MP8000 Programming Guide

MODBUS TCP Software Development Guide

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MP8000

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MP8000 Programming Guide

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INTRODUCTION

This guide is addressed to systems integrators who will be developing software for a master device to communicate with the Model MP8000 product. The software developer is expected to have reasonable working knowledge (example: understanding what uint16_t Base 10.xx means) for writing programs.

NOTE: Littelfuse has developed a PC based program called MP8000 Software. It is available for free and should work for most applications.

The master device would typically be a Programmable Logic Controller (PLC) or a Personal Computer (PC) that will communicate with one or more slave devices. A PLC normally would have the command protocols built into it, so the programmer would not have to develop them. If programming a Personal Computer, these would have to be developed or find a library online that supports MODBUS TCP.

If programming a PC, it may be worth noting that it is the responsibility of the master controller to initiate communication. In other words, the master controller must be programmed to periodically poll the slave devices and initiate a request for data or to issue a command to the Model MP8000 to stop or reset the Model MP8000's control relay. When the Model MP8000 responds with the requested data or confirmation of the stop command, it is the responsibility of the master controller to determine if the information arrived correctly with no communication errors. If there are communication errors or if there is a time-out waiting for a response, it is the responsibility of the master controller to reissue the command to the slave device. If the response arrives correctly, the master controller is then required to further process the data to put it in a form suitable for viewing by an operator.

MODBUS TCP CONFIGURATION

Connecting to the MP8000

The RJ45 jack on the side of the MP8000 is the interface for MODBUS TCP. The user can access the MP8000 via a network or via a direct connection. Accessing the MP8000 via a network can be done by simply connecting a standard Ethernet cable between the network (switch/router) and the MP8000 RJ45 jack. Another way to connect via a network that has Wi-Fi is to use a low cost router (example: VONETS VAR11N-300 or similar).

To connect directly from a laptop to the MP8000, connect a standard Ethernet cable between the laptop and the MP8000 RJ45 jack. You will need to configure according to the instructions in the MP8000 Point to Point Configuration Document.

MODBUS Memory and Data Location Terminology / Register vs. Address

The MODBUS standard defines a memory location in terms of registers and addresses. The "register" numbering system starts Xxxxxx1 and goes up to X65536, where the leading X is a reference number that designates a register type. The "address" numbering system starts at 0 rather than 1 and does not contain a prefix. The prefix indicates which read and write functions should be used to get or set the corresponding location. The Modicon MODBUS Protocol Reference Guide refers to these XX references, such as 4X reference for holding registers.

Older standards and products tend to use a 5-digit numbering system for registers. (Ex: 40,001 for the first holding register) However, other documentation is written using a 6-digit numbering system; MODBUS supports registers up to 65536. (Ex: 400,001 for the first holding register).

The "address" numbering system is defined in the standard to describe the message that is actually sent to the physical communications bus. By starting the addresses at 0 rather than 1 and by truncating the register type prefix or reference, the number of usable memory or data locations is maximized. This document will use the terms "address" and "location" interchangeably to refer to the actual address placed on the bus to get the intended piece of data. **Supported MODBUS Message Function Codes**

The following four function codes are supported. The 03 Read and 04 Read functions can be used on any register. Broadcast is not supported.

1. **FUNCTION CODE 03 Read Holding Registers:** Block read
2. **FUNCTION CODE 04 Read Input Registers:** Block read
3. **FUNCTION CODE 06 Preset Single Register:** Write one value
4. **FUNCTION CODE 16 (0x10) Preset Multiple Registers:** Block write

Registers are 16 bits. Many MP8000 parameters are stored as 32 bit integers. Therefore, two Register reads or writes are required when accessing these parameters.

Read Command Example

A typical request for a Model MP8000 would be to ask for the 3 voltages (32 bits each) starting at address 0x0226, which are the Voltage between L1-L2, L2-L3, and L3-L1. In the example below, the values will be returned as 481, 476, and 483 volts for these variables.

