Technical Reference PMBus BMR320x000/001

This appendix contains a detailed reference of the PMBus commands supported by the product.

Data Formats

The products make use of a few standardized numerical formats, along with custom data formats. A detailed walkthrough of the above formats is provided in AN304, as well as in sections 7 and 8 of the PMBus Specification Part II. The custom data formats vary depending on the command, and are detailed in the command description.

Standard Commands

The functionality of commands with code 0x00 to 0xCF is usually based on the corresponding command specification provided in the PMBus Standard Specification Part II (see Power System Management Bus Protocol Documents below). However there might be different interpretations of the PMBus Standard Specification or only parts of the Standard Specification applied, thus the detailed command description below should always be consulted.

Forum Websites

The System Management Interface Forum (SMIF)
http://www.powersig.org/
The System Management Interface Forum (SMIF) supports the rapid advancement of an efficient and compatible technology base that promotes power management and systems technology implementations. The SMIF provides a membership path for any company or individual to be active participants in any or all of the various working groups established by the implementer forums.

Power Management Bus Implementers Forum
(PMBUS-IF)
http://pmbus.org/
The PMBus-IF supports the advancement and early adoption of the PMBus protocol for power management. This website offers recent PMBus specification documents, PMBus articles, as well as upcoming PMBus presentations and seminars, PMBus Document Review Board (DRB) meeting notes, and other PMBus related news.

PMBus – Power System Management Bus Protocol Documents

These specification documents may be obtained from the PMBus-IF website described above. These are required reading for complete understanding of the PMBus implementation. This appendix will not re-address all of the details contained within the two PMBus Specification documents.

Specification Part I – General Requirements Transport And Electrical Interface
Includes the general requirements, defines the transport and electrical interface and timing requirements of hard wired signals.

Specification Part II – Command Language
Describes the operation of commands, data formats, fault management and defines the command language used with the PMBus.

SMBus – System Management Bus Documents

System Management Bus Specification, Version 2.0, August 3, 2000
This specification specifies the version of the SMBus on which Revision 1.2 of the PMBus Specification is based. This specification is freely available from the System Management Interface Forum Web site at:
http://www.smbus.org/specs/

PMBus Command Summary and Factory Default Values of Standard Configuration

The factory default values provided in the table below are valid for the Standard configuration. Factory default values for other configurations can be found using the Flex Power Designer tool.

Code	Name	Data Format	Factory Default Value Standard Configuration BMR320X000/001 R1		Min Set Value	Max Set Value	Unit
0x00	PAGE	R/W Byte					
0x01	OPERATION	R/W Byte					
0x02	ON_OFF_CONFIG	R/W Byte	0x16				
0x03	CLEAR_FAULTS	Send Byte					
0x10	WRITE_PROTECT	R/W Byte	0x00				
0x19	CAPABILITY	Read Byte	0x20				
0x20	VOUT_MODE	Read Byte	0x1B				
0x35	VIN_ON	R/W Word	0xE928	37.00	30	50	V
0x40	VOUT_OV_FAULT_LIMIT	R/W Word	0x00FB	7.84	0	17	V
0x41	VOUT_OV_FAULT_RESPONSE	R/W Byte	0x80	0.00			ms
0x42	VOUT_OV_WARN_LIMIT	R/W Word	0x00F0	7.50	0	17	V
0x43	VOUT_UV_WARN_LIMIT	R/W Word	0x0090	4.50	0	15	V
0x44	VOUT_UV_FAULT_LIMIT	R/W Word	0x0080	4.00	0	15	V
0x45	VOUT_UV_FAULT_RESPONSE	R/W Byte	0x80	0.00			ms
0x46	IOUT_OC_FAULT_LIMIT	R/W Word	0xF168	90.00	0	240	A
0x47	IOUT_OC_FAULT_RESPONSE	R/W Byte	0xC0	0.00			ms
0x4A	IOUT_OC_WARN_LIMIT	R/W Word	0xF154	85.00	0	150	A
0x4F	OT_FAULT_LIMIT	R/W Word	0x007D	125.00	25	130	°C
0x50	OT_FAULT_RESPONSE	R/W Byte	0x80	0.00			ms
0x51	OT_WARN_LIMIT	R/W Word	0x0073	115.00	25	130	°C
0x55	VIN_OV_FAULT_LIMIT	R/W Word	0xEA00	64.00	0	68	V
0x56	VIN_OV_FAULT_RESPONSE	R/W Byte	0x80	0.00			ms
0x59	VIN_UV_FAULT_LIMIT	R/W Word	0xE91C	35.50	0	50	V
0x5A	VIN_UV_FAULT_RESPONSE	R/W Byte	0x80	0.00			ms
0x68	POUT_OP_FAULT_LIMIT	R/W Word	0x01FF	511.00	0	3000	W
0x69	POUT_OP_FAULT_RESPONSE	R/W Byte	0x00	0.00			ms
0x6A	POUT_OP_WARN_LIMIT	R/W Word	0x01FF	511.00	0	3000	W
0x78	STATUS_BYTE	Read Byte					
0x79	STATUS_WORD	Read Word					
0x7A	STATUS_VOUT	Read Byte					
0x7B	STATUS_IOUT	Read Byte					
0x7C	STATUS_INPUT	Read Byte					
0x7D	STATUS_TEMPERATURE	Read Byte					
0x7E	STATUS_CML	Read Byte					
0x80	STATUS_MFR_SPECIFIC	Read Byte					
0x88	READ_VIN	Read Word					
0x8B	READ_VOUT	Read Word					
0x8C	READ_IOUT	Read Word					
0x8D	READ_TEMPERATURE_1	Read Word					
0x96	READ_POUT	Read Word					
0x98	PMBUS_REVISION	Read Byte	0x33				
0x99	MFR_ID	Read Block2	0x001A				
0x9A	MFR_MODEL	Read Block2	0x6000				
0x9B	MFR_REVISION	Read Block2	0x0002				
0x9D	MFR_DATE	Read Block2	Unit Specific				

