



# MAX20796 PMBus Command Set User Guide

*UG6453; Rev 1; 4/19*

## **Abstract**

This user guide complements the official PMBus Power System Management Protocol Specification, including descriptions of the PMBus commands specific to the MAX20796 integrated, two-phase, single-supply, step-down switching regulator.

## Introduction

This document details the PMBus™ commands implemented in the MAX20796 integrated, two-phase, single-supply, step-down switching regulator. Standard commands from the PMBus specification are not described in detail unless there are deviations from the PMBus specification functionality. Maxim manufacturer-specific commands are fully described in this document.

References for this document are found on the PMBus and SMBus organization websites. The command functionality is based on the revision 1.3 PMBus specifications.

<http://pmbus.org/specs.html>

<http://smbus.org/specs/>

The commands in this document are presented in the following format:

<b>&lt;COMMAND_NAME&gt;</b>			
<b>Reference:</b>	<"Standard" or "Maxim Specific">		
<b>Command Code:</b>	<hex value>	<b>Format:</b>	<data format>
<b>Data Bytes:</b>	<byte count>	<b>Units:</b>	<unit of measure>
<b>Transfer:</b>	<SMBus transaction>	<b>Factory Value:</b>	<Maxim setting>
<b>Description/Notes:</b>	<Command definition if Maxim-specific, or notes on command functionality where it differs from the PMBus specification.>		

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## On, Off, and Margin Testing Related Commands

<b>OPERATION</b>			
<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x01	<b>Format:</b>	Bit field
<b>Data Bytes:</b>	1	<b>Units:</b>	N/A
<b>Transfer:</b>	Read/Write Byte	<b>Factory Value:</b>	0x00 (see Description)
<b>Description/Notes:</b>	<p>See Section 12.1 of the PMBus Specification Part II.</p> <p>The device only supports five settings for OPERATION. Invalid data bytes trigger an “Invalid or Unsupported Data” response per section 10.9.3 of the PMBus specification.</p> <p><b>Supported values for the OPERATION command:</b></p> <p>0x00      Immediate-off, no sequencing ← factory setting</p> <p>0x40      Soft-off, with sequencing</p> <p>0x80      Output enabled, if allowed by <a href="#">ON_OFF_CONFIG</a> setting</p> <p>0x98      Margin low, act on faults</p> <p>0xA8      Margin high, act on faults</p>		

<b>ON_OFF_CONFIG</b>			
<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x02	<b>Format:</b>	Bit field
<b>Data Bytes:</b>	1	<b>Units:</b>	N/A
<b>Transfer:</b>	Read/Write Byte	<b>Factory Value:</b>	0x16 (see Description)
<b>Description/Notes:</b>	<p>See Section 12.2 of the PMBus Specification Part II.</p> <p>The device only supports seven settings for ON_OFF_CONFIG. Invalid data bytes trigger an “Invalid or Unsupported Data” response per section 10.9.3 of the PMBus specification.</p> <p><b>Supported Values for the ON_OFF_CONFIG command:</b></p> <p>0x02    Output always enabled</p> <p>0x12    Output always disabled</p> <p>0x16    Ignore bit 7 of <a href="#">OPERATION</a>, require EN high, soft-off on loss of EN ← factory setting</p> <p>0x17    Ignore bit 7 of OPERATION, require EN high, immediate-off on loss of EN</p> <p>0x1A    Require bit 7 of OPERATION, ignore EN</p> <p>0x1E    Require bit 7 of OPERATION <i>and</i> EN high, soft-off on loss of EN</p> <p>0x1F    Require bit 7 of OPERATION <i>and</i> EN high, immediate-off on loss of EN</p> <p>In general, odd values of ON_OFF_CONFIG that require EN high have an immediate-off shutdown when EN is low; even values that require EN high have a soft-off shutdown when EN is low. Values of ON_OFF_CONFIG that require bit 7 of OPERATION to be set shut down according to bit 6 of OPERATION if bit 7 is set to zero. Because of this, it is possible to trigger different shutdown types depending on how the output is disabled.</p>		

## Output Voltage Related Commands

VOUT_MODE			
<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x20	<b>Format:</b>	See Description
<b>Data Bytes:</b>	1	<b>Units:</b>	N/A
<b>Transfer:</b>	Read/Write Byte	<b>Factory Value:</b>	0x17 (Linear Mode, N = -9)
<b>Description/Notes:</b>	<p>See Section 13.1 of the PMBus Specification Part II.</p> <p>The device supports ULINEAR16 values for output-voltage related commands. The VOUT_MODE command supports two settings:</p> <p>0x16 Exponent = -10 0x17 Exponent = -9</p> <p>The device receives and returns output voltage data as a two-byte integer mantissa in the PMBus ULINEAR16 or SLINEAR16 formats, as appropriate for unsigned and signed output-voltage data respectively.</p>		

VOUT_COMMAND			
<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x21	<b>Format:</b>	ULINEAR16
<b>Data Bytes:</b>	2	<b>Units:</b>	V
<b>Transfer:</b>	Read/Write Word	<b>Factory Value:</b>	Set by external resistor value
<b>Description/Notes:</b>	<p>See Section 13.2 of the PMBus Specification Part II.</p> <p>The device can receive PMBus ULINEAR16 values. VOUT_COMMAND mantissa data sent to and from the device must be divided by 1024 to determine the actual voltage value.</p> <p>The initial value of VOUT_COMMAND is determined by external resistors. This value is placed in operating memory unless a VOUT_COMMAND value is received. The value of the pin-strap resistance is measured only once during initialization (power-up).</p> <p>VOUT_COMMAND accepts values from +0V to +7.999V, but the device has a minimum output voltage setting of 0.5V and maximum setting of 5.5V. See <a href="#">VOUT_MIN</a> and <a href="#">VOUT_MAX</a>.</p>		

VOUT_TRIM			
<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x22	<b>Format:</b>	SLINEAR16
<b>Data Bytes:</b>	2	<b>Units:</b>	V
<b>Transfer:</b>	Read/Write Word	<b>Factory Value:</b>	0x0000 (0V)
<b>Description/Notes:</b>	<p>See Section 13.3 of the PMBus Specification Part II.</p> <p>In the device, the value of VOUT_TRIM is summed with the value of <a href="#">VOUT_COMMAND</a> and the result is sent to the control loop as the output voltage setpoint.</p> <p>For telemetry purposes, the value of VOUT_TRIM is not subtracted from <a href="#">READ_VOUT</a>, so non-zero VOUT_TRIM values result in a difference between VOUT_COMMAND and READ_VOUT.</p>		

## VOUT\_TRIM

This command is intended to allow an end user of a PMBus device to tailor a specific supply to the performance requirements of a specific load device, while retaining use of a nominal voltage setpoint for all similar load devices.

VOUT\_TRIM accepts values from -62.5mV to +61.523mV.

## VOUT\_MAX

<b>Reference:</b>	Standard Command	<b>Format:</b>	ULINEAR16
<b>Command Code:</b>	0x24	<b>Units:</b>	V
<b>Data Bytes:</b>	2	<b>Factory Value:</b>	VOUT_COMMAND x 1.25
<b>Transfer:</b>	Read/Write Word		
<b>Description/Notes:</b>	See Section 13.5 of the PMBus Specification Part II. The initial value of VOUT_MAX is set during initialization to <a href="#">VOUT_COMMAND</a> x 1.25. VOUT_MAX must be set above <a href="#">VOUT_MIN</a> ; values equal to or less than VOUT_MIN are rejected as invalid data. VOUT_MAX accepts values from +0V to +5.5V. This command can only be written when the output is disabled.		

## VOUT\_MARGIN\_HIGH

<b>Reference:</b>	Standard Command	<b>Format:</b>	ULINEAR16
<b>Command Code:</b>	0x25	<b>Units:</b>	V
<b>Data Bytes:</b>	2	<b>Factory Value:</b>	VOUT_COMMAND x 1.05
<b>Transfer:</b>	Read/Write Word		
<b>Description/Notes:</b>	See Section 13.6 of the PMBus Specification Part II. The initial value of VOUT_MARGIN_HIGH is set during initialization to <a href="#">VOUT_COMMAND</a> x 1.05. If the device is set for margin-high operation, the output rises to VOUT_MARGIN_HIGH at the rate determined by VOUT_COMMAND/ <a href="#">TON_RISE</a> . Likewise, when margin-high mode is canceled, the output decreases to VOUT_COMMAND at a rate determined by -VOUT_COMMAND/ <a href="#">TOFF_FALL</a> . VOUT_MARGIN_HIGH accepts values from +0V to +7.999V.		

