USER MANUAL

DLS 2100 PRODUCT LINE

RU FLEX SENSOR W/ HLS

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Description

The RU Flex 2100 Digital Level Sensor is a solid-state device that measures and reports fluid levels 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 embedded with magnets to sense the top of a fluid level(s). There is a temperature sensor mounted inside the tube fourteen 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 then calculates the level and temperature and returns the data in a serial stream or Modbus RTU format, dependent on the format of the request.

Communications

The serial communication protocol is RS485 2-wire or 4-wire, field selectable via jumpers on the fuse board. The default baud rate is set to 9600, N, 8, 1. In 4-wire mode, one pair of wires is strictly for transmitting and another pair is 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.

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.

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.

Sensor Assembly

1. Install the 2-inch hub sensor-grip and either the 4” x 2” or 3” x 2” reducer based on the port size of the tank.
2. Remove the ground screw from the stainless steel sleeve on the sensor. With proper orientation, slide this assembly onto the top stainless steel sleeve of the sensor and hand-tighten the cord grip nut so that the assembly does not slide down.
3. Slide the 2-piece shaft collar clamp over the stainless sleeve and secure the clamp in place above the cord grip. This will prevent the sensor from fully entering the tank. Replace the ground screw..
4. Open the GR housing. Remove the sensor pigtail and attach the round connector to the sensor flange connector, feeding the white connector through the 1” port. Attach the GR housing to the sensor. Do not twist the pigtail wires during assembly.
5. Plug the white connector into the fuse board.
6. If not already installed, attach float(s) to the sensor tube using the float hardware provided. The float carrier is designed to match the proper orientation of the switches.
7. Verify the float(s) move freely along the length of the flexible tube.
8. It is recommended that you use the HHC-1000 or a laptop running terminal software to verify the sensor configuration and that the sensor is providing a level reading**.**

Installation

1. Carry the flexible sensor and the bottom weight separately up to the top of the tank.
2. Attach the weight to the bottom of the sensor tube while supporting the sensor so as to not allow excess stress on the sensor.
3. Once the weight is secured, lower the sensor through the tank port, being careful to control the sensor while uncoiling it into the tank.
4. When the sensor weight reaches bottom, loosen the cord grip nut and lower the cord grip assembly to the tank port while holding the sensor from slipping further into the tank.
5. Screw the reducer bushing into the port and tighten it securely. Raise the sensor up to make sure there is no slack in the sensor while the weight still touches the bottom of the tank. Raise and lower the sensor a couple of times to feel the position of the weight. Raise the sensor about one inch after touching the bottom of the tank.
6. Tighten the cord grip to secure the sensor from sliding down.
7. Rest the 2-piece shaft collar clamp at the top of the cord grip and tighten the bolts using a ¼” hex wrench to prevent the sensor from slipping over time.

CAUTION: CONFIRM THAT POWER IS *OFF* before proceeding.

Electrical Connection

1. Feed the external cable/wires through the open port on the side of the housing. Unplug the gray, 6-position connector from the internal fuse board.
2. 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.
3. Plug in the connector. Route wires away from the housing threads and screw in the housing cover.

HLS Option 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.

1. Apply thread sealant to CG165200-FT 4x3.
2. Screw CG into Reducer Bushing with proper orientation.
3. Disassemble CG for ease of installation.
4. Remove Ground Screw from sensor.
5. Locate the label on the top of the sensor tube to find the break in the label.
6. 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).
7. Assemble CG and slide the assembly down the sensor tube within one foot from the top. Hand-tighten the nut to keep the CG assembly from sliding down.
8. Place stainless steel hose clamp on the sensor tube just above the CG assembly and secure in place. Replace ground screw.
9. Unroll sensor and pull HLS float and float stop down until fully extended.
10. Lock in place by tightening the two set screws at the base of the SS tube.
11. Attach Stainless Steel Clip from float carrier to Stainless Steel wire loop, making sure the wire doesn’t wrap around the tube.
12. Install the weight on the bottom of sensor while on top of the catwalk prior to installation.
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. Secure the hose clamp and then 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. Raise the sensor about one inch and tighten the cord grip, making sure to align the 3/16” test pipe with the break in the label. Tighten the hose clamp against the cord grip nut.
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. Screw the chained screw cap back on the 3/16” tube.

