 1 location (closest to bottom)	7128	7328	7528	7728
temperature sensor 2 location	7130	7330	7530	7730
temperature sensor 3 location	7132	7332	7532	7732
temperature sensor 4 location	7134	7334	7534	7734
temperature sensor 5 location (closest to top)	7136	7336	7536	7736
Software version	7198	7398	7598	7798

3.21 Long Integer (32 bit) formats

3.21.1 Long, 32 bit, 16 bits of data per register

2 registers needed to get value. English Units, inches & degrees F

Data	Big Endian HWHB/ 1234	Little Endian Byte Swapped LWHB/ 3412	Big Endian Byte swapped HWLB/ 2143	Little Endian LWLB/ 4321
Product	31003	31203	31403	31603
Interface	31005	31205	31405	31605
product temperature	31007	31207	31407	31607
interface temperature	31009	31209	31409	31609
average temperature	31011	31211	31411	31611
status	31013	31213	31413	31613
Span	31015	31215	31415	31615
temperature 1	31017	31217	31417	31617
temperature 2	31019	31219	31419	31619
temperature 3	31021	31221	31421	31621
temperature 4	31023	31223	31423	31623
temperature 5	31025	31225	31425	31625
max temperature	31027	31227	31427	31627
temperature sensor 1 location (closest to bottom)	31029	31229	31429	31629
temperature sensor 2 location	31031	31231	31431	31631
temperature sensor 3 location	31033	31233	31433	31633
temperature sensor 4 location	31035	31235	31435	31635
temperature sensor 5 location (closest to top)	31037	31237	31437	31637
Software version	31099	31299	31499	31699

3.21.2 Long, 32 bit, 16 bits of data per register

2 registers needed to get value. Metric Units, centimeters & degrees C

Data	Big Endian HWHB/ 1234	Little Endian Byte Swapped LWHB/ 3412	Big Endian Byte swapped HWLB/ 2143	Little Endian LWLB/ 4321
Product	31103	31303	31503	31703
Interface	31105	31305	31505	31705
product temperature	31107	31307	31507	31707
interface temperature	31109	31309	31509	31709
average temperature	31111	31311	31511	31711
status	31113	31313	31513	31713
Span	31115	31315	31515	31715
temperature 1	31117	31317	31517	31717
temperature 2	31119	31319	31519	31719
temperature 3	31121	31321	31521	31721
temperature 4	31123	31323	31523	31723
temperature 5	31125	31325	31525	31725
max temperature	31127	31327	31527	31727
temperature sensor 1 location (closest to bottom)	31129	31329	31529	31729
temperature sensor 2 location	31131	31331	31531	31731
temperature sensor 3 location	31133	31333	31533	31733
temperature sensor 4 location	31135	31335	31535	31735
temperature sensor 5 location (closest to top)	31137	31337	31537	31737
Software version	31199	31399	31599	31799

3.21.3 Enron Modbus, Long, 32 bit, 32 bits of data per register

1 register needed to get value. English Units, inches & degrees F

Data	Big Endian HWHB/ 1234	Little Endian Byte Swapped LWHB/ 3412	Big Endian Byte Swapped HWLB/ 2143	Little Endian LWLB/ 4321
Product	5002	5202	5402	5602
Interface	5004	5204	5404	5604
product temperature	5006	5206	5406	5606
interface temperature	5008	5208	5408	5608
average temperature	5010	5210	5410	5610
status	5012	5212	5412	5612
Span	5014	5214	5414	5614
temperature 1	5016	5216	5416	5616
temperature 2	5018	5218	5418	5618
temperature 3	5020	5220	5420	5620
temperature 4	5022	5222	5422	5622
temperature 5	5024	5224	5424	5624
max temperature	5026	5226	5426	5626
temperature sensor 1 location (closest to bottom)	5028	5228	5428	5628
temperature sensor 2 location	5030	5230	5430	5630
temperature sensor 3 location	5032	5232	5432	5632
temperature sensor 4 location	5034	5234	5434	5634
temperature sensor 5 location (closest to top)	5036	5236	5436	5636
Software version	5098	5298	5498	5698

