

# **Digital Level Sensor**

**RU Flex 2100** 

User Manual May 2018

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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 two-piece shaft collar clamp over the stainless sleeve.
- 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.
- It is recommended that that you use the HHC-1000 or 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. 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.
- 6. Tighten the cord grip to secure the sensor from sliding down.
- 7. Rest the two-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: Make sure 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.
- 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 and replace the side cover.

## **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 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.

For 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.

#### Procedure

**Important Note:** 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 two-piece shaft collar clamp and cord grip and lift the sensor up and down a few times before resetting the sensor in the tank and retightening the cord grip and two-piece shaft collar clamp. You are now ready to set the initial offset.

- 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.

**For 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).

- 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.

## **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 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: UuuDIII.IIFtttEeeeeWwwww

```
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.

wwww = warning number

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

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 Serial Number (Version 3.15 and Higher) UsssssssNnn sssssss = seven-digit serial number

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 sIIII = 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]OsIII.II** Sets the top float offset. Example of setting top level offset for Unit 00 to 2.25 inches - U00L1O2.25

**UuuL[2|B]Oslll.II** 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.II = 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 UuulFxxxx

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 1-3 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\_4MAII.II\_20MAhhh.hh 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 uu = unit number xxxxxxxx = serial number.

#### Report Unit Number Corresponding to Serial Number (Version 3.15 and Higher) Usssssss? sssssss = 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.....]EeeeeWwww 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 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: **UuulF=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	<b>R/W</b> 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	40118	117	1	Factory	16 bit Signed
100: -9999 to 9999				setting: 0	
Temperature offset1	40119	118	1	Factory	16 bit Signed
x 10: -99 to 99				setting: 0	
Temperature offset2	40120	119	1	Factory	16 bit Signed
x 10: -99 to 99				setting: 0	
Temperature offset2	40121	120	1	Factory	16 bit Signed
x 10: -99 to 99				setting: 0	
Temperature offset4	40122	121	1	Factory	16 bit Signed
x 10: -99 to 99				setting: 0	
Temperature offset5	40123	122	1	Factory	16 bit Signed
x 10: -99 to 99				setting: 0	
Temperature offset6	40124	123	1	Factory	16 bit Signed
x 10: -99 to 99				setting: 0	
Temperature offset7	40125	124	1	Factory	16 bit Signed
x 10: -99 to 99				setting: 0	
Temperature offset8	40126	125	1	Factory	16 bit Signed