## VOUT\_MARGIN\_LOW

<b>Reference:</b>	Standard Command	<b>Format:</b>	ULINEAR16
<b>Command Code:</b>	0x26	<b>Units:</b>	V
<b>Data Bytes:</b>	2	<b>Factory Value:</b>	VOUT_COMMAND x 0.95
<b>Transfer:</b>	Read/Write Word		
<b>Description/Notes:</b>	See Section 13.7 of the PMBus Specification Part II. The initial value of VOUT_MARGIN_LOW is set during initialization to <a href="#">VOUT_COMMAND</a> x 0.95.		



## VOUT\_MARGIN\_LOW

If the device is set for margin-low operation, the output decreases to VOUT\_MARGIN\_LOW at the rate determined by  $-VOUT\_COMMAND/TOFF\_FALL$ . Likewise, when margin-low operation is canceled, the output increases to VOUT\_COMMAND at a rate determined by  $VOUT\_COMMAND/TON\_RISE$ .

VOUT\_MARGIN\_LOW accepts values from +0V to +7.999V.

## VOUT\_MIN

<b>Reference:</b>	Standard Command	<b>Format:</b>	ULINEAR16
<b>Command Code:</b>	0x2B	<b>Units:</b>	V
<b>Data Bytes:</b>	2	<b>Factory Value:</b>	0x0100 (0.500V)
<b>Transfer:</b>	Read/Write Word		
<b>Description/Notes:</b>	See Section 13.12 of the PMBus Specification Part II.  VOUT_MIN must be set below <a href="#">VOUT_MAX</a> ; values equal to or greater than VOUT_MAX are rejected as invalid data.  Also see the manufacturer-specific <a href="#">MFR_VOUT_MIN</a> command for PMBus Specification Revision 2 legacy application support.  VOUT_MIN accepts values from +0.5V to +7.999V.		

## MFR\_VOUT\_MIN

<b>Reference:</b>	Maxim Specific	<b>Format:</b>	ULINEAR16
<b>Command Code:</b>	0xA4	<b>Units:</b>	V
<b>Data Bytes:</b>	2	<b>Factory Value:</b>	0x0100 (0.500V)
<b>Transfer:</b>	Read/Write Word		
<b>Description/Notes:</b>	MFR_VOUT_MIN is a duplicate (mirror) of the standard <a href="#">VOUT_MIN</a> command included for support of PMBus Specification Revision 2 legacy applications, where the standard command was not yet available.  Changes to MFR_VOUT_MIN alter the value of VOUT_MIN, and vice-versa; this is simply a second PMBus command code that accesses the same function.  MFR_VOUT_MIN accepts values from +0.5V to +7.999V.		

## Switching Frequency and PWM Commands

<b>FREQUENCY_SWITCH</b>																					
<b>Reference:</b>	Standard Command																				
<b>Command Code:</b>	0x33	<b>Format:</b>	LINEAR11																		
<b>Data Bytes:</b>	2	<b>Units:</b>	kHz																		
<b>Transfer:</b>	Read/Write Word	<b>Factory Value:</b>	Set by external resistor value																		
<b>Description/Notes:</b>	<p>See Section 14.4 of the PMBus Specification Part II.</p> <p>The switching frequency is set during initialization by an external resistor, unless a specific value has been written to FREQUENCY_SWITCH. The values of the pin-strap resistances are measured only once during initialization (power-up).</p> <p>The device only supports eight possible switching frequency settings, as follows:</p> <table border="1"> <thead> <tr> <th><b>Switching Frequency, kHz</b></th> <th><b>LINEAR11 Value (typical)</b></th> </tr> </thead> <tbody> <tr><td>200</td><td>0xF320</td></tr> <tr><td>308</td><td>0xFA68</td></tr> <tr><td>400</td><td>0xFB20</td></tr> <tr><td>444</td><td>0xFB78</td></tr> <tr><td>500</td><td>0xFBE8</td></tr> <tr><td>571</td><td>0x023B</td></tr> <tr><td>667</td><td>0x029B</td></tr> <tr><td>800</td><td>0x0320</td></tr> </tbody> </table> <p>Other LINEAR11 values not listed above are rounded to the nearest supported setting.</p> <p>The FREQUENCY_SWITCH command should not be changed (written) while the device is regulating, as any change in the fundamental PWM frequency might disturb the output voltage, possibly enough to trigger faults or otherwise upset operation of a load device. Furthermore, a large change in switching frequency without corresponding changes to the analog compensation components could result in outright control-loop instability.</p>			<b>Switching Frequency, kHz</b>	<b>LINEAR11 Value (typical)</b>	200	0xF320	308	0xFA68	400	0xFB20	444	0xFB78	500	0xFBE8	571	0x023B	667	0x029B	800	0x0320
<b>Switching Frequency, kHz</b>	<b>LINEAR11 Value (typical)</b>																				
200	0xF320																				
308	0xFA68																				
400	0xFB20																				
444	0xFB78																				
500	0xFBE8																				
571	0x023B																				
667	0x029B																				
800	0x0320																				

<b>INTERLEAVE</b>			
<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x37	<b>Format:</b>	Bit field
<b>Data Bytes:</b>	2	<b>Units:</b>	N/A
<b>Transfer:</b>	Read Word	<b>Factory Value:</b>	Set by external resistor
<b>Description/Notes:</b>	<p>See Section 14.7 of the PMBus Specification Part II.</p> <p>The INTERLEAVE command indicates the phase delay, measured from the rising edge of an external clock applied at SYNC_IN to the rising edge of the first (phase one) PWM positive pulse, not including a 40° baseline offset.<sup>a</sup></p> <p>Consistent with the command description in the PMBus specification, bits [7:4] of the low byte of the command data show the total number of phase increments in a complete 360° SYNC_IN clock cycle, while bits [3:0] show the relative<sup>a</sup> phase position as an integer multiple of the phase increments.</p>		

<sup>a</sup> Note that absolute phase position for all PWM signals is delayed by approximately 40° from the rising edge of the SYNC\_IN symbol. All subsequent PWM signals are then interleaved relative to baseline timing, in accordance with the standard PMBus INTERLEAVE command definition.

## INTERLEAVE

The upper byte of this command is always 0x00 for this device; the Group ID number is not supported.

The value of this command is set by the SYNC\_OUT external resistor. The following data values are supported:

<b>INTERLEAVE</b>	<b>SYNC_OUT Pin-Strap Resistor</b>	<b>Phase Increment</b>	<b>Phase position LX2, LX1 (no external power- stage)</b>	<b>Phase position LX2, LX1, PWM3 (with external power-stage)</b>
0x0041	453Ω	90°	130°, 310°	130°, 250°, 370°
0x0061	549Ω	60°	100°, 280°	100°, 220°, 340°
0x0062	681Ω	60°	160°, 340°	160°, 280°, 400°
0x0081	976Ω	45°	85°, 265°	85°, 205°, 325°
0x0083	1.18kΩ	45°	175°, 355°	175°, 295°, 415°
0x0000	1.4kΩ (no clock output)	N/A	40°, 220°	40°, 160°, 280°
0x0000	>1.69kΩ (clock output active)	N/A	40°, 220°	40°, 160°, 280°

The INTERLEAVE command indicates the timing for the first phase PWM pulse rising edge. In general, when two phases are active (no external power-stage connected) the second phase is timed 180° after the first phase. If three phases are active, the second and third phase are timed 120° and 240° after the first phase, respectively.

