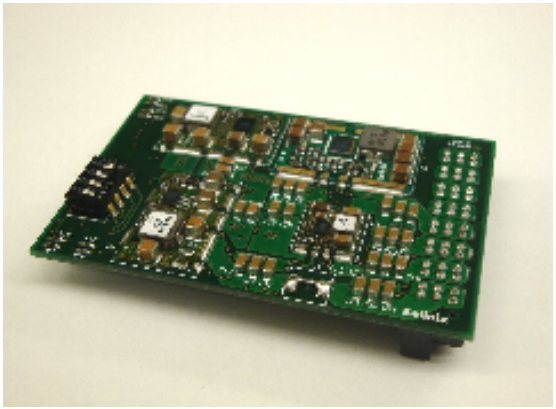
MGT Power Module Instruction Manual



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1. Scope

This document describes function of a multi-output power supply module that will provide all necessary voltage rails for Virtex-6 GTH or 7-Series GTX and GTH transceivers when mated to Xilinx multi-gigabit transceiver (MGT) characterization boards.

2. Feature List

The power modules include:

- Four output rails: 1.0-1.1V @ 12W, 1.1-1.2V @ 9.5W, 1.2V @ 1.5W and 1.8V @ 5W POL (Point Of Load) DC/DC converter modules made Bellnix Co., Ltd. are mounted
- Independent connectors for power and control
- Digitally controlled voltage set point and margining
- Digital current measurement
- Control interface: PMBus
- Differential point-of-load voltage sensing for each output rail
- Differential current sensing using host platform mounted sense resistors
- Power-on reset (POR_B)
- Power-up and power-down sequencing

Output rail names and default set-point voltages are different according to the intended host platform as shown in Table 1

Output Rail Number	Virtex-6 GTH	7-Series MGT	Bellnix DC/DC converter module
1	MGTHAVCC	MGTAVCC	BSV-1.5S12R0H
2	MGTHAVCCRX	MGTAVTT	BSV-3.3S8R0M
3	MGTHAVTT	(NOT USED)	BSV-1.8S4R0NA
4	MGTHAVCCPLL	MGTVCCAUX	BSV-3.3S3R0M

Table 1 Output Rail Names as a Function of FPGA Family and model name of DC/DC converter module

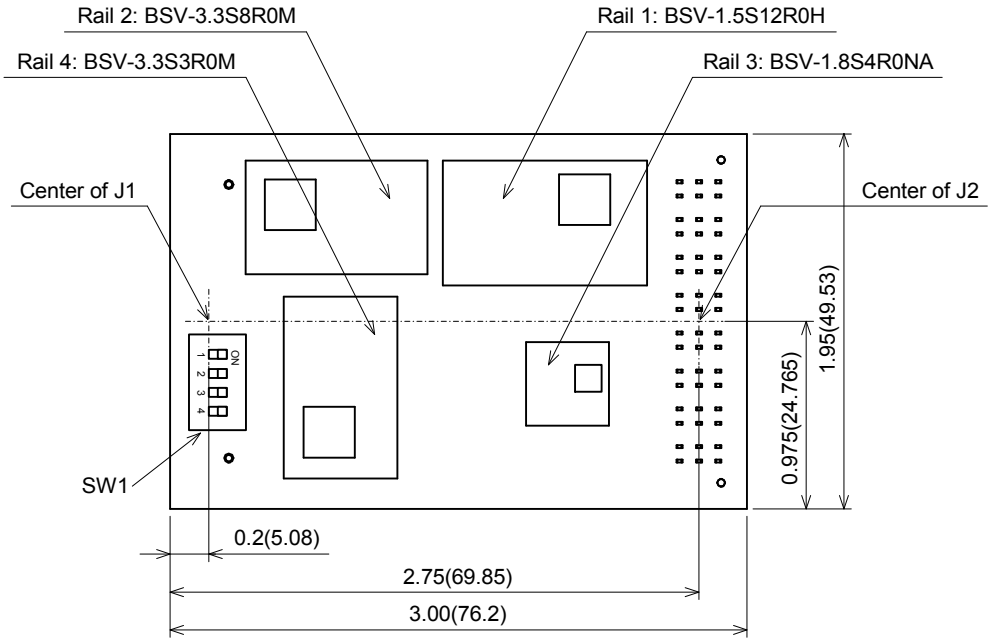
3. Specifications

3.1. Mechanical

The module use two different connectors to interface with the host platform: an 8-contact blade style connector for power and an 80-pin, 0.8mm connector for control and status.

