
7.1 DESCRIPTION

This chapter describes the functional specifications of the Modicon Modbus protocol for interface module for the Microprocessor Distribution Protection (MDP Relay) Digital Time Overcurrent Relaying System. The specifications cover Modicon Modbus application messages supported by the MDP interface software module. The objective is to move the MDP relay from communicating through a concentrator to direct connection to Modbus. The MDP direct interface should provide all the same functions as were implemented using the concentrator interface, with the addition of breaker control.

Additional information on the Modbus protocol can be found at www.modbus.org.

7.2 OVERVIEW

The Modicon Modbus interface module allows the MDP to communicate with the Power Leader Distribution Software (PLDS) running on a host computer via Modbus. The Modbus interface card is built into the MDP relay unit and communicates with the relay via a TTL level serial asynchronous protocol. The Modbus interface card does not provide any LED display or key switches as provided for other devices. The MDP relay provides the user interface. The Modbus device address for the MDP unit is configurable from the switches provided on the MDP relay itself; the specified address is read by the Modbus interface module using the serial protocol. The baud rate for serial communication is internally fixed at 2400 baud and is not configurable by the user. The Modbus card can be configured externally for the following baud rates: 1200, 2400, 9600, and 19200 baud.

The Modbus interface module provides the protocol conversions required to allow full operability on a Power Leader network.

7.3 MODBUS COMMANDS

The Modbus interface module provides the commands described below. Although some of the standard commands are specified in the Modicon Modbus reference guide PI-MBUS-300 REV.E (see www.modbus.org for additional information), they are described here for the sake of completeness.

a) READ HOLDING REGISTERS, FUNCTION CODE 03

Modbus description: Reads the binary contents of the MDP holding registers. Broadcast is not supported.

The following MDP registers are available to read: Unit ID/Modbus address, Setpoint parameters, COC software version, Product revision, and MDP software revision.

- **QUERY:** The query message specifies the starting register and quantity of registers to be read. Registers are addressed starting at zero; i.e., registers 1 to 16 are addressed as 0 to 15.
- **RESPONSE:** The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

Data is scanned in the slave at the rate of 125 register per scan each register contains two bytes.

b) READ INPUT REGISTERS, FUNCTION CODE 04

Modbus Description: Reads the binary contents of the input registers in the MDP relay.

The actual values available on the MDP are: Relay Status, Phase currents, Ground currents, Phase Trip currents, ground trip currents, and trip time.

- **QUERY:** The query message specifies the starting register and the quantity of the registers to be read. Registers are addressed starting at zero; i.e., registers 1 to 16 are addressed as 0 to 15
- **RESPONSE:** The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register the first byte contains the high order bits and the second contains the low order bits.

Data is scanned in the MDP at a rate of 125 registers per scan. In response to this command from Host the module will send back the latest actual value data stored in the MDP, these values will be periodically read by the module from the MDP relay.

c) FORCE SINGLE COIL: FUNCTION CODE 05

Modbus description: Forces a single coil (OX reference) to either ON or OFF. When broadcast, the function forces the same coil reference in all attached slaves.

MDP function to force: Breaker trip and breaker close.

- **QUERY:** The query message specifies the coil reference to be forced. Coils are addressed starting at zero: coil 1 is addressed as 0. The request ON/OFF state is specified by a constant in the query data field. A value of FF00 hex requests the coil to be ON. A value of 0000 requests it to be OFF. All other values are illegal and will not affect the coil.
- **RESPONSE:** The normal response is an echo of the query, returned after the coil state has been forced.

