

Modbus Protocol for MPM-100 and BDS-256 Series Monitors

For BMDM Software Version 4.10 or later,
MPMs with Firmware Version 1.20 or later,
and BDS with Controller Firmware Version 2.20 or later



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Modbus Protocol for MPM-100 and BDS-256, Book Revision 4.0

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1. Modbus™ Protocol (ASCII Frame)

Frame: Colon, Address (H), Address (L), Function (H), Function (L), Data, LRC (H), LRC (L), CR, LF

ASCII Character: Every field in the frame is sent in ASCII character. For example, if function 03H is sent out, we have to convert to 30H (ASCII code of high 4 bits of 03H) and 33H (ASCII code of low 4 bits of 03H).

Address: Device address is defined as:

MPM:	01H	
BDS:	String 1	01H
	String 2	02H
	
	String 16	10H

Error Control: LRC (If correct, send requested data back; if error is found, do nothing.) The following binary bytes in the frame are checked:

Address
Function
Data

Bits per Byte: 1 start bit, 7 data bits, 2 stop bits, no parity

Baud Rate: 9600

Note:

1. In the above frame, the first byte (colon) is counted as byte 0 in this document.

2. Register List for Function 3 and 16 (Data Address: 0000H – 270EH)

Category	Name	Reference	Data Address
Cell Voltage	Cell Voltage 1	40001	0000H
	Cell Voltage 2	40002	0001H

	Cell Voltage 512	40512	01FFH
Intercell Resistance	Intercell 1	40513	0200H

	Intercell 48	40560	022FH
		
Other Parameters	Overall Voltage	41025	0400H
	(Not used)	41026	0401H
	(Not used)	41027	0402H
	Ground Fault	41028	0403H
	Temperature 1	41029	0404H
	Temperature 2	41030	0405H

	Temperature 10	41038	040DH
	Intertier Resistance 1 (for MPM)	41039	040EH

	Intertier Resistance 8 (for MPM)	41046	0415H
	(Not used)	41047	0416H
	(Not used)	41048	0417H
	Test Current 1	41049	0418H

	Test Current 16	41064	0427H
	Current 1	41065	0428H
	Current 2	41066	0429H
	Current 3	41067	042AH
	Current 4	41068	042BH
	Intertier Resistance 1 (for BDS)	41069	042CH

	Intertier Resistance 15 (for BDS)	41083	043AH
	Cell Resistance 1 (for single DCM R-test)	41084	043BH
		
	Cell Resistance 48 (for single DCM R-test)	41131	046AH
	Current 5 (for float current 1 MPM)	41132	046BH
	Current 6 (for float current 2 MPM)	41133	046CH
	Current 7 (for float current 3 MPM)	41134	046DH
	Current 8 (for float current 4 MPM)	41135	046EH

Category	Name	Reference	Data Address
		
Current Alarm (≤ 95 alarms)	Alarm Type ^a of First Alarm	41153	0480H
	Starting Year / Month of First Alarm	41154	0481H
	Starting Day / Hour of First Alarm	41155	0482H
	Starting Minute / Second of First Alarm	41156	0483H

	Alarm Type of Last Alarm		
	Starting Year / Month of Last Alarm		
	Starting Day / Hour of Last Alarm		
	Starting Minute / Second of Last Alarm		
	0FFH		
		
Status Registers	String ID	41537	0600H
	Firmware Time (Year / Month)	41538	0601H
	Firmware Time (Day / Hour)	41539	0602H
	Firmware Time (Minute / Second)	41540	0603H
	System Status ^b	41541	0604H
	Firmware Control ^c	41542	0605H
	0	41543	0606H
	Remained Time of Next Historical Log (Day / Hour)	41544	0607H
	Remained Time of Next Historical Log (Minute / Second)	41545	0608H
	Remained Time of Next Resist. Test (Day / Hour)	41546	0609H
	Remained Time of Next Resist. Test (Minute / Second)	41547	060AH
	Remained Time of Alarm Disable (Day / Hour)	41548	060BH
	Remained Time of Alarm Disable (Minute / Second)	41549	060CH
	Discharge Timer (Day / Hour)	41550	060DH
	Discharge Timer (Minute / Second)	41551	060EH
	Remained Time of Load Test (Day / Hour)	41552	0600FH
	Remained Time of Load Test (Minute / Second)	41553	0610H
	DIP Switch	41554	0611H
	Hardware Diagnostics ^d	41555	0612H
	Indicators ^e	41556	0613H
Digital Inputs ^f	41557	0614H	
Reset Alarm ^g	41558	0615H	
Frame Number	41559	0616H	

Category	Name	Reference	Data Address
	String # / DCM #	41560	0617H
	Contacts ^h	41561	0618H
	Comm. Error Counts of DCM 1 - 2	41562	0619H
		
	Comm. Error Counts of DCM 15 - 16	41569	0620H
		
	Dial Out String #	41600	063FH
Configuration	Total Cell Number	41601	0640H
	Load Test Length / 0	41602	0641H
	Config # / 0	41603	0642H
	Shunt	41604	0643H
	Float Current Multiplier	41605	0644H
	Alarm Latch Selection	41606	0645H
	(Not used)	41607	0646H
	(Not used)	41608	0647H
	Intertier Number 1 (for MPM before version 4.01)	41609	0648H