Installation Test

1. Open the cover of the DLS2100 to access the 2350R1 fuse board.
2. Use the DMM to check continuity between CON 4-Pin 4 and CON 2-Pin 4 (red wire). Then check continuity between CON 4-Pin 2 and CON 2-Pin 3 (white wire).
   If the DMM shows discontinuity between either connection, replace the fuse board.
3. Use the DMM to check continuity between CON 4-Pin 3 and Pin 4 (HIHI) and between CON 4-Pin 2 and Pin 1 (HI).
4. Connect the DMM probes to CON 4, Pins 3 & 4, HIHI.
5. Pull the pull-tab to release the slack. Continue pulling and raising the HLS float until the circuit opens.
6. Close the circuit by releasing the pull-tab to return the HLS float to its normal position. Disconnect the DMM. Proceed to "Electrical Connection."

Electrical Connection

1. With the power disconnected, feed the external cables to the sensor through the open port on the side of the housing. Unplug the gray, 6-position connector from the internal fuse board.
2. Install the power and signal wires using the white depressor tool according to the diagram in Figure 6. Save the white depressor tool for future use.
3. Plug the connector into the fuse board.
4. Unplug the gray, 4-position connector from the internal fuse board.
5. Install the HLS signal wire. Route wires away from the housing threads and screw in the housing cover.

DLS Calibration & 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 level 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: Due to the height of the weight, the typical offset will be 2 to 4 inches above the height of the weight. This is due to the mechanical connection between the tube and the weight, as well as how the float(s) move in the tank.

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 9.50" offset is in the DLS and the DLS is still reading ¼" below actual level, the true offset should be 9.75." If you add a ¼" offset, the level reading will be 9.50" below actual level. Resetting the level offset to zero will make it easier to determine the correct offset value.

After **installing the RU Flex 2100 DLS and** ***before*** **setting the initial offset**, allow the sensor to rest in the tank for 10-15 minutes. This will allow the sensor to relax and straighten out. Colder weather environments and longer sensors should rest the full 15 minutes. Loosen the 2-piece shaft collar clamp and cord grip. Lift the sensor up and down a few times before resetting the sensor in the tank and retightening the cord grip and 2-piece shaft collar clamp. You are now ready to set the initial offset.

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 above the point where the bottom weight connects to the sensor tube. If the water is below the connection, then the water float is at the bottom of the sensor and the 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.
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 read the 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.

EXAMPLE: If the actual level is 156.25" and the DLS reading is 146.50," then the offset value will be 9.75" (156.25-146.50=9.75).

Testing and Troubleshooting

Refer to the list below to help diagnose problems with the Model 2100 DLS RU Flex w/ HLS.

Sensor is new and recently installed:

- The sensor wiring is incorrect: Check the 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.
- Sensor is HLS Option (v3.16) with float on. Not programmed for High Level.

Sensor sends temperature but not 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 (rigid sensors only).
- An incorrect number of floats are programmed. Check the sensor protocol command list to reprogram the sensor with the correct information.
- Sensor has an HLS float installed and is not programmed for High Level.

Digital Level Sensor Protocol

Command syntax

- Uppercase characters denote literals 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 lowercase.
- 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?
uu is a two-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: **UuuDlll.llFtttEeeeeWwwww**
uu = unit number
lll.ll = 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.

wwww = warning number
0 = No warnings
1 = Possible level degradation
2 = Possible level degradation due to level offset
3 = Missing HLS Float (when programmed for HLS)
4 = Missing float when programmed for dual float (Replaces *Error 2* on v3.18 RU Flex only). The data response will have actual Product level and zero for the Interface level.

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: **UuuMhhhhEeeeeWwwww**

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.

wwww = warning number

- 0 = No warnings
- 1 = Possible level degradation
- 2 = Possible level degradation due to level offset

Report Temperature Only

Uuu?T

Response: **UuuFxxEeeeeWwwww**

xx= temperature

Configuration Commands

Assign Unit Number

UuuNnn

uu = unit number (from 00 to 31)

nn = new unit number

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

Response: **UuuNOK**

uu = newly assigned unit number

Assign Unit Number to Sensor with the Corresponding SN# (v3.15 or 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]

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
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 level sensor
uu = unit number
slll = sign and offset with two implied decimal places

Note: If two floats, assign 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
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
uu = unit number
soo = -99 to 99 (optional sign)
Response: **UuuOFOK**

Set Multiple Temperature Sensor Offsets

UuuTnOso.o
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

UuuRmmm
uu = unit number
mmm = milliseconds (50 to 250). The default is 127ms.
Response: **UuuROK**

Set 4-20mA Poll Period

UuuMPpppp
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
uu = unit number
mm.mm = level for 4mA output (Default is 00.00)
Response: **UuuMINOK**

