The PIT Boss II

The PIT Boss II Plus

Modbus Communications User Guide

v2.0.x 02/17/2016

Modbus is a trademark of Modicon, Inc.

The PIT Boss II/The PIT Boss II Plus Modbus Communications User Guide

Revision History

Revision	Date	Author	Changes
1.x.x	29/11/2010	MDS	Initial version
1.4.x	04/172012	MDS	Update the look to match the Install manual better. Correct Controller Status Reason Codes
1.6.x	10/09/2013	MDS	Add in units.
1.7.x	02/21/2014	MDS	Add in Arrival Guard Time
2.0.x	02/17/2016	MAB	Add in velocity fields to Cycle Logs and Daily Logs Add in Fast Trip Velocity, Fast Trip Source and Optimization Source

Table of Contents

Index of Tables

Table of Figures

1 Introduction

The Remote Access Interface allows access to functions which are normally accessed using the integral front panel interface.

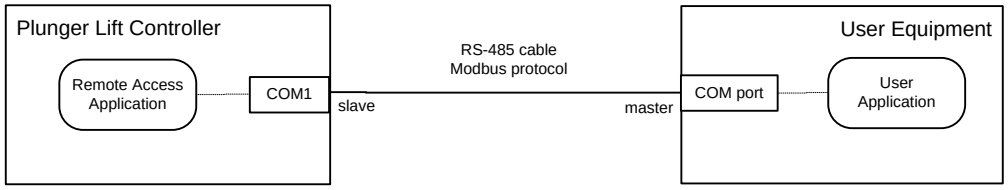

Figure 1 - High Level Connection Overview

This document describes how to use Modbus commands to operate the *Remote Access Application*. The Modbus registers and functionality described in this document are for the monitoring and modification of typical controller parameters.

1.1 References

[1] *The PIT Boss II/The PIT Boss II Plus Installation and Operations Manual*; Rev 1.x.x Nov 29, 2010; Extreme Telematics Corp.

[3] *Modicon Modbus Protocol Reference Guide*; PI-MBUS-300 Rev. J; June 1996; MODICON Inc.

[4] *Modbus Application Protocol Specification*; modbus.org; May 8, 2002.

2 Controller Setup

Access to the settings used for Modbus Communications are only available through the controller menus. The following sections give a brief overview of the initial setup required.

2.1 Communication Settings

The Modbus menu is available inside the Modbus Setup menu. To enter the Modbus Setup menu, press the "Menu" button and then press 8 to enter the Menu. You will be prompted for your 7 digit Installer or Operator code as this is a privileged access menu. This menu allows you to configure the settings of the controller. Please note that these settings must match the settings of your communications network and SCADA Host in order to function properly.

2.1.1 Station Address

The station address is a unique identifier that will be used by the host to communicate with a single controller. This address must not be duplicated within the same segment of your network. Valid addresses are 1 to 247. The default is 1.

2.1.2 Protocol

The protocol can be set to either RTU(binary) or ASCII (text). RTU is definitely more common as it takes less bits to transmit the same amount of information. This must match the same setting that is used by your SCADA Host. The default is RTU.

2.1.3 Baud Rate

The baud rate can be set to 1200, 2400, 4800, 9600, or 19200. This is used to se the bit rate of data transmitted on the communication line. This must match the same baud rate as the rest of your network. A mismatched baud rate will result in all communication being discarded at the controller. The default is 9600 bps.

2.1.4 Data Bits

The data bits parameter sets the number of bits in each transmitted or received character. This can be set to 7 or 8. The default is 8.

2.1.5 Parity

This parameter will set the parity of the character. It can be set to even, odd, or none. The default is none.

2.1.6 Stop Bits

The stop bits controls the number of stop bits that are to be present at the end of each character. This parameter can be set to 1 or 2. The default is 1.

3 Layer 1 Operation

The PIT Boss II Plunger Lift Controller has a single 2-wire RS-485 port (COM 1). See [1], for wiring details.

Supported bit rates: 1200, 2400, 4800, 9600, and 19,200 bps.

Supported character formats:

Table 1 - Supported Communication Rates and Formats

Data bits	Parity	Stop Bits	Protocol
7	None	2	ASCII
7	Odd	1	ASCII
7	Odd	2	ASCII
7	Even	1	ASCII
7	Even	2	ASCII
8	None	1	ASCII, RTU
8	None	2	ASCII, RTU
8	Odd	1	ASCII, RTU
8	Odd	2	ASCII, RTU
8	Even	1	ASCII, RTU
8	Even	2	ASCII, RTU

The bit rate and character format are configured using the front panel only. Technically, all character formats for RTU protocol support must be 11-bits in length with 8-bits of data. This allows for 1 start bit, 8 bits of data, and two bits for parity and stop. In actual practice, this is rarely followed, so all combinations are allowed.