7.4 MODBUS MEMORY MAP

Table 7–1: MODBUS MEMORY MAP (Sheet 1 of 4)

REGISTER	CONTENTS	RANGE	TYPE R/W	FORMAT CODE	BYTES	COMMNET COMMAND
FIXED VALUE INPUT REGISTERS (READ HOLDING REGISTERS)						
0000	Product ID	13h	RO	Unsigned Integer	1	80/01/01h
0001	Not assigned	0	RO	Unsigned Integer	1	
0002	Commnet Address	N/A	RO	Unsigned Integer	1	
0003	Modbus Address	N/A	RO	Unsigned Integer	1	
0004	COC Software Version	N/A	RO	Float4 digit BCD with decimal between 2nd & 3rd digits	2	80/74/14h
0006	Model	N/A	RO	Unsigned Integer 00h:1 A; 01h: 5 A	1	80/02/00h
0007	Ground Settings Scale	00h to 03h		Unsigned Integer 00h: Nominal, 01h: divide by 2 02h: Multiply by 3, 03h: Divide by 5	1	80/02/00h
0008	Product Revision	0.00 to 99.99	RO	4 digit BCD with decimal between 2nd and 3rd digits	2	80/01/05-06h
0010	MDP Software Revision	0.00 to 99.99	RO	4 digit BCD with decimal between 2nd and 3rd digits	2	80/01/02-03h
DYNAMIC VALUE INPUT REGISTERS						
1000	Number of pending events	0 to 24	RO	Integer	1	
1001	LED Status	0000h to 00FFh	RO	A bit set to 1 indicates the corresponding LED is ON b0: Ready, b1: Phase A, b2: Phase B, b3: Phase C, b4: Ground, b5: TOC Trip, b6: IOC Trip, b7: Pickup	1	80/74/00h
1002	Hardware Status	0000 to 008Fh	RO	b0: Breaker Status (1 = Open, 0 = Closed) b1: External Input, Block Ground (1 = Active) b2: External Input, Block IOC (1 = Active) b3: Settings Status (1 = Settings changed but unentered), 0 = Settings Normal) b4: Undefined, b5: Undefined b6: Undefined b7: Relay Status (1 = Fatal Error, 0 = OK)	1	80/74/01h
1003	Phase A current	0 to 10 A (5 A relay) 0 to 2 A (1 A relay)	RO	Float	2	80/74/01-02h
1005	Phase B current	0 to 10 A (5 A relay) 0 to 2 A (1 A relay)	RO	Float	2	80/74/03-04h
1007	Phase C current	0 to 10 A (5 A relay) 0 to 2 A (1 A relay)	RO	Float	2	80/74/05-06h
1009	Ground current	0 to 3 A (5 A relay) 0 to 0.7 A (1 A relay)	RO	Float	2	80/74/07-08h

Table 7-1: MODBUS MEMORY MAP (Sheet 2 of 4)

REGISTER	CONTENTS	RANGE	TYPE R/W	FORMAT CODE	BYTES	COMMNET COMMAND
1011	Phase A trip current	0 to 10 A (5 A relay) 0 to 2 A (1 A relay)	RO	Float	2	80/74/09-0Ah
1013	Phase B trip current	0 to 10 A (5 A relay) 0 to 2 A (1 A relay)	RO	Float	2	80/74/0B-0Ch
1015	Phase C trip current	0 to 10 A (5 A relay) 0 to 2 A (1 A relay)	RO	Float	2	80/74/0D-0Eh
1017	Ground trip current	0 to 3 A (5 A relay) 0 to 0.7 A (1 A relay)	RO	Float	2	80/74/0F-10h
1019	Trip time	0 to 999.99 sec.	RO	Float	2	80/74/11-14h
1021	Breaker Status	00 to 01h	RO	Unsigned Integer 00h: Closed, 01h: Open	1	80/57/00h
1022	Relay Hardware Status	00 to 04h	RO	Unsigned Integer 00h: Relay is OK 01h: Relay not responding to read 02h: Relay not responding to write 03h: Command error reported 04h: Fatal error in Relay	1	80/57/03h
COMMNET COMMUNICATION STATISTICS REGISTERS						
1500	Device Status	N/A	RO	1 = ALIVE, 0 = DEAD	1	N/A
1501	Total Communication errors	N/A	RO	Unsigned Integer	1	N/A
1502	CRC Errors	N/A	RO	Unsigned Integer	1	N/A
1503	Transmit Failures	N/A	RO	Unsigned Integer	1	N/A
1504	Receive Time-out	N/A	RO	Unsigned Integer	1	N/A
1505	Receive Errors	N/A	RO	Unsigned Integer	1	N/A
EVENT REGISTERS						
2000	Event Code - EVENT 1	0 to 256	RO	Unsigned Integer	1	
2001	Hour	0 to 23 hrs.	RO	Unsigned Integer	1	
2002	Minute	0 to 59 min.	RO	Unsigned Integer	1	
2003	Seconds	0 to 59 sec.	RO	Unsigned Integer	1	
2004	Milliseconds	msecs	RO	Unsigned Integer	1	
2005	Event specific data 1				1	
2006	Event specific data 2				1	
2007	Event specific data 3				1	
2008	Event specific data 4				1	
2009	Event specific data 5				1	
2010	Event specific data 6				1	
2011	Event code - EVENT 2	0 to 256	RO	Unsigned Integer	1	
2012	Hour	0 to 23 hrs.	RO	Unsigned Integer	1	
2013	Minute	0 to 59 min.	RO	Unsigned Integer	1	
2014	Seconds	0 to 59 sec.	RO	Unsigned Integer	1	
2015	Milliseconds	msecs	RO	Unsigned Integer	1	

