Agilent

Rough Pump Communications Guide (RS-232/RS-485/USB)

Addendum

Notices

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WARNING

A **WARNING** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Contents

Validity

This addendum lists a minimum set of information necessary to understand the operations of the Rough Pump Communications.

Window Protocol Description

Communication Format

- 8 data bits
- no parity
- 1 stop bit
- baud rate: 9600 default, programmable from 600 to 38400 depending on model.

Communication Protocol

The communication protocol is a MASTER/MINION type where:

- Host PC/PLC/MCU = MASTER
- Inverter, Motor, or Pump = MINION.

The communication is performed in the following way:

1. The MASTER sends a COMMAND to the MINION.
2. The MINION returns a RESPONSE to the MASTER.

Byte Type Format:

1. ASCII character bytes are shown between quotes. Example: '3'
   ASCII control character bytes will be shown underlined in italics. Example: STX
2. Hex bytes are shown with the prefix 0x __ . Example: 0x03

Decimal bytes are shown as numerical values with no additional formatting. Example: 3

NOTE The Agilent Pump Serial Module is a Python-based library built for RS-232 and RS-485 serial communication and is available at Agilent.com, ready for use. This library is complete with documentation that can aid the programmer in understanding and implementing this protocol in their application.

Sending

The COMMAND is a byte string with the following format:

<STX>+<ADDR>+<WIN>+<COM>+<DATA>+<ETX>+<CRC>

Where:

- <STX> (Start of transmission) = *STX* = 0x02 = 2
- <ADDR> (Unit address) = 0x80 + device number (0 to 31)
  (For RS 232 the device number is always 0, so the <ADDR> is 0x80)
- <WIN> (Window) Similar to a resister or memory location.
  The three digit window number (from '000' to '999').
  Each digit encoded as an ASCII character.
  For the meaning of each window number see the specific pump manual.
- <COM> (Command type)
  To read from a window use '0' = 0x30 = 48
  To write into the window use '1' = 0x31 = 49
- <DATA>
  An ASCII string of the data to be written into the window.
  This field is not present when using a read command.

  The <DATA> field length and contents vary according to the data type as shown in the following table:

Table 1

Data Type	Field Length (Bytes)	Valid Characters
Logic (L)	1	'0' = FALSE '1' = TRUE
Numeric (N)	6	'-', '.', '0' . . . '9' right justified with '0'
Alphanumeric (A)	10 or greater	from blank to '_' (ASCII) left justified with space " "

- <ETX> (End of transmission) = *ETX* = 0x03 = 3
- <CRC> (Cyclic Redundancy Check) Is an XOR of all bytes from <ADDR> to <ETX>. The XOR result is first encoded to hexadecimal, then each of the two hex digits are sent as sperate ASCII characters.

  Example: XOR = 0xB3 -> CRC = "B" & "3" = 0x42 & 0x33 = 66 & 51.
  (**Note:** if Hex digits A-F are present, they **must be uppercase**).

Receiving

The addressed MINION will reply with a RESPONSE whose structure depends on the MASTER COMMAND command type (<COM>).

When the MASTER COMMAND <COM> is a read type ('0'), the MINION will reply by transmitting a RESPONSE byte string similar in structure to the COMMAND.

<STX>+<ADDR>+<WIN>+<COM>+<DATA>+<ETX>+<CRC>

Where the content and format of the <DATA> bytes depend on the type of data requested. See the table below.

When the MASTER COMMAND <COM> is a write type ('1'), or if an error is encountered, the MINION will reply with a simplified RESPONSE byte string. The <WIN> & <COM> fields are removed, and the <REPLY> field is a single byte.

<STX>+<ADDR>+<REPLY>+<ETX>+<CRC>

This simplified RESPONSE format can be recognized by its short 6 byte length.

After a successful write command, the <REPLY> is an acknowledgment = *ACK* = 0x06 = 6.

If the MASTER COMMAND was invalid, the MINION will provide a simplified RESPONSE, with the <REPLY> byte corresponding to the encountered error as seen in the table below.