4 Layer 2 Operation

The PIT Boss II Plunger Lift Controller supports both the Modbus ASCII and RTU protocols (see [3]). Protocol selection is configured from the front panel only, and defaults to RTU mode.

The PIT Boss II Plunger Lift Controller Modbus station address is configured using the front panel only (range: 1 – 247), but has a default value of 1. The PIT Boss II Plunger Lift Controller will act on, but not respond to, commands using the broadcast address (i.e. zero).

The maximum byte-length of Modbus commands and responses is limited to 256 characters (see [4], §4.1).

When operating in ASCII mode, the PIT Boss II Plunger Lift Controller performs the following required layer 2 checks on incoming commands:

- Parity

- LRC

- Character silence period (1 second)

ASCII commands can be accepted upon silence detection without a terminating CR/LF.

When operating in RTU mode, the PIT Boss II Plunger Lift Controller performs the following required layer 2 checks on incoming commands:

- Parity

- CRC

- Character timeout period (1.5 character times)

- frame silence period (3.5 character times)

5 Layer 3 Operation

The following Modbus commands are supported:

Table 2 - Supported Modbus Commands

Code	Current Terminology	Classic Terminology	Data Resolution
01	Read Coils	Read Coil Status	1-bit
02	Read Input Discretes	Read Input Status	1-bit
03	Read Multiple Registers	Read Holding Registers	16-bit
04	Read Input Registers	Read Input Registers	16-bit
05	Write Coil	Force Single Coil	1-bit

06	Write Single Register	Preset Single Register	16-bit
15	Force Multiple Coils	Force Multiple Coils	16-bit
16	Write Multiple Registers	Preset Multiple Registers	16-bit

Normal responses are issued as required by [3].

Modbus allows for exception responses to be returned under certain failure conditions. Once again, this is not typically desired in the process control industry. As such, the controller does not normally return any exception responses. This can however be enabled through the user interface if desired. The following Modbus Exception Responses are supported:

Table 3 - Supported Modbus Exception Responses

Code	Response
01	Illegal Function
02	Illegal Data Address
03	Illegal Data Value
04	Slave Device Failure

The PIT Boss II Plunger Lift Controller performs consistency checks on the following items received in commands:

- Number of bytes received[1]

- *Number of Points* field

- *Byte Count* field (if present).

If any of these checks fail, an *Illegal Data Value* exception is returned.

If an *Address* field, either explicit or implicit, is outside the known range, an *Illegal Data Address* exception is returned. The *User Application* may read Input Register 3:0013 to determine the first bank and address in the command which caused the exception. No part of the command is executed.

A *Slave Device Failure* exception is used to indicate Application Layer errors. The *User Application* may read Input Register 3:0015 to determine the bank and address in the command which caused the exception. Execution of the command terminates at this address.

5.1 Address Coding

Each register of the PIT Boss II Plunger Lift Controller is accessed via a specific Modbus operation. Each operation contains an implied address offset. The mapping between traditional Modbus address notation, the operation performed, and the address sent in Modbus messages is shown below.

Table 4 - Modbus Message Coding

Code	Operation	Modbus Address Notation	Message Address
01	Read Coils	0: *abcd*	*abcd*
02	Read Input Discretes	1: *abcd*	*abcd*
03	Read Multiple Registers	4: *abcd*	*abcd*
04	Read Input Registers	3: *abcd*	*abcd*

[1] In the Modbus ASCII protocol, a single byte is sent as 2 HEX-ASCII characters.

05	Write Coil	0: *abcd*	*abcd*
06	Write Single Register	4: *abcd*	*abcd*
15	Force Multiple Coils	0: *abcd*	*abcd*
16	Write Multiple Registers	4: *abcd*	*abcd*

For example, accessing register 4:4000 is done via the following operations: ReadMultipleRegisters, WriteSingleRegister, and WriteMultipleRegisters. All of these operations use the address value 4000. Accessing register 0:4000 is done with the following operations: ReadCoils and WriteCoils. These two operations also use the address value 4000, but access a different register.

6 Application Layer Operation

6.1 Basic Operation

The PIT Boss II Plunger Lift Controller is designed to allow concurrent operation from the front panel and Modbus interface. This requires that the front panel user (*UI Application*) and the *User Application* (via the *Remote Access Interface*) not access data at the same time or overwrite each other's data. This is achieved by allowing each application to have a copy of the PIT Boss II Plunger Lift Controller parameters to read and modify. This imposes special requirements on the *User Application*.