0xB0	MFR_SPEC_SERIAL	Read Block4	Unit Specific				
0xB1	MFR_SPEC_MODEL_REV	Read Block8	Unit Specific				
0xC4	PASSW_I2C	Write Word					
0xC5	PASSW_OTP	Write Word					
0xC6	PASSW_ADDR	Write Word					
0xCF	OTP_WRITE	Read Byte					
0xD3	DEVICE_FULL_ADDRESS	Read Byte					
0xD4	DCX_VOUT_SS_FAULT	R/W Byte	0x08				
0xD6	OTP_UPLOAD	R/W Byte					
0xD8	NTC_CS_LUT_STATUS	Read Byte	0x03				
0xDF	DCX_SS_PROTECTION	R/W Byte	0x15	2.50			ms
0xE0	PMBUS_BASE_ADDRESS	R/W Byte	0x44				
0xE1	NTC_LUT_CRC16_READ	Read Word					
0xE2	CS_LUT_CRC16_READ	Read Word					
0xEE	CHECKSUM_CRC	Read Word	Unit Specific				
0xF0	REG_CON_OFFSET_IOUT	R/W Byte	Unit Specific				
0xF1	REG_CON_MULT_IOUT	R/W Byte	Unit Specific				

PMBus Command Details

PAGE (0x00)
Description: Page command

Bit	Description	Format
7:0	Command for compability only, no function. Valid values are 0x00 and 0xFF.	Integer Unsigned

OPERATION (0x01)
Description: Sets the desired PMBus enable operation.

Bit	Description	Value	Function	Description
7:6	Make the device enable or disable if PMBus Enable has been activated in ON_OFF_CONFIG.	00	Immediate Off	Disable Immediately without sequencing.
		10	Enable	Enable device to the set voltage.

ON_OFF_CONFIG (0x02)
Description: Configures how the device is controlled by the EN pin and the PMBus OPERATION command. Setting bit 3 in ON_OFF_CONFIG to 1 will automatically set OPERATION = 0.

Bit	Function	Description	Value	Function	Description
4	Powerup Operation	Must be set to 1.	1	Enable pin or PMBus	Unit does not power up until commanded by the CONTROL pin and OPERATION command.
3	PMBus Enable Mode	Controls how the unit responds to commands received via the serial bus.	0	Ignore PMBus	Unit ignores the on/off portion of the OPERATION command from serial bus.
			1	Use PMBus	To start, the unit requires that the on/off portion of the OPERATION command is instructing the unit to run.
2	Enable Pin Mode	Controls how the unit responds to the CONTROL pin.	0	Ignore pin	Unit ignores the CONTROL/Enable pin.
			1	Use pin	Unit requires the CONTROL pin to be asserted to start the unit.
1	Enable Pin Polarity	Polarity of the CONTROL pin.	1	Active High	Enable pin will cause device to enable when driven high.
			0	Active Low	Enable pin will cause device to enable when driven low.
0	Disable Action	Must be set to 1.	1	Imm. Off	Turn off the output and stop transferring energy to the output as fast as possible.

CLEAR_FAULTS (0x03)
Description: Clears all fault status bits

WRITE_PROTECT (0x10)
Description: The WRITE_PROTECT command is used to control writing to the PMBus device. The intent of this command is to provide protection against accidental changes. This command is not intended to provide protection against deliberate or malicious changes to a device's configuration or operation. Above what is specified in the PMBus standard the following protection modes are available: Data 0000 0011 => Disable all writes

Bit	Description	Value	Function	Description
7:0	All supported commands may have their parameters read, regardless of the WRITE_PROTECT settings.	0x80	Enable write command	Disable all writes except to the WRITE_PROTECT command.
		0x40	Enable operation	Disable all writes except to the WRITE_PROTECT, OPERATION and PAGE commands.
		0x20	Enable control and Vout commands	Disable all writes except to the WRITE_PROTECT, OPERATION, PAGE, ON_OFF_CONFIG and VOUT_COMMAND commands.
		0x03	Disable all writes	Disable all writes. Deadlock - needs a recycle of input voltage to unlock.
		0x02	Enable Vout command	Disable all writes except to the VOUT_COMMAND command. Deadlock - needs a recycle of input voltage to unlock.
		0x00	Enable all commands	Enable writes to all commands.

CAPABILITY (0x19)
Description: This command provides a way for a host system to determine some key capabilities of a PMBus device.