Table 2

Response Type	Response Length	Response Value	Description
Logic	1 byte	-	After a read command of a logic window
Numeric	6 bytes	-	After a read command of a numeric window
Alphanumeric	10 or greater bytes	-	After a read command of an alphanumeric window
ACK	1 byte	(0x6)	The command execution has been successfully completed
NACK	1 byte	(0x15)	The command execution has been failed
Unknown Window	1 byte	(0x32)	The specified window in the command is not a valid window
Data Type Error	1 byte	(0x33)	The data type specified in the command (Logic, Numeric or Alphanumeric) is not accorded with the specified Window
Out of Range	1 byte	(0x34)	The value expressed during a write command is out of range value of the specified window
Win Disabled	1 byte	(0x35)	The specified window is Read Only or temporarily disabled (for example) you can't write the Soft Start when the Pump is running)

Examples

Example 1: Start the pump

Pump address: 0
Window: "000" (Start/Stop)
Command Type: Write
Data: '1' to start (Logic data type)

MESSAGE Byte String					CRC XOR	
Byte Field	ASCII	HEX	DEC	BIN	BIN XOR	HEX XOR
<STX>	*STX*	0x02	2	00000010	Not Used	
<ADDR>	*N/A*	0x80	128	10000000	10000000	
<WIN>1	'0'	0x30	48	00110000	10110000	
<WIN>2	'0'	0x30	48	00110000	10000000	
<WIN>3	'0'	0x30	48	00110000	10110000	
<COM>	'1'	0x31	49	00110001	10000001	
<DATA>	'1'	0x31	49	00110001	10110000	
<ETX>	*ETX*	0x03	3	00000011	10110011	0xB3
<CRC> 1	'B'	0x38	56	00111000		
<CRC> 2	'3'	0x35	53	00110101		

Step-by-step COMMAND construction

<STX> The COMMAND begins with an ASCII "start of transmission" byte.
<STX> = *STX* = 0x02 = 2.

<ADDR> In this example the pump address is 0, so the <ADDR>= is 0x80+ 0.
<ADDR> = 0x80= 128

<WIN> In this example the Start/Stop window is 0. This would be found in the specific pump manual. The <WIN> field is three ASCII digits, right justified with leading zeros. In this case, <WIN> = '0', '0', '0' =0x30, 0x30, 0x30 = 48, 48, 48.

<COM> This example is writing a value to a window, so the write command
<COM> = 0x31 = "1" = 49, is used.

<DATA> The start/stop window will accept a logical '1' or '0' to start or stop the pump. Logic <DATA> is formatted as a single ASCII character byte. In this case a '1' to start the pump. <DATA> = '1' = 0x31 = 49.

<ETX> The COMMAND is ended with an ASCII "end of transmission" byte.
<ETX> = *ETX* = 0x03 = 3

<CRC> The two byte CRC is generated from the XOR of all bytes from the <ADDR> to <ETX>. The XOR is shown in the above table to the right of the divider. The XOR result is encoded to Hexadecimal, in this case 0xB3. The CRC is the ASCII character bytes for each Hexadecimal digit, in this case "B" and "3"

The resulting <CRC> is two bytes = 'B', '3' = 0x42, 0x33 = 66, 51.

Step by step RESPONSE deconstruction

The pump replies with an acknowledgement in the following format.

RESPONSE Byte String					CRC XOR	
Byte Field	ASCII	HEX	DEC	BIN	BIN XOR	HEX XOR
<STX>	*STX*	0x02	2	00000010	Not Used	
<ADDR>	*N/A*	0x80	128	10000000	10000000	
<REPLY>	*ACK*	0x06	6	00000110	10000110	
<ETX>	*ETX*	0x03	3	00000011	10000101	0x85
<CRC> 1	'8'	0x38	56	00111000		
<CRC> 2	'5'	0x35	53	00110101		

Reading the serial line

When reading the serial line, listen for the <STX> byte to begin recording the byte string. Continue recording bytes while listening for the <ETX> byte, signaling the end of the COMMAND. Then record the following two CRC bytes for comparison.

Note: If you're using a multi-address RS485 network, the <ADDR> address byte should be verified.

Verifying the CRC

When receiving a RESPONSE It is good practice to recompute the CRC and verify it against the received CRC. In this case the XOR from <ADDR> to <EXT> is 0x85, resulting in a CRC of the two ASCII characters '8', '5'. The recomputed CRC matches the received CRC, so it is safe to interpret the reply.

Extracting the Reply

Since the RESPONSE length is 6 bytes long, it is the simplified reply format. Reading the 3rd byte or removing the first two bytes (<STX>, <ADDR>), and the last three bytes (<ETX>, <CRC>1, <CRC>2) will Isolate the reply. In this case the <REPLY> is an acknowledgement = *ACK* = 0x06 = 6.