It has DIP switches (SW1) that select output voltage and sequence settings for GEN6 GTH or 7-Series MGT and PMBus Device Address.

3.1.1. PCB Dimensions



Dimmention: Inches(mm)

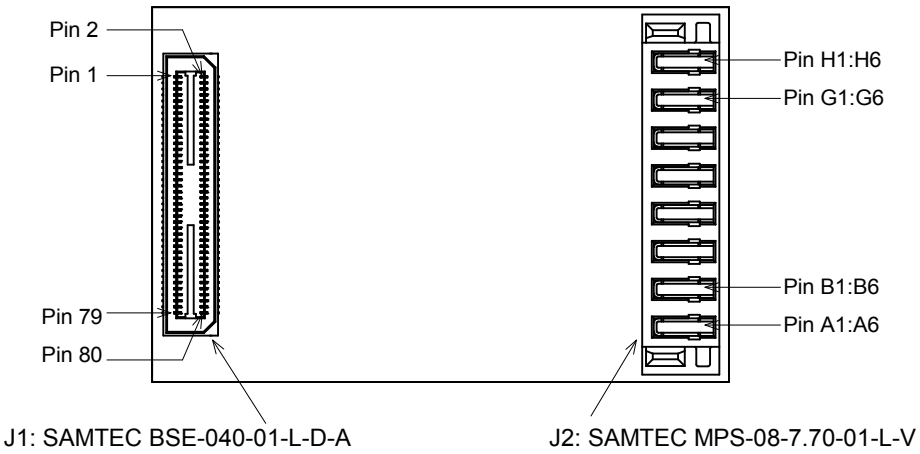


Figure 1 PWB Form Factor and Connector Locations

3.1.2. Power Connector

A SAMTEC MPS-08-7.70-01-L-V power strip is used for analog voltages and analog ground.

Power connector pin assignments are shown in Table 2.

Connector Pin	Description	Type	Max Current[A]
A1:A6	NC	—	—
B1:B6	5.0V	IN	8.0
C1:C6	NC	—	—
D1:D6	GND	IN	20
E1:E6	HGTHAVCC, GEN6	OUT	5.2
	MGTAVCC, 7-Series		12.0
F1:F6	HGTHAVCCRX, GEN6	OUT	3.5
	MGTAVTT, 7-Series		8.0
G1:G6	HGTHAVTT, GEN6	OUT	1.5
	7-Series, (None)		1.5
H1:H6	HGTHAVCCPLL, GEN6	OUT	2.6
	MGTAVCCAUX, 7-Series		2.6

Table 2 Power Strip Connector Pin Assignments (J1)

3.1.3. Control Connector

An 80-position SAMTEC BSE-040-01-L-D-A connector is used for control interfaces and digital ground. Signal assignments are as shown in Table 3.

Connector Pin	Signal	Direction	Connector Pin	Signal	Direction
1	ALT_PMBUS_ADDR	IN	2	NC	
3	NC		4	NC	
5	NC		6	NC	
7	NC		8	NC	
9	GND		10	GND	
11	GND		12	GND	
13	MGTHAVCC_CS+	IN	14	MGTHAVCC_SNS+	IN
15	GND		16	GND	
17	MGTHAVCC_CS−	IN	18	MGTHAVCC_SNS−	IN
19	GND		20	GND	
21	MGTHAVCCRX_CS+	IN	22	MGTHAVCCRX_SNS+	IN
23	GND		24	GND	
25	MGTHAVCCRX_CS−	IN	26	MGTHAVCCRX_SNS−	IN
27	GND		28	GND	
29	MGTHAVTT_CS+	IN	30	MGTHAVTT_SNS+	IN
31	GND		32	GND	
33	MGTHAVTT_CS−	IN	34	MGTHAVTT_SNS−	IN
35	GND		36	GND	
37	MGTHAVCCPLL_CS+	IN	38	MGTHAVCCPLL_SNS+	IN
39	GND		40	GND	
41	MGTHAVCCPLL_CS−	IN	42	MGTHAVCCPLL_SNS−	IN
43	GND		44	GND	
45	GND		46	GND	
47	NC		48	NC	
49	NC		50	NC	
51	GND		52	GND	
53	GND		54	GND	
55	NC		56	NC	
57	NC		58	NC	
59	NC		60	NC	
61	NC		62	NC	
63	GND		64	GND	
65	GND		66	GND	
67	PMBUS_CLK	IN	68	NC	
69	PMBUS_DATA	BI	70	NC	
71	PMBUS_CTRL	IN	72	GND	
73	PMBUS_ALERT	OUT	74	GND	
75	GND		76	NC	
77	POR_B	IN	78	NC	
79	INSTALLED	OUT	80	NC	