Bit	Function	Description	Value	Function	Description
7	Packet Error Checking	Packet error checking.	00	Not Supported	Packet Error Checking not supported.
			01	Supported	Packet Error Checking is supported.
6:5	Maximum Bus Speed	Maximum bus speed.	00	100kHz	Maximum supported bus speed is 100 kHz.
			01	400kHz	Maximum supported bus speed is 400 kHz.
			10	1MHz	Maximum supported bus speed is 1 MHz.
4	Smbalert	SMBALERT	00	No Smbalert	The device does not have a SMBALERT# pin and does not support the SMBus Alert Response protocol.
			01	Have Smbalert	The device does have a SMBALERT# pin and does support the SMBus Alert Response protocol.
3	Numeric Format	Numeric format.	0	LINEAR or DIRECT Format	Numeric data is in LINEAR or DIRECT format.
			1	IEEE Half Precision Floating Point Format	Numeric data is in IEEE half precision floating point format.
2	AVSBus Support	AVSBus support.	0	AVSBus Not Supported	AVSBus not supported.

			1	AVSBus Supported	AVSBus supported.

VOUT_MODE (0x20)
Description: Controls how future VOUT-related commands parameters will be interpreted.

Bit	Function	Description	Format
4:0		Five bit two's complement EXPONENT for the MANTISSA delivered as the data bytes for VOUT_COMMAND in VOUT_LINEAR Mode, five bit VID code identifier per in VID Mode or always set to 00000b in Direct Mode.	Integer Signed

Bit	Function	Description	Value	Function	Description
7:5		Set to 000b to select VOUT_LINEAR Mode (Five bit two's complement exponent for the MANTISSA delivered as the data bytes for an output voltage related command), set to 001b to select VID Mode (Five bit VID code identifier per) or set to 010b to select Direct Mode (Always set to 00000b).	000	Linear	Linear Mode Format.
			001	VID	VID Mode.
			010	Direct	Direct Mode.

VIN_ON (0x35)
Description: The VIN_ON command sets the value of the input voltage, in volts, at which the unit should start power conversion.

Bit	Description	Format	Unit
15:0	Sets the VIN ON threshold. Linear exponent must be set to -3.	Linear	V

VOUT_OV_FAULT_LIMIT (0x40)
Description: Output over voltage fault limit. The actual level needed to trig a fault flag needs to be greater than the set level. This means the resolution will affect the exact trig level.

Bit	Description	Format	Unit
15:0	Output over voltage fault limit.	Vout Mode Unsigned (Exp = -5)	V

VOUT_OV_FAULT_RESPONSE (0x41)
Description: Output over voltage fault response.

Bit	Function	Description	Format	Unit
2:0	Retry Time and Delay Time	Delay time in 200 ms units between attempts to restart.	Fixed Point Unsigned	ms

Bit	Function	Description	Value	Function	Description
7:6	Response		00	Ignore Fault	The PMBus device continues operation without interruption.

		Describes the device interruption operation. 00b - The PMBus device continues operation without interruption. 10b - The device shuts down (disables the output) and responds according to the Retry Setting in bits [5:3].	10	Disable and retry	The device shuts down (disables the output) and responds according to the retry setting in bits [5:3].
5:3	Retries	The device attempts to restart the number of times set by these bits. 000b means the device does not attempt a restart. 111b means the device attempts restarting continuously.	000	Do Not Retry	A zero value for the Retry Setting means that the unit does not attempt to restart. The output remains disabled until the fault is cleared (Section 10.7).
			001	Retry Once	The PMBus device attempts to restart 1 time. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			010	Retry Twice	The PMBus device attempts to restart 2 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			011	Retry 3 times	The PMBus device attempts to restart 3 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.

			100	Retry 4 times	The PMBus device attempts to restart 4 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			101	Retry 5 times	The PMBus device attempts to restart 5 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			110	Retry 6 times	The PMBus device attempts to restart 6 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			111	Retry Continuously	The PMBus device attempts to restart continuously, without limitation, until it is commanded OFF (by the CONTROL pin or OPERATION command or both), bias power is removed, or another fault condition causes the unit to shut down.

VOUT_OV_WARN_LIMIT (0x42)
Description: Output over voltage warning limit.

Bit	Description	Format	Unit
15:0	Output over voltage warning limit.	Vout Mode Unsigned (Exp = -5)	V

VOUT_UV_WARN_LIMIT (0x43)
Description: Output under voltage warning limit.

Bit	Description	Format	Unit
15:0	Output under voltage warning limit.	Vout Mode Unsigned (Exp = -5)	V

VOUT_UV_FAULT_LIMIT (0x44)
Description: Output under voltage fault limit.

Bit	Description	Format	Unit
15:0	Output under voltage fault limit.	Vout Mode Unsigned (Exp = -5)	V

VOUT_UV_FAULT_RESPONSE (0x45)
Description: Output under voltage fault response.

Bit	Function	Description	Format	Unit
2:0	Retry Time and Delay Time	Delay time in 200 ms units between attempts to restart.	Fixed Point Unsigned	ms

Bit	Function	Description	Value	Function	Description
7:6	Response	Describes the device interruption operation. 00b - The PMBus device continues operation without interruption. 10b - The device shuts down (disables the output) and responds according to the Retry Setting in bits [5:3].	00	Ignore Fault	The PMBus device continues operation without interruption.
			10	Disable and retry	The device shuts down (disables the output) and responds according to the retry setting in bits [5:3].
5:3	Retries	The device attempts to restart the number of times set by these bits. 000b means the device does not attempt a restart. 111b means the device attempts restarting continuously.	000	Do Not Retry	A zero value for the Retry Setting means that the unit does not attempt to restart. The output remains disabled until the fault is cleared (Section 10.7).
			001	Retry Once	The PMBus device attempts to restart 1 time. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.