The information within the PIT Boss II Plunger Lift Controller is grouped into a number of data-sets. Before accessing any data within a data-set, it must be retrieved by the *Remote Access Application*. This is done so that:

- The *User Application* can read a consistent data-set: That is, one in which the data is not changing while it is being read. This means that, in general, the data-set will be out-of-date. The *User Application* should have the *Remote Access Application* retrieve a fresh copy of a data-set before each read "session".

- Changes made to a data-set will not be lost: If parameters are changed using the front panel and *User Application* at the same time, there is a potential for changes to be lost. For this reason, a lock-out mechanism is provided. The *User Application* can retrieve a data-set "for writing". This will lock-out changes to the data-set by the front panel.

6.1.1 Register Set Access

A register set is defined as a fixed number of contiguous 16-bit memory locations that represent a single PIT Boss II Plunger Lift Controller parameter. For a register set to be valid it must be accessed as an aggregate from the start address.

For read operations, the *User Application* should query the starting register address and read the entire length of the register set. Register sets must be written from low to high order with no intervening write operations. The register set is validated, by the *Remote Access Application*, as an aggregate when the high order register is written.

PIT Boss II Plunger Lift Controller register set formats are defined in §7.1.

6.2 Automatic Dependent Parameter Update

The range of values for some control parameters depend on the current value of other parameters. This means that when a parameter is changed, its dependent parameters may become invalid. In this case, the dependent parameters are automatically changed in order to avoid an invalid configuration. Register assignments are such that dependent parameters have a higher register number than their "parent". This allows a group of parameters to be written with a single Modbus command with no undesired side-effects.

6.3 Concurrency Issues

6.3.1 Plunger Lift Controller Algorithm

Changes to plunger lift control parameters may be made while the control algorithm is running. These changes are saved when the Modbus Write Time expires, but are not applied until the start of the next plunger lift cycle or controller cycle restart.

The following Historical Logs are updated by the control algorithm:

Table 5 - Available Logs

Log	Updated
Plunger Cycle	At the end of each plunger lift cycle when the controller moves from Close to Wait Arrival.
Daily Production	When the Day Start time is reach each day, the Daily Production log will be written to memory and the current day will start again at zero.

It is possible; therefore, that the history is being updated while it is being read by the *User Application*. For example, at the end of the cycle, the Log 1 data becomes Log 2 and Log 25 data is removed. It is the responsibility of the *User Application* to manage this sliding window of log data at the gas day or plunger cycle boundary.

6.4 Error Reporting

When a *Slave Device Failure* exception is returned, the *User Application* may read Input Register 3:0014 to determine the type of failure, as follows:

Table 6 - Supported Modbus Error Codes

Error Type	Code	Description
MODBUS_ACCESS_DENIED	01	Modbus access to registers has been lockout from the device front panel. Only registers 1:0300, and 3:0300-3:0302 are accessible.
FUNCTION_NOT_SUPPORTED	02	The specified functionality of this register is not available in this firmware version.
FEATURE_NOT_ENABLED	03	The application attempted to access a data item belonging to a disabled value-added firmware feature. These features may only be enabled from the front panel.

Error Type	Code	Description
FUNCTION_NOT_ENABLED	04	The application attempted to access a data item that requires activation via another register.
DEVICE_NOT_ENABLED	05	The application attempted to access a real device which is not present (i.e. enabled) in the PIT Boss II Plunger Lift Controller configuration.
DATASET_NOT_LOCKED	06	The application attempted to write to a dataset which was not locked.
DEPENDENT_DATASET_NOT_LOCKED	07	The application attempted to modify parameter in a locked dataset that required an auto update parameter in an unlocked dependent dataset.
DATASET_ALREADY_LOCKED	08	The application attempted to lock a dataset which is currently locked by the integral control panel user. Try the request at a later time.
VALUE_OUT_OF_RANGE	09	The preset value for a register was outside the acceptable range of values.
WRITE_SEQUENCE_ERROR	10	The registers in a register set were not written in the proper order.
LOG_NOT_SELECTED	11	The application attempted to read a data value belonging to a historical log which has not been loaded.
CONTROLLER_RUNNING	12	The application attempted to force a valve operation while the controller was running.
LOW_BATTERY	13	The request could not be performed because the PIT Boss II Plunger Lift Controller is in a low battery condition.

