MWOCP67-5500-B-RM PMBus Protocol

Open Rack V3 50V 5.5kW power supply

PMBus Specification

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1 Scope

Communication follows the Power System Management Protocol Specification (PMBus V1.2) for power support regarding system communication, command, and control. Not all PMBus functions are supported. PSU shall accept with or without PEC from system side.

2 Reference Documents

PMBus Power system management protocol Specification (V1.2) Part I and Part II.

System Management Bus (SMBus) Specification, Revision 2.0; Aug 3, 2000

3 Device Base Addressing

The PSU PMBus device address locations are shown below. For redundant systems there are three signals to set the address location of the PSU once it is installed in the system: Address2(A2), Address1 (A1), Address0 (A0).

Address2/Address1/Address0	0/0/0[2]	0/0/1[2]	0/1/0[2]	0/1/1[2]	1/0/0[2]	1/0/1[2]	1/1/0[2]	1/1/1[2]
PMBus Address W/R[2]	B0h/B1h[1]	B2h/B3h[1]	B4h/B5h[1]	B6h/B7h[1]	B8h/B9h[1]	BAh/BBh[1]	BCh/BDh[1]	BEh/BFh[1]
IPMI compliant EEPROM Address W/R[2]	A0h/A1h[1]	A2h/A3h[1]	A4h/A5h[1]	A6h/A7h[1]	A8h/A9h[1]	AAh/ABh[1]	ACh/ADh[1]	AEh/AFh[1]

[1] The addressing method uses the 7 MSB bits to set the address and the LSB to define whether a device is reading or writing. The addresses defined above use 8 bits including the read/write bit.

[2] The '0' and '1' correspond to '0' = signal is grounded; '1' = signal not grounded;

4 Hardware Design

The device in the power supply shall be compatible with both SMBus 2.0 'high power' specification for I2C Vcc based power and drive (for Vcc = 3.3V). This bus shall operate at 3.3V.

4.1 PMBus Power Sourcing

The circuits inside the power supply shall derive their power from the standby output. For redundant power supplies the device(s) shall be powered from the system side of the or'ing device. The PMBus device shall be on whenever AC power is applied to one of redundant power supply in the system.

4.2 Pull ups

Pull-up resistors shall be on SCL or SDA inside the power supply. Refer to PSU hardware specification.

4.3 Data Speed

The PMbus device in the power supply shall operate at the SMBus speed stated in below table and avoid using clock stretching that can slow down the bus. For example, the power supply can clock stretch while parsing a command or a power supply servicing multiple internal interrupts or NACK may require some use of clock stretching. Unsupported commands may respond with a NACK but must always set the communication error status bit in STATUS_CML.

Parameter	Value
SMBus speed	50kHz to 400kHz

The PMBus device shall support SMBus cumulative clock low extend time (Tlow:sext) if < 25msec. This requires the device to extend the clock time no more than 25msec between START and STOP for any given messages.

4.4 Bus Errors

The PMBus device shall support SMBus clock-low timeout (Ttimeout). This capability requires the device to abort any transaction and drop off the bus if it detects the clock being held low for >25ms, and be able to respond to new transactions 10ms later.
The device must recognize SMBus START and STOP conditions on ANY clock interval. (These are requirements of the SMBus specifications but are often missed in first-time hardware designs.) The device must not hang due to 'runt clocks', 'runt data', or other out-of-spec bus timing. This is defined as signals, logic-level glitches, setup, or hold times that are shorter than the minimums specified by the SMBus specification. The device is not required to operate normally but must return to normal operation once 'in spec' clock and data timing is again received. Note if the device 'misses' a clock from the master due to noise or other bus errors, the device must continue to accept 'in spec' clocks and re-sync with the master on the next START or STOP condition.
Note: A PSU cannot become the bus Master and communicate with the system host through the PMBus.

5 Write to the power supply

When responding to read commands, the power supply shall extend the clock until all writing of data to the command is complete. The power supply must still meet the Tlow:sext max time of 25msec. This is needed to make sure if the system performs a series of write and then immediately read to the same command, the power supply returns the value just written to the power supply.

6 PMBus Command List

Command Code	Command Name	SMBus Transaction Type	Number of Bytes	Bit(s) Number	Bit Name	Definition	Supported
00	PAGE	R/W Byte	1			Command to provide ability to configure, control & monitor multiple outputs Value= 00h, 01h and FFh	**YES**
01	OPERATION	R/W Byte	1			Turn the unit on/off. Value = 80h:PSU main output on(default). Value = 00h: PSU main output off.	**YES**
02	ON_OFF_CONFIG	R Byte	1				**YES**
03	CLEAR_FAULTS	Send Byte	0			Sending a CLEAR_FAULTS command to the PSU shall reset all STATUS bits to 0.	**YES**
05	PAGE_PLUS_WRITE	Write Block	Variable			Set the page within a device, send a command, and send the data for the command in one packet. Used with SMBALERT_MASK (0x1B), STATUS_IOUT (0x7B), STATUS_INPUT (0x7C), STATUS_TEMPERATURE (0x7D), STATUS_CML (0x7E)	**YES**
06	PAGE_PLUS_READ	Block Write - Block Read Process Call	Variable			Set the page within a device, send a command, and read the data returned by the command in one packet. Used with SMBALERT_MASK (0x1B), STATUS_WORD (0x79), STATUS_IOUT (0x7B), STATUS_INPUT (0x7C), STATUS_TEMPERATURE (0x7D), STATUS_CML (0x7E)	**YES**
10	WRITE_PROTECT	R/W Byte	1			Value = 00h(default)	**YES**
19	CAPABILITY	Read Byte	1			This command provides a way for a host system to determine some key capabilities of a PMBus device. Always read 90h. PEC = supported Bus speed = 100kHz SMBAlert# = supported	**YES**
1A	QUERY	Block Write - Block Read Process Call	1			Used to ask a PMBus device if it supports a given command, and if so, what data formats it supports for that command.	**YES**
				7	CMD_SUPPORTED	Command is supported	**YES**
				6	CMD_SUPPORTED_WR	Command is supported for write	**YES**
				5	CMD_SUPPORTED_RD	Command is supported for read	**YES**
				4:2	CMD_FORMAT	Data format - 0 = Linear data format, 011 = Direct mode format, 111 = Non numeric data	**YES**
				1	RESERVED	Reserved	**NO**
				0	RESERVED	Reserved	**NO**

Command Code	Command Name	SMBus Transaction Type	Number of Bytes	Bit(s) Number	Bit Name	Definition	Supported
1B	SMBALERT_MASK	Write Word/Block Write - Block Read Process Call	2 / Variable			Used to prevent a warning or fault condition from asserting the SMBALERT# signal. Used with STATUS_WORD (0x79), STATUS_IOUT (0x7B), STATUS_INPUT (0x7C), STATUS_TEMPERATURE (0x7D)	**YES**
20	VOUT_MODE	Read Byte	1			Single data byte sets the READ_VOUT sensor to linear mode data format and supplies N = -9 exponent for translation to volts. Always read 17h	**YES**
30	COEFFICIENT	Block Write - Block Read Process Call	5			Used to retrieve the m, b and R coefficients needed by data in the DIRECT format. Used with READ_EIN (0x86) and READ_EOUT (0x87) Always read m = 1, b = 0, R= 0	**YES**
35	VIN_ON	Read Word	2			brown-in threshold	**NO**
36	VIN_OFF	Read Word	2			brown-out threshold	**NO**
3A	FAN_CONFIG_1_2	Read Byte	1			Show the config of fan. Always read 90h	**YES**
				7	FAN_1_INSTALLATION	Asserted when fan is installed in position 1	**YES**
				6	FAN_1_SETTING_MODE	Asserted when fan is commanded in RPM (Clear when fan is commanded in Duty Cycle)	**YES**
				5	FAN_1_TACH_PULSES	Fan 1 Tachometer pulses per revolution (upper bit)	**YES**
				4	FAN_1_TACH_PULSES	Fan 1 Tachometer pulses per revolution (lower bit)	**YES**
				3	FAN_2_INSTALLATION	Asserted when fan is installed in position 2	**NO**
				2	FAN_2_SETTING_MODE	Asserted when fan is commanded in RPM (Clear when fan is commanded in Duty Cycle)	**NO**
				1	FAN_2_TACH_PULSES	Fan 2 Tachometer pulses per revolution (upper bit)	**NO**
				0	FAN_2_TACH_PULSES	Fan 2 Tachometer pulses per revolution (lower bit)	**NO**
3B	FAN_COMMAND_1	R/W Word	2			Manual fan override command fan speed value in Duty Cycle (0-100) Command speed formatted in Linear	**YES**

Command Code	Command Name	SMBus Transaction Type	Number of Bytes	Bit(s) Number	Bit Name	Definition	Supported
40	VOUT_OV_FAULT_LIMIT	Read Word	2			Sets the value of the output voltage, in volts, that causes the overvoltage detector to indicate an overvoltage fault condition.	NO
41	VOUT_OV_FAULT_RESPONSE	Read Byte	1				NO
42	VOUT_OV_WARN_LIMIT	Read Word	2			Sets the value of the output voltage, in volts, that causes the overvoltage detector to indicate an overvoltage warning condition.	NO
43	VOUT_UV_WARN_LIMIT	Read Word	2			Sets the value of the output voltage, in volts, that causes the undervoltage detector to indicate an undervoltage warning condition.	NO
44	VOUT_UV_FAULT_LIMIT	Read Word	2			Sets the value of the output voltage, in volts, that causes the undervoltage detector to indicate an undervoltage fault condition.	NO
45	VOUT_UV_FAULT_RESPONSE	Read Byte	1				NO
46	IOUT_OC_FAULT_LIMIT	Read Word	2			Sets the value of the output current, in amperes, that causes the overcurrent detector to indicate an overcurrent fault condition.	YES
47	IOUT_OC_FAULT_RESPONSE	Read Byte	1				NO
4A	IOUT_OC_WARN_LIMIT	Read Word	2			Sets the value of the output current, in amperes, that causes the overcurrent detector to indicate an overcurrent warning.	YES
4F	OT_FAULT_LIMIT	Read Word	2			Set the temperature, in degrees Celsius, of the unit at which it should indicate an Overtemperature fault condition	NO
51	OT_WARN_LIMIT	Read Word	2			Set the temperature, in degrees Celsius, of the unit at which it should indicate an Overtemperature Warning alarm.	NO
55	VIN_OV_FAULT_LIMIT	Read Word	2			Sets the value of the input voltage, in volts, that causes the overvoltage detector to indicate an overvoltage fault condition.	NO
56	VIN_OV_FAULT_RESPONSE	Read Byte	1				NO
57	VIN_OV_WARN_LIMIT	Read Word	2			Sets the value of the input voltage, in volts, that causes the overvoltage detector to indicate an overvoltage warning condition.	NO
58	VIN_UV_WARN_LIMIT	Read Word	2			Sets the value of the input voltage, in volts, that causes the undervoltage detector to indicate an undervoltage warning condition.	NO
59	VIN_UV_FAULT_LIMIT	Read Word	2			Sets the value of the input voltage, in volts, that causes the undervoltage detector to indicate an undervoltage fault condition.	NO
5A	VIN_UV_FAULT_RESPONSE	Read Byte	1				NO

