REV	ACTION	DRAWN	CHECKED	APPROVED	DATE
AA	L8347	LANGBEIN	LANGBEIN	HOLLAND	00/05/08
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Totalflow Modbus Protocol for SPOC 6313

PRODUCT LINE TOTALFLOW ®	DATE 3	ABB TOTALFLOW Products						
DESIGN SIEVERS		TITLE TOTALFLOW MODBUS PROTOCOL SPOC 6313 MODBUS						
DRAWN LANGBEIN								
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APPROVED G. HOLLAND		SCALE NONE	SIZE A	TYPE AI	DRAWING NO. 2100207	REV AB	SHEET 1 OF 16	

Totalflow Modified Modbus Protocol

I. Purpose

This paper describes Modbus communications protocol for Totalflow Smart Pump-Off Controllers.

II. Modbus Description

The Modbus protocol is described in the document entitled "Gould Modbus Protocol Reference Guide" published January, 1985 by Gould Inc., Programmable Control Division, Andover, Massachusetts.

Modbus uses the master, slave communications concept. Slave devices speak only when spoken to by the master. Each slave is identified by an unsigned, one byte number ranging from 1 to 247 (inclusive). A slave must send a single response to a master's request for data.

Modbus messages may be one of two formats:

Modbus RTU message frame format:

Packet	CRC
N x 8 bits	16-bits

Packet: The packet field consists of the Modbus packet being sent or received. Packet format varies with the function being performed and the register group being accessed.

CRC: The error check field consists an 16 bit cyclic redundancy check calculated over the length of the packet field.

Modbus ASCII message frame format:

BOF	Packet	LRC	EOF	Ready
:	2 x Number of bytes in Modbus packet	8-bits	CR	LF

BOF: A colon (:) character is used to indicate beginning of frame.

Packet: The packet field consists of hexadecimal ASCII characters representing the Modbus packet being sent or received. The number of characters is twice the number of bytes in the Modbus packet because each packet byte is converted into two hexadecimal ASCII characters ('0'-'9','A'-'F'.)

LRC: The error check field consists an 8 bit longitudinal redundancy check calculated over the length of the packet field before it is converted to hexadecimal ASCII.

EOF/Ready: A carriage return and line feed are used to delineate end of frame.

Note: *Total message frame length can not exceed 256 bytes.*

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III. Totalflow Modbus Implementation

Totalflow Modbus supports RTU or ASCII mode. Support has also been added for long integer, floating point, and archive record registers. Totalflow Modbus supports the following subset of the Gould Modbus defined functions:

Code	Function	Description
01	Read Boolean	Reads group of boolean registers
03	Read Registers	Reads group of 16/32 bit registers
05	Set Single Boolean	Set or clear a boolean register
06	Set Single Register	Set a 16/32 bit register to specified value
16	Set Multiple Register	Set multiple 16/32 bit registers
128-143	Exception Response	Used in FCU response packets to indicate errors in processing function codes 1-16.

Packet formats:

Read Query

Address	Function	Register	Quantity
8-bits	8-bits	16-bits	16-bits

Read Response

Address	Function	Byte Count	Data
8-bits	8-bits	8-bits	N x 8 bits

Set Query

Address	Function	Register	Data
8-bits	8-bits	16-bits	N x 8 bits

Set Response

Address	Function	Register	Data
8-bits	8-bits	16-bits	N x 8 bits

Set Multiple Query

Address	Function	Register	Quantity	Byte Count	Data
8-bits	8-bits	16-bits	16-bits	8-bits	N x 8 bits

Set Multiple Response

Address	Function	Register	Quantity
8-bits	8-bits	16-bits	16-bits

Exception Response

Address	Function	Code
8-bits	8-bits	8-bits

Address: The address field contains the slave address of the FCU intended to receive the packet. Each FCU must be assigned a unique address in the range of 1 to 247.

Function: The function code field contains a code which tells the FCU what to do or what data to send. The high order bit in this field may be set by the FCU in the response packet to indicate an error response.

Register: The register field contains the register number of the FCU data item to fetch or set. For read functions, this is the starting register number.

Code: The code field contains an error value for the exception response. Currently there are three values used; 1 indicates that the function code is unsupported, 2 indicates the register number requested is invalid, 3 indicates that too many data values were requested and that the maximum packet size was exceeded. The maximum packet size for ASCII is 122 bytes and for RTU the maximum packet size is 250.

Quantity: The quantity field contains the number of consecutive registers to fetch or set. This field is not present in all packets (only read and set multiple queries).

Byte Count: The byte count field contains the number of bytes of data being transferred. This field is not present in all packets (only read response and set multiple query).

Data: The data field contains the actual data values being transferred. This field is not present in all packets. The size and format of the data values depend on the register group being accessed. The byte order of data items is high to low (MSB first, LSB last).