x 10: -99 to 99				setting: 0	
Sensor Description Regis	ters	[			
Serial number high	40127	126	1	Read only	16 bit
					Unsigned
Serial number	40128	127	1	Read only	16 bit
medium high					Unsigned
Serial number	40129	128	1	Read only	16 bit
medium low					Unsigned
Serial number low	40130	129	1	Read only	16 bit
		100			Unsigned
Version number	40131	130	1	Read only	16 bit
	40400	104			Unsigned
Number of modules:	40132	131	1	Read only	16 DIt
1 to 8	40400	122		Developed	Unsigned
Number of switches	40133	132	1	Read only	10 DIC
Curitala diatanaa y 10.	40124	122	4	Deedershi	
Switch distance x 10:	40134	133	T	Read only	10 DIL
5 UF 10	40125	124	1	Deedershi	
	40135	134	T	Read only	10 Ult
1 to 9					Unsigned
Liuo	40126	125	1	Dood only	16 hit
Sensor status: 0 or 1,	40130	135	T	Read only	10 Ult
1 - Sonsor orrors or					(v2 15 and
low hattery					higher)
Group O top	40127	126	1	Road only	16 hit
Group o top	40137	130	1	Read Only	Linsigned
					(v3 15 and
					higher)
1	1	1	1	1	ויצייפייי ו

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	Туре
Float 1 (Top	43991	3990	1	Read Only	Total Fluid Level in
Float)					Tank
					16 bit Unsigned
					integer or 32 bit
					floating point
Float 2	43992	3991	1	Read Only	Water Interface
(Bottom					Level in Tank
Float)					16 bit Unsigned
					integer or 32 bit
					floating point
Oil Level in	43993	3992	1	Read Only	Oil Level in Tank
Tank (top to					(top-bottom)
bottom)					16 bit Unsigned
					integer or 32 bit
					floating point
Total Volume	43994	3993	1	Read Only	Total Volume (top
(top level x					level x K factor)
K_factor)					16 bit Unsigned
					integer or 32 bit
					floating point
Oil Volume	43995	3994	1	Read Only	Oil Volume
(top level –					16 bit Unsigned
bottom level)					integer or 32 bit
x K_factor					floating point
Water	43996	3995	1	Read Only	Water Volume
Volume					16 bit Unsigned
(bottom level					integer or 32 bit
x K_factor)					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
				<b></b>	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	44005	4004	1	Read Only	Battery Voltage
Voltage					(*100 for 16 bit)
Ū					16 bit Unsigned
					integer or 32 bit
					floating point
Error	44006	4005	1	Read Only	16 bit Unsigned
Register:				-	integer (See Notes)
Warnings	44007	4006	1	Read Only	16 bit Unsigned
Register:					integer (See Notes)

## Table 3. Holding Registers (2 x 16 bit)

Sensor Data	Register	Address	No. Reg.	Values	Туре
Float 1 (Top	45001	5000	2	Read	Total Fluid Level in Tank
Float)				Only	Floating point upper two bytes
					(V3.14 and nigner)
	45002	5001		Read	Total Fluid Level in Tank
				Only	Floating point lower two bytes
					(v3.14 and higher)
Float 2 (Bottom	45003	5002	2	Read	Water Interface Level in Tank
Float)				Only	Floating point upper two bytes
					(v3.14 and higher)
	45004	5003		Read	Water Interface Level in Tank
				Only	Floating point lower two bytes
				-	(v3.14 and higher)
Oil Level in	45005	5004	2	Read	Oil Level in Tank(top-bottom)
Tank (top to				Only	Floating point upper two bytes
bottom)				-	(v3.14 and higher)
	45006	5005		Read	Oil Level in Tank(top-bottom)
				Only	Floating point lower two bytes
				-	(v3.14 and higher)
Total Volume	45007	5006	2	Read	Total Volume(top level x K factor)
(top level x K				Only	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	Battery Voltage(*100 for 16 bit)
, ,				Only	Floating point upper two bytes
				- /	(v3.14 and higher)
	45030	5029		Read	Battery Voltage(*100 for 16 bit)
				Only	Floating point lower two bytes
				<b>,</b>	(v3.14 and higher)
Error Register	45031	5030	2	Read	Floating point upper two bytes
