Using Modbus Protocol with the ALTUS™ Net Oil Computer

Instruction Manual

November 2000

Micro Motion

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Contents

1 Using the NOC Screen

1.1 Overview

This section describes how to use the screen of the Series 3000 NOC to set up communication parameters. For detailed screen use instructions, refer to the *ALTUS Net Oil Computer Manual*.

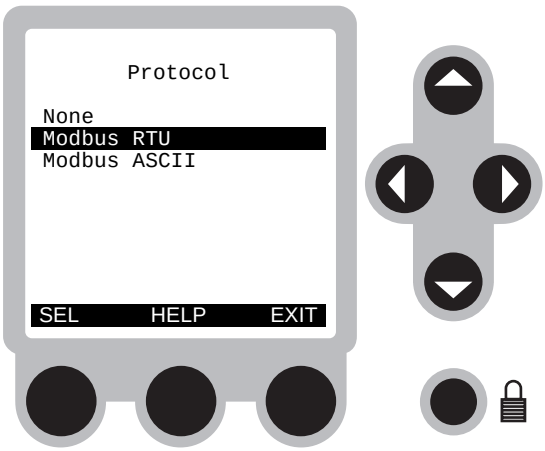
1.2 Changing the communication parameters

You can change the following communication parameters:

- Protocol
- Baud rate
- Parity
- Data bits
- Stop bits
- Slave address
- Byte order

Protocol

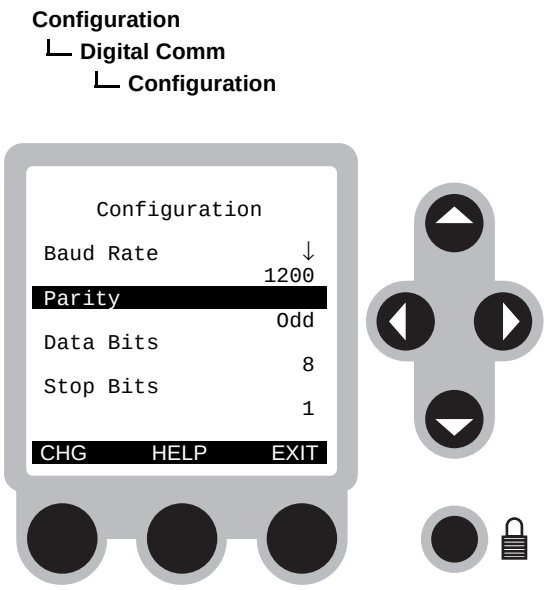
Configuration
└ Digital Comm
└ Protocol



To change the protocol:

1. Select **Configuration**.
2. Select **Digital Comm**.
3. Select **Protocol**.
4. Select **Modbus RTU** or **Modbus ASCII**.
5. Press **EXIT**.

Other communication parameters



To change all other communication parameters:

1. Select **Communication**.
2. Select **Digital Comm**.
3. Select **Configuration**.
4. Highlight the parameter you want to change and press **CHG**. The possible values for each parameter are listed in Table 1-1.
5. Press **EXIT**.

Table 1-1. Communication parameter values

Parameter	Values
Baud rate	1200, 2400, 4800, 9600, 19200, 38400
Parity	None, Odd, Even
Data bits	7, 8
Stop bits	0, 1
Slave address	1–15, 32–47, 64–79, or 96–110
Byte order	1-2-3-4 3-4-1-2 2-1-4-3 4-3-2-1

2 Configuration

2.1 Overview

The procedures in this section will enable you to configure the following Series 3000 NOC parameters:

- Mode of operation
- Units of measurement
- Well data
- Transient bubble remediation

2.2 Mode of operation

The NOC operates in either continuous mode or well test mode.

To view the current mode of operation, examine discrete input 10259. If the discrete input is ON, the NOC is in continuous mode. If the discrete input is OFF, the NOC is in well test mode.

To change the mode of operation:

1. If you want to set the mode of operation to *continuous* mode, then set coil 00285 to ON.
2. If you want to set the mode of operation to *well test* mode, then set coil 00286 to ON.

For Modbus procedures in continuous mode, refer to *Continuous Mode*, page 9. For Modbus procedures in well test mode, refer to *Well Test Mode*, page 11.

Table 2-1. Modbus addresses for mode of operation

Address	Address Type	Description	Values
1 0259	Read-only discrete input	NOC is in continuous mode	• ON, the NOC is in continuous mode • OFF, the NOC is in well-test mode
0 0285	Read/write coil	Enable continuous run mode	ON, changes the mode of operation to *continuous*
0 0286	Read/write coil	Enable well test mode	ON, changes the mode of operation to *well test*

2.3 Units of measurement

You can use Modbus protocol to select the temperature units the NOC will use for measuring net oil and net water.

To set the temperature units of measurement, set holding register 41705 to the desired units integer code. For integer codes, refer to *Temperature Unit Codes*, page 42

Table 2-2. Modbus addresses for units of measurement

Address	Address Type	Description	Values
4 1705	Holding register	Reference temperature index	Integer code for one of the four possible temperature units

2.4 Well data

Using Modbus protocol, you can set oil and water densities and deviations for a well.

The well which will be affected by changing the parameters below depends on the mode in which the NOC is operating:

- If the NOC is operating in continuous mode, the parameters below will affect the current well.
- If the NOC is operating in well test mode, you must select the well you want to configure before changing the parameters below. Set holding register 41701 to the number of the well you want to configure.

You can set the following well data parameters:

- Well name (well test mode only)
- Oil density
- Water density
- Purge time (well test mode only)
- Oil deviation
- Water deviation
- Oil density averaging duration
- Water density averaging duration

Well name

You can only change the well name while the NOC is in well test mode. The well name can be up to 16 characters long. To set the well name, enter the name across ASCII character registers 52306–52313. Each ASCII character register can hold 2 characters.

Oil density

To set the oil density for the well, set floating-point register pair 21675–21676 to the known oil density, in g/cc, at reference temperature. If you perform a density determination, the oil density from the density determination will be automatically placed into these registers (see *Density Determination*, page 13).

Water density

To set the water density for the well, set floating-point register pair 21679–21680 to the known water density, in g/cc, at reference conditions. If you perform a density determination, the water density from the density determination will be automatically placed into these registers (see *Density Determination*, page 13).

Purge time

You can only set the purge time for the well while the NOC is in well test mode. To set the purge time, set holding register 41693 to the amount of time that the NOC will allow the separator contents from the previous test to purge.

Oil deviation

To set the oil deviation, set floating-point register pair 21677–21678 to the maximum oil density deviation, in g/cc, that will be allowed during density determination. Oil densities that fall outside of this deviation limit will cause the NOC to restart the density determination.

Water deviation

To set the water deviation, set floating-point register pair 21681–21682 to the maximum water density deviation, in g/cc, that will be allowed during density determination. Water densities that fall outside of this deviation limit will cause the NOC to restart the density determination.

Oil density averaging duration

To set the oil averaging duration, set holding register 41691 to the length of time you want the oil density to be averaged during density determination (see *Density Determination*, page 13).

Water density averaging duration

To set the water averaging duration, set holding register 41692 to the length of time you want the produced water density to be averaged during density determination (see *Density Determination*, page 13).