## Output Voltage Sequencing Commands

TON_DELAY			
<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x60	<b>Format:</b>	LINEAR11
<b>Data Bytes:</b>	2	<b>Units:</b>	ms
<b>Transfer:</b>	Read/Write Word	<b>Factory Value:</b>	0x0000 (0ms)
<b>Description/Notes:</b>	<p>See Section 16.1 of the PMBus Specification Part II.</p> <p>The TON_DELAY command sets the delay time between a valid enable condition and the beginning of the output ramp.</p> <p>TON_DELAY accepts values from 0 to 127ms with 0.5ms resolution.</p>		

TON_RISE			
<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x61	<b>Format:</b>	LINEAR11
<b>Data Bytes:</b>	2	<b>Units:</b>	ms
<b>Transfer:</b>	Read/Write Word	<b>Factory Value:</b>	Set by external resistor
<b>Description/Notes:</b>	<p>See Section 16.2 of the PMBus Specification Part II.</p> <p>The TON_RISE command sets the ramp-up time from 0V to regulation at <a href="#">VOUT_COMMAND</a>.</p> <p>TON_RISE accepts values from 0 to 25ms with 0.25ms resolution.</p>		

TOFF_DELAY			
<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x64	<b>Format:</b>	LINEAR11
<b>Data Bytes:</b>	2	<b>Units:</b>	ms
<b>Transfer:</b>	Read/Write Word	<b>Factory Value:</b>	0x0000 (0ms)
<b>Description/Notes:</b>	<p>See Section 16.5 of the PMBus Specification Part II.</p> <p>The TOFF_DELAY command sets the delay time between loss of enable condition and the beginning of the output ramp-down.</p> <p>TOFF_DELAY accepts values from 0 to 127ms with 0.5ms resolution.</p>		

## TOFF\_FALL

<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x65	<b>Format:</b>	LINEAR11
<b>Data Bytes:</b>	2	<b>Units:</b>	ms
<b>Transfer:</b>	Read/Write Word	<b>Factory Value:</b>	0.5ms (0xF002)
<b>Description/Notes:</b>	See Section 16.6 of the PMBus Specification Part II. The TOFF_FALL command sets the ramp-down time from regulation at <a href="#">VOUT_COMMAND</a> to 0V. TOFF_FALL accepts values from 0 to 25ms with 0.25ms resolution.		

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## Fault-Related Commands

CLEAR_FAULTS			
<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x03	<b>Format:</b>	N/A
<b>Data Bytes:</b>	0	<b>Units:</b>	N/A
<b>Transfer:</b>	Send Byte	<b>Factory Value:</b>	N/A
<b>Description/Notes:</b>	See Section 15.1 of the PMBus Specification Part II.		

VOUT_OV_FAULT_LIMIT			
<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x40	<b>Format:</b>	ULINEAR16
<b>Data Bytes:</b>	2	<b>Units:</b>	V
<b>Transfer:</b>	Read Word	<b>Factory Value:</b>	See Description
<b>Description/Notes:</b>	<p>See Section 15.2 of the PMBus Specification Part II.</p> <p>There are two output-overvoltage protection thresholds in the device. The first threshold is a “tracking” fault limit which always follows the nominal output voltage<sup>b</sup> as follows:</p> $\text{VOUT\_MAX} \leq 2.437\text{V: VOUT\_OV\_FAULT\_LIMIT} = (\text{Nominal } V_{\text{OUT}}) + 210\text{mV}$ $\text{VOUT\_MAX} > 2.437\text{V: VOUT\_OV\_FAULT\_LIMIT} = (\text{Nominal } V_{\text{OUT}}) + 460\text{mV}$ <p>The second threshold is a fixed, “absolute” (also called “umbrella”) voltage threshold, as follows:</p> $\text{VOUT\_MAX} \leq 2.437\text{V: Umbrella overvoltage limit} = 2.5\text{V}$ $\text{VOUT\_MAX} > 2.437\text{V: Umbrella overvoltage limit} = 6.0\text{V}$ <p>If either of these overvoltage limits is exceeded, the device responds per the setting of <a href="#">VOUT_OV_FAULT_RESPONSE</a>.</p> <p>When read, the VOUT_OV_FAULT_LIMIT command returns the tracking fault limit value. The command cannot be written.</p>		

VOUT_OV_FAULT_RESPONSE			
<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x41	<b>Format:</b>	Bit field
<b>Data Bytes:</b>	1	<b>Units:</b>	N/A
<b>Transfer:</b>	Read/Write Byte	<b>Factory Value:</b>	0xB9 (Shut down, retry indefinitely)
<b>Description/Notes:</b>	<p>See Sections 10.5.1 and 15.3 of the PMBus Specification Part II.</p> <p>The device supports three settings for the output overvoltage fault response:</p>		

<sup>b</sup> The nominal output voltage is either VOUT\_COMMAND, VOUT\_MARGIN\_HIGH, or VOUT\_MARGIN\_LOW (depending on the OPERATION command setting), plus the value of VOUT\_TRIM, bounded by the settings of VOUT\_MAX and VOUT\_MIN.

## VOUT\_OV\_FAULT\_RESPONSE

Data Value	Fault Response
0x00	Continue operating without interruption
0x80	Shut down with no retry attempts
0xB9	Shutdown and retry indefinitely ( <i>Factory setting</i> )
The command data comprises three bit-fields:	
Bits [7:6] determine the basic fault-response mode.	
00	Ignore the fault condition
01	Not supported
10	Stop regulating immediately, retry according to bits [5:3] ( <i>Factory setting</i> )
11	Not supported
Bits [5:3] determine the number of retry attempts.	
000	No attempt is made to restart after a fault shutdown.
001-110	Not supported
111	Attempt to restart continuously until commanded off, or until another fault condition causes the unit to shut down. ( <i>Factory setting</i> )
Bits [2:0] determine the retry-delay timing.	
000	Timing not applicable; no retry
001	Retry after 50ms ( <i>Factory setting</i> )
010-111	Not supported
Changes to the VOUT_OV_FAULT_RESPONSE command only take effect when the output is disabled.	

## VOUT\_OV\_WARN\_LIMIT

<b>Reference:</b>	Standard Command	<b>Format:</b>	ULINEAR16
<b>Command Code:</b>	0x42	<b>Units:</b>	V
<b>Data Bytes:</b>	2	<b>Factory Value:</b>	VOUT_COMMAND x 1.125
<b>Transfer:</b>	Read/Write Word		
<b>Description/Notes:</b>	See Section 15.4 of the PMBus Specification Part II. The initial value of VOUT_OV_WARN_LIMIT is set during initialization to <a href="#">VOUT_COMMAND</a> x 1.125. VOUT_OV_WARN_LIMIT accepts values from +0V to +7.999V.		

## VOUT\_UV\_WARN\_LIMIT

<b>Reference:</b>	Standard Command	<b>Format:</b>	ULINEAR16
<b>Command Code:</b>	0x43	<b>Units:</b>	V
<b>Data Bytes:</b>	2	<b>Factory Value:</b>	VOUT_COMMAND x 0.875
<b>Transfer:</b>	Read/Write Word		
<b>Description/Notes:</b>	See Section 15.5 of the PMBus Specification Part II. The initial value of VOUT_UV_WARN_LIMIT is set during initialization to <a href="#">VOUT_COMMAND</a> x 0.875.		

## VOUT\_UV\_WARN\_LIMIT

VOUT\_UV\_WARN\_LIMIT accepts values from +0V to +7.999V.

## VOUT\_UV\_FAULT\_LIMIT

<b>Reference:</b>	Standard Command	<b>Format:</b>	ULINEAR16
<b>Command Code:</b>	0x44	<b>Units:</b>	V
<b>Data Bytes:</b>	2	<b>Factory Value:</b>	See Description
<b>Transfer:</b>	Read Word		
<b>Description/Notes:</b>	See Section 15.6 of the PMBus Specification Part II. The output-undervoltage protection threshold is a “tracking” fault limit which always follows the nominal output voltage <sup>b</sup> as follows: $\text{VOUT\_MAX} \leq 2.437\text{V: VOUT\_UV\_FAULT\_LIMIT} = (\text{Nominal } V_{\text{OUT}}) - 290\text{mV}$ $\text{VOUT\_MAX} > 2.437\text{V: VOUT\_UV\_FAULT\_LIMIT} = (\text{Nominal } V_{\text{OUT}}) - 640\text{mV}$ If the output voltage falls below this undervoltage limit while the output is enabled, the device responds according to the setting of <a href="#">VOUT_UV_FAULT_RESPONSE</a> . When read, the VOUT_UV_FAULT_LIMIT command returns the fault limit value. The command cannot be written.		