Set 4-20mA Maximum (20mA) Range
UuuMAXmmm.mm
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)
UuuSETERRx
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
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 represents 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 the 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

Configuration Request Commands

Report Number of Floats

UuuF?
Response: **UuuFn**
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**
uu = unit number
snn.nn = sign and offset with two implied decimal places

Report Temperature Offset

UuuOF?
Response: **UuuOFsff**
uu = unit number s = sign
ff = temperature offset (degrees F)

Report Multiple Temperature Offsets

UuuTO?
Response: **UuuTnOs0.0**
TnOsn.n repeated for additional temperature sensors
uu = unit number
n = temperature sensor (1-8, 1 is top sensor)
s = sign
0.0= temperature offset

Report Switch Distance

UuuD?
Response: **UuuDd**
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**
uu = unit number
mmm = delay

Report Total Switches

UuuS?
Response: **UuuSssss**
uu = unit number
ssss = total number of switches in the sensor

Report Receive to Transmit delay

UuuR?
Response: **UuuRmmm**
uu = unit number
mmm = delay in milliseconds

Report 4-20mA Configuration

UuuMC?
Response: **UuuPppppL1_4MAll.ll_20MAhhh.hh**
uu = unit number
Ppppp = Polling period in seconds
L1 = Data source is top float
_4MAll.ll = Level to output 4 mA
_20MAhhh.hh = Level to output 20 mA

Report Serial Number

UuuSN?
Response: **UuuSNxxxxxxx**
uu = unit number
xxxxxxxx = serial number.

Report Unit Number Corresponding to Serial Number (Version 3.15 and Higher)

UsssssssN?
sssssss = seven-digit serial number
Response: **UsssssssNuu**
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
UuuDlll.ll[Dlll.ll]Fttt[Fttt……]EeeeeWwwww
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

Report the Level Error Setting (Version 3.09 and Higher)

UuuSETERR?
Response: **UuuSETERR=x**
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**
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**
uu = unit number
vv.v = battery voltage in volts

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. 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	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.

RU Flex 2100 DLS Specifications

Measurement Length:
Available from 2 to 48 feet in length

Tubing Material:
UHMW-PE

Float: Nitrophyl/stainless steel
One float used for single liquid level measurement; two floats used for 2 liquids
Two-piece floats for field installation and replacement
Designed to fit though a 3-inch NFPT tank port

Level Measurement Increments and Accuracy:
1/8-in. resolution; +/- 3/16-in. accuracy
1/4-in. resolution; +- 1/8-in. accuracy
1/2-in. resolution; +/- 1/4-in. accuracy
+/- 0.1% repeatability

Coiled Diameter:
Approximately 36-inch diameter (will vary slightly with the length of the sensor)

Operating Temperature Range:
-40° C to +85° C

Temperature Measurement:
First sensor 14" 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:
40 psi: standard

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.

Anchor Weight:

3 in. diameter; required weight can vary based on sensor length

Wiring:
18 AWG recommended for digital circuits

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

Certification:
ANSI/UL-913, 7th Edition
CAN/CSA C22.2, No. 157

RU Flex 2100 DLS Reference Illustrations

Figure 1 - Model 210 0DLS RU Flex w/ HLS

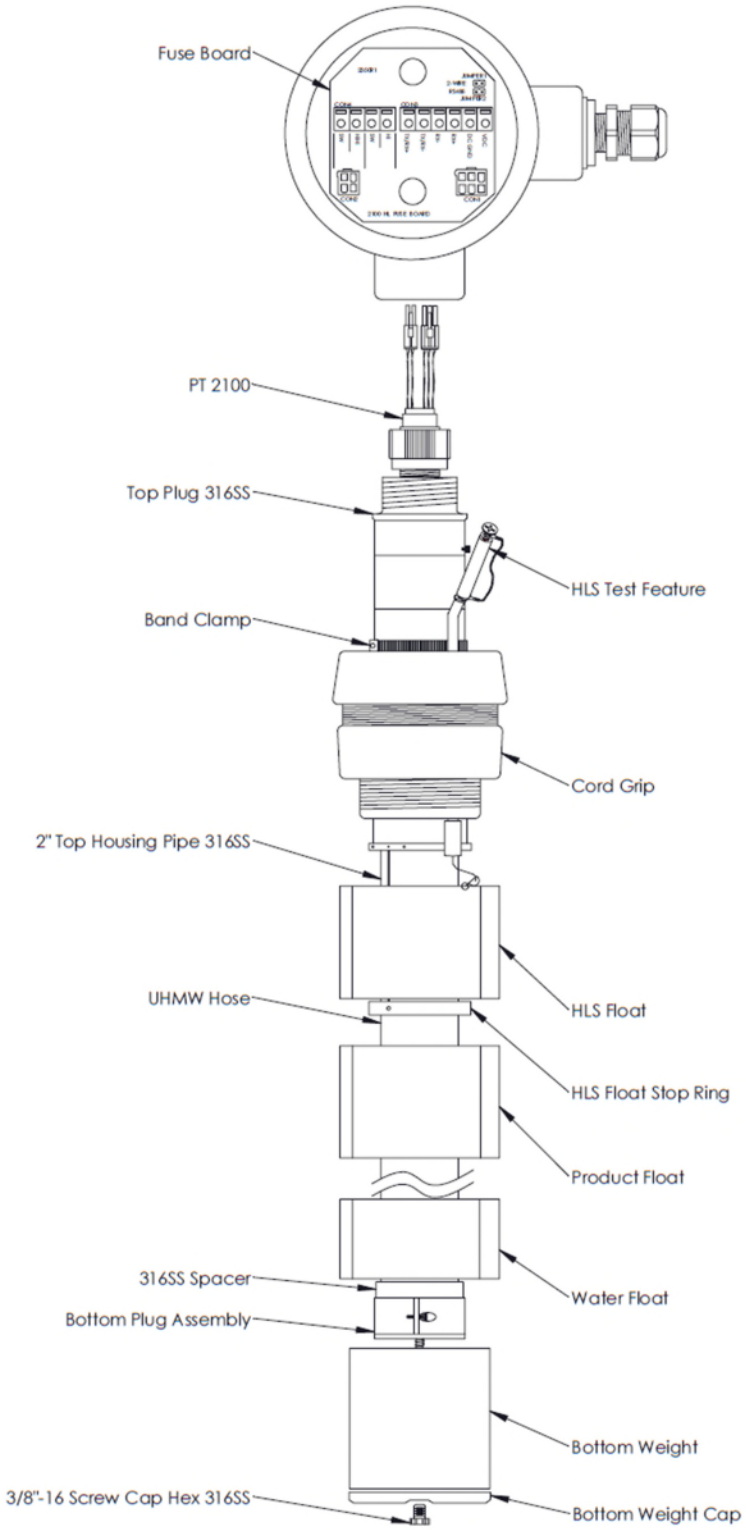

Figure 2 - Model 2100 DLS RU Flex w/ HLS Assembly Diagram

INSTALLATION NOTES AND STANDARD REFERENCES

1.) COMPLETE INSTALLATION TO BE IN ACCORDANCE WITH ALL PROVISIONS OF FOLLOWING STANDARDS: NATIONAL ELECTRIC CODE - NFPA 70 (LASTEST 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 OF 25 OHMS RESISTANCE. LARGE I 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.