7 Address Assignments

7.1 Register Formats

LSW = least significant word (16-bits)
MSW = most significant word (16 bits)

7.1.1 Date/Time Register

- Range: 0 – 4,294,967,295
- Write MSW first when writing in seconds format
- Use the Time Format Holding Regsiter to switch the format

Table 7 - Date/Time Register Format

Number	Description (Seconds Format)	Description(H:M:S Format)
Start	Seconds since January 1, 2000 (MSW)	Year
Start + 1	Seconds since January 1, 2000 (LSW)	Month
Start + 2	Reserved	Day
Start + 3	Reserved	Hours
Start + 4	Reserved	Minutes
Start + 5	Reserved	Seconds

7.1.2 Elapsed Time Register

- Range: 0 – 3,599,999 seconds (1000 hours)
- Use the Time Format Holding Register to switch the format

Table 8 - Elapsed Time Register Format

Number	Description (Seconds Format)	Description(H:M:S Format)
Start	Seconds (MSW)	Hours
Start + 1	Seconds (LSW)	Minutes
Start + 2	Reserved	Seconds

7.1.3 Double Word Register

Table 9 - Double Word Register Format

Number	Description
Start	MSW
Start + 1	LSW

7.2 Coils

Table 10 - Available Coils

Register	Description	Read	Write
0:0001	Valve A Status ***Privileged Access*** *Write operations only work when controller is Stopped. This coil forces the valve operation and is not the same as pressing the Close and Open buttons on the keypad of the physical controller.*	0 – Closed 1 – Open	0 – Close 1 – Open

Register	Description	Read	Write
0:0002	Valve B Status ***Privileged Access*** *Write operations only work when controller is Stopped. This coil forces the valve operation and is not the same as pressing the Close and Open buttons on the keypad of the physical controller.*	0 – Closed 1 – Open	0 – Close 1 – Open
0:0003	Auto Catcher Status ***Privileged Access*** *Write operations only work when controller is Stopped. This coil forces the valve operation and is not the same as pressing the Close and Open buttons on the keypad of the physical controller.*	0 – Closed 1 – Open	0 – Close 1 – Open
0:0004	Units Se the units that appear on the display. Does not affect values retrieved through Modbus.	0 – Imperial 1 - Metric	0 – Imperial 1 - Metric
0:0003 – 0:0013	Reserved	N/A	N/A
0:0014	Reset All Alarms	N/A	1 - Reset Log
0:0015 – 0:0018	Reserved	N/A	N/A
0:0019	Reset All Data ***Privileged Access*** Reset all data logs and settings back to factory defaults	N/A	1 - Reset Log

Register	Description	Read	Write
0:0020	Reset Plunger Statistics ***Privileged Access*** Reset the plunger statistics, ie Arrivals and Travel Distance	N/A	1 - Reset Log

7.3 Input Discretes

Table 11 - Available Input Discretes

Register	Description	Read
1:0001	Operator Present Indicates whether or not the display is on.	0 – No operator at the controller 1 – An operator is currently using the controller
1:0002 – 1:0014	Reserved	N/A
1:0015	Alarms Present	0 – None 1 – Alarms Present
1:0016	Date Time Set Indicates whether the date has been set since the last power up	0 – Not Set 1 – Set
1:0017	Firmware Option Pressure Optimization	0 – Disabled 1 – Enabled
1:0018	Firmware Option Timer Optimization	0 – Disabled 1 – Enabled
1:0019 – 1:0030	Reserved	N/A
1:0031	Battery Switch Status	0 – Reset 1 – Tripped

Register	Description	Read
1:0032	Line Pressure Switch Status	0 – Reset 1 – Tripped
1:0033	Casing Pressure Switch Status	0 – Reset 1 – Tripped
1:0034	Flow Differential Pressure Switch Status	0 – Reset 1 – Tripped
1:0035	Flow Switch Status	0 – Reset 1 – Tripped

7.4 Input Registers

Table 12 - Available Input Registers

Register	Description	Read
3:0001	Controller Mode Current Pressure Optimization mode	1 = Line Pressure 2 = Casing Pressure 3 = Flow DP
3:0002	Battery Voltage Value Last read voltage of battery in centi-volts (ie. 600 = 6 Volts)	350 – 800 cV
3:0003	Reserved	N/A
3:0004	Casing Pressure Sensor Value Last read Casing Pressure reading in PSI with an extra digit for a decimal place (ie. A returned value of 1000 is 100.0 PSI) *Casing Pressure Sensor Max Value found in Holding Register 4:0083*	0.0 – Casing Pressure Sensor Max Value (PSI)

