

Interface Manual

Chemical Injection Gear Meter System

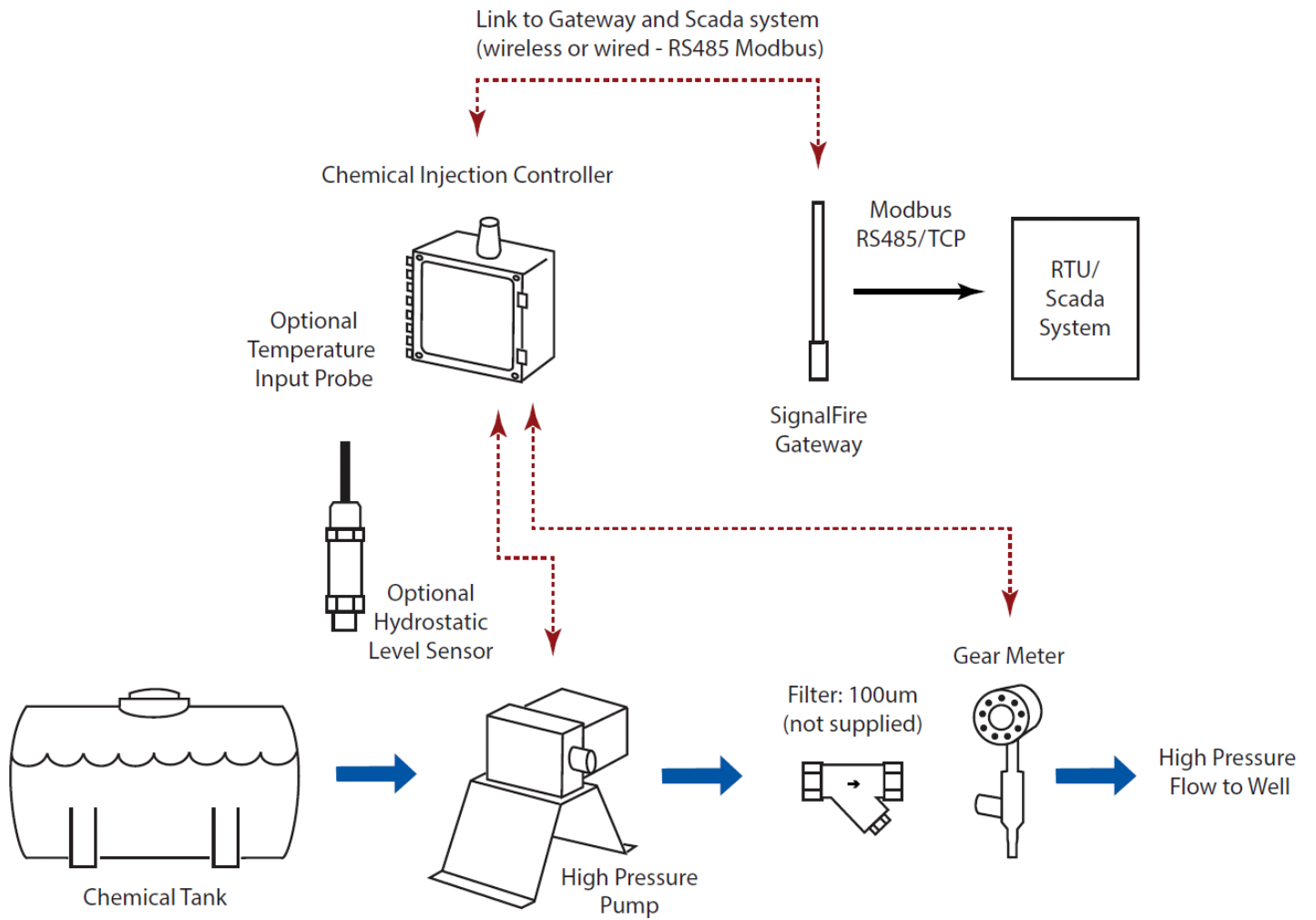
SignalFire Part Numbers: CIJ-FLOW-x-x-x-x



SignalFire Chemical Injection Controller

The SignalFire Chemical Injection System (CIS) consists of the following:

- SignalFire chemical injection controller in NEMA enclosure
- Precision gear meter to monitor chemical injection
- Internal display for quickly checking system status
- Optional wireless radio, pressure sensor for level, and temperature probe.
- Internal hourly logging
- Battery backed up real time clock



SignalFire Chemical Injection System Diagram

Specifications

Controller

Power	10-30 VDC
Operating Temperature	-40°C to +80°C
DC Pump Control Driver	12VDC, 12A max
Pressure Sensor	1-5V interface, 0 to 48" H2O
Modbus RTU Interface	RS485
Radio Frequency	902-928MHz ISM band, FHSS radio, SMA connector

Gear Meter

Process connections	1/4" NPTF
Materials	Housing: SS316L Seal: PTFE
Operating Pressure	2900psi, max

Connections and Components

The Chemical Injection Controller provides screw terminals for easy connection to the pump motor, gear meter and pressure sensor.

Power is protected by an on-board (15A) fuse (10-30VDC, 12VDC nominal).

The controller is designed to run standard 12VDC injection pumps that are controlled in an on/off manner. Consult SignalFire for information on controlling other types of injection pumps.

Installation

Gear Meter

The gear meter must be installed on the high pressure output of the injection pump. It is recommended that the gear meter be located at least 3 feet away from the pump outlet so it is isolated from any pump vibrations and flow pulsations. At least one 90-degree bend is also recommended to further reduce pulsations. The preferred orientation for mounting gear meters is so that the internal shaft/gear assembly is in a horizontal orientation (housing bolts facing sideways, not up/down). Note the fluid flow direction marked on the gear meter.

Gray = Power

White = Signal

Green = Ground

Filtration is required to prevent contaminants from entering the flow meter, the gear meter requires a 100-micron filter.