## VOUT\_UV\_FAULT\_RESPONSE

<b>Reference:</b>	Standard Command	<b>Format:</b>	Bit field																						
<b>Command Code:</b>	0x45	<b>Units:</b>	N/A																						
<b>Data Bytes:</b>	1	<b>Factory Value:</b>	0xB9 (Shutdown, retry indefinitely)																						
<b>Transfer:</b>	Read/Write Byte																								
<b>Description/Notes:</b>	See Sections 10.5.1 and 15.7 of the PMBus Specification Part II. The device supports three different settings for the output undervoltage fault response: <table border="1"><thead><tr><th>Data Value</th><th>Fault Response</th></tr></thead><tbody><tr><td>0x00</td><td>Continue operating without interruption</td></tr><tr><td>0x80</td><td>Shut down with no retry attempts</td></tr><tr><td>0xB9</td><td>Shutdown and retry indefinitely (<i>Factory setting</i>)</td></tr></tbody></table> The command data comprises three bit fields: Bits [7:6] determine the basic fault-response mode. <table border="1"><tbody><tr><td>00</td><td>Ignore the fault condition</td></tr><tr><td>01</td><td>Not supported</td></tr><tr><td>10</td><td>Stop regulating immediately, retry according to bits [5:3] (<i>Factory setting</i>)</td></tr><tr><td>11</td><td>Not supported</td></tr></tbody></table> Bits [5:3] determine the number of retry attempts. <table border="1"><tbody><tr><td>000</td><td>No attempt is made to restart after a fault shutdown.</td></tr><tr><td>001-110</td><td>Not supported</td></tr><tr><td>111</td><td>Attempt to restart continuously until commanded off, or until another fault condition causes the unit to shut down. (<i>Factory setting</i>)</td></tr></tbody></table>			Data Value	Fault Response	0x00	Continue operating without interruption	0x80	Shut down with no retry attempts	0xB9	Shutdown and retry indefinitely ( <i>Factory setting</i> )	00	Ignore the fault condition	01	Not supported	10	Stop regulating immediately, retry according to bits [5:3] ( <i>Factory setting</i> )	11	Not supported	000	No attempt is made to restart after a fault shutdown.	001-110	Not supported	111	Attempt to restart continuously until commanded off, or until another fault condition causes the unit to shut down. ( <i>Factory setting</i> )
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## VOUT\_UV\_FAULT\_RESPONSE

	Bits [2:0] determine the retry-delay timing.
000	Timing not applicable; no retry
001	Retry after 50ms ( <i>Factory setting</i> )
010-111	Not supported
Changes to the VOUT_UV_FAULT_RESPONSE command only take effect when the output is disabled.	

## IOOUT\_OC\_FAULT\_LIMIT

<b>Reference:</b>	Standard Command	<b>Format:</b>	LINEAR11																																				
<b>Command Code:</b>	0x46	<b>Units:</b>	A																																				
<b>Data Bytes:</b>	2	<b>Factory Value:</b>	See Description																																				
<b>Transfer:</b>	Read Word																																						
<b>Description/Notes:</b>	<p>See Section 15.8 of the PMBus Specification Part II.</p> <p>The device supports sixteen possible overcurrent fault-limit values; eight each for two-phase and three-phase application circuits. These values are the output current level at which the device enters active current-limit operation, and sustained operation at this level triggers a fault shutdown.</p> <p>The maximum output current is programmed by an external resistor connected between the PGMD pin and ground. This value cannot be changed by PMBus command, so the IOOUT_OC_FAULT_LIMIT command is read-only.</p> <table border="1"> <thead> <tr> <th><b>Two-Phase Fault Limit, Amps</b></th> <th><b>LINEAR11 Value (typical)</b></th> </tr> </thead> <tbody> <tr><td>20.0</td><td>0xDA80</td></tr> <tr><td>26.6</td><td>0xDB53</td></tr> <tr><td>33.4</td><td>0xE216</td></tr> <tr><td>40.0</td><td>0xE280</td></tr> <tr><td>46.6</td><td>0xE2EA</td></tr> <tr><td>53.4</td><td>0xE356</td></tr> <tr><td>60.0</td><td>0xE3C0</td></tr> <tr><td>66.6</td><td>0xEA15</td></tr> </tbody> </table> <table border="1"> <thead> <tr> <th><b>Three-Phase Fault Limit, Amps</b></th> <th><b>LINEAR11 Value (typical)</b></th> </tr> </thead> <tbody> <tr><td>30.0</td><td>0xDBC0</td></tr> <tr><td>39.9</td><td>0xE27E</td></tr> <tr><td>50.1</td><td>0xE322</td></tr> <tr><td>60.0</td><td>0xE3C0</td></tr> <tr><td>69.9</td><td>0xEA2F</td></tr> <tr><td>80.1</td><td>0xEA81</td></tr> <tr><td>90.0</td><td>0xEAD0</td></tr> <tr><td>99.9</td><td>0xEB1F</td></tr> </tbody> </table>			<b>Two-Phase Fault Limit, Amps</b>	<b>LINEAR11 Value (typical)</b>	20.0	0xDA80	26.6	0xDB53	33.4	0xE216	40.0	0xE280	46.6	0xE2EA	53.4	0xE356	60.0	0xE3C0	66.6	0xEA15	<b>Three-Phase Fault Limit, Amps</b>	<b>LINEAR11 Value (typical)</b>	30.0	0xDBC0	39.9	0xE27E	50.1	0xE322	60.0	0xE3C0	69.9	0xEA2F	80.1	0xEA81	90.0	0xEAD0	99.9	0xEB1F
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80.1	0xEA81																																						
90.0	0xEAD0																																						
99.9	0xEB1F																																						

## IOOUT\_OC\_FAULT\_RESPONSE

<b>Reference:</b>	Standard Command	<b>Format:</b>	Bit field
<b>Command Code:</b>	0x47	<b>Units:</b>	N/A
<b>Data Bytes:</b>	1	<b>Factory Value:</b>	0xF9 (Shut down and retry)
<b>Transfer:</b>	Read/Write Byte		

## IOUT\_OC\_FAULT\_RESPONSE

**Description/Notes:** See Sections 10.5.2 and 15.9 of the PMBus Specification Part II.

The device supports two options for overcurrent fault response:

<u>Data Value</u>	<u>Fault Response</u>
-------------------	-----------------------

0xC0	Shut down with no retry attempts
------	----------------------------------

0xF9	Shut down and retry indefinitely ( <i>default setting</i> )
------	---

The IOUT\_OC\_FAULT\_RESPONSE command data comprises three bit fields:

Bits [7:6] determine the basic fault-response mode. The device supports the following modes:

00	Not supported
----	---------------

01	Not supported
----	---------------

10	Not supported
----	---------------

11	Stop regulating immediately, delay for the time specified in bits [2:0], then attempt to restart according to bits [5:3]. ( <i>Factory setting</i> )
----	--

Bits [5:3] determine the number of retry attempts.

000	Do not attempt to restart
-----	---------------------------

001-110	Not supported
---------	---------------

111	Attempt to restart continuously until commanded off, or until another fault condition causes the unit to shut down. ( <i>Factory setting</i> )
-----	--

Bits [2:0] determine the retry-delay timing.

000	Timing not applicable; no retry
-----	---------------------------------

001	Retry after 50ms ( <i>Factory setting</i> )
-----	---

010-111	Not supported
---------	---------------

Changes to the IOUT\_OC\_FAULT\_RESPONSE command only take effect when the output is disabled.

## IOUT\_OC\_WARN\_LIMIT

<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x4A	<b>Format:</b>	LINEAR11
<b>Data Bytes:</b>	2	<b>Units:</b>	A
<b>Transfer:</b>	Read/Write Word	<b>Factory Value:</b>	See Description

**Description/Notes:** See Section 15.12 of the PMBus Specification Part II.

The IOUT\_OC\_WARN\_LIMIT command accepts any value between 0A and 110A. The factory value of IOUT\_OC\_WARN\_LIMIT is determined by the pin-strapped value of [IOUT\\_OC\\_FAULT\\_LIMIT](#) as follows:

Phases	IOUT_OC_FAULT_LIMIT, Amps	IOUT_OC_WARN_LIMIT, Amps	
	Decimal	Decimal	LINEAR11
2	20	18	0xDA40
	26.6	18	0xDA40
	33.4	30	0xDBC0
	40	30	0xDBC0
	46.6	42	0xE2A0
	53.4	42	0xE2A0
	60	54	0xE360
	66.6	54	0xE360
3	30	18	0xDA40
	39.9	30	0xDBC0
	50.1	42	0xE2A0
	60	54	0xE360
	69.9	66	0xEA10
	80.1	78	0xEA70
	90	78	0xEA70
	99.9	90	0xEAD0

## OT\_FAULT\_LIMIT

<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x4F	<b>Format:</b>	LINEAR11
<b>Data Bytes:</b>	2	<b>Units:</b>	°C
<b>Transfer:</b>	Read/Write Word	<b>Factory Value:</b>	0xF258 (150°C)

**Description/Notes:** See Section 15.17 of the PMBus Specification Part II.

The OT\_FAULT\_LIMIT applies to both the internal temperature signal reported by [READ TEMPERATURE 1](#) and the external power-stage temperature signal reported by [READ TEMPERATURE 2](#). If either signal exceeds the limit value, the fault is triggered.