Table 2-3. Modbus addresses for well data

Address	Address Type	Description	Values
5 2306 5 2307 5 2308 5 2309 5 2310 5 2311 5 2312 5 2313	ASCII character string	1st pair of characters of well name 2nd pair of characters of well name 3rd pair of character of well name 4th pair of characters of well name 5th pair of characters of well name 6th pair of characters of well name 7th pair of characters of well name 8th pair of characters of well name	Any ASCII characters—the combined strings make up the name of the well
2 1675 2 1676	Floating-point register pair	Density of oil at reference temperature	Known density of oil, in g/cc
2 1677 2 1678	Floating-point register pair	Maximum deviation of oil density during density determination	Limit in g/cc, beyond which density determination will be restarted
2 1679 2 1680	Floating-point register pair	Density of water at reference temperature	Known density of water, in g/cc
2 1681 2 1682	Floating-point register pair	Maximum deviation of water density during density determination	Limit in g/cc, beyond which density determination will be restarted
4 1691	Holding register	Time during which live oil density will be averaged during density determination	Length of time, in seconds
4 1692	Holding register	Time during which produced water density will be averaged during density determination	Length of time, in seconds
4 1693	Holding register	Purge time for the NOC to allow the separator contents of the previous test to purge	Length of time, in seconds

2.5 Transient bubble remediation

Transient bubble remediation corrects density and water cut readings during brief periods when gas bubbles are passing through the sensor.

To set the transient bubble remediation:

1. Set floating-point register pair 21683–21684 to the drive gain level, in volts, above which the NOC will indicate transient bubbles.
2. Set holding register 41706 to the integer code for one of the following three states (for integer codes, refer to *TBR Event Action*, page 44):
   - *Hold last value*—When transient bubbles are detected, the NOC will hold its last good value.
   - *Stop well test*—The NOC will stop the well test if transient bubbles are detected.
   - *Alarm only*—The NOC will report an alarm on discrete output 1.
3. If you selected *Hold last value* in Step 2, then set holding register 41694 to the amount of time, in seconds, that the NOC should use before transient bubbles were detected to derive a density value.

Table 2-4. Modbus addresses for transient bubble remediation

Address	Address Type	Description	Values
2 1683 2 1684	Floating-point register pair	Drive gain level	Level, in volts, above which the NOC indicates the presence of transient bubbles
4 1694	Holding register	Action taken	• 0 hold last value • 1 stop well test • 2 alarm only
4 1706	Holding register	Time period	Time, in seconds, the NOC should use before detecting transient bubbles to derive a density value

3 Continuous Mode

3.1 Overview

The procedures in this section will enable you to use the Series 3000 NOC in continuous mode to:

- View well performance data
- Pause and resume accumulated production measurements
- Reset production measurements

3.2 Viewing well performance data

Well performance data include such information as test start time, elapsed test time, flow rates, and accumulated totals. To view well performance data, examine floating-point register pairs 21537–21822. Refer to *Floating point register pairs*, page 28, for descriptions of each of the registers.

3.3 Pausing and resuming production measurements

The NOC accumulates production measurements unless it is instructed to suspend its accumulation. To pause the accumulation of production measurements, set coil 00269 to ON. To resume the accumulation of production measurements, set coil 00270 to ON.

While the accumulation of production measurements is paused, you can view how long the accumulation has been paused by examining floating-point register pair 21713–21714.

Table 3-1. Modbus addresses for pausing and resuming accumulation of production measurements

Address	Address Type	Description	Values
0 0269	Read/write coil	Pause production measurements	ON, pause the accumulation of production measurements
0 0270	Read/write coil	Resume production measurements	ON, resumes the accumulation of production measurements
2 1713 2 1714	Floating-point register pair	Paused time	Length of time that production measurements have been paused

3.4 Resetting production measurements

You can reset any of the accumulated production measurements by setting the associated Modbus read/write coil to ON. The production measurements and their associated reset coil are listed in Table 3-2.

Table 3-2. Reset coils for production measurements

Production measurement	Reset coil
All measurements	00271
Back flow	00272
Density	00273
Drive gain	00274
Gross flow	00275
Mass flow	00276
Net oil	00277
Net water	00278
Temperature	00279
Uncorrected gross	00280
Uncorrected oil	00281
Uncorrected water	00282
Uncorrected water cut	00283
Water cut	00284

4 Well Test Mode

4.1 Overview

The procedures in this section will enable you to:

- Conduct a well test
- View a well test in progress
- View well test archives

4.2 Conducting a well test

To conduct a well test:

1. Set holding registers 41703 and 41704 to zero.
2. Set holding registers 41701 and 41702 to the number of the well to be tested.
3. Start the test with or without a leading purge time. The leading purge time is defined in holding register 41693.
   - To start the test *with* a leading purge time, set coil 00287 to ON.
   - To start the test *without* a leading purge time, set coil 00289 to ON.

Note: To stop a purge, set coil 00288 to ON. To stop a test, set coil 00290 to ON. The results of the test, even if it is stopped before completing, will be saved to the well test archive.

4. If you started the test with a leading purge time, monitor discrete input 10331. This discrete input will be ON while the purge is in progress.

When the test is complete, you can review the well performance data, the test start time, and the test elapsed time by examining floating-point register pairs 21537–21822. Refer to *Floating point register pairs*, page 28, for descriptions of individual registers.

4.3 Viewing a well test in progress

To view a well test in progress, set floating-point register pair 21703–21704 to zero and examine registers 21537–21822. Refer to *Floating point register pairs*, page 28, for descriptions of individual registers.

4.4 Viewing well test archives

To view the test archive for a particular well:

1. Set holding register 41703 to the archive you want to view.
2. Set holding register 41704 to the number of the well within the archive that you want to view.

Floating-point register pairs 21537–21822 will show well performance data for the specified well test. Refer to *Floating point register pairs*, page 28, for descriptions of individual registers.

5 Density Determination

5.1 Overview

Density determination involves the following procedures:

- Determining the water density at reference temperature
- Measuring the wet oil density and temperature
- Entering the water cut of the oil
- Determining the dry oil density at reference temperature

5.2 Determining the water density at reference temperature

The water density at reference temperature can be determined by either of the following procedures:

- Measuring the water density and temperature
- Manually entering the water density and temperature

Measuring the water density and temperature

To measure the water density and temperature:

1. Switch in the well to be determined, making sure the production fluid from the previous well has been completely purged.
2. Switch out the well that is connected to the test separator.
3. Close the outlet valve downstream from the sensor. Wait for the phases to separate in the separator. The separation usually requires 5–15 minutes. See Figure 5-1, page 14.
4. Open the outlet valve to allow the free water accumulated in the separator to flow through the sensor.
5. Monitor the density and temperature, watching for the readings to stabilize.
6. Set coil 00323 to ON to start the density and temperature average.
7. Monitor discrete input 10331. This discrete input will be ON when the density calculation is completed.
8. Examine floating-point register pairs 21831–21832 and 21833–21834 to review the calculated results.
9. Set coil 00325 to ON to save the results.

