



Digital Level Sensor Model 2100 with High Level Shut-In

User Manual
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Description

The Model 2100 Digital Level Sensor is a solid-state device that measures and reports fluids level and temperatures in storage tanks. It is called a digital sensor because it reports the information in a serial bit stream. The sensor uses a float imbedded with magnets to sense the top of a fluid level(s). There is a temperature sensor mounted inside the tube 14 inches from the bottom. When the sensor is polled for data, a series of microprocessors read and determine the position of the float(s) along the sensor tube. The main microprocessor calculates the level and temperature and returns the data in a serial stream.

The HLS Option (High Level Shut-In) is a separate circuit from the continuous level circuitry and is distinguished by the RED flange at the top of the sensor tube. The HLS Option contains two distinct digital output circuits mounted on the upper one-foot of measurement. The lower (HI) circuit is normally closed and opens when the product float's magnetic field activates the switches and will remain open as long as the float is over the switches. The upper (HIHI) circuit is held normally closed by virtue of the High Level (HL) float resting on the HL float stop at 6" from the top of the total measurement. As the HL float rises the HIHI circuit will open, approximately 4" from the maximum measurement length of the sensor. This will be roughly the center of the overflow line on most tanks.

Communications

The serial communication protocol is RS485 2-wire or 4-wire, field selectable via jumpers on the fuse board. The baud rate is set to 9600, N, 8, 1. In 4-wire mode, one pair of wires is used strictly for transmitting and another pair is used for receiving. For 2-wire mode, only one pair of wires is needed for both transmit and receive. Two wires are needed for the power supply, therefore 4-wire communications require a 3-pair cable, while 2-wire communications require a 2-pair cable.

The digital outputs on the HLS Option are dry contact switches that require no voltage, but can accept up to 36vdc for intrinsically safe operation.

Wiring Connections

The sensor requires a power supply of 5.6 to 13 volts DC. To connect the sensor communication lines to the telemetry equipment, connect the sensor data receive to the RTU data transmit and the sensors data transmit to the RTU data receive for 4-wire RS485 communications. For 2-wire RS485 communications, connect TX/RX+ from the sensor to TX/RX+ on the receiving equipment and TX/RX- from the sensor to TX/RX- on the receiving equipment. The voltage supply can be connected to a switched output so power is applied only during sensor polling.

With the HLS Option, digital outputs require no voltage and are wired into the digital inputs of the telemetry equipment as specified by the telemetry equipment's wiring requirements. The digital outputs can also be used to control a solid state relay, but not drive a load directly.

Standard Installation

To install the sensor, follow the simple steps below while referring to the assembly diagram in Figure 2 at the end of this manual. For the High Level Shut-In option, refer to Figure 5 and the HLS Option Installation below.

1. For stainless steel square tube sensors, install the 2-inch hub sensor-grip and a reducer for the tank port size that is to be used. Slide this assembly onto the bottom of the tube. *Go to Step 3.*
2. For round fiberglass tube sensors (not available with HLS Option), install a reducer for the tank port size that is used on the tank. The reducer should be fed up the sensor tube and screwed onto the sensor cord grip fixed to the top of the sensor. Be careful tightening the cord grip and reducer so as not to damage the sensor. Loosen the cord grip and slide the assembly as far up the sensor as it will go. Hand-tighten it at this point. Reattach the upper hose clamp around the sensor tube at the top of the side strip.
3. Slide the float onto the sensor. The **yellow strip** on the side of the sensor tube must match up with the **white mark** on the float. On round fiberglass tubes, the white mark will line up on the ridge.
4. Install the float stop at the bottom of the sensor tube.
5. Install the DLS into the tank port, using the Installation Guide Tool, if necessary. Carefully insert the bottom end of the sensor into the tank top port and lower the sensor slowly into the tank. Be careful with the float so it does not hang up on the port edge.

CAUTION: DO NOT drop the sensor into the tank. The sensor contains many glass reed switches and a sharp impact will break them.

6. When the sensor end is resting on the tank bottom, slide the reducer/sensor-mount assembly down to the tank port and tighten it into the port. Tighten the sensor mount tight enough so the sensor cannot rotate by hand.
7. Unscrew the round side cover from the sensor top housing and feed the signal cable through the cord grip on the side of the sensor top. Unplug the gray, 6-position connector from the internal fuse board.
8. Make sure power is off before proceeding.
9. Using the white depressor tool, install the six wires (4-wire communication) or four wires (2-wire communication) as directed in the connection (hook-up) diagram in Figure 3.
10. Plug in the connector and replace the side cover.

HLS Option Installation

To install the sensor, follow the simple steps below while referring to the assembly diagram in Figure 5 at the end of this manual.

1. Apply thread sealant to cord grip and 3x2 or 4x2 Reducer Bushing.
2. Screw CG into Reducer Bushing with proper orientation.
3. Disassemble CG for ease of installation.
4. Locate the label on the top of the sensor tube to find the break in the label.
5. Slide separated parts onto the SS tube, beginning with the nut and gasket with mounted 3/16" tube against the side of the tube with the break in the label (nut must sit against gasket).
6. Assemble CG and slide the assembly up the sensor tube within one-foot from the top. Hand-tighten the nut to keep the CG assembly from sliding down.
7. Install the HLS Float on the tube with the mounting tab on the same side as the 3/16" tube and slide the float up next to the CG assembly.
8. Attach Stainless Steel Clip from float carrier to Stainless Steel wire loop.
9. Slide HLS Float Stop up the sensor tube and secure centered over the thin, yellow electrical tape.
10. Install the product and water interface float (if required) on the sensor tube, aligning the white paint on the float(s) with the yellow paint on the tube.
11. Install the Bottom Float Stop and tighten the mounting screw and set screw.
12. Install the DLS into the tank port, using the installation guide tool, if necessary.
13. Carefully lower the sensor into the tank port (avoid damaging the floats and test apparatus).
14. Make sure the HLS Stainless Steel wire is loose, but not excessively so.
15. Unscrew the cord grip nut completely to loosen the rubber gasket so the sensor can rest on the tank floor and not rotate.
16. Screw the cord grip and reducer bushing into the tank port.
17. Unscrew the chained screw cap from the test fixture to expose the pull-tab.
18. Push the gasket down to seat in the cord grip body.
19. The pull-tab should be loose, not taut.
20. If the pull-tab is taut, push the 3/16" tube into the gasket until it is loose.
21. Tighten the cord grip nut.
22. HLS INSTALLATION COMPLETE.

DLS Calibration Procedure - Setting the Initial Offset

The Model 2100 Digital Level Sensor is designed to provide an accurate and dependable level measurement for oil and water levels in production tanks. The only calibration required is to set the offset value in the DLS. This can be done in the DLS or at the EFM, RTU, or PLC by determining the difference of the level between the electronic reading and the actual fluid level in the tank, measured with an approved gauge line. Once the level offset is entered in either the DLS or SCADA system, the level offset will be added to the raw value of the DLS to provide an accurate fluid level.

The level offset is determined by reading the DLS with the HHC-1000 Hand-Held Communicator while simultaneously gauging the level in the tank. For best results, the tank should *not* be in active production so that the fluid is not agitated at the time of reading. If it is not possible to isolate the tank, then it is recommended to take several readings of both the DLS and gauge line to make sure the readings are consistent.

Note: If there is no fluid in the tank, the level offset cannot be determined.

Note: The level offset is always added to the raw value. If a mistake is made when entering the level offset, reset the offset value to zero before proceeding to avoid large swings in readings. If there is an offset programmed in the DLS and the actual level is not correctly displayed, simply changing the offset value will **not** include the previous offset value.

Example: If a 1.50" offset is in the DLS and the DLS is still reading $\frac{1}{4}$ " below actual level, the true offset should be 1.75". If you add a $\frac{1}{4}$ " offset, the level reading will be 1.50" below actual level. Resetting the level offset to zero will make it easier to determine the correct offset value.

Procedure:

1. Using the Hand-Held Communicator (HHC-1000), connect to the DLS and take initial readings of level and temperature. Refer to the *HHC -1000 User Manual* for instructions.
2. If readings are providing both water and oil levels, then verify that the two readings are more than 3" apart. If the difference is less than 3", the two floats will be touching and a valid offset cannot be determined.
3. Verify that the water level is more than 3". If less than 3", then the water float is sitting on the bottom of the tank and level offset cannot be determined.
4. Using a gauge line, measure the actual level in the tank and note the level. Subtract the electronic reading from the gauged level to determine the level offset value.

For example, if the actual level is 156.25" and the DLS reading is 155.50", then the offset value will be 0.75" ($156.25 - 155.50 = 0.75$).

5. To program the level offset in the DLS using the HHC-1000, go to the "Set Points" menu and then to the "Level" menu. Press F2 in the "Level" menu to bring up the level offset screen.
6. To set the total fluid level offset, enter a value of 1 for the top float and then enter the offset value. If the value is less than one, enter the decimal value, then press Enter.
7. To set the water-interface level offset, enter a value of 2 for the bottom float, then enter the offset value and press "Enter."
8. To verify that the offset is correct, return to the main screen and then read level and temperature values to verify the DLS is reading correctly.
9. Once the level offsets are entered, there is no further calibration required unless the DLS is removed and reinstalled in another tank.