Assume that the Model MP8000 has been programmed with a device address of A02. The MODBUS command message from the master device to a slave device would look like:

Byte	Contents	Example (in Hex)
1	Address of Slave Device	02
2	Command to Slave Device	03
3	High Byte of Address	02 .(Address of L1-L2)
4	Low Byte of Address	26
5	High Byte of Number of Registers	00 .(Read 6 registers)
6	Low Byte of Number of Registers	06

The above sequence would be a request to read 6 registers (12 bytes) starting at address 0x0226. The normal response from the slave device to the master device would look something like:

Byte	Contents	Example (in Hex)
1	Address of Slave Device	02
2	Echo of Command to Slave Device	03
3	Number of Bytes sent back	10
4	High Byte of Word at 0017	00 (L1-L2 = 481)
5	Low Byte of Word at 0017	00
4	High Byte of Word at 0018	01
5	Low Byte of Word at 0018	E1
6	High Byte of Word at 0019	00 (L2-L3 = 476)
7	Low Byte of Word at 0019	00
6	High Byte of Word at 001A	01
7	Low Byte of Word at 001A	DC
8	High Byte of Word at 001B	00 (L3-L1 = 483)
9	Low Byte of Word at 001B	00
8	High Byte of Word at 001C	01
9	Low Byte of Word at 001C	E3

The voltage values listed would be values that might be expected from a 480 volt system.

The Address and Number-Of-Words-To-Send words are sent with the high byte first followed by the low byte.

Special Notes When Using the 4X Addresses

Some software packages, such as Human-Machine-Interface (HMI) software packages for PLCs, can only use registers from 400001 to 465536 in the MODBUS 03 and 06 commands.

If this is the case, add 400001 to the hexadecimal addresses in the tables to select the start of the data to read. Many of these software packages will automatically subtract the 400001 part of the address before sending the actual address in the MODBUS command.

MP8000 MODBUS MEMORY MAP

Many MP8000 parameters are stored as 32 bit integers. Therefore, two Register (defined as 16 bits) reads or writes are required when accessing these parameters. See the tables below for address and bit details. Although all parameters are stored as integers (excluding the device name), the integers may be "scaled" in various ways. See Table 3 - Memory Map Data Format Codes for details.

CONFIGURATION SETTINGS

Table 1 - MP8000 Memory Map Settings (Configuration parameters)