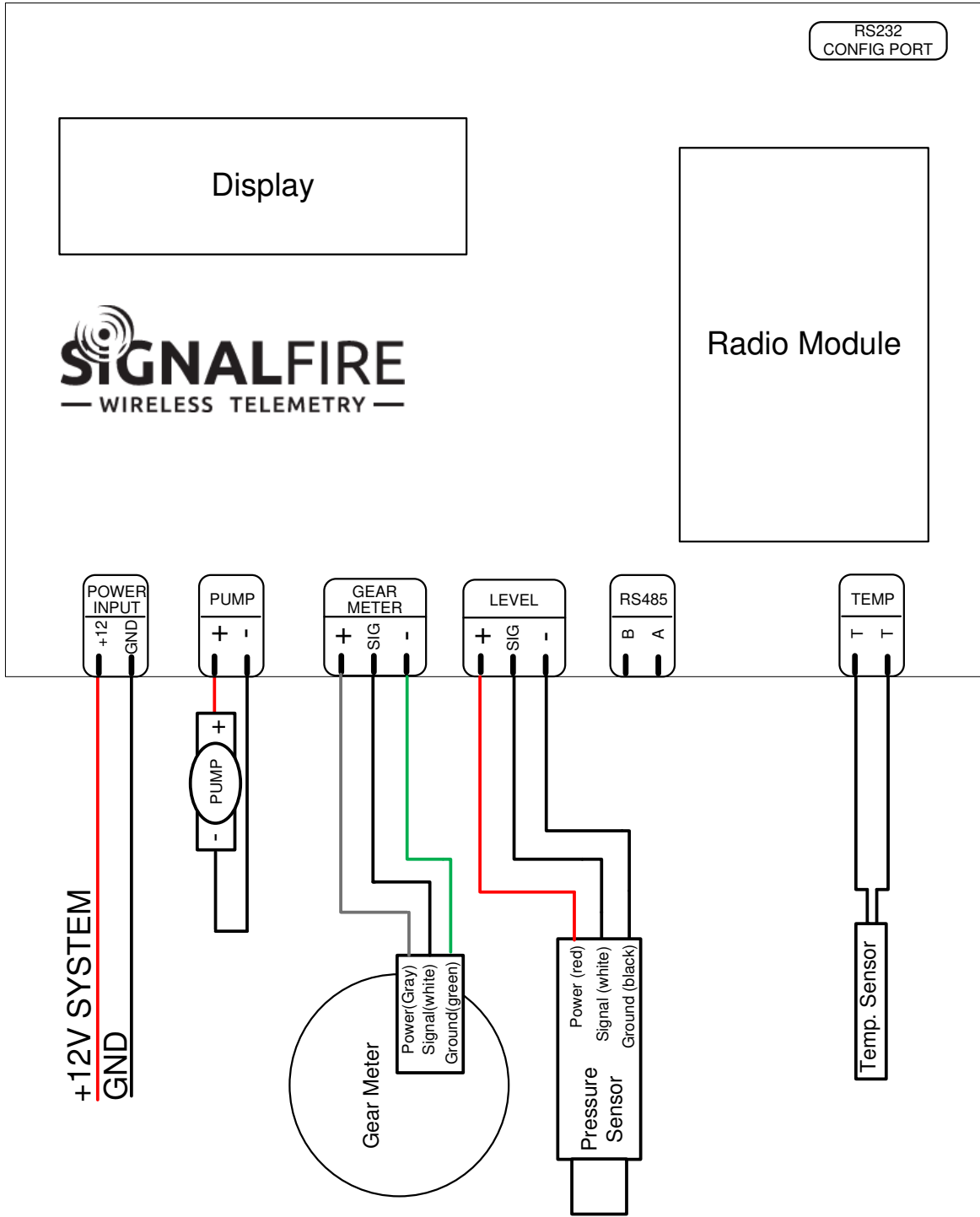
Pressure Sensor for Level

For systems including a pressure sensor, the sensor has a 1/2" NPT process connection and should be installed between the outlet of the tank and the input of the injection pump. The sensor should be installed at or below the bottom of the tank. The controller supports a configurable offset to correct the sensor position with the level of fluid in the tank.

Chemical Injection Controller

Mount the NEMA enclosure containing the chemical injection controller in a suitable location.

Connect the gear meter, injection pump and optional pressure sensor per the wiring diagram on the following page. Connect power to the system.



Wiring Diagram

Configuration

Basic Configuration

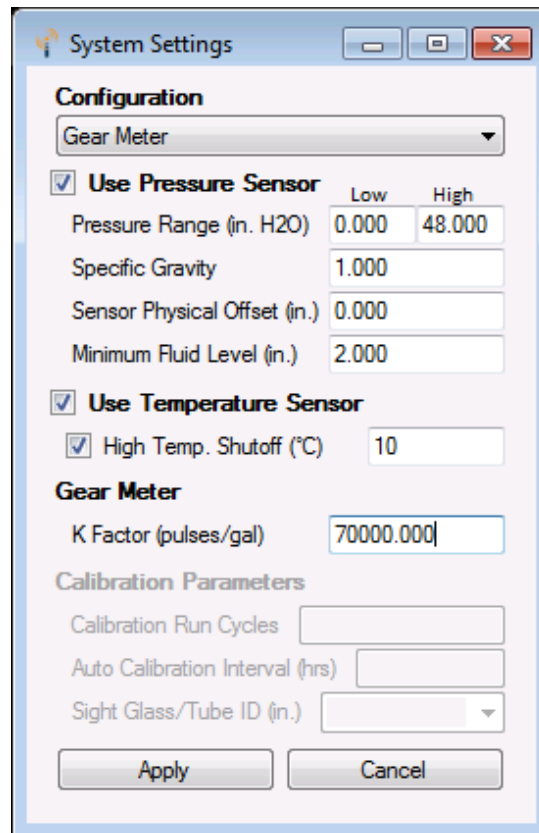
For the system to operate some basic configuration must be done at installation time, using the SignalFire ToolKit. These configuration settings are accessed by going to the settings menu and selecting system settings.

Level Settings

For systems using a pressure sensor it is important to enter the specific gravity of the chemical being used for accurate tank level measurements. In addition, if the pressure sensor is located above or below the bottom of the tank enter a sensor physical offset. For example, if the sensor is located 6" below the bottom of the tank you would enter an offset of -6. A sensor mounted above the bottom of the tank would have a positive offset. The default pressure range for the pressure sensor provided is 0 to 48. The 'Minimum Fluid Level' settings sets the threshold for the system to disable injection if the level drops below this point.