Totalflow Modified Modbus Protocol

IV. Register Group Configuration

Registers are grouped by data type. The grouping is fixed, but the base (or starting) register number of each group is configurable. Default register group assignments:

Default Base	Type	Description
100	INTEGER	Register Configuration Group
1001	BOOLEAN	1 Bit Boolean Group
3001	INTEGER	16 Bit Integer Group
5001	LONG INTEGER	32 Bit Long Integer Group
7001	FLOATING POINT	32 Bit IEEE Floating Point Group
0 (Disabled)	FLOATING POINT	Configurable Read-only Floating Point Group

Group configuration registers are read using function code 03 and set using function code 06 or 16. To disable a register group, set the base register to zero (0).

Register	Access	Description
100	Read/Write	Configuration Group Base Register Number
101	Read/Write	Boolean Register Group Base Register Number
102	Read/Write	Integer Register Group Base Register Number
103	Read/Write	Long Register Group Base Register Number
104	Read/Write	Floating Point Register Group Base Register Number
105	Read/Write	Daily Flow Archive Register Group Base Register Number
106	Read/Write	Log Period Archive Register Group Base Register Number
107	Read/Write	Event Log Archive Register Group Base Register Number
110	Read/Write	Configurable Register Group Base Register Number
111	Read/Write	Configurable Register 1
112	Read/Write	Configurable Register 2
113	Read/Write	Configurable Register 3
114	Read/Write	Configurable Register 4
115	Read/Write	Configurable Register 5
116	Read/Write	Configurable Register 6
117	Read/Write	Configurable Register 7
118	Read/Write	Configurable Register 8
119	Read/Write	Configurable Register 9
120	Read/Write	Configurable Register 10
121	Read/Write	Configurable Register 11
122	Read/Write	Configurable Register 12
123	Read/Write	Configurable Register 13
124	Read/Write	Configurable Register 14
125	Read/Write	Configurable Register 15
126	Read/Write	Configurable Register 16
127	Read/Write	Configurable Register 17
128	Read/Write	Configurable Register 18
129	Read/Write	Configurable Register 19
130	Read/Write	Configurable Register 20
131	Read/Write	Configurable Register 21
132	Read/Write	Configurable Register 22
133	Read/Write	Configurable Register 23
134	Read/Write	Configurable Register 24
135	Read/Write	Configurable Register 25
136	Read/Write	Configurable Register 26

Register	Access	Description
137	Read/Write	Configurable Register 27
138	Read/Write	Configurable Register 28
139	Read/Write	Configurable Register 29
140	Read/Write	Configurable Register 30
141	Read/Write	Configurable Register 31
142	Read/Write	Configurable Register 32
143	Read/Write	Configurable Register 33
144	Read/Write	Configurable Register 34
145	Read/Write	Configurable Register 35
146	Read/Write	Configurable Register 36
147	Read/Write	Configurable Register 37
148	Read/Write	Configurable Register 38
149	Read/Write	Configurable Register 39
150	Read/Write	Configurable Register 40
151	Read/Write	Configurable Register 41
152	Read/Write	Configurable Register 42
153	Read/Write	Configurable Register 43
154	Read/Write	Configurable Register 44
155	Read/Write	Configurable Register 45
156	Read/Write	Configurable Register 46
157	Read/Write	Configurable Register 47
158	Read/Write	Configurable Register 48
159	Read/Write	Configurable Register 49
160	Read/Write	Configurable Register 50
161	Read/Write	Configurable Register 51
162	Read/Write	Configurable Register 52
163	Read/Write	Configurable Register 53
164	Read/Write	Configurable Register 54
165	Read/Write	Configurable Register 55
166	Read/Write	Configurable Register 56
167	Read/Write	Configurable Register 57
168	Read/Write	Configurable Register 58
169	Read/Write	Configurable Register 59
170	Read/Write	Configurable Register 60
171	Read/Write	Configurable Register 61
172	Read/Write	Configurable Register 62

V. Configurable Register Group

Registers 110-172 can be used to configure a custom floating point register group as follows:

- Define the register group by writing the fixed register numbers of the data items to be included in this register group into registers 111-172. Any of the Boolean, Integer, Long Integer, or Floating Point registers may be specified. The data from boolean, integer, and long integer registers will be converted to floating point before they are inserted into the response packet.

- Enable the register group by writing a base register number into register 110. This will be the starting register number of the custom register group.

Example Custom Group Definition:

110 = 8001 (Starting register number of group)
111 = 0 (Null)
112 = 0 (Null)
113 = 7052 (POC 1, current day statistics, duty cycle
114 = 7053 (POC 1,current day statistics, average strokes)
115 = 7054 (POC 1,previous day statistics, duty cycle)
116 = 7055 (POC 1,previous day statistics, average strokes)

Using the above group definition, a poll of registers 8001-8010 will return:

8001 = zero (0.0)
8002 = zero (0.0)
8003 = current day duty cycle value for POC # 1
8004 = current day duty cycle value for POC # 1
8005 = previous day duty cycle value for POC # 1
8006 = previous day duty cycle value for POC # 1

As shown in the example above, null (0) register entries are allowed. The response packet will be padded with zero (0.0) values for each null register polled. Attempts to write to null register entries will be ignored.

VI. Boolean Register Group

Boolean registers are read using function code 01 or set using function code 05. The base register number for this register group defaults to 1001 when the unit is cold started. It can be changed by setting register 101 to the desired starting register number of the group.