MP8000 MEMORY MAP CONFIGURATION							
FIELD NAME	ADDRESS		SIZE BYTES	DESCRIPTION	FORMAT TABLE	PERMISSION	REF
	HEX	REGISTER					
FW_REV	0x0000	40001	4	Software Revision	C	R	
PC	0x0004	40005	2	Product Code	B	R	
CT	0x0006	40007	2	Current Transformer Ratio	B	R/W	IM* 4.8.1
PT	0x0008	40009	2	Potential Transformer Ratio	B	R/W	IM* 4.8.2
LV	0x000A	40011	4	Low Voltage Holdoff Condition	H	R/W	IM* 4.7.1
HV	0x000E	40015	4	High Voltage Holdoff Condition	H	R/W	IM* 4.7.2
VUB	0x0012	40019	2	Voltage Unbalance Holdoff Percentage	G	R/W	IM* 4.7.3
TC	0x0014	40021	2	NEMA Trip Class	B	R/W	IM* 4.7.7
OC	0x0016	40023	4	Overcurrent Threshold (FLA of motor)	H	R/W	IM* 4.7.4
UC	0x001A	40027	4	Undercurrent Threshold	H	R/W	IM* 4.7.5
ULTD	0x001E	40031	2	Underload Trip Delay	L	R/W	IM* 4.8.3
CUB	0x0020	40033	2	Current Unbalance Threshold	G	R/W	IM* 4.7.6
Reserved	0x0022	40035					
LINTD	0x0024	40037	2	Linear Overcurrent Trip Delay	L	R/W	IM* 4.8.4
RD0	0x0026	40039	4	Restart Delay 0	L	R/W	IM* 4.7.8
RD1	0x002A	40043	4	Restart Delay 1	L	R/W	IM* 4.7.9
RD2	0x002E	40047	4	Restart Delay 2	L	R/W	IM* 4.7.10
RD3	0x0032	40051	4	Restart Delay 3	L	R/W	IM* 4.7.11
RU	0x0036	40055	2	Restart Attempts for Undercurrent Trips	B	R/W	IM* 4.7.12
RF	0x0038	40057	2	Restart Attempts for all other faults	B	R/W	IM* 4.7.13
GFTC	0x003A	40059	4	Ground Fault Trip Current	H	R/W	IM* 4.8.5
GFTD	0x003E	40063	2	Ground Fault Trip Delay	S	R/W	IM* 4.8.6
Reserved	0x0040	40065	2				
LKW	0x0042	40067	4	Low Power Trip Threshold	H	R/W	IM* 4.8.7
HKW	0x0046	40071	4	High Power Trip Threshold	H	R/W	IM* 4.8.8
HPTD	0x004A	40075	2	High Power Trip Delay	C	R/W	IM* 4.8.9
STLP	0x004C	40077	2	Stall Percentage (of OC)	B	R/W	IM* 4.8.10
STLTD	0x004E	40079	2	Stall Trip Delay	Q	R/W	IM* 4.8.11
STLID	0x0050	40081	2	Stall Inhibit Delay	Q	R/W	IM* 4.8.12
Reserved	0x0052	40083	2				
Reserved	0x0054	40085	2				
Reserved	0x0056	40087	4				
CNFG	0x005A	40091	4	Hardware Configuration Fields	C	R/W	Table 2
Reserved	0x005E	40095	4				
Reserved	0x0062	40099	4				
Reserved	0x0066	40103	4				
NAME	0x006A	40107	12	Friendly Device Name	R	R/W	
CMD	0x0076	40119	2	Command Interface	C	W	Table 4

* See Instruction Manual (IM) Ref section for more details

See Instruction Manual (IM) tables 4.2 & 4.5 for default values

NOTE: "Reserved" fields should be maintained as 0.

Table 2 - CNFG Details (Hardware Configuration Control Register)

CNFG (CONFIGURATION CONTROL REGISTER)				
FIELD NAME	BIT	MASK	DESCRIPTION	*VERSION
GFMT	0	0x0001	Setting to a one enables the motor control relay to trip during a ground fault. Setting to zero will enable the auxiliary relay to trip instead. (: Bit 1 below must be set to a one also)	2.0.17.12
AUXCNTL	1	0x0002	Setting to a one enables the auxiliary relay to be activated via the command interface (0x0030 & 0x0031). NOTE: Bit 0 above must be set to a one also.	2.3.17.17
Disable BLE	2	0x0004	Setting to a one disables the Smartphone interface	2.3.17.17
Reserved	3	0x0008		2.0.17.12
Reserved	4	0x0010		2.0.17.12
Single-Phase Motor	5	0x0020	Set to one if this is a single-phase motor application. The following applies: – Voltage unbalance and voltage single-phase protection disabled – Reverse-phase protection disabled – Contact failure trip disabled	2.0.17.12
3-Phase w/1 Volt	6	0x0040	Set to one if only one phase of a three phase motor is connected to the MP8000	2.0.17.12
Reserved	7	0x0080		2.0.17.12
Reserved	8	0x0100		2.0.17.12
PTC Enable	9	0x0200	Set to one if you have an external PTC connected	2.0.17.12
Reserved	10	0x0400		2.0.17.12
Reserved	11	0x0800		2.0.17.12
CBA Phase Rotation	12	0x1000	Set to zero for MP8000's wired for ABC rotation. Set to one for MP8000's wired for CBA rotation	2.0.17.12
RD0 on Power Up	13	0x2000	Set to one to enable a power up delay (RD0)	2.0.17.12
RD1 on Current Loss	14	0x4000	Set to one to enable a delay when there has been a loss of current	2.0.17.12
Reserved	15	0x8000		2.0.17.12

*Available in the listed Version or newer.