Register	Description	Read
3:0005	Line Pressure Sensor Value Last read Casing Pressure reading in PSI with an extra digit for a decimal place (ie. A returned value of 1000 is 100.0 PSI) *Line Pressure Sensor Max Value found in Holding Register 4:0074*	0.0 – Line Pressure Sensor Max Value psi
3:0006	Flow Differential Pressure Sensor Value Last read Flow Differential Pressure reading in Inches of Water Column with an extra digit for a decimal place (ie. A returned value of 100 is 10.0 inches of water) *FlowDP Sensor Max Value found in Holding Register 4:0077*	0.0 – FlowDP Sensor Max Value (“H20)
3:0007	Flow Rate Sensor Value Last read Flow Rate in e3m3/day with an extra digit for a decimal place (ie. A returned value of 100 is 10.0 e3m3/day)	0.0 – 99.9 e3m3/day
3:0008 – 3:0009	Controller Serial Number	3000 – 99999
3:0010	Firmware Rework Count	0 – 255
3:0011	Firmware Version App Code	84 = Test 69 = Experimental 80 = Production
3:0012	Firmware Version Number Software Version (400 = 4.0.0)	0 – 65535

Register	Description	Read
3:0013	Illegal Address The last register that caused an illegal address response	0 – 65535
3:0014	Slave Device Failure Type	0 – 16
3:0015	Slave Device Failure Address The last register that caused a failure response	0 – 65535
3:0016	Current Controller State	0 = AfterFlow 1 = AfterFlow Delay 2 = Close 3 = Extended Close 4 = Extended Flow 5 = Wait Arrival 6 = Stopped

Register	Description	Read
3:0017	Current Controller Status Reason	0 = Fast Trip 1 = High Line Pressure 2 = High Casing-Line Diff 3 = Low Casing Pressure 4 = Low Battery 5 = Low Flow 6 = Max Open Timer Expired 7 = Non Arrivals 8 = Normal Operation 9 = Operator Command 10 = Startup 11 = Hold Closed 12 = Hold Open
3:0018 – 3:0020	Controller Status Time Remaining	Elapsed Time format
3:0021	Need Input Device Change	0 = Arrival Sensor 1 = Line Pressure 2 = Casing Pressure 3= Flow Differential Pressure 4 = Casing/Line Differential Pressure 5 = Flow Rate 6 = CP and FDP 7 = CP and Flow Rate 8 = None

Register	Description	Read
3:0022 – 3:0027	Current State Begin Time	Date/Time format
3:0028 – 3:0032	Reserved	N/A
3:0033 – 3:0038	Alarm Reset Time	Date/Time format
3:0039	Alarm Reset Time – Time Set	0 = Not Set 1 = Set
3:0040	Controller Reset Alarm Count Number of times the controller has been powered off without proper shutdown	0 – 999
3:0041	Low Battery Shutdown Alarm Count Number of times the controller has shut in due to low battery conditions	0 – 999
3:0042	Reserved	N/A
3:0043	Non-Arrival Alarm Count Number of times the plunger has failed to arrive	0 – 999
3:0044	Fast Trip Alarm Count Number of times the plunger has arrived within the fast trip window	0 – 999
3:0045	Reserved	N/A
3:0046	Casing Pressure Sensor Fault Count Number of times the sensor reads out of range	0 – 999
3:0047	Line Pressure Sensor Fault Count Number of times the sensor reads out of range	0 – 999
3:0048	Flow DP Sensor Fault Count Number of times the sensor reads out of range	0 – 999

Register	Description	Read
3:0049	Reserved	N/A
3:0050	AfterFlow Casing Line DP Alarm Count	0 – 999
3:0051 – 3:0052	Plunger History Total Arrivals Number of arrivals logged since last reset	0 – 99999
3:0053 – 3:0054	Plunger History Total Kilometers Traveled Number of meters plunger has traveled since last reset	0 – 99999
3:0055 – 3:0082	Reserved	N/A
Plunger Cycle Logs		
3:0083 + 3(n-1) – 3:0085 + 3(n-1)	Cycle Log Rise Time 25 Consecutive triple registers “n” in the register column represents the cycle log number.	Elapsed Time format
3:0158 + 3(n-1) – 3:0160 + 3(n-1)	Cycle Log AfterFlow Time 25 Consecutive triple registers	Elapsed Time format
3:0233 + 3(n-1) – 3:0235 + 3(n-1)	Cycle Log Close Time 25 Consecutive triple registers	Elapsed Time format
3:0308	Cycle Log Count	0 - 25
3:0309 + 6(n -1) - 3:0314 + 6(n -1)	Cycle Log Start Time 25 Consecutive date/time registers.	Date/Time format

