Terminator™ ECM Controller

ECM DCS Communication Guide

Thermon, Inc.

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Contents

1 Modbus RTU Communication Protocol

The Terminator ECM module uses the MODBUS RTU (Receiver/Transmitter Unit) Communications Protocol over a serial connection RS485. The ECM is considered a slave device for MODBUS. When setting up the ECM to communicate to a master device (likely a desktop computer), it is important that both the master device and the slave device are using the MODBUS RTU protocol (Figure 1). If the master device does not use the MODBUS RTU Protocol then a protocol conversion device must be used.

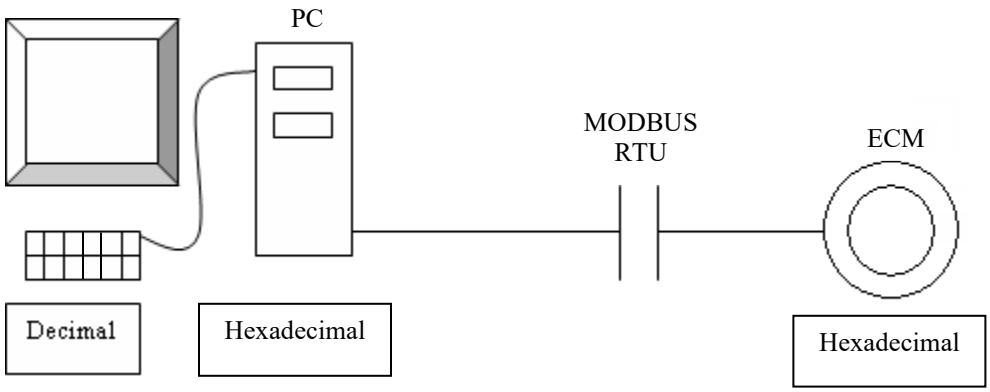

Figure 1. Conceptual block diagram of MODBUS RTU hexadecimal communication from master device to slave device with data displayed to user in decimal format.

The MODBUS RTU Protocol's message data is in hexadecimal format (i.e. raw unconverted binary) which is unlike that of the ASCII Protocol which converts the hexadecimal data into ASCII format. The frame for the RTU message is 8 bytes long for read requests, write requests, and write replies. Messages can be longer than 8 bytes for read replies if more than one register is requested. Figure 2 is an example of a read request, and Figure 3 is an example of a write request for MODBUS RTU.

	1	2	3	4	5	6	7	8
3.5 Characters	0x01	0x04	0x00	0x0D	0x00	0x01	0xYZ	0xWX
Start Message Silent Interval	Controller Address	Function Code	Memory Location or Register		Number of Memory Locations to Read		CRC Lo Byte	CRC Hi Byte

Figure 2. MODBUS RTU Read Request for ECM "Present Controller RTD Temperature" memory location.

MODBUS RTU bytes are sent consecutively with no space in between them. However, there is at least a 3-1/2 character space silent interval or pause between each RTU message frame sent. This allows the master or slave device to know when a new message is starting.

Baud rate = 9600 bps
Data bits = 8
Parity = None
Stop bits = 1
Flow control = None
Delay between Polls = 500 ms (minimum)

	1	2	3	4	5	6	7	8
3.5 Characters	0x01	0x06	0x00	0x04	0x00	0x00	0xYZ	0xWX
Start Message Silent Interval	Controller Address	Function Code	Memory Location or Register		Value to be written		CRC Lo Byte	CRC Hi Byte

Figure 3. MODBUS RTU Write Request for ECM "Reset Controller Module" memory location or register to hold 0x0000 which is required to cause the Controller to reset.

The 8 byte RTU message frame ends with two error checking bytes called a CRC or Cyclic Redundancy Check. The CRC resides in the final two bytes of the message frame and is calculated for the hexadecimal bytes of the RTU message up to and not including two CRC bytes. For the RTU message example in Figure 3, the CRC is calculated from the first 6 bytes 0x010600040000 with the calculated CRC of 0xWXYZ residing in byte 7 and byte 8 of the MODBUS RTU frame where byte 7 is the low byte 0xYZ of the CRC and byte 8 is the high byte 0xWX of the CRC.