	Intertier Number 4 (for MPM before version 4.01)	41612	064BH
	Critical Alarm Selection	41613	064CH
	Maintenance Alarm Selection	41614	064DH
	Print Alarm Selection	41615	064EH
	IP Address (Part 1 / part 2)	41616	064FH
	IP Address (Part 3 / part 4)	41617	0650H
	(Not used)	41618	0651H
	Historical Log Period	41619	0652H
	Resistance Test Period	41620	0653H
	Load Test Period	41621	0654H
	Firmware Version ^l	41622	0655H
	PCB Version ^l	41623	0656H
	Cell Mode	41624	0657H
	Station Phone # (Byte 1 / Byte 2)	41625	0658H
		
	Station Phone # ^j (Byte 19 / Byte 20)	41634	0661H
	Alarm Report Selection ^k	41635	0662H
	Parameter Option 1 ^L	41636	0663H
	Parameter Option 2 ^L	41637	0664H
	Control Option ^m	41638	0665H
	Low Cell Voltage for Discharge	41639	0666H
	Low Overall Voltage for Discharge	41640	0667H
	Maximum Discharge Time (In minutes)	41641	0668H
High Temperature for Charger	41642	0669H	
Low Temperature for Charger	41643	066AH	
Digital Input Selection ⁿ	41644	066BH	

Category	Name	Reference	Data Address
	Digital Input Connection Selection °	41645	066CH
	Log Threshold for Cell Voltage	41646	066DH
	Log Threshold for Overall Voltage	41647	066EH
	Log Threshold for Current	41648	066FH
	Location Name (Byte 1 / Byte 2)	41649	0670H
		
	Location Name (Byte 19 / Byte 20)	41658	0679H
	Battery Name (Byte 1 / Byte 2)	41659	067AH
		
	Battery Name (Byte 19 / Byte 20)	41668	0683H
	String Name (Byte 1 / Byte 2)	41669	0684H
		
	String Name (Byte 19 / Byte 20)	41678	068DH
	Password 1 (Byte 1 / Byte 2)	41679	068EH
	Password 1 (Byte 3 / Byte 4)	41680	068FH
	Password 1 (Byte 5 / 0)	41681	0690H
	Password 2 (Byte 1 / Byte 2)	41682	0691H
	Password 2 (Byte 3 / Byte 4)	41683	0692H
	Password 2 (Byte 5 / 0)	41684	0693H
	Password 3 (Byte 1 / Byte 2)	41685	0694H
	Password 3 (Byte 3 / Byte 4)	41686	0695H
	Password 3 (Byte 5 / 0)	41687	0696H
	Discharge Mode	41688	0697H
	Temperature Name 1 (Byte 1 / Byte 2)	41689	0698H

	Temperature Name 1 (Byte 19 / Byte 20)	41698	06A1H

	Temperature Name 10 (Byte 1 / Byte 2)	41779	06F2H

	Temperature Name 10 (Byte 19 / Byte 20)	41788	06FBH
	Intertier Number 1	41789	06FCH

	Intertier Number 15	41803	070AH
	Digital Input Report Selection	41804	070BH
	Digital Input Critical Alarm Selection	41805	070CH
	Digital Input Maintenance Alarm Selection	41806	070DH
	Digital Input Print Alarm Selection	41807	070EH
	Digital Output Trigger 1 - 2	41808	070FH
	Digital Output Trigger 3 - 4	41809	0710H
	Digital Output Trigger 5 - 6	41810	0711H
	Digital Output Trigger 7 - 8	41811	0712H
	Digital Output Enable Selection	41812	0713H
	Digital Output Latch Selection	41813	0714H

Category	Name	Reference	Data Address
	Netmark (Part 1 / Part 2)	41814	0715H
	Netmark (Part 3 / Part 4)	41815	0716H
	Gateway (Part 1 / Part 2)	41816	0717H
	Gateway (Part 3 / Part 4)	41817	0718H
		
DCM Configuration	Cell # of DCM 1 / Cell # of DCM 2	41857	0740H
		
	Cell # of DCM 15 / Cell # of DCM 16		
	OV # / 0		
	Dis. Current # / Float Current #		
	Temp. # 1 / Temp. # 2		
		
	Temp. # 9 / Temp. # 10		
	LS of DCM 1 - 2		
		
	LS of DCM 15 - 16		
	Readings / LS of DCM 1 - 2		
		
	Readings / LS of DCM 15 - 16		
	Readings / Last LS of DCM 1 - 2		
		
	Readings / Last LS of DCM 15 - 16		
	Step Start # of DCM 1 - 2		
		
	Step Start # of DCM 15 - 16		
.....			
Calibration Constants	Cell Voltage Cal. of Unit 1	41985	07C0H
	Intercell Voltage Cal. of Unit 1		
	Overall Voltage Cal. of Unit 1		
	Current 1 Cal. of Unit 1		
	Current 2 Cal. of Unit 1		
	Ground Fault Cal. of Unit 1		
	Temperature 1 Cal. of Unit 1		
	Intertier Voltage Cal. of Unit 1		
	Test Current Cal. of Unit 1		
	Temperature 2 Cal. of Unit 1		
		
	Cell Voltage Cal. of Unit 16		
	Intercell Voltage Cal. of Unit 16		
	Overall Voltage Cal. of Unit 16		
	Current 1 Cal. of Unit 16		
	Current 2 Cal. of Unit 16		
	Ground Fault Cal. of Unit 16		
Temperature 1 Cal. of Unit 16			

