Filtertechnik

Filtration, Purification &
Separation Solutions

MODBUS
Serial Communications Protocol

REVISION HISTORY

DATE	REV	ORIGINATOR	DESCRIPTION OF CHANGE
3-27-2012	1	Brad Meyerott	First Draft

1.0 Scope:

This protocol description is divided into three parts. Section 2 contains communication parameters used for communication between the host PC and the Filtertechnik. Section 3 describes the MODBUS message structure and the various commands, which the host PC can issue, and the responses from the Filtertechnik to those commands. Finally, section 4 details the Filtertechnik register structure and definitions.

2.0 Communication Parameters:

2.1 The Filtertechnik communicates with a host personal computer over an **RS-232/RS485** serial communications interface.

2.2 Fixed configuration: **9600 Baud, 8 data bits, No parity, 1 stop bit.**

2.3 Allow up to a maximum of **500 milliseconds** for command/data response from Filtertechnik. Most responses occur in a little as 10 milliseconds.

2.4 Filtertechnik has a minimum of **4 - 5 milliseconds** of idle line detection.

3.0 MODBUS Message Protocol, Commands and Responses:

The Modicon MODBUS specification (PI-MBUS-300 Rev J) includes two methods of structuring communications. One method sends all communications with ASCII characters. The second method uses binary communications and is called RTU format. Filtertechnik uses the MODBUS RTU formatted protocol (not ASCII). However, some registers may have packed ASCII codes into one byte.

Because of the binary RTU communications, no specific character or group of characters signifies the end of a message. The end of a message, or preparation for the beginning of a new message, is signaled by the lack of activity on the communications line. End of message/New message is signaled by *Idle Line*. The official MODBUS specification is for 3.5 character times (minimum) of *Idle Line*.

The general form of a message is shown below. Each line represents an 8-bit byte of data, with exception to *Idle Line*. The message structure is the same from host to remote device or from remote device to host.

Idle Line
Address
Function Code
Data
nData
CRC (lsb)
CRC (msb)
Idle Line

Description of message contents:

Address:

MODBUS specifies valid addresses range of 1-247 and is programmable for Filtertechnik.

Function Code:

Specifies the action to be taken by Filtertechnik in response to the message or echoes the command received in the response message.

Data:

Information being sent to registers in the Filtertechnik or register information from the Filtertechnik in the response.

CRC:

The message is surveyed and a cyclical redundancy check is performed for data integrity purposes. This CRC code is sent with the message so that the receiving host/device can check the integrity of the message contents before acting upon it.

Command Function Codes:

Description	**Transmitted Code**	
Read Registers	3	(0x03 hexadecimal)
Preset Single Register	6	(0x06 hexadecimal)
Preset Multiple Register	16	(0x10 hexadecimal)

The data structure is specific to the command. In general the registers are 16 bits and require two adjacent bytes to contain the data. The register address number is 16 bit and requires two adjacent bytes to send.

Command Message Structures

"Read Registers" command from host – Command Function Code 0x03
Idle Line (minimum 5 character times) /
Address Byte (1 – 247) /
Command Byte = 0x03/
Beginning Register Address Upper Byte /
Beginning Register Address Lower Byte /
Number of Registers (Length) Upper Byte /
Number of Registers (Length) Lower Byte /
CRC Lower Byte /
CRC Upper Byte /
Idle Line (minimum 5 character times)

Note: that CRC upper/lower order is reverse of the data and register upper/lower order.

Response from HIAC ROC to "Read Registers" command
Idle Line (minimum 5 character times)
Address Byte (1 – 247) (address of device responding) /
Echo of Command Byte = 0x03 /
Data Byte Count = 2 * number of registers being read /
Beginning Register Contents Upper Byte /
Beginning Register Contents Lower Byte /
….
Ending Register Contents Upper Byte /
Ending Register Contents Lower Byte /
CRC Lower Byte /
CRC Upper Byte /
Idle Line (minimum 5 character times)

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"Preset Single Register" command from host – Command Function Code 0x06
Idle Line (minimum 5 character times) /
Address Byte (1 – 247) /
Command Byte = 0x06 /
Register Address Upper Byte /
Register Address Lower Byte /
Register Preset Data Upper Byte /
Register Preset Data Lower Byte /
CRC Lower Byte /
CRC Upper Byte /
Idle Line (minimum 5 character times)