3.21.4 Enron Modbus, Long, 32 bit, 32 bits of data per register

1 register needed to get value. Metric Units, centimeters & degrees C

Data	Big Endian HWHB/ 1234	Little Endian Byte Swapped LWHB/ 3412	Big Endian Byte swapped HWLB/ 2143	Little Endian LWLB/ 4321
Product	5102	5302	5502	5702
Interface	5104	5304	5504	5704
product temperature	5106	5306	5506	5706
interface temperature	5108	5308	5508	5708
average temperature	5110	5310	5510	5710
status	5112	5312	5512	5712
Span	5114	5314	5514	5714
temperature 1	5116	5316	5516	5716
temperature 2	5118	5318	5518	5718
temperature 3	5120	5320	5520	5720
temperature 4	5122	5322	5522	5722
temperature 5	5124	5324	5524	5724
max temperature	5126	5326	5526	5726
temperature sensor 1 location (closest to bottom)	5128	5328	5528	5728
temperature sensor 2 location	5130	5330	5530	5730
temperature sensor 3 location	5132	5332	5532	5732
temperature sensor 4 location	5134	5334	5534	5734
temperature sensor 5 location (closest to top)	5136	5336	5536	5736
Software version	5198	5398	5598	5798

3.22 Status Bit Definitions

NOTICE Status should always be viewed in an integer format (integer or long), as opposed to floating point, in order to see the individual bits.

bit	Definition
0-7	Reserved
8	Magnet missing / Fault with Product or Interface
9	Temperature 1 Fault
10	Temperature 2 Fault
11	Temperature 3 Fault
12	Temperature 4 Fault
13	Temperature 5 Fault
14	Span (Probe Length)
15	Not connected to probe
16-31	Reserved

Common values:
Status = 256 indicates magnet error
Status = 32768 indicates DM231 not communicating with probe

Section 4

Section 4: Troubleshooting

4.1 Factory Assistance

AMETEK Drexelbrook can answer any questions about The DM231 Series instrument. Call Customer Service at 1-800-553-9092 (US and Canada) or +1 215 674-1234 (International).

If you require assistance and attempts to locate the problem have failed:

Contact your local Drexelbrook representative,

Telephone the Service department toll-free:
- 1-800-527-6297 (US and Canada)
- +1 215 674-1234 (International)

FAX: Service Department + 215-443-5117
E-Mail: drexelbrook.service@ametek.com

Please provide the following information:

- Instrument Model Number
- Sensing Element Model Number and Length
- Original Purchase Order Number
- Material being measured
- Temperature
- Pressure
- Agitation
- Brief description of the problem
- Checkout procedures that have failed

4.2 Field Service

Trained field servicemen are available on a time-plus-expense basis to assist in start-ups, diagnosing difficult application problems, or in-plant training of personnel. Contact the service department for further details.

4.3 Customer Training

Periodically, AMETEK Drexelbrook instrument training seminars for customers are held at the factory. These sessions are guided by Drexelbrook engineers and specialists, and provide detailed information on all aspects of level measurement, including theory and practice of instrument operation. For more information write to:
AMETEK Drexelbrook, Communications/ Training Group
or call 215-674-1234.

4.4 Equipment Return

In order to provide the best service, any equipment being returned for repair or credit must be pre-approved by the factory.

In many applications, sensing elements are exposed to hazardous materials.

- **OSHA mandates** that our employees be informed and protected from hazardous chemicals.
- **Material Safety Data Sheets (MSDS)** listing the hazardous materials to which the sensing element has been exposed MUST accompany any repair.
- It is your responsibility to fully disclose all chemicals and **decontaminate** the sensing element.

To obtain a return authorization (RA#), contact the Service department at 1-800-527-6297 (US and Canada) or + 215-674-1234 (International).

- Please provide the following information:
- Model Number of Return Equipment
- Serial Number
- Original Purchase Order Number
- Process Materials to which the equipment has been exposed.
- MSDS sheets for any hazardous materials
- Billing Address
- Shipping Address
- Purchase Order Number for Repairs
- Please include a purchase order even if the repair is under warranty. If repair is covered under warranty, you will not be charged.