			010	Retry Twice	The PMBus device attempts to restart 2 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			011	Retry 3 times	The PMBus device attempts to restart 3 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			100	Retry 4 times	The PMBus device attempts to restart 4 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			101	Retry 5 times	The PMBus device attempts to restart 5 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.

			110	Retry 6 times	The PMBus device attempts to restart 6 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			111	Retry Continuously	The PMBus device attempts to restart continuously, without limitation, until it is commanded OFF (by the CONTROL pin or OPERATION command or both), bias power is removed, or another fault condition causes the unit to shut down.

IOUT_OC_FAULT_LIMIT (0x46)
Description: Output over current limit. The actual level needed to trig a fault flag needs to be greater than the set level. This means the resolution will affect the exact trig level.

Bit	Description	Format	Unit
15:0	Output over current fault limit. Linear exponent must be -2.	Linear	A

IOUT_OC_FAULT_RESPONSE (0x47)
Description: Output over current fault response.

Bit	Function	Description	Format	Unit
2:0	Retry Time and Delay Time	Delay time in 200 ms units between attempts to restart.	Fixed Point Unsigned	ms

Bit	Function	Description	Value	Function	Description
7:6	Response	For all values of bits [7:6],the device: Sets the corresponding fault bit in the status registers and If the device supports notifying the host, it does so.	00	Ignore Fault	The PMBus device continues to operate indefinitely while maintaining the output current at the value set by IOUT_OC_FAULT_LIMIT without regard to the output voltage (known as constant-current or brickwall limiting).
			11	Disable and Retry	The device shuts down (disables the output) and responds according to the retry setting in bits [5:3].
5:3	Retries		000	Do Not Retry	A zero value for the Retry Setting means that the unit does not attempt to restart. The output remains disabled until the fault is cleared (Section 10.7).

		The device attempts to restart the number of times set by these bits. 000b means the device does not attempt a restart. 111b means the device attempts restarting continuously.	001	Retry Once	The PMBus device attempts to restart 1 time. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			010	Retry Twice	The PMBus device attempts to restart 2 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			011	Retry 3 times	The PMBus device attempts to restart 3 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			100	Retry 4 times	The PMBus device attempts to restart 4 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.

			101	Retry 5 times	The PMBus device attempts to restart 5 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			110	Retry 6 times	The PMBus device attempts to restart 6 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			111	Retry Continuously	The PMBus device attempts to restart continuously, without limitation, until it is commanded OFF (by the CONTROL pin or OPERATION command or both), bias power is removed, or another fault condition causes the unit to shut down.

IOUT_OC_WARN_LIMIT (0x4A)
Description: Output over current warning limit. The actual level needed to trig a fault flag needs to be greater than the set level. This means the resolution will affect the exact trig level.

Bit	Description	Format	Unit
15:0	Output over current warning limit. Linear exponent must be set to -2.	Linear	A

OT_FAULT_LIMIT (0x4F)
Description: Over temperature fault limit. The actual level needed to trig a fault flag needs to be greater than the set level. This means the resolution will affect the exact trig level.

Bit	Description	Format	Unit
15:0	Over temperature fault limit. Linear exponent must be set to 0.	Linear	°C

OT_FAULT_RESPONSE (0x50)
Description: Over temperature fault response.

Bit	Function	Description	Format	Unit
2:0	Retry Time and Delay Time	Delay time in 200 ms units between attempts to restart.	Fixed Point Unsigned	ms

Bit	Function	Description	Value	Function	Description
7:6	Response		00	Ignore Fault	The PMBus device continues operation without interruption.
			10	Disable and retry	The device shuts down (disables the output) and responds according to the retry setting in bits [5:3].
5:3	Retries		000	Do Not Retry	A zero value for the Retry Setting means that the unit does not attempt to restart. The output remains disabled until the fault is cleared (Section 10.7).
			001	Retry Once	The PMBus device attempts to restart 1 time. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			010	Retry Twice	The PMBus device attempts to restart 2 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			011	Retry 3 times	The PMBus device attempts to restart 3 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.

			100	Retry 4 times	The PMBus device attempts to restart 4 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			101	Retry 5 times	The PMBus device attempts to restart 5 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			110	Retry 6 times	The PMBus device attempts to restart 6 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			111	Retry Continuously	The PMBus device attempts to restart continuously, without limitation, until it is commanded OFF (by the CONTROL pin or OPERATION command or both), bias power is removed, or another fault condition causes the unit to shut down.

OT_WARN_LIMIT (0x51)
Description: Over temperature warning limit. The actual level needed to trig a fault flag needs to be greater than the set level. This means the resolution will affect the exact trig level.

Bit	Description	Format	Unit
15:0	Over temperature warning limit. Linear exponent must be set to 0.	Linear	°C

VIN_OV_FAULT_LIMIT (0x55)
Description: Input over voltage fault limit. The input status register is not updated when the unit is in standby mode (not enabled). This means that an input over-voltage is detected just after the unit starts to ramp and consequently shut down again. The actual level needed to trig a fault flag needs to be greater than the set level. This means the resolution will affect the exact trig level.

Bit	Description	Format	Unit
15:0	Input over voltage fault limit. Linear exponent must be set to -3.	Linear	V

VIN_OV_FAULT_RESPONSE (0x56)
Description: Input over voltage fault response.