Table 7-1: MODBUS MEMORY MAP (Sheet 3 of 4)

REGISTER	CONTENTS	RANGE	TYPE R/W	FORMAT CODE	BYTES	COMMENT COMMAND
2016	Event specific data 1				1	
2017	Event specific data 2				1	
2018	Event specific data 3				1	
2019	Event specific data 4				1	
2020	Event specific data 5				1	
2021	Event specific data 6				1	
↓	↓	↓	↓	↓	↓	↓
2253	Event code - EVENT 24	0 to 256	RO	Unsigned Integer	1	
2254	Hour	0 to 23 hrs.	RO	Unsigned Integer	1	
2255	Minute	0 to 59 min.	RO	Unsigned Integer	1	
2256	Seconds	0 to 59 sec.	RO	Unsigned Integer	1	
2257	Milliseconds	msecs	RO	Unsigned Integer	1	
2258	Event specific data 1				1	
2259	Event specific data 2				1	
2260	Event specific data 3				1	
2261	Event specific data 4				1	
2262	Event specific data 5				1	
2263	Event specific data 6				1	
SETPOINT REGISTERS						
3000	Hour	0 to 23 hrs.	RW	Integer	1	N/A
3001	Minute	0 to 59 min.	RW	Integer	1	N/A
3002	Second	0 to 59 sec.	RW	Integer	1	N/A
3003	Password	N/A	RW	Integer	1	N/A
3004	Phase Curve Selection	00 to 04h	RO	Unsigned Integer 00h: Not used, 01h: Long Time Inverse 02h: Very Inverse, 03h:Extremely Inverse, 04h: Inverse	1	80/73/00h
3005	Phase Definite Time	sec.	RO	Float (set to 0 if not used)	2	80/73/00h
3007	Ground Curve Selection	00 to 04h	RO	Unsigned Integer 00h: Not used, 01h: Long Time Inverse 02h: Very Inverse 03h: Extremely Inverse, 04h: Inverse	1	80/73/00h
3008	Ground Definite Time	sec.	RO	Float (set to 0 if not used)	2	80/73/00h
3010	Output Selection	00 to 01h	RO	unsigned Integer (00h: A, 01h: B)	1	80/73/01h
3011	Ground Time Dial	0.5 to 10 (5 A relay) 0.05 to 1.0 (1 A relay)	RO	Float	2	80/73/02h
3013	Ground IOC Delay	0 to 1.55 sec.	RO	Float	2	80/73/02h
3015	Ground TOC pickup	0 to 4.375 A (5 A) 0 to 0.0875 A (1 A)	RO	Float	2	80/73/03h
3017	Ground IOC pickup	0 to 31 x TOC	RO	Float	2	80/73/03h