Command Code	Command Name	SMBus Transaction Type	Number of Bytes	Bit(s) Number	Bit Name	Definition	Supported
5D	IIN_OC_WARN_LIMIT	Read Word	2			Read the value of the input current, in amperes, that causes the overcurrent detector to indicate an input overcurrent warning condition.	YES
60	TURN_ON_DELAY	R/W Word	2				NO
6A	POUT_OP_WARN_LIMIT	Read Word	2				YES
6B	PIN_OP_WARN_LIMIT	Read Word	2				YES
78	STATUS_BYTE	Read Byte	1	7	BUSY_F	Assserted when device busy and unable to respond fault	NO
				6	UNIT_OFF	Asserted when unit not providing power to the output	YES
				5	OUTPUT_OV_F	Asserted when an output overvoltage fault has occurred	YES
				4	OUTPUT_OC_F	Asserted when an output overcurrent fault has occurred	YES
				3	INPUT_UV_F	Asserted when an input undervoltage fault has occurred	YES
				2	TEMPERATURE_F_W	Asserted when an overtemperature fault or warning has occurred	YES
				1	CML_F	Asserted when a communications, memory, or logic fault has occurred	YES
				0	NONE_F_W	Asserted when a fault not listed in [7:1] occurred	YES
79	STATUS_WORD	Read Word	2	7	BUSY_F	Assserted when device busy and unable to respond fault	NO
				6	UNIT_OFF	Asserted when unit not providing power to the output	YES
				5	OUTPUT_OV_F	Asserted when an output overvoltage fault has occurred	YES
				4	OUTPUT_OC_F	Asserted when an output overcurrent fault has occurred	YES
				3	INPUT_UV_F	Asserted when an input undervoltage fault has occurred	YES
				2	TEMPERATURE_F_W	Asserted when an overtemperature fault or warning has occurred	YES
				1	CML_F	Asserted when a communications, memory, or logic fault has occurred	YES
				0	NONE_F_W	Asserted when a fault not listed in [7:1] occurred	YES
				7	VOUT_F_W	Asserted when an output voltage fault or warning has occurred	YES
				6	IOUT_POUT_F_W	Asserted when an output current / output power fault or warning has occurred	YES
				5	INPUT_F_W	Asserted when an Input voltage/current/power fault or warning has occurred	YES
				4	MFG_SPECIFIC_F_W	Manufacturer specific fault or warning has occurred	Yes
				3	POWER_GOOD_L	Asserted when the POWER_GOOD signal is negated	YES
				2	FANS_F_W	Asserted when a fan fault or warning has occurred	YES
				1	STATUS_OTHER_F_W	Asserted when a bit in command STATUS_OTHER set	NO

Command Code	Command Name	SMBus Transaction Type	Number of Bytes	Bit(s) Number	Bit Name	Definition	Supported
				0	UNKNOWN_F_W	Asserted when a fault not listed in [15:1] has occurred	NO
7A	STATUS_VOUT	R/W Byte	1	7	VOUT_OV_F	Asserted when an output overvoltage fault has occurred	YES
				6	VOUT_OV_W	Asserted when an output overvoltage warning has occurred	NO
				5	VOUT_UV_W	Asserted when an output undervoltage warning has occurred	NO
				4	VOUT_UV_F	Asserted when an output undervoltage fault has occurred	YES
				3	VOUT_MAX_F	Asserted when the output is set higher than the commanded VOUT_MAX limit	NO
				2	TON_MAX_F	Asserted when the output turn-on timing has exceeded the TON_MAX fault timing	NO
				1	TON_MAX_W	Asserted when the output turn-on timing has exceeded the TON_MAX warning timing	NO
				0	VOUT_TRACKING_E	Asserted when an error in the output voltage during power-up/down has occurred	NO
7B	STATUS_IOUT	R/W Byte	1	7	IOUT_OC_F	Asserted when an output overcurrent fault has occurred	YES
				6	IOUT_OC_SHUTDOWN	Asserted when an output overcurrent and low voltage shutdown fault has occurred	NO
				5	IOUT_OC_W	Asserted when an output overcurrent warning has occurred	YES
				4	IOUT_UC_W	Asserted when an output undercurrent fault has occurred	NO
				3	CURRENT_SHARE_F	Asserted when an output current share fault has occurred	NO
				2	POWER_LIMIT_MODE	Asserted when the unit has entered output power limiting mode	NO
				1	POUT_OP_F	Asserted when an output overpower fault has occurred	YES
				0	POUT_OP_W	Asserted when an output overpower warning has occurred	YES
7C	STATUS_INPUT	R/W Byte	1	7	VIN_OV_F	Asserted when an input overvoltage fault has occurred (Vin > 300Vac/310Vdc)	YES
				6	VIN_OV_W	Asserted when an input overvoltage warning has occurred	YES
				5	VIN_UV_W	Asserted when an input undervoltage warning has occurred	YES

Command Code	Command Name	SMBus Transaction Type	Number of Bytes	Bit(s) Number	Bit Name	Definition	Supported
				4	VIN_UV_F	Asserted when an input undervoltage fault has occurred (<150Vdc)	YES
				3	VIN_UV_OFF	Asserted when the Unit is OFF for insufficient input voltage	YES
				2	IIN_OC_F	Asserted when an input overcurrent fault has occurred	NO
				1	IIN_OC_W	Asserted when an input overcurrent warning has occurred	YES
				0	PIN_OP_W	Asserted when an input overpower warning has occurred	YES
7D	STATUS_TEMPERATURE	R/W Byte	1	7	TEMPERATURE_OT_F	Asserted when an overtemperature fault has occurred	YES
				6	TEMPERATURE_OT_W	Asserted when an overtemperature warning has occurred	YES
				5	TEMPERATURE_UT_W	Asserted when an under-temperature warning has occurred	NO
				4	TEMPERATURE_UT_F	Asserted when an under-temperature fault has occurred	NO
				3	RESERVED	Reserved	NO
				2	RESERVED	Reserved	NO
				1	RESERVED	Reserved	NO
				0	RESERVED	Reserved	NO
7E	STATUS_CML	R/W Byte	1	7	CML_COMMAND_E	Asserted when an invalid or unsupported command is received	YES
				6	CML_DATA_E	Asserted when invalid or unsupported data is received	YES
				5	CML_PEC_E	Asserted when a packet error checking (PEC) failed has occurred	YES
				4	CML_MEMORY_F	Asserted when a memory fault is detected (example: Checksum errors during bootloader)	NO
				3	CML_PROCESSOR_F	Asserted when a processor fault is detected	NO
				2	RESERVED	Reserved	NO
				1	CML_NONE_F	Asserted when a communication fault not listed in [7:3] has occurred	NO
				0	CML_OTHER_F	Asserted when another memory or logic fault has occurred (example: UART error)	NO
7F	STATUS_OTHER	R Byte	1	7	OFF	Asserted when ac voltage over frequency fault has occurred	YES
				6	UFF	Asserted when ac voltage under frequency fault has occurred	YES
				5	OFW	Asserted when ac voltage over frequency warning has occurred	YES

Command Code	Command Name	SMBus Transaction Type	Number of Bytes	Bit(s) Number	Bit Name	Definition	Supported
				4	UFW	Asserted when ac voltage under frequency warning has occurred	YES
				3	RESERVED	Reserved	NO
				2	RESERVED	Reserved	NO
				1	RESERVED	Reserved	NO
				0	RESERVED	Reserved	NO
80	STATUS_MFR_SPECIFIC	R/W Byte	1	7	PFC OVP Fault	PFC OV fault occurred	YES
				6			Yes
				5			Yes
				4	LINE_STATUS_CHANGE	Power supply line status change	Yes
				3	PFC_UVP	PFC UV fault occurred	Yes
				2			Yes
				1	RESERVED	Reserved	NO
				0	RESERVED	Reserved	NO
81	STATUS_FANS_1_2	R/W Byte	1	7	FAN_1_F	Fan 1 fault	YES
				6			YES
				5	FAN_1_W	Fan 1 warning	YES
				4			YES
				3	FAN_1_OVERRIDE	Fan 1 speed overridden	YES
				2			NO
				1	FAN_AIRFLOW_F	Airflow fault	NO
				0	FAN_AIRFLOW_W	Airflow warning	NO
86	READ_EIN	Block Read	6			Input Energy count, Rollover count and Sample count	YES
						Direct data format, coefficients supplied by command COEFFICIENT	
						Energy count Resolution: 1W	
87	READ_EOUT	Block Read	6			Output Energy count, Rollover count and Sample count	YES
						Direct data format, coefficients supplied by command COEFFICIENT	
						Energy count Resolution: 1W	
88	READ_VIN	Read Word	2			Input Voltage Sensor Reading in Vdc	YES