Table 3 Digital Control Connector Pin Assignments (J2)

3.2. Electrical

3.2.1. GEN6 GTH Settings and 7-Series MGT Settings

When DIP switch SW1-1 (refer to Figure 1) is off, output voltages and sequence settings will set for GEN6 GTH. When SW1-1 is on, output voltages and sequence settings will set for 7-Series MGT.

The DIP switch state is checked only when the power is supplied to the module.

3.2.2. Input Voltage

The module uses a single input voltage source: 5.0V. Input voltage must be accurate to within ±5.0%.

3.2.3. Output Voltage and Current Specifications

At power-up, all output rails are default to the set-point values shown in Table 4 using non-volatile control constants.

Parameter	MGTHAVCC or MGTAVCC	MGTHAVCCRX or MGTAVTT	MGTHAVTT	MGTHAVCCPLL or MGTVCCAUX	Units
Nominal Manufacturing Set-point Voltage, GEN6 GTH Settings [1]	1.10	1.10	1.20	1.80	VDC
Nominal Manufacturing Set-point Voltage, 7-Series MGT Settings [2]	1.00	1.20	1.20	1.80	VDC
Set-point Accuracy, max.	±1.0	±1.0	±1.0	±1.0	% of nominal
Adjustment Range, max.	±15	±15	±15	±15	% of nominal
Output Ripple, max.	10	10	10	10	mV p-p
Output Current, max.	12.0 [3]	8.0	1.50	2.60	A
Current Measurement Resolution	15.625	15.625	7.8125	15.625	mA
Current Sense Resistor	0.005	0.005	0.005	0.005	ohms

Table 4 Output Voltage and Current Specifications

NOTES

[1] SW1-1 is off.

[2] SW1-1 is on.

[3] 6.0A maximum at continuous load.

3.2.4. Power Sequencing

3.2.4.1. GEN6 GTH settings

Power-up and power-down sequencing for GEN6 GHT is shown in Figure 2. These settings can change from PMBus TON_DELAY and TOFF_DELAY commands.