Testing and Troubleshooting

If the sensor fails to respond or does not report an accurate level, several things could be at fault. See the list of symptoms below for help in diagnosing the problem.

Sensor does not respond:Sensor is new and recently installed:

- The sensor wiring is incorrect: Check with sensor connection (hook-up) diagram.
- Wrong baud rate: (Factory default is 9600)
- Wrong protocol: (Factory default is N81)
- There is insufficient voltage: The sensor needs at least 5.6 VDC.

Sensor has been in service for some time but is not working:

- There are corroded connections or damaged cables.
- Blown fuse or shorted suppressor on the barrier board (if equipped). Check the fuses with a continuity tester.
- There is possible damage to sensor electronics.

Sensor sends inaccurate level or temperature:

- An incorrect level or temperature offset is programmed into sensor, RTU, or host.
- An incorrect number of floats are programmed. Check the sensor protocol list to reprogram the sensor with the correct information (rigid sensors only).
- Sensor is HLS Option (v3.16) with float on. Not programmed for High Level.

Sensor doesn't report the top foot of measurement (v3.16, non- HLS).

- Sensor is programmed for High Level. Program sensor for no high level.

Sensor doesn't report the top foot of measurement (v3.16, HLS Option).

- Sensor is programmed for High Level. Correct response from sensor.

Sensor sends temperature but no valid level:

- If the sensor reports error code 1, the float is not on the sensor in the correct orientation. The white mark on the float must be on top of the strip on the side of the sensor.
- An incorrect number of floats are programmed. Check the sensor protocol command list to reprogram the sensor with the correct information.
- Sensor has a HLS float installed and isn't programmed for High Level.

Sensor sends Warning 3

- Sensor is programmed for HLS but no float is detected. Float is off scale or rotated 90 degrees.

Digital Outputs: (HLS Option only)

HI Switch not detected (Open): PT2000 connector(s) not fully seated in socket or product float is not within 1' of top of the sensor measurement.

HIHI Switch not detected (Open): Float is not installed, is rotated 90-degrees, or float stop is positioned incorrectly. The float stop should be centered over the thin, yellow electrical tape located near the top of the sensor tube. If there is no tape, use the following formula to locate the float stop mounting position by measuring from the bottom of the sensor tube: measurement length – 7", or measurement length – 1' + 5".

HIHI Switch not closed after installation: Float may be suspended from Teflon string. Unscrew "screw cap" from the test fixture attached to the mounting cord grip and gently pull up on the "pull-tab". If there is no slack in the string, push down on the 3/16" tube to insert the tube deeper into the tank until there is slack in the string and secure the screw cap properly. The mounting cord grip nut must be loose in order to push or pull on the 3/16" tube.

HLS Test

While the sensor is installed:

1. Open the cover of the DLS2100 to access the 2350R1 fuse board.
2. Connect the DMM probes to Con 4, pins 3 and 4, **HIHI** (Closed with float seated).
3. Unscrew the screw cap on the test fixture attached to the mounting cord grip.
4. Pull up gently on the pull-tab to raise the float to open the circuit.
5. Release the pull-tab to return the HLS float to the float stop to close the circuit.
6. Screw the screw cap back on the test fixture.
7. Disconnect the DMM.
8. Close the cover of the DLS2100

Digital Level Sensor Protocol

Command syntax

- Uppercase characters denote littorals in the command and response streams.
- Lowercase characters represent data fields in the command and response streams. Further explanation of data field structure is provided as necessary with each command.
- All commands are terminated with carriage return **<cr>**.
- All responses are terminated with **Ccccc** (cccc=16 bit CRC field in hexadecimal) followed by a carriage return linefeed pair **<cr><lf>**. All alpha hexadecimal characters are lower case.
- The prefix to all commands and responses is **Uuu** where *uu* is the unit number (00-31). The unit number is the identity of the level sensor to which a command is addressed or which generates the response. '*' may be used as a wild card character for either digit in the unit number field 'uu'. The responding level sensor will always convert wildcard characters to the actual unit number.
- Commands, which modify a level sensor configuration, always return the command string and 'OK' if successful. 'EEerr' replaces 'OK' if there is a problem storing the configuration data in the level sensor EEPROM.

Data Request Commands

Report Level and Temperature

Uuu?

where uu is a 2 digit unit number from 00 to 31("*" may be used as a wildcard for either digit)

Note: Do Not use the wildcard "*" if connected to more than one level sensor, as all sensors will respond simultaneously.

Response: **UuuDIII.IIFtttEeeeeWwwwww**

where uu = unit number

III.II = level in inches (repeated for sensors with 2 floats)

ttt = temperature in degrees F

eeee = error number

0 = No errors

- 1= No float detected
- 2 = One float is out of range on a two-float sensor
- 3 = Too many groups
- 4 = (reserved)
- 5 = Transmit to slave processor for level failed
- 6 = Transmit to slave processor for temperature failed
- 7 = Receive from slave processor of level failed
- 8 = Receive from slave processor of temperature failed
- 9 = No slave processors responding

Note: *If errors 5 through 9 occur and persist after power cycling, the sensor should be returned for repair.*

www = warning number

0 = No warnings

1 = Possible level degradation

2 = Possible level degradation due to level offset

3 = No float detected on a sensor programmed for HLS (v3.16 and higher)

Under normal circumstances the warning field is 0. It will display 1 if the sensor is configured for two floats and only one group of switches is detected (i.e., only one float is present or both floats are abutted).

Note: *The number of decimal places in a data field implies nothing about the accuracy of the data, i.e., levels are not accurate to 0.01 inches.*

Report Level and Temperature Continuously (factory diagnostics)

Uuu??

Response: **Same as above**, except continuously with internal module configuration and reported individual switch activation and groups of activated switches.

Note: *The unit must be powered down before it will respond to other commands.*

Report 4-20mA output level (version 3.09 and higher)

Uuu?M

Response:

UuuMhhhhEeeeeWwww

Where uu = unit number

hhhh = hex value 0x0000-0xFFFF

eeee = error number

0 = No errors

1= No float detected

2 = One float is out of range on a two-float sensor

3 = Too many groups

4 = (reserved)

5 = Transmit to slave processor for level failed

- 6 = Transmit to slave processor for temperature failed
- 7 = Receive from slave processor of level failed
- 8 = Receive from slave processor of temperature failed
- 9 = No slave processors responding

Note: *If errors 5 through 9 occur and persist after power cycling, the sensor should be returned for repair.*

www = warning number

- 0 = No warnings
- 1 = Possible level degradation
- 2 = Possible level degradation due to level offset
- 3 = No float detected on a sensor programmed for HLS (v3.16 and higher)

Report Temperature only

Uuu?T

Response: UuuFxxEeeeeWwww

Where

xx= temperature

Configuration Commands

Assign Unit Number

UuuNnn

Where

uu = unit number (from 00 to 31)

nn = new unit number

Note: Unit number 00 is not valid in Modbus RTU mode

Response: **UuuNOK**

Where

uu = newly assigned unit number

Assign Unit Number to Sensor With the Corresponding Serial Number (version 3.15 and higher)

UsssssssNnn

sssssss= seven-digit serial number

nn= two-digit unit number

Response:

UuuNOK

uu = new unit number

UuuEEerr Write to EEPROM failed

Set Baud Rate

UuuBbbbb[b][pds]

Where

bbbb[b] = 1200, 9600, 14400, 19200, or 38400, (9600 is default); 57600 (v3.15 and higher)

pds = parity, data length, stop bit (pds options)

N81

(default)

E71

O71

For example to program Unit 00 to 9600 E 7 1 would be U00B9600E71

Note: It is not necessary to power down the Model 2100 before this command takes effect. The Model 1000 must have power cycled for this command to take effect.

Response: **UnnBOK**

Set Number of Floats

UuuFn

Where

uu = unit number

n = float number (1 or 2 – Standard; 11 or 12 – 1/8" Resolution; 11- Single Float; 12 – Dual float)

Response: **UuuFOK**

Set Level Offset

UuuLOslll Sets the offset for the levels sensor Where

uu = unit number

slll = sign and offset with two implied decimal places

Note: If two floats, assigns the same offset to both

Response: **UuuOLOK**

Set Level Offsets for Individual Floats

UuuL[1|T]Oslll.ll Sets the top float offset.

Example of setting top level offset for Unit 00 to 2.25 inches - U00L1O2.25

UuuL[2|B]Oslll.ll Sets the bottom float offset. (*Dual Float Sensor only*)

Example of setting bottom level offset for water interface to 1.75 inches - U00L2O1.75

Where

uu = unit number

slll.ll = sign and offset with two implied decimal places. The Plus (+) sign is assumed.

The Minus (-) must precede the offset value if required.