	1	2	3	4	5	6	7	8
3.5 Characters	0x01	0x04	0x00	0x01	0x00	0x29	0xYZ	0xWX
Start Message Silent Interval	Controller Address	Function Code	Memory Location or Register		Number of Memory Locations to Read		CRC Lo Byte	CRC Hi Byte

Figure 4. MODBUS RTU Read Request for multiple memory locations or registers of ECM Controller.

To request reads of more than one memory location or register, an 8 byte RTU message frame must be sent that includes the starting memory location and the number of memory locations to be read. The example RTU frame in Figure 4 would perform a multiple memory location read request for 41 memory locations starting at 0x0001, the lowest two bytes of "Operational Time in Minutes", and ending at 0x0029, "Limiter Reset Position". A reply from Figure 4's read request can be seen in Figure 5. Note that a multiple memory location read request is limited to 127 of the 16 bit data locations or registers (equivalent to 254 bytes of data).

	1	2	3	4	5
3.5 Characters	0x01	0x04	0x52	0x0D	0xAC
Start Message Silent Interval	Controller Address	Function Code	Byte Count	Data#1 Hi Byte	Data#1 Lo Byte

6	7	8	9	10	11	12	13
0x00	0x64	0x00	0x64	0x00	0x3C	0x00	0x00
Data#2 Hi Byte	Data#2 Lo Byte	Data#3 Hi Byte	Data#3 Lo Byte	Data#4 Hi Byte	Data#4 Lo Byte	Data#5 Hi Byte	Data#5 Lo Byte

14	15	…	…	84	85	86	87
0x00	0x28	…	…	0x00	0x01	0xYZ	0xWX
Data#6 Hi Byte	Data#6 Lo Byte	…	…	Data#41 Hi Byte	Data#41 Lo Byte	CRC Lo Byte	CRC Hi Byte

Figure 5. MODBUS RTU Read Reply to Figure 4 Read Request for multiple memory locations or registers of ECM.

The read reply for multiple memory locations or registers seen in Figure 5 is a 87 byte message. The 3rd byte of this message is the Byte Count which gives you how many Data Bytes are returned (in this case it is 82). The returned Data Registers #1 to #41 (each two bytes in size) correspond to the first 41 contiguous blocks of 2 byte memory locations that were read from the ECM module.

2 Modbus Memory Map for the ECM Module

The Terminator ECM Module's memory can be accessed using the MODBUS RTU protocol over serial RS485. The memory map for this memory access is described in this section and referenced in the Settings tables. The term "memory location" in this guide should be construed as equivalent to the Modbus protocol term "register."

MODBUS read and write requests require a 16 bit data address to be referenced. The limits of the data address references in a MODBUS message are from 0 to 9998 or 0x0000 to 0x270E. The data address range corresponds to either a read-only Function 04 Analog Input Registers 30001 to 39999 or the read/write Function 03/06 Analog Output Holding Registers 40001 to 49999. For the ECM, the range of all possible memory reference calls using MODBUS read and write requests is shown as follows:

Function 04 Read-Only (0x0001 to 0x0029)

0x0001 to 0x000B are for ECM Global Settings
0x000C to 0x001A are for ECM Controller Settings
0x001B to 0x0029 are for ECM Limiter Settings

Function 06 Writes (various locations 0x0001 to 0x0001F)

0x0001 to 0x0003 are for ECM Global Settings
0x0004 & 0x000F to 0x0012 for ECM Controller Settings
0x0005, 0x001E to 0x0020 for ECM Limiter Settings

The ECM only allows MODBUS 04 reads and 06 writes. The ECM Controller, Limiter, and Global Settings tables which follow describe the ECM memory map in more detail.

All memory location addresses as well as all data lengths are two bytes or 16 bits.

Some DCS systems automatically put in an offset of plus or minus one for the memory location. As such, the memory locations should be checked against a known value to establish the automatic offset value.