Category	Name	Reference	Data Address
	Intertier Voltage Cal. of Unit 16		
	Test Current Cal. of Unit 16		
	Temperature 2 Cal. of Unit 16		
		
Alarm Thresholds	High Cell Voltage Alarm Threshold	42241	08C0H
	Low Cell Voltage Alarm Threshold		
	High Cell Resistance Alarm Threshold		
	0		
	High Intercell Resistance Alarm Threshold		
	0		
	High Overall Voltage Alarm Threshold		
	Low Overall Voltage Alarm Threshold		
	High Float Alarm Threshold		
	0		
	0		
	0		
	High Ground Fault Alarm Threshold		
	0		
	High Temperature 1 Alarm Threshold		
	Low Temperature 1 Alarm Threshold		
		
	High Temperature 10 Alarm Threshold		
	Low Temperature 10 Alarm Threshold		
	High Intertier Resistance Alarm Threshold (for MPM)		
	0		
	(17 registers are not used)		
	Discharge Level		
	Warning Percentage		
	High Intertier Resistance 1 Alarm Threshold (for BDS)		
	0		
	...		
	High Intertier Resistance 15 Alarm Threshold (for BDS)		
0			
.....			
Historical Events (128 bytes) --- For BDS only	Alarm Type ^A of First Event	42369	0940H
	Start Year / Month of First Event	42370	0941H
	Start Day / Hour of First Event	42371	0942H
	Start Minute / Second of First Event	42372	0943H

Category	Name	Reference	Data Address
	...		
	Alarm Type ^A of 16th Event		
	Start Year / Month of 16th Event		
	Start Day / Hour of 16th Event		
	Start Minute / Second of 16th Event	42432	097FH
Historical Events (34 bytes) --- For MPM only	String ID	42369	0940H
	Discharge Start Date (Year / Month)	42370	
	Discharge Start Date (Day / Hour)	42371	
	Discharge Start Time (Minute / Second)	42372	
	Discharge Detail (Not used)	42373	
	Warning Start Date (Year / Month)	42374	
	Warning Start Date (Day / Hour)	42375	
	Warning Start Time (Minute / Second)	42376	
	Warning Detail	42377	
	Alarm Start Date (Year / Month)	42378	
	Alarm Start Date (Day / Hour)	42379	
	Alarm Start Time (Minute / Second)	42380	
	Alarm Detail (= Alarm Type)	42381	
	Reset-Alarm Date (Year / Month)	42382	
	Reset-Alarm Date (Day / Hour)	42383	
	Reset-Alarm Time (Minute / Second)	42384	
	Status ^P	42385	
		
Memo (262 Bytes = 131 registers)	Year / Month	42433	0980H
	Day / Hour
	Minute / Second		
	Memo (character 1 / character 2)		
		
	Memo (character 255 / 0)		
		
DCM Diagnostics (6 registers X 16 = 96 registers)	Self Test ^Q of DCM 1	42625	0A40H
	Firmware Version of DCM 1		
	Hardware Reset Times of DCM 1		
	Firmware Reset Times of DCM 1		
	DIP 1 of DCM 1		
	DIP 2 of DCM 1		
		
	Self Test of DCM 16		
	Firmware Version of DCM 16		
	Hardware Reset Times of DCM 16		
	Firmware Reset Times of DCM 16		

Category	Name	Reference	Data Address
	DIP 1 of DCM 16		
	DIP 2 of DCM 16		
		
Discharge Summary (3 x 50 = 150 registers)	Year / Month of First Discharge	42881	0B40H
	Day / Hour of First Discharge		
	Minute / Second of First Discharge		
	...		
	Year / Month of 50 th Discharge		
	Day / Hour of 50 th Discharge		
	Minute / Second 50 th First Discharge	43030	0BD5H
...			
Not used (1536 registers)		43073	0C00H
Upgrade Controller Firmware (130 bytes)	Address	44609	1200H
	Code 1 / Code 2		
	Code 3 / Code 4		
		
	Code 127 / Code 128		
.....			
Upgrade Firmware (66 bytes = 33 registers)	Address	44737	1280H
	Code 1 / Code 2		
	Code 3 / Code 4		
		
	Code 63 / Code 64		
.....			
Historical Alarm (5 records each time)	Alarm Type of First Record	44801	12C0H
	Peak Value of First Record		
	Starting Year / Month of First Record		
	Starting Day / Hour of First Record		
	Starting Minute / Second of First Record		
	Ending Year / Month of First Record		
	Ending Day / Hour of First Record		
	Ending Minute / Second of First Record		
	Reset Year / Month of First Record		
	Reset Day / Hour of First Record		
	Reset Minute / Second of First Record		
		
Alarm Type of 5th Record			

Category	Name	Reference	Data Address
	Peak Value of 5th Record		
	Starting Year / Month of 5th Record		
	Starting Day / Hour of 5th Record		
	Starting Minute / Second of 5th Record		
	Ending Year / Month of 5th Record		
	Ending Day / Hour of 5th Record		
	Ending Minute / Second of 5th Record		
	Reset Year / Month of 5th Record		
	Reset Day / Hour of 5th Record		
	Reset Minute / Second of 5th Record		
		