If no decimal places are required, then you do not need to add to value

Note: "O" in the command is the letter O and not the number zero

Response: **UuuLOOK**

Set Temperature Offset

UuuOFsoo Where

uu = unit number

soo = -99 to 99 (optional sign)

Response: **UuuOFOK**

Set Multiple Temperature Sensor Offsets**UuuTnOso.o**

Where

uu = unit number

n = temperature sensor identifier (1-8, 1 is at

top) so.o = -9.9 to 9.9 degrees (optional sign)

Response: **UuuTnOOK**

Set Receive to Transmit delay

UuuRmm

m Where

uu = unit number

mmm = milliseconds (50 to 250). The default is 127ms

Response: **UuuROK**

Set 4-20mA Poll Period

UuuMPpppp

Where

uu = unit number

pppp = seconds (Default is 30 seconds)

Response: **UuuMPOK**

NOTE: Poll Periods less than 20 seconds may shorten the life expectancy of the 4/20mA converter board. The relay (which power cycles the sensor to reduce power consumption) is rated for 10,000,000 cycles.

Set 4-20mA Minimum (4mA) Range

UuuMINmm.mm

Where

uu = unit number

mm.mm = level for 4mA output (Default is

00.00) Response: **UuuMINOK**

Set 4-20mA Maximum (20mA) Range

UuuMAXmmm.mm

Where

uu = unit number

mmm.mm = level for 20mA output in inches (Default is 240.00")

Example: For 20 foot long sensors = 240.00

Response: **UuuMAXOK**

Set the Level Error setting (version 3.09 and higher)

UuuSETERR

Rx Where

uu = unit number

x = 0 will set the level error report to be 999.99. This is the default setting.

x = 1 will set the level error report to be 000.00.

Response: UuuSETERROK

Set the Modbus 16 bit Unsigned Integer, 32 bit or 2 x 16 bit floating point mode

UuuIFxxxx

Where

uu = unit number

xxxx = 1007 will set the 16 bit Unsigned integer mode. This is the default setting.

xxxx = 1008 will set the 32 bit floating point mode.

xxxx = 1009 will set the 2x16 bit floating point mode (**v3.14 and higher**).

Response: UuuIFOK

Force sensor to enter Boot Load mode (version 3.15 and higher, (future use))

UuuFB

uu = two-digit unit number

Response: **none**

Enter High level Electronic Shut Down (ESD mode) (version 3.15 and higher)**UuuESDONn**

uu = unit number

n = one-digit number from 1 to 3 which represent the number of level request commands that will respond with the maximum level without cycling power. After this number, the sensor reverts to normal operation (Note: If power is cycled, then the count reverts back to programmed number of polls).

Response: **UuuESDONOK** ESD mode was successfully activated

Exit High level Electronic Shut Down (ESD mode) (version 3.15 and higher)**UuuESDOFF**

Response: **UuuESDOFFOK** ESD mode exit successfully

Note: UuuESDON0 also turns off ESD mode

Enable High Level Shut-In (version 3.16 and higher)

UuuHLnnn

Where

uu = unit number

nnn = level in inches from top of measurement

Response: **UuuHLOK**

Factory Programmed if HLS Option

Configuration Request Commands**Report Number of Floats**

UuuF?

Response: **UuuFn**

Where

uu = unit number

n = number of floats (1 or 2- Standard; 11 or 12 – 1/8" Resolution; 11 – Single Float; 12 – Dual Float).

Report Level Offsets

UuuLO?

Response:

UuuL1Osnn.nnL2Osnn.nn Where

uu = unit number

snn.nn = sign and offset with two implied decimal places

Report Temperature Offset

UuuOF?

Response: **UuuOFsff**

Where

uu = unit number s = sign

ff = temperature offset (degrees F)

Report Multiple Temperature Offsets

UuuTO?

Response: **UuuTnOso.o..... \pm TnOsn.n** repeated for additional temperature sensors

Where

uu = unit number

n = temperature sensor (1-8, 1 is top sensor)

s = sign

o.o= temperature offset

Report Switch Distance

UuuD?

Response: **UuuDd**

Where

uu = unit number

d = distance between switches as integral tenths of an inch (e.g., 5 = 0.5 inches, 10=1 inches)

UuuR?

Response: **UuuRmmm**

Where

uu = unit number

mmm = delay

Report Total Switches

UuuS?

Response: **UuuSssss**

Where

uu = unit number

ssss = total number of switches in the sensor

Report Receive to Transmit delay

UuuR?

Response: **UuuRmmm**

Where

uu = unit number

mmm = delay in milliseconds

Report 4-20mA Configuration

UuuMC?

Response: **UuuPppppL1_4MAII.II_20MAhhh.hh**

Where

uu = unit number

Ppppp = Polling period in seconds L1 = Data source is top float

_4MAII.II = Level to output 4 mA

_20MAhhh.hh = Level to output 20 mA

Report Serial Number

UuuSN?

Response: UuuSNxxxxxxx

Where

uu = unit number

xxxxxxx = serial number.

Report Unit Number corresponding to Serial Number (version 3.15 and higher)

UssssssN?

ssssss = seven digit serial number

Response: UssssssNuu

uu = unit number

Report sensor Health Status (version 3.15 and higher)

UuuH?

uu = two digit unit number

Response:

grp0=ttt-bbb--

grp1=ttt-bbb

grp3=ttt-bbb--

grp4=ttt-bbb

UuuDIII.II[DIII.II]Fttt[Fttt.....]EeeeeWw

www BATTERY-VOLTAGE:vv.vV

If sensor works in normal operation parameters the message
will be UuuSENSOR-OK

Error, one or more of the following Error

messages NO-SWITCH-CLOSED

ONLY-ONE-GROUP-FOUND-ON-A-TWO-FLOAT-
SYSTEM TOO-MANY-GROUPS-TO-RESOLVE-THE-
LEVEL

NO-FLOAT-CONFIGURED

TRANSMIT-TO-PIC-PROCESSOR-FOR-LEVEL-
FAILED RECEIVE-FROM-PIC-PROCESSOR-FOR-
LEVEL-FAILED TRANSMIT-TO-PIC-PROCESSOR-
FOR-TEMP-FAILED RECEIVE-FROM-PIC-
PROCESSOR-FOR-TEMP-FAILED

Warning, one or all of the following Warning

messages: WARNING!-POSSIBLE-LEVEL-

DEGRADATION

WARNING!-POSSIBLE-LEVEL-DEGRADATION-DUE-TO-OFFSET

WARNING!-HIGH-LEVEL-FLOAT-MISSING (v3.16 and Higher)

Report the Level Error setting (version 3.09 and higher)

UuuSETERR?

Response:

UuuSETERR=x

Where

uu = unit number

x = 0 is set for level error report to be 999.99 (default)

x = 1 is set for level error report to be 000.00

Report the Modbus 16 bit Unsigned Integer, 32 bit or 2 x 16 bit floating point mode

UuuIF?

Response: **UuuIF=x**

Where

uu = unit number

x = 0 is set for 16 bit Unsigned integer mode. This is the default setting. x = 1 is set for 32 bit floating point mode.

x = 2 is set for 2x16 bit floating point mode (**v3.14 and higher**)

Report Battery Voltage

UuuBV?

Response :**UuuBVvv.vV**

Where

uu = unit number

vv.v = battery voltage in volts

Report High Level Trigger (version 3.16 and higher)

UuuHL?

Response :**UuuHLnnn**

Where

uu = unit number

nnn = trigger level, in inches, from top of level measurement

Used with HLS Option

Modbus Registry Map

Read/Write functions are given in Table 1. The read only functions in the holding registry are referenced in Table 2 and Table 3. The sensor warnings codes are provided in Table 4 and the error codes are given in Table 5.

Table 1. Read/Write Registers

Configuration Registers	Register Read/Write	Address	No. Reg.	Notes	Integer Type
ESD ON: 0 = ESD off 1 to 3 ESD ON, 1 to 3 times	40106	105	1	R/W Factory setting: 0	16 bit Unsigned (v3.15 and higher)
Assign Sensor unit number	40107	106	1	Default value is 1	16 bit Unsigned
Select 16 bit unsigned integer (0) or 32 bit floating point (1) for registers that hold top float, bottom float, and temperature or 2x 16 bit floating point (2)	40108	107	1	Factory setting: 16 bit unassigned integer (see Note for advanced users)	16 bit Unsigned
Set baud rate (1200, 9600, 14400, 19200, 38400) (57600 v3.15 and higher)	40109	108	1	Factory setting: 9600	16 bit Unsigned
Set parity: 78 (N) = No parity	40110	109	1	Factory setting: 78	16 bit Unsigned
79 (O) = Odd parity 69 (E) = Even parity					
Set data bit: 8	40111	110	1	Factory setting: 8	16 bit Unsigned
Set stop bit: 1	40112	111	1	Factory setting: 1	16 bit Unsigned
Rx to Tx delay [ms]: 50 to 250	40113	112	1	Factory setting: 127	16 bit Unsigned
Set number of floats: 1, 2, 11 or 12	40114	113	1	Factory setting: 1	16 bit Unsigned
Level error report: 0 or 1	40115	114	1	Factory setting: 0	16 bit Unsigned
K factor x 100: 10 to 1000 bbls/in	40116	115	1	Factory setting: 167	16 bit Unsigned
Top level offset x 100: -9999 to 9999	40117	116	1	Factory setting: 0	16 bit Signed