Register	Access	Description	DeviceType
1001	Read Only	Digital Input 1	SPOC
1002	Read Only	Digital Input 2	SPOC
1003	Read Only	Digital Input 3	SPOC
1004	Read Only	Digital Input 4	SPOC
1005	Read/Write	Digital Output 1	SPOC
1006	Read/Write	Digital Output 2	SPOC
1007	Read/Write	Digital Output 3	SPOC
1008	Read/Write	Digital Output 4	SPOC
1009	Read/Write	Digital Output 5	SPOC
1010	Read/Write	Digital Output 6	SPOC
1011	Read/Write	Digital Output 7	SPOC
1012	Read/Write	Digital Output 8	SPOC
1013 – 1062	Read/Write	User Bools 1 –50	SPOC
1063	Read/Write	Pump-off controller 1, mode	SPOC
1064	Read/Write	Pump-off controller 1, override select	SPOC
1065	Read/Write	Pump-off controller 1, sensor failure	SPOC
1066	Read/Write	Pump-off controller 1, DO state	SPOC
1067	Read/Write	Pump-off controller 1, current cycle status	SPOC
1068	Read/Write	Pump-off controller 2, mode	SPOC
1069	Read/Write	Pump-off controller 2, override select	SPOC
1070	Read/Write	Pump-off controller 2, sensor failure	SPOC
1071	Read/Write	Pump-off controller 2, DO state	SPOC
1072	Read/Write	Pump-off controller 2, current cycle status	SPOC
1073	Read/Write	Pump-off controller 3, mode	SPOC
1074	Read/Write	Pump-off controller 3, override select	SPOC
1075	Read/Write	Pump-off controller 3, sensor failure	SPOC
1076	Read/Write	Pump-off controller 3, DO state	SPOC
1077	Read/Write	Pump-off controller 3, current cycle status	SPOC
1078	Read/Write	Pump-off controller 4, mode	SPOC
1079	Read/Write	Pump-off controller 4, override select	SPOC
1080	Read/Write	Pump-off controller 4, sensor failure	SPOC

1081	Read/Write	Pump-off controller 4, DO state	SPOC
1082	Read/Write	Pump-off controller 4, current cycle status	SPOC
1083	Read/Write	Pump-off controller 5, mode	SPOC
1084	Read/Write	Pump-off controller 5, override select	SPOC
1085	Read/Write	Pump-off controller 5, sensor failure	SPOC
1086	Read/Write	Pump-off controller 5, DO state	SPOC
1087	Read/Write	Pump-off controller 5, current cycle status	SPOC

VII. Short Integer Register Group

Short integer registers are read using function code 03 and set using function code 06 or 16. The base register number for this register group defaults to 3001 when the unit is cold started. It can be changed by setting register 102 to the desired starting register number of the group.

Register	Access	Description	Device Type
3001	Read/Write	Modbus Slave Address	SPOC
3002	Read/Write	Remote Comm Baud (0=1200,1=2400,2=4800,3=9600)	SPOC
3003	Read/Write	Remote Comm Data Bits (7 or 8)	SPOC
3004	Read/Write	Remote Comm Parity (0 = None, 1 = Odd, 2 = Even)	SPOC
3005	Read/Write	Remote Comm Stop Bits (1 or 2)	SPOC
3006	Read/Write	Radio power up delay(milliseconds)	SPOC
3007	Read/Write	Xmitter key delay(milliseconds)	SPOC
3008	Read/Write	Xmitter unkey delay (milliseconds)	SPOC
3009	Read/Write	Remote Comm Protocol (0 = Totalflow, 1 = Modbus)	SPOC
3010	Read/Write	Remote Comm Link Establish Time (Totalflow Protocol)	SPOC
3011-3015	Read/Write	SPOC ID	SPOC
3016–3027	Read/Write	SPOC Location	SPOC
3028-3033	Read Only	Software Part Number	SPOC
3034-3045	Read Only	Software Part Name	SPOC
3046-3047	Read/Write	Software Revision	SPOC
3048	Read/Write	Modbus Id group	SPOC
3049	Read/Write	Current Id group	SPOC
3050	Read/Write	Remote port timeout	SPOC
3051	Read/Write	Local port timeout	SPOC
3052-3071	Read/Write	User Ints	SPOC
3072	Read/Write	Pump-Off controller 1, state	SPOC
3073	Read/Write	Pump-Off controller 1, early shut-off cycles	SPOC
3074	Read/Write	Pump-Off controller 1, sensor	SPOC
3075	Read/Write	Pump-Off controller 1, motor	SPOC
3076	Read/Write	Pump-Off controller 1, run counter	SPOC
3077	Read/Write	Pump-Off controller 1, stroke counter	SPOC
3078	Read/Write	Pump-Off controller 1, stroke delta	SPOC
3079	Read/Write	Pump-Off controller 1, maximum delta	SPOC
3080	Read/Write	Pump-Off controller 1, stroke interval	SPOC
3081	Read/Write	Pump-Off controller 1, average stroke	SPOC
3082	Read/Write	Pump-Off controller 1, maximum stroke	SPOC
3083	Read/Write	Pump-Off controller 1, current day statistics, nbr cycles	SPOC
3084	Read/Write	Pump-Off controller 1, previous day stats, nbr cycles	SPOC
3085	Read/Write	Pump-Off controller 1, current month stats, nbr cycles	SPOC
3086	Read/Write	Pump-Off controller 1, previous month stats, nbr cycles	SPOC
3087	Read/Write	Pump-Off controller 1, current cycle speed	SPOC
3088	Read/Write	Pump-Off controller 1, current cycle full barrel	SPOC
3089	Read/Write	Pump-Off controller 2, state	SPOC
3090	Read/Write	Pump-Off controller 2, early shut-off cycles	SPOC
3091	Read/Write	Pump-Off controller 2, sensor	SPOC
3092	Read/Write	Pump-Off controller 2, motor	SPOC
3093	Read/Write	Pump-Off controller 2, run counter	SPOC
3094	Read/Write	Pump-Off controller 2, stroke counter	SPOC
3095	Read/Write	Pump-Off controller 2, stroke delta	SPOC
3096	Read/Write	Pump-Off controller 2, maximum delta	SPOC
3097	Read/Write	Pump-Off controller 2, stroke interval	SPOC