Ship equipment freight prepaid to:

AMETEK-DREXELBROOK.
205 KEITH VALLEY ROAD
HORSHAM, PA 19044-1499
COD shipments will not be accepted

Section 5: Specifications

Technology:
Magnetostrictive

Calibration:
None

Operating Voltage:
10 - 30 VDC

Output Signal:
Modbus RTU / ASCII

Response Time:
1.0 Second

Temperature Range:
Process: -40°F to 257° F +/-1° F
(-40° C to 125° C +/- 0.5° C)
Ambient: -40° F to 185° F
(-40°C to 85°C)

Pressure Rating:
3**16SS tube:** 1000 psig. (69 bar)
Float: Dependant
316SS floats typical to
350 psig, (24 bar)
consult factory

Resolution:
+/- 0.0001”

Repeatability:
+/- 0.0001”

Accuracy:
Level: 0.01% or +/- 0.023” (0.06mm)
which ever is greater
Temperature: +/- 1°F (+/- 0.5°C)

Null Zone:
9.25" (235 mm)

Minimum Interface Measurement:
≥ 4" (100 mm)

Hysteresis:
0.002%

Deadband:
2.75" (70 mm)

Enclosure Rating:
IP66, NEMA 4-4X

Span Length:
8” to 276”
(203 - 7010 mm)
Max. Temp. Dependant

Probe Length and Temperature Sensor Locations:
Probes available in 1” (25 mm) increments

STANDARD PROBE LENGTHS:

TEMPERATURE	MAXIMUM	MINIMUM TEMP.	MINIMUM O.A.L. (in)		FIRST TEMPERATURE	REMAINDER TEMPERATURE
SENSOR TYPE	O.A.L. (in)	SPAN (in)	-40°C TO 70°C	-40°C TO 125°C	SENSOR SPACING @ 21°C	SENSOR SPACING @ 21°C
R5	288	24	41	47	12″ TO PROBE FOOT	(TEMP. SPAN-9.25″)/5
R1	288	10	29	33	12″ TO PROBE FOOT	

Section 5: Specifications (Continued)

Approvals Available:

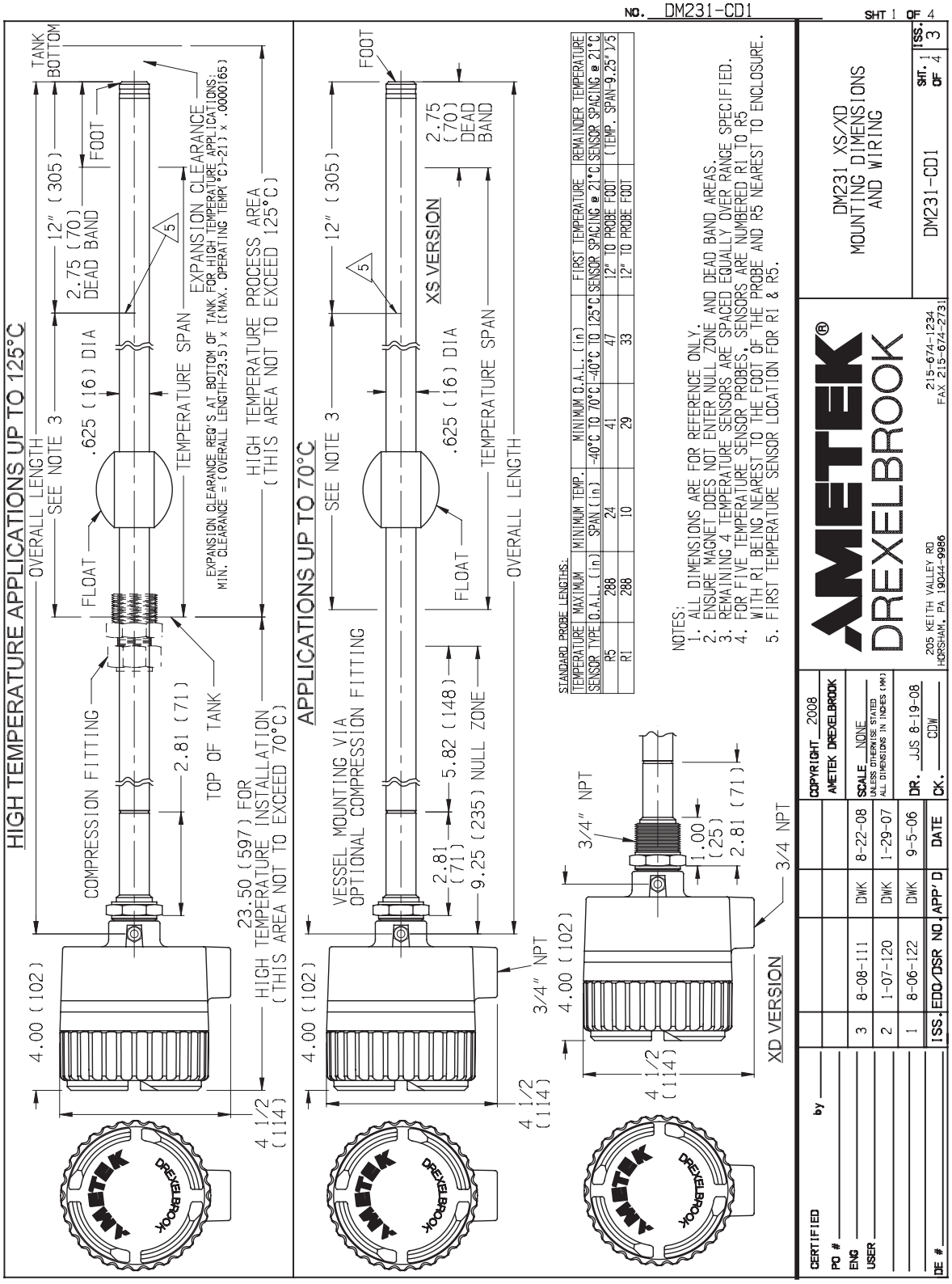
FM: (US and Canada)