Bottom level offset x 100: -9999 to 9999	40118	117	1	Factory setting: 0	16 bit Signed
Temperature offset1 x 10: -99 to 99	40119	118	1	Factory setting: 0	16 bit Signed
Temperature offset2 x 10: -99 to 99	40120	119	1	Factory setting: 0	16 bit Signed
Temperature offset2 x 10: -99 to 99	40121	120	1	Factory setting: 0	16 bit Signed
Temperature offset4 x 10: -99 to 99	40122	121	1	Factory setting: 0	16 bit Signed
Temperature offset5 x 10: -99 to 99	40123	122	1	Factory setting: 0	16 bit Signed
Temperature offset6 x 10: -99 to 99	40124	123	1	Factory setting: 0	16 bit Signed
Temperature offset7 x 10: -99 to 99	40125	124	1	Factory setting: 0	16 bit Signed
Temperature offset8 x 10: -99 to 99	40126	125	1	Factory setting: 0	16 bit Signed
Sensor Description Registers					
Serial number high	40127	126	1	Read only	16 bit Unsigned
Serial number medium high	40128	127	1	Read only	16 bit Unsigned
Serial number medium low	40129	128	1	Read only	16 bit Unsigned
Serial number low	40130	129	1	Read only	16 bit Unsigned
Version number	40131	130	1	Read only	16 bit Unsigned
Number of modules: 1 to 8	40132	131	1	Read only	16 bit Unsigned
Number of switches	40133	132	1	Read only	16 bit Unsigned
Switch distance x 10: 5 or 10	40134	133	1	Read only	16 bit Unsigned
Number of temperature sensors: 1 to 8	40135	134	1	Read only	16 bit Unsigned
Sensor status: 0 or 1, 0= Good 1= Sensor errors or low battery	40136	135	1	Read only	16 bit Unsigned (v3.15 and higher)
Group 0 top	40137	136	1	Read only	16 bit Unsigned (v3.15 and higher)

Group 0 bottom	40138	137	1	Read only	16 bit Unsigned (v3.15 and higher)
Group 1 top	40139	138	1	Read only	16 bit Unsigned (v3.15 and higher)
Group 1 bottom	40140	139	1	Read only	16 bit Unsigned (v3.15 and higher)
Group 2 top	40141	140	1	Read only	16 bit Unsigned (v3.15 and higher)
Group 2 bottom	40142	141	1	Read only	16 bit Unsigned (v3.15 and higher)
Group 3 top	40143	142	1	Read only	16 bit Unsigned (v3.15 and higher)
Group 3 bottom	40144	143	1	Read only	16 bit Unsigned (v3.15 and higher)

Table 2. Holding Registers

Sensor Data	Register	Address	No. Reg.	Values	Type
Float 1 (Top Float)	43991	3990	1	Read Only	Total Fluid Level in Tank 16 bit Unsigned integer or 32 bit floating point
Float 2 (Bottom Float)	43992	3991	1	Read Only	Water Interface Level in Tank 16 bit Unsigned integer or 32 bit floating point
Oil Level in Tank (top to bottom)	43993	3992	1	Read Only	Oil Level in Tank (top-bottom) 16 bit Unsigned integer or 32 bit floating point
Total Volume (top level x K_factor)	43994	3993	1	Read Only	Total Volume (top level x K factor) 16 bit Unsigned integer or 32 bit floating point
Oil Volume (top level – bottom level) x K_factor	43995	3994	1	Read Only	Oil Volume 16 bit Unsigned integer or 32 bit floating point
Water Volume (bottom level x K_factor)	43996	3995	1	Read Only	Water Volume 16 bit Unsigned integer or 32 bit floating point
Temperature1	43997	3996	1	Read Only	Temperature1 16 bit Unsigned integer or 32 bit floating point
Temperature2	43998	3997	1	Read Only	Temperature2 16 bit Unsigned integer or 32 bit floating point
Temperature3	43999	3998	1	Read Only	Temperature3 16 bit Unsigned integer or 32 bit floating point
Temperature4	44000	3999	1	Read Only	Temperature4 16 bit Unsigned integer or 32 bit floating point
Temperature5	44001	4000	1	Read Only	Temperature5 16 bit Unsigned

					integer or 32 bit floating point
Temperature6	44002	4001	1	Read Only	Temperature6 16 bit Unsigned integer or 32 bit floating point
Temperature7	44003	4002	1	Read Only	Temperature7 16 bit Unsigned integer or 32 bit floating point
Temperature8	44004	4003	1	Read Only	Temperature8 16 bit Unsigned integer or 32 bit floating point
Battery Voltage	44005	4004	1	Read Only	Battery Voltage (*100 for 16 bit) 16 bit Unsigned integer or 32 bit floating point
Error Register:	44006	4005	1	Read Only	16 bit Unsigned integer (See Notes)
Warnings Register:	44007	4006	1	Read Only	16 bit Unsigned integer (See Notes)

Table 3. Holding Registers (2 x 16 bit)

Sensor Data	Register	Address	No. Reg.	Values	Type
Float 1 (Top Float)	45001	5000	2	Read Only	Total Fluid Level in Tank Floating point upper two bytes (v3.14 and higher)
	45002	5001		Read Only	Total Fluid Level in Tank Floating point lower two bytes (v3.14 and higher)
Float 2 (Bottom Float)	45003	5002	2	Read Only	Water Interface Level in Tank Floating point upper two bytes (v3.14 and higher)
	45004	5003		Read Only	Water Interface Level in Tank Floating point lower two bytes (v3.14 and higher)
Oil Level in Tank (top to bottom)	45005	5004	2	Read Only	Oil Level in Tank(top-bottom) Floating point upper two bytes (v3.14 and higher)
	45006	5005		Read Only	Oil Level in Tank(top-bottom) Floating point lower two bytes (v3.14 and higher)
Total Volume (top level x K)	45007	5006	2	Read Only	Total Volume(top level x K factor) Floating point upper two bytes

factor)					(v3.14 and higher)
	45008	5007		Read Only	Total Volume(top level x K factor) Floating point lower two bytes (v3.14 and higher)
Oil Volume (top level – bottom level) x K factor	45009	5008	2	Read Only	Oil Volume (v3.14 and higher) Floating point upper two bytes
	45010	5009		Read Only	Oil Volume (v3.14 and higher) Floating point lower two bytes
Water Volume (bottom level x K factor)	45011	5010	2	Read Only	Water Volume(bottom level x K factor) Floating point upper two bytes (v3.14 and higher)
	45012	5011		Read Only	Water Volume(bottom level x K factor) Floating point lower two bytes (v3.14 and higher)
Temperature1	45013	5012	2	Read Only	Temperature1 (v3.14 and higher) Floating point upper two bytes
	45014	5013		Read Only	Temperature1 (v3.14 and higher) Floating point lower two bytes
Temperature2	45015	5014	2	Read Only	Temperature2 (v3.14 and higher) Floating point upper two bytes
	45016	5015		Read Only	Temperature2 (v3.14 and higher) Floating point lower two bytes
Temperature3	45017	5016	2	Read Only	Temperature3 (v3.14 and higher) Floating point upper two bytes
	45018	5017		Read Only	Temperature3 (v3.14 and higher) Floating point lower two bytes
Temperature4	45019	5018	2	Read Only	Temperature4 (v3.14 and higher) Floating point upper two bytes
	45020	5019		Read Only	Temperature4 (v3.14 and higher) Floating point lower two bytes
Temperature5	45021	5020	2	Read Only	Temperature5 (v3.14 and higher) Floating point upper two bytes
	45022	5021		Read Only	Temperature5 (v3.14 and higher) Floating point lower two bytes
Temperature6	45023	5022	2	Read Only	Temperature6 (v3.14 and higher) Floating point upper two bytes
	45024	5023		Read Only	Temperature6 (v3.14 and higher) Floating point lower two bytes
Temperature7	45025	5024	2	Read Only	Temperature7 (v3.14 and higher) Floating point upper two bytes
	45026	5025		Read Only	Temperature7 (v3.14 and higher) Floating point lower two bytes
Temperature8	45027	5026	2	Read Only	Temperature8 (v3.14 and higher) Floating point upper two bytes
	45028	5027		Read Only	Temperature8 (v3.14 and higher) Floating point lower two bytes

Battery Voltage	45029	5028	2	Read Only	Battery Voltage(*100 for 16 bit) Floating point upper two bytes (v3.14 and higher)
	45030	5029		Read Only	Battery Voltage(*100 for 16 bit) Floating point lower two bytes (v3.14 and higher)
Error Register (see Table 4)	45031	5030	2	Read Only	Floating point upper two bytes (See Notes) (v3.14 and higher)
	45032	5031		Read Only	Floating point lower two bytes (See Notes) (v3.14 and higher)
Warnings Register (see Table 3)	45033	5032	2	Read Only	Floating point upper two bytes (See Notes) (v3.14 and higher)
	45034	5033		Read Only	Floating point lower two bytes (See Notes) (v3.14 and higher)