(see Table 4)				Only	(See Notes) (v3.14 and higher)
	45032	5031		Read	Floating point lower two bytes
				Only	(See Notes) (v3.14 and higher)
Warnings	45033	5032	2	Read	Floating point upper two bytes
Register <b>(see</b>				Only	(See Notes) (v3.14 and higher)
Table 3)					
	45034	5033		Read	Floating point lower two bytes
				Only	(See Notes) (v3.14 and higher)

#### Table 4. Warning Codes

Binary Value (for 16 bit Unsigned)	Warning Code	Indication
	0	No warnings
Bit O	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, 7<sup>th</sup> Edition CAN/CSA C22.2, No. 157

## **RU Flex 2100 DLS Illustrations**



Figure 1: RU Flex 2100 DLS coiled (on left) and straightened (on right).



Figure 2. RU Flex 2100 Sensor Assembly Diagram



Figure 3a. IS Barrier Connection Diagram – 2-Wire

#### INSTALLATION NOTES AND STANDARD REFERENCES

1.) COMPLETE INSTALLATION TO BE IN ACCORDANCE WITH ALL PROVISIONS OF FOLLOWING STANAPARDS: NATIONAL ELETOTRIC CET NIPPARO (LASTEST EECONMENDED POWERING AND GROUNDING SENSITIVE ELECTRONIC EQUIPMENT. <u>18-XX</u> POWER 12V-DC GN EXAMPLATING SENSITIVE ELECTRONIC ECOLOMENT. 2.) WIRING METHODS USED FOR SYSTEM INTERCONNECTION MUST COMPLY AT ALL TIMES WITH SECTION 903 AND 725-91 OF THE NATIONAL ELECTRIC CONVER LIMITED CIRCUITS WHEN CLASS II POWER SUPPLIES ARE UTILIZED. DO NOT USE SECTION 725-521 3.) INTRINSICALLY SAFE SYSTEMS MUST COMPLY AT ALL TIMES WITH ARTICLE 504 OF THE: NATIONAL ELECTRIC CODE. 4.) POWERED CIRCUITS INFOLVED тх RX ₩ 4114 0 Ы 0 ര ര ര 0 Ø 88-2110 2100 SENSOR 2100 SENSOR 2100 SENSOR 4.) POWERED CIRCUITS (INCLUDING ALL BRANCHES) MUST UTILIZE OVER -CURRENT PROTECTION IN ACCORDANCE WITH ARTICLE 240 OF THE : NATIONAL ELECTRIC CODE. ø đ ÷ Ð Ð 0 0 0 0 0 0 5) WIRE AND CABLE SELECTION MUST BE IN ACCORDANCE WITH ARTICLE 310 AS REFERENCED IN CHART 310-16 PER THE: NATIONAL ELECTRIC CODE. FOR FUTURE EXE 6.) MAINTAIN WORKING SPACE IN PULL BOXES, JUNCTION CABINETS AND MARSHALING ENCLOSURES PER SECTION 110-16 OF THE: NATIONAL ELECTRIC CODE. Λſ 86 11 NATIONAL ELECTRIC CODE. 9) CENERAL REQUIREMENTS FOR GROUNDING AND BONDING M. CROUNDING AND BONDING M. COMPLIANCE WITH SECTION 2024 OF HOULD BE DESIGNED TO MAINTAIN EFFECTURE GROUND FAULT UNRENT INDUCTOR STATUS AND AND TO UNRENT SOLATED BROWNED COMPLICATION OF CONTRACT OF THE NATIONAL DESCTION OF CONTRACT OF THE NATIONAL DESCTION TESTED BY FALL OF POTENTIAL TEST PROCEDURE TO COMPLICATION SHOULD RESISTANCE SHOULD BE SOME SHOULD SECTION RESISTANCE SHOULD BE SOME SHOULD SECTION SHOULD BE DESCRIPTION ON SHOULD electrol Label octrola 11.) ELECTRODE INSTALLATION SHOULD COMPLY WITH 250.52(A)(4) THROUGH (A)(8) OF THE: NATIONAL ELECTRIC CODE. œ **P** 12.) CONFIRM THAT GROUNDING CONDUCTORS ARE INSULATED IN ORDER TO PREVENT AIRECT CONTACT WITH GROUND OR CONCRETE PER SECTION 250.64 OF THE: NATIONAL ELECTRIC CODE. AND MUST BE TERMINATED WITHIN 18" OF THE FINISHED GRADE GRADE. 13) ELECTRODE CONNECTION AND CABLE SIZING SHOULD BE MADE PER SECTION 250.66 OF THE: NATIONAL ELECTRIC CODE.





#### Figure 4a. Control Drawing 2191-001



Figure 4b. Control Drawing 2191-002

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 4. RU Flex 2100 DLS Part Numbering System

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

- 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, then default will be Unit 01.

## **Contact Information**

For further information or for assistance, please contact: Electrolab, Inc. 159 Enterprise Parkway Boerne, Texas 78006 Phone: (210) 824-5364 TF: (888) 301-2400 Email: InsideSales@electrolabcontrols.com www.electrolabcontrols.com