Figure 5-1. Stratification with no flow

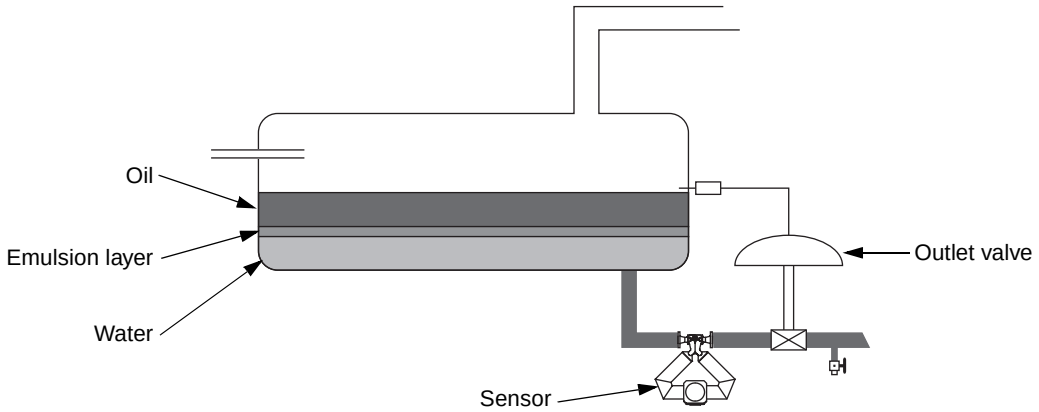


Table 5-1. Modbus addresses for water density measurement

Address	Address Type	Description	Values
0 0323	Read/write coil	Start water density measurement	ON, start water density measurement
1 0331	Discrete input	Density operation complete flag	ON, density operation finished
2 1831 2 1832	Floating point register pair	Container for density used in density determination calculations	Density result of calculation
2 1833 2 1834	Floating point register pair	Container for temperature used in density determination calculations	Temperature result of calculation
0 0325	Read/write coil	Save results from calculated water density measurement	ON, save the calculation results

Manually entering the water density and temperature

If the separator does not contain enough water to determine a stable flowing density, use the manual entry method to determine water density and temperature.

To determine water density by manually entering density and temperature values:

1. Switch in the well to be determined, making sure that the production fluid from the previous well has been completely purged.
2. Switch out the well that is connected to the test separator.
3. Close the outlet valve downstream from the sensor. Wait for the phases to separate in the separator. The separation usually requires 5 to 15 minutes. See Figure 5-2, page 15.
4. Take a water sample from the bottom of the test separator or the water trap. See Figure 5-2, page 15.

5. Place a lid on the sample container and allow the sample to cool to near-ambient temperature.
6. Use a hygrometer to measure the water density and a thermometer to measure the water temperature.
7. Enter the density of the water sample in floating-point register pair 21831–21832.
8. Enter the temperature of the water sample in floating-point register pair 21833–21834.
9. Enter density of the water sample in floating-point register pair 21839–21840.
10. Set coil 00320 to ON to start the density calculation.
11. Examine floating-point register pair 21839–21840 to view the result of the calculation.
12. Set coil 00321 to ON to save the result of the calculation.

Figure 5-2. Taking a water sample from the separator

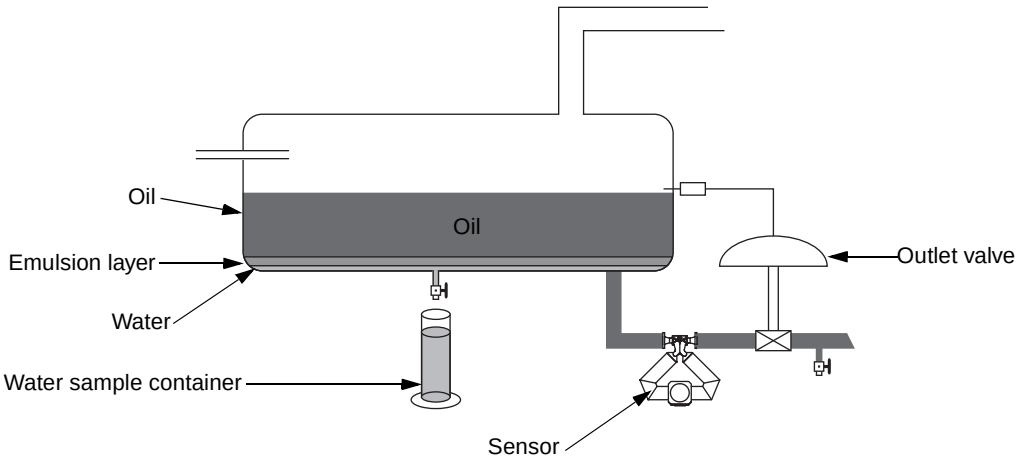


Table 5-2. Modbus addresses for manually determining water density

Address	Address Type	Description	Values
2 1831 2 1832	Floating point register pair	Container for density used in density determination calculations	Known density of water sample
2 1833 2 1834	Floating point register pair	Container for temperature used in density determination calculations	Known temperature of water sample
0 0320	Read/write coil	Calculate water density from manually entered values	ON, start density calculation
2 1839 2 1840	Floating point register pair	Container for results from manual water density calculation	Water density at reference temperature
0 0321	Read/write coil	Saves results from calculated water density	ON, save calculation result

5.3 Measuring the wet oil density and temperature

To measure the wet oil density and temperature:

1. Allow the fluid level in the separator to drop by continuing to drain water from the bottom of the stratified separator, through the outlet valve.
2. Monitor the density until it stabilizes at a density value that indicates oil is flowing through the sensor.
3. Set coil 00326 to ON to start the oil density calculation.
4. Monitor discrete input 10331. This discrete input will be ON when the density calculation is completed.
5. While oil density and temperature are being averaged, take a sample for use in entering the water cut. See Figure 5-3, page 17.

Note: As an alternative, the reading from a water cut probe can be averaged while the oil density and temperature are being averaged.

6. Examine floating-point register pair 21831–21832 to view the density calculation result.
7. Examine floating-point register pair 21833–21834 to view the temperature calculation result.
8. Set coil 00328 to ON to save the results of the calculation.

Note: The NOC will not begin using the most recently averaged oil density until a water cut value has been entered as instructed under* Entering the water cut, *page 18.

Figure 5-3. Taking an oil sample

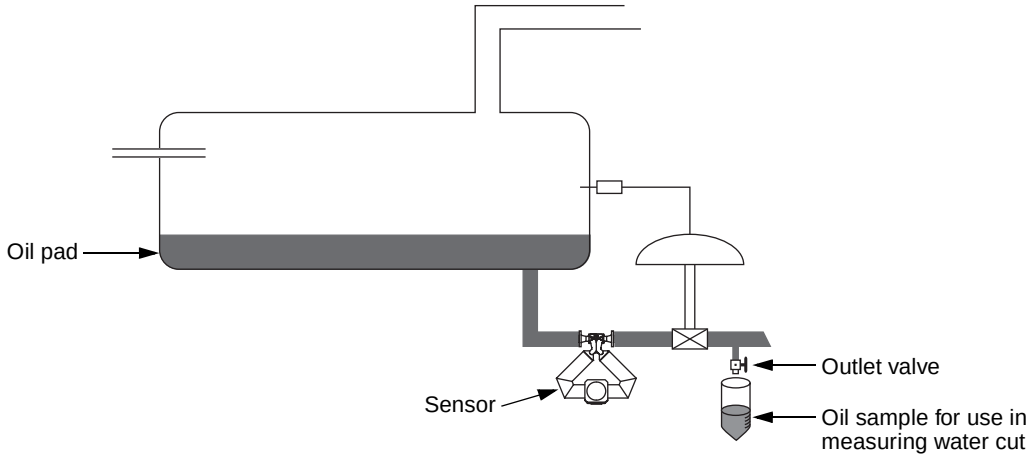


Table 5-3. Modbus addresses for measuring wet oil density

Address	Address Type	Description	Values
0 0326	Read/write coil	Start oil density measurement	ON, start density and temperature calculation
1 0331	Discrete input	Density operation complete flag	ON, density operation finished
2 1831 2 1832	Floating-point register pair	Container for density used in density determination calculations	Density result of the calculation
2 1833 2 1834	Floating-point register pair	Container for temperature used in density determination calculations	Temperature result of the calculation
0 0328	Read/write coil	Save intermediate results from oil density determination measurement	ON, save the calculation results

⚠ CAUTION

Changing the density internal damping in floating-point register pair 20193–20194 from its default of 1.7 seconds may adversely change the operation of the density determination routines.
It is advised to leave the density internal damping at the default value when performing a density determination.