-40° C ≤ Tamb. ≤ 125° C
XP Class I, Div. 1, Groups A, B, C, D T4
DIP Class II, III, Groups E, F, G, T4

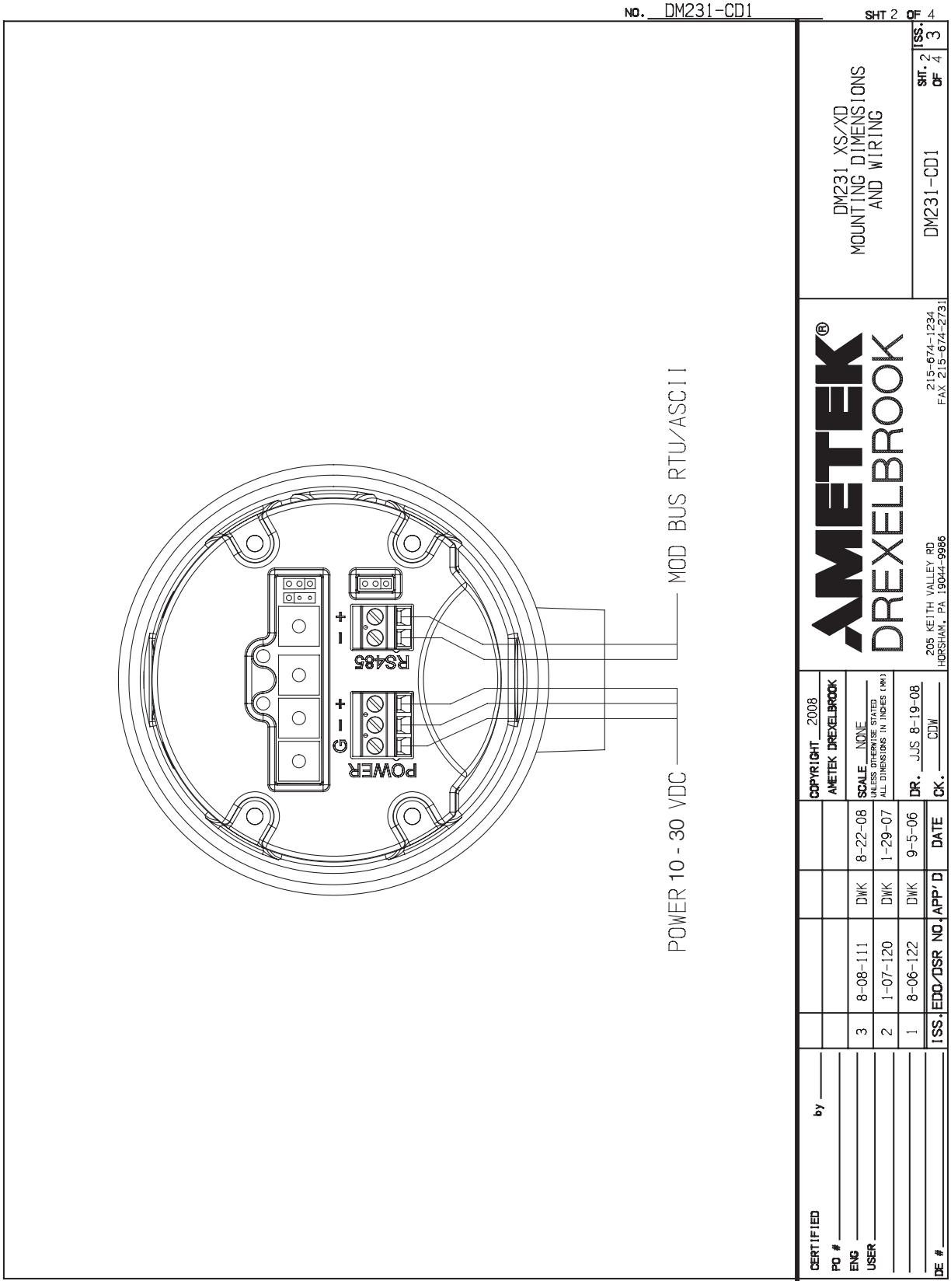
Specifications are subject to change without notice