Command Code	Command Name	SMBus Transaction Type	Number of Bytes	Bit(s) Number	Bit Name	Definition	Supported
						PMBus Data Format: Linear	
						PMBus Max Resolution: 0.25Vdc	
						Full-scale: 511Vdc	
						Accuracy: +/-1%	
89	READ_IIN	Read Word	2			Input Current Sensor Reading in Arms	**YES**
						PMBus Data Format: Linear	
						PMBus Resolution: 40.2832mA	
						Full-scale: 82.5A	
						Accuracy: +/-0.5A@<15% load, +/-2% @15-30% load, +/-1% @30-100% load	
8A	READ_VCAP	Read Word	2			Bulk Capacitor Voltage Sensor Reading in Vdc	**YES**
						PMBus Data Format: Linear	
						PMBus Resolution: 0.5Vdc	
						Full-scale: 532.7 Vdc	
8B	READ_VOUT	Read Word	2			Output Voltage Sensor Reading in Vdc	**YES**
						PMBus Data Format: Linear (N = -9) supplied by command VOUT_MODE	
						PMBus Resolution: 0.00625Vdc	
						Full-scale: 55 Vdc	
						Accuracy: +/-0.5%	
8C	READ_IOUT	Read Word	2			Output Current Sensor Reading in Adc	**YES**
						PMBus Data Format: Linear	
						PMBus Resolution: 0.1A	
						Full-scale: 409A	
						Accuracy: +/-10% @10-20% load, +/-5% @>20-50% load, +/-1% @>50-100% load	
8C	READ_SLAVE_IOUT	Read Word	2			Output Current Sensor Reading in Adc	**YES**
						PMBus Data Format: Linear	
						PMBus Resolution: 0.1A	
						Full-scale: 409A	
						Accuracy: +/-10% @10-20% load, +/-5% @>20-50% load, +/-1% @>50-100% load	
8D	READ_TEMPERATURE_1	Read Word	2			Temperature Sensor Ambient reading in °C	**YES**
						PMBus Data Format: Linear (N = -3)	

Command Code	Command Name	SMBus Transaction Type	Number of Bytes	Bit(s) Number	Bit Name	Definition	Supported
						PMBus Resolution: 0.125 °C	
						Range: -128°C to 128°C	
						Accuracy: +/-2°C	
8E	READ_TEMPERATURE_2	Read Word	2			Temperature Sensor Sec Hot Spot reading in °C	**YES**
						PMBus Sensor Data Format: Linear (N = -3)	
						PMBus Sensor Resolution: 0.125 °C	
						Range: -128°C to 128°C	
						Accuracy: +/-2°C	
8F	READ_TEMPERATURE_3	Read Word	2			Temperature Sensor Pri Hot Spot reading in °C	**YES**
						PMBus Data Format: Linear (N = -3)	
						PMBus Resolution: 0.125 °C	
						Range: -128°C to 128°C	
						Accuracy: +/-2°C	
90	READ_FAN_SPEED_1	Read Word	2			Fan Speed Sensor reading in RPM	**YES**
						PMBus Data Format: Linear (N = 5 or N = 6)	
						PMBus Resolution: 32 RPM (N=5) , 64 RPM (N=6)	
						Full-scale: 37000 RPM	
						Accuracy: +/-500RPM of full-speed	
96	READ_POUT	Read Word	2			Output Power Sensor reading in watts	**YES**
						PMBus Data Format: Linear	
						PMBus Resolution: 0.125 Watts	
						Full-scale :8191W	
						Accuracy: +/-25W@<10%, +/-3% @10-20% load, +/-2% @>20-100% load	
97	READ_PIN	Read Word	2			Input Power Sensor reading in watts	**YES**
						PMBus Data Format: Linear	
						PMBus Resolution: 0.1 Watts	
						Full-scale: 8191W	
						Accuracy: +/-25W@<10%, +/-5% @10-20% load, +/-3% @20-100% load	
98	PMBUS_REVISION	Read Byte	1			Reading of the PMBus revision to which the power supply is compliant	**YES**

Command Code	Command Name	SMBus Transaction Type	Number of Bytes	Bit(s) Number	Bit Name	Definition	Supported
						Always read 22h	
99	MFR_ID	Block Read	1+9			Manufacture's ID (ASCII code): Murata-PS	**YES**
9A	MFR_MODEL	Block Read	1+17			Manufacture's Model Number (ASCII code) : MWOCP67-5500-B-RM	**YES**
9B	MFR_REVISION	Block R/W	1+14			Manufacturer's model revision (ASCII code). XXXX-YYYY-0000 XXXX - Primary FW version/revision, YYYY- Secondary FW version/revision	**YES**
9C	MFR_LOCATION	Block R/W	1+5			Identify the location that manufactured the unit (ASCII code) : China	**YES**
9D	MFR_DATE	Block R/W	1+4			Identify the unit's date of manufacture (ASCII code: YYWW, e.g. 1535, 15-> year, 35 -> week)	**YES**
9E	MFR_SERIAL	Block R/W	1+12			Serial Number: SSYYWWRR**** MPS 12-digit serial number	**YES**
9F	APP_PROFILE_SUPPORT	Read Byte	1			Provides a mean for a host to determine which PMBus Applications Profiles, and the revision of those profiles, that the device supports. Always read 05h	**YES**
A0	MFR_VIN_MIN	Read Word	2			Minimum rated value of the input voltage = 176V (AC input) / 186V (DC input). Always read 00B0h (AC input) / 00BAh (DC input).	**YES**
A1	MFR_VIN_MAX	Read Word	2			Maximum rated value of the input voltage = 315V (AC input) / 410V (DC input). Always read 013Bh (AC input) / 019Ah (DC input).	**YES**
A2	MFR_IIN_MAX	Read Word	2			Maximum rated value of the input current = 31 Amps (High line AC or DC input) . Always read 001Fh (High line AC or DC input)	**YES**
A3	MFR_PIN_MAX	Read Word	2			Maximum rated value of the input power = 5759W (High line AC or DC input) (Pout = 5500 with lowest Efficiency 95.5%). Always read 1AD0h (High line AC or DC input).	**YES**
A4	MFR_VOUT_MIN	Read Word	2			Minimum rated value of the output voltage = 40V. Linear (N = -9) supplied by command VOUT_MODE. Always read 5000h.	**YES**
A5	MFR_VOUT_MAX	Read Word	2			Maximum rated value of the output voltage = 52.5V. Linear (N = -9) supplied by command VOUT_MODE. Always read 6900h.	**YES**
A6	MFR_IOUT_MAX	Read Word	2			Maximum rated value of the output current = 114.583A (High line AC or DC input). Always read 1B95h (High line AC or DC input)	**YES**
A7	MFR_POUT_MAX	Read Word	2			Maximum rated value of the output power = 5500W (High line AC or DC input). Always read 1AB0h (High line AC or DC input)	**YES**
A8	MFR_TAMBIENT_MAX	Read Word	2			Maximum ambient temperature 55degC. Always read E370h	**YES**
A9	MFR_TAMBIENT_MIN	Read Word	2			Minimum ambient temperature: 0degC. Always read 0	**YES**
AB	MFR_EFFICIENCY_HL	Block Read	14				**YES**

Command Code	Command Name	SMBus Transaction Type	Number of Bytes	Bit(s) Number	Bit Name	Definition	Supported
AD	MB_DCDC_ALARM_STATUS	Read Word	2			Refer to Section 7	**YES**
AE	MB_TEMP_ALARM_STATUS	Read Word	2			Refer to Section 7	**YES**
AF	MB_COMM_ALARM_STATUS	Read Word	2			Refer to Section 7	**YES**
B0	MB_INPUT_POWER	Block Read	1 + 4			MB_INPUT_POWER_INST Input Power Sensor reading in watts (instantaneous RMS value) (unsigned) MB_INPUT_POWER Input Power Sensor reading in watts (~1 second average window) (unsigned) Data Format: Integer adjusted with N value (N = -3) Resolution: 0.1Watts Full-scale: 8191W Accuracy: +/-25W@<10%, +/-5% @10-20% load, +/-3% @20-100% load	**YES**
B1	MB_PSU_SETTING	R/W Word	2			Refer to Section 7	**YES**
B2	MB_LED_OVERRIDE	R/W Word	2			Refer to Section 7	**YES**
B3	MB_PSU_HW_REVISION	BlockRead	1+8			8 bytes of ASCII "P4 "	**YES**
B4	MB_PSU_RPM_FAN0	R/W Word	2			Fan Speed Sensor reading in RPM Data Format: Integer adjusted with N value (N = 0) Resolution: 1 RPM Full-scale: 37000 RPM Accuracy: +/-500RPM of full-speed	**YES**
B5	MB_MAX_TEMP	Read Word	2			Max value of several temp sensors inside PSU Data Format: Integer adjusted with N value (N = -7) Resolution: 0.125 °C	**YES**
B6	MB_FAULT_COUNT	Read Word	2			Increment when there is a fault (Main Output Overpower Fault, Main Output Overcurrent Fault, Main Output Overvoltage Fault, Main Output Undervoltage Fault, input overvoltage fault, input undervoltage fault, PFC Overvoltage Fault, PFC Undervoltage Fault, Main Output Oring Fault, Internal communication Fault) Data Format: Integer adjusted with N value (N = 0)	**YES**

Command Code	Command Name	SMBus Transaction Type	Number of Bytes	Bit(s) Number	Bit Name	Definition	Supported
B7	PMBUS_CRC_ERROR_CNT	Block Read	1+4			CRC error on communication counter	**YES**
B8	PMBUS_TIMEOUT_ERROR_CNT	Block Read	1+4			Increment if there is PMBus timeout	**YES**
B9	MB_PSU_TEMP0_INLET	Read Word	2			Inlet Temperature reading in °C Data Format: Integer adjusted with N value (N = -7) PMBus Resolution: 0.125 °C Range: -128°C to 128°C Accuracy: +/-2°C	**YES**
BA	MB_PSU_TEMP0_OUTLET	Read Word	2			Outlet Temperature reading in °C Data Format: Integer adjusted with N value (N = -7) PMBus Resolution: 0.125 °C Range: -128°C to 128°C Accuracy: +/-2°C	**YES**
BB	MB_MIN_TEMP	Read Word	2			Min value of several temp sensors inside PSU Data Format: Integer adjusted with N value (N = -7) PMBus Resolution: 0.125 °C	**YES**
BC	MB_OUTPUT_CURRENT	Read Word	2			Output Current Sensor Reading in Adc (unsigned) Data Format: Integer adjusted with N value (N = -6) Resolution: 0.1A Full-scale: 409A Accuracy: +/-10% @10-20% load, +/-5% @>20-50% load, +/-1% @>50-100% load	**YES**
BD	MB_ISHARE_CURRENT	ReadWord	2			Current iShare Reading in Adc (unsigned) Data Format: Integer adjusted with N value (N = -6)	**YES**