5.4 Entering the water cut of the oil

After the average oil density has been saved, enter the water cut of the oil.

To enter the water cut of the oil:

1. Use a standard procedure (centrifuge, distillation, Karl-Fischer) to measure the water cut in volume percent from the sample taken during oil density determination. See Step 5, page 16.

Note: As an alternative, enter the average water cut probe reading determined during oil density determination.

2. Enter the water cut percentage in floating-point register pair 21835–21836.

Table 5-4. Modbus addresses for entering the water cut

Address	Address Type	Description	Values
2 1835 2 1836	Floating-point register pair	Container for water cut percentage used in density determination calculations	Measured water cut in volume percent

5.5 Determining the dry oil density at reference temperature

To determine the dry oil density at reference temperature:

1. Set coil 00329 to ON to start the calculation.
2. Examine floating-point register pair 21855–21856 to view the results of the calculation.
3. Set coil 00330 to ON to save the oil density at reference temperature.

Table 5-5. Modbus addresses for determining dry oil density

Address	Address Type	Description	Values
0 0329	Read/write coil	Calculate actual oil density at reference from oil density measurement and user supplied water cut	ON, calculate actual oil density at reference
2 1855 2 1856	Floating-point register pair	Results from calculation of oil density at reference	Density result of the calculation
0 0330	Read/write coil	Save actual oil density at reference	ON, save calculation results

6 Calibration and Trim

6.1 Overview

Calibration and trim involve the following three procedures:

- Auto zero
- Density calibration
- Temperature calibration
- Output trim

6.2 Auto zero

Auto zero establishes sensor zero by measuring the offset of the flow signal during zero flow conditions.

To perform the zero procedure:

1. Fill the sensor completely.
2. Close the shutoff valve downstream from the sensor. Flow through the sensor must be completely stopped to enable accurate zeroing.
3. If possible, shut off mechanical noise sources such as motors, pumps, and valves.
4. Examine floating-point register pair 20233–20234 to view the current zero values.
5. Set holding register 40136 to the desired maximum zero time.
6. Set coil 00005 to ON to start the auto zero calculation.
7. Monitor bit 14 of input register 30126. This bit will be ON while the auto zero calculation is in progress.

Note: To abort the auto zero calculation, set coil 00005 to OFF.

8. Examine bits 8–10 of input register 30126 to determine success or failure of the auto zero calculation. For each bit, a value of zero indicates success.
9. Examine floating-point register pair 20233–20234 to view the new zero values.

Table 6-1. Modbus addresses for auto zero

Address	Address Type	Description	Values
2 0233 2 0234	Floating-point register pair	Container for the flow signal offset at zero flow	Results of the auto zero calculation
4 0136	Holding register	Maximum zero time	Longest time to keep trying the auto zero calculation
0 0005	Read/write coil	Perform flowmeter zeroing	ON, starts the auto zero calculation
3 0126	Input register	Container for transmitter alarm codes	• Bit #8 Calibration failure • Bit #9 Zero too low • Bit #10 Zero too high

Diagnosing zeroing failure

The following are the most common sources of zeroing failure:

- Flow of fluid through sensor during zeroing
- Flow tubes not **completely** filled with fluid during zeroing
- Mechanical noise from equipment such as motors, pumps, or valves
- Inappropriate zero time or standard deviation

6.3 Density calibration

Modbus protocol can be used for performing a two-point density calibration in the field. The procedure includes a low-density calibration and a high-density calibration. Before performing the low-density or high-density calibration, you must prepare the sensor for calibration.

Preparing the sensor for density calibration

To prepare the sensor for density calibration:

1. Use produced water to flush the flow line.
2. Remove the sensor from the flow line.
3. Drain the fluid from the sensor.
4. Rinse the sensor tubes with toluene at least twice, then rinse the tubes with acetone at least twice. Use another oil solvent if toluene or acetone is not available.

5. Use compressed air to blow the sensor dry until residual acetone or other solvent has been completely evaporated.
6. If sensor wiring was disconnected at step 2, reconnect the wiring and cycle power off, then on.
7. Wait approximately 5 minutes for the sensor flow tubes to achieve the ambient air temperature.

Low-density calibration

To perform the low-density calibration:

1. Fill the sensor with a low-density material (e.g., air).
2. If possible, shut off the flow. Otherwise, pump the material through the sensor at the lowest flow rate allowed by the process.
3. Use any established method to derive an accurate density, in g/cc, for the fluid at line conditions.
4. Enter the fluid density in floating-point register pair 20155–20156.
5. Set coil 00013 to ON to start the density calculation.
6. Monitor bit 14 of input register 30126. This bit will be ON while the density calculation is occurring.
7. Examine bit 8 of input register 30126 to determine whether the calibration failed or succeeded. A value of zero indicates success.

Table 6-2. Modbus addresses for low-density calibration

Address	Address Type	Description	Values
2 0155 2 0156	Floating-point register pair	Container for density for low-density calibration (g/cc)	Known density of the low-density fluid
0 0013	Read/write coil	Perform low-density calibration	ON, start density calculation
3 0126	Input register	Container for transmitter alarm codes	• Bit #8 Calibration failure • Bit #14 Zeroing in progress

High-density calibration

To perform the high-density calibration:

1. Fill the sensor with a high-density fluid (e.g., water).
2. If possible, shut off the flow. Otherwise, pump the fluid through the sensor at the slowest flow rate allowed by the process.

Note: To ensure stable density, make sure the fluid in the flow tubes remains completely free of gas bubbles during the calibration.

3. Use any established method to derive an accurate density, in g/cc, for the fluid at line conditions.
4. Enter the fluid density in floating-point register pair 20157–20158.
5. Set coil 00014 to ON to start the density calculation.
6. Monitor bit 14 of input register 30126. This bit will be ON while the density calculation is occurring.
7. Examine bit 8 of input register 30126 to determine whether the calibration failed or succeeded. A value of zero indicates success.
8. Examine floating-point register pairs 20155–20156, 20157–20158, 20159–20160, and 20161–20162 for the results of the density calculation.

Table 6-3. Modbus addresses for high-density calibration

Address	Address Type	Description	Values
0 0014	Read/write coil	Perform high-density calibration	ON, start density calculation
3 0126	Input register	Container for transmitter alarm codes	• Bit #8 Calibration failure • Bit #14 Zeroing in progress
2 0155 2 0156	Floating-point register pair	Density for low-density calibration (g/cc)	Known density of low-density fluid
2 0157 2 0158	Floating-point register pair	Density for high-density calibration (g/cc)	Known density of high-density fluid
2 0159 2 0160	Floating-point register pair	Density calibration constant 1 (μsec)	Results of density calculation
2 0161 2 0162	Floating-point register pair	Density calibration constant 2 (μsec)	Results of density calculation

6.4 Temperature calibration

Modbus protocol can be used for performing a temperature calibration in the field.