Table 3 - Memory Map Data Format Codes

All fields are in little endian!

CODE	DESCRIPTION	SIZE BYTES
A	uint8_t	1
B	uint16_t	2
C	uint32_t	4
D	int8_t	1
E	int16_t	2
F	int32_t	4
G	uint16_t Base 10.xx	2
H	uint32_t Base 10.xx	4
I	int16_t Base 10.xx	2
J	int32_t Base 10.xx	4
K	uint32_t Unix time_t	4
L	uint32_t Seconds	4
M	int32_t Seconds	4
N	int16_t Signed Percentage	2
O	uint8_t Base 10.x	1
P	int16_t Power Factor	2
Q	uint16_t Seconds	2
R	String	N/A
S	uint16_t 1/10s of a Seconds (10 == 1 sec)	2

Command Register

Write to the Command Interface register (0x0076) to perform the following tasks.

Table 4 – CMD (Command Interface; address 0x0076)

VALUE	DESCRIPTION	*VERSION
0x0009	Reset Relay - Attempt to Restart the Motor assuming no voltage faults are present.	2.0.17.12
0x0010	Reset Motor Service time to NOW	2.0.17.12
0x0011	Fault Lookup (From FIDX and FRO) [Modbus only]	2.0.17.12
0x0012	Reset Configuration to Factory Defaults	2.0.17.12
0x0013	Reset the amount of time current has been detected flowing though the MP8000	2.0.17.12
0x0014	Reset the number of times the motor has started	2.0.17.12
0x0020	Force the MP8000 to trip, require restart to recover	2.3.17.17
0x0030	De-Energize/Release the AUX relay	2.3.17.17
0x0031	Energize/Activate the AUX relay	2.3.17.17

*Available in the listed Version or newer.

Real Time Status

All parameters listed in Table 5 - MP8000 Memory Map Real Time Status are updated every second.

Table 5 - MP8000 Memory Map Real Time Status

MP8000 MEMORY MAP REAL TIME STATUS							
FIELD NAME	ADDRESS		SIZE	DESCRIPTION	FORMAT	PERMISSION	*VERSION
	HEX	REGISTER					
MST	0x0200	40513	4	Time since motor last serviced (can only be written to zero)	L	R	2.0.17.12
MRT	0x0204	40517	4	Amount of time the motor has had current flowing	L	R	2.0.17.12
SCNT	0x0208	40521	2	Start Count -- Number of Motor starts (since last cleared)	B	R	2.0.17.12
FAULT_STAT	0x020A	40523	4	Current Fault Status Mask	C	R	2.0.17.12
WARN_STAT	0x020E	40527	4	Current Warning Status Mask	C	R	2.0.17.12
FAULT_CODE	0x0212	40531	2	Indicates the reason we have tripped or are in holdoff.	B	R	2.0.17.12
RTDT	0x0214	40533	4	Remaining Trip Delay Time	L	R	2.0.17.12
RDR	0x0218	40537	4	Restart time remaining	L	R	2.0.17.12
TCU	0x021C	40541	2	Thermal Capacity Used	B	R	2.0.17.12
MLF	0x021E	40543	2	Measured Line Frequency	G	R	2.0.17.12
SEQ	0x0220	40545	2	Measured Phase Sequence	B	R	2.0.17.12
VUBM	0x0222	40547	2	Measured Voltage Unbalance	G	R	2.0.17.12
CUBM	0x0224	40549	2	Measured Current Unbalance	G	R	2.0.17.12
V1	0x0226	40551	4	Measured line 1 Voltage RMS	H	R	2.0.17.12
V2	0x022A	40555	4	Measured line 2 Voltage RMS	H	R	2.0.17.12
V3	0x022E	40559	4	Measured line 3 Voltage RMS	H	R	2.0.17.12
I1	0x0232	40563	4	Measured line 1 Current RMS	H	R	2.0.17.12
I2	0x0236	40567	4	Measured line 2 Current RMS	H	R	2.0.17.12
I3	0x023A	40571	4	Measured line 3 Current RMS	H	R	2.0.17.12
P1	0x023E	40575	4	Measured line 1 Power	C	R	2.0.17.12
P2	0x0242	40579	4	Measured line 2 Power	C	R	2.0.17.12
P3	0x0246	40583	4	Measured line 3 Power	C	R	2.0.17.12
PF1	0x024A	40587	2	Measured line 1 Power Factor	P	R	2.0.17.12
PF2	0x024C	40589	2	Measured line 2 Power Factor	P	R	2.0.17.12
PF3	0x024E	40591	2	Measured line 3 Power Factor	P	R	2.0.17.12
IGF	0x0250	40593	4	Ground Fault Current	H	R	2.0.17.12
PTC	0x0254	40597	2	Positive Temperature Coeficent	E	R	2.0.17.12
MOTORR	0x0256	40599	2	Motor Relay State (0-open, 1-energized)	E	R	2.3.17.17
AUXR	0x0258	40601	2	Aux Relay State (0-open, 1-energized)	E	R	2.3.17.17