Command Code	Command Name	SMBus Transaction Type	Number of Bytes	Bit(s) Number	Bit Name	Definition	Supported
						Resolution: 0.1A Full-scale: 272A	
BE	MB_OUTPUT_POWER	Read Word	2			Output Power Sensor reading in watts (unsigned) Data Format: Integer adjusted with N value (N = -3) Resolution: 0.125 Watts Full-scale :8191W Accuracy: +/-25W@<10%, +/-3% @10-20% load, +/-2% @>20-100% load	YES
BF	MB_BULK_CAP_VOLTAGE	Read Word	2			Bulk Capacitor Voltage Sensor Reading in Vdc Data Format: Integer adjusted with N value (N = -6) Resolution: 0.5Vdc Full-scale: 532.7 Vdc	YES
C0	MFR_MAX_TEMP1	Read Word	2			Maximum rated temperature (Ambient): 50degC. Always read 32h	YES
C1	MFR_MAX_TEMP2	Read Word	2			Maximum rated temperature (hot-spot sec): 120degC. Always read 78h	YES
C2	MFR_MAX_TEMP3	Read Word	2			Maximum rated temperature (hot-spot primary): 110degC. Always read 6Eh	YES
C3	READ_TEMP_CLIP_P	Read Word	2			Temperature Sensor Busbar Clip + reading in °C PMBus Data Format: Linear (N = -3) PMBus Resolution: 0.125 °C Range: -128°C to 128°C Accuracy: +/-3°C	YES
C4	READ_TEMP_CLIP_N	Read Word	2			Temperature Sensor Busbar Clip - reading in °C PMBus Data Format: Linear (N = -3) PMBus Resolution: 0.125 °C Range: -128°C to 128°C Accuracy: +/-3°C	YES

Command Code	Command Name	SMBus Transaction Type	Number of Bytes	Bit(s) Number	Bit Name	Definition	Supported
C5	MB_POWER_CYCLE_UNIX_TIME	Block RW	1+6			Turn_Off_Time_Of_Power_Cycle_Unix_Time (Byte1,2) Default 120 seconds; minimum 1 second and maximum 3600 seconds Keep the previous setting when input is out of the range. Power_Cycle_Unix_Time (Byte3,4,5,6) Turn off the PSU output voltage for time period defined "Turn_Off_Time_Of_Power_Cycle_Unix_Time" and default is 120 seconds (to reset IT gears) when Unix time gets equal to this Power_cycle Unix time. -- default 0x0000. Vout shall go below 40V whithin 1s	YES
C6	MB_FBPART	Block Read	1+16			16 bytes of ASCII "0123456789ABCDEF"	YES
C7	MB_WORKORDER	Block Read	1+8			8 bytes of ASCII "01234567"	YES
C8	MB_UNIX_TIME	Block RW	1+4			Time stamping for blackbox	YES
C9	MB_CONFIG_PLS_TIMING	R/W Word	2			Assert the PLS pin after ac or PSU dc outage for the number of seconds -- default 45s. Range 1s-300s.	YES
CA	MB_VIN_MIN	R/W Word	2			Min voltage PSU can work, default 173V, but can be increased. Range 173-250V (+0V/-3V accuracy) if Vin_min were set higher than 173V, the operation at low voltage setting (PSU setting, high byte, bit 2) is ignored and considered disabled. (unsigned) Data Format: Integer adjusted with N value (N = -6) Resolution: 0.1 V Range 173-250V	YES
CB	MB_VIN_MAX	R/W Word	2			Max voltage PSU can work, default 307V, but can be reduced. Range 250-307V (+3V/- 0V accuracy) (unsigned) Data Format: Integer adjusted with N value (N = -6) Resolution: 0.1 V Range 250-307V	YES
CC	MB_VOUT_SETPOINT_H	R/W Word	2			default 50V, but can be changed Data Format: Integer adjusted with N value (N = -10) Resolution: 0.001V range 50 +/- 0.25V	YES
CD	MB_VOUT_SETPOINT_L	R/W Word	2			default 48V, but can be changed	YES

Command Code	Command Name	SMBus Transaction Type	Number of Bytes	Bit(s) Number	Bit Name	Definition	Supported
						Data Format: Integer adjusted with N value (N = -10)	
						Resolution: 0.001V	
						range 48 +/- 0.25V	
CE	MB_VOUT_CHANGE_TIMER	R/W Word	2			switch output voltage from H to L for the written number of seconds. If the bus voltage stays at L for >10s, increase the PSU voltage to H and reset this timer to 0 (see spec sec Peak power shaving mode for details) -- default 0	**YES**
						Data Format: Integer adjusted with N value (N = 0)	
						Resolution: 1 second	
						range: 10 - 20 second	
CF	MB_FBL_FW_REVISION	Block Read	1+8			8 bytes of ASCII	**YES**
D0	Reserved						**NO**
D1	MB_READ_ITHD	ReadWord	2			iTHD reading in % (unsigned)	**YES**
						Data Format: Integer adjusted with N value (N = -9)	
						Resolution: 0.002%	
						range: 0-100%	
D2	MB_READ_POWER_FACTOR	ReadWord	2			Power Factor (unsigned)	**YES**
						Data Format: Integer adjusted with N value (N = -9)	
						Resolution: 0.002	
						range: 0-1	
D4	MFR_FRU_PROTECTION	R/W Byte	1	1-7	RESERVED		**NO**
				0	FRUWR_PROT_ENABLE	Writing a 1 enables FRU Write Protection. Writing 0 to disable FRU Write Protection	**YES**
D5	MFR_BLACKBOX	Block Read	1+151			Black box data includes system tracking data and power supply event data Block Count + File Offset (0 or 1) + 150 bytes of blackbox data Always reads the latest black box file. Switches the file offset (0 or 1) each time it is read.	**YES**
D6	Refer to BootLoader command definitions						**YES**
D7	Refer to BootLoader command definitions						**YES**
D8	Refer to BootLoader command definitions						**YES**

Command Code	Command Name	SMBus Transaction Type	Number of Bytes	Bit(s) Number	Bit Name	Definition	Supported
D9	MB_FW_REVISION	Block Read	1+14			Manufacturer's model revision (ASCII code). XXXX-YYYY-0000 XXXX - Primary FW version/revision, YYYY- Secondary FW version/revision	YES
DF	MB_AC_PWR_CYC_COUNT	Read Word	2			Count only by 1 during cold start up.	
E0	MFR_CLEAR_BLACK_BOX	Send Byte	0			The MFR_CLEAR_BLACKBOX command is used to clear all black box records simultaneously. This command is write only. There is no data byte for this command.	YES
E1	MB_AC_OUTAGE_COUNTER	Read Word	2			Count by one if any AC fail detected not include cold start (regular AC on/off events)	YES
E2	MB_GENERAL_ALARM_STATUS	Read Word	2			Refer to Section 7	YES
E3	MB_PFC_ALARM_STATUS	Read Word	2			Refer to Section 7	YES
E5	MB_TOTAL_UP_TIME	Custom Read	4			Total time the PSU has been on in second	YES
E6	MB_TIME_SINCE_LAST_ON	Custom Read	4			Continuous time in seconds which PSU output has been ON, reset to zero once off	YES
E7	FAULT_STATUS	Read Word	2			Fault summary which synchronizes to status registers. Bit15:VOUT_OV_F Bit14:VOUT_UV_F Bit13:IOUT_OC_F Bit12:IOUT_OC_W Bit11:POUT_OP_F Bit10:POUT_OP_W Bit9:VIN_OV_F Bit8:VIN_UV_F Bit7:TEMP_OT_F Bit6:CML_PROC_F Bit5:I_SENSE_F Bit4:TEMP_SENSE_F Bit3:WRONG_PID Bit2:ORING_FAULT Bit1:FAN_1_F Bit0:FAN_2_F	YES
E8	PSU_INPUT_POWER_INST	Read Word	2			reading from E-meter or equivalent, unsigned N=3	YES
E9	PSU_INPUT_CURRENT_AC_INST	Read Word	2			reading from E-meter or equivalent, unsigned N=10	YES
EA	LED_TIMING	R/W Byte	1			Read Write counter to synchronize LED blink timing	YES

Command Code	Command Name	SMBus Transaction Type	Number of Bytes	Bit(s) Number	Bit Name	Definition	Supported
EC	MB_POSITION_NUMBER	Block Read	1+4			Position ID of the PSU inside the shelf (unsigned 32 bit)	YES
ED	ORV3_INFO	Block Read	1+2	BYTE_COUNT		Byte Count = 2	YES
				7	IP_OVER_FREQ_F	Input over frequency fault	YES
				6	IP_OVER_FREQ_W	Input over frequency warn	YES
				5	IP_UNDER_FREQ_W	Input under frequency warn	YES
				4	IP_UNDER_FREQ_F	Input under frequency fault	YES
				3:0	RESERVED	Reserved	NO
				7	MAIN_REG_STATUS	0 - > Main output regulation is 50V, 1 - > Main output regulation is 48V	YES
				6:0	RESERVED	Reserved	NO
EE	READ_VOUT_INT	Read Word	2			Output Internal Voltage Sensor Reading in Vdc (unsigned)	YES
						PMBus Sensor Data Format : Linear (N = -9) supplied by command VOUT_MODE	
						PMBus Sensor Resolution: 0.015Vdc	
						Full-scale : 55 Vdc	
						Accuracy: +/- 0.5%	
EF	MB_OUTPUT_VOLTAGE	Read Word	2			Output Voltage Sensor Reading in Vdc (unsigned)	YES
						Data Format : Integer adjusted with N value (N = -10)	
						Resolution: 0.00625Vdc	
						Full-scale : 55 Vdc	
						Accuracy: +/-0.5%	
F5	RESERVED	Read Word	2			Internal Use	YES
F6	MB_INPUT_VOLTAGE	Read Word	2			Input Voltage Sensor Reading in Vdc (unsigned)	YES
						Data Format : Integer adjusted with N value (N = -6)	
						Max Resolution: 0.25Vdc	
						Full-scale : 511Vdc	
						Accuracy: +/-1%	