Latched Alarm (5 records each time)	Alarm Type of First Record	44865	1300H
	Peak Value of First Record		
	Starting Year / Month of First Record		
	Starting Day / Hour of First Record		
	Starting Minute / Second of First Record		
	Latched Year / Month of First Record		
	Latched Day / Hour of First Record		
	Latched Minute / Second of First Record		
		
	Alarm Type of 5th Record		
	Peak Value of 5th Record		
	Starting Year / Month of 5th Record		
	Starting Day / Hour of 5th Record		
	Starting Minute / Second of 5th Record		
	Latched Year / Month of 5th Record		
	Latched Day / Hour of 5th Record		
	Latched Minute / Second of 5th Record		
.....			
Historical Resistance ^r (64 words each time)	First Word of Data	44929	1340H
	Second Word of Data		
		
	64th Word of Data		
Historical Data ^s (64 words each time)	First Word of Data	44993	1380H
	Second Word of Data		
		
	64th Word of Data		
Discharge Data (10 records each time)	Data Type ^t of First Record	45057	13C0H
	Year / Month of First Record		
	Day / Hour of First Record		

Category	Name	Reference	Data Address
each time)	Minute / Second of First Record		
	Value of First Record		
		
	Data Type of 10th Record		
	Year / Month of 10th Record		
	Day / Hour of 10th Record		
	Minute / Second of 10th Record		
	Value of 10th Record		
		
Upgrade DCM Firmware (66 bytes = 33 registers)	Address	45121	1400H
	Code 1 / Code 2		
	Code 3 / Code 4		
		
	Code 63 / Code 64		
.....			
Not used		45185	1440H
....			
End of Mapping		49999	270EH

Notes:

A. Alarm Type for both current and historical alarms is defined as:

Bit 15:	End symbol (= 0: record; = 1: end)
Bit 9-14:	Alarm Number
	High Cell Voltage : 0
	Low Cell Voltage : 1
	High Resistance : 2
	High Intercell R : 3
	High Overall Voltage : 4
	Low Overall Voltage : 5
	High Float Current : 6
	Warning : 7
	Ground Fault : 8
	High Temperature : 9
	Low Temperature : 10
	High Intertier R : 29
	Discharge : 39
	Digital Input 1 : 40

	Digital Input 16 : 55

	UPS Low Voltage : 62
	UPS Line Fail : 63

Bit 0-8: Cell Number (0 – 511)

Cell Number is given the temperature number (0 – 9, which indicates temperature 1 - 10) for temperature alarms. For intertier alarms, Cell Number is given the intertier number (0 – 14, which indicates temperature 1 - 15). After the last record, 0FFH is stuffed into all the remaining spaces of the current and historical memory.

B. System Status register (41541) is defined as

Bit 15	= 1 :	Alarm disabled
	= 0 :	Alarm enabled
Bit 14	= 1 :	Critical alarm happened
	= 0 :	No critical alarm
Bit 13	= 1 :	Maintenance alarm happened
	= 0 :	No maintenance alarm
Bit 12	= 1 :	Controller is logging discharge data
	= 0 :	Idle
Bit 11	= 1 :	DCM comm. error
	= 0 :	No comm. error
Bit 10	= 1 :	Historical alarm logged
	= 0 :	No historical alarm

Bit 9	= 1 :	Discharge disabled
	= 0 :	Discharge enabled
Bit 8	= 1 :	Discharge in progress
	= 0 :	No discharge in progress
Bit 7	= 1 :	Discharge report logged
	= 0 :	No discharge report
Bit 6	= 1 :	Resistance test in progress
	= 0 :	No resistance test in progress
Bit 5	= 1 :	Resistance values logged
	= 0 :	No resistance values
Bit 4	= 1 :	Warning
	= 0 :	No warning
Bit 3	= 1 :	Not used
Bit 2	= 1 :	Memory test finished
	= 0 :	Nothing
Bit 1	= 1 :	Calibration in progress
	= 0 :	No calibration in progress
Bit 0	= 1 :	Hardware problem
	= 0 :	No hardware problem

C. Firmware control register (41542) =

0000H	:	Start resistance test
0001H	:	Stop resistance test
0002H	:	Start firmware scan
0003H	:	Stop firmware scan
0004H	:	Load on (not used)
0005H	:	Load off
0006H	:	Start diagnostics
0007H	:	Stop diagnostics
0008H	:	Reset alarm
0009H	:	Not used
000AH	:	Start load test
000BH	:	Stop load test
000CH	:	Start EEPROM test
000DH	:	Stop EEPROM test (Not used)
000EH	:	Not used
000FH	:	Stop flash memory test (Not used)
0010H	:	Enable alarm
0011H	:	Disable alarm
0012H	:	Close alarm contact
0013H	:	Open alarm contact
0014H	:	Close charger contact
0015H	:	Open charger contact
0016H	:	Run firmware in PROM

