

Multi Products

Petro-Casing Modbus Protocol Manual

Ver 1.1 Oct 14, 2011

The Multi Products Petro-Casing controller, board Rev 1.3, software Ver. 1.205 and above, supports Standard Modbus. It also has some Enron Modbus compatibility as listed below. In the controller Options menu, you may select baud rates, parity and standard or extended receiver (slave) addressing. Most actions that can be done at the controller can also be done via Modbus. While in Auto Mode, multiple pressure settings should be changed in one Modbus command because pressure setting changes take place immediately. You don't want half of the changes to take place while the controller is actively using the pressure settings. Note that you can check to see if the controller door is open or not. This can help avoid changing settings remotely while someone is using the controller locally. Remote actions via Modbus do not lock out local actions at the controller. The local controller screen displays "MODBUS" to warn the operator that remote access is occurring.

Local actions can lock out some remote actions. If the local operator opens the door and sees that the controller is already in Manual mode, or he presses the Stop button, putting the controller in Manual mode, the remote operator cannot put the controller in Auto mode or open/close the valves. To re-enable those remote actions, the local operator must put the controller in Auto mode and close the door. This provides some safety for the local operator. However, we strongly recommend disabling remote control by either shutting off the controller or disconnecting the Modbus cable during well maintenance.

Modbus modes supported: RTU

Modbus function codes supported: 01(Read Coils), 02(Read Discrete Inputs), 03(Read Holding Reg)
04(Read Input Reg), 05(Write Single Coil), 06(Write Single Reg), 15(Write Multiple Coils),
16(Write Multiple Reg)

Supported Hardware: RS485, half duplex (two-wire)

Supported Baud rates: 2400, 9600, 19.2K, 38.4K, 57.6K, 115.2K

Parity: Even, Odd, None

Register transfer limit: Up to 160 registers can be transferred in one Modbus message.

Register format: All registers are 16 bit unsigned integers, except signed holding register "Degrees F".

Turner equation registers 28-41 are 16 bit unsigned integer pairs that convert to real numbers.

Enron Modbus compatibility: Only Enron registers in the 1001-1999 range (Boolean) and the 3001-3999 range (16 bit short integer) and 7000s (32bit floating point) are supported, using function codes 01, 03, 05, 06, 16. Standard Modbus address "zero" refers to register "one", while Enron Modbus address "zero" refers to register "zero". Both Standard and Enron addresses are listed in the map below. For more compatibility with certain devices, function codes 03 and 06 may be substituted for 01 and 05, but the data format remains standard Modbus for 01 and 05 (coils and discrete input registers). The Enron 7000 series registers add 32 bit float compatibility to the Turner equation registers. Floating point registers from are big endian, byte order "1 2 3 4", where byte "1" contains the most significant bits.

For devices that cannot read bit formats (coils and discrete input registers) we have alternate 3000 range addressing. Example: Instead of Coil address 1001 for one bit, you can use 16 bit unsigned register 3501 with values of '1' or '0'.

Timing

Holding Registers: for 41 total, response time of less than 200ms.

Input Registers: for 160 total, response time of less than 20ms (all ten plunger logs.)

For all other function codes, response time is less than 200ms.

Modbus Register Map

Holding Reg Address Standard/Enron	Name	Description
Pressure Settings		
0 / 3001	Low Casing Limit	Valve A closes when casing pressure less than this limit
1 / 3002	High Line Limit	Shuts A valve while line pressure exceeds this limit
2 / 3003	High Line Window Limit	After High Line limit is exceeded, line pressure must go below that limit minus this window to exit High Line mode.
3 / 3011	High Casing Limit	Valve A opens when casing pressure more than this limit
Time Settings		
3 / 3004	Sales Open Time	Max time allowed for plunger to arrive on A valve.
4 / 3005	Hold Time	Time valve stays closed at cycle end. (Pressure settings can override).
5 / 3006	OrifTank Time	3-valve system only. How long to wait for plunger on orifice/tank valve open.
6 / 3007	Trap Open Time	Time to keep A valve open even after plunger arrives.
7 / 3008	Fallback	3-valve system only. Time to allow plunger to fall to bottom of well.
8 / 3009	Shut-in Time	3-valve system only. Time to keep well shut-in after plunger misses once.
9 / 3010	MaxPlgrRuns	Number of times plunger allowed to arrive before holding plunger for inspection.