Command Code	Command Name	SMBus Transaction Type	Number of Bytes	Bit(s) Number	Bit Name	Definition	Supported
F7	MB_INPUT_CURRENT	Block Read	1+4			MB_INPUT_CURRENT_INST Input Current Sensor Reading in Arms (instantaneous) (unsigned) MB_INPUT_CURRENT Input Current Sensor Reading in Arms (~1s average window) (unsigned)	**YES**
						Data Format : Integer adjusted with N value (N = -10)	
						Resolution: 40.2832mA	
						Full-scale : 82.5A	
						Accuracy: +/-0.5A@<15% load, +/-2% @15-30% load, +/-1% @30-100% load	
F8	MB_INPUT_FREQ	Read Word	2			Input frequency of AC in Hz (unsigned)	**YES**
						Data Format : Integer adjusted with N value (N = 0)	
						Resolution: 1Hz	
						Range: 40-125Hz	
F9	RESERVED	Read Word	2			Internal Use	**YES**
FA	PSU_COOLING	Block Write	1+8	KEY_0 (BYTE_0)		Key to change PSU Cooling Method => Fan Cooling: 0xFC, Immersion Cooling: 0x1C,	**YES**
				KEY_1 (BYTE_1)		Key to change PSU Cooling Method => Fan Cooling: 0x46, Immersion Cooling: 0x49, ASCII Data => Fan Cooling: "F", Immersion Cooling: "I"	
				KEY_2 (BYTE_2)		Key to change PSU Cooling Method => Fan Cooling: 0x61, Immersion Cooling: 0x6D, ASCII Data => Fan Cooling: "a", Immersion Cooling: "m"	
				KEY_3 (BYTE_3)		Key to change PSU Cooling Method => Fan Cooling: 0x6E, Immersion Cooling: 0x6D, ASCII Data => Fan Cooling: "n", Immersion Cooling: "m"	
				KEY_4 (BYTE_4)		Key to change PSU Cooling Method => Fan Cooling: 0x43, Immersion Cooling: 0x43, ASCII Data => Fan Cooling: "C", Immersion Cooling: "C"	
				KEY_5 (BYTE_5)		Key to change PSU Cooling Method => Fan Cooling: 0x6F, Immersion Cooling: 0x6F, ASCII Data => Fan Cooling: "o", Immersion Cooling: "o"	
				KEY_6 (BYTE_6)		Key to change PSU Cooling Method => Fan Cooling: 0x6F, Immersion Cooling: 0x6F, ASCII Data => Fan Cooling: "o", Immersion Cooling: "o"	
				KEY_7 (BYTE_7)		Key to change PSU Cooling Method => Fan Cooling: 0x6C, Immersion Cooling: 0x6C, ASCII Data => Fan Cooling: "I", Immersion Cooling: "I"	
FA	PSU_COOLING	Block Read	1+1	7		Reserved	**NO**
				6		1 => Immersion Cooling, 0 => Fan Cooling	**YES**
				5:0		Reserved	**NO**
FB	For PSU Calibration (Internal Use)						

Command Code	Command Name	SMBus Transaction Type	Number of Bytes	Bit(s) Number	Bit Name	Definition	Supported
FC	For PSU Calibration (Internal Use)						
FD	For PSU Calibration (Internal Use)						
FE	MFR_PID_FW_REV	Read Custom	14			Hex value represent PID and FW version with the following naming convention: xxxx.aaaa.bbbb (e.g. 000C.0200.0300) xxxx: Product ID (000C), aaaa: primary FW revision, bbbb: secondary FW revision. FW version format: Major (1st digit), Minor (2nd digit), Test rev (3rd and 4th digit)	**YES**

7 Bits Field Define

10h Command Table

10h	WRITE_PROTECT			
Bits	**Name**	**Value**	**Description**	**Default**
7:0	Write Protect	1000 0000	Disable all writes except to the WRITE_PROTECT command	0000 0000
		0100 0000	Disable all writes except to the WRITE_PROTECT, OPERATION and PAGE commands	
		0000 0000	Enable writes to all commands.	

E2h Command Table

E2h	General Alarm Status Register			
Name		**Bit**	**Description**	**Default**
General Alarm Status	High Byte	7		0
		6		0
		5		0
		4		0
		3	Fan Alarm	0
		2	Temp Alarm	0
		1	DC/DC converter failure	0
		0	PFC Converter Fail	0
	Low Byte	7		0
		6		0
		5		0
		4		0
		3	Communication	0
		2	Temperature	0
		1	DCDC	0
		0	PFC	0

E3h Command Table

E3h	PFC Alarm Status Register			
Name		**Bit**	**Description**	**Default**
PFC Alarm Status	High Byte	7		0
		6		0
		5		0
		4		0
		3	PFC Fail	0
		2	Input Relay Off	0
		1	Bulk Not Ok	0
		0	AC Not OK	0
	Low Byte	7		0
		6		0
		5	Freq high	0
		4	Freq low	0
		3		0
		2		0
		1	AC OVP	0
		0	AC UVP	0

ADh Command Table

ADh	DCDC Alarm Status Register			
Name		**Bit**	**Description**	**Default**
DCDC Alarm Status	High Byte	7		0
		6		0
		5		0
		4		0
		3		0
		2	Oring Fail	0
		1	secondary MCU fail	0
		0	DC/DC fail	0
	Low Byte	7		0
		6		0
		5		0
		4		0
		3	MAIN_SCKT	0
		2	MAIN_OCP	0
		1	MAIN_OVP	0
		0	MAIN_UVP	0

AEh Command Table

AEh	Temperature Alarm Status Register			
Name		**Bit**	**Description**	**Default**
Temperature Alarm Status	High Byte	7		0
		6		0
		5		0
		4		0
		3		0
		2		0
		1		0
		0	Fan Failure	0
	Low Byte	7		0
		6		0
		5	PFC temp alarm	0
		4	LLC temp alarm	0
		3	Sync temp alarm	0
		2	Oring temp alarm	0
		1	Inlet temp alarm	0
		0	Outlet temp alarm	0

AFh Command Table

AFh	Communication Alarm Status Register			
Name		**Bit**	**Description**	**Default**
Communication Alarm Status	High Byte	7		0
		6		0
		5		0
		4		0
		3		0
		2		0
		1		0
		0		0
	Low Byte	7		0
		6		0
		5		0
		4		0
		3		0
		2		0
		1	Secondary – Logic MCU Fault	0
		0	Primary – Secondary MCU Fault	0

B1h Command Table

B1h	PSU Setting Register			
Name		**Bit**	**Description**	**Default**
PSU Setting	High Byte	7	Power Cycle Turn off the PSU output voltage for certain time defined at 0x005B (to reset IT gears) after 2s of delay. 1 for power cycle, 0 for disable - (operation can be cancelled if 0 is written within the delay time)	0
		6	Clear PSU faults and latch write 1 for clear faults and start PSU to operate if not working due to a fault.	0
		5		0
		4		0
		3	Active current sharing enable/disable 1 for enable, 0 for disable	1
		2		0
		1	output voltage setting (50/48V) 1 for 50V, 0 for 48V	1
		0		0
	Low Byte	7		0
		6		0
		5		0
		4		0
		3		0
		2		0
		1		0
		0	Enable writing on PSU Disabled=0 Enabled=1	1

B2h Command Table

B2h	LED Override Register			
Name		**Bit**	**Description**	**Default**
LED Override	High Byte	7		0
		6		0
		5		0
		4		0
		3		0
		2	Status Amber LED Read only b00@Off, b01@ On, b10 @ blinking	0
		1		0
		0	Status Blue LED Read only b00@Off, b01@ On, b10 @ blinking	0
	Low Byte	7		0
		6	Amber LED 0=Off 1=On	0
		5	Blue LED 0=Off 1=On	0
		4		0
		3		0
		2		0
		1		0
		0	LED Override Disabled=0 Enabled=1	0

8 Reset of Status Bits

The STATUS_ commands shall be reset only by the below methods. If the event is still present that caused the assertion of the status bit, the bit shall stay assert after clearing.

- Sending a CLEAR_FAULTS command to the PSU shall reset all STATUS_ bits to '0'. CLEAR_FAULTS shall clear all STATUS commands at a given PAGE if PAGE command is supported. If the PAGE is set to FFh; all STATUS bits in all PAGEs shall be cleared..
- Cycling input power OFF for 1 second or more the ON shall reset all STATUS_ bits to '0'.
- Power cycling with PSKILL
- Systems with redundant power supplies where only one of the supplies cycle input power OFF/ON (input voltage should drop to 0V when power off); the power cycled PSU shall reset the STATUS_ bits to '0' only when powered back ON. If the PSU is kept OFF, the STATUS_ bits shall not be reset.
- Writing a '1' to bit 6 of high byte of PSU Setting (0xB1) register.
- Writing a '1' to any given bit location shall reset only that bit of the command.

8.1 SMBALERT#

SMBALERT# is a signal (active low) sourced by the PSU to indicate when a STATUS register bit assertion has taken place. If one STATUS bit asserts (sets to '1') while its corresponding SMBALERT_MASK bit is cleared to '0', then an SMBALERT# signal must be driven and remain asserted as long as the underlying condition exists.

The SMBALERT_MASK default values are such that only STATUS_ bits asserted within PAGE 01h (ME) instance will generate SMBALERT#. And by default the SMBAlert# signal is asserted for the following cases in FW default design.

[1] STATUS_IOUT (Iout OC Warning).

[2] STATUS_TEMPERATURE (OT Warning)

[3] STATUS_INPUT (Vin UV Warning, Vin OV Warning).

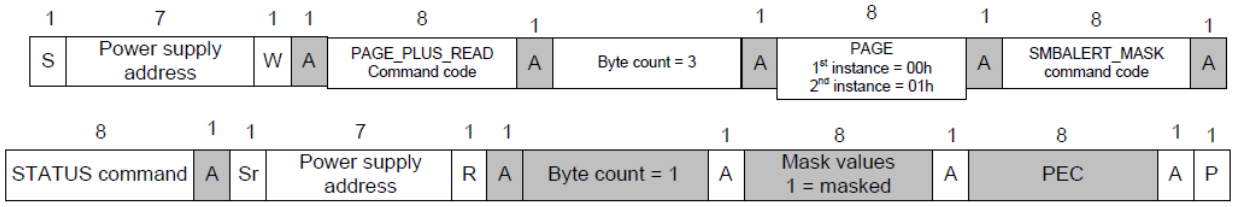
[4] STATUS_VOUT (VOUT_UV_FAULT).