Table 4. Warning Codes

Binary Value (for 16 bit Unsigned)	Warning Code	Indication
	0	No warnings
Bit 0	1	Possible level degradation
Bit 1	2	Possible level degradation due to level offset
Bit 4	3	High Level float missing (v3.16 and higher)

Table 5. Error Codes

Binary Value (for 16 bit Unsigned)	Error Code	Indication
	0	No errors
Bit 0	1	Can't resolve level reading or no float is detected
Bit 1	2	One float is out of range on a two float sensor
Bit 2	4	Too many groups
Bit 3	8	Not used
Bit 4	16	Transmit to slave processor for level failed
Bit 5	32	Transmit to slave processor for temperature failed
Bit 6	64	Receive from slave processor for level failed
Bit 7	128	Receive from slave processor for temperature failed
Bit 8	256	No slave processor responding

Notes for advanced users: Writing 1007 at register address 107 will set register 107 to "0", and will set the device registers that hold top float, bottom float, and temperature to 16 bit Unsigned integer. Writing 1008 at register address 107 will set register 107 to "1", and will set the device hold registers 43991(3990) to 44007(4006) to 32 bit floating point format. Writing 1009 at register address 107 will set register 107 to "2", and will set the device hold registers 45001(5000) to 45034(5033) to 2 x 16 bit floating point format. Reading register 107 will return "0" for 16 bit, "1" for 32 bit floating point, and "2" for 2 x 16 bit floating point format.

Model 2100 DLS Specifications

Measurement Length:

Available from 2 to 35 feet in length

Tubing Material:

316L stainless steel: standard 18 gauge: standard

Fiberglass: optional

Float:

Nitrophyl/stainless steel

One used for single liquid

Two used for 2 liquids

Designed to fit though a 3 inch NPT female tank port (Stainless Steel)

Designed to fit though a 4 inch NPT female tank port (Fiberglass)

Level measurement increments and accuracy:

1/4 inch resolution, +/- 1/8 inch accuracy

1/2 inch resolution, +/- 1/4 inch accuracy

Operating Temperature Range:

-40° C to +85° C

Temperature Measurement:

First sensor 12 inches from bottom

Up to 8 temperature sensors available with desired spacing: optional

+/- 1.5° C accuracy

Power Requirements:

5.6 VDC to 13 VDC

Power Consumption:

15mA nominal

20mA maximum

Pressure:

15 psi: standard

Higher pressure ratings available as custom orders

Communication:

RS485

Two- or four-wire communications

Baud rate and parity programmable (up to 57600 baud on v.3.15 and higher)

4-20mA signal available when connected to digital-to-analog converter board

Wireless capable

Protocol:

Modbus RTU 16 bit unsigned integer*

Modbus RTU 32 bit floating point*

Modbus RTU (2x 16 bit) for alternate 32 bit floating point**

Serial data via ASCII

*Note Modbus RTU available in version 3.13 and higher.

**Available in version 3.14 and higher.

Wiring:

Two-wire communication: two twisted pair, (16-18 AWG) recommended

Four-wire communication: three twisted pair, (16-18 AWG) recommended

Digital Outputs, (16-18 AWG) recommended

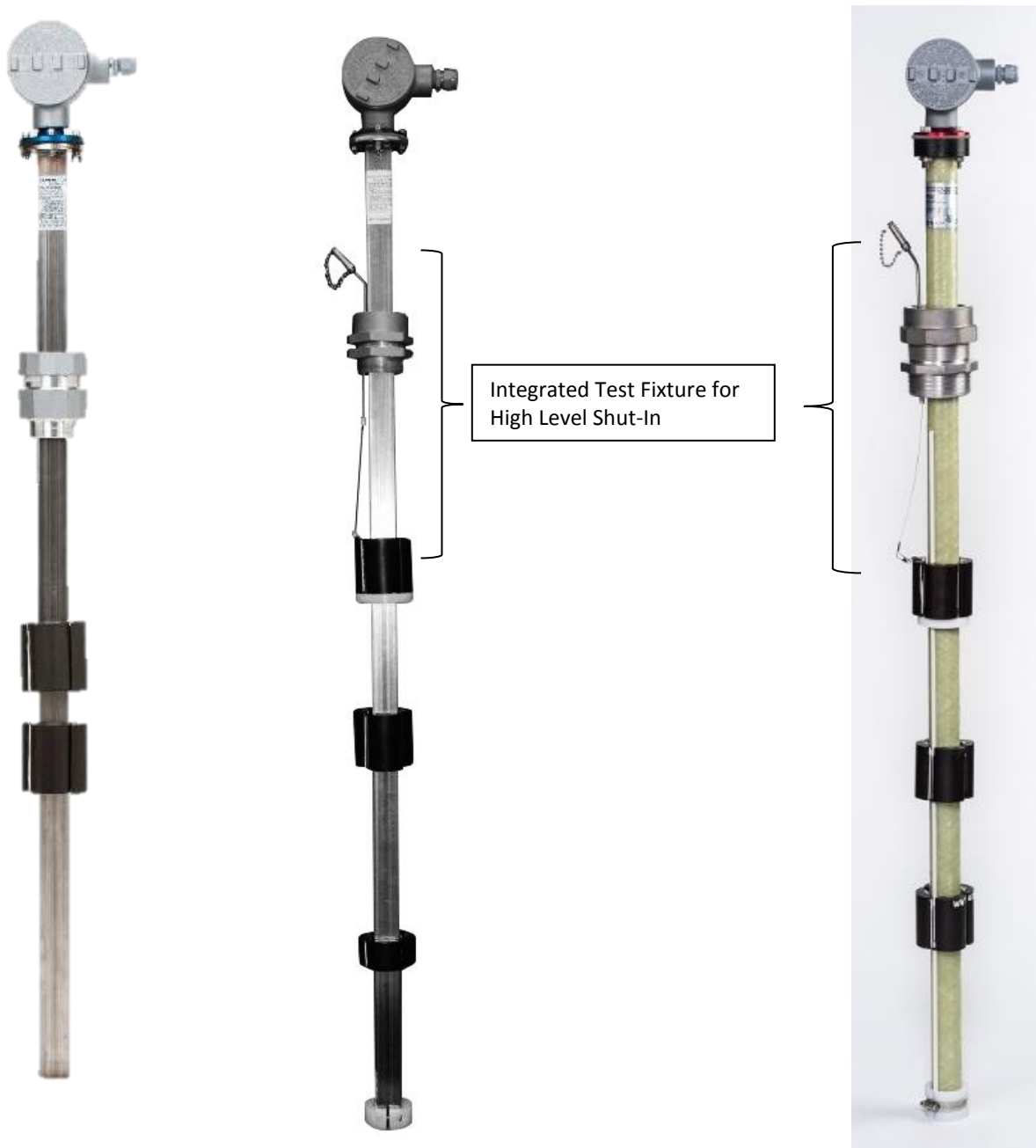
Classification:

Class I, Div 1, Group D Hazardous Locations (when connected to an approved intrinsically safe barrier)

Certification:

ANSI/UL-913

CAN/CSA C22.2, No. 157



Photos Model 2100 DLS and Model 2100 DLS with High Level Shut-In.



**Figure 1. Model 2100 Digital Level Sensor (on left with blue flange)
Model 2100 with High Level Shut-In (on right with red flange)**



Model DLS2100 – Fiberglass with HLS (Red Flange)