Example 2: Set Pump Speed

Pump address: 0
Window: "120" (Pump Speed (Hz))
Command Type: Write
Data: "60" (Numerical (Hz))

COMMAND Byte String					CRC XOR	
Byte Field	ASCII	HEX	DEC	BIN	BIN XOR	HEX XOR
<STX>	*STX*	0x02	2	00000010	Not Used	
<ADDR>	*N/A*	0x80	128	10000000	10000000	
<WIN>1	'1'	0x31	49	00110001	10110001	
<WIN>2	'2'	0x32	50	00110010	10000011	
<WIN>3	'0'	0x30	48	00110000	10110011	
<COM>	'1'	0x31	49	00110001	10000010	
<DATA>1	'0'	0x30	48	00110000	10110010	
<DATA>2	'0'	0x30	48	00110000	10000010	
<DATA>3	'0'	0x30	48	00110000	10110010	
<DATA>4	'0'	0x30	48	00110000	10000010	
<DATA>5	'6'	0x36	54	00110110	10110100	
<DATA>6	'0'	0x30	48	00110000	10000100	
<ETX>	*ETX*	0x03	3	00000011	10000111	0x87
<CRC> 1	'8'	0x38	56	00111000		
<CRC> 2	'7'	0x37	55	00110111		

Step by step COMMAND construction

<STX> The COMMAND begins with the ASCII "start of transmission" byte.
<STX> = *STX* = 0x02 = 2.
<ADDR> In this example the pump address is 0, so the <ADDR> is 0x80+ 0 = 0x80.

<WIN> In this example the "target speed" window is 120. This would be found in the specific pump manual. The <WIN> field is three ASCII digits, right justified with leading zeros. In this case <WIN> = '1', '2', '0' =0x31, 0x32, 0x30 = 49, 50, 48.

<COM> This example is writing a value to the window, so the write command <COM> = 0x31 = "1" = 49 is used.

<DATA> Since numerical data is being sent, the field needs to be formatted to 6 bytes long, right justified, padded with '0's. In this case we are sending a 60Hz command so our <DATA> byte string would be '000060'.

<ETX> The COMMAND is ended with the ASCII "end of transmission" byte.
<ETX> = *ETX* = 0x03 = 3

<CRC> The two byte CRC is generated from the XOR of all bytes from <ADDR> to <ETX>. The XOR is shown in the above table, to the right of the divider. The XOR result is encoded to Hexadecimal, in this case 0x87. The CRC is the ASCII character bytes for each Hexadecimal digit, in this case "8" and "7"
The resulting <CRC> is two bytes = '8', '7' = 0x38, 0x37 = 56, 55.

Pump RESPONSE

The pump replies with an acknowledgement in the following format.

RESPONSE Byte String					CRC XOR	
Byte Field	ASCII	HEX	DEC	BIN	BIN XOR	HEX XOR
<STX>	*STX*	0x02	2	00000010	Not Used	
<ADDR>	*N/A*	0x80	128	10000000	10000000	
<REPLY>	*ACK*	0x06	6	00000110	10000110	
<ETX>	*ETX*	0x03	3	00000011	10000101	0x85
<CRC> 1	'8'	0x38	56	00111000		
<CRC> 2	'5'	0x35	53	00110101		

This is the same response as Example 1, see that example for the step-by-step deconstruction.

Example 3: Read the pump's onboard pressure gauge

Pump address: 0

Window: "224" (Gauge Pressure)

Command Type: Read

Expected Data: Alphanumerical Scientific Notation ('X.XXE±XX ')

COMMAND Byte String					CRC XOR	
Byte Field	ASCII	HEX	DEC	BIN	BIN XOR	HEX XOR
<STX>	*STX*	0x02	2	00000010	Not Used	
<ADDR>	*N/A*	0x80	128	10000000	10000000	
<WIN>1	'2'	0x32	50	00110010	10110010	
<WIN>2	'2'	0x32	50	00110010	10000000	
<WIN>3	'4'	0x34	52	00110100	10110100	
<COM>	'0'	0x30	48	00110000	10000100	
<ETX>	*ETX*	0x03	3	00000011	10000111	0x87
<CRC> 1	'8'	0x38	56	00111000		
<CRC> 2	'7'	0x35	53	00110101		

Step by step COMMAND construction

<STX> The COMMAND begins with the ASCII "start of transmission" byte.
<STX> = *STX* = 0x02 = 2.