OT\_FAULT\_LIMIT accepts values from 10°C to +150°C.

## OT\_FAULT\_RESPONSE

<b>Reference:</b>	Standard Command																												
<b>Command Code:</b>	0x50	<b>Format:</b>	Bit field																										
<b>Data Bytes:</b>	1	<b>Units:</b>	N/A																										
<b>Transfer:</b>	Read/Write Byte	<b>Factory Value:</b>	0xB9 (Shut down and retry)																										
<b>Description/Notes:</b>	<p>See Sections 10.5.1 and 15.18 of the PMBus Specification Part II.</p> <p>The device supports two different settings for the overtemperature fault response:</p> <table border="1"> <thead> <tr> <th>Data Value</th> <th>Fault Response</th> </tr> </thead> <tbody> <tr> <td>0x80</td> <td>Shut down with no retry attempts</td> </tr> <tr> <td>0xB9</td> <td>Shutdown and retry indefinitely (<i>Factory setting</i>)</td> </tr> </tbody> </table> <p>The command data comprises three bit fields:</p> <p>Bits [7:6] determine the basic fault-response mode.</p> <table border="1"> <tbody> <tr> <td>00</td> <td>Not supported</td> </tr> <tr> <td>01</td> <td>Not supported</td> </tr> <tr> <td>10</td> <td>Stop regulating immediately, retry according to bits [5:3] (<i>Factory setting</i>)</td> </tr> <tr> <td>11</td> <td>Not supported</td> </tr> </tbody> </table> <p>Bits [5:3] determine the number of retry attempts.</p> <table border="1"> <tbody> <tr> <td>000</td> <td>No attempt is made to restart after a fault shutdown</td> </tr> <tr> <td>001-110</td> <td>Not supported</td> </tr> <tr> <td>111</td> <td>Attempt to restart continuously until commanded off, or until another fault condition causes the unit to shut down. (<i>Factory setting</i>)</td> </tr> </tbody> </table> <p>Bits [2:0] determine the retry-delay timing.</p> <table border="1"> <tbody> <tr> <td>000</td> <td>Timing not applicable; no retry</td> </tr> <tr> <td>001</td> <td>Retry after 50ms (<i>Factory setting</i>)</td> </tr> <tr> <td>010-111</td> <td>Not supported</td> </tr> </tbody> </table> <p>Changes to the OT_FAULT_RESPONSE command only take effect when the output is disabled.</p>			Data Value	Fault Response	0x80	Shut down with no retry attempts	0xB9	Shutdown and retry indefinitely ( <i>Factory setting</i> )	00	Not supported	01	Not supported	10	Stop regulating immediately, retry according to bits [5:3] ( <i>Factory setting</i> )	11	Not supported	000	No attempt is made to restart after a fault shutdown	001-110	Not supported	111	Attempt to restart continuously until commanded off, or until another fault condition causes the unit to shut down. ( <i>Factory setting</i> )	000	Timing not applicable; no retry	001	Retry after 50ms ( <i>Factory setting</i> )	010-111	Not supported
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001-110	Not supported																												
111	Attempt to restart continuously until commanded off, or until another fault condition causes the unit to shut down. ( <i>Factory setting</i> )																												
000	Timing not applicable; no retry																												
001	Retry after 50ms ( <i>Factory setting</i> )																												
010-111	Not supported																												

## OT\_WARN\_LIMIT

<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x51	<b>Format:</b>	LINEAR11
<b>Data Bytes:</b>	2	<b>Units:</b>	°C
<b>Transfer:</b>	Read Word	<b>Factory Value:</b>	OT_FAULT_LIMIT - 10°C
<b>Description/Notes:</b>	<p>See Section 15.19 of the PMBus Specification Part II.</p> <p>The OT_WARN_LIMIT is always 10°C below the <a href="#">OT_FAULT_LIMIT</a> value, and thus has a range of 0°C to 140°C.</p> <p>The OT_WARN_LIMIT applies to both the internal temperature signal reported by <a href="#">READ TEMPERATURE 1</a> and the external power-stage temperature signal reported by <a href="#">READ TEMPERATURE 2</a>. If either signal exceeds the limit value, the warning is triggered.</p>		

## TON\_MAX\_FAULT\_LIMIT

<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x62	<b>Format:</b>	LINEAR11
<b>Data Bytes:</b>	2	<b>Units:</b>	ms
<b>Transfer:</b>	Read Word	<b>Factory Value:</b>	TON_RISE + 5ms
<b>Description/Notes:</b>	<p>See Section 16.3 of the PMBus Specification Part II.</p> <p>The timer for TON_MAX_FAULT_LIMIT is started when <a href="#">TON_DELAY</a> elapses and the ramp-up begins (coincident with the beginning of <a href="#">TON_RISE</a>).</p> <p>TON_MAX_FAULT_LIMIT is automatically set to TON_RISE + 5ms.</p>		

## TON\_MAX\_FAULT\_RESPONSE

<b>Reference:</b>	Standard Command																												
<b>Command Code:</b>	0x63	<b>Format:</b>	Bit field																										
<b>Data Bytes:</b>	1	<b>Units:</b>	N/A																										
<b>Transfer:</b>	Read/Write Byte	<b>Factory Value:</b>	0xB9 (Shut down, retry indefinitely)																										
<b>Description/Notes:</b>	<p>See Section 16.4 of the PMBus Specification Part II.</p> <p>The device supports two options for the maximum startup time fault response:</p> <table border="1"> <thead> <tr> <th>Data Value</th> <th>Fault Response</th> </tr> </thead> <tbody> <tr> <td>0x80</td> <td>Shut down with no retry attempts</td> </tr> <tr> <td>0xB9</td> <td>Shutdown and retry indefinitely (<i>Factory setting</i>)</td> </tr> </tbody> </table> <p>The TON_MAX_FAULT_RESPONSE command data comprises three bit fields:</p> <p>Bits [7:6] determine the basic fault-response mode. The device supports the following modes:</p> <table border="1"> <tbody> <tr> <td>00</td> <td>Not supported</td> </tr> <tr> <td>01</td> <td>Not supported</td> </tr> <tr> <td>10</td> <td>Stop regulating immediately, retry according to bits [5:3] (<i>Factory setting</i>)</td> </tr> <tr> <td>11</td> <td>Not supported</td> </tr> </tbody> </table> <p>Bits [5:3] determine the number of retry attempts.</p> <table border="1"> <tbody> <tr> <td>000</td> <td>No attempt is made to restart after a fault shutdown.</td> </tr> <tr> <td>001-110</td> <td>Not supported</td> </tr> <tr> <td>111</td> <td>Attempt to restart continuously until commanded off, or until another fault condition causes the unit to shut down. (<i>Factory setting</i>)</td> </tr> </tbody> </table> <p>Bits [2:0] determine the retry-delay timing.</p> <table border="1"> <tbody> <tr> <td>000</td> <td>Timing not applicable; no retry</td> </tr> <tr> <td>001</td> <td>Retry after 50ms (<i>Factory setting</i>)</td> </tr> <tr> <td>010-111</td> <td>Not supported</td> </tr> </tbody> </table> <p>Changes to the TON_MAX_FAULT_RESPONSE command only take effect when the output is disabled.</p>			Data Value	Fault Response	0x80	Shut down with no retry attempts	0xB9	Shutdown and retry indefinitely ( <i>Factory setting</i> )	00	Not supported	01	Not supported	10	Stop regulating immediately, retry according to bits [5:3] ( <i>Factory setting</i> )	11	Not supported	000	No attempt is made to restart after a fault shutdown.	001-110	Not supported	111	Attempt to restart continuously until commanded off, or until another fault condition causes the unit to shut down. ( <i>Factory setting</i> )	000	Timing not applicable; no retry	001	Retry after 50ms ( <i>Factory setting</i> )	010-111	Not supported
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000	Timing not applicable; no retry																												
001	Retry after 50ms ( <i>Factory setting</i> )																												
010-111	Not supported																												