Bit	Function	Description	Format	Unit
2:0	Retry Time and Delay Time	Delay time in 200 ms units between attempts to restart.	Fixed Point Unsigned	ms

Bit	Function	Description	Value	Function	Description
7:6	Response		00	Ignore Fault	The PMBus device continues operation without interruption.
			10	Disable and retry	The device shuts down (disables the output) and responds according to the retry setting in bits [5:3].
5:3	Retries		000	Do Not Retry	A zero value for the Retry Setting means that the unit does not attempt to restart. The output remains disabled until the fault is cleared (Section 10.7).
			001	Retry Once	The PMBus device attempts to restart 1 time. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			010	Retry Twice	The PMBus device attempts to restart 2 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.

			011	Retry 3 times	The PMBus device attempts to restart 3 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			100	Retry 4 times	The PMBus device attempts to restart 4 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			101	Retry 5 times	The PMBus device attempts to restart 5 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			110	Retry 6 times	The PMBus device attempts to restart 6 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			111	Retry Continuously	The PMBus device attempts to restart continuously, without limitation, until it is commanded OFF (by the CONTROL pin or OPERATION command or both), bias power is removed, or another fault condition causes the unit to shut down.

VIN_UV_FAULT_LIMIT (0x59)
Description: Input under voltage fault limit.

Bit	Description	Format	Unit
15:0	Input under voltage fault limit. Linear exponent must be set to -3.	Linear	V

VIN_UV_FAULT_RESPONSE (0x5A)
Description: Input under voltage fault response.

Bit	Function	Description	Format	Unit
2:0	Retry Time and Delay Time	Delay time in 200 ms units between attempts to restart.	Fixed Point Unsigned	ms

Bit	Function	Description	Value	Function	Description
7:6	Response		00	Ignore Fault	The PMBus device continues operation without interruption.
			10	Disable and retry	The device shuts down (disables the output) and responds according to the retry setting in bits [5:3].
5:3	Retries		000	Do Not Retry	A zero value for the Retry Setting means that the unit does not attempt to restart. The output remains disabled until the fault is cleared (Section 10.7).
			001	Retry Once	The PMBus device attempts to restart 1 time. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			010	Retry Twice	The PMBus device attempts to restart 2 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.

			011	Retry 3 times	The PMBus device attempts to restart 3 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			100	Retry 4 times	The PMBus device attempts to restart 4 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			101	Retry 5 times	The PMBus device attempts to restart 5 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			110	Retry 6 times	The PMBus device attempts to restart 6 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			111	Retry Continuously	The PMBus device attempts to restart continuously, without limitation, until it is commanded OFF (by the CONTROL pin or OPERATION command or both), bias power is removed, or another fault condition causes the unit to shut down.

POUT_OP_FAULT_LIMIT (0x68)
Description: Sets the Output power over-power fault limit. The actual level needed to trig a fault flag needs to be greater than the set level. This means the resolution will affect the exact trig level.

Bit	Description	Format	Unit
15:0	Output power over-power fault limit. Linear exponent must be set to 3.	Linear	W

POUT_OP_FAULT_RESPONSE (0x69)
Description: Sets the output power Over-Power fault response.

Bit	Function	Description	Format	Unit
2:0	Retry Time and Delay Time	Delay time in 200 ms units between attempts to restart.	Fixed Point Unsigned	ms

Bit	Function	Description	Value	Function	Description
7:6	Response		00	Ignore Fault	The PMBus device continues operation without interruption.
			10	Disable and retry	The device shuts down (disables the output) and responds according to the retry setting in bits [5:3].
5:3	Retries		000	Do Not Retry	A zero value for the Retry Setting means that the unit does not attempt to restart. The output remains disabled until the fault is cleared (Section 10.7).
			001	Retry Once	The PMBus device attempts to restart 1 time. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			010	Retry Twice	The PMBus device attempts to restart 2 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.

			011	Retry 3 times	The PMBus device attempts to restart 3 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			100	Retry 4 times	The PMBus device attempts to restart 4 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			101	Retry 5 times	The PMBus device attempts to restart 5 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			110	Retry 6 times	The PMBus device attempts to restart 6 times. If the device fails to restart, it disables the output and remains off until the fault is cleared as described in Section 10.7. The time between the start of each attempt to restart is set by the value in bits [2:] along with the delay time unit specified for that particular fault.
			111	Retry Continuously	The PMBus device attempts to restart continuously, without limitation, until it is commanded OFF (by the CONTROL pin or OPERATION command or both), bias power is removed, or another fault condition causes the unit to shut down.

POUT_OP_WARN_LIMIT (0x6A)
Description: Sets the Output power over-power warn limit. The actual level needed to trig a fault flag needs to be greater than the set level. This means the resolution will affect the exact trig level.

Bit	Description	Format	Unit
15:0	Output power over-power warn limit. Linear exponent must be set to 3.	Linear	W

STATUS_BYTE (0x78)
Description: Returns a brief fault/warning status byte. Status flags are not cleared after enable on/off as described in PMBus 1.4 §10.2.3.

