PDU 1 Channel Specification-1

Original Document Approval Information			
Action	**Name**	**Position**	**Date**
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Document Revision History			
Revision	**Description**	**Approved By**	**Date**
-		M. Avrutsky	09-26-2018
A	Added discrete description	M. Avrutsky	05-03-2020
B	Channel Status 2 command fixed typos	M. Avrutsky	11-18-2020
C	Added zero padding description for data in Par 7.3.1 Fixed Par 7.3.4.4 Opcode	M. Avrutsky	11-19-2020

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1 General Description

- Defined maximum current per channel – Current Limit
- Large capacitance charge capability
- 1 input 8 output Power distribution unit.
- Configurable current breaker per Switch – Overload Protection Switch
- I^2t curve for overload switching delay duration
- Configurable turn-on sequence by card wake up and by discrete input
- Meets MIL-STD-1275E
  - Steady state Voltage levels 6V - 33V
  - Surge 100V 50ms & Spike 250V 70µs
  - Reverse voltage protection for both card and consumers
- Meets MIL-STD- 461E\F
- Interface and control:
  - RS – 485 interface
  - CAN interface
  - 5 Discrete inputs
  - 1 Discreet output (Trip error output)
  - Manual shutdown input

2 Electrical Characteristics

Table 1 - Electrical Characteristics

SPECIFICATIONS (T_A = 25°C unless otherwise noted)						
Power						
Symbol	**Parameter**	**Conditions**	**Min.**	**Typ.**	**Max.**	**Units**
	Drop voltage	I_{OUT} = 25A for All outputs		70		mV
I_{LIM}	Short circuit current programing range	Vin =28V, short at output	13		125	A
t_{LIM}	Short circuit duration	Vin = 33V, I_{LIM}= 125A Vin = 28V, I_{LIM}= 13A		0.5 8		ms
	clamp voltage			65		V
I_{CUT}	Overload current programing range		3		25	A
ΔI_{CUT}	Overload current programing resolution			0.5		A
	Capacitive load charge	Vin = 28V, I_{LIM}= 13A Vin = 33V, I_{LIM}= 125A Vin = 28V, I_{LIM}= 20A			9 3.5 7	mF
	Current measure accuracy			0.25		A
	Current measure resolution			0.1		A
	Voltage measure accuracy			0.05		V
	Voltage measure resolution			0.05		V
Discrete Inputs & Manual Reset (Over Temperature Range)						
V_{PU}	Pullup voltage		3.23	3.3	3.37	V
R_{PU}	Pullup resistance		9.5	10	11	KΩ
V_{IL}	Negative-going threshold		0.55	0.9	1.25	V
V_{IH}	Positive-going threshold		0.85	2	2.55	V
$t_{W,MIN}$	Minimal input pulse length	From input to controller detection	0.2		100	µs

Table 2 - Electrical Characteristics (cont'd)

SPECIFICATIONS (T_A = 25°C unless otherwise noted)						
Discrete & Trip Error Outputs (Over Temperature Range)						
Symbol	**Parameter**	**Conditions**	**Min.**	**Typ.**	**Max.**	**Units**
R_{OC}	Open Collector resistance	Output is logic level low	9.5	10	11	KΩ
I_{LEAK}	Output leakage current	Output is logic level high T_A = 25°C T_A = 55°C			 0.5 10	µA
RS-485 (Over Temperature Range)						
R_{DIFF}	Differential input resistance		100			KΩ
V_{OD}	Differential driver output		2		3.37	V
V_{ITH}	Input receiver threshold		-200	-125	-50	mV
Br	Baudrate configuration option		1200		115200	bps
CANbus (Over Temperature Range)						
R_{DIFF}	Differential input resistance		100			KΩ
Br	Baudrate configuration option		250		1000	kbps

3 Connectors & Pin$_{OUT}$

Table 3 - Connectors & Pin$_{OUT}$

Pin Number	P1 Pins Name	P2 Pins Name
A1	VIN	CH7_OUT
A2	VIN	CH6_OUT
A3	VIN	CH5_OUT
A4	VIN	CH4_OUT
A5	VIN	CH3_OUT
A6	VIN	CH2_OUT
A7	VIN_RTN	CH1_OUT
A8	N/A	CH0_OUT
1	CAN_L	
2	CAN_H	
3	BATTLE_SHORT_N	
4	DCI_N	
5	BR1	
6	BR2	
7	ADDR _RTN	
8	ADDR_1	
9	FAULT_OUT	
10	ADDR_2	
11	RAT	
12	ADDR_3	
13	SHUTDOWN_N	
14	28VDC_RTN	
15	IS_COM_GND	
16	RS_485_P	
17	RS_485_N	