Temperature Settings

For systems supplied with a temperature sensor, check the 'User Temperature Sensor' box. If the 'High Temp. Shutoff' box is checked, the controller will automatically disable the injection pump when the ambient temperature increases above the set point and re-enable it when the temperature falls back below it.



Gear Meter

The default gear meter K-Factor is 70,000 pulses per gallon. This is a starting point only. The system must be run through the calibration process to generate an actual system K-factor for accurate flow measurements.

Operational Settings

The Modbus Slave ID must be configured to a unique address for use either with the SignalFire radio or for local Modbus control. In addition, if the SignalFire radio is used the Radio Network and Radio Network Group must be set to match the SignalFire Gateway's settings.

Chemical Injection Controller Passed

File Settings Updates Tools Help

IP Addr:Port 10.1.10.234:10002

Connected to 10.1.10.234:10002

Open Close Offline

TCP Connection Clear Saved IPs

Connect/Update

Product/Mode	CIC/Gear Meter
Slave ID	1
Node Name	not set
Radio Connectivity	N/A
Mainboard Version	0.16
Radio Version	N/A
Radio Address	N/A
Corporate ID	N/A
Radio Network	N/A
Radio Network Group	N/A
Radio Power (dBm)	N/A
Radio Range	N/A
Checkin Interval	1 minute

Settings

Radio Range Set

Radio Network Set

Radio Network Group Set

Checkin Interval 1 minute Set

Node Name Set

Modbus Slave ID 1 Set

RS485 Baud Rate 9600 Set

RS485 UART Mode 8N1 Set

Reported Controller Registers

Chemical Injection Controller

Address	Description	Value
1100	Operation Mode	MANUAL
1101	Pump On Time (sec*10)	100
1102	Pump On Interval (sec*10)	200
1103	Production Rate (bbl/hr)	0
1104	Dosing Amount (ppm)	0
1105	Error Status Bits	0
1106	Auto Pump On Time (sec*10)	68
1107	Auto Pump On Interval (sec*10)	600
1108	Hours Since Calibration	16
1109	Temperature (°C * 10)	249
1110	Analog Input Voltage (mV)	3
1111	Pump On Current (mA)	2412
1112	Digital Input State	1
1113-1114	Digital Input Counts	165853
1115-1116	Dosing Amount (qt/hr)	0.25
1117-1118	Analog Input Scaled (in. H2O)	0
1119-1120	Depth of Fluid (inches)	0
1121-1122	Vol. Pumped this Period (qt)	0.04828228
1123-1124	Vol. Pumped last Period (qt)	0.817716
9995	Supply Voltage (mV)	12969

Update Reported Controller Values

Controller Parameters

Operation Mode **MANUAL** Set Mode

Contract Hour (hh:mm) 00:00 Set

TIMED Mode Settings

Pump On Time (sec) 10 Set Parameters

Pump On Interval (sec) 20 Set Parameters

Estimated Daily Volume (qt) 99.1

AUTO VOLUME Mode Settings

Dosing Amount (qt/hr) 0.250 Set

Estimated Daily Volume (qt) 6.0

AUTO TRACKING Mode Settings

Production Rate (bbl/hr) 0 Set Parameters

Dosing Amount (ppm) 0 Set Parameters

Estimated Daily Volume (qt)

Calibration

Pump Constant (qt/hr) 8.255417

Last Calibration Date/Time 5/17/2016 5:01:53 PM

MANUAL Control & Status

Pump Control **OFF** OFF ON

Valve Control **N/A** OPEN CLOSE

Pump Calibration **N/A** STOP CALIBRATION

Run-time Errors: No Errors

Calibration Errors: No Errors

Clock Setting

Current Date and Time Wed, 18 May 2016 09:36:55

(24-hour format) Read Set to PC Set

Success

Calibration

After installation it is necessary to perform a calibration of the system to calibrate the gear meter to the pump and chemical being injected. **The system must be calibrated when it is installed.** Calibration should also be done anytime there is a change in setup of the pump, plumbing, or chemical being injected. The system must be fully primed and purged of air before calibration. The pump may be controlled for priming using the buttons and display on the controller.

The calibration procedure should be performed for at least 3 cycles. The calibration wizard will take an average of the calibration cycles to create an accurate K-factor for the system.