Response from HIAC ROC to "Preset Single Register" command
Idle Line (minimum 5 Character times) /
Address Byte (1 – 247) (address of device responding) /
Echo of Command byte = 0x06 /
Register Address Upper Byte /
Register Address Lower Byte /
Register Preset Data Upper Byte /
Register Preset Data Lower Byte /
CRC Lower Byte /
CRC Upper Byte /
Idle Line (minimum 5 character times)

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"Preset Multiple Register" command from host – Command Function Code 0x10

Idle Line (minimum 5 character times) /
Address Byte (1 – 247) /
Command Byte = 0x10 /
Beginning Register Address Upper Byte /
Beginning Register Address Lower Byte /
Number of Registers Upper Byte/
Number of Registers Lower Byte/
Data Byte Count (2 * Number of Registers Being Set)/
Beginning Register Preset Data Upper Byte /
Beginning Register Preset Data Lower Byte /
….
Ending Register Preset Data Upper Byte /
Ending Register Preset Data Lower Byte /
CRC Lower Byte /
CRC Upper Byte /
Idle Line (minimum 5 character times)

Response from Filtertechnik to "Preset Multiple Register" command

Idle Line (minimum 5 Character times) /
Address Byte (1 – 247) (address of device responding) /
Echo of Command byte = 0x10 /
Beginning Register Address Upper Byte /
Beginning Register Address Lower Byte /
Number of Registers Upper Byte/
Number of Registers Lower Byte/
CRC Lower Byte /
CRC Upper Byte /
Idle Line (minimum 5 character times)

4.0 Filtertechnik Register Structure and Definitions:

Identification Block (Registers 0 - 99)						
Reg #	**Parameter**	**Read/ Write**	**Number of Bytes**	**Data Description**	**Data Default**	**Data Write Range**
0-14	Manufacturer ID	R	30 bytes	Printable ASCII (20-7E hex, unused = 0)	HIAC	n/a
15-24	Model Number	R	20 bytes	Printable ASCII (20-7E hex, unused = 0)	ROC	n/a
25-29	Serial Number	R	10 bytes	Printable ASCII (20-7E hex, unused = 0)	n/a	n/a
30-33	Sensor ID	R	8 bytes	Printable ASCII (20-7E hex, unused = 0)	HIAC ROC	n/a
34	Last Calibration Date Year	R	2 bytes	Unused	0	n/a
35	Last Calibration Date Month and Day	R	2 bytes	Unused, (Month = Upper byte, Day = Lower byte)	0	n/a
36	Calibration Due Date Year	R	2 bytes	Unused	0	n/a
37	Calibration Due Date Month and Day	R	2 bytes	Unused, (Month = Upper byte, Day = Lower byte)	0	n/a
38	Firmware Version (Counter)	R	2 bytes	100 = V1.00	n/a	n/a
39	Hardware Version	R	2 bytes	100 = V1.00	n/a	n/a
40	Reserved	R	2 bytes	Read returns 0	0	n/a
41-47	Firmware Number and Revision	R	14 bytes	Printable ASCII (20-7E hex, unused = 0)	2089263-1 RevX (X = Current Release)	n/a
48-99	Expansion	n/a	n/a	n/a	n/a	n/a