3098	Read/Write	Pump-Off controller 2, average stroke	SPOC
3099	Read Only	Pump-Off controller 2, maximum stroke	SPOC
3100	Read/Write	Pump-Off controller 2, current day statistics, nbr cycles	SPOC
3101	Read/Write	Pump-Off controller 2, previous day stats, nbr cycles	SPOC
3102	Read/Write	Pump-Off controller 2, current month stats, nbr cycles	SPOC
3103	Read/Write	Pump-Off controller 2, previous month stats, nbr cycles	SPOC
3104	Read/Write	Pump-Off controller 2, current cycle speed	SPOC
3105	Read/Write	Pump-Off controller 2, current cycle full barrel	SPOC
3106	Read/Write	Pump-Off controller 3, state	SPOC
3107	Read/Write	Pump-Off controller 3, early shut-off cycles	SPOC
3108	Read/Write	Pump-Off controller 3, sensor	SPOC
3109	Read/Write	Pump-Off controller 3, motor	SPOC
3110	Read/Write	Pump-Off controller 3, run counter	SPOC
3111	Read/Write	Pump-Off controller 3, stroke counter	SPOC
3112	Read/Write	Pump-Off controller 3, stroke delta	SPOC
3113	Read/Write	Pump-Off controller 3, maximum delta	SPOC
3114	Read/Write	Pump-Off controller 3, stroke interval	SPOC
3115	Read/Write	Pump-Off controller 3, average stroke	SPOC
3116	Read/Write	Pump-Off controller 3, maximum stroke	SPOC
3117	Read/Write	Pump-Off controller 3, current day statistics, nbr cycles	SPOC
3118	Read/Write	Pump-Off controller 3, previous day stats, nbr cycles	SPOC
3119	Read/Write	Pump-Off controller 3, current month stats, nbr cycles	SPOC
3120	Read/Write	Pump-Off controller 3, previous month stats, nbr cycles	SPOC
3121	Read/Write	Pump-Off controller 3, current cycle speed	SPOC
3122	Read/Write	Pump-Off controller 3, current cycle full barrel	SPOC
3123	Read/Write	Pump-Off controller 4, state	SPOC
3124	Read/Write	Pump-Off controller 4, early shut-off cycles	SPOC
3125	Read/Write	Pump-Off controller 4, sensor	SPOC
3126	Read/Write	Pump-Off controller 4, motor	SPOC
3127	Read/Write	Pump-Off controller 4, run counter	SPOC
3128	Read/Write	Pump-Off controller 4, stroke counter	SPOC
3129	Read/Write	Pump-Off controller 4, stroke delta	SPOC
3130	Read/Write	Pump-Off controller 4, maximum delta	SPOC
3131	Read/Write	Pump-Off controller 4, stroke interval	SPOC
3132	Read/Write	Pump-Off controller 4, average stroke	SPOC
3133	Read/Write	Pump-Off controller 4, maximum stroke	SPOC
3134	Read/Write	Pump-Off controller 4, current day statistics, nbr cycles	SPOC
3135	Read/Write	Pump-Off controller 4, previous day stats, nbr cycles	SPOC
3136	Read/Write	Pump-Off controller 4, current month stats, nbr cycles	SPOC
3137	Read/Write	Pump-Off controller 4, previous month stats, nbr cycles	SPOC
3138	Read/Write	Pump-Off controller 4, current cycle speed	SPOC
3139	Read/Write	Pump-Off controller 4, current cycle full barrel	SPOC
3140	Read/Write	Pump-Off controller 5 state	SPOC
3141	Read/Write	Pump-Off controller 5, early shut-off cycles	SPOC
3142	Read/Write	Pump-Off controller 5, sensor	SPOC
3143	Read/Write	Pump-Off controller 5, motor	SPOC
3144	Read/Write	Pump-Off controller 5, run counter	SPOC
3145	Read/Write	Pump-Off controller 5, stroke counter	SPOC
3146	Read/Write	Pump-Off controller 5, stroke delta	SPOC
3147	Read/Write	Pump-Off controller 5, maximum delta	SPOC
3148	Read/Write	Pump-Off controller 5, stroke interval	SPOC
3149	Read/Write	Pump-Off controller 5, average stroke	SPOC
3150	Read/Write	Pump-Off controller 5, maximum stroke	SPOC
3151	Read/Write	Pump-Off controller 5, current day statistics, nbr cycles	SPOC
3152	Read/Write	Pump-Off controller 5, previous day stats, nbr cycles	SPOC
3153	Read/Write	Pump-Off controller 5, current month stats, nbr cycles	SPOC
3154	Read/Write	Pump-Off controller 5, previous month stats, nbr cycles	SPOC
3155	Read/Write	Pump-Off controller 5, current cycle speed	SPOC
3156	Read/Write	Pump-Off controller 5, current cycle full barrel	SPOC