Section 6: Drawings

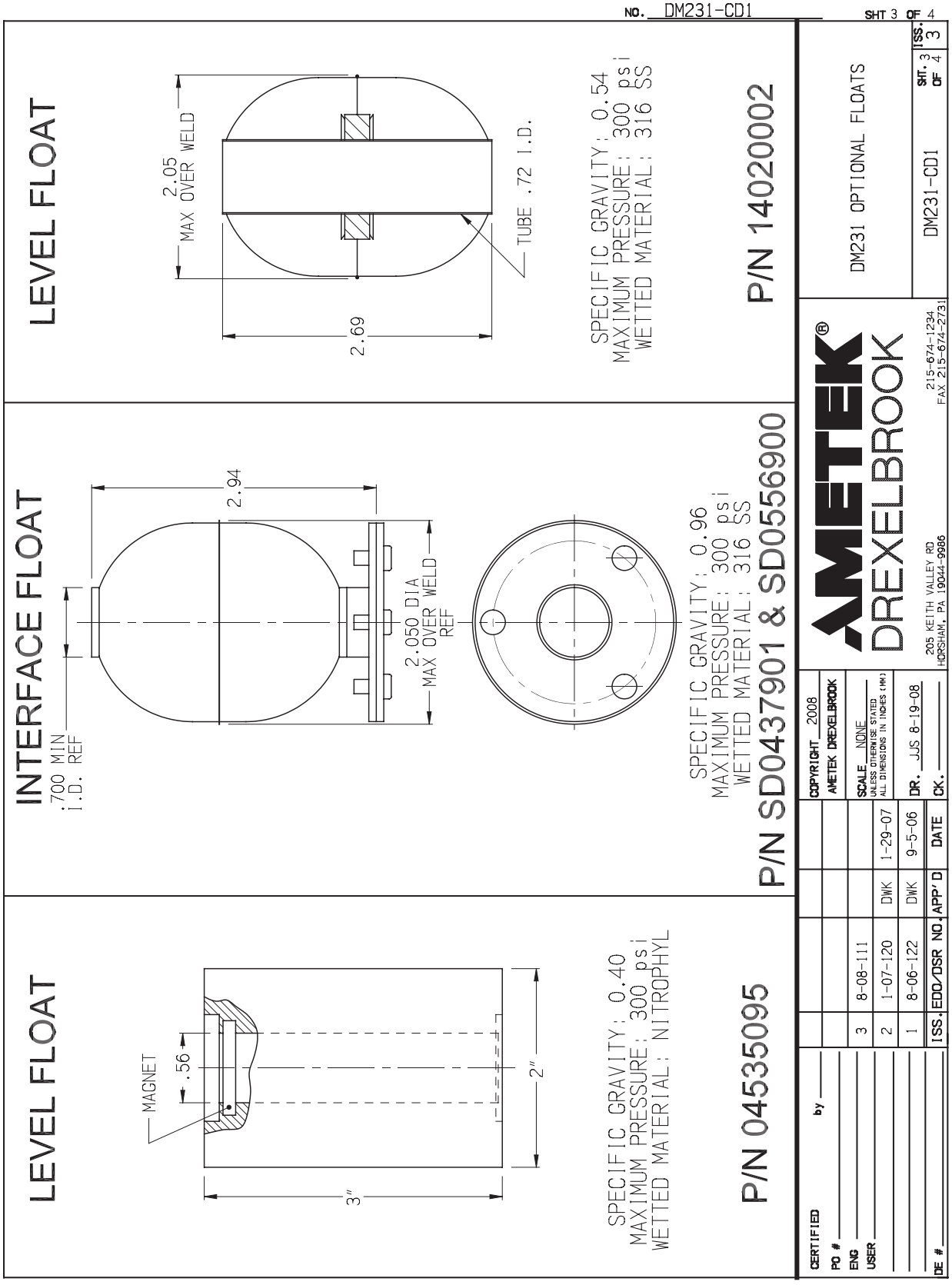
6.1 Installation Drawings