## SLV\_FAULT\_RESPONSE

<b>Reference:</b>	Maxim Specific		
<b>Command Code:</b>	0xD9	<b>Format:</b>	Bit field
<b>Data Bytes:</b>	1	<b>Units:</b>	N/A
<b>Transfer:</b>	Read/Write Byte	<b>Factory Value:</b>	0xB9 (Shut down, retry indefinitely)
<b>Dual-Rail:</b>	Independent		
<b>Description/Notes:</b>	<p>The device can detect and respond to faults and protective actions that occur in the external power-stage device, if present. The fault response options are a subset of those listed in section 10.5.1 of the PMBus Specification.</p> <p>Bits [7:6] determine the basic fault-response mode. The device supports the following modes:</p> <ul style="list-style-type: none"><li>00 Not supported (ignore)</li><li>01 Not supported (delay, then shut down)</li><li>10 Stop regulating immediately, delay for the time specified in bits [2:0], then attempt to restart according to bits [5:3]. (<i>Default setting</i>)</li><li>11 Not supported (wait for abate)</li></ul> <p>Bits [5:3] determine the number of retry attempts.</p> <ul style="list-style-type: none"><li>000 Do not attempt to restart</li><li>000-110 Not supported</li><li>111 Attempt to restart continuously until commanded off, or until another fault condition causes the unit to shut down. (<i>Default setting</i>)</li></ul> <p>Bits [2:0] determine the retry-delay timing.</p> <ul style="list-style-type: none"><li>000 Timing not applicable; no retry</li><li>001 Retry after 50ms (<i>Factory setting</i>)</li><li>010-111 Not supported</li></ul> <p>Changes to the SLV_FAULT_RESPONSE command only take effect when the output is disabled.</p>		

## Unit Status Commands

### SMBALERT\_MASK

<b>Reference:</b>	Standard Command			
<b>Command Code:</b>	0x1B		<b>Format:</b>	Bit field
<b>Data Bytes:</b>	1		<b>Units:</b>	N/A
<b>Transfer:</b>	Block	Write-Block	Read	<b>Factory Value:</b> See Description
	Process Call			

**Description/Notes:** See Section 15.38 of the PMBus Specification Part II.

Assertion of the /ALERT\ output can be selectively masked for all supported faults represented in the following status registers:

Register Name	Command (Hex)	Factory Mask Setting
<a href="#">STATUS_VOUT</a>	0x7A	0x00
<a href="#">STATUS_IOUT</a>	0x7B	0x00
<a href="#">STATUS_INPUT</a>	0x7C	0x00
<a href="#">STATUS_TEMPERATURE</a>	0x7D	0x00
<a href="#">STATUS_CML</a>	0x7E	0x00
<a href="#">STATUS_OTHER</a>	0x7F	0x00
<a href="#">STATUS_MFR_SPECIFIC</a>	0x80	0x00

The factory setting is for all sources to be unmasked. For simplicity of implementation, mask bits for STATUS\_ register bits that are not supported are always set to zero.

Note that the STATUS\_MFR\_SPECIFIC register can only be entirely masked or entirely unmasked; for this register only, bit-by-bit masking is not supported.

Also note that the STATUS\_OTHER register is not maskable, because the only supported function is the “first to assert SMBALERT” flag.

### STATUS\_BYTE

<b>Reference:</b>	Standard Command			
<b>Command Code:</b>	0x78		<b>Format:</b>	Bit field
<b>Data Bytes:</b>	1		<b>Units:</b>	N/A
<b>Transfer:</b>	Read Byte		<b>Factory Value:</b>	N/A

**Description/Notes:** See Section 17.1 of the PMBus Specification Part II.

Bit	Meaning
7	Busy
6	Off
5	VOUT OV Faults
4	IOUT OC Faults
3	---
2	TEMPERATURE Faults
1	CML Faults
0	NONE OF THE ABOVE: A fault or warning not listed in bits [7:1] of STATUS_BYTE has occurred.

## STATUS\_WORD

<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x79	<b>Format:</b>	Bit field
<b>Data Bytes:</b>	2	<b>Units:</b>	N/A
<b>Transfer:</b>	Read Word	<b>Factory Value:</b>	N/A

**Description/Notes:** See Section 17.2 of the PMBus Specification Part II.

	Bit	Meaning
High Byte	15	VOUT Faults and Warnings, TON Max Fault
	14	IOUT Faults and Warnings
	13	VIN Faults and Warnings
	12	Firmware Fault, Configuration Fault
	11	POWER_GOOD# (Power Good signal <i>not</i> asserted)
	10	---
	9	OTHER (First to assert /ALERT\)
	8	UNKNOWN: A fault type not given in bits (15:1) of the STATUS_WORD has been detected
Low Byte	7	Busy
	6	Off
	5	VOUT OV Faults
	4	IOUT OC Faults
	3	---
	2	TEMPERATURE Faults
	1	CML Faults
	0	NONE OF THE ABOVE: A fault or warning not listed in bits [7:1] of STATUS_BYTE has occurred.

## STATUS\_VOUT

<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x7A	<b>Format:</b>	Bit field
<b>Data Bytes:</b>	1	<b>Units:</b>	N/A
<b>Transfer:</b>	Read Byte	<b>Factory Value:</b>	N/A

**Description/Notes:** See Section 17.3 of the PMBus Specification Part II.

Bit	Meaning
7	VOUT OV Fault
6	VOUT OV Warning
5	VOUT UV Warning
4	VOUT UV Fault
3	VOUT MAX and MIN Warnings
2	TON MAX Fault
1	---
0	---



## STATUS\_IOUT

<b>Reference:</b>	Standard Command																				
<b>Command Code:</b>	0x7B	<b>Format:</b>	Bit field																		
<b>Data Bytes:</b>	1	<b>Units:</b>	N/A																		
<b>Transfer:</b>	Read Byte	<b>Factory Value:</b>	N/A																		
<b>Description/Notes:</b>	See Section 17.4 of the PMBus Specification Part II.																				
	<table border="1"><thead><tr><th>Bit</th><th>Meaning</th></tr></thead><tbody><tr><td>7</td><td>IOUT OC Fault</td></tr><tr><td>6</td><td>---</td></tr><tr><td>5</td><td>IOUT OC Warning</td></tr><tr><td>4</td><td>---</td></tr><tr><td>3</td><td>---</td></tr><tr><td>2</td><td>---</td></tr><tr><td>1</td><td>---</td></tr><tr><td>0</td><td>---</td></tr></tbody></table>	Bit	Meaning	7	IOUT OC Fault	6	---	5	IOUT OC Warning	4	---	3	---	2	---	1	---	0	---		
Bit	Meaning																				
7	IOUT OC Fault																				
6	---																				
5	IOUT OC Warning																				
4	---																				
3	---																				
2	---																				
1	---																				
0	---																				

## STATUS\_INPUT

<b>Reference:</b>	Standard Command																				
<b>Command Code:</b>	0x7C	<b>Format:</b>	Bit field																		
<b>Data Bytes:</b>	1	<b>Units:</b>	N/A																		
<b>Transfer:</b>	Read Byte	<b>Factory Value:</b>	N/A																		
<b>Description/Notes:</b>	See Section 17.5 of the PMBus Specification Part II.																				
	<table border="1"><thead><tr><th>Bit</th><th>Meaning</th></tr></thead><tbody><tr><td>7</td><td>---</td></tr><tr><td>6</td><td>---</td></tr><tr><td>5</td><td>---</td></tr><tr><td>4</td><td>---</td></tr><tr><td>3</td><td>Unit Off for Low Input Voltage</td></tr><tr><td>2</td><td>---</td></tr><tr><td>1</td><td>---</td></tr><tr><td>0</td><td>---</td></tr></tbody></table>	Bit	Meaning	7	---	6	---	5	---	4	---	3	Unit Off for Low Input Voltage	2	---	1	---	0	---		
Bit	Meaning																				
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6	---																				
5	---																				
4	---																				
3	Unit Off for Low Input Voltage																				
2	---																				
1	---																				
0	---																				

## STATUS\_TEMPERATURE

<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x7D	<b>Format:</b>	Bit field
<b>Data Bytes:</b>	1	<b>Units:</b>	N/A
<b>Transfer:</b>	Read Byte	<b>Factory Value:</b>	N/A