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Long integer registers are read using function code 03 and set using function code 06 or 16. The base register number for this register group defaults to 5001 when the unit is cold started. It can be changed by setting register 103 to the desired starting register number of the group.

Register	Access	Description	Device Type
5001 / 5001	Read/Write	Date / Time (Julian - # seconds since 00:00:00 1/1/70)	SPOC
5002 / 5003	Write	Modbus security seed	SPOC
5003 / 5005	Read Only	Feature flags	SPOC
5004 /5007	Read Only	Cold start date time	SPOC
5005 / 5009	Read Only	Ram size	SPOC
5006 / 5011	Read Only	Banked ram size	SPOC
5007 / 5013	Read Only	Free banked ram size	SPOC
5008 / 5015	Read/Write	Pump-off controller 1 start interval	SPOC
5009 / 5017	Read/Write	Pump-off controller 1 POC maximum	SPOC
5010 / 5019	Read/Write	Pump-off controller 1 POC minimum	SPOC
5011 / 5021	Read/Write	Pump-off controller 1 POC interval	SPOC
5012 / 5023	Read/Write	Pump-off controller 1 run interval	SPOC
5013 / 5025	Read/Write	Pump-off controller 1run timer	SPOC
5014 / 5027	Read/Write	Pump-off controller 1 timer interval	SPOC
5015 / 5029	Read/Write	Pump-off controller 1 rest interval	SPOC
5016 / 5031	Read/Write	Pump-off controller 1 rest timer	SPOC
5017 / 5033	Read/Write	Pump-off controller 1 state timer	SPOC
5018 / 5035	Read/Write	Pump-off controller 1, current day stats, elapsed time	SPOC
5019 / 5037	Read/Write	Pump-off controller 1, current day stats, run time	SPOC
5020 / 5039	Read/Write	Pump-off controller 1, current day stats, down time	SPOC
5021 / 5041	Read/Write	Pump-off controller 1, previous day stats, elapsed time	SPOC
5022 / 5043	Read/Write	Pump-off controller 1, previous day stats, run time	SPOC
5023 / 5045	Read/Write	Pump-off controller 1, previous day stats, down time	SPOC
5024 / 5047	Read/Write	Pump-off controller 1, current month stats, elapsed time	SPOC
5025 / 5049	Read/Write	Pump-off controller 1, current month stats, run time	SPOC
5026 / 5051	Read/Write	Pump-off controller 1, current month stats, down time	SPOC
5027 / 5053	Read/Write	Pump-off controller 1, previous month stats, elapsed time	SPOC
5028 / 5055	Read/Write	Pump-off controller 1, previous month stats, run time	SPOC
5029 / 5057	Read/Write	Pump-off controller 1, previous month stats, down time	SPOC
5030 / 5059	Read/Write	Pump-off controller 1, previous cycle run time	SPOC
5031 / 5061	Read/Write	Pump-off controller 2 start interval	SPOC
5032 / 5063	Read/Write	Pump-off controller 2 POC maximum	SPOC
5033 / 5065	Read/Write	Pump-off controller 2 POC minimum	SPOC
5034 / 5067	Read/Write	Pump-off controller 2 POC interval	SPOC
5035 / 5069	Read/Write	Pump-off controller 2 run interval	SPOC
5036 / 5071	Read/Write	Pump-off controller 2 run timer	SPOC
5037 / 5073	Read/Write	Pump-off controller 2 timer interval	SPOC
5038 / 5075	Read/Write	Pump-off controller 2 rest interval	SPOC
5039 / 5077	Read/Write	Pump-off controller 2 rest timer	SPOC
5040 / 5079	Read/Write	Pump-off controller 2 state timer	SPOC
5041 / 5081	Read/Write	Pump-off controller 2, current day stats, elapsed time	SPOC
5042 / 5083	Read/Write	Pump-off controller 2, current day stats, run time	SPOC
5043 / 5085	Read/Write	Pump-off controller 2, current day stats, down time	SPOC
5044 / 5087	Read/Write	Pump-off controller 2, previous day stats, elapsed time	SPOC
5045 / 5089	Read/Write	Pump-off controller 2, previous day stats, run time	SPOC
5046 / 5091	Read/Write	Pump-off controller 2, previous day stats, down time	SPOC
5047 / 5093	Read/Write	Pump-off controller 2, current month stats, elapsed time	SPOC
5048 / 5095	Read/Write	Pump-off controller 2, current month stats, run time	SPOC
5049 / 5097	Read/Write	Pump-off controller 2, current month stats, down time	SPOC
5050 / 5099	Read/Write	Pump-off controller 2, previous month stats, elapsed time	SPOC
5051 / 5101	Read/Write	Pump-off controller 2, previous month stats, run time	SPOC
5052 / 5103	Read/Write	Pump-off controller 2, previous month stats, down time	SPOC
5053 / 5105	Read/Write	Pump-off controller 2, previous cycle run time	SPOC
5054 / 5107	Read/Write	Pump-off controller 3 start interval	SPOC