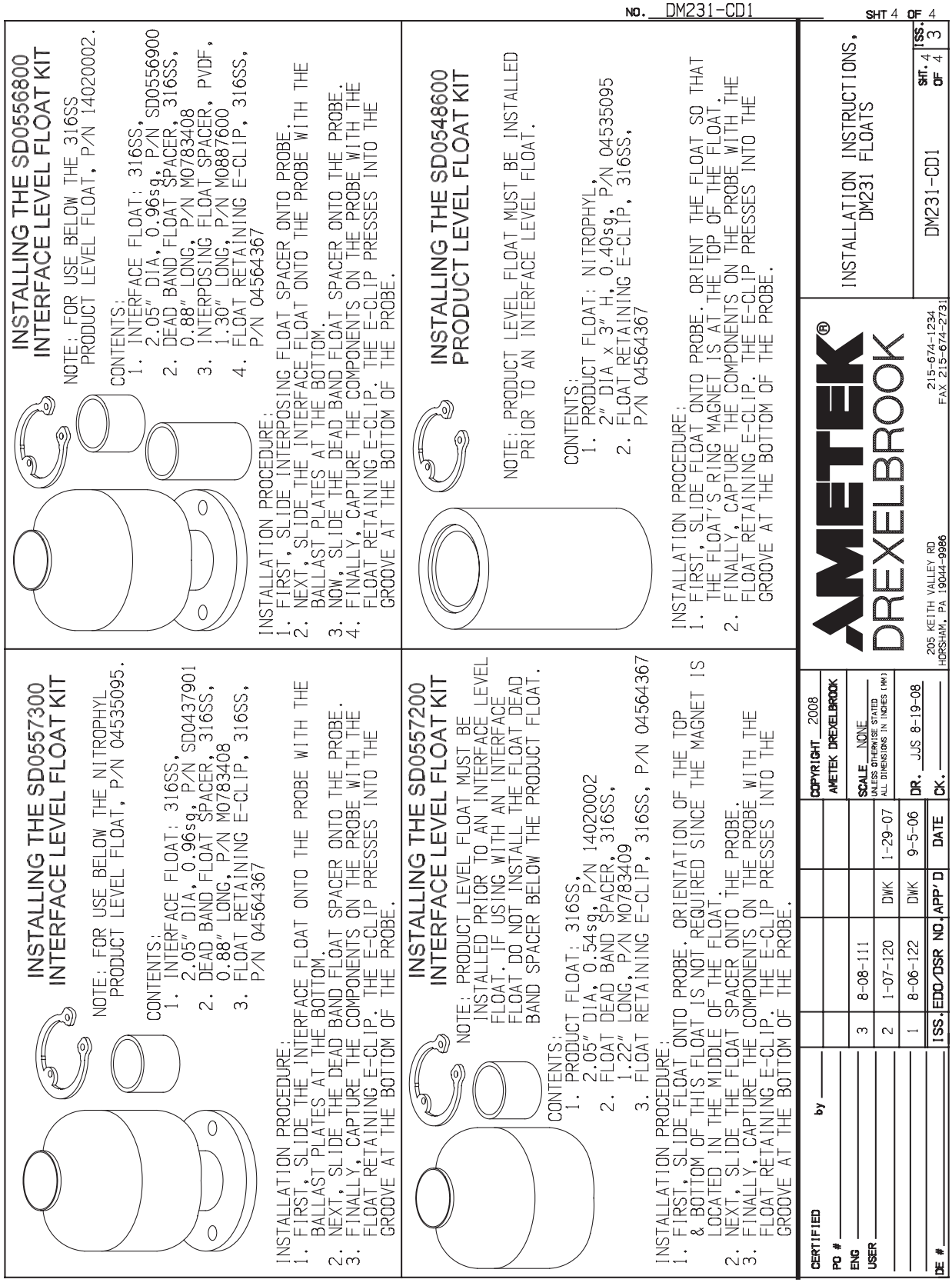
6.1 Installation Drawings (Continued)