## STATUS\_TEMPERATURE

**Description/Notes:** See Section 17.6 of the PMBus Specification Part II.

Bit	Meaning
7	OT Fault
6	OT Warning
5	---
4	---
3	---
2	---
1	---
0	---

## STATUS\_CML

<b>Reference:</b>	Standard Command	<b>Format:</b>	Bit field
<b>Command Code:</b>	0x7E	<b>Units:</b>	N/A
<b>Data Bytes:</b>	1	<b>Factory Value:</b>	N/A
<b>Transfer:</b>	Read Byte		

**Description/Notes:** See Section 17.7 of the PMBus Specification Part II.

Bit	Meaning
7	Invalid or Unsupported Command Received
6	Invalid or Unsupported Data Received
5	Packet Error Check Failed
4	Memory Error Detected
3	---
2	--- (Reserved, per PMBus specification)
1	A communication fault other than the ones listed in this table has occurred
0	---

## STATUS\_OTHER

<b>Reference:</b>	Standard Command	<b>Format:</b>	Bit field
<b>Command Code:</b>	0x7F	<b>Units:</b>	N/A
<b>Data Bytes:</b>	1	<b>Factory Value:</b>	N/A
<b>Transfer:</b>	Read Byte		

## STATUS\_OTHER

**Description/Notes:** See Section 17.8 of the PMBus Specification Part II.

Bit	Meaning
7	---
6	---
5	---
4	---
3	---
2	---
1	---
0	First to assert /ALERT\

## STATUS\_MFR\_SPECIFIC

<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x80	<b>Format:</b>	Bit field
<b>Data Bytes:</b>	1	<b>Units:</b>	N/A
<b>Transfer:</b>	Read Byte	<b>Factory Value:</b>	N/A

**Description/Notes:** See Section 17.9 of the PMBus Specification Part II.

Bit	Meaning
7	(Not used)
6	(Not used)
5	Unit off for low VCC voltage
4	Pin open/short detection fault
3	RADC over-/under-range fault
2	External power-stage (slave) fault
1	SNSP open fault
0	PWM open fault

## Telemetry Commands

### READ\_VIN

<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x88	<b>Format:</b>	LINEAR11
<b>Data Bytes:</b>	2	<b>Units:</b>	V
<b>Transfer:</b>	Read Word	<b>Factory Value:</b>	N/A
<b>Description/Notes:</b>	See Section 18.1 of the PMBus Specification Part II.		

### READ\_VOUT

<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x8B	<b>Format:</b>	ULINEAR16
<b>Data Bytes:</b>	2	<b>Units:</b>	V
<b>Transfer:</b>	Read Word	<b>Factory Value:</b>	N/A
<b>Description/Notes:</b>	See Section 18.4 of the PMBus Specification Part II.		

### READ\_IOUT

<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x8C	<b>Format:</b>	LINEAR11
<b>Data Bytes:</b>	2	<b>Units:</b>	A
<b>Transfer:</b>	Read Word	<b>Factory Value:</b>	N/A
<b>Description/Notes:</b>	See Section 18.5 of the PMBus Specification Part II.		

### READ\_TEMPERATURE\_1

<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x8D	<b>Format:</b>	LINEAR11
<b>Data Bytes:</b>	2	<b>Units:</b>	°C
<b>Transfer:</b>	Read Word	<b>Factory Value:</b>	N/A
<b>Description/Notes:</b>	See Section 18.6 of the PMBus Specification Part II. The device uses READ_TEMPERATURE_1 to report the highest of its internal power stages' (i.e., die) temperature.		

### READ\_TEMPERATURE\_2

<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x8E	<b>Format:</b>	LINEAR11
<b>Data Bytes:</b>	2	<b>Units:</b>	°C
<b>Transfer:</b>	Read Word	<b>Factory Value:</b>	N/A
<b>Description/Notes:</b>	See Section 18.6 of the PMBus Specification Part II.		

## READ\_TEMPERATURE\_2

The device uses READ\_TEMPERATURE\_2 to report the temperature of the external power stage, if present. If no external power stage is present, the READ\_TEMPERATURE\_2 command returns a value of 0°C.

## TELEMETRY\_ADDR

<b>Reference:</b>	Maxim Specific	<b>Format:</b>	Unsigned integer
<b>Command Code:</b>	0xFC	<b>Units:</b>	N/A
<b>Data Bytes:</b>	1	<b>Factory Value:</b>	0x00
<b>Transfer:</b>	Read/Write Byte		
<b>Description/Notes:</b>	This command sets the telemetry register address to be read using <a href="#">TELEMETRY_DATA</a> . This pair of commands provides access to device parameters that are digitized, but not associated with a dedicated PMBus telemetry command.		

## TELEMETRY\_DATA

<b>Reference:</b>	Maxim Specific	<b>Format:</b>	Unsigned integer
<b>Command Code:</b>	0xFD	<b>Units:</b>	N/A
<b>Data Bytes:</b>	2	<b>Factory Value:</b>	N/A
<b>Transfer:</b>	Read Word		
<b>Description/Notes:</b>	This command returns the raw ADC data for the telemetry register address specified by <a href="#">TELEMETRY_ADDR</a> . This pair of commands provides access to device parameters that are digitized, but not associated with a dedicated PMBus telemetry command.		

## Calibration and Tuning Commands

### PWM\_RAMP

<b>Reference:</b>	Maxim Specific	<b>Format:</b>	Unsigned Integer
<b>Command Code:</b>	0xD4	<b>Units:</b>	N/A
<b>Data Bytes:</b>	1	<b>Factory Value:</b>	Set by external resistor
<b>Transfer:</b>	Read/Write Byte		

**Description/Notes:** This command sets both the steady-state value of the pulse-width modulator (PWM) ramp rate, and configures the dynamic behavior during soft-start and soft-stop (as controlled by [TON\\_RISE](#) and [TOFF\\_FALL](#)).

The PWM modulator ramp rate accepts integer values from 0 to 15 in the low four bits [3:0] of the data byte. The factory value of the modulator ramp rate is set by external resistor to a setting of 2, 5, 8, or 10 as highlighted in the table below.

PWM Modulator Ramp Rate		
Setting	Value	Units
15	9.55	V/ $\mu$ s
14	8.28	
13	7.01	
12	5.73	
11	5.10	
10	4.46	
9	3.82	
8	3.18	
7	2.55	
6	1.91	
5	1.27	
4	0.850	
3	0.637	
2	0.425	
1	0.212	
0	0.00	

The dynamic behavior during startup and shutdown is configured using bits [5:4] in the upper nibble. This feature starts the PWM modulator ramp value at a higher initial setting of either 100%, 50%, or 25%, and decreases the modulator ramp level linearly to the target steady-state value set by bits [3:0] during the TON\_RISE time. (Note that the converse is also true: the PWM modulator ramp level is *increased* linearly from the target value, back to the initial setting of 100%, 50%, or 25%, during TOFF\_FALL.)

The factory setting is 1 to start the PWM modulator ramp from 50%.

Dynamic PWM Modulator Ramp-Rate Adjustment	
Setting	Description
0	Decrease modulator ramp linearly from 100% (255d) to target value during TON_RISE
1	Decrease modulator ramp linearly from 50% (127d) to target value during TON_RISE ( <i>Factory Setting</i> )
2	Decrease modulator ramp linearly from 25% (63d) to target value during TON_RISE
3	Disable dynamic modulator ramp adjustment feature

## LEAD\_LAG

<b>Reference:</b>	Maxim Specific		
<b>Command Code:</b>	0xD5	<b>Format:</b>	Unsigned Integer
<b>Data Bytes:</b>	1	<b>Units:</b>	N/A
<b>Transfer:</b>	Read/Write Byte	<b>Factory Value:</b>	0x00 (Disabled)

**Description/Notes:** This command configures the voltage loop lead/lag compensator. Integer values from 0 to 15 are accepted.

Setting	Attenuator DC Gain	Phase boost, degrees	Frequency, kHz
0	Disabled	Disabled	Disabled
1	0.81	Disabled	Disabled
2	0.54	Disabled	Disabled
3	0.34	Disabled	Disabled
4	0.81	25	60
5	0.81	25	90
6	0.81	25	120
7	0.81	25	160
8	0.54	35	60
9	0.54	35	90
10	0.54	35	120
11	0.54	35	160
12	0.34	45	60
13	0.34	45	90
14	0.34	45	120
15	0.34	45	160

## IDES\_GAIN

<b>Reference:</b>	Maxim Specific		
<b>Command Code:</b>	0xE7	<b>Format:</b>	Unsigned Integer
<b>Data Bytes:</b>	1	<b>Units:</b>	N/A
<b>Transfer:</b>	Read/Write Byte	<b>Factory Value:</b>	Set by external resistor

**Description/Notes:** This command sets a voltage-control loop-gain value. Integer values from 0 to 31 are accepted.

The factory value is set by external resistor to any value from 0 to 7, as highlighted in the following table.