ECM Global Settings				
Function Code(s)	**Base Mem Location or Register**		**Description**	**Allowed Values**
	Hex	Decimal		
04	0x0001	1	Operational Time in Minutes (0 to 16777215 max, *approx. 31.9 years*)	Lowest 16 bits of 24 bit minute count
04	0x0002	2		Low Byte only: Highest 8 bits of 24 bit minute count
04	0x0003	3	Date of Last Calibration	Low Byte: Last 2 digits of Year (0 to 99); High Byte: Month (1 to 12)
04	0x0004	4		Low Byte only: Day (1 to 31)
04	0x0005	5	Revision Number	Low Byte: Major Software Revision High Byte: Minor Software Revision
04	0x0006	6		Low Byte only: Hardware Revision
04	0x0007	7	ECM Module Settings	Low Byte only: ECM Module Settings[(1)]
04	0x0008	8	Serial Number	0 to 65535 max
04	0x0009	9	Modbus Slave Address	1 to 247
04	0x000A	10	Temperature Unit	0 = °F; 1 = °C
04	0x000B	11	Internal High Temperature Trip[(2)]	(0 to 85°C) or (32 to 185°F)
06	0x0001	1	Modbus Slave Address Change Enable	Write 0x1818 to Enable (must write to Slave Address on next Modbus message)
06	0x0002	2	Modbus Slave Address	Write 1 to 247 (clears change enable after write)
06	0x0003	3	Clear Software System Fault	Write 0x0000 to clear

[(1)] **ECM Module Settings –** Reference the lower byte bits 8765 4321, where 8 is MSB and 1 is LSB (below, the X's in the Binary Code are don't cares)**:**

	Binary Code	Settings Based on Binary Code
ECM Type, top two bits 8 and 7:	11XX XXXX	CL, Controller/Limiter Type
	10XX XXXX	L, Limiter Type
	01XX XXXX	C, Controller Type
Communication, bits 6 and 5:	XX11 XXXX	4-20mA Communication
	XX10 XXXX	CAN Bus Communication
	XX01 XXXX	RS485 Serial Communication
	XX00 XXXX	No communication interface
Voltage, bits 4 and 3:	XXXX 10XX	230V Supply Voltage
	XXXX 01XX	120V Supply Voltage
Relay Board, bottom two bits 2 and 1:	XXXX XX10	Dual Pole Relay Board
	XXXX XX01	Single Pole Relay Board

[(2)] **Internal High Temperature Reset Condition –** Assuming the Control and/or Limiter Relays have tripped due to reaching the Internal High Temperature Trip temperature, the Control and/or Limiter Relays close based on negative hysteresis control in which this condition has been reached (Internal Control Band = 5°C or 9°F):

Internal NTC Thermistor Temperature <= Internal High Temperature Trip - Internal Control Band

ECM Controller Settings				
Function Code(s)	**Base Mem Location or Register**		**Description**	**Allowed Values**
	Hex	Decimal		
04	0x000C	12	Controller Data Base Type[3]	Low Byte only: 0xFF = Factory default 0x01 = Thermon GUI default 0x0A = Thermon GUI custom 0x0B = Modbus RTU custom
04	0x000D	13	Present Controller RTD Temperature	(-60 to 500°C) or (-76 to 932°F)
04	0x000E	14	Maintain Temperature	(0 to 500°C) or (32 to 932°F)
04/06	0x000F	15	Control Band Type	0 = %; 1 = Offset
04/06	0x0010	16	Control Band	Offset:(3 to 100°C) or (5 to 180°F) %: (1 to 100%)
04/06	0x0011	17	Alarm Band	Offset:(3 to 100°C) or (5 to 180°F) %: (1 to 100%) 0 = Disable Low Temperature Alarm
04/06	0x0012	18	Highest Temperature Seen	(-60 to 500°C) or (-76 to 932°F) 1= Reset Highest Temperature Seen
04	0x0013	19	Status of Controller Alarm Relay	0 = Controller Alarm Relay Open, 1 = Controller Alarm Relay Closed
04	0x0014	20	Status of Controller Relay	0 = Controller Relay Open; 1 = Controller Relay Closed
04	0x0015	21	Present Controller Fault	Low Byte only: See Fault Code Settings[4]
04	0x0016	22	Total Number of Controller Faults	0 to 65535 max
04	0x0017	23	Number of Times Controller Relay Switched	Highest 16 bits of 32 bit count
04	0x0018	24		Lowest 16 bits of 32 bit count
04	0x0019	25	Number of Times Controller Alarm Relay Switched	Highest 16 bits of 32 bit count
04	0x001A	26		Lowest 16 bits of 32 bit count
06	0x0004	4	Reset Controller Module	Write 0x0000 to reset

[3] **Data Base Type -** Represents the profile type for important configuration parameters such as: Max Internal Circuit Temperature at which the module should de-Energize the relays, delays associated with the control and the alarm relays, etc.