22 / 3023	Clock Month	Clock used to time stamp logs.
23 / 3024	Clock Day	Clock used to time stamp logs.
24 / 3025	Clock Year	Clock used to time stamp logs.
25 / 3026	Clock Hour	Clock used to time stamp logs.
26 / 3027	Clock Minute	Clock used to time stamp logs.
27 / 3028	Clock Second	Clock used to time stamp logs.
	Turner equation values----->	Can use Enron 32bit float 7000 registers (big endian)
28/3029/7001	Gas flow	First part of float (from EFM)
29 / 3030	Gas flow	Second part of float
30/3031/7002	Degrees F	First part of float (from EFM)
31 / 3032	Degrees F	Second part of float
32/3033/7003	Liquid density	First part of float (internal or EFM)
33 / 3034	Liquid density	Second part of float
34/3035/7004	Gas gravity	First part of float (internal or EFM)
35 / 3036	Gas gravity	Second part of float
36/3037/7005	Surface tension	First part of float (internal or EFM)
37 / 3038	Surface tension	Second part of float
38/3039/7006	Pipe id	First part of float (internal or EFM)
39 / 3040	Pipe id	Second part of float
40/3041/7007	Gas compressibility constant	First part of float (internal or EFM)
41 / 3042	Gas compressibility constant	Second part of float

**Coil Reg /
Holding Reg**

Address	Name	
0 / 1001/3501	Run Button	Write '1' to start auto mode (Momentary contact, so always reads '0').
1 / 1002/3502	Stop Button	Write '1' to start manual mode (Momentary contact, so always reads '0').
2 / 1003/3503	Sales Valve (HiFlo)	Write '1' to open A valve, '0' to close. (Must be in Manual Mode for write. Sales and Tank cannot be open at the same time.)
3 / 1004/3504	Trap Valve	Write '1' to open B valve, '0' to close.
4 / 1005/3505	OrifTank Valve	Write '1' to open OrifTank valve, '0' to close. Only for 3-valve systems.

(Must be in Manual Mode for write. Sales and OrifTank cannot be open at the same time.)

**Discrete Input
Reg /Input Reg
Address/Holding**

Reg Address	Name	
0 / 1010/ 3510	Plunger Sensor	'1' =Plunger up, '0'=Plunger down.
1 / 1011/ 3511	Plunger Arrival	'1'=Plunger did arrive on this cycle, '0'=Plunger has not yet arrived.
2 / 1012/ 3512	AUX	'1'=AUX input is closed, '0'=AUX input is open.
3 / 1013/ 3513	Door sensor	'0'=Controller Door is Open, '1'= Controller Door is Closed.

**Input Register
Address**

Address	Name	
0 / 3100	Mode	Mode that controller is in. Auto, Manual, etc. See Appendix A.
1 / 3101	Casing Pressure	Current Casing Pressure in PSI.
2 / 3102	Unused	Not used.
3 / 3103	Line Pressure	Current Line Pressure in PSI.
4 / 3104	Current State	State code. See Appendix B
5 / 3105	Summary Plunger Arrival Count	Number of times plunger arrives since Summary was reset.
6 / 3106	Summary Plunger Total Count	Number of times plunger missed or arrived since Summary was reset (resettable only at the controller).
7 / 3107	Summary A (Sales) Open Time	Time that valve A (Sales) was open since Summary was reset (resettable only at the controller).

Time that valve A (Sales) was open since Summary was reset (resettable only at the controller).

Plunger Logs

Ten Plunger logs are in groups of 16 registers starting at address 100.

Plunger arrival Month (or timeout).

Plunger arrival Day (or timeout).

Plunger arrival 4 digit year (or timeout).

Plunger arrival hours (24hr)(or timeout).

Plunger arrival minutes (or timeout).

Plunger arrival seconds (or timeout).

Time from opening of A or B valve and arrival of plunger. (Zero if plunger fails to arrive.)

Time from opening of A or B valve and arrival of plunger. (Zero if plunger fails to arrive.)

Time from opening of A or B valve and arrival of plunger. (Zero if plunger fails to arrive.)

Casing pressure at time of plunger arrival or timeout.

Tubing pressure at time of plunger arrival or timeout.

Line pressure at time of plunger arrival or timeout.

Code to indicate on what valve was open when plunger arrived, was AUX on, etc. See appendix C.

Total time A valve was open, selling gas.

Total time A valve was open, selling gas.

Total time A valve was open, selling gas.