Register	Description	Read
3:0459 + (n -1)	Cycle Log Type 25 Consecutive registers	0 = Normal 1 = Fast-Trip 2 = Non-Arrival 3 = Max Open 4 = Low Battery Shutdown 5 = Operator Change 6 = Line Pressure Shut In 7 = Startup
3:0484 + (n -1)	Cycle Log Average Velocity	0-65535
3:0509 + (n -1)	Cycle Log Surface Velocity	0-65535
3:0509 + (n -1)	Cycle Log Velocity Confidence Code	0-23 0 = Velocity Sensor Not Enabled 1 = Poor confidence 2 = Low Confidence 3-8 = Good Confidence 20 = Velocity Under Range 21 = Velocity Over Range 22-23 = Poor Plunger Signal – Velocity Calculation Impossible 24 = Communication Error
3:0534– 3:1000	Reserved	N/A

Daily Production Logs		
3:1001	Daily Production Log Count	0 - 8
3:1002 + 6(n -1) - 3:1007 + 6(n -1)	Daily Production Log - Save Time 8 Consecutive date/time registers. "n" in the register column represents the daily production log number. The first date/time register in each set is the current day stats. (n = 1 to 8)	Date/Time format
3:1050 + 3(n -1) - 3:1052 + 3(n -1)	Daily Production Log - Open Time 8 Consecutive triple registers	Elapsed Time format
3:1074 + 3(n -1) - 3:1076 + 3(n -1)	Daily Production Log - Close Time 8 Consecutive triple registers	Elapsed Time format
3:1098 + 2(n -1) - 3:1099 + 2(n -1)	Daily Production Log – Production Volume 8 Consecutive double registers	0.0 – 99.9 e3m3 *Value is returned with an extra digit for a decimal place ie. 100 = 10.0*
3:1114 + (n -1)	Daily Production Log - Cycle Count 8 Consecutive single registers	0 - 65535
3:1122 + (n -1)	Daily Production Log - Normal Arrival Count 8 Consecutive single registers	0 - 65535
3:1130 + (n -1)	Daily Production Log - Non-Arrival Count 8 Consecutive single registers	0 - 65535
3:1138 + (n -1)	Daily Production Log - Fast Trip Count 8 Consecutive single registers	0 - 65535

3:1146 + (n -1)	Daily Production Log - Line Pressure Shut-in Count 8 Consecutive single registers	0 - 65535
3:1154 + (n -1)	Daily Production Log – Max Open Count 8 Consecutive single registers	0 - 65535
3:1162 + (n -1)	Daily Production Log – Low Battery Count 8 Consecutive single registers	0 - 65535
3:1170 + (n -1)	Daily Production Log – Operator Change Count 8 Consecutive single registers	0 - 65535
3:1178 + (n -1)	Daily Production Log – Startup Count 8 Consecutive single registers	0 - 65535

7.5 Holding Registers

Table 13 - Available Holding Registers

Register	Description	Read/Write
4:0001 – 4:0002	Operator ID Write either the operator ID or the Installer ID to gain access to protected registers.	Double Word format: 0 – 9999999
4:0003	Cycle Restart Request State ***Privileged Access*** Write this register to change the operation of the controller. This would behave the same as pressing Open or Close on the keypad of the physical controller.	Write 0 = Close 1 = Wait Arrival 2 = AfterFlow 3 = Stop Read 0 = AfterFlow 1 = AfterFlowDelay 2 = Close 3 = ExtendedClose 4 = ExtendedFlow 5 = Wait Arrival 6 = Stopped
4:0004 – 4:0006	Cycle Restart Request Duration Write this register to set the length of time the controller should remain in the state that is set in the Cycle Restart Request State register.	Elapsed Time format: 1 – 3599999 (000:00:00 – 999:59:59)
4:0007 – 4:0008	Well Depth	Double Word format: 0 - 99999

Register	Description	Read/Write
4:0009	Optimization Mode	0 = Manual 1 = Oil 2 = Gas 3 = Oil then Gas 4 = Pressure Based
4:0010	Plunger Type	0 = Conventional 1 = Freecycle 2 = Pacemaker
4:0011	Adjustment Type	0 = Escalating 1 = 1:1 2 = 2:1 3 = 3:1
4:0012	Arrival Sensor Config	0 = Disabled 1 = Two-Wire Sensor 2 = Three-Wire Sensor
4:0013 - 4:0014	Reserved	N/A
4:0015	Sensor Delay Time	0 – 120 seconds A value of zero disables the timer.
4:0016 – 4:0017	Reserved	N/A