Configuration Block (Registers 100 - 199)						
Reg #	**Parameter**	**Read/ Write**	**Number of Bytes**	**Data Description**	**Data Default**	**Data Write Range**
100	Node ID	R/W	2 bytes	1 – 247	138	1 - 247
101	Counter Date Year	R/W	2 bytes	Unused	0	2000 - 2100
102	Counter Date Month and Day	R/W	2 bytes	Unused, (Month = Upper byte, Day = Lower byte)	0,0	1 - 12, 1 - 31 (Month, Day)
103	Counter Time Hour	R/W	2 bytes	Unused (24 Hour Format)	0	0-23
104	Counter Time Minutes and Seconds	R/W	2 bytes	Unused, (Min = Upper byte, Sec = Lower byte)	00:00	00:00 to 59:59 (MM:SS)
105	Sample Period Minutes and Seconds	R/W	2 bytes	Min = Upper byte, Sec = Lower byte	00:10	00:05 to 59:59 (MM:SS)
106	Hold Period Minutes and Seconds	R/W	2 bytes	Min = Upper byte, Sec = Lower byte	00:05	00:02 to 59:59 (MM:SS)
107	Alarm Relay Trigger	R/W	2 bytes	0 = SYS STAT, 1 = ISO, 2 = NAS, 3 = SAE	0	0 - 3
108	Alarm Relay Direction	R/W	2 bytes	0 = CleanToDirty, 1 = DirtyToClean (For "Alarm Relay Triggers" 1 - 3 only)	1	0 - 1
109	Alarm Relay Control Logic	R/W	2 bytes	0 = Active Closed, 1 = Active Open	0	0 - 1
110	ISO/SAE Ch1 Code/Class Limit Alarm, or NAS Ch2 - Ch3 Class Limit Alarm	R/W	2 bytes	-3 = None, -2 = 000, -1 = 00, 0 = 0, >0 = value with 1-digit implied decimal. (note: register value based on "Alarm Relay Trigger" setting)	-3	ISO = -3, 0-29 (0 implies <1, 29 implies > 28.9). NAS = -3, 00-12 SAE = -3, 000-12
111	ISO/SAE Ch2 Code/Class Limit Alarm, or NAS Ch3 - Ch4 Class Limit Alarm	R/W	2 bytes	-3 = None, -2 = 000, -1 = 00, 0 = 0, >0 = value with 1-digit implied decimal. (note: register value based on "Alarm Relay Trigger" setting)	-3	ISO = -3, 0-29 (0 implies <1, 29 implies > 28.9). NAS = -3, 00-12 SAE = -3, 000-12
112	ISO/SAE Ch3 Code/Class Limit Alarm	R/W	2 bytes	-3 = None, -2 = 000, -1 = 00, 0 = 0, >0 = value with 1-digit implied decimal. (note: register value based on "Alarm Relay Trigger" setting)	-3	ISO = -3, 0-29 (0 implies <1, 29 implies > 28.9). SAE = -3, 000-12
113	ISO/SAE Ch4 Code/Class Limit Alarm	R/W	2 bytes	-3 = None, -2 = 000, -1 = 00, 0 = 0, >0 = value with 1-digit implied decimal. (note: register value based on "Alarm Relay Trigger" setting)	-3	ISO = -3, 0-29 (0 implies <1, 29 implies > 28.9). SAE = -3, 000-12
114-199	Expansion	n/a	n/a	n/a	n/a	n/a

Sample Data Block (Registers 300 - 399)						
Reg #	**Parameter**	**Read/ Write/ Protected**	**Number of Bytes**	**Data Description**	**Data Default**	**Data Write Range**
300	New Data Available	R/W	2 bytes	0 = False, 1 = True (write 0 only)	0	0
301	Sample UTC Timestamp Year	R	2 bytes	UNUSED (Read returns 0)	n/a	n/a
302	Sample UTC Timestamp Month/Day	R	2 bytes	UNUSED (Read returns 0)	n/a	n/a
303	Sample UTC Timestamp Hour	R	2 bytes	UNUSED (Read returns 0)	n/a	n/a
304	Sample UTC Timestamp Min/Sec	R	2 bytes	UNUSED (Read returns 0)	n/a	n/a
305	Sample Period Minutes/Seconds	R	2 bytes	MS (0-59, 0-59)	n/a	n/a
306	Sample Status Alarms	R	4 bytes	See Bit wise map below.	n/a	n/a
308	Size 1 Counts	R	4 bytes	0 – 2,500,000 counts/mL 2-digit implied decimal	n/a	n/a
310	Size 2 Counts	R	4 bytes	0 – 2,500,000 counts/mL 2-digit implied decimal	n/a	n/a
312	Size 3 Counts	R	4 bytes	0 – 2,500,000 counts/mL 2-digit implied decimal	n/a	n/a
314	Size 4 Counts	R	4 bytes	0 – 2,500,000 counts/mL 2-digit implied decimal	n/a	n/a
316	ISO Code Ch1	R	2 bytes	0 – 290 = code 0.0 – 29.0 (note: 0 implies code <1, 29 implies code >28.9)	n/a	n/a
317	ISO Code Ch2	R	2 bytes	0 – 290 = code 0.0 – 29.0 (note: 0 implies code <1, 29 implies code >28.9)	n/a	n/a
318	ISO Code Ch3	R	2 bytes	0 – 290 = code 0.0 – 29.0 (note: 0 implies code <1, 29 implies code >28.9)	n/a	n/a
319	ISO Code Ch4	R	2 bytes	0 – 290 = code 0.0 – 29.0 (note: 0 implies code <1, 29 implies code >28.9)	n/a	n/a
320	NAS Class Ch2 – Ch3	R	2 bytes	-1 = Class 00, 0 – 12 = Class 0 - 12, 13 = Class >12	n/a	n/a
321	NAS Class Ch3 – Ch4	R	2 bytes	-1 = Class 00, 0 – 12 = Class 0 - 12, 13 = Class >12	n/a	n/a
322	SAE Class Ch1	R	2 bytes	-2 = Class 000, -1 = Class 00, 0 – 12 = Class 0 - 12, 13 = Class >12	n/a	n/a
323	SAE Class Ch2	R	2 bytes	-2 = Class 000, -1 = Class 00, 0 – 12 = Class 0 - 12, 13 = Class >12	n/a	n/a
324	SAE Class Ch3	R	2 bytes	-2 = Class 000, -1 = Class 00, 0 – 12 = Class 0 - 12, 13 = Class >12	n/a	n/a
325	SAE Class Ch4	R	2 bytes	-2 = Class 000, -1 = Class 00, 0 – 12 = Class 0 - 12, 13 = Class >12	n/a	n/a