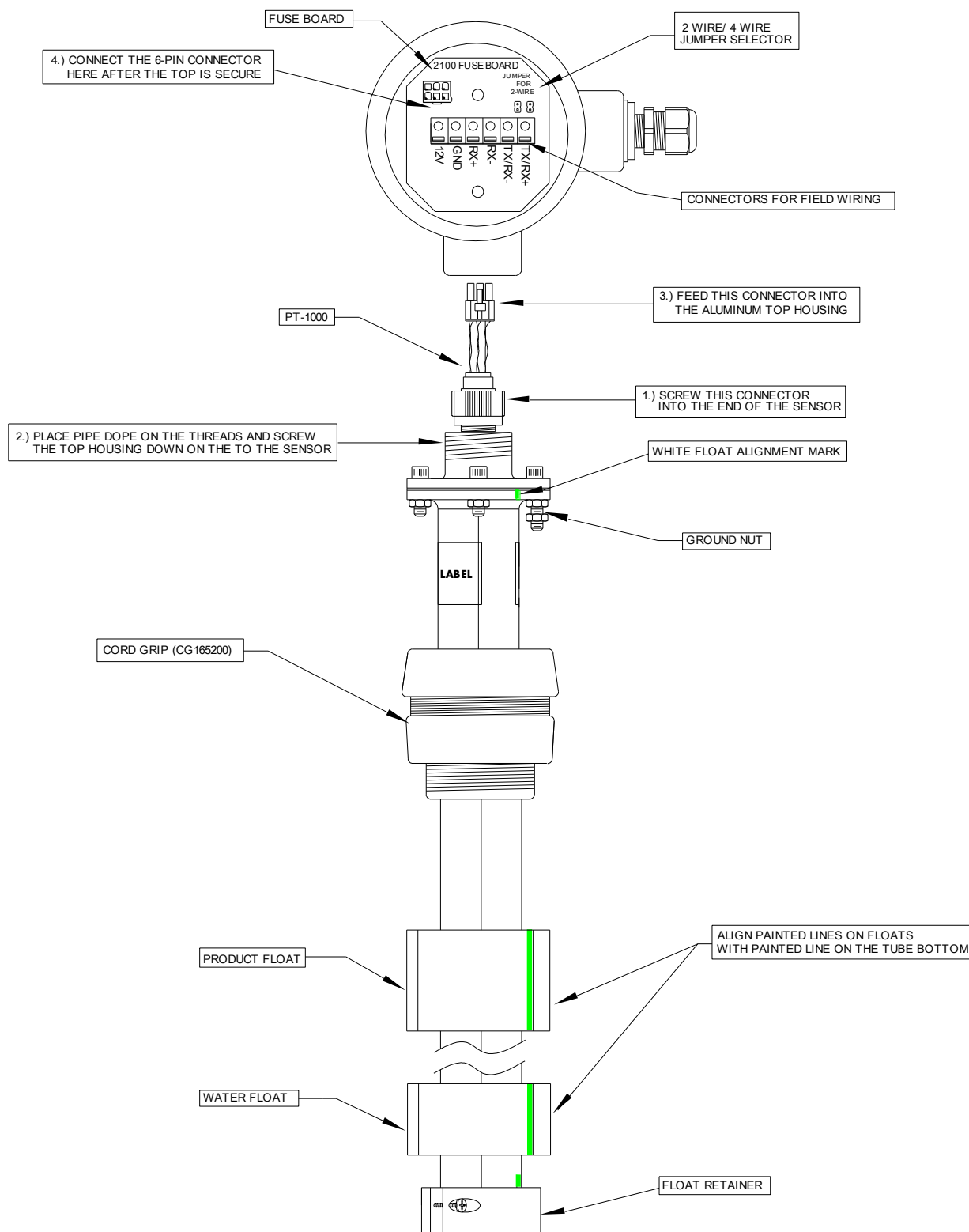
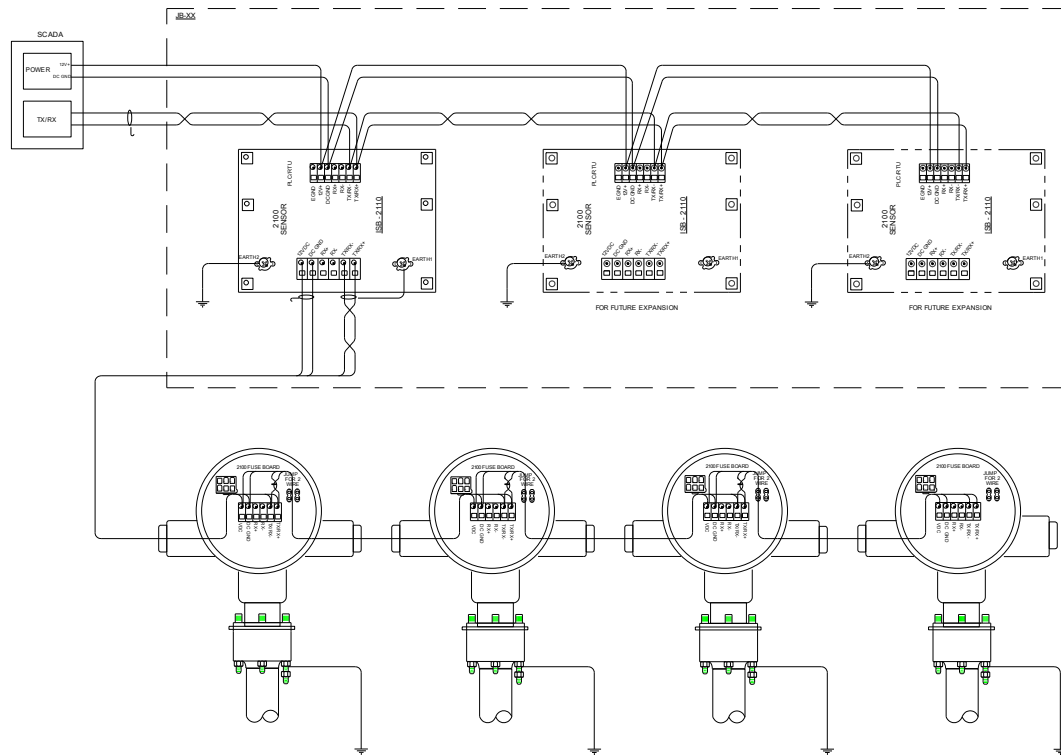


Figure 2. DLS2100 Assembly Diagram



INSTALLATION NOTES AND STANDARD REFERENCES

- 1.) COMPLETE INSTALLATION TO BE IN ACCORDANCE WITH ALL PROVISIONS OF FOLLOWING STANDARDS: NATIONAL ELECTRIC CODE - NFPA 70 (LATEST EDITION) IEEE STANDARD 1100-1999 RECOMMENDED POWERING AND GROUNDING SENSITIVE ELECTRONIC EQUIPMENT.
- 2.) WIRING METHODS USED FOR SYSTEM INTERCONNECTION MUST COMPLY AT ALL TIMES WITH SECTION 90-3 AND 725-61 OF THE NATIONAL ELECTRIC CODE - CONTROL, SIGNALING AND POWER LIMITED CIRCUITS WHEN CLASS II POWER SUPPLIES ARE UTILIZED. DO NOT USE SECTION 725-52!
- 3.) INTRINSICALLY SAFE SYSTEMS MUST COMPLY AT ALL TIMES WITH ARTICLE 504 OF THE: NATIONAL ELECTRIC CODE.
- 4.) POWERED CIRCUITS (INCLUDING ALL BRANCHES) MUST UTILIZE OVER-CURRENT PROTECTION IN ACCORDANCE WITH ARTICLE 240 OF THE: NATIONAL ELECTRIC CODE.
- 5.) WIRE AND CABLE SELECTION MUST BE IN ACCORDANCE WITH ARTICLE 310 AS REFERENCED IN CHART 310-16 PER THE: NATIONAL ELECTRIC CODE.
- 6.) MAINTAIN WORKING SPACE IN PULL BOXES, JUNCTION CABINETS AND MARSHALING ENCLOSURES PER SECTION 110-16 OF THE: NATIONAL ELECTRIC CODE.
- 7.) INSTALLATION SHOULD ONLY BE MADE INTO SYSTEMS COMPLYING FULLY WITH ARTICLE 250 - GROUNDING AND BONDING OF THE: NATIONAL ELECTRIC CODE.
- 8.) GROUNDING CONDUCTORS SHOULD BE SIZED IN FULL COMPLIANCE WITH SECTION 250.122 OF THE: NATIONAL ELECTRIC CODE.
- 9.) GENERAL REQUIREMENTS FOR GROUNDING AND BONDING IN COMPLIANCE WITH SECTION 250.4 OF THE: NATIONAL ELECTRIC CODE SHOULD BE DESIGNED TO MAINTAIN EFFECTIVE GROUND FAULT CURRENT PATHS WHEN USING 250.96(B) ISOLATED GROUNDING CIRCUITS.
- 10.) GROUNDING SYSTEMS EMPLOYING ONE OR MORE ELECTRODES SHOULD COMPLY WITH 250.5 OF THE: NATIONAL ELECTRIC CODE, AND SHOULD BE PERIODICALLY TESTED BY FALL OF POTENTIAL TEST PROCEDURE TO CONFIRM MAXIMUM OF 25 OHMS RESISTANCE. TARGET RESISTANCE SHOULD BE 5 OHMS OR LESS.
- 11.) ELECTRODE INSTALLATION SHOULD COMPLY WITH 250.52(A)(4) THROUGH (A)(8) OF THE: NATIONAL ELECTRIC CODE.
- 12.) CONFIRM THAT GROUNDING CONDUCTORS ARE INSULATED IN ORDER TO PREVENT DIRECT CONTACT WITH GROUND OR CONCRETE PER SECTION 250.64 OF THE: NATIONAL ELECTRIC CODE, AND MUST BE TERMINATED WITHIN 18" OF THE FINISHED GRADE.
- 13.) ELECTRODE CONNECTION AND CABLE SIZING SHOULD BE MADE PER SECTION 250.66 OF THE: NATIONAL ELECTRIC CODE.

Figure 3. DLS2100 IS Barrier Connection Diagram

Part Numbering System

The sample below is a the part number for a 20 ft. sensor with ¼ inch resolution, one temperature sensor, and a single float going into a tank with a 4-inch port and being wired up as two-wire RS485.