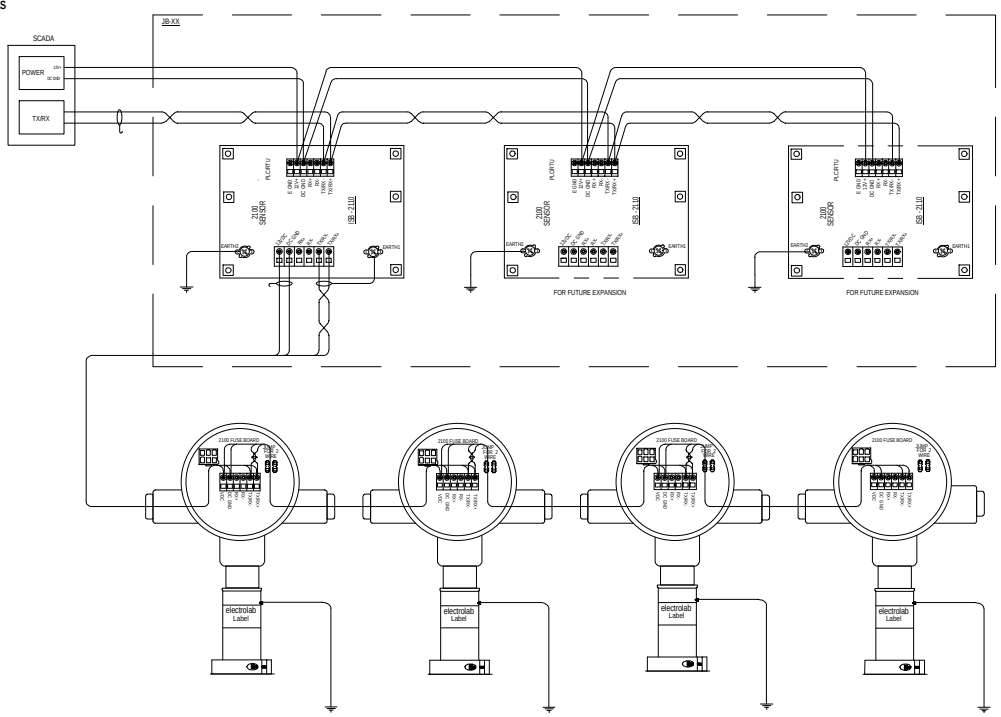

Figure 3 - IS Barrier Connection Diagram. 2-wire

INSTALLATION NOTES AND STANDARD REFERENCES

1.) COMPLETE INSTALLATION TO BE IN ACCORDANCE WITH ALL PROVISIONS OF FOLLOWING STANDARDS: NATIONAL ELECTRIC CODE - NFPA 70 (LASTEST 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 OF 25 OHMS RESISTANCE. LARGE I 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.