<ADDR> In this example the pump address is 0, so the <ADDR> is 0x80+ 0 = 0x80

<WIN> In this example the pump pressure gauge window is 224. This would be found in the specific pump manual. The <WIN> field is three ASCII digits, right justified with leading zeros. In this case <WIN> = '2', '2', '4' =0x32, 0x32, 0x34 = 50, 50, 52.

<COM> This example is reading the data from a window, so the read command, <COM> = "0"=0x30 = 49 is used.

<DATA> Since this is a read command no <DATA> bytes are sent.

<ETX> The COMMAND is ended with the ASCII "end of transmission" byte.
<ETX> = *ETX* = 0x03 = 3

<CRC> The two byte CRC is generated from the XOR of all bytes from <ADDR> to <ETX>. The XOR is shown in the above table, to the right of the divider. The XOR result is encoded to Hexadecimal, in this case 0x87. The CRC is the ASCII character bytes for each Hexadecimal digit, in this case “8” and “7”

The resulting <CRC> is two bytes = ‘8’, ‘7’ = 0x38, 0x37 = 56, 55.

Step by step RESPONSE deconstruction

The pump responds with the following RESPONSE.

RESPONSE Byte String					CRC XOR	
Byte Field	ASCII	HEX	DEC	BIN	BIN XOR	HEX XOR
<STX>	*STX*	0x02	2	00000010	Not Used	
<ADDR>	*N/A*	0x80	128	10000000	10000000	
<WIN>1	'2'	0x32	50	00110010	10110010	
<WIN>2	'2'	0x32	50	00110010	10000000	
<WIN>3	'4'	0x34	52	00110100	10110100	
<COM>	'0'	0x30	48	00110000	10000100	
<DATA>1	'3'	0x33	51	00110011	10110111	
<DATA>2	'.'	0x2E	46	00101110	10011001	
<DATA>3	'6'	0x36	54	00110110	10101111	
<DATA>4	'5'	0x35	53	00110101	10011010	
<DATA>5	'E'	0x45	69	01000101	11011111	
<DATA>6	'-'	0x2D	45	00101101	11110010	
<DATA>7	'0'	0x30	48	00110000	11000010	
<DATA>8	'3'	0x33	51	00110011	11110001	
<DATA>9	' '	0x20	32	00100000	11010001	
<DATA>10	' '	0x20	32	00100000	11110001	
<DATA>11	' '	0x20	32	00100000	11010001	
<ETX>	*ETX*	0x03	3	00000011	11010010	0xD2
<CRC> 1	'D'	0x44	68	01000100		
<CRC> 2	'2'	0x32	50	00110010		

Reading the serial and CRC validation

See Example #1.

Since this RESPONSE is greater than 6 bytes, it is the full-length standard format.

Confirming the Window (optional)

In a full length RESPONSE, bytes 3, 4, & 5 should contain the same window number as the requested read window. In this case the received window '224' matches the requested window 224.

Extracting the Reply

Removing the first five bytes (<STX>, <ADDR>, <WIN>1, <WIN>2, <WIN>3, <COM>), and the last three bytes (<ETX>, <CRC>1, <CRC>2) will Isolate the <DATA>. Since the remaining <DATA> is 11 bytes long, it is an alphanumeric data type (>=10 bytes). The expected format is ASCII characters, left justified with spaces.

The isolated <DATA> ASCII byte string reads '3.65E-03 '

In this case it is gauge pressure in scientific notation. A separate window typically controls the reported pressure units. See the specific pump manual for more details.

Common Pitfalls

1. No response – Verify Serial/Baud rate settings
2. Python's default Hex literal output is lower case. The CRC must use capital ASCII Characters for the HEX digits.
   If the CRC uses Lowercase ASCII letters, you will get a simplified RESPONSE with <REPLY> = *NACK* = 0x15 = 21.
3. Since the RESPONSE lengths vary significantly by data type, and there is no line terminator, typical serial read line functions will timeout. Seeking the *ETX* character is a more responsive way to read the serial RESPONSE.

NOTE Python Library for WIN Protocol exists on Agilent.com.

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- Rough Pump Communications Guide

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