326	Temperature	R	2 bytes	-30 - 99.9℃, 1-digit implied decimal	n/a	n/a
327-399	Expansion	n/a	n/a	n/a	n/a	n/a

Miscellaneous Functions Block (Registers 1100 - 1199)						
Reg #	**Parameter**	**Read/ Write/ Protected**	**Number of Bytes**	**Data Description**	**Data Default**	**Data Write Range**
1100	For Factory Use only	n/a	2 bytes	Not Used	n/a	n/a
1101	Instrument Reset	W	2 bytes	0x55 forces instrument reset (Note: no MODBUS response for this command)	n/a	0x55
1102	Save Settings	W	2 bytes	0x5A saves user data within Configuration block section	n/a	0x5A
1103-1199	Expansion	n/a	n/a	n/a	n/a	n/a

Sample Status Alarm Bit Wise Map (See Registers 306 - 307)			
BIT #	**Parameter**	**Active Alarm Condition**	**Comments**
0	Laser Current Low	Set when <30mA	Laser Diode Current
1	Laser Current High	Set when >73mA	
2	Photo Diode Power Low	Set when <4.50V	Received Photo Power
3	Photo Diode Power High	Set when >4.90V	
4	Temperature Low	Set when <-10.0℃	Filtertechnik Internal Temp
5	Temperature High	Set when >60℃	
6	Concentration Low	Set when channel 1 ISO code <5.0	Particle Concentration/ml
7	Concentration High	Set when channel 1 ISO code >=29	
8	Channel 1 Alarm	Set when selected cleanliness code has been meet	See registers #107, 108, & 110-113
9	Channel 2 Alarm	Set when selected cleanliness code has been meet	See registers #107, 108, & 110-113
10	Channel 3 Alarm	Set when selected cleanliness code has been meet	See registers #107, 108, & 110-113
11	Channel 4 Alarm	Set when selected cleanliness code has been meet	See registers #107, 108, & 110-113
12	Reserved		
13	Reserved		
14	Reserved		
15	Reserved		
16	Reserved		
17	Reserved		
18	Reserved		
19	Reserved		
20	Reserved		
21	Reserved		
22	Reserved		

23	Reserved		
24	Reserved		
25	Reserved		
26	Reserved		
27	Reserved		
28	Reserved		
29	Reserved		
30	Reserved		
31	Reserved		
	Bits set to 1 indicate an alarm condition for that corresponding bit. For example, a status value of 2 decimal (binary 10) indicates a Laser Current High alarm. A value of 320 (binary 101000000) indicates a Concentration Low and Channel 1 alarm.		

MODBUS Exception Codes Used			
Code #	**Exception Type**	**Description**	**Comments**
01	ILLEGAL FUNCTION	The function code received in the query is not an allowable action for the Filtertechnik.	
02	ILLEGAL DATA ADDRESS	The data address received in the query is not an allowable address for the Filtertechnik.	
03	ILLEGAL DATA VALUE	A value contained in the query data field is not an allowable value for the Filtertechnik.	