Bit	Function	Description	Value	Description
6	Off	This bit is asserted if the unit is not providing power to the output, regardless of the reason, including simply not being enabled.	0	No fault
			1	Fault
5	Vout Overvoltage Fault	An output overvoltage fault has occurred.	0	No fault
			1	Fault
4	Iout Overcurrent Fault	An output overcurrent fault has occurred.	0	No fault
			1	Fault
3	Vin Undervoltage Fault	An input undervoltage fault has occurred.	0	No fault
			1	Fault
2	Temperature	A temperature fault or warning has occurred.	0	No fault
			1	Fault
1	Communication/Logic	A communications, memory or logic fault has occurred.	0	No fault
			1	Fault
0	None of the Above	A fault or warning not listed in bits [7:1] has occurred.	0	No fault
			1	Fault

STATUS_WORD (0x79)
Description: Returns an extended fault/warning status byte. Status flags are not cleared after enable on/off as described in PMBus 1.4 §10.2.3.

Bit	Function	Description	Value	Description
15	Vout	An output voltage fault or warning has occurred.	0	No fault
			1	Fault
14	Iout/Pout	An output current or output power fault or warning has occurred.	0	No Fault.
			1	Fault.
13	Input	An input voltage, input current, or input power fault or warning has occurred.	0	No Fault.
			1	Fault.
12	Mfr Specific	A manufacturer specific fault or warning has occurred.	0	No Fault.
			1	Fault.
11	Power-Good	The Power-Good signal, if present, is negated.	0	No Fault.
			1	Fault.
6	Off	This bit is asserted if the unit is not providing power to the output, regardless of the reason, including simply not being enabled.	0	No fault
			1	Fault
5	Vout Overvoltage Fault	An output overvoltage fault has occurred.	0	No Fault.
			1	Fault.
4	Iout Overcurrent Fault	An output overcurrent fault has occurred.	0	No Fault.
			1	Fault.
3	Vin Undervoltage Fault	An input undervoltage fault has occurred.	0	No Fault.
			1	Fault.
2	Temperature	A temperature fault or warning has occurred.	0	No Fault.
			1	Fault.

1	Communication/Logic	A communications, memory or logic fault has occurred.	0	No fault.
			1	Fault.
0	None of the Above	A fault or warning not listed in bits [7:1] has occurred.	0	No fault.
			1	Fault.

STATUS_VOUT (0x7A)
Description: Returns Vout-related fault/warning status bits. Status flags are not cleared after enable on/off as described in PMBus 1.4 §10.2.3.

Bit	Function	Description	Value	Description
7	Vout Overvoltage Fault	Vout Overvoltage Fault.	0	No Fault.
			1	Fault.
6	Vout Overvoltage Warning	Vout Overvoltage Warning.	0	No Warning.
			1	Warning.
5	Vout Undervoltage Warning	Vout Undervoltage Warning.	0	No Warning.
			1	Warning.
4	Vout Undervoltage Fault	Vout Undervoltage Fault.	0	No Fault.
			1	Fault.

STATUS_IOUT (0x7B)
Description: Returns Iout-related fault/warning status bits. Status flags are not cleared after enable on/off as described in PMBus 1.4 §10.2.3.

Bit	Function	Description	Value	Description
7	Iout Overcurrent Fault	Iout Overcurrent Fault.	0	No Fault.
			1	Fault.
5	Iout Over Current Warning	Iout Overcurrent Warning.	0	No Warning.
			1	Warning.
1	Pout Over Power Fault	Pout Over Power Fault.	0	No Fault.
			1	Fault.
0	Pout Over Power Warning	Pout Over Power Warning.	0	No Warning.
			1	Warning.

STATUS_INPUT (0x7C)
Description: Returns VIN/IIN-related fault/warning status bits. Status flags are not cleared after enable on/off as described in PMBus 1.4 §10.2.3.

Bit	Function	Description	Value	Description
7	Vin Overvoltage Fault	Vin Overvoltage Fault.	0	No Fault.
			1	Fault.
6	Vin Overvoltage Warning	VIN Overvoltage Warning.	0	No Warning.
			1	Warning.
5	Vin Undervoltage Warning	Vin Undervoltage Warning.	0	No Warning.
			1	Warning.
4	Vin Undervoltage Fault	Vin Undervoltage Fault.	0	No Fault.
			1	Fault.
3	Insufficient Vin	Asserted when either the input voltage has never exceeded the input turn-on threshold Vin-On, or if the unit did start, the input voltage decreased below the turn-off threshold.	0	No Insufficient VIN encountered yet.
			1	Insufficient Unit is off.

STATUS_TEMPERATURE (0x7D)
Description: Returns the temperature-related fault/warning status bits. Status flags are not cleared after enable on/off as described in PMBus 1.4 §10.2.3.

Bit	Function	Description	Value	Description
7	Overtemperature Fault	Overtemperature Fault.	0	No Fault.
			1	Fault.
6	Overtemperature Warning	Overtemperature Warning.	0	No Warning.
			1	Warning.

STATUS_CML (0x7E)
Description: Returns Communication/Logic/Memory-related fault/warning status bits. Status flags are not cleared after enable on/off as described in PMBus 1.4 §10.2.3.

Bit	Function	Description	Value	Description
7	Invalid or Unsupported Command Received	Invalid or Unsupported Command Received.	0	No Invalid Command Received.
			1	Invalid Command Received.
6	Invalid or Unsupported Data Received	Invalid or Unsupported Data Received.	0	No Invalid Data Received.
			1	Invalid Data Received.
5	Packet Error Check Failed	Packet Error Check Failed.	0	No Failure.
			1	Failure.
4	Memory Fault Detected	Memory Fault Detected.	0	No Fault.
			1	Fault.