0017H : Run firmware in flash memory (Not used)
 0018H : Set 10 seconds delay for R-test
 0019H : Set 3 minutes delay for R-test (Not used)
 001AH : Reboot firmware
 001BH : Erase discharge data
 001CH : Not erase discharge data
 001DH : Clear EEPROM
 001EH : Set Historical Log Period
 001FH : Set Resistance Test Period
 0020H : Set Load Test Period
 0021H : Enable DCM battery setup
 0022H : Let Controller start to get all setting from all DCM
 0023H : Not used
 0024H : Not used
 0025H : Let Controller start to get alarm threshold from one DCM
 0026H : Clear Hardware Reset and Firmware Reset Counters
 0027H : Start R-test in a DCM
 0028H : Start DCM Address Check
 0029H : Stop DCM Address Check
 002AH : Clear DCM Comm. Error Counts
 002BH : Enable DCM calibration setup
 002CH : Get IP address
 002DH : Set IP address
 002EH : Erase resistance data
 002FH : Not erase resistance data
 0030H : Erase historical data
 0031H : Not erase historical data
 0032H : Erase historical alarm data
 0033H : Not erase historical alarm data
 0034H : Start load test in BDS
 0035H : Stop load test in BDS

D. Hardware Diagnostics register (41555) is defined as

Low Byte	Bit 0	:	Processor (8031)
	Bit 1	:	External RAM
	Bit 2	:	PROM
	Bit 3	:	Not used
	Bit 4	:	A/D
	Bit 5	:	Modem
	Bit 6	:	Dial tone
	Bit 7	:	Not used
High Byte	Bit 8	:	EEPROM
	Bit 9	:	Flash memory
	Bit10-14	:	Not used
	Bit 15	:	= 1 Running the firmware in flash memory = 0 Running the firmware in PROM

Except for Bit 15, the value of other bits is defined as

= 0 OK
= 1 Fail

E. Indicator register (41556) is defined as (= 1: on; = 0: off)

MPM:

Bit 0 : Scan light
Bit 1 : Alarm light
Bit 3 : Resistance test light
Bit 4 : Alarm disable light
Bit 7 : Error light
Others : Not used

BDS:

Bit 0 : Not used
Bit 1 : Scan light
Bit 2 : Maintenance alarm light
Bit 3 : Critical alarm light
Bit 4 : Resistance test light
Bit 5-15 : Not used

F. Only low byte of DIP Switch register (41554) and Digital Inputs registers (41557) is used.

G. Reset Alarm register (41558) is defined as

Bit 0 = 1 : ON
 = 0 : OFF

H. Contacts register (41561) is defined as (= 1: on; = 0: off)

Bit 0 - 9 : Contact 1 - 10
Bit 10 : Critical Alarm Contact
Bit 11 : Maintenance Alarm Contact
Bit 12-15 : Not used

I. Firmware Version # register (41622) is defined as an integer. For example, 120 indicates Version 1.20. PCB Version # register (41623) is defined as a letter, such as A, B, or C.

J. Station Phone Number (41625 – 41634) is terminated by two bytes: 0DH, 0AH.

K. Alarm Report Selection register (41635), Alarm Latch register (41606), Critical Alarm Selection (41613), Maintenance Alarm Selection (41614) and Print Alarm Selection (41615) are defined as

- Bit 0 : = 1 Enable high cell voltage alarm
 = 0 Disable
- Bit 1 : = 1 Enable low cell voltage alarm
 = 0 Disable
- Bit 2 : = 1 Enable high overall voltage alarm
 = 0 Disable
- Bit 3 : = 1 Enable low overall voltage alarm
 = 0 Disable
- Bit 4 : = 1 Enable high temperature alarm
 = 0 Disable
- Bit 5 : = 1 Enable low temperature alarm
 = 0 Disable
- Bit 6 : = 1 Enable high internal resistance alarm
 = 0 Disable
- Bit 7 : = 1 Enable high intertier resistance alarm
 = 0 Disable
- Bit 8 : = 1 Enable high float current alarm
 = 0 Disable
- Bit 9 : = 1 Enable high intercell resistance alarm
 = 0 Disable
- Bit 10-13: Not used
- Bit 14 : = 1 Enable discharge
 = 0 Disable
- Bit 15: Not used

L. Parameter Option 1&2 register (41636 and 41637) is defined as (= 1: has; = 0: no):

- Bit 0-3 : Current 1-4
- Bit 4-7 : The number of temperatures
- Bit 8-11 : Float current 1-4
- Bit 12-15 : Not used
- Bit 16-25 : Intertier resistance 1-10
- Bit 26 : R-test dual mode
- Bit 27-31 : Not used

M. Control Option register (41638) is defined as

- Bit 0 : = 1 Enable auto call out
 = 0 Disable auto call out
- Bit 1 : = 1 Report problem discharge only
 = 0 Report all discharge
- Bit 2 : = 1 Select "Load Test" in Charger setup
 = 0 Select "Thermal Runaway Detection" in Charger setup
- Bit 3 : = 1 Disable discharge
 = 0 Enable discharge
- Bit 4 : = 1 Disable historical log
 = 0 Enable historical log

Bit 5	:	= 1	Disable R-test
		= 0	Enable R-test
Bit 6	:	= 1	Disable load test
		= 0	Enable load test
Bit 7	:	= 1	Average R-test mode
		= 0	Standard R-test mode
Bit 8	:	= 1	Temperature compensation
		= 0	Normal
Bit 9	:	= 1	Enable Telco MUX
		= 0	Disable Telco MUX

N. Digital Input Selection register (41644) is defined as: Bit = 1: Selected; Bit = 0: Not selected.

O. Digital Input Connection Selection register (41645) is defined as: Bit = 1: Open; Bit = 0: Close.

P. Status register (42385) of Alarm Events is defined as

Bit 0:	= 1	Resistance test in progress
	= 0	No resistance test in progress
Bit 1 - 15:	Not used	