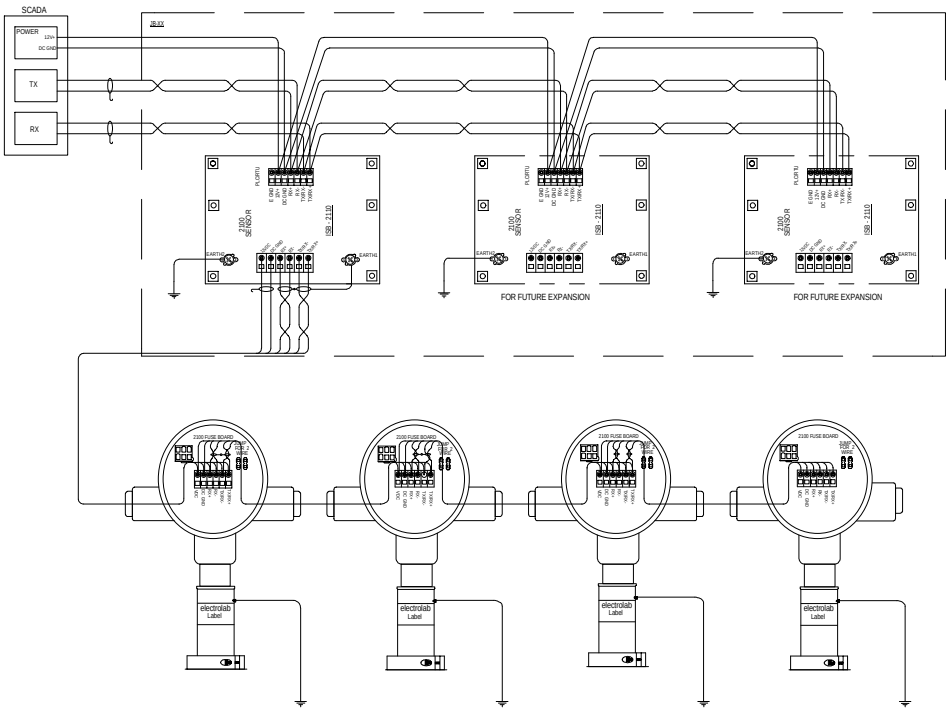

Figure 3 - IS Barrier Connection Diagram, 4-wire

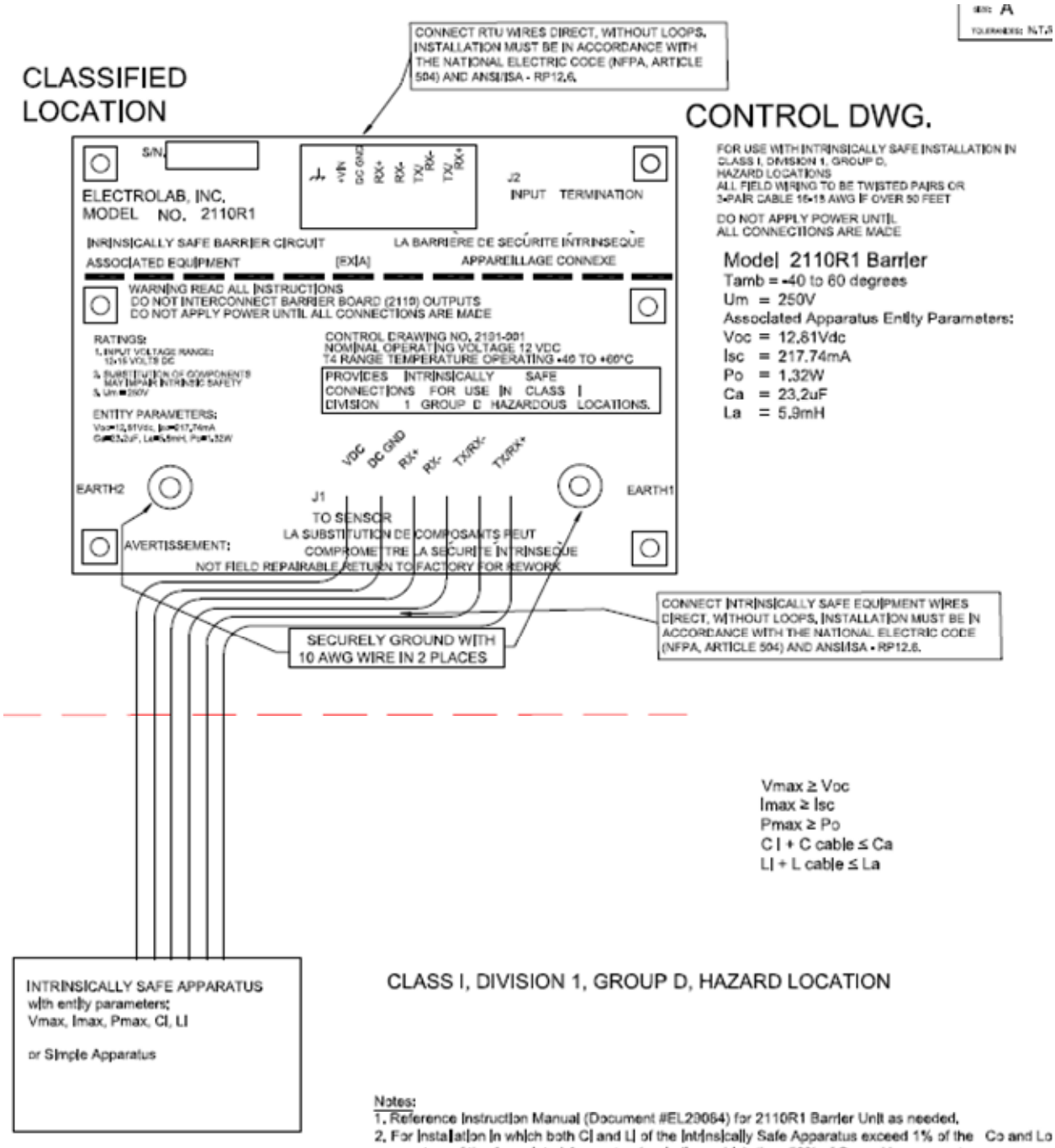

Figure 4 - Control Drawing 2191-001

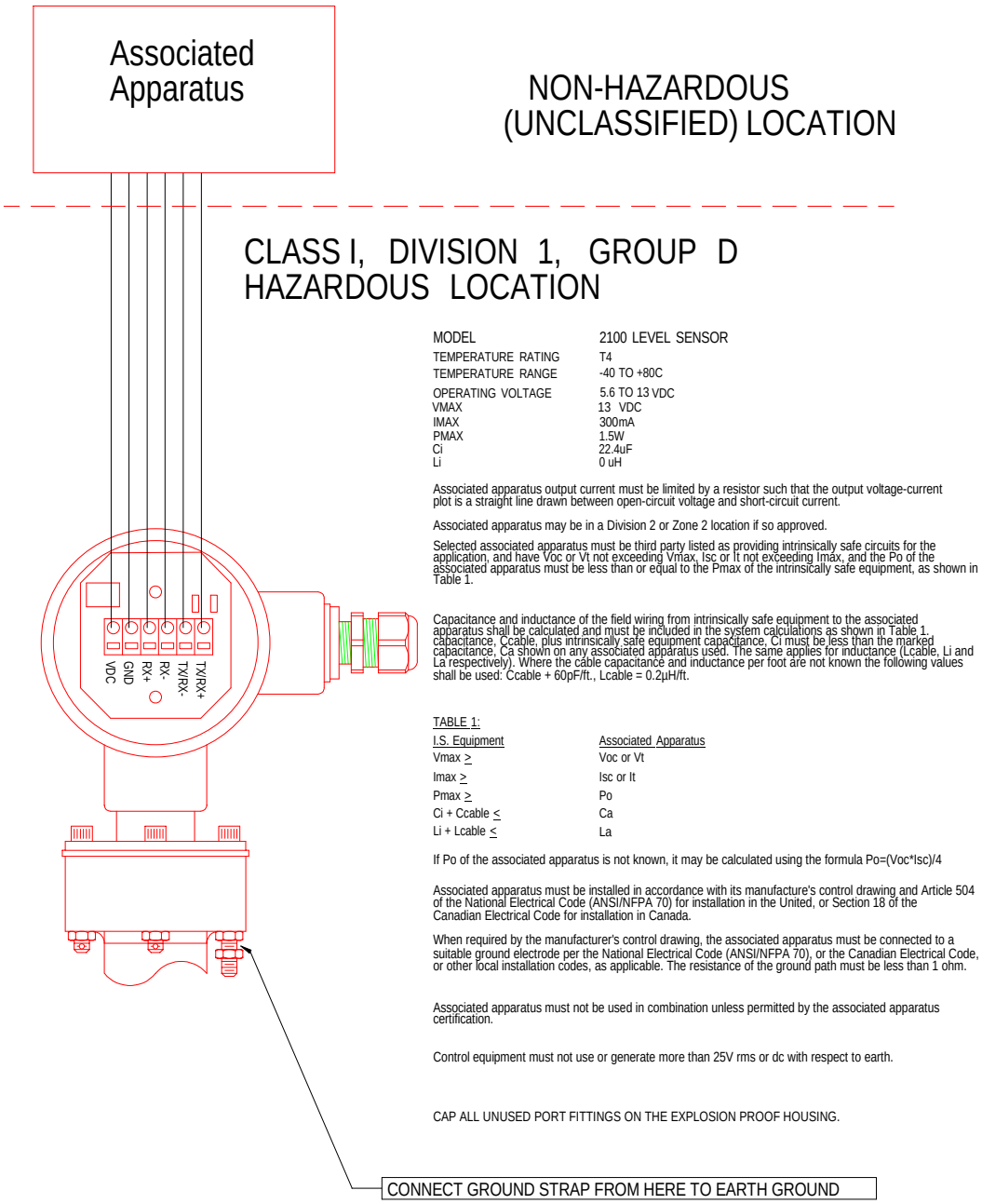

Figure 5 - Control Drawing 2191-002

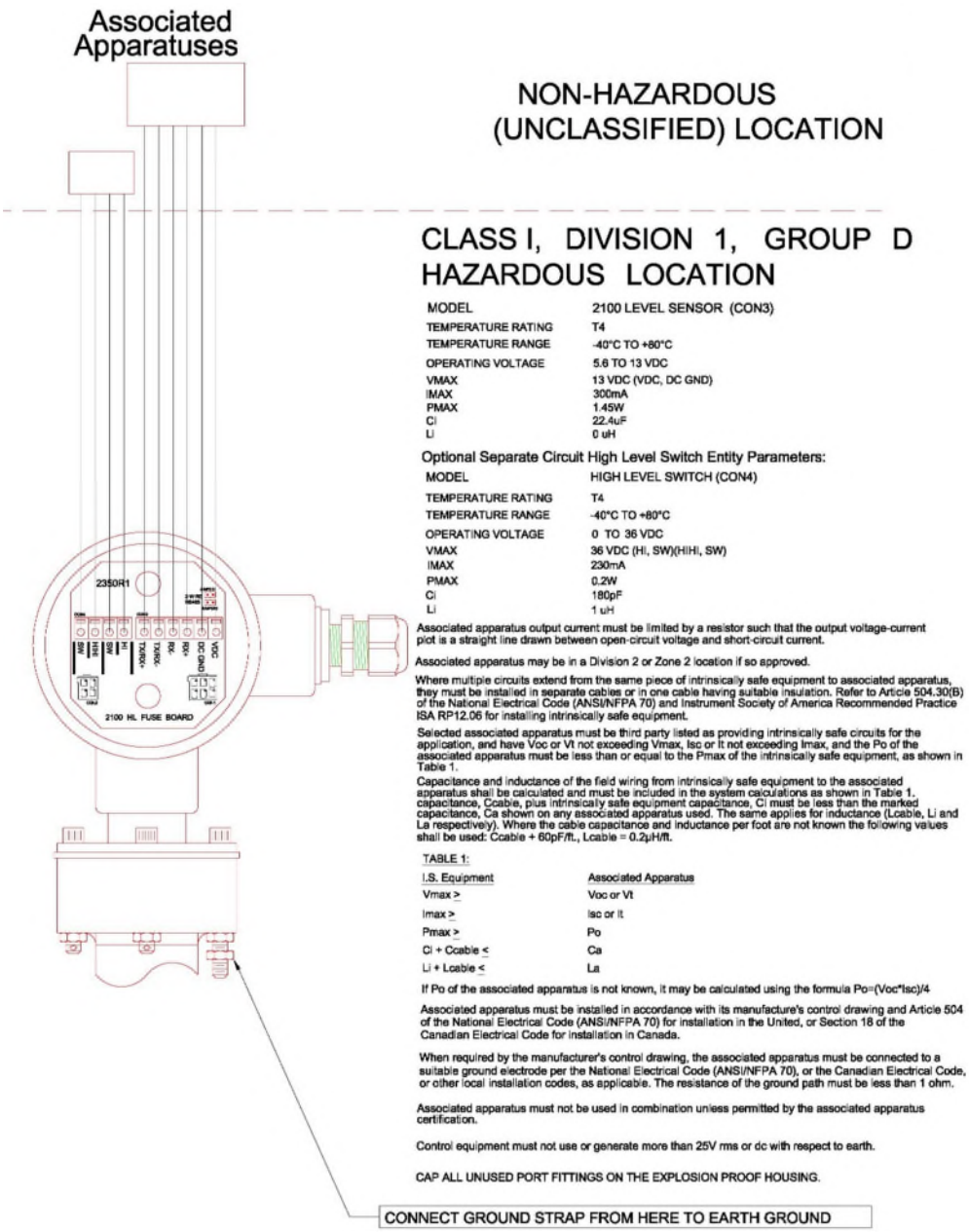