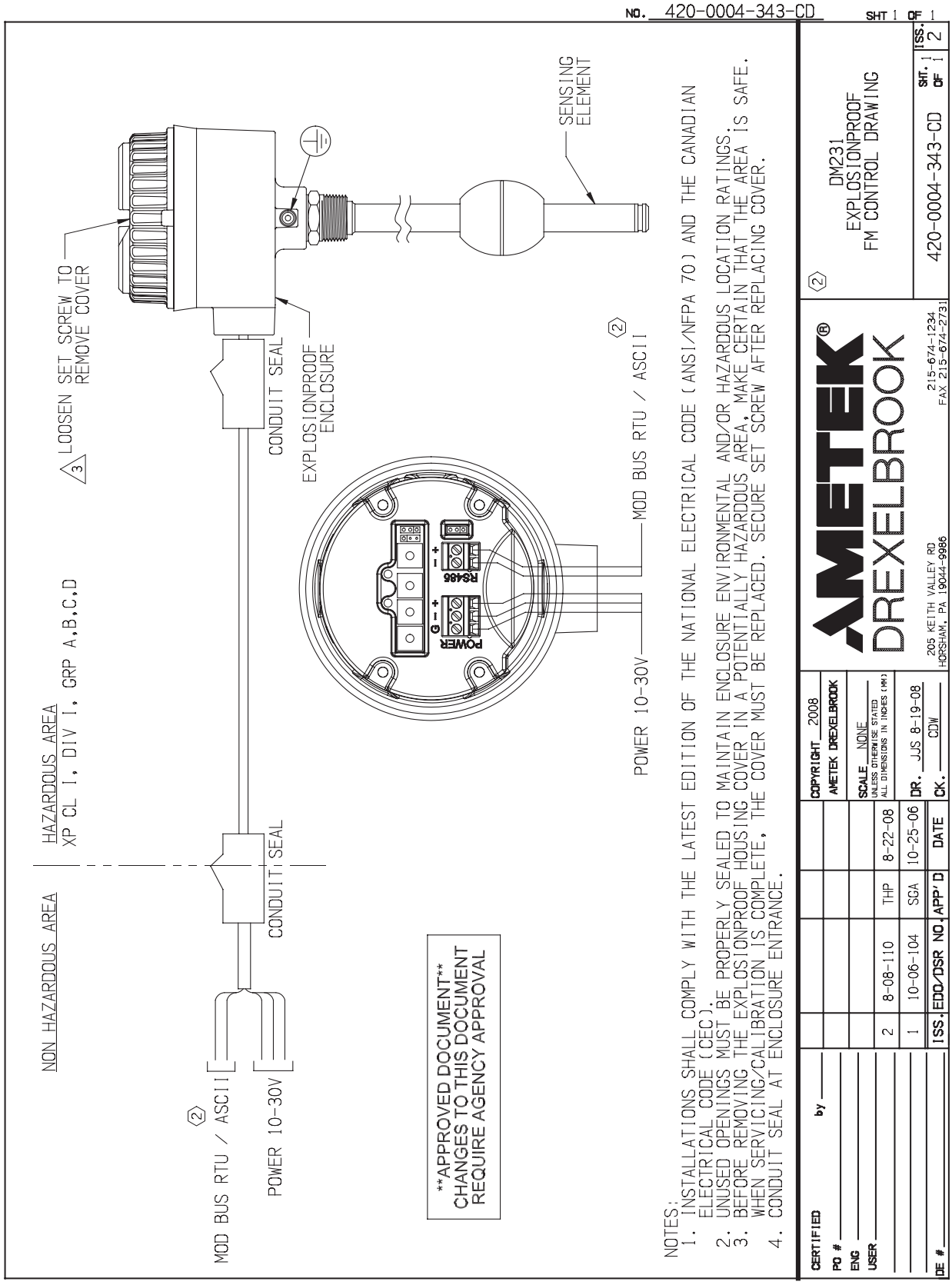
6.1 Installation Drawings (Continued)



6.1 Installation Drawings (Continued)



6.2 Control Drawings



AMETEK®
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