To perform a temperature calibration:

1. Fill the sensor with a low-temperature fluid and allow the sensor to achieve thermal equilibrium.
2. Set floating-point register pair 20151–20152 to the temperature of the low-temperature fluid.
3. Set coil 00015 to ON to perform the temperature offset calculation.
4. Fill the sensor with a high-temperature fluid and allow the sensor to achieve thermal equilibrium.
5. Set floating-point register pair 20151–20152 to the temperature of the high-temperature fluid.
6. Set coil 00016 to ON to perform the temperature slope calculation.
7. Examine floating-point register pairs 20411–20412 and 20413–20414 for the results of the temperature calibration.

Table 6-4. Modbus addresses for temperature calibration

Address	Address Type	Description	Values
2 0151 2 0152	Floating-point register pair	Container for temperature for temperature calibration	Known temperature of the process fluid
0 0015	Read/write coil	Perform low-temperature calibration	ON, start temperature calculation
0 0016	Read/write coil	Perform high-temperature calibration	ON, start temperature calculation

6.5 Output trim

Output trim adjusts the transmitter's digital-to-analog converter to match primary and secondary milliamp outputs with a specific reference standard, receiver, or readout device.

To perform a milliamp output trim:

1. Set floating-point register pair 20143–20144 to the 4.0 mA point.
2. Set coil 00010 to ON to fix the mA output.
3. Enter the mA reference reading in floating-point register pair 20143–20144.
4. Set coil 00006 to ON to trim the output.
5. Set floating-point register pair 20143–20144 to the 20.0 mA point.
6. Set coil 00010 to ON to fix the mA output.

7. Enter the mA reference reading in floating-point register pair 20143–20144.
8. Set coil 00007 to ON to trim the output.
9. Set floating-point register pair 20143–20144 to 0.0.
10. Set coil 00010 to ON to release the mA output.

You can trim the secondary mA output by substituting the Modbus addresses listed in Table 6-5.

Table 6-5. Substitution mA trim registers

If the address for the primary mA output is:	Use this address for the secondary mA output:
20143–20144	20145–20146
00010	00011
00006	00008
00007	00009

Table 6-6. Modbus addresses for output trim

Address	Address Type	Description	Values
2 0143 2 0144	Floating-point register pair	Fixed current for primary mA output test (milliamps)	Value at 4.0 mA or 20.0 mA
0 0010	Read/write coil	Fix current level from primary mA output	ON, fix mA output
0 0006	Read/write coil	Trim primary mA output at 4.0 mA	ON, trim mA output
0 0007	Read/write coil	Trim primary mA output at 20.0 mA	ON, trim mA output

7 Modbus Mapping Assignments

Read/write coils

Address	Description
0 0003	Reset all totalizers
0 0004	Reset all inventories
0 0005	Perform flowmeter zeroing
0 0006	Trim primary mA output at 4 mA
0 0007	Trim primary mA output at 20 mA
0 0008	Trim secondary mA output at 4 mA
0 0009	Trim secondary mA output at 20 mA
0 0010	Fix current level from primary mA output
0 0011	Fix current level from secondary mA output
0 0012	Fix frequency from frequency/pulse output
0 0013	Perform low-density calibration
0 0014	Perform high-density calibration
0 0015	Perform temperature offset calibration
0 0016	Perform temperature slope calibration
0 0018	Perform third-point density (FD) calibration
0 0056	Reset mass total
0 0057	Reset line volume (gross volume) total
0 0150	Enable Coriolis
0 0151	Enable sensor alarms

Read/write coils (continued)

Address	Description
0 0269	Pause production measurements
0 0270	Resume production measurements
0 0271	Reset all production measurements
0 0272	Reset back flow
0 0273	Reset density
0 0274	Reset drive gain
0 0275	Reset gross flow
0 0276	Reset mass flow
0 0277	Reset net oil rate (min/max/avg)
0 0278	Reset net water cut (min/max/avg)
0 0279	Reset temperature
0 0280	Reset uncorrected gross
0 0281	Reset uncorrected oil
0 0282	Reset uncorrected water
0 0283	Reset uncorrected water cut
0 0284	Reset water cut
0 0285	Enable continuous run mode
0 0286	Enable well test mode
0 0287	Start purge
0 0288	Stop purge
0 0289	Start well test
0 0290	Stop well test
0 0295	Start determination of oil density
0 0296	Stop determination of oil density
0 0297	Start determination of produced water density
0 0298	Stop determination of produced water density
0 0320	Calculate water density from manually entered values
0 0321	Save results from calculated water density
0 0322	Reset density determination volume total
0 0323	Start water density determination measurement
0 0324	Abort water density determination measurement
0 0325	Save results from water density determination measurement
0 0326	Start oil density determination measurement
0 0327	Abort oil density determination measurement
0 0328	Save intermediate results from old density determination measurement
0 0329	Calculate actual oil density at reference from oil density measurement and user supplied water cut
0 0330	Save actual oil density at reference

Read-only discrete inputs

Address		Description
1	0021	(E)EPROM checksum failure
1	0022	RAM diagnostic failure
1	0023	Real-time interrupt failure
1	0024	Sensor failure
1	0025	Temperature sensor failure
1	0026	Flowmeter zeroing failure
1	0027	Undefined
1	0028	Transmitter initializing/warming up
1	0029	Primary variable out of range
1	0030	Non-primary variable out of range
1	0031	Milliamp output(s) saturated
1	0032	Milliamp output(s) fixed
1	0033	Watchdog timer error
1	0034	Power reset occurred
1	0035	Undefined
1	0036	Transmitter electronics failure
1	0259	NOC is in continuous mode
1	0260	NOC is in pause mode
1	0300	Configuration memory initialized; NOC not configured
1	0301	NOC configuration corrupted
1	0302	NOC configuration mismatched
1	0303	NOC configuration invalid
1	0304	Temperature out of range
1	0305	Density out of range (slug flow) warning
1	0306	Density out of range (slug flow) alarm
1	0307	Continuous-mode measurements paused for more than 15 minutes
1	0308	Transient bubbles in sensor (TBR) warning
1	0309	Transient bubbles in sensor (TBR) alarm
1	0310	Density calculation error
1	0311	Purge in progress
1	0331	Density operation complete flag (ON = finished)