[5] STATUS_OTHERS (Over Frequency Fault, Under Frequency Fault)

8.1.1 SMBALERT_MASK (1Bh)

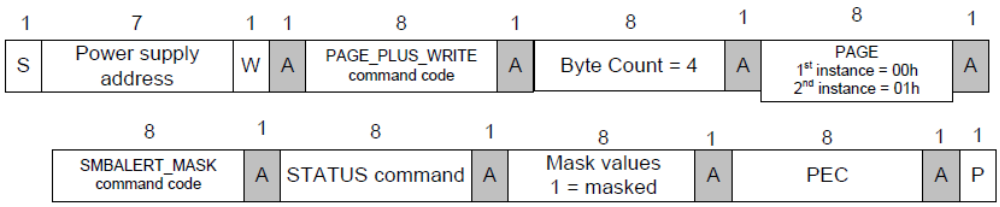
This allows the system to mask events from asserting the SMBAlert# signal and to read back this information from the PSU. SMBALERT_MASK command can be used with any of the supported STATUS events. The events are masked from asserting SMBAlert# by writing a '1' to the associated STATUS bits. The SMBALERT_MASK command is used in conjunction with the PAGE_PLUS command and STATUS_ commands. Below are the protocols.

Reading mask values using PAGE_PLUS
Block Write – Block Read Process Call with PEC



PAGE_PLUS_READ command.

Writing mask values using PAGE_PLUS
Block Write with PEC



STATUS_WORD is not used with SMBALERT_MASK. Only the 'root' event bits are used to control the SMBAlert signal

PAGE_PLUS_WRITE command.

8.1.2 Setting and Resetting the SMBAlert# signal

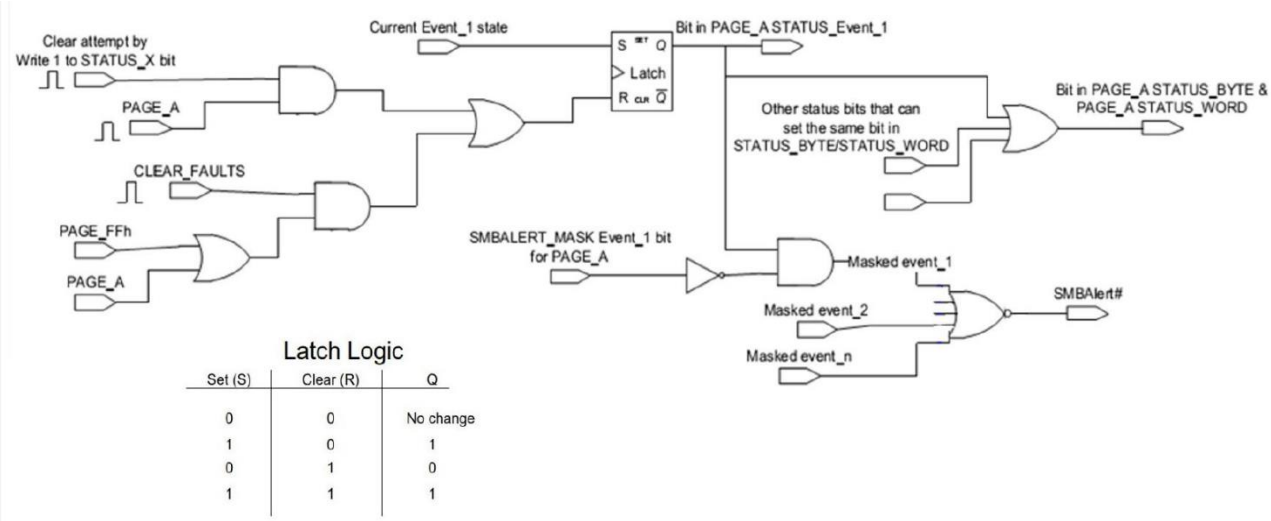
The SMBAlert# signal shall be asserted whenever any un-masked event has occurred. This is a level detected event. Whenever the event is present SMBAlert# shall be asserted. The SMBAlert# signal shall not de-assert at any time if the event that has caused the assertion is still present.

The SMBAlert# signal shall be cleared and re-armed by the following methods:

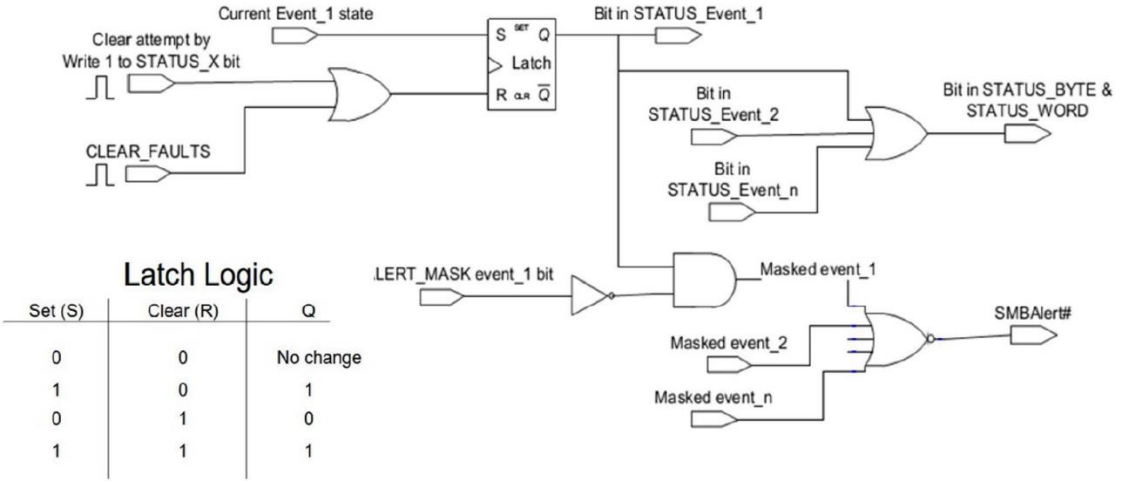
- Clearing STATUS bits causing the asserted SMBAlert# signal.
- Power cycling with PSKILL or with input power
- Masking the event with SMBALERT_MASK

8.1.3 Conceptual View of How Status Bits and SMBALERT# Work

Below figure show conceptual schematics of how the status bits and SMBALERT# are to function.



Conceptual Schematic of STATUS Bits and SMBALERT# for commands that support PAGE_PLUS_



Conceptual Schematic of STATUS Bits and SMBALERT# without PAGE_PLUS_

9 Query(1Ah)

1Ah	QUERY		
Bits	**Value**	**Description**	**Default**
7	1	Command is supported.	
	0	Command is not supported.	
6	1	Command is supported for write.	
	0	Command is not supported for write.	
5	1	Command is supported for read.	
	0	Command is not supported for read.	
4:2	000	Linear Data Format used	
	001	16 bit signed number	
	010	Reserved	
	011	Direct Mode Format used	
	100	8 bit unsigned number	
	101	VID Mode Format used	
	110	Manufacturer specific format used	
	111	Command does not return numeric data. This is also used for commands that return blocks of data.	
1:0	XX	Reserved for future use	00

Note: Only Read_Ein & Read_Eout support direct mode Format.

1Ah command Table

CMD code	Command Name	Bit7 1: support 0: not support	Bit6 1: support to write 0: not support to write	Bit5 1: support to read 0: not support to read	Bit4-bit2 000: Linear 011: Direct 100: 8 bit unsigned 111: Non-numeric	Bit1-bit0
00h	PAGE	1	1	1	100	00
01h	OPERATION	1	1	1	111	00
02h	ON_OFF_CONFIG	1	1	1	111	00
03h	CLEAR_FAULTS	1	1	0	111	00
05h	PAGE_PLUS_WRITE	1	1	0	111	00
06h	PAGE_PLUS_READ	1	0	1	111	00
10h	WRITE_PROTECT	1	1	1	111	00
19h	CAPABILITY	1	0	1	111	00
1Ah	QUERY	1	0	1	111	00
1Bh	SMBALERT_MASK	1	1	1	111	00
20h	VOUT_MODE	1	0	1	111	00
30h	COEFFICIENT	1	0	1	111	00
3Ah	FAN_CONFIG_1_2	1	0	1	111	00
3Bh	FAN_COMMAND_1	1	1	1	000	00
46h	IOUT_OC_FAULT_LIMIT	1	0	1	000	00
4Ah	IOUT_OC_WARN_LIMIT	1	0	1	000	00
5Dh	IIN_OC_WARN_LIMIT	1	0	1	111	00
6Ah	POUT_OP_WARN_LIMIT	1	1	1	000	00
6Bh	PIN_OP_WARN_ LIMIT	1	1	1	000	00
78h	STATUS_BYTE	1	0	1	111	00
79h	STATUS_WORD	1	0	1	111	00
7Ah	STATUS_VOUT	1	1	1	111	00
7Bh	STATUS_IOUT	1	1	1	111	00