4 Typical Characteristics

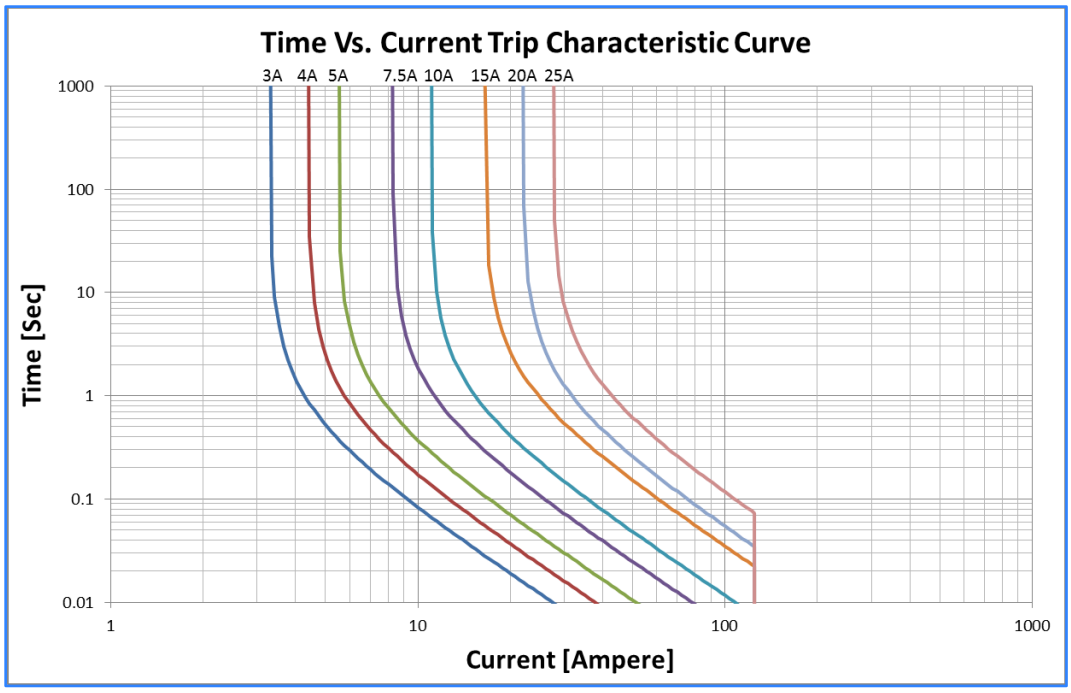

Figure 1 - Time vs. Current Trip

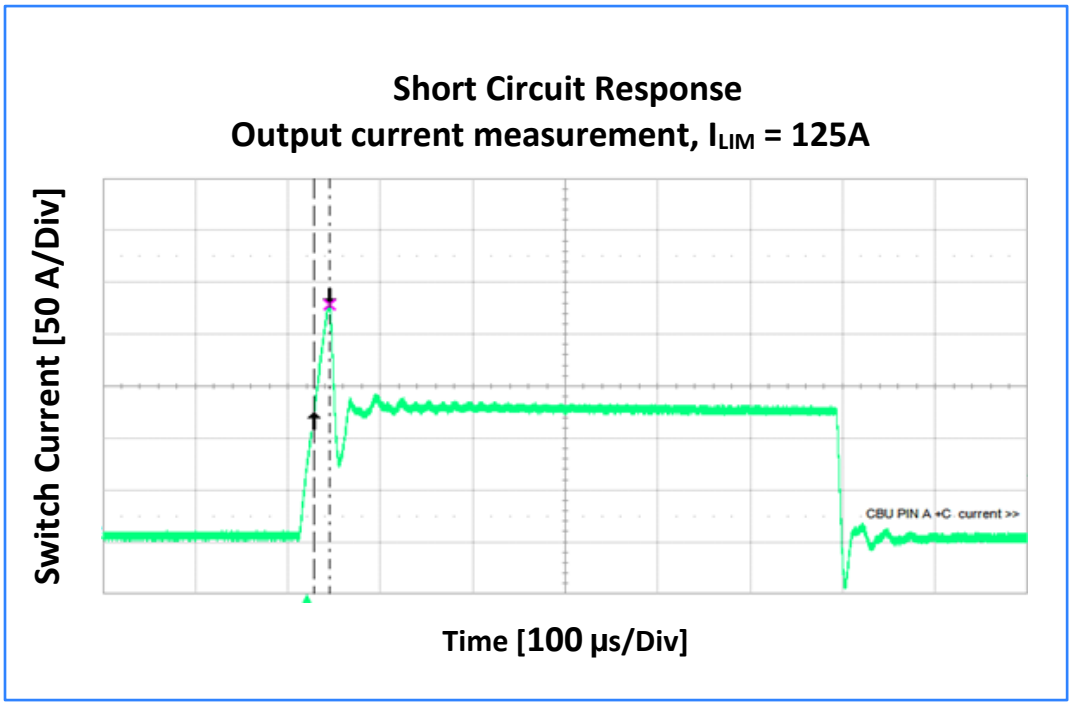

Figure 2 - Short Circuit Response

5 Overview

5.1 Interface Description

5.1.1 POR

Power On Reset (POR) is a sequence of operations that happens automatically when device starts up. The PDU has the ability to start pre defines switches automatically on POR and wait a predefined amount of time between each switch. The delay and sequencing options let the whole system to start smoothly with as low as possible stress.

To configure POR the user should send a macro command with element = 230 and State = 1. Later the user should send commands that support macros like switch on/off and delay. When complete the user should send the macro command again but with State = 0.

5.1.2 Discrete Inputs

M9516-1 has 3 discrete inputs which can help control the device:

BATTLE_SHORT_N - active low signal. If active then all outputs are switched to battle mode. Switch will not trip due to overload, but it will trip in case of shortcircuit. If short-circuit ocure then the switch will trip but will shortly resume in a auto retry mode.

DCI_N – General discrete that can configure automatic enable and disable of outputs. Each output can turn on in delay from previous output.

RAT – active low signal. reset the trip status of all outputs.

5.1.3 Discrete Outputs

FAULT_OUT is active low signal, if any of the outputs trips, then the FAULT_OUT signal is shorthed to 28VDC_RTN.

5.1.4 CAN and RS485

Interfaces exist for commands, telemetries and program parameters. See chapter **Error! R eference source not found.** for more information.

6 Compliance

6.1 Environmental

1. MIL-STD-810E:
    a. Vibrations: Method 514.5 Category 20
    b. Functional Shock: Method 516.4 Procedure I

6.2 EMC

2. MIL-STD-1275E
3. MIL-STD-1275D , Surge (3.1.2.1)*
4. MIL-STD-461F:
    a. CE102, conducted emissions, power leads, 10 kHz to 10 MHz
    b. CS101, conducted susceptibility, power leads, 30 Hz to 150 kHz
    c. CS114, conducted susceptibility, bulk cable injection, 10 kHz to 200 MHz
    d. CS115, Conducted susceptibility, bulk cable injection, impulse excitation
    e. CS116, conducted susceptibility, damped sinusoidal transients, cables and power leads, 10 kHz to 100 MHz
    f. RE102, radiated emissions, electric field, 10 kHz to 18 GHz*
    g. RS103, radiated susceptibility, electric field, 2 MHz to 40 GHz

7 Communication Interface

7.1 RS-485 Messages

7.1.1 Message Structure

The communication is ASCII coded. Every RS-485 packet starts with ':' char and ends with '\r\n' chars. Message format is:

Parameter	Description	Values	Type
Start Byte	Each packet start with this byte. If previous message didn't complete receiving it will be discarded.	':' (0x3A)	char
Address	Address to which the message is intended.	{0b110,ADDR[3:1],0b00}	Uint8
Type	The purpose of the message.	0x65 – RS-485 Configuration 0x67 – All other messages	Uint8
Payload	The payload data of the message	If Type is 0x65 see par. 0 If type is 0x67 see par. 7.3	Uint8[8]
Checksum	Message error detection checksum byte	See calculation	Uint8
End Bytes	Each packet ends with these bytes.	'\r\n' (0x0D0A)	Char[2]

7.1.2 Payload for 0x65 messages

0x65 message is used to configure the RS-485 protocol parameters. Payload structure is:

Parameter	Description	Values	Type
Baudrate	Baud rate to be used in none default mode. Formula: 2995200/(Baudrate in bps)	26 - 2496 Default is 156	Uint16
Parity	Parity selected	0 – None 1 – Even 2 – Odd	Uint8
Timeout	Byte timeout for which a message will be discarded. Formula: (time in seconds) * 0.1	1 – 50 Default is 10	Uint8
Null	Not used bytes	Don't care	Uint8[4]

7.1.3 Checksum calculation

Checksum is calculated without the start and end bytes, the sum of the bytes modulo 256 should be zero.