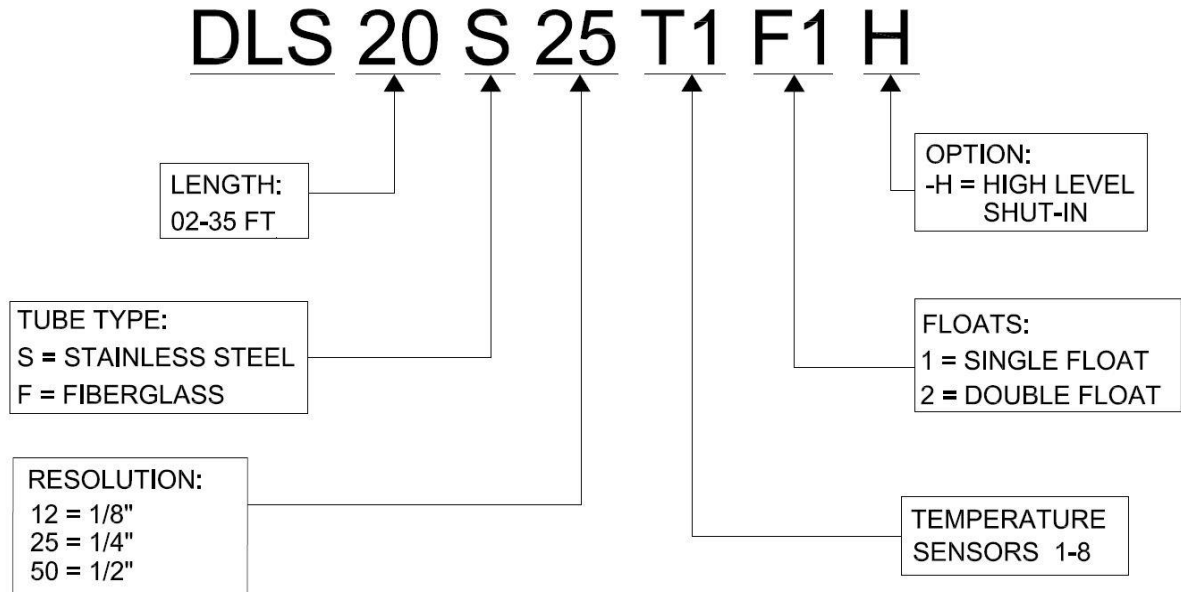


Figure 4. DLS Part Numbering System

In addition to the information provided within the part number, other information is necessary when ordering:

1. **Total Tube Length:** Default is Measurement Length plus 18 inches.
Note: If installing in a dome-top tank, like a fiberglass tank, you will need to order a sensor that is 1' longer than the tank height to accommodate the extra height the dome adds.
2. **Baud Rate and Parity desired:** Default is 9600, N, 8, 1. If other baud rate and parity are required, please specify.
3. **Unit Numbers Required:** If ordering more than one sensor for a location you may have the level sensors pre-addressed with the required unit numbers prior to shipment for the tanks on that location. Example: If there are 3 tanks on one location, then specify that the level sensors be addressed U01, U02, and U03. Alternate numbering sequences may be chosen. If no unit numbers are specified than default will be Unit 01.

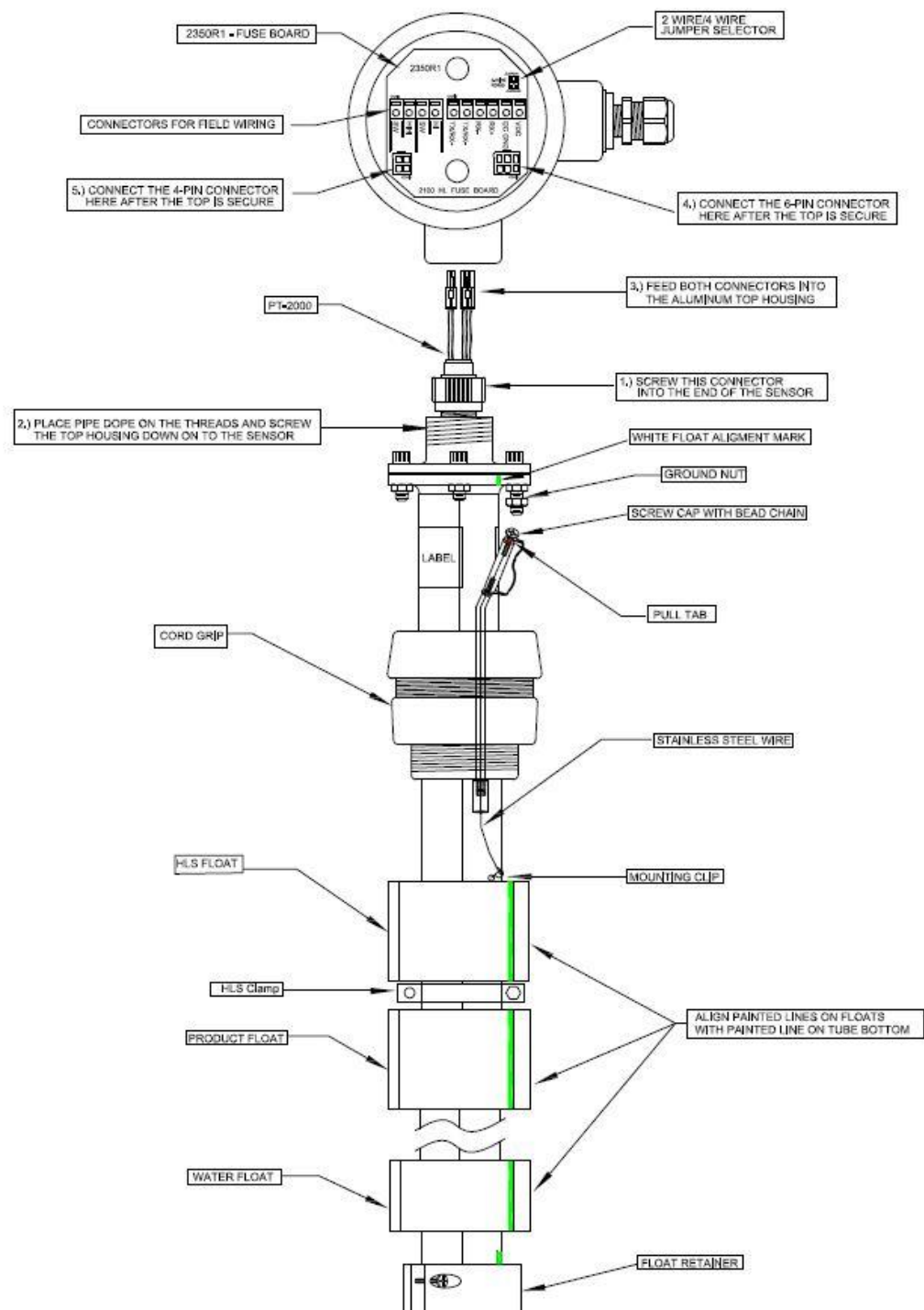
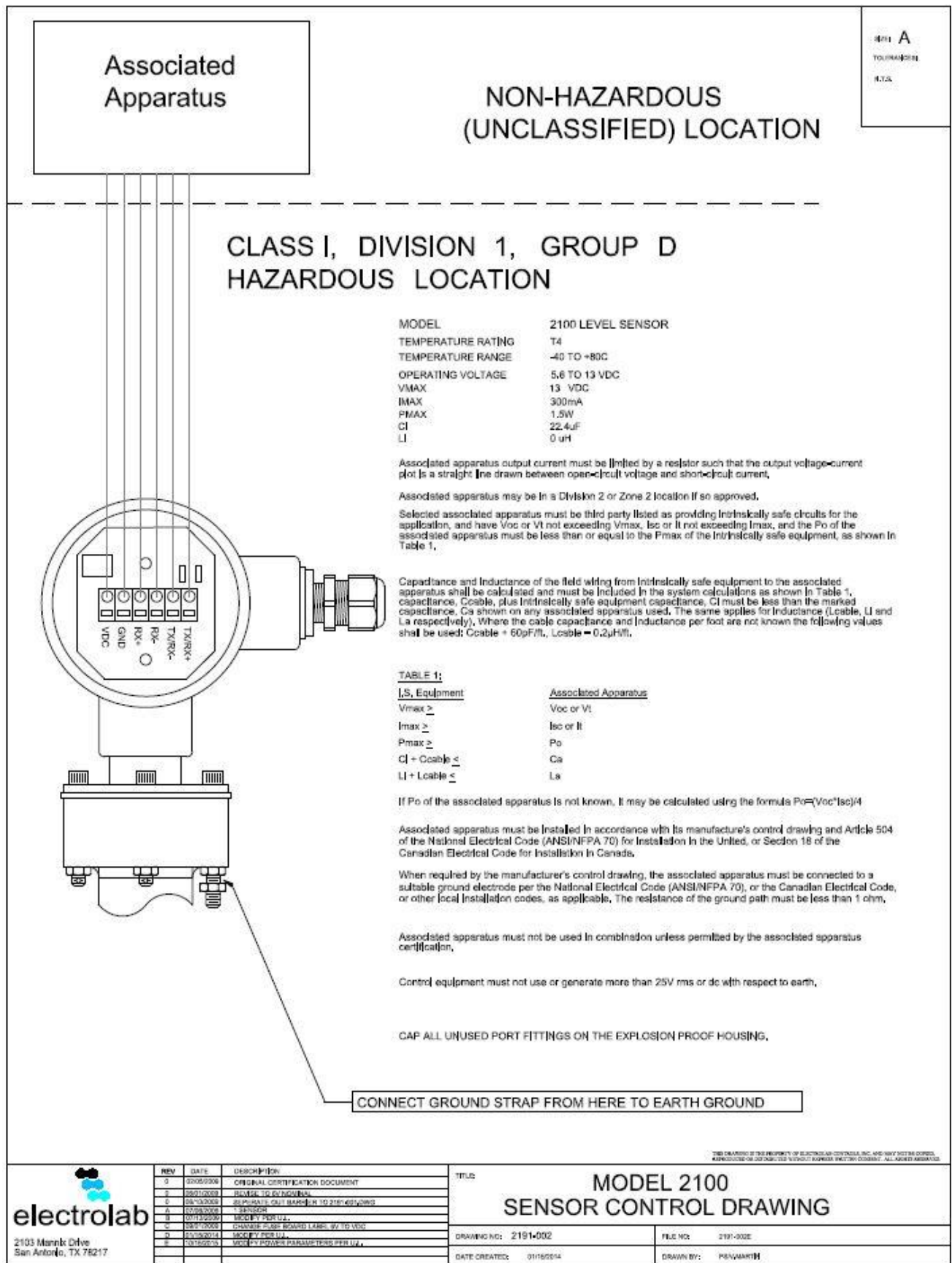
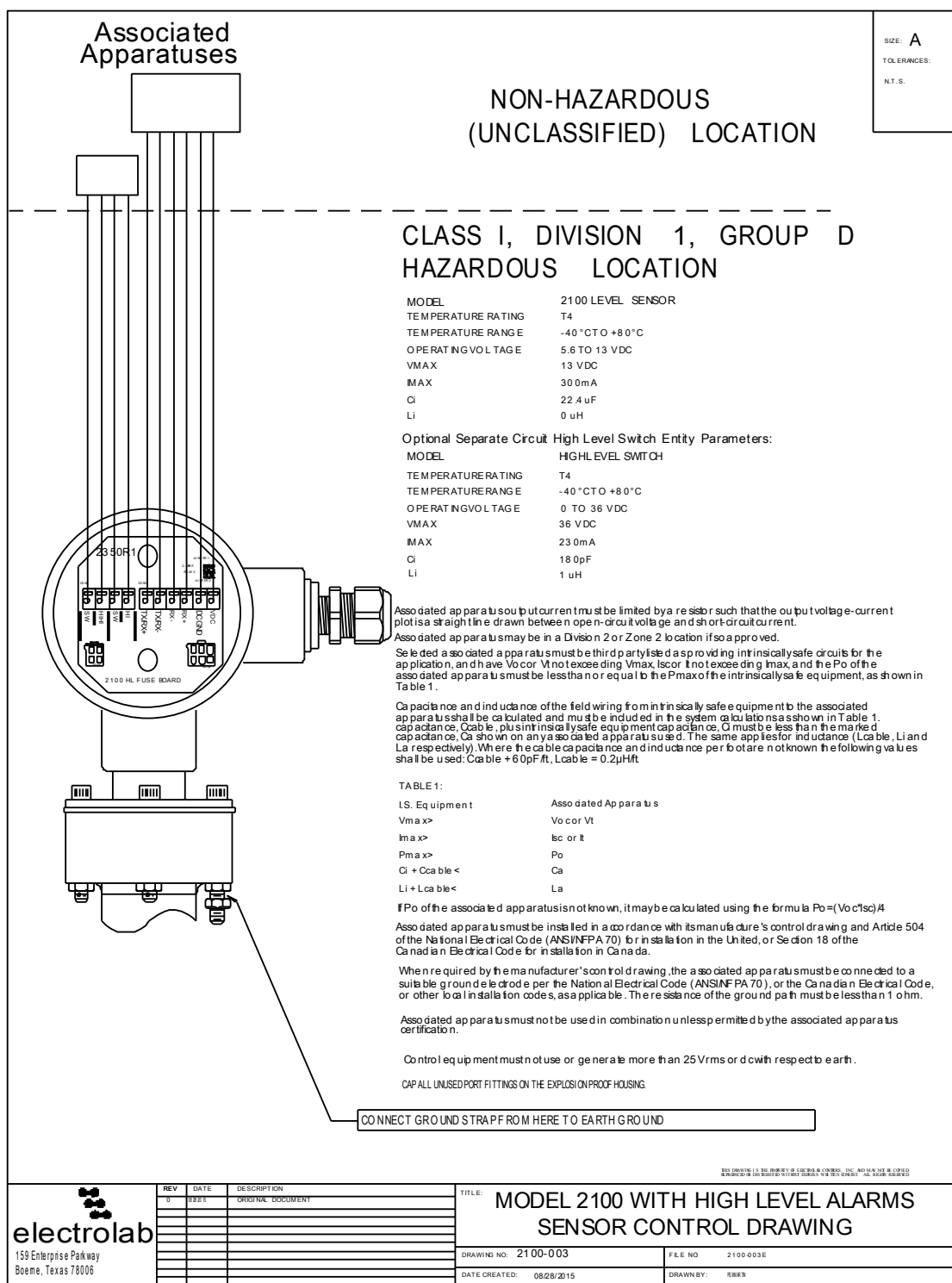