100 / 3200	Plunger Log Month
101 / 3201	Plunger Log Day
102 / 3202	Plunger Log Year
103 / 3203	Plunger Log Hour
104 / 3204	Plunger Log Minutes
105 / 3205	Plunger Log Seconds
106 / 3206	Plunger Travel Hours
107 / 3207	Plunger Travel Minutes
108 / 3208	Plunger Travel Seconds
109 / 3209	Plunger Log Casing Pressure
110 / 3210	Plunger Log Tubing Pressure
111 / 3211	Plunger Log Line Pressure
112 / 3212	Plunger Log Code
113 / 3213	Plunger Log Sales Time Hours
114 / 3214	Plunger Log Sales Time Minutes
115 / 3215	Plunger Log Sales Time Seconds
116-131 / 3216-3231	Plunger Log 2
132-147 / 3232-3247	Plunger Log 3
148-163 / 3248-3263	Plunger Log 4
164-179 / 3264-3279	Plunger Log 5
180-195 / 3280-3295	Plunger Log 6
196-211 / 3296-3311	Plunger Log 7

212-227 / 3312-3327 Plunger Log 8
 228-243 / 3328-3343 Plunger Log 9
 244-259 / 3344-3359 Plunger Log 10

**Appendix A
 Modes**

Number	Name	Description
1	Manual	Stop button was pressed or controller was powered on. Valves off, automatic control is stopped.
2	Auto Cycle Start	Invoked by Run button. Automatic control is started. If plunger is up, then "HiFlow" or "Sales Time, if not, then "Waiting on Plunger".
3	Auto Closed	Not currently used.
4	Error Manual	Invoked by controller error, valves off, automatic control is stopped.
5	Manual Low Battery	Invoked by low battery voltage, valves off, automatic control is stopped.
6	AUX On	AUX switch is on, valves are open or closed as selected in the Options/AUX menu.

**Appendix B
 States**

Number	Name	Description
0	Manual or Algorithm Error	"Controller Screen display", Description If not in Manual Mode, then "Algorithm Error" Software error.
1	none_plunger_down	"Checking for Plunger" Determines where algorithm starts.
2	tank_plunger_middle	"WaitingToTrapPlunger" Orif/Tank valve open, Sales valve closed.

3	finish_tank_close	"Orif/Tank closing" Orif/Tank valve closing.
4	sales_plunger_up	"Plunger Up, Selling" Sales valve is open, Orif/Tank valve closed, plunger is in lubricator.
5	drop_plunger	"Dropping Plunger" Orif/Tank and Sales valves closed, Trap open, waiting for plunger to fall.
6	fallback	"Fallback Time" Both valves are closed, plunger is falling to bottom.
7	none_close_time	"Hold Time" Both valves are closed, plunger is held in lubricator waiting for Hold time to expire.
8	shutin	"Shut-in Time!" plunger missed arrival so valves closed, building pressure.
9	plunger_error	" Plunger Trap Error!" Plunger sensor claims plunger is still at top, Trap Open timed out.
10	line_error_up	" Line Limit!" Line pressure above High Line limit, valves closed, waiting for line pressure reduction.
11	setting_err_msg	" Check Settings." Algorithm stopped. Settings are incorrect.
12	hold_plunger1	" Plunger on Hold" Max Plunger Runs exceeded. Valves closed, plunger held, waiting for inspection.
13	none_plunger_down2	2-valve " Dropping Plunger" Trap open, waiting for plunger drop, valves closed.
14	lo_flow_plunger_middle	" Waiting on Plunger" Valve is opened, yet Plunger sensor claims plunger is still at top.
15	hi_afterflow	" HiFlo A Valve Open" Selling gas, plunger in

		lubricator.
16	delay_plunger_drop	" Plunger Hold Time " Valves closed, plunger in lubricator for Hold Time.
17	line_error_up2	" Line Limit! " Line pressure above High Line limit, valves closed, waiting for line pressure reduction.
18	setting_err_msg2	" Check Settings." Algorithm stopped. Settings are incorrect.
19	plunger_error2	" Plunger Error!" Plunger sensor claims plunger is still at top, Trap Open timed out.
20	hold_plunger	" Plunger on Hold" Max Plunger Runs exceeded. Valves closed, plunger held, waiting for inspection.

Appendix C Plunger Log Code

Binary Number	Code name	Description
0b01000000	INIT_CODE	Use printable characters 0x40 to 0x5F so USB log backwards compatible. Use bitwise OR to set bits to indicate additional events.
0b00000001	TANK_VALVE_CODE	Plunger arrived on Tank valve.
0b00000010	SALES_VALVE_CODE	Plunger arrived on Sales valve.
0b00000100	TRAP_FAIL_CODE	Trap failed so plunger fell unexpectedly, or plunger sensor failed.
0b00001000	AUX_CODE	Aux line was active during cycle.
0b00010000	HI_LINE_CODE	Line pressure exceeded limit during cycle.

Ver. 1.0 initial version

Ver. 1.1 adds High Casing