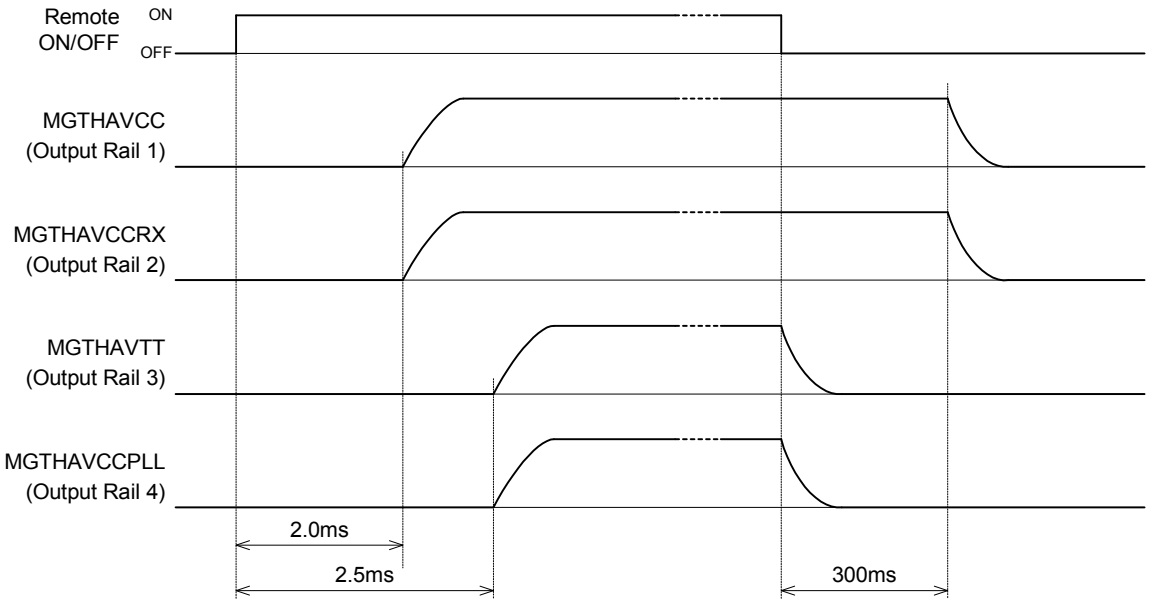


Figure 2 GEN6 Power-Up/Down Sequencing

3.2.4.2. 7-Series MGT settings

Power-up and power-down sequencing for 7-Series MGT is shown in Figure 3. These settings can change from PMBus TON_DELAY and TOFF_DELAY commands.

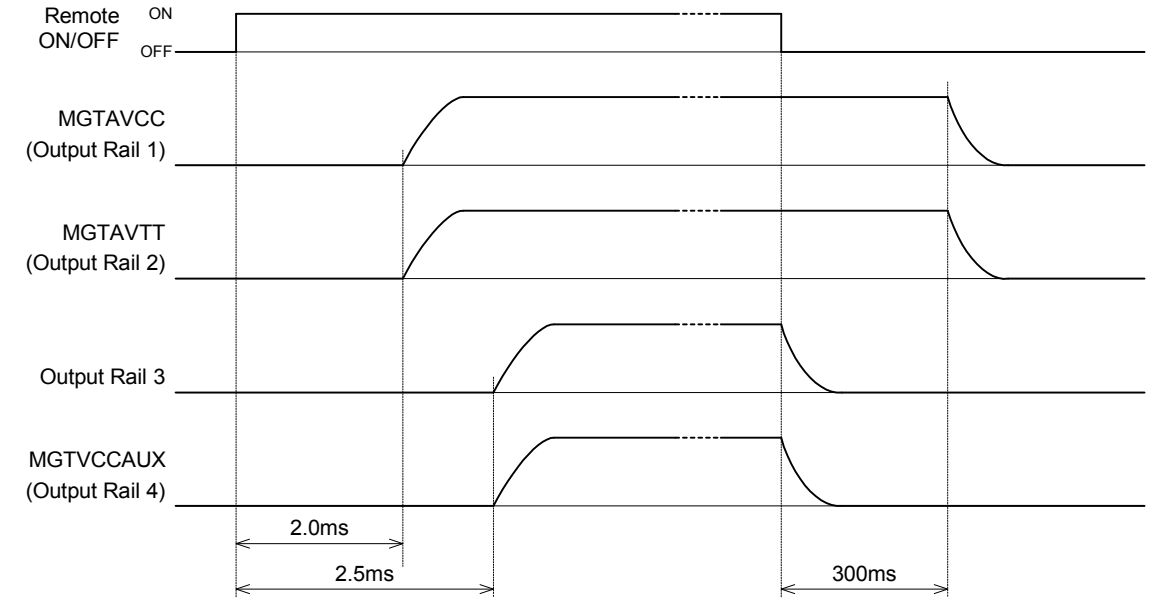


Figure 3 7-Series Power-Up/Down Sequencing

3.2.5. Ambient Operating Temperature

Ambient operating temperature is 55°C maximum.

3.3. Control

3.3.1. Remote ON/OFF Control

Combining the following three signals perform remote on/off control:

- POR_B pin input,
- PMBUS_CTRL pin input, and
- OPERATION PMBus command.

Power-up sequence starts when all signals are commanding output to be on. Power-down sequence start when one or more signals are commanding output to be off. The signals that disabled do not affect the remote on/off control.

At default, remote on/off control by PMBUS_CLRL pin input and OPERATION PMBus command are disabled. How to enable the remote on/off control is described in 3.3.2.4.2. ON_OFF_CONFIG (02h).

Input supply voltages must be stable prior to the start of a power-up sequence and must remain asserted throughout the power-down sequence.

3.3.1.1. POR_B

The POR_B pin is an input signal that is used at floating or logic low (0 – 0.6V). The POR_B pin is floating means output to be on. The POB_B pin is logic low means output to be off.

The POR_B pin is internally pulled up to 3.3V.