7.2 CAN BUS Messages

7.2.1 Message Structure

The PDU is using SAE J1939 over CAN. The CAN ID structure for all messages sent to PDU is:

0xC77E	ADDR[3:1]	0x0	Source Computer Address
Length 16 bits	Length 3 bits	Length 2 bits	Length 8 bits

Followed by Control set for data frame and 8 bytes of data.

CAN ID for return messages from PDU will be:

0x18EF	Source Computer Address	0x6	ADDR[3:1]	0x0
Length 13 bits	Length 8 bits	Length 3 bits	Length 3 bits	Length 2 bits

Followed by Control set for data frame and 8 bytes of data.

Alert messages will be with the following CAN ID format:

0x18FFF1	0x6	ADDR[3:1]	0x0
Length 21 bits	Length 3 bits	Length 3 bits	Length 2 bits

Followed by Control set for data frame and 8 bytes of data.

The Data bytes for CAN message are the same as the payload bytes for 0x67 RS-485 messages and appear in Section 7.3

7.3 Message Payload

7.3.1 Payload general structure

The data is in format of little-endian. Payload structure to both CAN and RS-485 Messages:

Parameter	Description	Values	Type
OpCode	A code to specify the command	Odd number x for command Even number x+1 for response	Uint8
Status	A field applicable to response only notifying the execution status of the command.	See following description	Bit[6]
R/W	A flag to set the command as write or read or macro command. Not all opcodes have all the options	0 – Read 1 – Write 2 – Macro	Bit[2]
Data	A data related to the opcode. If data is less then 6 bytes, then it will be padded with zeros.	See next paragraphs	

Status values and meaning:

Status Value	Description
0x00	Successful execution
0x01	General R/W error
0x02	Read not supported for opcode
0x03	Write not supported for opcode
0x05	Error writing to flash
0x07	Wrong element selected
0x08	Channel number doesn't exist
0x09	Group number doesn't exist
0x0A	Sensor doesn't exist
0x0B	Board doesn't exist
0x0C	Wrong address
0x0D	Wrong page
0x14	Wrong State
0x17	Wrong flash index
0x18	Wrong flash key
0x20	Group is empty
0x30	Current limit or overload threshold is out of bounds
0x3E	Opcode doesn't exist
0x3F	General Error

7.3.2 Controls

7.3.2.1 Channel Control 1

The command turns on or off a channel or a group. If selected write command than the channel or group will be effected immediately. If selected as part of macro sequence than the channel or group will be effected when macro is triggered.

Parameter	Description	Values	Type
OpCode	A code to specify the command	0x01 for command 0x02 for response	Uint8
Status	A field applicable to response only notifying the execution status of the command.	See 7.3.1	Bit[6]
R/W	A flag to set the command as write or read or macro command.	1 – Write 2 – Macro	Bit[2]
Element	The Channel or group to control	Channel 0-99 : 0 – 99 Group 0-49 : 100 - 149	Uint8
State	Turn on or off selection	0 – Turn off 1 – turn on	Uint8

7.3.2.2 Channel Control 2

The command enables or disables battle mode for channel or a group. When enabled, the channel or group will to disconnect due to over load. In case of short circuit the switch will disconnect only if overheated and after it cools it will retry. If selected write command than the channel or group will be effected immediately. If selected as part of macro sequence than the channel or group will be effected when macro is triggered.

Parameter	Description	Values	Type
OpCode	A code to specify the command	0x03 for command 0x04 for response	Uint8
Status	A field applicable to response only notifying the execution status of the command.	See 7.3.1	Bit[6]
R/W	A flag to set the command as write or read or macro command.	1 – Write 2 – Macro	Bit[2]
Element	The Channel or group to control	Channel 0-99 : 0 – 99 Group 0-49 : 100 - 149	Uint8
Battle	Battle mode enable disable	0x00 – Disable 0x0D – Enable Else – No action	Uint8

7.3.2.3 Reset

The command resets the device immediately.