Note: A standard calibration pump setting sight glass is required for calibration (not included). The sight glass must have marks in quarts per day for a 1-minute test.



Example Calibration Sight Glass

Calibration Procedure

1. In the SignalFire ToolKit select 'Calibration Wizard' from the Tools menu
2. Enter the number of calibration cycles to run (1-5). The default of 3 is the recommended minimum numbers of cycles to run for accurate calibrations.
3. Fill the sight glass close to the top and shut the valve from the tank so that the pump will pump from the sight glass only
4. Set the slide marker at the fluid level and enter the starting Quarts Per Day (QPD) reading into the ToolKit (If the sight glass does not have numbered tick-marks enter 0)
5. Click the "Pump ON/OFF" button to start the pump, carefully watch the level in the sight glass and click to stop the pump before the sight glass is empty but toward the bottom of the sight glass. Must pump at least 4" of fluid from the sight glass for a valid calibration.
6. Set the slide marker at the new fluid level and enter the QPD reading into the ToolKit (If the sight glass does not have numbered tick-marks, count and enter the total number of marks between the start and fend levels)
7. Repeat this process for the number of calibration cycles selected.
8. After the calibration cycles are complete an average gear meter K-factor is calculated. Click 'Apply K-Factor' button to set the calibrated K-factor into the controller.
9. Set the valves so the pump will draw from the tank and click 'Finish'

Operating Modes

The Chemical Injection System has 5 operational modes, listed below. The operational mode to be used should be selected using the ToolKit. Select the desired operation mode and configure it before running calibration.

Disabled

The pump will be forced off and the valve will remain open (not energized). The system will ignore any commands to control the pump or the valve.

Manual

In Manual Mode the pump and valve may be controlled either through the Toolkit (via a local connection) or remotely (via Modbus coil writes) through the gateway. This is the only mode that allows manual control. The mode is generally used for testing only.

Timed

In timed mode, the pump will run based on the configured **pump-on-time** and **pump-interval**. The pump-on-time range is 0.01 to 180 seconds and the pump-interval range is 0.01 to 180 seconds. Ensure that the pump-on-time is less than or equal to the pump-interval. To run the pump full time enter a pump-on-time of 30 and a pump-interval of 30.

Auto Volume

In auto volume mode, the pump-on-time and the pump-interval are automatically adjusted based on the configured desired daily dosing rate and flow measurements from the gear meter.

In auto volume mode the valid pumping times range from .1 seconds every 3 minutes to 30 seconds every 30 seconds (pump always on). These are automatically calculated based on the flow measured from the gear meter and the desired injection rate. The controller will automatically adjust to meet the daily dosing rate target.

Auto Tracking

In auto tracking mode, the pump-on-time and the pump-interval are automatically calculated based on the configured production rate, dosing PPM. Auto tracking mode requires the production rate and dosing PPM to be configured.

In auto tracking mode the valid pumping times range from 0.1 seconds every 3 minutes to 30 seconds every 30 seconds (pump always on). These are automatically calculated based on the PPM dosing

rate, production rate and measured flow from the gear meter. The controller will automatically adjust if any of these parameters change.

Operation

The Chemical Injection System will do the following:

- Automatically energize injection pump for calculated or configured amount of time
- Slave chemical dosing rate to well production rate in automatic mode
- Use feedback from the gear meter to accurately monitor and control actual amount of chemical injected
- Report system parameters via a wireless link to the gateway or over a local RS485 Modbus connection
- Real time clock for setting and measuring dosing amount over a contract 24-hour period
- Report tank level (if equipped with a level sensor)
- Automatic pump shut off on low fluid level (if equipped with a pressure sensor)

All configuration items may be set locally using the SignalFire Toolkit, via RS485 Modbus RTU, or via Modbus over the wireless link from a PLC (or Totalflow, CygNet, etc.) for maximum flexibility.

Status LEDs

The Chemical Injection System module has a green status LED which blinks indicating the module is running. If a radio is installed, the status LED also indicates the signal strength between the module and the gateway. In addition, there are TX/RX LEDs to indicate radio messages to/from the module.

The status LED will blink once a second if it is not connected to a gateway. If the module is connected to a gateway, it will blink a link quality code every 3 seconds.