STATUS_MFR_SPECIFIC (0x80)
Description: Returns manufacturer specific status information. Status flags are not cleared after enable on/off as described in PMBus 1.4 §10.2.3.

Bit	Function	Description	Value	Description
7	Analog Ratio Protection	Analog Ratio Protection.	0	No Fault.
			1	Fault.
6	Digital Ratio Protection	Digital Ratio Protection; N * Vout - VINSS.	0	No Fault.
			1	Fault.
5	Buck Duty Fault	Buck duty fault; |VBUS - VINSS| < K * VINSS.	0	No Fault.
			1	Fault.
4	Analog (peak) OC Protection	Analog (peak) OC protection.	0	No Fault.
			1	Fault.
2	Vout Monotonic Rise Fault	Vout rise is not monotonic at startup, i.e. short circuit on output.	0	No Fault.
			1	Fault.
1	VCC Boot Below Threshold	At the start-up, the VCC was below threshold.	0	No Fault.
			1	Fault.
0	Vout Boot Below Threshold	At the start-up, the VOUT was below threshold.	0	No Fault.
			1	Fault.

READ_VIN (0x88)
Description: Returns the measured input voltage.

Bit	Description	Format	Unit
15:0	Returns the input voltage reading.	Linear	V

READ_VOUT (0x8B)
Description: Returns the measured output voltage.

Bit	Description	Format	Unit

15:0	Returns the measured output voltage.	Vout Mode Unsigned (Exp = -5)	V

READ_IOUT (0x8C)
Description: Returns the measured output current.

Bit	Description	Format	Unit
15:0	Returns the measured output current.	Linear	A

READ_TEMPERATURE_1 (0x8D)
Description: Reads temperature from the internal sensor.

Bit	Description	Format	Unit
15:0		Linear	°C

READ_POUT (0x96)
Description: Returns the calculated output power.

Bit	Description	Format	Unit
15:0		Linear	W

PMBUS_REVISION (0x98)
Description: Returns the PMBus revision number for this device.

Bit	Function	Description	Value	Function	Description
7:4	Part I Revision	Part I Revision.	0x0	1.0	Part I Revision 1.0.
			0x1	1.1	Part I Revision 1.1.
			0x2	1.2	Part I Revision 1.2.
			0x3	1.3	Part I Revision 1.3.
3:0	Part II Revision	Part II Revision.	0x0	1.0	Part II Revision 1.0.
			0x1	1.1	Part II Revision 1.1.
			0x2	1.2	Part II Revision 1.2.
			0x3	1.3	Part II Revision 1.3.

MFR_ID (0x99)
Description: Sets the Manufacturers ID

Bit	Description	Format
15:0	Manufacturer ID.	Integer Unsigned

MFR_MODEL (0x9A)
Description: Mfr. Model

Bit	Description	Format
15:0	Mfr. Model.	ASCII

MFR_REVISION (0x9B)
Description: Sets the MFR revision string.

Bit	Description	Format
15:0	Mfr. Revision.	Integer Unsigned

MFR_DATE (0x9D)
Description: This command returns the date the regulator was manufactured.

Bit	Function	Description	Format
15:8	Mfr. Week	The week number.	Integer Unsigned
7:0	Mfr. Year	The year (e.g. 20 stands for 2020).	Integer Unsigned

MFR_SPEC_SERIAL (0xB0)
Description: Contains serial # from production.

Bit	Function	Description	Format
31:27	Test station number	Test station number, e.g. 00000 = X01	Integer Unsigned
26:0	Serial number	Serial number. Decimal number calculated as: 100000 x (Last three digits of production order number) + counter number	Integer Unsigned

MFR_SPEC_MODEL_REV (0xB1)
Description: Contains product number and revision information.

Bit	Function	Description	Format
63	Scheme ID	Always 1	Integer Unsigned
59:50	BMR number 3-digit	Number 001-999.	Integer Unsigned
49:46	BMR number 1-digit	Number 0-9.	Integer Unsigned
45:42	BMR number 1-digit	Number 0-9.	Integer Unsigned
41:38	BMR number 1-digit	Number 0-9.	Integer Unsigned
37:34	BMR number 1-digit	Number 0-9.	Integer Unsigned
33:24	BMR number after /	Number 001-999.	Integer Unsigned
22:17	Product revision number	Number 1-63.	Integer Unsigned
16:12	Product revision letter	Number 1-26 represents A-Z.	Integer Unsigned
10:6	Config revision letter	Number 1-26 represents A-Z.	Integer Unsigned
5:0	Config revision number	Number 1-63. Ignore for sharp release.	Integer Unsigned

Bit	Function	Description	Value	Description
23	Product preliminary revision	0=Sharp revision (e.g. R1A), 1=Preliminary revision (e.g. P1A)	0	Sharp revision (e.g. R1A)
			1	Preliminary revision (e.g. P1A)
11	Config preliminary revision	0=Sharp revision, 1=Preliminary revision	0	Sharp revision
			1	Preliminary revision

PASSW_I2C (0xC4)
Description: Password for I2C

Bit	Description	Format
15:0	Write value 0xC93F to this command to enable I2C register writes. Writing the password to this command is also required for passwords in 0xC5 and 0xC6 to be effective.	Byte Array