Register	Description	Read/Write
4:0018	Valve B Config	0 = Disabled 1 = Line, Valve A open during AfterFlow 2 = Line, Valve A & B open during AfterFlow 3 = Tank
4:0019 - 4:0023	Reserved	N/A
4:0024 - 4:0026	Fast Trip Time	Elapsed Time format: 0 – 219599 (000:00:00 – 60:59:59) A value of zero disables the timer.
4:0027	Fast Trip Count	0 – 99
4:0028 - 4:0030	Target Rise Time	Elapsed Time format: 1 – 3599998 (000:00:01 – 999:59:58)
4:0031 - 4:0033	Wait Arrival	Elapsed Time format: 1 – 3599999 (000:00:01 – 999:59:59)
4:0034- 4:0036	Max Open Time Maximum time for the valves to be in the Open position. Used for optimization.	Elapsed Time format: 1 – 3599998 (000:00:01 – 999:59:58)
4:0037 - 4:0039	Min AfterFlow Time	Elapsed Time format: 0 – 3599998 (000:00:00 – 999:59:58)
4:0040 - 4:0042	Max AfterFlow Time	Elapsed Time format: 1 – 3599999 (000:00:01 – 999:59:59)

Register	Description	Read/Write
4:0043 - 4:0045	AfterFlow Time	Elapsed Time format: 1 – 3599998 (000:00:01 – 499:59:58)
4:0046 - 4:0048	AterFlow Delay Time For Two Valve Operation. Once plunger arrival has been detected this is how long the controller waits before switching to the AfterFlow Valve Configuration	Elapsed Time format: 0 – 36000 (000:00:00 – 10:00:00)
4:0049 - 4:0051	Tank Delay Time For Two Valve (Tank) Operation. If the plunger has not arrived prior to this time, the second valve (tank valve) will be opened.	Elapsed Time format: 0 – 3599999 (000:00:00 – 999:59:59)
4:0052 - 4:0054	Arrival Guard Time Ignore trip indications for extended flow devices for this period at the start of Afterflow.	Elapsed Time format: 0 – 1799999 (000:00:00 – 499:59:59)
4:0055 - 4:0057	Reserved	N/A
4:0058 - 4:0060	Min Close Time	Elapsed Time format: 1 – 3599998 (000:00:01 – 999:59:58)
4:0061 - 4:0063	Max Close Time	Elapsed Time format: 2 – 3599999 (000:00:02 – 999:59:59)
4:0064 - 4:0066	Close Time	Elapsed Time format: 7 – 3599999 (000:00:07 – 999:59:59)
4:0067 - 4:0069	Extended Close Time	Elapsed Time format: 1 – 3599999 (000:00:01 – 999:59:59)

Register	Description	Read/Write
4:0070	Non Arrival Count	0 – 99 A value of zero disables the alarm.
4:0071	Backup Fail Count	0 – 99 A value of zero disables the alarm.
4:0072	Backup Fail to AfterFlow Type	0 = Min AfterFlow 1 = 25% AfterFlow 2 = 50% AfterFlow 3 = 75% AfterFlow
4:0073	Line Pressure Device Config	0 = Disabled 1 = Line Pressure Switch 2 = Line Pressure Sensor
4:0074	Line Pressure Sensor Max Value	100.0 – 1000.0 PSI *All sensor reading values are returned with an extra digit for a decimal place ie. 1000 = 100.0*
4:0075	Reserved	N/A
4:0076	Flow Differential Pressure Device Config	0 = Disabled 1 = Flow Differential Pressure Switch 2 = Flow Differential Pressure Sensor

Register	Description	Read/Write
4:0077	Flow Differential Pressure Sensor Max Value	25.0 – 3000.0 “H20 *All sensor reading values are returned with an extra digit for a decimal place ie. 1000 = 100.0*
4:0078 - 4:0081	Reserved	N/A
4:0082	Casing Pressure Device Config	0 = Disabled 1 = Casing Pressure Switch 2 = Casing Pressure Sensor
4:0083	Casing Pressure Sensor Max Value	100.0 – 1000.0 psi *All sensor reading values are returned with an extra digit for a decimal place ie. 1000 = 100.0*
4:0084 – 4:0090	Reserved	N/A
4:0091	Wait Arrival Line Pressure Config	0 = Disabled 1 = Enabled
4:0092	Wait Arrival Line Pressure Trip Point	0.0 – Line Pressure Sensor Max Value psi
4:0093	Wait Arrival Line Pressure Reset Point	0.0 – Line Pressure Sensor Max Value psi
4:0094	Wait Arrival Line Pressure Stable Time	0 – 7199 seconds This value is usually set to 5 seconds.
4:0095	Reserved	N/A
4:0096	AfterFlow Line Pressure Config	0 = Disabled 1 = Enabled