3.3.1.2. PMBUS_CTRL

The PMBUS_CTRL pin is an input signal that is used at logic high (2.8 – 5.5V) or logic low (0 – 0.6V). Which means either output to be on logic high and logic low can be programmed by ON_OFF_CONFIG command. Refer to 3.3.2.4.2. ON_OFF_CONFIG (02h).

PMBUS_CTRL pin must keep logic high or logic low, even if you do not use remote on/off control by PMBUS_CTRL pin.

3.3.1.3. OPERATION PMBus Command

Using the OPERATION PMBus command, you can control output on/off for each output rail. Refer to 3.3.2.4.1. OPERATION (01h).

3.3.2. Serial Communication Bus (PMBus)

The module supports a digital communication bus that can be used to write control constants and read status. The following items are programmable using the digital bus:

- Change voltage with a margining range of ±15%
- Change turn-on and turn-off time
- Write control values to non-volatile memory
- Read output voltage and load current

Serial interface is compliant with PMBus Specification Revision 1.1. Packet Error Checking is not support.

Pull-up resistors for PMBus signals are not included on the module. Please connect Pull-up resistors on the host platform.

3.3.2.1. Device Address

Device Address is set by the state of SW1-3, SW1-4 and ALT_PMBUS_ADDR signal.

ALT_PMBUS_ADDR signal is used at floating or connected directly to GND. ALT_PMBUS_ADDR is internally pulled up to 3.3V.

Switch and ALT_PMBUS_ADDR signal state is checked only when the power is supplied to the module.

	Device Address			
	SW1-3: off SW1-4: off	SW1-3: off SW1-4: on	SW1-3: on SW1-4: off	SW1-3: on SW1-4: on
ALT_PMBUS_ADDR: Floating	24	25	26	27
ALT_PMBUS_ADDR: Connect to GND	32	33	34	35

Table 5 PMBus Device Address Assignments [1]

NOTES:

[1] All addresses are in decimal.

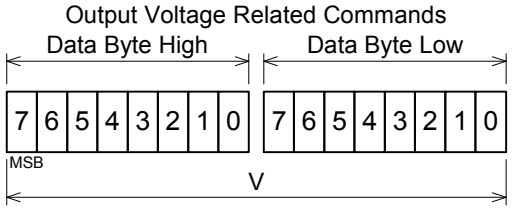
3.3.2.2. Data Formats

3.3.2.2.1. 16-bit Linear Format

16-bit Linear Format is used for output voltage related commands. The 16-bit Linear Format is two values with:

- An exponent *N*, and
- A 16 bit mantissa *V*.

The exponent used in this module is fixed value. The exponent is −12.



The Voltage is calculated from the equation:

$$Voltage = V \times 2^N$$

Where:

Voltage is the parameter of interest in volts;

V is a 16 bit unsigned binary integer; and

N is −12.

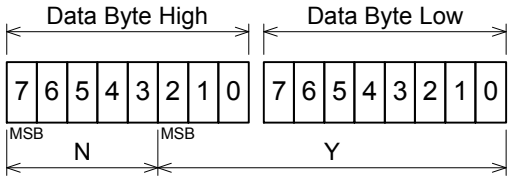
3.3.2.2.2. 11-bit Linear Data Format

The 11-bit Linear Data Format is used for commanding and reporting the parameters such as the following:

- Output Current (READ_IOUT),
- Turn-on Delay (TON_DELAY), and
- Turn-off Delay (TOFF_DELAY).

The 11-bit Linear Data Format is a two-byte value with:

- An 11 bit, two's complement mantissa and
- A 5 bit, two's complement exponent.



The relation between *Y*, *N* and the "real world" value is:

$X = Y \times 2^N$

Where, as described above:

X is the "real world" value;

Y is an 11 bit, two's complement integer; and

N is a 5 bit, two's complement integer.

3.3.2.3. PMBus Commands

The module may use the below commands.