5055 / 5109	Read/Write	Pump-off controller 3 POC maximum	SPOC
5056 / 5111	Read/Write	Pump-off controller 3 POC minimum	SPOC
5057 / 5113	Read/Write	Pump-off controller 3 POC interval	SPOC
5058 / 5115	Read/Write	Pump-off controller 3 run interval	SPOC
5059 / 5117	Read/Write	Pump-off controller 3 run timer	SPOC
5060 / 5119	Read/Write	Pump-off controller 3 timer interval	SPOC
5061 / 5121	Read/Write	Pump-off controller 3 rest interval	SPOC
5062 / 5123	Read/Write	Pump-off controller 3 rest timer	SPOC
5063 / 5125	Read/Write	Pump-off controller 3 state timer	SPOC
5064 / 5127	Read/Write	Pump-off controller 3, current day stats, elapsed time	SPOC
5065 / 5129	Read/Write	Pump-off controller 3, current day stats, run time	SPOC
5066 / 5131	Read/Write	Pump-off controller 3, current day stats, down time	SPOC
5067 / 5133	Read/Write	Pump-off controller 3, previous day stats, elapsed time	SPOC
5068 / 5135	Read/Write	Pump-off controller 3, previous day stats, run time	SPOC
5069 / 5137	Read/Write	Pump-off controller 3, previous day stats, down time	SPOC
5070 / 5139	Read/Write	Pump-off controller 3, current month stats, elapsed time	SPOC
5071 / 5141	Read/Write	Pump-off controller 3, current month stats, run time	SPOC
5072 / 5143	Read/Write	Pump-off controller 3, current month stats, down time	SPOC
5073 / 5145	Read/Write	Pump-off controller 3, previous month stats, elapsed time	SPOC
5074 / 5147	Read/Write	Pump-off controller 3, previous month stats, run time	SPOC
5075 / 5149	Read/Write	Pump-off controller 3, previous month stats, down time	SPOC
5076 / 5151	Read/Write	Pump-off controller 3, previous cycle run time	SPOC
5077 / 5153	Read/Write	Pump-off controller 4 start interval	SPOC
5078 / 5155	Read/Write	Pump-off controller 4 POC maximum	SPOC
5079 / 5157	Read/Write	Pump-off controller 4 POC minimum	SPOC
5080 / 5159	Read/Write	Pump-off controller 4 POC interval	SPOC
5081 / 5161	Read/Write	Pump-off controller 4 run interval	SPOC
5082 / 5163	Read/Write	Pump-off controller 4 run timer	SPOC
5083 / 5165	Read/Write	Pump-off controller 4 timer interval	SPOC
5084 / 5167	Read/Write	Pump-off controller 4 rest interval	SPOC
5085 / 5169	Read/Write	Pump-off controller 4 rest timer	SPOC
5086 / 5171	Read/Write	Pump-off controller 4 state timer	SPOC
5087 / 5173	Read/Write	Pump-off controller 4, current day stats, elapsed time	SPOC
5088 / 5175	Read/Write	Pump-off controller 4, current day stats, run time	SPOC
5089 / 5177	Read/Write	Pump-off controller 4, current day stats, down time	SPOC
5090 / 5179	Read/Write	Pump-off controller 4, previous day stats, elapsed time	SPOC
5091 / 5181	Read/Write	Pump-off controller 4, previous day stats, run time	SPOC
5092 / 5183	Read/Write	Pump-off controller 4, previous day stats, down time	SPOC
5093 / 5185	Read/Write	Pump-off controller 4, current month stats, elapsed time	SPOC
5094 / 5187	Read/Write	Pump-off controller 4, current month stats, run time	SPOC
5095 / 5189	Read/Write	Pump-off controller 4, current month stats, down time	SPOC
5096 / 5191	Read/Write	Pump-off controller 4, previous month stats, elapsed time	SPOC
5097 / 5193	Read/Write	Pump-off controller 4, previous month stats, run time	SPOC
5098 / 5195	Read/Write	Pump-off controller 4, previous month stats, down time	SPOC
5099 / 5197	Read/Write	Pump-off controller 4, previous cycle run time	SPOC
5100 / 5199	Read/Write	Pump-off controller 5 start interval	SPOC
5101 / 5201	Read/Write	Pump-off controller 5 POC maximum	SPOC
5102 / 5203	Read/Write	Pump-off controller 5 POC minimum	SPOC
5103 / 5205	Read/Write	Pump-off controller 5 POC interval	SPOC
5104 / 5207	Read/Write	Pump-off controller 5 run interval	SPOC
5105 / 5209	Read/Write	Pump-off controller 5 run timer	SPOC
5106 / 5211	Read/Write	Pump-off controller 5 timer interval	SPOC
5107 / 5213	Read/Write	Pump-off controller 5 rest interval	SPOC
5108 / 5215	Read/Write	Pump-off controller 5 rest timer	SPOC
5109 / 5217	Read/Write	Pump-off controller 5 state timer	SPOC
5110 / 5219	Read/Write	Pump-off controller 5, current day stats, elapsed time	SPOC
5111 / 5221	Read/Write	Pump-off controller 5, current day stats, run time	SPOC
5112 / 5223	Read/Write	Pump-off controller 5, current day stats, down time	SPOC
5113 / 5225	Read/Write	Pump-off controller 5, previous day stats, elapsed time	SPOC
5114 / 5227	Read/Write	Pump-off controller 5, previous day stats, run time	SPOC