CMD code	Command Name	Bit7 1: support 0: not support	Bit6 1: support to write 0: not support to write	Bit5 1: support to read 0: not support to read	Bit4-bit2 000: Linear 011: Direct 100: 8 bit unsigned 111: Non-numeric	Bit1-bit0
7Ch	STATUS_INPUT	1	1	1	111	00
7Dh	STATUS_TEMPERATURE	1	1	1	111	00
7Eh	STATUS_CML	1	1	1	111	00
7Fh	STATUS_OTHER	1	0	1	111	00
80h	STATUS_MFR_SPECIFIC	1	1	1	111	00
81h	STATUS_FANS_1_2	1	1	1	111	00
86h	READ_EIN	1	0	1	011	00
87h	READ_EOUT	1	0	1	011	00
88h	READ_VIN	1	0	1	000	00
89h	READ_IIN	1	0	1	000	00
8Ah	READ_CAP	1	0	1	000	00
8Bh	READ_VOUT	1	0	1	000	00
8Ch	READ_IOUT	1	0	1	000	00
8Dh	READ_TEMPERATURE_1	1	0	1	000	00
8Eh	READ_TEMPERATURE_2	1	0	1	000	00
8Fh	READ_TEMPERATURE_3	1	0	1	000	00
90h	READ_FAN_SPEED_1	1	0	1	000	00
96h	READ_POUT	1	0	1	000	00
97h	READ_PIN	1	0	1	000	00
98h	PMBUS_REVISION	1	0	1	111	00
99h	MFR_ID	1	0	1	111	00
9Ah	MFR_MODEL	1	0	1	111	00
9Bh	MFR_REVISION	1	0	1	111	00
9Ch	MFR_LOCATION	1	0	1	111	00
9Dh	MFR_DATE	1	0	1	111	00
9Eh	MFR_SERIAL	1	0	1	111	00
9Fh	APP_PROFILE_SUPPORT	1	0	1	111	00
A0h	MFR_VIN_MIN	1	0	1	000	00
A1h	MFR_VIN_MAX	1	0	1	000	00
A2h	MFR_IIN_MAX	1	0	1	000	00
A3h	MFR_PIN_MAX	1	0	1	000	00
A4h	MFR_VOUT_MIN	1	0	1	000	00
A5h	MFR_VOUT_MAX	1	0	1	000	00
A6h	MFR_IOUT_MAX	1	0	1	000	00
A7h	MFR_POUT_MAX	1	0	1	000	00
A8h	MFR_TAMBIENT_MAX	1	0	1	000	00
A9h	MFR_TAMBIENT_MIN	1	0	1	000	00
ABh	MFR_EFFICIENCY_HL	1	0	1	000	00
ADh	MB_DCDC_ALARM_STATUS	1	0	1	111	00
AEh	MB_TEMP_ALARM_STATUS	1	0	1	111	00
AFh	MB_COMM_ALARM_STATUS	1	0	1	111	00
B0h	MB_INPUT_POWER	1	0	1	111	00
B1h	MB_PSU_SETTING	1	1	1	111	00
B2h	MB_LED_OVERRIDE	1	1	1	111	00
B3h	MB_PSU_HW_REVISION	1	0	1	111	00
B4h	MB_PSU_RPM_FAN0	1	0	1	111	00
B5h	MB_MAX_TEMP	1	0	1	111	00

CMD code	Command Name	Bit7 1: support 0: not support	Bit6 1: support to write 0: not support to write	Bit5 1: support to read 0: not support to read	Bit4-bit2 000: Linear 011: Direct 100: 8 bit unsigned 111: Non-numeric	Bit1-bit0
B6h	MB_FAULT_COUNT	1	0	1	111	00
B7h	PMBUS_CRC_ERROR_CNT	1	0	1	000	00
B8h	PMBUS_TIMEOUT_ERROR_CNT	1	0	1	000	00
B9h	MB_PSU_TEMP0_INLET	1	0	1	111	00
BAh	MB_PSU_TEMP0_OUTLET	1	0	1	111	00
BBh	MB_MIN_TEMP	1	0	1	111	00
BCh	MB_OUTPUT_CURRENT	1	0	1	111	00
BDh	MB_ISHARE_CURRENT	1	0	1	111	00
BEh	MB_OUTPUT_POWER	1	0	1	111	00
BFh	MB_BULK_CAP_VOLTAGE	1	0	1	111	00
C0h	MFR_MAX_TEMP_1	1	0	1	000	00
C1h	MFR_MAX_TEMP_2	1	0	1	000	00
C2h	MFR_MAX_TEMP_3	1	0	1	000	00
C3h	READ_TEMP_CLIP_P	1	0	1	000	00
C4h	READ_TEMP_CLIP_N	1	0	1	000	00
C5h	MB_POWER_CYCLE_UNIX_TIME	1	1	1	111	00
C6h	MB_FBPART	1	0	1	111	00
C7h	MB_WORKORDER	1	0	1	111	00
C8h	MB_UNIX_TIME	1	1	1	111	00
C9h	MB_CONFIG_PLS_TIMING	1	1	1	111	00
CAh	MB_VIN_MIN	1	1	1	111	00
CBh	MB_VIN_MAX	1	1	1	111	00
CCh	MB_VOUT_SETPOINT_H	1	1	1	111	00
CDh	MB_VOUT_SETPOINT_L	1	1	1	111	00
CEh	MB_VOUT_CHANGE_TIMER	1	1	1	111	00
CFh	MB_FBL_FW_REVISION	1	0	1	111	00
D1h	MB_READ_ITHD	1	0	1	111	00
D2h	MB_READ_POWER_FACTOR	1	0	1	111	00
D4h	MFR_FRU_PROTECTION	1	1	1	111	00
D5h	MFR_BLACKBOX	1	0	1	111	00
D6h	MFR_FWUPLOAD_MODE	1	1	1	111	00
D7h	MFR_FWUPLOAD	1	1	0	111	00
D8h	MFR_FWUPLOAD_STATUS	1	0	1	111	00
D9h	MB_FW_REVISION	1	1	0	111	00
DFh	MFR_AC_PWR_CYC_COUNT	1	0	1	111	00
E0h	MFR_CLEAR_BLACK_BOX	1	1	0	111	00
E1h	MB_AC_OUTAGE_COUNTER	1	0	1	111	00
E2h	MB_GENERAL_ALARM_STATUS	1	0	1	111	00
E3h	MB_PFC_ALARM_STATUS	1	0	1	111	00
E5h	MB_TOTAL_UP_TIME	1	0	1	111	00
E6h	MB_TIME_SINCE_LAST_ON	1	0	1	111	00
E7h	FAULT_STATUS	1	0	1	111	00
E8h	PSU_INPUT_POWER_INST	1	0	1	111	00
E9h	PSU_INPUT_CURRENT_AC_INST	1	0	1	111	00
EAh	LED_TIMING	1	1	1	111	00
ECh	MB_POSITION_NUMBER	1	0	1	111	00
EDh	ORV3_INFO	1	0	1	111	00

CMD code	Command Name	Bit7 1: support 0: not support	Bit6 1: support to write 0: not support to write	Bit5 1: support to read 0: not support to read	Bit4-bit2 000: Linear 011: Direct 100: 8 bit unsigned 111: Non-numeric	Bit1-bit0
EEh	READ_VOUT_INT	1	0	1	111	00
EFh	MB_OUTPUT_VOLTAGE	1	0	1	111	00
F5h	RESERVED	1	1	1	111	00
F6h	MB_INPUT_VOLTAGE	1	0	1	111	00
F7h	MB_INPUT_CURRENT	1	0	1	111	00
F8h	MB_INPUT_FREQ	1	0	1	111	00
F9h	RESERVED	1	1	1	000	00
FAh	PSU_COOLING	1	1	1	111	00
FBh	Calibration Related Command 1	1	1	0	111	00
FCh	Calibration Related Command 2	1	1	0	111	00
FDh	Calibration Related Command 3	1	0	1	111	00
FEh	MFR_PID_FW_REV	1	0	1	111	00

10 PSU Parameter Measurement and Reporting Accuracy

10.1 PMBus Accuracy

The sensor commands shall meet the accuracy requirements mentioned in HW spec. 100% load is based on high line max load.

Measurement accuracy

Parameter	Load	Accuracy
AC input power	<10%	±25W
	10-20%	± 5%
	20-100%	±3%
AC input current	<15%	±0.5A
	15 -30%	±2%
	30-100%	±1%
AC input current THD (Error difference not %)	<10%	±10
	10-30%	±2
	30-100%	±1.5
Power factor (Error difference not %)	<10%	±0.1
	10-30%	±0.05
	30-100%	±0.01
AC input voltage	0-100%	±1%
Output voltage	0-100%	±0.5%
Output current	10-20%	±10%
	20-50%	±5%
	50-100%	±1%
Output power	<10%	±25W
	10-20%	±3%
	20-100%	±2%

Temperature	0-100%	±2 ℃

Accuracy (%) = [|PMBus reading – Meter measurement | / Meter measurement] *100%
Temperature accuracy: | PMBus reading – Meter Measurement | <=3 ℃

11 FRU requirements

The FRU data format shall be compliant with the IPMI ver.1.0 (per rev.1.1 from Sept. 25, 1999) specification. The following is the exact listing of the EEPROM content. During testing this listing shall be followed and verified.

11.1 FRU Device Protocol

The FRU device will implement the same protocols as the commonly used AT24C02 or equivalent device, including the byte read, sequential read, byte write, and page read protocols.

11.2 Data Format

The minimum information to be contained in the FRU device is shown in the following table.

Area Type	Description
Common header	As defined by the IPMI FRU document
Product Info Area	As defined by the IPMI FRU document

11.3 MFR_FRU_PROTECTION (D4h)

The contents of the FRU can be protected with this PMBus command. A write/read value of 00h means content of FRU is write-enabled, while a value of 01h means its content is write-protected.

12 Black Box

This specification defines the requirements for power supplies with PMBus capability to store PMBus and other data into non-volatile memory inside the power supply. The data shall be saved to non-volatile memory upon a critical failure that caused the power supply to shut down.

12.1 Fault events saved to the Black Box

Data is saved to the Black Box for the following fault events:
- Over voltage on output
- Under voltage on output
- Over current on output
- Short circuit on output
- AC Input under voltage fault
- AC Input over voltage fault
- AC Input out of range frequency fault
- Fan failure
- Over temperature fault

12.2 Black Box Data

Black Box Data can be read through PMBus command 0xD5 with Block Read PMBus protocol. Black box data includes system tracking data and power supply event data.

There is total 300 bytes data per black box record.

In 1st Read Request from host is received, PMBus packet with structure: Block Count + File Offset (0) + 1st half of 150 bytes of Blackbox data will be returned.

In 2nd Read Request form host is received, PMBus packet with structure: Block Count + File Offset (1) + 2nd half of 150 bytes of Blackbox data will be returned.

Read Request afterwards will repeat sending these two halves alternatively.