PMBus command Name	Command code	Transaction type	Scope	Number of Data Bytes	Data format
PAGE	00h	R/W Byte	Common	1	—
OPERATION	01h	R/W Byte	PAGE	1	—
ON_OFF_CONFIG	02h	R/W Byte	Common	1	—
CLEAR_FAULTS	03h	Send Byte	Common	0	—
STORE_USER_ALL	15h	Send Byte	Common	0	—
RESTORE_USER_ALL	16h	Send Byte	Common	0	—
VOUT_COMMAND	21h	R/W Word	PAGE	2	Linear (16bit)
VOUT_MARGIN_HIGH	25h	R/W Word	PAGE	2	Linear (16bit)
VOUT_MARGIN_LOW	26h	R/W Word	PAGE	2	Linear (16bit)
TON_DELAY	60h	R/W Word	PAGE	2	Linear (11bit)
TOFF_DELAY	64h	R/W Word	PAGE	2	Linear (11bit)
STATUS_BYTE	78h	Read Byte	Common	1	—
STATUS_WORD	79h	Read Word	Common	2	—
STATUS_CML	7Eh	Read Byte	Common	1	—
READ_VOUT	8Bh	Read Word	PAGE	2	Linear (16bit)
READ_IOUT	8Ch	Read Word	PAGE	2	Linear (11bit)

Table 6 PMBus Commands

The meaning of Transaction type in Table 6 is as follows.

Transaction type	Bus protocol
Send Byte	Send Byte Protocol
Read Byte	Read Byte Protocol
Read Word	Read Word Protocol
R/W Byte	Read Byte Protocol and Write Byte Protocol
R/W Word	Read Word Protocol and Write Word Protocol

Table 7 Bus Protocols

3.3.2.4. PAGE (00h)

The PAGE command is used to select the rail to configure, control, and monitor.

The data byte for the PAGE command is an unsigned binary integer.

Corresponding page number and output rail number is as follows.

Data Byte	Selected Output Rail Number
0	1
1	2
2	3
3	4
4 – FEh	Invalid
FFh	All

Table 8 PAGE Data Byte

3.3.2.4.1. OPERATION (01h)

The OPERATION command is used to turn output rails on and off. It is also used to change the output voltage to the upper or lower margin voltages.

The contents of the data byte are shown in Table 9. Any value not shown in the table is an invalid command.

Output rail to be set are selected by the PAGE command. You can change all rails settings at once (PAGE = FFh).

The data byte of OPERATION command cannot copy to non-volatile User Store Memory. It is initialized to 80h when power is supplied to the module.

Bits [7:6]	Bits [5:4]	Bits [3:2]	Bits [1:0]	Output On or Off	Margin State
01	XX	XX	XX	Off	Off
10	00	XX	XX	On	Off
10	01	10	XX	On	Margin Low
10	10	10	XX	On	Margin High

Table 9 OPERATION Data Byte Contents [1]

NOTES:

[1] Bits are written as 'X', can be either '0' or '1'.

3.3.2.4.2. ON_OFF_CONFIG (02h)

The ON_OFF_CONFIG command configures action of the PMBUS_CTRL pin input and OPERATION command.

The details of the ON_OFF_CONFIG data byte are shown in Table 10.

ON_OFF_CONFIG parameter is the same for all rails. Cannot be set differently for each rail.

The default value of ON_OFF_CONFIG parameter is 02h.

Bit Number	Purpose	Bit Value	Meaning
[7:5]		000	Invalid
4	To enable or disable remote on/off control by PMBUS_CTRL pin input and OPERATION command	0	To disable remote on/off control by PMBUS_CTRL pin input and OPERATION command
		1	To enable remote on/off control by PMBUS_CTRL pin input and OPERATION command
3	To enable or disable remote on/off control by OPERATION command	0	To disable remote on/off control by OPERATION command
		1	To enable remote on/off control by OPERATION command
2	To enable or disable remote on/off control by PMBUS_CTRL pin input	0	To disable remote on/off control by PMBUS_CTRL pin input
		1	To enable remote on/off control by PMBUS_CTRL pin input
1	Polarity of the PMBUS_CTRL pin input	0	Active low (Output to be on when PMBUS_CTRL is low)
		1	Active high (Output to be on when PMBUS_CTRL is high)
0	PMBUS_CTRL pin action when commanding the output to turn off	0	Turned off by applying a turn-off delay time set by the TOFF_DELAY command
		1	Invalid

Table 10 ON_OFF_CONFIG Data Byte Contents

3.3.2.4.3. CLEAR_FAULTS (03h)

The CLEAR_FAULTS command is used to clear any fault bits that have been set. This command clears all bits in all status registers simultaneously.

If the fault is still present when the bit is cleared, the fault bit will immediately be set again.

This command is write only. There is no data byte for this command.