*Available in the listed Version or newer.

Fault Record Retrieval

There are two methods of requesting a fault record: By index, and by date. (See Table 6)

To request fault records by Index:

1. Write the fault index to the FRI register (0x300). Note, this index is zero based, so the most recent fault record will have an index of zero.
   a. Also the maximum valid index is 1023
2. Write to the CMD register (0x0076) with command 0x11 (see Table 4)
3. Continuously read the FRI register until it has been updated to 0xFFFF
4. The fault record is ready to read, starting at address 0x0308. (see Table 6)

To request fault records by date:

1. Write zero to the FRI register (0x0300).
2. Write the UNIX (32bit) time stamp to the FRO register (0x0304).
   a. The log entry with the next earlier time entry will be retrieved.
3. Write to the CMD register (0x0076) with command 0x11 (see Table 4)
4. Continuously read the FRI register until it has been updated to 0xFFFF
5. The fault record is ready to read, starting at address 0x0308. (see Table 6)

Table 6 - Fault Record Retrieval

MP8000 FAULT RECORD RETRIEVAL					
FIELD NAME	ADDRESS	SIZE	DESCRIPTION	FORMAT	PERMISSION
FRI	0x0300	4	Fault Request Index (Or base DT)	C	R/W
FRO	0x0304	4	Fault Request Offset	F	W
FCODE	0x0308	4	Fault Code indicating the source of the fault	B	R
FDT	0x030C	4	Date Time of Fault	K	R
V1F	0x0310	4	Measured line 1 Voltage RMS	H	R
V2F	0x0314	4	Measured line 2 Voltage RMS	H	R
V3F	0x0318	4	Measured line 3 Voltage RMS	H	R
I1F	0x031C	4	Measured line 1 Current RMS	H	R
I2F	0x0320	4	Measured line 2 Current RMS	H	R
I3F	0x0324	4	Measured line 3 Current RMS	H	R
MRTF	0x0328	4	Time since motor started	H	R
TCUF	0x032C	4	Thermal Capacity Used	L	R
P1F	0x0330	4	Measured line 1 Power	C	R
P2F	0x0334	4	Measured line 2 Power	C	R
P3F	0x0338	4	Measured line 3 Power	C	R
PF1F	0x033C	2	Measured line 1 Power Factor	P	R
PF2F	0x033E	2	Measured line 2 Power Factor	P	R
PF3F	0x0340	2	Measured line 3 Power Factor	P	R
IGFF	0x0342	4	Ground Fault Current	H	R
VUBF	0x0346	2	Measured Voltage Unbalance	G	R
CUBF	0x0348	2	Measured Current Unbalance	G	R
FAF	0x034A	2	Frequency Measured from Phase A	G	R
SEQF	0x034C	2	Measured Phase Sequence	G	R
FSDF	0x034E	10	Fault Specific Data	N.A	R