3 Blinks	=	Strong Signal
2 Blinks	=	Good Signal
1 Blink	=	Weak Signal

The pump and valve output drivers also have green LED which turns on while the pump output is energized.

Display

The chemical injection controller includes a 16x2 character display that is used to display running parameters and status information for the system. An icon in the lower left corner goes solid to indicate the pump is turned on.

Press 'NEXT' to cycle through the status screens.

Press 'MENU' to enter the configuration menu. From here the pump can be manually primed or a calibration started. Use the 'NEXT' button to select the function and press 'ENTER' to run.

Internal Logging

The controller will automatically store up to 30 days of hourly logs. Each log entry will contain either the volume pumped (or pump constant), the supply voltage, and the temperature. Access to the log is available from a local connection to the ToolKit.

Error Status

The status of the Chemical Injection System will be reported in register 1105. This register contains a bit masked set of error bits defined below. More than one error can occur at a time. If any of the error conditions are met the system will stop injection until the error is cleared.

Bit Position	Error Description
0x20	Low tank error. Tank level is < Config. min. level (automatically cleared if tank above threshold)
0x40	Configured to pump too much. Pump can't meet configured settings. (must be manually cleared)
0x100	Configuration error. Parameter out of range. (automatically cleared if configured is corrected)
0x400	No flow detected by gear meter (must be manually cleared)
0x800	Injection disabled due to temperature above configured threshold (automatically cleared if temperature drops below threshold)

Modbus Register Mapping

Register Address	Register Number	Description	Data Type	Function Codes
101	00102	Pump energize – Used in manual mode only	Coil	05
1000	41001	Modbus Slave ID	Int	03, 04, 06, 16
1001	41002	Modbus Baud Rate	Int	03, 04, 06, 16
1002	41003	Modbus UART Mode	Int	03, 04, 06, 16
1100	41101	Mode (0=Disabled,1=Manual,2=Timed,3=AutoTrack,4=AutoVol)	Int	03, 04, 06, 16
1101	41102	Pump on time (seconds) – used in timed mode	Int	03, 04, 06, 16
1102	41103	Pump on interval (seconds) – used in timed mode	Int	03, 04, 06, 16
1103	41104	Production Rate (bbl/hr) – used in auto tracking mode	Int	03, 04, 06, 16
1104	41105	Dosing Amount (PPM) – used in auto tracking mode	Int	03, 04, 06, 16
1105	41106	Error Status Bits (0 = no errors, See Manual for Bit Definitions)	Int	03, 04
1106	41107	Calculated Automatic Pump on time (seconds times 10)	Int	03, 04
1107	41108	Calculated Automatic Pump on interval (seconds times 10)	Int	03, 04
1108	41109	Hours since last gear meter calibration	Int	03, 04
1109	41110	Ambient Temperature (degrees Celsius times 10)	Signed Int	03, 04
1110	41111	Pressure Sensor Analog Input Value (mV)	Int	03, 04
1111	41112	Pump Current (mA)	Int	03, 04
1112	41113	Digital Input State (gear meter input)	Int	03, 04
1113	41114	Gear Meter Counts (high word)	Int32	03, 04
1114	41115	Gear Meter Counts (low word)	Int32	03, 04
1115	41116	Dosing Amount (qt/hr) (high word) – used in auto volume mode	Float	03, 04, 16
1116	41117	Dosing Amount (qt/hr) (low word) – used in auto volume mode	Float	03, 04, 16
1117	41118	Pressure Sensor Scaled Reading (in. H2O) (high word)	Float	03, 04
1118	41119	Pressure Sensor Scaled Reading (in. H2O) (low word)	Float	03, 04
1119	41120	Depth of fluid (inches) (high word)	Float	03, 04
1120	41121	Depth of fluid (inches) (low word)	Float	03, 04
1121	41122	Amount pumped this contract period (quarts) (high word)	Float	03, 04
1122	41123	Amount pumped this contract period (quarts) (low word)	Float	03, 04
1123	41124	Amount pumped previous contract period (quarts) (high word)	Float	03, 04
1124	41125	Amount pumped previous contract period (quarts) (low word)	Float	03, 04
1150	41151	Pump Output state (1=energized, 0=de-energized)	Int	03, 04
1151	41152	Valve Output state (1=energized, 0=de-energized)	Int	03, 04
1152	41153	Pump Calibration Status (0 = not in cal, 1 = cal in process)	Int	03, 04
1153	41154	<i>Not used</i>	Int	03, 04, 06, 16
1154	41155	<i>Not used</i>	Int	03, 04, 06, 16
1155	41156	Current Month (1 - 12)	Int	03, 04, 06, 16
1156	41157	Current Day (1 - 31)	Int	03, 04, 06, 16
1157	41158	Current Year (0 - 99, 0 = 2000)	Int	03, 04, 06, 16
1158	41159	Current Day of Week (0 - 6, 0 = Sunday)	Int	03, 04, 06, 16
1159	41160	Current Hour (0 - 23)	Int	03, 04, 06, 16
1160	41161	Current Minute (0 - 59)	Int	03, 04, 06, 16
1161	41162	Current Second (0 - 59)	Int	03, 04, 06, 16
1162	41163	Start of Contract Period, Hour (0 - 23)	Int	03, 04, 06, 16
1163	41164	Start of Contract Period, Minute (0 - 59)	Int	03, 04, 06, 16