3.3.2.4.4. STORE_USER_ALL (15h)

The STORE_USER_ALL command instructs the module to copy Operating Memory to non-volatile User Store Memory. The parameter of OPERATION command is not copy to non-volatile memory.

This command is write only. There is no data byte for this command.

3.3.2.4.5. RESTORE_USER_ALL (16h)

The RESTORE_USER_ALL command instructs the module to copy non-volatile User Store Memory to Operating Memory.

This command is write only. There is no data byte for this command.

3.3.2.4.6. VOUT_COMMAND (21h)

The VOUT_COMMAND sets the output voltage at Margin State is Off.

The two data bytes are mantissa of 16-bit Linear Format.

Output rail to be set are programmed by the PAGE command. Change all rails settings at once (PAGE = FFh) is not support.

Output Rail Number	Default Value		Range	Resolution
	GEN6 Settings	7-Series Settings		
1	1.100V (119Ah)	1.000V (1000h)	0.850V (0D9Ah) – 1.265V (143Dh)	0.7324mV
2	1.100V (119Ah)	1.200V (1333h)	0.935V (0EF6h) – 1.380V (1614h)	
3	1.200V (1333h)	1.200V (1333h)	1.020V (1052h) – 1.380V (1614h)	
4	1.800V (1CCDh)	1.800V (1CCDh)	1.530V (187Bh) – 2.070V (211Fh)	

Table 11 VOUT_COMMAND Data Bytes

3.3.2.4.7. VOUT_MARGIN_HIGH (25h)

The VOUT_MARGIN_HIGH sets the output voltage at Margin State is Margin High.

The two data bytes are mantissa of 16-bit Linear Format.

Output rail to be set are programmed by the PAGE command. Change all rails settings at once (PAGE = FFh) is not support.

Output Rail Number	Default Value		Range	Resolution
	GEN6 Settings	7-Series Settings		
1	1.265V (143Dh)	1.150V (1266h)	0.850V (0D9Ah) – 1.265V (143Dh)	0.7324mV
2	1.265V (143Dh)	1.380V (1614h)	0.935V (0EF6h) – 1.380V (1614h)	
3	1.380V (1614h)	1.380V (1614h)	1.020V (1052h) – 1.380V (1614h)	
4	2.070V (211Fh)	2.070V (211Fh)	1.530V (187Bh) – 2.070V (211Fh)	

Table 12 VOUT_MARGIN_HIGH Data Bytes

3.3.2.4.8. VOUT_MARGIN_LOW (26h)

The VOUT_MARGIN_LOW sets the output voltage at Margin State is Margin Low.

The two data bytes are mantissa of 16-bit Linear Format.

Output rail to be set are programmed by the PAGE command. Change all rails settings at once (PAGE = FFh) is not support.

Output Rail Number	Default Value		Range	Resolution
	GEN6 Settings	7-Series Settings		
1	0.935V (0EF6h)	0.850V (0D9Ah)	0.850V (0D9Ah) – 1.265V (143Dh)	0.7324mV
2	0.935V (0EF6h)	1.020V (1052h)	0.935V (0EF6h) – 1.380V (1614h)	
3	1.020V (1052h)	1.020V (1052h)	1.020V (1052h) – 1.380V (1614h)	
4	1.530V (187Bh)	1.530V (187Bh)	1.530V (187Bh) – 2.070V (211Fh)	

Table 13 VOUT_MARGIN_LOW Data Bytes

3.3.2.4.9. TON_DELAY (60h)

The TON_DELAY sets the time, in ms, from when a start condition is received until the output voltage starts to rise.

The two data bytes are formatted in the 11-bit Linear Data Format.

Output rail to be set are programmed by the PAGE command. Change all rails settings at once (PAGE = FFh) is not support.

Output Rail Number	Default Value		Range	Resolution
	GEN6 Settings	7-Series Settings		
1	2.0ms (F008h)	2.0ms (F008h)	0.25ms (F001h) – 100ms (F190h)	0.25ms
2	2.0ms (F008h)	2.0ms (F008h)	0.25ms (F001h) – 100ms (F190h)	0.25ms
3	2.5ms (F00Ah)	2.5ms (F00Ah)	2.25ms (F009h) – 100ms (F190h)	0.25ms
4	2.5ms (F00Ah)	2.5ms (F00Ah)	0.25ms (F001h) – 100ms (F190h)	0.25ms

Table 14 TON_DELAY Data Bytes

3.3.2.4.10. TOFF_DELAY (64h)

The TOFF_DELAY sets the time, in ms, from when a stop condition is received until the output voltage starts to fall.