Figure 5. DLS2100 with HLS Assembly Diagram



Control Drawing 2191-002

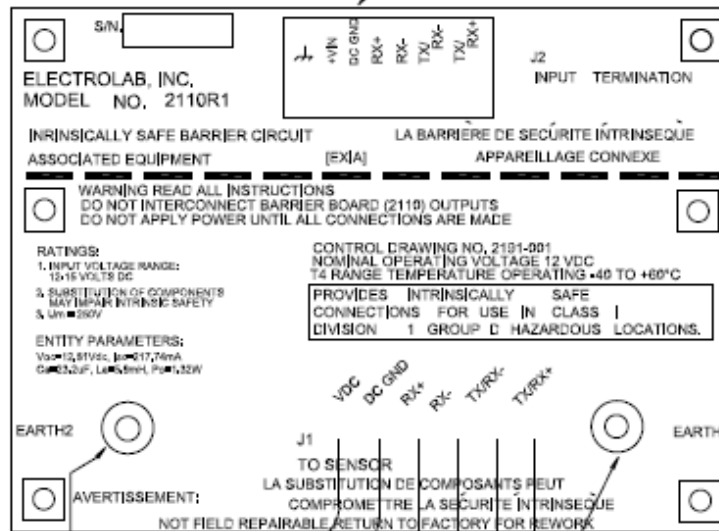


Control Drawing 2100-003

SER: A
 TOLERANCES: NT,5

**CLASSIFIED
LOCATION**

 CONNECT RTU WIRES DIRECT, WITHOUT LOOPS.
 INSTALLATION MUST BE IN ACCORDANCE WITH
 THE NATIONAL ELECTRIC CODE (NFPA, ARTICLE
 504) AND ANSI/ISA - RP12.6.

CONTROL DWG.

 FOR USE WITH INTRINSICALLY SAFE INSTALLATION IN
 CLASS I, DIVISION 1, GROUP D,
 HAZARD LOCATIONS
 ALL FIELD WIRING TO BE TWISTED PAIRS OR
 3-PAIR CABLE 16-18 AWG IF OVER 50 FEET

 DO NOT APPLY POWER UNTIL
 ALL CONNECTIONS ARE MADE

Model 2110R1 Barrier
 $T_{amb} = -40$ to 60 degrees

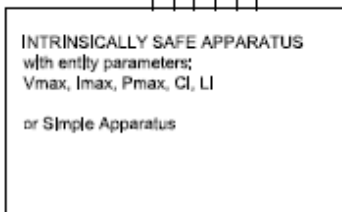
 $U_m = 250V$

Associated Apparatus Entity Parameters:

 $V_{oc} = 12.81V_{dc}$
 $I_{sc} = 217.74mA$
 $P_o = 1.32W$
 $C_a = 23.2uF$
 $L_a = 5.9mH$

 SECURELY GROUND WITH
 10 AWG WIRE IN 2 PLACES

 CONNECT INTRINSICALLY SAFE EQUIPMENT WIRES
 DIRECT, WITHOUT LOOPS, INSTALLATION MUST BE IN
 ACCORDANCE WITH THE NATIONAL ELECTRIC CODE
 (NFPA, ARTICLE 504) AND ANSI/ISA - RP12.6.

 $V_{max} \geq V_{oc}$
 $I_{max} \geq I_{sc}$
 $P_{max} \geq P_o$
 $C_l + C_{cable} \leq C_a$
 $L_l + L_{cable} \leq L_a$

CLASS I, DIVISION 1, GROUP D, HAZARD LOCATION
Notes:

1. Reference Instruction Manual (Document #EL29054) for 2110R1 Barrier Unit as needed.
2. For installation in which both C_l and L_l of the Intrinsically Safe Apparatus exceed 1% of the C_o and L_o parameters of the Associated Apparatus (excluding cable), then 50% of C_o and L_o parameters are applicable and shall not be exceeded.

Control Drawing 2191-001

Contact Information

For further information or for assistance, please contact:

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