Q. Self Test register of DCM Diagnostics is defined as

Bit 0	:	Processor (8031)
Bit 1	:	External RAM
Bit 2	:	PROM
Bit 3	:	PIO
Bit 4	:	A/D
Bit 5-15	:	Not used

R. Historical Resistance is stored in the following structure:

For MPM configurations:

```

Year / Month of First Record
Day / Hour of First Record
Minute / Second of First Record
Resistance of First Cell in First Record
...
Resistance of Last Cell in First Record
Intertier Resistance 1 in First Record
...
Intertier Resistance 10 in First Record
.....
Year / Month of Last Record
Day / Hour of Last Record
Minute / Second of Last Record
Resistance of First Cell in Last Record
...
Resistance of Last Cell in Last Record

```

Intertier Resistance 1 in Last Record
...
Intertier Resistance 10 in Last Record

For BDS configurations:

Year / Month of First Record
Day / Hour of First Record
Minute / Second of First Record
Resistance of First Cell in First Record
...
Resistance of Last Cell in First Record
Intercell Resistance of First Cell in First Record
...
Intercell Resistance of Last Cell in First Record
Intertier Resistance 1 in First Record
...
Intertier Resistance 15 in First Record
.....
Year / Month of Last Record
Day / Hour of Last Record
Minute / Second of Last Record
Resistance of First Cell in Last Record
...
Resistance of Last Cell in Last Record
Intercell Resistance of First Cell in Last Record
...
Intercell Resistance of Last Cell in Last Record
Intertier Resistance 1 in Last Record
...
Intertier Resistance 15 in Last Record

Here is the detail information about the algorithm to extract the historical resistance data.

1) Extract data

We must follow the following steps to get the historical resistance data.

- 1.1 Calculate the number of bytes for getting one record.
- 1.2 Using function 16 to set Frame Number register (41559) to 0.
- 1.3 Using function 3 to get a frame from 64 registers for the historical resistance (starting address is 44929). In the procedure to get a frame, check whether you have received enough bytes for one frame. If yes, the next byte in the frame will be the first byte of next record. If you see FF at the first byte of a record, that means, there is no more record. Specially, if the first byte of the first frame is FF, that means, there is no any data available. Then, go to 1.7.
- 1.4 Increment Frame Number.
- 1.5 If Frame Number \geq 85, stop, go to 1.7.
- 1.6 Repeat 1.2 - 1.5.
- 1.7 Using function 16 to set Firmware Control register (41542) to 002E to let the hardware erase all old records; Or, set this register to 002F to let the hardware do not erase the data.

2) Process the data for BDS

The data received from the hardware is the raw data. You have to process it before display it.

2.1 Internal Resistance

$$\text{Internal Resistance} = \text{Raw data} / \text{BDSConstant}$$

where

$$\begin{aligned} \text{BDSConstant} &= 2.097152 * 8.065 && (2V \text{ o } 4V \text{ cell}) \\ &= 0.065536 * 5.235 && (\text{Others}) \end{aligned}$$

2.2 Intercell Resistance

$$\text{Intercell Resistance} = \text{Raw data} / 8.192$$

2.3 Intertier Resistance

$$\text{Intertier Resistance} = \text{Raw data} / 2.048$$

3) Process the data for MPM

3.1 Internal Resistance

$$\text{Internal Resistance} = \text{Raw data} / \text{BDSConstant}$$

where

$$\begin{aligned} \text{BDSConstant} &= 2.097152 && (2V \text{ cell}) \\ &= 5.24288 && (4V \text{ cell}) \\ &= 1.31072 && (6V \text{ cell}) \\ &= 1.31072 && (8V \text{ cell}) \\ &= 0.65536 && (12V \text{ cell}) \end{aligned}$$

3.2 Intertier Resistance

$$\text{Intertier Resistance} = \text{Raw data} / 2.048$$

S. Historical Data is stored in the following structure:

Year / Month of First Record
Day / Hour of First Record
Minute / Second of First Record
Cell Voltage of First Cell in First Record
....
Cell Voltage of Last Cell in First Record
Overall Voltage in First Record
Current 1 in First Record
....
Current 8 in First Record
Temperature 1 in First Record
....
Temperature 10 in First Record
Ground Fault in First Record
.....
Year / Month of Last Record
Day / Hour of Last Record
Minute / Second of Last Record
Cell Voltage of first Cell in Last Record
....
Cell Voltage of Last Cell in Last Record
Overall Voltage in Last Record
Current 1 in Last Record
....
Current 8 in Last Record
Temperature 1 Last First Record
....
Temperature 10 in Last Record
Ground Fault in Last Record

T. Data Type in Discharge Data is defined as:

- Bit 15 : End symbol (= 0: new record; = 1: End)
- Bit 13-14 : Status defined as follows.
 - Bit 14=1, Bit 13=0: Discharge start (attached on the first record)
 - Bit 14=0, Bit 13=1: Discharge end (attached on the last record)
 - Bit 14=0, Bit 13=0: Discharge in progress (attached on all middle records)
- Bit 10-12 : Parameter type
 - Bit 12=0, Bit 11=0, Bit 10=0: Cell voltage
 - Bit 12=1, Bit 11=0, Bit 10=0: Overall voltage
 - Bit 12=0, Bit 11=1, Bit 10=0: Discharge current 1
 - Bit 12=1, Bit 11=1, Bit 10=0: Temperature
 - Bit 12=0, Bit 11=0, Bit 10=1: Not used
 - Bit 12=0, Bit 11=1, Bit 10=1: Discharge current 2
 - Bit 12=1, Bit 11=0, Bit 10=1: Discharge current 3
 - Bit 12=1, Bit 11=1, Bit 10=1: Discharge current 4
- Bit 9 : = 0 : Discharge data
= 1 : Load test data
- Bit 0-8 : Cell number (0 – 511)

Cell Number is given the temperature number (0 – 9, which indicates temperature 1 - 10) for temperature alarms. After the last record, 0FFH is stuffed into all remaining spaces of the memory.