Table 7 - Fault Status

ALIAS	ACTIVE FAULT/TRIP CONDITION	MASK	FAULT CODE	*VERSION
NOFAULT	No fault or warning condition	0x00000000	0	2.0.17.12
OCF	Tripped on overcurrent	0x00000001	1	2.0.17.12
UCF	Tripped on undercurrent	0x00000002	2	2.0.17.12
CUBF	Tripped on current unbalance	0x00000004	3	2.0.17.12
CSPF	Tripped on current single-phasing	0x00000008	4	2.0.17.12
CTCF	Tripped on contactor failure	0x00000010	5	2.0.17.12
GFF	Tripped on ground fault	0x00000020	6	2.0.17.12
HPF	Tripped on High Power Fault	0x00000040	7	2.0.17.12
LPF	Tripped on low power fault	0x00000080	8	2.0.17.12
LCVF	Low Control Voltage Fault	0x00000100	9	2.0.17.12
PTCF	Trip or holdoff due to PTC fault	0x00000200	10	2.0.17.12
RMTF	Tripped triggered from remote source	0x00000400	11	2.0.17.12
LIN	Tripped on Linear Overcurrent	0x00000800	12	2.0.17.12
STALL	Tripped Motor Stall	0x00001000	13	2.0.17.12
ARD0	Active Restart Delay Field Bit 0	0x00010000	N/A	2.0.17.12
ARD1	Active Restart Delay Field Bit 1	0x00020000	N/A	2.0.17.12
ARD2	Active Restart Delay Field Bit 2	0x00040000	N/A	2.0.17.12
PTCS	Tripped on PTC Short	0x00200000	14	2.0.17.12
PTCO	Tripped on PTC Open	0x00400000	15	2.0.17.12
MANR	Manual Restart Required	0x00080000	N/A	2.0.17.12
FWUpdate	F/W Update	n/a	0x1000	2.0.17.12
UNDEFF	Undefined trip condition	0x00100000	61166	2.0.17.12
FMEA	MP8000 Replacement Fault	0x01000000	4097	2.2.17.15

*Available in the listed Version or newer.

Table 8 - Active Restart Delay

ARD[2:0]	RDR IS
000	Inactive
001	RD0
010	RD1
011	RD2
100	RD3

Table 9 - Warning Status

PRIORITY	ACTIVE WARNING OR HOLDOFF	MASK	CODE
1	Any VUB is greater than or equal to the VUB setting	0x00040000	102
2	Phase order does not match ACB setting	0x00080000	103
3	Any line-to-line voltage is less than or equal to the LV setting	0x00010000	100
4	Any line-to-line voltage is greater than or equal to the HV setting	0x00020000	101
5	Contactor Failure; occurs if there is a CUB condition present, but no VUB condition	0x00000010	N/A
6	Motor Stall Detected	0x00001000	N/A
7	Any CUB is greater than or equal to the CSP setting	0x00000008	N/A
8	Any phase current is greater than or equal to the OC setting	0x00000001	N/A
9	The power is less than or equal to the HPR setting	0x00000040	N/A
10	Linear Overcurrent Detected	0x00000800	N/A
11	Any CUB is greater than or equal to the CUB setting and no single phase is detected	0x00000004	N/A
12	The average current is less than or equal to the UC setting	0x00000002	N/A
13	The power is less than or equal to the LPR setting	0x00000080	N/A
14	The GF current is greater than or equal to the GF setting	0x00000020	N/A
15	PTC Holdoff	0x00000200	N/A
16	No fault or warning condition	0x00000000	N/A

Questions?

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