Table 7-1: MODBUS MEMORY MAP (Sheet 4 of 4)

REGISTER	CONTENTS	RANGE	TYPE R/W	FORMAT CODE	BYTES	COMMNET COMMAND
3019	Phase Time Dial	0.5 to 10 (5 A relay) 0.05 to 1.0 (1 A relay)	RO	Float	2	80/73/04h
3021	Phase IOC Delay	0 to 1.55 sec.	RO	Float	2	80/73/04h
3023	Phase TOC pickup	1.5 to 13.12 A (5 A) 0.3 to 2.625 A (1 A)	RO	Float	2	80/73/05h
3025	Phase IOC pickup	0 to 31 x TOC	RO	Float	2	0/73/05h

7.5 COIL COMMANDS

Table 7-2: COMMAND REGISTES (READ COIL STATUS)

COIL NUMBER	CONTENTS	MODBUS USAGE	COMMNET COMMAND
0	Reset an event	Force ON (FF00) to reset the event	80/58h
1	Trip breaker	Force ON (FF00) to trip the breaker	52h
2	Close breaker	Force ON (FF00) to close the breaker	53h

7.6 EVENT HANDLING

All asynchronous events are logged by the MDP. The most recent N (to be specified) events per device are available. The Concentrator stores the latest 24 events, this number was decided upon based on memory and timing constraints. Eleven registers are associated with each event. Events are stored in event registers in chronological order, EVENT 1 being the oldest event and EVENT n being the latest one. If there are more events than can be stored in the register map the oldest event is removed from the register map and rest of the event registers are shifted freeing the last set of event registers for the latest event.

'Number of active Events' indicates the unpolled events by the master. When there are no more unpolled events, the number of active events will be set to 0. The 'Number of active Events' register is stored at address 1000 in dynamic value registers.

Event registers are automatically cleared after the host reads them. Partially read events are not cleared. The number of Active Events register reflects unread events. If host does not read all the existing events, events registers are shifted to represent remaining events to be read by host.

The host may read event registers starting at any event register set boundary. Events registers following the event that was read will be shifted up. Events registers before the registers that are read will not be affected. Host requests to read event registers partially (e.g. only Event Code register) will be returned with an exception code.

Each status/event message is time stamped. Events will be stored in the same format for all devices. Event code register value 0 implies that there is no event in that register. One global event code table is maintained for all commnet devices. The event registers are shown in addresses 2000 to 2263 of the memory map.

Event specific data registers will be filled for the events which need to supply more data than just the event code. Event codes and their interpretation are listed in the table below:

Table 7–3: EVENT CODES

EVENT CODE	DESCRIPTION	MDP
00	No Event - Register is cleared.	✓
01	Remote command execution error	✓
02	Configuration change (80/56)	✓
03	Address conflict detected (80/56)	✓
04	General hardware failure	✓
05	Unknown event	✓
06	Device opened for a reason other than an event caused by the programmer	✓
07	Real energy cleared.	✗
08	Reactive energy cleared	✗
09	NVM failure (80/56)	✗
10	ROM failure (80/56)	✗
11	RAM failure (80/56)	✗
12	A/D converter failure (80/56)	✗
13	All voltages are OK. (80/50)	✗
14	Phase A-N voltage lost. (80/50)	✗
15	Phase B-N voltage lost. (80/50)	✗
73	Breaker status change	✓
74	EPROM checksum test failure	✓
75	Interface module not ready	✓
76	Communication error	✓
77	Relay is OK	✓
78	Relay is not responding to READ	✓
79	Relay is not responding to WRITE	✓
80	Relay reports an error	✓
81	Fatal error in relay	✓
82	Phase timed overcurrent trip	✓
83	Phase instantaneous overcurrent trip	✓
84	Ground timed overcurrent trip	✓
85	Ground instantaneous overcurrent trip	✓