U. The address of Modem Multiplexer Box is 0FFH. Its memory mapping is shown below:

Name	Logic Address
Device Channel Number	0000H

Device Channel Number is a number between 1 - 16.

3. Function and Data Fields of Commands Sent by Master

Function			Data	
Name	Byte 3	Byte 4	Values	Byte #
Read Holding Registers (Function 3)	30H	33H	First byte of starting address (H)	Byte 5
			First byte of starting address (L)	Byte 6
			Second byte of starting address (H)	Byte 7
			Second byte of starting address (L)	Byte 8
			First byte of number of points (H)	Byte 9
			First byte of number of points (L)	Byte 10
			Second byte of number of points (H)	Byte 11
			Second byte of number of points (L)	Byte 12
Preset Multiple Registers (Function 16)	31H	30H	First byte of starting address (H)	Byte 5
			First byte of starting address (L)	Byte 6
			Second byte of starting address (H)	Byte 7
			Second byte of starting address (L)	Byte 8
			First byte of number of points (H)	Byte 9
			First byte of number of points (L)	Byte 10
			Second byte of number of points (H)	Byte 11
			Second byte of number of points (L)	Byte 12
			Byte count (H)	Byte 13
			Byte count (L)	Byte 14
			First byte of value 1 (H)	Byte 15
			First byte of value 1 (L)	Byte 16
			Second byte of value 1 (H)	Byte 17
			Second byte of value 1 (L)	Byte 18
.....			

Notes:

1. The starting address, number of points, and data values that are to be set each have 2 bytes. The first byte is the high byte; the second byte is the low byte.
2. (H) indicates the ASCII code of high 4 bits of hex number; (L) indicates the ASCII code of low 4 bits of hex number.

4. Function and Data Fields of Response Sent by Slave

Function			Data	
Name	Byte 3	Byte 4	Values	Byte #
Read Holding Registers (Function 3)	30H	33H	Byte count (H)	Byte 5
			Byte count (L)	Byte 6
			First byte of value 1 (H)	Byte 7
			First byte of value 1 (L)	Byte 8
			Second byte of value 1 (H)	Byte 9
			Second byte of value 1 (L)	Byte 10
		
Preset Multiple Registers (Function 16)	31H	30H	First byte of starting address (H)	Byte 5
			First byte of starting address (L)	Byte 6
			Second byte of starting address (H)	Byte 7
			Second byte of starting address (L)	Byte 8
			First byte of number of points (H)	Byte 9
			First byte of number of points (L)	Byte 10
			Second byte of number of points (H)	Byte 11
Second byte of number of points (L)	Byte 12			

5. Using the Commands

In the communication frames, only integer numbers can be transmitted. The transformation between integer number and decimal number is necessary when the computer receives and sends the data.

Data Transformation

Parameters	Transformation	
	Before Send	After Receive
Overall voltage (volts)		$\div 2^4$
Cell voltage (volts)		$\div 2^{10}$
Discharge and test current (amps)		$\times \text{Shunt} \div 2^7$
Float current (manps)		$\times \text{FConstant}^*$
Internal resistance ($\mu\Omega$)		$\div \text{RConstant}^{**}$
Intertier resistance ($\mu\Omega$)		$\times 10^3 \div 2^{11}$
Intercell resistance ($\mu\Omega$)		$\times 10^3 \div 2^{17}$
Temperature		see below
Calibration for overall voltage	$\times 2^{17}$	$\div 2^{17}$
Calibration for cell voltage	$\times 2^{24}$	$\div 2^{24}$
Calibration for discharge & float current	$\times 2^{18}$	$\div 2^{18}$
Calibration for test current	$\times 2^{17}$	$\div 2^{17}$
Calibration for intertier voltage	$\times 2^{18}$	$\div 2^{18}$
Calibration for temperature	$\times 2^{17}$	$\div 2^{17}$
Calibration for intercell resistance	$\times 2^{20}$	$\div 2^{20}$
Threshold of overall voltage	$\times 2^4$	$\div 2^4$
Threshold of cell voltage	$\times 2^{10}$	$\div 2^{10}$
Threshold of float current	$\div \text{FConstant}^*$	$\times \text{FConstant}^*$
Threshold of temperature	$\times 2^7$	$\div 2^7$
Threshold of internal resistance	$\times \text{Rconstant}^{**}$	$\div \text{Rconstant}^{**}$
Threshold of intertier resistance	$\times 2^{11} \div 10^3$	$\times 10^3 \div 2^{11}$
Threshold of intercell resistance	$\times 2^{13} \div 10^3$	$\times 10^3 \div 2^{13}$
Discharge level in voltage mode	$\times 2^4$	$\div 2^4$
Discharge level in current mode	$\div \text{Shunt} \times 2^7$	$\times \text{Shunt} \div 2^7$