5115 / 5229	Read/Write	Pump-off controller 5, previous day stats, down time	SPOC
5116 / 5231	Read/Write	Pump-off controller 5, current month stats, elapsed time	SPOC
5117 / 5233	Read/Write	Pump-off controller 5, current month stats, run time	SPOC
5118 / 5235	Read/Write	Pump-off controller 5, current month stats, down time	SPOC
5119 / 5237	Read/Write	Pump-off controller 5, previous month stats, elapsed time	SPOC
5120 / 5239	Read/Write	Pump-off controller 5, previous month stats, run time	SPOC
5121 / 5241	Read/Write	Pump-off controller 5, previous month stats, down time	SPOC
5122 / 5243	Read/Write	Pump-off controller 5, previous cycle run time	SPOC

Floating point registers are read using function code 03 and set using function code 06 or 16. The base register number for this register group defaults to 7001 when the unit is cold started. It can be changed by setting register 104 to the desired starting register number of the group.

Register	Access	Description	Device Type
7001-7050/ 7001-7099	Read/Write	User Floats	SPOC
7051 / 7101	Read/Write	Pump-off controller 1, early shut-off interval	SPOC
7052 / 7103	Read/Write	Pump-off controller 1, current day stats, duty cycle	SPOC
7053 / 7105	Read/Write	Pump-off controller 1, current day stats, average strokes	SPOC
7054 / 7107	Read/Write	Pump-off controller 1, previous day stats, duty cycle	SPOC
7055 / 7109	Read/Write	Pump-off controller 1, previous day stats, average strokes	SPOC
7056 / 7111	Read/Write	Pump-off controller 1, current month stats, duty cycle	SPOC
7057 / 7113	Read/Write	Pump-off controller 1, current month stats, average strokes	SPOC
7058 / 7115	Read/Write	Pump-off controller 1, previous month stats, duty cycle	SPOC
7059 / 7117	Read/Write	Pump-off controller 1, previous month stats, average strokes	SPOC
7060 / 7119	Read/Write	Pump-off controller 1, previous cycle strokes	SPOC
7061 / 7121	Read/Write	Pump-off controller 2, early shut-off interval	SPOC
7062 / 7123	Read/Write	Pump-off controller 2, current day stats, duty cycle	SPOC
7063 / 7125	Read/Write	Pump-off controller 2, current day stats, average strokes	SPOC
7064 / 7127	Read/Write	Pump-off controller 2, previous day stats, duty cycle	SPOC
7065 / 7129	Read/Write	Pump-off controller 2, previous day stats, average strokes	SPOC
7066 / 7131	Read/Write	Pump-off controller 2 current month stats, duty cycle	SPOC
7067 / 7133	Read/Write	Pump-off controller 2, current month stats, average strokes	SPOC
7068 / 7135	Read/Write	Pump-off controller 2, previous month stats, duty cycle	SPOC
7069 / 7137	Read/Write	Pump-off controller 2, previous month stats, average strokes	SPOC
7070 / 7139	Read/Write	Pump-off controller 2, previous cycle strokes	SPOC
7071 / 7141	Read/Write	Pump-off controller 3, early shut-off interval	SPOC
7072 / 7143	Read/Write	Pump-off controller 3, current day stats, duty cycle	SPOC
7073 / 7145	Read/Write	Pump-off controller 3, current day stats, average strokes	SPOC
7074 / 7147	Read/Write	Pump-off controller 3, previous day stats, duty cycle	SPOC
7075 / 7149	Read/Write	Pump-off controller 3, previous day stats, average strokes	SPOC
7076 / 7151	Read/Write	Pump-off controller 3, current month stats, duty cycle	SPOC
7077 / 7153	Read/Write	Pump-off controller 3, current month stats, average strokes	SPOC
7078 / 7155	Read/Write	Pump-off controller 3, previous month stats, duty cycle	SPOC
7079 / 7157	Read/Write	Pump-off controller 3, previous month stats, average strokes	SPOC
7080 / 7159	Read/Write	Pump-off controller 3, previous cycle strokes	SPOC
7081 / 7161	Read/Write	Pump-off controller 4, early shut-off interval	SPOC
7082 / 7163	Read/Write	Pump-off controller 4, current day stats, duty cycle	SPOC
7083 / 7165	Read/Write	Pump-off controller 4, current day stats, average strokes	SPOC
7084 / 7167	Read/Write	Pump-off controller 4, previous day stats, duty cycle	SPOC
7085 / 7169	Read/Write	Pump-off controller 4, previous day stats, average strokes	SPOC
7086 / 7171	Read/Write	Pump-off controller 4, current month stats, duty cycle	SPOC
7087 / 7173	Read/Write	Pump-off controller 4, current month stats, average strokes	SPOC
7088 / 7175	Read/Write	Pump-off controller 4, previous month stats, duty cycle	SPOC
7089 / 7177	Read/Write	Pump-off controller 4, previous month stats, average	SPOC