Floating point register pairs

Address	Description
2 0141 0142	Slug duration (seconds)
2 0143 0144	Fixed current for primary mA output test (milliamps)
2 0145 0146	Fixed current for secondary mA output test (milliamps)
2 0147 0148	Fixed frequency for frequency/output test (Hertz)
2 0151 0152	Temperature for temperature offset/slope calibrations
2 0155 0156	Density for low-density calibration (g/cc)
2 0157 0158	Density for high-density calibration (g/cc)
2 0159 0160	Density calibration constant 1 (µsec)
2 0161 0162	Density calibration constant 2 (µsec)
2 0163 0164	Density temperature coefficient
2 0165 0166	High mass flow limit of sensor
2 0167 0168	High temperature limit of sensor
2 0169 0170	High density limit of sensor (g/cc)
2 0171 0172	High volume flow limit of sensor
2 0173 0174	Low mass flow limit of sensor
2 0175 0176	Low temperature limit of sensor
2 0177 0178	Low density limit of sensor (g/cc)
2 0179 0180	Low volume flow limit of sensor
2 0181 0182	Mass flow minimum range
2 0183 0184	Temperature minimum range
2 0185 0186	Density minimum range
2 0187 0188	Volume flow minimum range
2 0189 0190	Flow rate internal damping (seconds)
2 0191 0192	Temperature internal damping (seconds)
2 0193 0194	Density internal damping (seconds)
2 0195 0196	Mass flow cutoff for frequency/pulse output
2 0197 0198	Volume flow cutoff for frequency/pulse output
2 0199 0200	Slug flow high-density limit (g/cc)
2 0201 0202	Slug flow low-density limit (g/cc)
2 0203 0204	Primary mA output present current (milliamps)
2 0205 0206	Added damping on primary mA output (seconds)
2 0207 0208	Flow cutoff for primary mA output
2 0209 0210	Primary variable at 20 mA/High current level for primary mA event
2 0211 0212	Primary variable at 4 mA/Low current level for primary mA event
2 0213 0214	Secondary mA output present current (milliamps)
2 0215 0216	Added damping on secondary mA output (seconds)
2 0217 0218	Flow cutoff for secondary mA output
2 0219 0220	Secondary variable at 20 mA/high current level for secondary mA event
2 0221 0222	Secondary variable at 4 mA/low current level for secondary mA event
2 0223 0224	Frequency setpoint or number of pulses (Hz)
2 0225 0226	Flow rate or total represented by frequency or number of pulses
2 0227 0228	Frequency pulse width (milliseconds)
2 0229 0230	Frequency/pulse output present frequency (Hz)

Floating point register pairs (continued)

Address	Description	
2 0231 0232	Flowmeter zeroing standard deviation	
2 0233 0234	Present flow signal offset at zero flow	
2 0245 0246	1	(E)EPROM checksum failure
	2	RAM diagnostic failure
	4	Sensor failure
	8	Temperature sensor failure
	16	Input overrange
	32	Frequency/pulse output saturated
	64	Transmitter not configured
	128	Real-time interrupt failure
	256	Primary mA output saturated
	512	Secondary mA output saturated
	1024	Primary mA output fixed
	2048	Secondary mA output fixed
	4096	Density overrange
	8192	Calibration failure
	16384	Zero value too low
	32768	Zero value too high
	65536	Transmitter electronics failure
	131072	Flowmeter zeroing in progress
	262144	Slug flow
	524288	Power reset occurred
	1048576	Undefined
	2097152	Transmitter initializing/warming up
2 0247 0248	Mass flow rate	
2 0249 0250	Density	
2 0251 0252	Temperature	
2 0253 0254	Volume flow rate	
2 0259 0260	Mass total	
2 0261 0262	Volume total	
2 0263 0264	Mass inventory	
2 0265 0266	Volume inventory	
2 0277 0278	Density for FD calibration (g/cc)	
2 0279 0280	Mass rate factor	
2 0281 0282	Volume rate factor	
2 0283 0284	Density rate factor	
2 0285 0286	Raw tube frequency (Hz)	
2 0291 0292	Drive gain	
2 0293 0294	Mass flow live zero flow	

Floating point register pairs (continued)

Address	Description
2 0303 0304	Flowing density constant
2 0407 0408	Flow calibration factor
2 0409 0410	Temperature coefficient for flow
2 0411 0412	Temperature calibration slope
2 0413 0414	Temperature calibration offset
2 1101 1102	Frequency output pulses/unit
2 1103 1104	Frequency output units/pulse
2 1109 1110	Primary mA fault setting value
2 1111 1112	Secondary mA fault setting value
2 1537 1538	Actual back flow rate
2 1539 1540	Actual density
2 1541 1542	Actual drive gain
2 1543 1544	Actual gross flow rate
2 1545 1546	Actual mass flow rate
2 1547 1548	Actual net oil flow rate
2 1549 1550	Actual net water flow rate
2 1551 1552	Actual temperature
2 1553 1554	Actual uncorrected net oil flow rate
2 1555 1556	Actual uncorrected net water cut
2 1557 1558	Actual water cut
2 1567 1568	Average back flow rate
2 1569 1570	Average density
2 1571 1572	Average drive gain
2 1573 1574	Average gross flow rate
2 1575 1576	Average mass flow rate
2 1577 1578	Average net oil flow rate
2 1579 1580	Average net water flow rate
2 1581 1582	Average temperature
2 1583 1584	Average uncorrected net oil flow rate
2 1585 1586	Average uncorrected net water cut
2 1587 1588	Average water cut
2 1597 1598	Maximum back flow rate
2 1599 1600	Maximum density
2 1601 1602	Maximum drive gain
2 1603 1604	Maximum gross flow rate
2 1605 1606	Maximum mass flow rate
2 1607 1608	Maximum net oil flow rate
2 1609 1610	Maximum net water flow rate
2 1611 1612	Maximum temperature
2 1613 1614	Maximum uncorrected net oil flow rate
2 1615 1616	Maximum uncorrected net water cut
2 1617 1618	Maximum water cut

Floating point register pairs (continued)

Address	Description
2 1627 1628	Minimum back flow rate
2 1629 1630	Minimum density
2 1631 1632	Minimum drive gain
2 1633 1634	Minimum gross flow rate
2 1635 1636	Minimum mass flow rate
2 1637 1638	Minimum net oil flow rate
2 1639 1640	Minimum net water flow rate
2 1641 1642	Minimum temperature
2 1643 1644	Minimum uncorrected net oil flow rate
2 1645 1646	Minimum uncorrected net water cut
2 1647 1648	Minimum water cut
2 1657 1658	Gross volume total
2 1659 1660	Mass total
2 1661 1662	Net oil volume total
2 1663 1664	Net water volume total
2 1665 1666	Uncorrected oil volume total
2 1675 1676	Density of oil at reference temperature
2 1677 1678	Maximum deviation of oil density during density determination
2 1679 1680	Density of water at reference temperature
2 1681 1682	Maximum deviation of water density during density determination
2 1683 1684	Drive gain threshold for TBR (volts)
2 1711 1712	Well test elapsed time
2 1713 1714	Well test paused time
2 1715 1716	Well test purge time remaining
2 1725 1726	Time and date of last production measurement reset
2 1727 1728	Time and date last well test was stopped
2 1729 1730	Time and date last well test was started
2 1741 1742	Time and date maximum back flow was achieved
2 1743 1744	Time and date maximum density was achieved
2 1745 1746	Time and date maximum drive gain was achieved
2 1747 1748	Time and date maximum gross flow rate was achieved
2 1749 1750	Time and date maximum mass flow rate was achieved
2 1751 1752	Time and date maximum net oil flow rate was achieved
2 1753 1754	Time and date maximum net water flow rate was achieved
2 1755 1756	Time and date maximum temperature was achieved
2 1757 1758	Time and date maximum uncorrected net oil flow rate was achieved
2 1759 1760	Time and date maximum uncorrected water cut was achieved
2 1761 1762	Time and date maximum water cut was achieved
2 1771 1772	Time and date minimum back flow was achieved
2 1773 1774	Time and date minimum density was achieved
2 1775 1776	Time and date minimum drive gain was achieved
2 1777 1778	Time and date minimum gross flow rate was achieved
2 1779 1780	Time and date minimum mass flow rate was achieved
2 1781 1782	Time and date minimum net oil flow rate was achieved
2 1783 1784	Time and date minimum net water flow rate was achieved
2 1785 1786	Time and date minimum temperature was achieved
2 1787 1788	Time and date minimum uncorrected net oil flow rate was achieved
2 1789 1790	Time and date minimum uncorrected water cut was achieved
2 1791 1792	Time and date minimum water cut was achieved