*The constant to transform the float current, Fconstant, is defined as follows

$$\text{Fconstant} = \text{Shunt} \times 100 \times \text{Float Current Multiplier} \div 2^7$$

**The constant to transform the internal resistance, RConstant, is defined as follows

MPM:

$$\begin{aligned} \text{RConstant} &= 2^{21} \div 10^6 && (2 \text{ volts module}) \\ &2^{19} \div 10^5 && (4 \text{ volts module}) \\ &2^{17} \div 10^5 && (6 \text{ volts module}) \\ &2^{16} \div 10^5 && (12 \text{ volts module}) \end{aligned}$$

BDS:

$$\begin{aligned} \text{RConstant} &= 2^{21} \div 10^6 \times 8.065 && (2 \text{ and } 4 \text{ volts module}) \\ &2^{16} \div 10^6 \times 5.235 && (\text{Others}) \end{aligned}$$

When the firmware processes the temperature, the unit of the temperature is always Centigrade (°C). Therefore, in the U.S., the temperature and its constants need to be converted from Centigrade (°C) to Fahrenheit (°F) when the computer receives the value from the firmware, and converted from (°F) to (°C) before the computer sends the value to the firmware. Also, when the computer receives the temperature value (16 bits), before convert from (°C) to (°F) if necessary, the following transformation has to be done:

$$\begin{aligned} \text{If Bit 15 (Most significant bit)} &= 0 \\ \text{Temperature} &= \text{Received value} / 128 && (\text{Temperature} \geq 0) \\ \\ \text{If Bit 15 (Most significant bit)} &= 1 \\ \text{Temperature} &= -1 * (\text{Received value} - 32768) / 128 && (\text{Temperature} < 0) \end{aligned}$$

The peak value of Temperature uses a different definition in MPM and BDS configurations. When the computer receives the peak value of temperature, the following transformation has to be done:

$$\begin{aligned} \text{Peak value} &= \text{Received value} / 128 - 100 && (\text{in MPM}) \\ \text{Peak value} &= \text{Received value} / 128 && (\text{in BDS}) \end{aligned}$$

The discharge current uses the following format:

$$\begin{aligned} \text{bit 15} &= 1: \text{ Discharge current} > 0 \\ &= 0: \text{ Discharge current} < 0 \\ \text{bit 0-14} &= \text{ Absolute value} \end{aligned}$$

6. Examples

Here are some examples to show how to use the Modbus Protocol to get the data from the MPM.

6.1 Read a Single Register

Here is an example of a frame to obtain Overall Voltage of Battery 2. The master should send the following frame to the slave:

:020306000001 <LRC> CR LF

The slave should respond with the following frame:

:020302 <OV Raw Value (2 Bytes)> <LRC> CR LF

Thus,

$$\text{Overall Voltage} = \text{OV Raw Value} \div 2^4$$

6.2 Read Multiple Registers

Here is an example of a frame to obtain Cell Voltage 1 to 30 of Battery 1. The master should send the following frame to the slave:

:01030000001E <LRC> CR LF

The slave should respond with the following frame:

:01033C <CV1 Raw Value> <CV2 Raw Value> . . .
<CV30 Raw Value> <LRC> CR LF

Thus, for Cell x (x = 1, 2, . . . , 30),

$$\text{Cell Voltage } x = \text{CV}_x \text{ Raw Value} \div 2^{10}$$

6.3 Read Current Alarms

To get the current alarms in registers starting from register 41793, End Symbol (Bit 15) of Alarm Type must be checked when reading each record (4 registers). If it is 0, this record contains current alarm information; if it is 1, there are no more current alarms after this point.

6.4 Read Historical Alarms

Because the historical alarms are stored in a cyclic queue which is composed of registers 43073 - 44671, the position of new alarms may be located before the old alarms. Thus, all 100 records must be checked. If End Symbol (Bit 15) of Alarm Type is 0, this record (8 registers) contains a historical alarm information; If it is 1, go to check next record.

6.5 Read Current Resistances

Just like 7.2, the current resistances can be gotten from registers 40513 - 41023.

6.6 Read Historical Resistances

To get the historical resistances in registers starting from register 44709, the Year / Month register of each record must be checked first. If Bit 15 (MSB) of the Year / Month register is 0, this record contains historical resistances; if it is 1, there is no more historical resistance after this point.

6.7 Read Discharge

Function 04H must be used to get discharge data. Before reading each record (5 registers), End Symbol (Bit 15) of Data Type should be checked. If it is 0, this record contains discharge information; if it is 1, there is no more discharge data after this point.

7. References

This document may be found on the Albécorp Web site in the Technical Library/Modbus Register Maps section under MPM-100. Access Albécorp on the Web at: <http://www.alber.com>

Consult the following source for assistance with the Modbus protocol:

Modicon Modbus Protocol Reference Guide.

Modicon, Inc., Industrial Automation Systems, 1 High Street, North Andover, MA 01845

Modicon, Inc. is on the Web at: <http://www.modicon.com>

Consult the following source for third party test software to access all of the MPM Modbus registers:

Wintech Software, P.O. Box 907, Lewisburg, WV 24901

Wintech is on the Web at <http://www.win-tech.com>

The test software is Modscan.