		strokes	
7090 / 7179	Read/Write	Pump-off controller 4, previous cycle strokes	SPOC
7091 / 7181	Read/Write	Pump-off controller 5, early shut-off interval	SPOC
7092 / 7183	Read/Write	Pump-off controller 5, current day stats, duty cycle	SPOC
7093 / 7185	Read/Write	Pump-off controller 5, current day stats, average strokes	SPOC
7094 / 7187	Read/Write	Pump-off controller 5, previous day stats, duty cycle	SPOC
7095 / 7189	Read/Write	Pump-off controller 5, previous day stats, average strokes	SPOC
7096 / 7191	Read/Write	Pump-off controller 5, current month stats, duty cycle	SPOC
7097 / 7193	Read/Write	Pump-off controller 5, current month stats, average strokes	SPOC
7098 / 7195	Read/Write	Pump-off controller 5, previous month stats, duty cycle	SPOC
7099 / 7197	Read/Write	Pump-off controller 5, previous month stats, average strokes	SPOC
7100 / 7199	Read/Write	Pump-off controller 5, previous cycle strokes	SPOC
7101 / 7201	Read/Write	Custom group scale register	SPOC

X. Radio Power Duty Cycling and Group Operation.

Duty cycling the power to the radio can significantly decrease the solar panel and battery requirements of a remote installation. Totalflow Modbus uses group addressing to control radio duty cycling. Using Modbus group addresses also removes the standard Modbus limit of 247 slave addresses per communications channel.

Totalflow Modbus group addressing and radio duty cycling work as follows:

Writing a group number into the Modbus group address register (3070) invokes Modbus group addressing. The FCU will listen for its standard Modbus slave address (0-247) only when the Modbus group address register (3070) matches the current group select register (3071) set by a previous broadcast.

The duty cycle is specified by setting the link establishment register (3020) to the desired cycle time (seconds). The FCU will power the radio once each duty cycle and listen for broadcasts. A duty cycle time of zero (0) means that the radio is always powered (used for group addressing without duty cycling).

When the remote unit is duty cycling the radio, the host must broadcast function code 6 (single register write command) to the current group select register (3071) continuously for the duty cycle interval. This forces remote units with matching Modbus group address registers (3070) to keep it's radio powered up and listen for subsequent commands (addressed to the standard slave address) until the group address register (3070) no longer matches the current group select register (3071).

The group returns to duty cycling when the host broadcasts a different group select. The current group select register is also reset (to 0) upon expiration of the maximum listen time specified in the listen timeout register (3072).

For example, the following ASCII mode broadcast command would set the current group select register to 1. As mentioned above, this command must be repeated for the configured duty cycle.

Broadcast :

BOF	Address	Function	Register	Data	LRC	EOF	Ready
:	00	06	0B FF	00 01	??	CR	LF

The remote device does not respond to the broadcast. It powers the radio and listens for Modbus commands directed to it's standard Modbus slave address. When the host is finished polling this group, it switches to the next goup by broadcasting a new group select address. If the host does not intend to switch to a new group, it should disable the current group by broadcasting a group select of zero (0).

Totalflow Modified Modbus Protocol

XI. Communications Setup

The Totalflow Portable Calibration and Collection Unit (PCCU) or Laptop PCCU emulation software should be used to configure the FCU communications port. The following items can be set from the PCCU remote communications setup menu:

- Listen cycle: 1 second, 2 second, 4 second (Totalflow protocol only) (rdc=0,1,2)
- Radio Powerup Delay (Milliseconds) (rkd=ms)
- Transmit Key Delay (Milliseconds) (rxkd=mx)
- Transmit Unkey Delay (Milliseconds) (rxud=ms)
- Protocol: Totalflow, Modbus RTU, Modbus ASCII (rpp=1,5)
- Modbus Slave Address: 1-247 (mba=sa)
- BaudRate: 1200, 2400, 4800, 9600 (rbr=0,1,2,3,4)
- Number of Data Bits: 7 or 8 (rdb=7,8)
- Parity: None, Even, or Odd (rpr=0,1,2)
- Number of Stop Bits: 1 or 2 (rsb=1,2)
- Interface Module: RS-232, RS-485 (rxi=12,28)
- 32/16 Bit long/float registers (rp16=0,1)
- 16 bit long/float register with word swap (rp16=2)
- Zero base bias (rp16=64)