PASSW_OTP (0xC5)
Description: Password for OTP

Bit	Description	Format
15:0	Write value 0x4B6A to this command to enable the burn OTP function (0xD6 command). It is also required that the password is written to command 0xC4.	Byte Array

PASSW_ADDR (0xC6)
Description: Password for ADDRESS

Bit	Description	Format
15:0	Write value 0xF1C0 to this command to enable the custom PMBUS base address setting (0xE0 command). It is also required that the password is written to command 0xC4.	Byte Array

OTP_WRITE (0xCF)
Description: Available # of OTP write cycles

Bit	Description	Format
7:0	Returns how many OTP writes that are left. Use before a 0xD6 command write.	Integer Unsigned

DEVICE_FULL_ADDRESS (0xD3)
Description: Reads PMBus address 8 bit

Bit	Description	Format
7:0	Returns the PMBus device address aligned on 8 bit.	Byte Array

DCX_VOUT_SS_FAULT (0xD4)
Description: Soft start rise check step size

Bit	Description	Format
7:0	Enable/disable and specify the incremental step of the monotonic check in Vout mantissa number. The value is Vout_step (value of Vout PMBUS mantissa) where Vout(n+1)>Vout(n)+Vout_step for a regular soft start. The sampling (n+1) and (n) are defined by the command 0xDF. A value of 0 means monotonic check is disabled. The check is also always disabled when Vout > 0.5 VOUT_UV_FAULT_LIMIT.	Integer Unsigned

OTP_UPLOAD (0xD6)
Description: Store to OTP command

Bit	Description	Format
7:0	In Write mode, it saves the config values from RAM into OTP memory. Use payload 0xAA. PMBus commands are not accepted, wait 120 ms for the writing time. Before command is written, passwords must be written to 0xC4 and 0xC5. In Read mode, it returns 0xCC = written successfully; 0xFF = it's an error.	Byte Array

NTC_CS_LUT_STATUS (0xD8)
Description: LUT memory area status

Bit	Description	Value	Function	Description

7:0	Returns the status of the LUT memory area: If 0x01, LUT NTC stored If 0x02, LUT CS stored If 0x03, LUT NTC and CS stored	0x00	No LUT stored	No LUT stored.
		0x01	NTC LUT stored	NTC LUT stored.
		0x02	CS Gain LUT stored	CS Gain LUT stored.
		0x03	NTC and CS Gain LUTs stored	NTC and CS Gain LUTs stored.

DCX_SS_PROTECTION (0xDF)
Description: Defines the sampling instants (n+1) and (n) for the command 0xD4.

Bit	Function	Description	Format	Unit
5:3	Initial sample time	From 0.5 ms [000] to 2.25 ms [111], step 0.25 ms.	Fixed Point Unsigned	ms

Bit	Function	Description	Value	Function	Description
2:0	Pace of samples (n) and (n+1)	From 0.75 ms [011] to 1.75 ms [111], step 0.25 ms.	011	0.75 ms	
			100	1.00 ms	
			101	1.25 ms	
			110	1.50 ms	
			111	1.75 ms	

PMBUS_BASE_ADDRESS (0xE0)
Description: Sets the PMBUS base address of the address range. If a store failed and with blank part a default base address set equal to 0x1 (16d). Before command is written, passwords must be written to 0xC4 and 0xC6. After write, input voltage must be cycled before the base address is actually changed.

Bit	Description	Format
7:5	Base Address to start from. 000b => base address 0x00, 001b => base address 0x10, 010b => base address 0x20, 011b => base address 0x30, etc.	Fixed Point Unsigned

NTC_LUT_CRC16_READ (0xE1)
Description: Reads the checksum value for the NTC LUT.

Bit	Description	Format
15:0	NTC LUT CRC16 value.	Integer Unsigned

CS_LUT_CRC16_READ (0xE2)
Description: Reads the checksum value for the CS Gain LUT.

Bit	Description	Format
15:0	CS Gain LUT CRC16 value.	Integer Unsigned

CHECKSUM_CRC (0xEE)
Description: Calculated config file CRC

Bit	Description	Format
15:0	Returns the CRC16 calculated based on the configuration file. At POR and after STORE, the embedded processor compares the CRC16 signature placed in the configuration file with the calculated CRC16. If they don't match, IC enters Recovery mode (no configuration file), triggers the Memory Fault in STATUS_CML and set the PMBUS address to 0xB0.	Direct

REG_CON_OFFSET_IOUT (0xF0)
Description: READ_IOUT calibration offset

Bit	Function	Description	Format	Unit
6:0	READ_IOUT calibration offset value	Setting the offset to the READ_IOUT mantissa: Bit 7 = 0 for positive values and 1 for negative Bit 6:0 = offset of the PMBUS mantissa	Fixed Point Unsigned	A

Bit	Function	Description	Value	Function	Description
7	READ_IOUT calibration offset sign bit	Setting the offset to the READ_IOUT mantissa: Bit 7 = 0 for positive values and 1 for negative Bit 6:0 = offset of the PMBUS mantissa	0	Positive offset	Positive offset.
			1	Negative offset	Negative offset.

REG_CON_MULT_IOUT (0xF1)
Description: READ_IOUT calibration gain

Bit	Description	Format
7:0	Setting the internal gain of the READ_IOUT value.	Fixed Point Unsigned