Floating point register pairs (continued)

Address	Description
2 1801 1802	Time and date back flow was reset
2 1803 1804	Time and date density was reset
2 1805 1806	Time and date drive gain was reset
2 1807 1808	Time and date gross flow rate was reset
2 1809 1810	Time and date mass flow rate was reset
2 1811 1812	Time and date net oil flow rate was reset
2 1813 1814	Time and date net water flow rate was reset
2 1815 1816	Time and date temperature was reset
2 1817 1818	Time and date uncorrected net oil flow rate was reset
2 1819 1820	Time and date uncorrected water cut was reset
2 1821 1822	Time and date water cut was reset
2 1831 1832	Container for density used in density determination calculations
2 1833 1834	Container for temperature used in density determination calculations
2 1835 1836	Container for water cut percentage used in density determination calculations
2 1839 1840	Results from calculated water density operation
2 1843 1844	Results from last water density determination measurement
2 1847 1848	Current water density at reference
2 1851 1852	Current oil density at reference
2 1855 1856	Results from calculation of oil density at reference
2 1859 1860	Density determination volume total

Input registers

Address		Description	
3	0001	Bit #0	(E)EPROM checksum failure
		Bit #1	Undefined
		Bit #2	Sensor failure
		Bit #3	Temperature sensor failure
		Bit #4	Input overrange
		Bit #5	Frequency/pulse output saturated
		Bit #6	Transmitter not configured
		Bit #7	Real-time interrupt failure
		Bit #8	Milliamp output(s) saturated
		Bit #9	Milliamp output(s) fixed
		Bit #10	Density overrange
		Bit #11	Calibration failure
		Bit #12	Transmitter electronics failure
		Bit #13	Slug flow
		Bit #14	Transmitter initializing/warming up
		Bit #15	Power reset occurred
3	0002	Mass flow rate scaled integer	
3	0003	Density scaled integer	
3	0004	Temperature scaled integer	
3	0005	Volume flow rate scaled integer	
3	0008	Mass total scaled integer	
3	0009	Volume total scaled integer	
3	0010	Mass inventory scaled integer	
3	0011	Volume inventory scaled integer	
3	0125	Bit #0	Primary mA output saturated
		Bit #1	Secondary mA output saturated
		Bit #2	Primary mA output fixed
		Bit #3	Secondary mA output fixed
		Bit #4	Density overrange
		Bit #5	Drive gain overrange
		Bit #6	Undefined
		Bit #7	Undefined
		Bit #8	(E)EPROM checksum failure
		Bit #9	RAM diagnostic failure
		Bit #10	Sensor failure
		Bit #11	Temperature sensor failure
		Bit #12	Input overrange
		Bit #13	Frequency/pulse output saturated
		Bit #14	Transmitter not configured
		Bit #15	Real-time interrupt failure

Input registers (continued)

Address	Description	
3 0126	Bit #0	Undefined
	Bit #1	Power reset occurred
	Bit #2	Undefined
	Bit #3	Undefined
	Bit #4	Undefined
	Bit #5	Undefined
	Bit #6	Undefined
	Bit #7	Undefined
	Bit #8	Calibration failure
	Bit #9	Zero value too low
	Bit #10	Zero value too high
	Bit #11	Undefined
	Bit #12	Transmitter electronics failure
	Bit #13	Undefined
	Bit #14	Flowmeter zeroing in progress
	Bit #15	Slug flow
3 0419	Bit #0	(E)EPROM checksum error
	Bit #1	RAM test error
	Bit #2	Real-time interrupt failure
	Bit #3	Sensor not responding
	Bit #4	Temperature sensor out of range
	Bit #5	Calibration failure
	Bit #6	Undefined
	Bit #7	Transmitter initializing/warming up
	Bit #8	Undefined
	Bit #9	Undefined
	Bit #10	Undefined
	Bit #11	Undefined
	Bit #12	Undefined
	Bit #13	Undefined
	Bit #14	Undefined
	Bit #15	Undefined

Input registers (continued)

Address	Description	
3 0420	Bit #0	Primary mA output saturated
	Bit #1	Secondary mA output saturated
	Bit #2	Primary mA output fixed
	Bit #3	Secondary mA output fixed
	Bit #4	Density overrange
	Bit #5	Drive overrrange
	Bit #6	Undefined
	Bit #7	Undefined
	Bit #8	(E)EPROM checksum failure
	Bit #9	RAM diagnostic failure
	Bit #10	Sensor not responding
	Bit #11	Temperature sensor failure
	Bit #12	Input overrange
	Bit #13	Frequency/pulse output saturated
	Bit #14	Transmitter not configured
	Bit #15	Real-time interrupt failure
3 0421	Bit #0	Undefined
	Bit #1	Power reset occurred
	Bit #2	Transmitter initializing/warming up
	Bit #3	Undefined
	Bit #4	Undefined
	Bit #5	Undefined
	Bit #6	Undefined
	Bit #7	Undefined
	Bit #8	Calibration failure
	Bit #9	Zero value too low
	Bit #10	Zero value too high
	Bit #11	Undefined
	Bit #12	Transmitter electronics failure
	Bit #13	Undefined
	Bit #14	Calibration in progress
	Bit #15	Slug flow

Input registers (continued)

Address	Description	
3 0423	Bit #0	Undefined
	Bit #1	Undefined
	Bit #2	Frequency output fixed
	Bit #3	Undefined
	Bit #4	Undefined
	Bit #5	Undefined
	Bit #6	Undefined
	Bit #7	Undefined
	Bit #8	Undefined
	Bit #9	Undefined
	Bit #10	Undefined
	Bit #11	Undefined
	Bit #12	Undefined
	Bit #13	Undefined
	Bit #14	Undefined
	Bit #15	Undefined
3 1837	Timecode when density determination performed (high order register of 4-byte integer)	
3 1838	Timecode when density determination performed (low order register of 4-byte integer)	
3 1841	Timecode for last calculated water density operation (high order register of 4-byte integer)	
3 1842	Timecode for last calculated water density operation (low order register of 4-byte integer)	
3 1845	Timecode for last water density determination measurement (high order register of 4-byte integer)	
3 1846	Timecode for last water density determination measurement (low order register of 4-byte integer)	
3 1849	Timecode for current water density at ref. (high order register of 4-byte integer)	
3 1850	Timecode for current water density at ref. (low order register of 4-byte integer)	
3 1853	Timecode for current oil density at ref. (high order register of 4-byte integer)	
3 1854	Timecode for current oil density at ref. (low order register of 4-byte integer)	
3 1857	Timecode for last calculation of oil density at ref. (high order register of 4-byte integer)	
3 1858	Timecode for last calculation of oil density at ref. (low order register of 4-byte integer)	