1164	41165	Asset ID Register 1	Int	03, 04, 06, 16
1165	41166	Asset ID Register 2	Int	03, 04, 06, 16
1166	41167	Asset ID Register 3	Int	03, 04, 06, 16
1167	41168	Asset ID Register 4	Int	03, 04, 06, 16
1168	41169	Asset ID Register 5	Int	03, 04, 06, 16
1169	41170	Asset ID Register 6	Int	03, 04, 06, 16
1170	41171	Asset ID Register 7	Int	03, 04, 06, 16
1171	41172	Asset ID Register 8	Int	03, 04, 06, 16
1172	41173	Calculated Pump Constant (quarts/hour times 100)	Int	03, 04
1173	41174	Specific gravity (times 100)	Int	03, 04, 06, 16
1174	41175	<i>Not used</i>	<i>Int</i>	<i>03, 04, 06, 16</i>
1175	41176	Pressure Sensor Scale Low (times 100)	Int	03, 04, 06, 16
1176	41177	Pressure Sensor Scale High (times 100)	Int	03, 04, 06, 16
1177	41178	Pressure Sensor Physical Offset (inches times 100)	Signed Int	03, 04, 06, 16
1178	41179	Gear Meter K Factor (pulses/gal)	Int	03, 04, 06, 16
1179	41180	High Temperature Shutoff (degrees Celsius times 10)	Signed Int	03, 04, 06, 16
1180	41181	Calculated Pump Constant (quarts/hour)	Float	03, 04
1182	41183	Specific gravity	Float	03, 04, 16
1184	41185	<i>Not used</i>	<i>Float</i>	<i>03, 04, 16</i>
1186	41187	Pressure Sensor Scale Low (signed int, Ex. 0 psi)	Float	03, 04, 16
1188	41189	Pressure Sensor Scale High (signed int, 30 psi)	Float	03, 04, 16
1190	41191	Pressure Sensor Physical Offset (inches) (-36 to +36)	Float	03, 04, 16
1192	41193	Gear Meter K Factor (pulses/gal)	Float	03, 04, 16
1194	41195	High Temperature Shutoff (degrees Celsius)	Float	03, 04, 16
9987	49988	Major revision number for the mainboard	Int	03, 04
9988	49989	Minor revision number for the mainboard	Int	03, 04
9989	49990	Major revision number for the radio	Int	03, 04
9990	49991	Minor revision number for the radio	Int	03, 04
9991	49992	High 16 bits of SFTS node address	Int	03, 04
9992	49993	Low 16 bits of SFTS node address (the radio ID)	Int	03, 04
9993	49994	Slave ID readback	Int	03, 04
9994	49995	Received signal strength of last packet from the slave	Signed Int	03, 04
9995	49996	Supply voltage of the CI controller, in millivolts	Int	03, 04
9996	49997	Minutes until the slave will time out, unless new data is received	Int	03, 04
9997	49998	Number of registers cached for this slave device	Int	03, 04
9998	49999	Remote device type	Int	03, 04
1162	41163	Current Second (0 – 59)	Int	03, 04, 06, 16