12.3 Commands

Name: MFR_BLACKBOX
Format: Read Block with PEC (300 bytes)
Code: D5h

Record Number		Number of Word	Data to store	Encoding
0	19	20	AC Input Voltage - rectified (20 samples per 1ms)	Unsigned N=6
20	39	20	AC Input Current - rectified (20 samples per 1ms)	Unsigned N=10
40	59	20	Main Output Voltage (20 samples per 1ms)	Unsigned N=10
60	79	20	Main Output Current (20 samples per 1ms)	Unsigned N=6
80	84	5	Temp0 – Inlet (5 samples per 5 sec)	Signed N=7
85	89	5	Temp1 – Outlet (5 samples per 5 sec)	Signed N=7
90	94	5	RPM Fan 0 (5 samples per 5 sec)	Unsigned N=0
95	96	2	TOTAL_UP_TIME	Unsigned N=0
97	98	2	TIME_SINCE_LAST_ON	Unsigned N=0
99	99	1	AC Power Cycle Counter	Unsigned N=0
100	100	1	AC Outage Counter	Unsigned N=0
101	102	2	Reserved	
103	103	1	General Alarm Status Register	Bit mapped per failure

104	104	1	PFC Alarm Status Register	Bit mapped per failure
105	105	1	DCDC Alarm Status Register	Bit mapped per failure
106	106	1	Temperature Alarm Status Register	Bit mapped per failure
107	107	1	Communication Alarm Status Register	Bit mapped per failure
108	108	1	PSU Input Power Inst	Unsigned N=3
109	109	1	PSU Input Current AC Inst	Unsigned N=10
110	110	1	PSU RPM fan0	Unsigned N=0
111	111	1	PSU RPM fan1	Unsigned N=0
112	112	1	PSU Temp0 - Inlet	Signed N=7
113	113	1	PSU Temp1 – Outlet	Signed N=7
114	114	1	PSU Max Temp	Signed N=7
115	115	1	PSU Min Temp	Signed N=7
116	117	2	PSU Position number	Unsigned N=0
118	119	2	CRC error counter	Unsigned N=0
120	121	2	Timeout error counter	Unsigned N=0
122	122	1	PSU Output Voltage	Unsigned N=10
123	123	1	PSU Output Current	Unsigned N=6
124	124	1	I share current value	Unsigned N=6
125	125	1	PSU Output Power	Unsigned N=3
126	126	1	PSU Bulk Cap Voltage	Unsigned N=6
127	127	1	PSU input frequency AC	Unsigned N=0
128	128	1	PSU iTHD	Unsigned N=9
129	129	1	PSU power factor	Unsigned N=9
130	130	1	PSU Input Power	Unsigned N=3

131	131	1	PSU Input Voltage AC	Unsigned N=6
132	132	1	PSU Input Current AC	Unsigned N=10
133	133	1	PSU fault counter	Unsigned N=0
134	136	3	Reserved	
137	137	1	PSU setting register	Bit mapped
138	138	1	Communication baud rate	Unsigned N=0
139	139	1	Fan Override rpm	Unsigned N=0
140	140	1	LED Override	Bitmapped
141	142	2	Unix time	Unsigned N=0
143	143	1	Configurable PLS timing	Unsigned N=0
144	144	1	Vin Min	Unsigned N=6
145	145	1	Vin Max	Unsigned N=6
146	146	1	Vout setpoint H	Unsigned N=10
147	147	1	Vout setpoint L	Unsigned N=10
148	148	1	Vout change timer	Unsigned N=0
149	149	1	Checksum (2's complement of sum of all 16 bit blackbox data)	

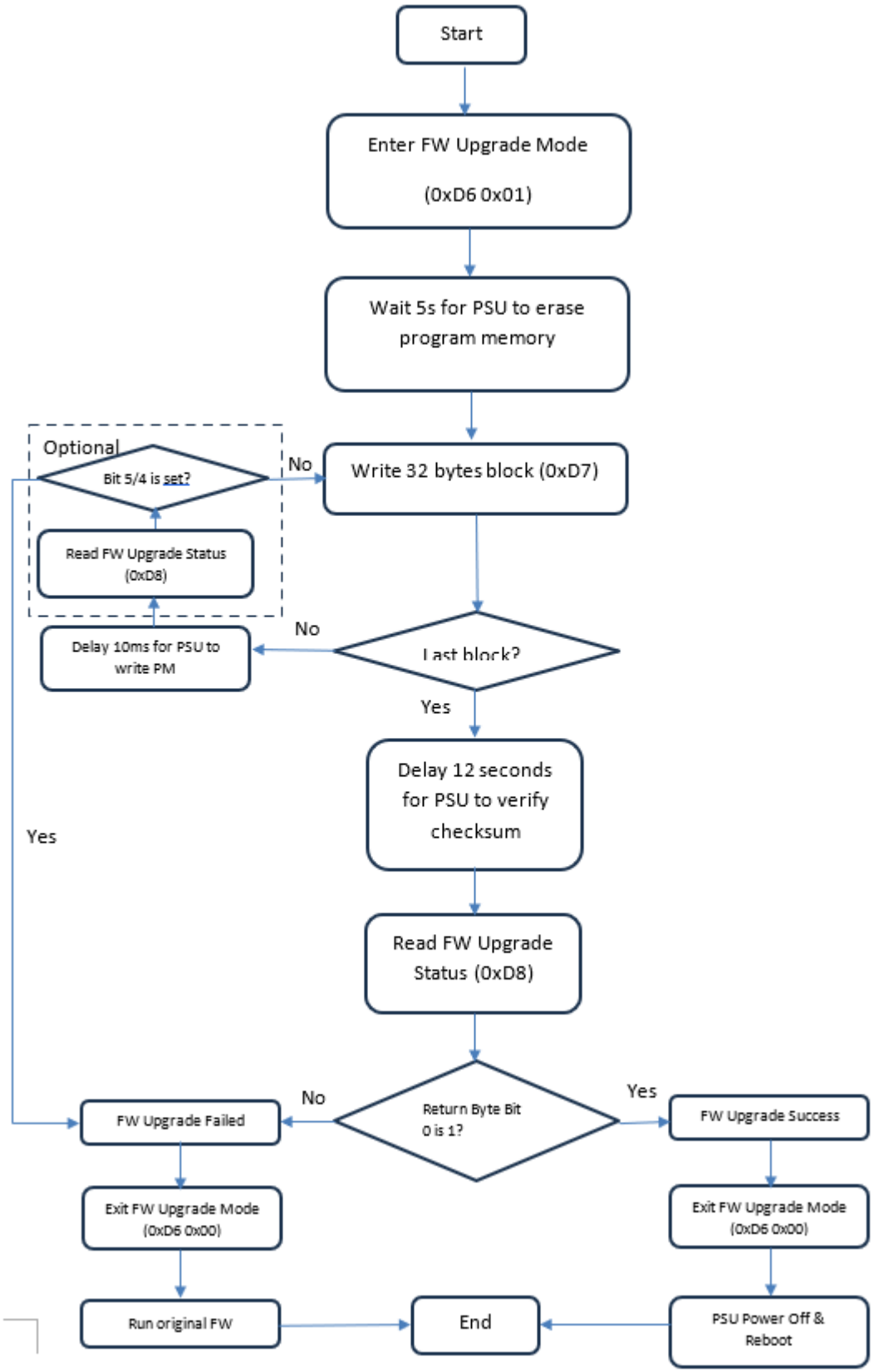
Name: MFR_CLEAR_BLACKBOX
Format: Send Byte with PEC
Code: E0h

The MFR_CLEAR_BLACKBOX command is used to clear all black box records simultaneously.
This command is write only. There is no data byte for this command.

13 On-Line System Bootloader Firmware Update

FW in the main microcontroller on both primary and secondary side of the power supply must be able to be updated in the system using the In-System Firmware Update feature while in the ON state (i.e. with AC power present). The primary and secondary microcontrollers have their own backup image in internal FLASH, if the FW update failed finally, the PSU will be able to recover output with the backup version firmware.

13.1 Firmware update process



13.2 FW update commands

The Power Management firmware module implemented in system includes an algorithm for the PSU firmware update. It will use PMBus Specific commands which are implemented in both PSU and system. The PMBus specific commands used for PSU firmware upgrading are detailed below:

Cmd Code	Cmd Name	Cmd Type	No. of Bytes	Byte Name	Bit No.	Definition	Support in BL / Normal mode
D6	MFR_FWUPLOAD_MODE	Read/Write Byte	1		0	0=exit firmware upload mode 1=enter firmware upload mode	Both
					1-7	Reserved	
D7	MFR_FWUPLOAD	Block Write	1+32	BYTE_COUNT		Byte Count = 32	BL only
				Image data		Command used to send each block of the FW image	
D8	MFR_FWUPLOAD_STATUS	Read Word	2		0	1= Full image received successfully	Both
					1	1 = Full image not received yet. PSU will keep this bit asserted until the full image is received by the PSU.	
					2	Reserved	
					3	1= Full image received but image is bad or corrupt. Power supply can power ON and support full features.	
					4	1 = FW image is not supported by PSU. If the PSU receives the image header and determines that PSU HW does not support the image being sent by the system. It shall not accept the image and it shall assert this bit.	
					5	Command format does not match	
					6	Reserved	
					7-15	Reserved	

Name: MFR_FWUPLOAD_MODE
Format: Read/Write Byte
Code: D6h
Writing a 1 puts the power supply into firmware upload mode and gets it ready to receive the 1st image block via the MFR_FW_UPLOAD command. The system can use this command at any time to restart sending the FW image.
Writing a 0 puts the power supply back into normal operating mode.

Name: MFR_FWUPLOAD
Format: Block Write
Code: D7h

This command is used to send 32 bytes image data each time to PSU with block write PMBus protocol.

Name: MFR_FWUPLOAD_STATUS
Format: Read Word
Code: D8h

For read operations this command returns a 16-bit status register that reflects programming conditions. At any time during or after the firmware image upload the system can read this command to determine status of the firmware upload process.

Name: MFR_FW_REVISION
Format: Block Read
Code: D9h
Manufacturer's model revision (ASCII code). XXXX-YYYY-0000
XXXX - Primary FW version/revision, YYYY- Secondary FW version/revision

Byte	Value	Description
0	0 - 255 (ASCII code)	Major revision: primary
1	0 - 255 (ASCII code)	Minor revision: primary
2-3	0 - 255 (ASCII code)	Test revision: primary
4	0x2D (ASCII code)	“-“
5	0 - 255 (ASCII code)	Major revision: secondary
6	0 - 255 (ASCII code)	Minor revision: secondary
7-8	0 - 255 (ASCII code)	Test revision: secondary
9	0x2D (ASCII code)	“-“
10	0x30 (ASCII code)	“0”
11	0x30 (ASCII code)	“0”
12/13	0x3030 (ASCII code)	“00”