Parameter	Description	Values	Type
OpCode	A code to specify the command	0x07 for command 0x08 for response	Uint8
Status	A field applicable to response only notifying the execution status of the command.	See 7.3.1	Bit[6]
R/W	A flag to set the command as write or read or macro command.	1 – Write	Bit[2]

7.3.3 Status

7.3.3.1 Channel Status 1

Parameter	Description	Values	Type
OpCode	A code to specify the command	0x21 for command 0x22 for response	Uint8
Status	A field applicable to response only notifying the execution status of the command.	See 7.3.1	Bit[6]
R/W	A flag to set the command as write or read or macro command.	0 – Read	Bit[2]
Element	The Channel or group to control	Channel 0-99 : 0 – 99 Group 0-49 : 100 - 149	Uint8
Current	Current of selected channel or group	Current = Value*0.01 – 80,000	Uint24
Voltage	Voltage of selected channel or group	Voltage = Value*0.05 – 1,606	Uint16

7.3.3.2 Channel Status 2

Parameter	Description	Values	Type
OpCode	A code to specify the command	0x25 for command 0x26 for response	Uint8
Status	A field applicable to response only notifying the execution status of the command.	See 7.3.1	Bit[6]
R/W	A flag to set the command as write or read or macro command.	0 – Read	Bit[2]
Element	The Channel or group to control	Channel 0-99 : 0 – 99	Uint8

		Group 0-49 : 100 - 149	
SwState	Switch physical state	0 – Off 1 - On	Bit[2]
CmdState	Switch commanded state	0 – Off 1 - On	Bit[2]
OutputV	Output voltage is greater than 60% of input	0 – Voltage is low 1 – Voltage is high	Bit[2]
OutputI	Output current is greater than 30% of overload setting current	0 – Current is high 1 – Current is high	Bit[2]
Trip	Trip status of output	0 – No trip has occurred 1 – Trip has occurred	Bit[4]
BIT	BIT Status of selected output. Bit is asserted when output voltage doesn't appear when switch is supposed to be on (on command and no trip) or when voltage or current appear when switch is supposed to be off (off command or trip)	0 – Normal 1 - Error	Bit[2]
Battle	Battle status of output	0 – Normal 1 – Battle	Bit[2]
Group	Group of selected output	0 – 50 when grouped 251 – when not grouped	Uint8
N\A	For future use		Uint8
N\A	For future use		Bit[6]
Sharing	Status of current distribution between to switches of same group. Asserted when more than 10% difference between switches	0 – OK 1 – Current isn't shared	Bit[2]

7.3.3.3 Input Status

Parameter	**Description**	**Values**	**Type**
OpCode	A code to specify the command	0x27 for command 0x28 for response	Uint8
Status	A field applicable to response only notifying the execution status of the command.	See 7.3.1	Bit[6]
R/W	A flag to set the command as write or read or macro command.	0 – Read	Bit[2]
Element	Selection of input	190	Uint8

Current	Current of selected channel or group	Current = Value*0.01 – 80,000	Uint24
Voltage	Voltage of selected channel or group	Voltage = Value*0.05 – 1,606	Uint16

7.3.3.4 Temperature

Parameter	Description	Values	Type
OpCode	A code to specify the command	0x33 for command 0x34 for response	Uint8
Status	A field applicable to response only notifying the execution status of the command.	See 7.3.1	Bit[6]
R/W	A flag to set the command as write or read or macro command.	0 – Read	Bit[2]
Element	Selection of input	152	Uint8
Temperature	Board temperature in degrees centigrade	Temp. = Value*0.03125 – 273	Uint16

7.3.3.5 Grouped Channels

Parameter	Description	Values	Type
OpCode	A code to specify the command	0x35 for command 0x36 for response	Uint8
Status	A field applicable to response only notifying the execution status of the command.	See 7.3.1	Bit[6]
R/W	A flag to set the command as write or read or macro command.	0 – Read	Bit[2]
Element	Selection of input	Group 0-49 : 100 - 149	Uint8
N\A	For future use		Uint8
Channel_0	Channel 0 membership to the specified group	0 – Channel 0 is not part of the group 1 - Channel 0 is part of the group	Bit[2]
Channel_1	Channel 1 membership to the specified group	0 – Channel 1 is not part of the group 1 - Channel 1 is part of the group	Bit[2]
Channel_15	Channel 15 membership to the specified group	0 – Channel 15 is not part of the group 1 - Channel 15 is part of the group	Bit[2]