The two data bytes are formatted in the 11-bit Linear Data Format.

Output rail to be set are programmed by the PAGE command. Change all rails settings at once (PAGE = FFh) is not support.

Output Rail Number	Default Value		Range	Resolution
	GEN6 Settings	7-Series Settings		
1	300ms (FA58h)	300ms (FA58h)	0ms (F800h) – 500ms (FBE8h)	0.5ms
2	300ms (FA58h)	300ms (FA58h)	0ms (F800h) – 500ms (FBE8h)	0.5ms
3	0ms (F800h)	0ms (F800h)	0ms (F800h) – 500ms (FBE8h)	0.5ms
4	0ms (F800h)	0ms (F800h)	0ms (F800h) – 500ms (FBE8h)	0.5ms

Table 15 TOFF_DELAY Data Bytes

3.3.2.4.11. STATUS_BYTE (78h)

The STATUS_BYTE command returns one byte of information with a summary of the most critical faults.

The STATUS_BYTE message content is described in Table 16.

Bit Number	Status Bit Name	Meaning
7	BUSY	Read as 0
6	OFF	This bit is asserted if one or more output rails are not providing power to the output
5	VOUT_OV	Read as 0
4	IOUT_OC	Read as 0
3	VIN_UV	Read as 0
2	TEMPERATURE	Read as 0
1	CML	This bit is asserted if one or more bits are asserted for STATUS_CML register
0	NONE OF ABOVE	Read as 0

Table 16 STATUS_BYTE Message Contents

3.3.2.4.12. STATUS_WORD (79h)

The STATUS_WORD command returns two bytes of information with a summary of the module's fault condition.
The low byte of the STATUS_WORD is the same register as the STATUS_BYTE command.
The STATUS_WORD message content is described in Table 17.

Byte	Bit Number	Bit Name	Meaning
Low	7	BUSY	Read as 0
	6	OFF	This bit is asserted if one or more output rails are not providing power to the output
	5	VOUT_OV	Read as 0
	4	IOUT_OC	Read as 0
	3	VIN_UV	Read as 0
	2	TEMPERATURE	Read as 0
	1	CML	This bit is asserted if one or more bits are asserted for STATUS_CML register
	0	NONE OF ABOVE	Read as 0
High	7	VOUT	Read as 0
	6	IOUT/POUT	Read as 0
	5	INPUT	Read as 0
	4	MFR	Read as 0
	3	POWER_GOOD#	This bit is asserted if one or more output voltages are abnormal. Abnormalities are detected in power-good output signals of mounted DC/DC converter modules.
	2	FANS	Read as 0
	1	OTHER	Read as 0
	0	UNKNOWN	Read as 0

Table 17 STATUS_WORD Message Contents

3.3.2.4.13. STATUS_CML (7Eh)

The STATUS_CML command returns one data byte with contents as follows:

Bit	Meaning
7	Invalid Or Unsupported Command Received
6	Invalid Or Unsupported Data Received
5	Read as 0
4	Read as 0
3	Read as 0
2	Read as 0
1	Read as 0
0	Read as 0

Table 18 STATUS_CML Message Contents

3.3.2.4.14. READ_VOUT (8Bh)

READ_VOUT command returns the measured output voltage.
The two data bytes are mantissa of 16-bit Linear Format.
Output rail to be read are set by the PAGE command.

3.3.2.4.15. READ_IOUT (8Ch)

READ_IOUT command returns the measured output current in amperes.

The two data bytes are formatted in the 11-bit Linear Data Format.

Output rail to be read are set by the PAGE command.

3.3.2.5. PMBUS_ALERT signal

PMBUS_ALERT signal is SMBALERT# signal, as described in SMBus specification, Version 1.1.

It is asserted when the CML bit in the STAUS_WORD is set.

3.3.3. Dedicated Controls

3.3.3.1. INSTALLED

INSTALLED is an output signal that is directly connected to digital ground on the module.

3.3.4. Differential Point-of-Load Voltage Sense

Each output rail has differential Kelvin connections to sense IR drops through the module connector and host platform power planes to the load.

3.3.5. Differential Current Sense

Each output rail has differential Kelvin connections to current sense resistors located on the host platform.