Figure 6 -Control Drawing 2100-003E DLS 2100 with HLS

Part Numbering System

The sample below is 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.

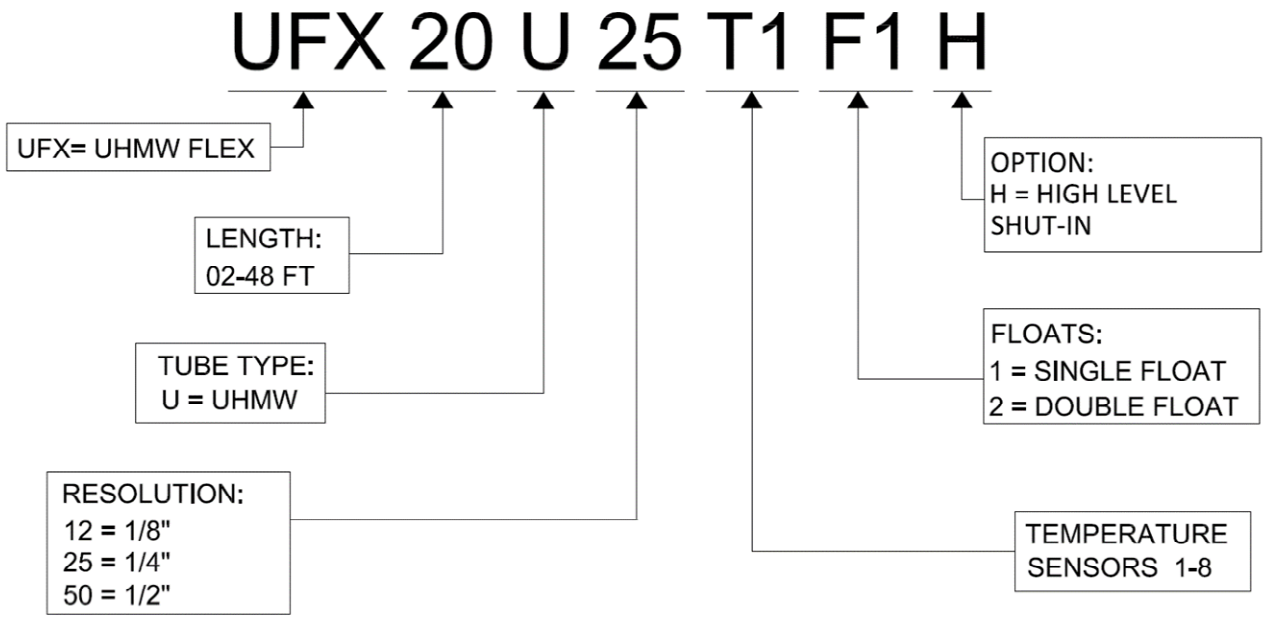

Figure 7 - RU Flex 2100 DLS Part Numbering System

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, sensor will need to be ordered 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, then default will be Unit 01.

Contact Information

For further information or for assistance, please contact: Electrolab, Inc.

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