ECM Limiter Settings				
Function Code(s)	**Base Mem Location or Register**		**Description**	**Allowed Values**
	Hex	Decimal		
04	0x001B	27	Limiter Data Base Type[3]	Low Byte only: 0xFF = Factory default 0x01 = Thermon GUI default 0x0A = Thermon GUI custom 0x0B = Modbus RTU custom
04	0x001C	28	Present Limiter RTD Temperature	(-60 to 500°C) or (-76 to 932°F)
04	0x001D	29	Limiter High Temperature Trip[5]	(0 to 500°C) or (32 to 932°F)
04/06	0x001E	30	Limiter Control Band Type	0 = %; 1 = Offset
04/06	0x001F	31	Limiter Control Band[5]	Offset:(3 to 100°C) or (5 to 180°F) %: (1 to 100%)
04/06	0x0020	32	Highest Temperature Seen	(-60 to 500°C) or (-76 to 932°F) 1= Reset Highest Temperature Seen
04	0x0021	33	Status of Limiter Alarm Relay	0 = Limiter Alarm Relay Open, 1 = Limiter Alarm Relay Closed
04	0x0022	34	Status of Limiter Relay	0 = Limiter Relay Open, 1 = Limiter Relay Closed
04	0x0023	35	Present Limiter Fault	Low Byte only: See Fault Code Settings[4]
04	0x0024	36	Total Num of Limiter Faults	0 to 65535 max
04	0x0025	37	Number of Times Limiter Relay Switched	Highest 16 bits of 32 bit count
04	0x0026	38		Lowest 16 bits of 32 bit count
04	0x0027	39	Number of Times Limiter Alarm Relay Switched	Highest 16 bits of 32 bit count
04	0x0028	40		Lowest 16 bits of 32 bit count
04	0x0029	41	Limiter Reset Position	0 = Auto[5]; 1 or 2 = Manual
06	0x0005	5	Reset Limiter Module	Write 0x0000 to reset

[4] Fault Code Settings (for low data byte only)**:**

The Fault Code can be computed from a column 3 entry in combination with a column 4 or 5 header for a given fault type (e.g. for an RTD Limiter Fault that is a short, it is computed from 0x3? + 0x?2 to be 0x32)**.**

ECM Type	Fault Type	Fault Code	0x?1	0x?2
C/L/CL	System Fault	**0x1?**	Software	Communication
C/CL	RTD Controller Fault	**0x2?**	Open	Short
L/CL	RTD Limiter Fault	**0x3?**	Open	Short
C/CL	Invalid Maintain Temperature	**0x4?**	< Min	> Max
L/CL	Invalid High Temperature Trip 1	**0x5?**	< Min	> Max
CL	Invalid High Temperature Trip 2	**0x6?**	< Maint Temp	-
C/CL	High/Low Temperature Alarm	**0x7?**	-	Controller
L/CL	High Temperature Trip	**0x8?**	Internal	Limiter
C/L/CL	Low Voltage Fault	**0x9?**	-	Low Voltage

[5] Limiter Reset Condition – Assuming the Limiter Reset Position is set to Auto and the Limiter Relay has tripped due to reaching the High Temperature Trip temperature, the Limiter Relay will close based on negative hysteresis control in which this condition has been reached:

Present Limiter RTD Temperature <= Limiter High Temperature Trip - Limiter Control Band

3 Help

Help Information

The DCS communications interface is intended to be used with the support of this instruction guide, the specific control module operating guide, and the specific DCS system operating manuals applicable. If special support needs do arise, Thermon provides local support through its area representatives and affiliate companies as well as through a toll free user support line.

For support dial 1-800-820-HEAT.

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