7.3.4 Configuration

7.3.4.1 Channel Setting

Parameter	Description	Values	Type
OpCode	A code to specify the command	0x61 for command 0x62 for response	Uint8
Status	A field applicable to response only notifying the execution status of the command.	See 7.3.1	Bit[6]
R/W	A flag to set the command as write or read or macro command.	0 – Read 1 – Write	Bit[2]
Element	Selection of input	Channel 0-99 : 0 – 99 Group 0-49 : 100 - 149	Uint8
OverLoad	Overload threshold setting, where I2T curve is active	Current = Value*0.01 – 80,000	Uint24
CLimit	Current limit threshold setting, where active current limit is applied to protect from short circuit	Current = Value*0.5	Uint16

7.3.4.2 Calibration

Parameter	Description	Values	Type
OpCode	A code to specify the command	0x67 for command 0x68 for response	Uint8
Status	A field applicable to response only notifying the execution status of the command.	See 7.3.1	Bit[6]
R/W	A flag to set the command as write or read or macro command.	1 – Write	Bit[2]
Element	Selection of channel	Channel 0-99 : 0 – 99	Uint8
CalType	Calibration type	0 – Offset Calibration 1 – Current Slope 2 – Voltage Slope 3 – Factory Setting	Uint8
Data	Data relative to CalType field	See Table	Uint8[3]

R/W	CalType	Data
Write	Offset calibration	If channel if off than an offset calibration is performed for current and voltage management. Data will be ignored If channel is off than the message will return Error 0x3F(General)
Write	Current Slope	Data[3:0] – the current measured externally formatted as value = Current*100 + 8,000,000
Write	Voltage Slope	Data[3:0] – the voltage measured externally formatted as value = Voltage*20 + 32,120
Write	Factory Setting	Set to Factory setting. Data is ignored.

7.3.4.3 Save Configuration

Parameter	**Description**	**Values**	**Type**
OpCode	A code to specify the command	0x71 for command 0x72 for response	Uint8
Status	A field applicable to response only notifying the execution status of the command.	See 7.3.1	Bit[6]
R/W	A flag to set the command as write or read or macro command.	1 – Write	Bit[2]
FlashPage	Flash page where current configuration will be saved	0 - 7	Uint8
MagicNum	Magic number to enable configuration save	0xACAB	Uint16

7.3.4.4 Page Mapping

Parameter	Description	Values	Type
OpCode	A code to specify the command	0x73 for command 0x74 for response	Uint8
Status	A field applicable to response only notifying the execution status of the command.	See 7.3.1	Bit[6]
R/W	A flag to set the command as write or read or macro command.	0 – Read 1 – Write	Bit[2]
Address	Address for the flash page to link to.	0 - 7	Uint8
Page	Flash page to link to Address	0 – 7	Uint8
Page_2	Flash page to link to Address+1	0 – 7 – in order to link 255 – in order to ignore	Uint8
Page_3	Flash page to link to Address+2	0 – 7 – in order to link 255 – in order to ignore	Uint8
Page_4	Flash page to link to Address+3	0 – 7 – in order to link 255 – in order to ignore	Uint8
Page_5	Flash page to link to Address+4	0 – 7 – in order to link 255 – in order to ignore	Uint8

7.3.4.5 Macro Record

Parameter	Description	Values	Type
OpCode	A code to specify the command	0x83 for command 0x84 for response	Uint8
Status	A field applicable to response only notifying the execution status of the command.	See 7.3.1	Bit[6]
R/W	A flag to set the command as write or read or macro command.	1 – Write	Bit[2]
Element	Selection of element to configure macro to	POR - 230	Uint8
State	Macro Start and stop options	0 – Stop Recording 1 – Start Recording high triggered macro	Uint8

		2 – Start Recording low triggered macro 3 – Change macro mask	

7.3.4.6 Delay (For Macro Use)

Parameter	Description	Values	Type
OpCode	A code to specify the command	0x85 for command 0x86 for response	Uint8
Status	A field applicable to response only notifying the execution status of the command.	See 7.3.1	Bit[6]
R/W	A flag to set the command as write or read or macro command.	1 – Write	Bit[2]
Delay	Delay time in milliseconds		Uint16