Register	Description	Read/Write
4:0097	AfterFlow Line Pressure Trip Point	0.0 – Line Pressure Sensor Max Value psi
4:0098	AfterFlow Line Pressure Reset Point	0.0 – Line Pressure Sensor Max Value psi
4:0099	AfterFlow Line Pressure Stable Time	0 – 7199 seconds This value is usually set to 5 seconds.
4:0100 – 4:0104	Reserved	N/A
4:0105	Flow DP Trip Point	0.0 – FlowDP Sensor Max Value psi
4:0106	Flow DP Reset Point	0.0 – FlowDP Sensor Max Value psi
4:0107	Flow DP Stable Time	0 – 7199 seconds This value is usually set to 5 seconds.
4:0108	Reserved	N/A
4:0109	Flow Rate Trip Point	0.0 – 99.9 e3m3/day
4:0110	Flow Rate Reset Point	0.0 – 99.9 e3m3/day
4:0111	Flow Rate Stable Time	0 – 7199 seconds This value is usually set to 5 seconds.
4:0112	Reserved	N/A
4:0113	Gas Temperature	0 – 199 **º**F

Register	Description	Read/Write
4:0114	Gas Specific Gravity	0.0 – 0.99 *The value that is returned will be the decimal digits. ie, 99 = 0.99*
4:0115	Gas Meter Run	2 – 4 in.
4:0116	Orifice Size	1 – 11 *Value is number of 1/8^{ths} of an inch. ie, a value of 4 is 4/8ths or 0.50 inches*
4:0117	Reserved	N/A
4:0118	AfterFlow Casing Differential Trip Point	0.0 – 1000.0 psi
4:0119	AfterFlow Casing Differential Reset Point	0.0 – 1000.0 psi
4:0120	AfterFlow Casing Differential Stable Time	0 – 7199 seconds This value is usually set to 5 seconds.
4:0121	Reserved	N/A
4:0122	Close Casing Pressure Trip Point	0.0 – Casing Pressure Sensor Max Value psi
4:0123	Close Casing Pressure Reset Point	0.0 – Casing Pressure Sensor Max Value psi
4:0124	Close Casing Pressure Stable Time	0 – 7199 seconds This value is usually set to 5 seconds.
4:0125	Reserved	N/A
4:0126	Close Line Pressure Config	0 = Disabled 1 = Enabled

Register	Description	Read/Write
4:0127	Close Line Pressure Trip Point	0.0 – Line Pressure Sensor Max Value psi
4:0128	Close Line Pressure Reset Point	0.0 – Line Pressure Sensor Max Value psi
4:0129	Close Line Pressure Stable Time	0 – 7199 seconds This value is usually set to 5 seconds.
4:0130	Reserved	N/A
4:0131	Close Casing Line DP Trip Point	0.0 – 1000.0 psi
4:0132	Close Casing Line DP Reset Point	0.0 – 1000.0 psi
4:0133	Close Casing Line DP Stable Time	0 – 7199 seconds This value is usually set to 5 seconds.
4:0134	Reserved	N/A
4:0135	Display Brightness	0 = 25% 1 = 50% 2 = 75% 3 = 100%
4:0136 – 4:0141	Controller Date	Date/Time format
4:0142	Daylight Savings Time Config	0 = Disabled 1 = Enabled
4:0143 – 4:0144	Day Start Time Time in minutes	Elapsed Time Format: 0 – 1439 (00:00 – 23:59) When in HH:MM:SS format, only Hours and Minutes are available.

Register	Description	Read/Write
4:0145	ModBus Timeout Number of seconds to wait for ModBus write inactivity before writing current changes to persistent memory. If zero, changes will be committed to memory immediately.	0 – 600 Seconds
4:0146	Reserved	N/A
4:0147	Time Format	0 = Seconds 1 = Hours/Minutes/Seconds

8 Acronyms

ADC	**Analog-to-Digital Converter**
AI	**Analog Input**
CVC	**Configurable Valve Controller**
DAC	**Digital-to-Analog Converter**
DI	**Digital Input**
DO	**Digital Output**
ESD	**Emergency Shut Down**
N/C	**Normally Closed**
N/O	**Normally Open**
PIT	**Premier Integrated Technologies**
PSI	**Pounds per Square Inch**
R	**Read Permission**
RTU	**Remote Terminal Unit**
R/W	**Read/Write Permission**
SCADA	**Supervisory Control And Data Acquisition**
V	**Volts**
VFD	**Vacuum Fluorescent Display**
VI	**Virtual Input**