Holding registers

Address	Description
4 0012	Primary milliamp output variable
4 0013	Secondary milliamp output variable
4 0014	Frequency/pulse output variable
4 0016	Transmitter software revision
4 0017	Flow direction (forward/backward)
4 0018	Maximum integer
4 0019	Mass flow offset
4 0020	Density offset
4 0021	Temperature offset
4 0022	Volume flow offset
4 0024	Pressure offset
4 0025	Mass total offset
4 0026	Volume total offset
4 0027	Mass inventory offset
4 0028	Volume inventory offset
4 0029	Mass flow scale factor
4 0030	Density scale factor
4 0031	Temperature scale factor
4 0032	Volume flow scale factor
4 0034	Pressure scale factor
4 0035	Mass total scale factor
4 0036	Volume total scale factor
4 0037	Mass inventory scale factor
4 0038	Volume inventory scale factor
4 0039	Mass flow rate unit
4 0040	Density unit
4 0041	Temperature unit
4 0042	Volume flow rate unit
4 0045	Mass total or mass inventory unit
4 0046	Volume total or volume inventory unit
4 0120	Device type code
4 0121	Manufacturer ID
4 0129	Sensor flange type
4 0130	Sensor flow tube construction material
4 0131	Sensor flow tube liner material

Holding registers (continued)

Address	Description
4 0136	Maximum zeroing time
4 0312	Undefined
4 0313	Modbus slave address
4 0521	Floating point byte order
4 1107	Frequency/pulse output fault code
4 1108	Frequency/pulse output scaling method
4 1113	Primary milliamp output fault code
4 1114	Secondary milliamp output fault code
4 1150	Coriolis and sensor alarm timeout (minutes)
4 1151	Discrete output 1 variable
4 1152	Discrete output 1 power source
4 1139	Undefined
4 1691	Time duration which oil density will be averaged during density determination (seconds)
4 1692	Time duration which produced water density will be averaged during density determination (seconds)
4 1693	Purge time for the NOC to allow the separator contents of the previous test to purge (minutes)
4 1694	Look-back time interval for TBR (5–30 seconds)
4 1701	Well to be configured (1–48)
4 1702	Well that is being tested (1–48)
4 1703	Test results (0 = well currently under test, 1 = last test, 2 = next-to-last test, 3 = oldest test)
4 1704	Well within archive for test results (1–48)
4 1705	Reference Temperature (60 °F, 15 °C, 20 °C)
4 1706	Action to be taken on TBR event (0 = hold last value, 1 = stop well test, 2 = alarm only)
4 2305	Index of well name to configure (1–48)

ASCII character strings

Address	Description	
Note		
Always write character string as single-write multiple.		
5 2306	1st two characters of well name	Single-write multiple
5 2307	2nd two characters of well name	
5 2308	3rd two characters of well name	
5 2309	4th two characters of well name	
5 2310	5th two characters of well name	
5 2311	6th two characters of well name	
5 2312	7th two characters of well name	
5 2313	8th two characters of well name	

Integer codes

Mass flow unit codes (holding register 40039)

70	Grams/second
71	Grams/minute
72	Grams/hour
73	Kilograms/second
74	Kilograms/minute
75	Kilograms/hour
76	Kilograms/day
77	Metric tons/minute
78	Metric tons/hour
79	Metric tons/day
80	Pounds/second
81	Pounds/minute
82	Pounds/hour
83	Pounds/day
84	Short tons (2000 pounds)/minute
85	Short tons (2000 pounds)/hour
86	Short tons (2000 pounds)/day
87	Long tons (2240 pounds)/hour
88	Long tons (2240 pounds)/day

Mass totalizer or mass inventory unit codes (holding register 40045)

60	Grams
61	Kilograms
62	Metric tons
63	Pounds
64	Short tons (2000 pounds)
65	Long tons (2240 pounds)

Integer codes (continued)

Volume flow unit codes (holding register 40042)

15	Cubic feet/minute
16	U.S. gallons/minute
17	Liters/minute
18	Imperial gallons/minute
19	Cubic meters/hour
22	U.S. gallons/second
23	Million U.S. gallons/day
24	Liters/second
26	Cubic feet/second
27	Cubic feet/day
28	Cubic meters/second
29	Cubic meters/day
30	Imperial gallons/hour
31	Imperial gallons/day
130	Cubic feet/hour
131	Cubic meters/minute
132	Barrels/second
133	Barrels/minute
134	Barrels/hour
135	Barrels/day
136	U.S. gallons/hour
137	Imperial gallons/second
138	Liters/hour
235	U.S. gallons/day

Volume totalizer or volume inventory unit codes (holding register 40046)

40	U.S. gallons
41	Liters
42	Imperial gallons
43	Cubic meters
46	Barrels (42 U.S. gallons)
112	Cubic feet

Integer codes (continued)

Temperature unit codes (holding register 40041)

32	Degrees Celsius
33	Degrees Fahrenheit
34	Degrees Rankine
35	Degrees Kelvin

Density unit codes (holding register 40040)

91	Grams/cubic centimeter
92	Kilograms/cubic meter
93	Pounds/gallon
94	Pounds/cubic foot
96	Kilograms/liter
97	Grams/liter
98	Pounds/cubic inch
99	Short tons (2000 pounds)/cubic yard

Discrete output 1 power source codes (holding register 41152)

0	External
1	Internal

Discrete output 1 output variable codes (holding register 41151)

251	None
54	Discrete input 1
55	Discrete input 2
97	Transient bubble remediation
72	Fault alarm

Milliamp ouput variable codes (holding register 40012 or 40013)

0	Mass flow rate
1	Temperature
3	Density
5	Volume flow rate
70	Drive gain
73	Actual uncorrected oil flow
74	Actual uncorrected water cut
75	Actual uncorrected water flow
76	Actual uncorrected gross flow
77	Actual uncorrected back flow
78	Net oil flow
79	Water cut
80	Gross flow
81	Net water flow
82	Average uncorrected oil flow
83	Average uncorrected water cut
84	Average uncorrected gross flow
85	Average uncorrected water flow
86	Average back flow
87	Average net oil flow
88	Average water cut
89	Average gross flow
90	Average net water flow

Integer codes (continued)

Flow direction codes (holding register 40017)

0	Forward flow only
1	Backward flow only

Frequency/pulse output variable codes (holding register 40014)

0	Mass flow rate
5	Volume flow rate
57	Frequency Input
73	Actual uncorrected oil flow
75	Actual uncorrected water flow
77	Actual uncorrected back flow
78	Net oil flow
80	Gross flow
81	Net water flow

Frequency/pulse output scaling method codes (holding register 41108)

0	Frequency=flow
1	Pulses/unit
2	Units/pulse

Sensor flange type codes (holding register 40129)

0	ANSI 150
1	ANSI 300
2	ANSI 600
5	PN 40
7	JIS 10K
8	JIS 20K
9	ANSI 900
10	Sanitary clamp
11	Union
12	PN 100
250	Reserved
251	None
252	Unknown
253	Special
254	Reserved
255	Reserved

Flow tube construction material codes (holding register 40130)

3	Hastelloy® C-22
4	Monel®
5	Tantalum
6	Titanium
19	316L stainless steel
23	Inconel®
252	Unknown
253	Special

Integer codes (continued)

Flow tube liner material codes (holding register 40131)

16	Tefzel®
251	None/other

Fault output codes (holding register 40007 or 40013)

0	Upscale
1	Downscale
2	Last measured value
3	Internal zero

Reference temperature index table (register 41705):

0	60 °F
1	15 °C
2	20 °C

TBR event action table (register 41706):

0	Hold last value
1	Stop well test
2	Alarm only

Timecode reference

All timecodes are in seconds referenced to 01 January 1998.

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