Setting	Value	Units
0	0.98	V/V
1	1.258	
2	1.536	
3	1.814	
4	2.092	
5	2.37	
6	2.648	
7	2.926	
8	3.204	
9	3.482	
10	3.76	
11	4.038	
12	4.316	
13	4.594	
14	4.872	
15	5.15	
16	5.428	
17	5.706	
18	5.984	
19	6.262	
20	6.54	
21	6.818	
22	7.096	
23	7.374	
24	7.652	
25	7.93	
26	8.208	
27	8.486	
28	8.764	
29	9.042	
30	9.32	
31	9.598	



## F\_ZERO

<b>Reference:</b>	Maxim Specific		
<b>Command Code:</b>	0xE8	<b>Format:</b>	Unsigned Integer
<b>Data Bytes:</b>	1	<b>Units:</b>	N/A
<b>Transfer:</b>	Read/Write Byte	<b>Factory Value:</b>	Set by external resistor

**Description/Notes:** This command sets the voltage loop zero frequency. Integer values from 0 to 15 are accepted.

The factory value is set by external resistor to a setting of 2, 4, 5, or 8 as highlighted in the table below.

Setting	Value	Units
15	50.3	kHz
14	47.2	
13	44.2	
12	41.1	
11	38.0	
10	35.0	
9	31.9	
8	28.8	
7	25.8	
6	22.7	
5	19.6	
4	16.5	
3	13.4	
2	10.3	
1	7.20	
0	4.10	

## ROCR\_RINT

<b>Reference:</b>	Maxim Specific	<b>Format:</b>	Unsigned Integer
<b>Command Code:</b>	0xF1	<b>Units:</b>	N/A
<b>Data Bytes:</b>	1	<b>Factory Value:</b>	Set by external resistor
<b>Transfer:</b>	Read/Write Byte		

**Description/Notes:** This command sets both the orthogonal current rebalancing gain-set resistance value (ROCR) and the integrator gain-set resistance value (RINT). The data byte consists of two 4-bit nibbles, each of which accepts an integer value from 0 to 15. The upper four bits [7:4] are an index for the RINT value, and the lower four bits [3:0] are an index for the ROCR value, as shown in the following tables.

RINT (high nibble)			ROCR (low nibble)		
Setting (hex)	Value	Units	Setting (hex)	Value	Units
0	13090		F	26810	
1	10950		E	23920	
2	8803		D	22190	
3	6662		C	20450	
4	4522		B	18720	
5	3668		A	16990	
6	2964		9	15260	
7	2209		8	13530	
8	1761	Ω	7	11800	
9	1257		6	10070	
A	1098		5	8341	
B	878		4	6613	
C	732		3	4885	
D	627		2	3155	
E	518		1	2002	
F	421		0	1422	

The factory value of ROCR\_RINT is set by external resistor to one of the eight combinational values as highlighted in the tables. For example, the resistor bin value that selects RINT index 6 (2964Ω) also selects ROCR index 8 (13530Ω). The mapping of RINT to ROCR values is intended to provide reasonable loop compensation for typical application circuit use cases.

The external resistor pin-strap tables can be found in the MAX20796 data sheet. Though only eight combinational values are selectable by external resistor pin-strap, any combination of the ROCR and RINT index values can be set using the PMBus command.

## Inventory Information and Device Identification Commands

<b>CAPABILITY</b>			
<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x19	<b>Format:</b>	Bit field
<b>Data Bytes:</b>	1	<b>Units:</b>	N/A
<b>Transfer:</b>	Read Byte	<b>Factory Value:</b>	0xD0
<b>Description/Notes:</b>	See Section 11.12 of the PMBus Specification Part II. The following features are supported: <ul style="list-style-type: none"> <li>• Packet Error Checking</li> <li>• 1MHz bus speed</li> <li>• SMBALERT#</li> <li>• LINEAR11 numeric format</li> </ul>		

<b>PMBUS_REVISION</b>			
<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0x98	<b>Format:</b>	Bit field
<b>Data Bytes:</b>	1	<b>Units:</b>	N/A
<b>Transfer:</b>	Read Byte	<b>Factory Value:</b>	0x33 (Revision 1.3, Parts I & II)
<b>Description/Notes:</b>	See Section 22.1 of the PMBus Specification Part II. Bits [7:4] describe the PMBus specification Part I revision level as follows: <ul style="list-style-type: none"> <li>0000 Revision 1.0</li> <li>0001 Revision 1.1</li> <li>0010 Revision 1.2</li> <li>0011 Revision 1.3</li> </ul> Bits [3:0] describe the PMBus specification Part II revision level as follows: <ul style="list-style-type: none"> <li>0000 Revision 1.0</li> <li>0001 Revision 1.1</li> <li>0010 Revision 1.2</li> <li>0011 Revision 1.3</li> </ul>		

<b>IC_DEVICE_ID</b>			
<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0xAD	<b>Format:</b>	ASCII string
<b>Data Bytes:</b>	13	<b>Units:</b>	N/A
<b>Transfer:</b>	Read Block	<b>Factory Value:</b>	MAX20796ETMA1
<b>Description/Notes:</b>	See Section 22.2.7 of the PMBus Specification Part II.		

<b>IC_DEVICE_REV</b>			
<b>Reference:</b>	Standard Command		
<b>Command Code:</b>	0xAE	<b>Format:</b>	ASCII string

<b>IC_DEVICE_REV</b>			
<b>Data Bytes:</b>	3	<b>Units:</b>	N/A
<b>Transfer:</b>	Read Block	<b>Factory Value:</b>	Die Revision (see Description)
<b>Description/Notes:</b>	<p>See Section 22.2.8 of the PMBus Specification Part II.</p> <p>The default value is the product revision number stored as an ASCII string. The Maxim PowerTool™ GUI uses this information to identify the supported command set for a specific device version.</p>		

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## Security Commands

### WRITE\_PROTECT

<b>Reference:</b>	Standard Command	<b>Format:</b>	Bit field
<b>Command Code:</b>	0x10	<b>Units:</b>	N/A
<b>Data Bytes:</b>	1	<b>Factory Value:</b>	0x00
<b>Transfer:</b>	Read/Write Byte		

**Description/Notes:** See Section 11.1 of the PMBus Specification Part II.

Only the following values of WRITE\_PROTECT are supported:

Data Byte Value	Meaning
0x80	Disable all writes except to the WRITE_PROTECT command
0x40	Disable all writes except to the WRITE_PROTECT and OPERATION commands
0x20	Disable all writes except to the WRITE_PROTECT, OPERATION, ON_OFF_CONFIG and VOUT_COMMAND commands
0x00	Enable writes to all commands.

Note that Send Byte commands are still accepted even when WRITE\_PROTECT is set to a non-zero value. (This is compatible with the PMBus specification because Send Byte is not a data-write operation.)

### FORCE\_PEC

<b>Reference:</b>	Maxim Specific	<b>Format:</b>	Unsigned Integer
<b>Command Code:</b>	0xF2	<b>Units:</b>	N/A
<b>Data Bytes:</b>	1	<b>Factory Value:</b>	0x00
<b>Transfer:</b>	Read/Write Byte		

**Description/Notes:** This command enables or disables a special mode, wherein the device does not accept any write transactions (including Send Byte) if a valid PEC byte is not included in the transaction.

**Valid Settings**

- 0x00 Normal PMBus operation. The packet error check (PEC) byte is optional: if sent, it must be correct, but if not sent, the data byte(s) are accepted according to their normal criteria.
- 0x01 PEC byte is mandatory: Write-Byte, Write-Word, Block-Write, or Send Byte transactions are not accepted without a valid PEC byte at the end of the transaction. This mode enhances communication security by requiring all writes to the device to undergo the PEC calculation check.

## Memory and Storage Commands

RESTORE_MAXIM_ALL			
<b>Reference:</b>	Maxim Specific		
<b>Command Code:</b>	0xEA	<b>Format:</b>	N/A
<b>Data Bytes:</b>	0	<b>Units:</b>	N/A
<b>Transfer:</b>	Send Byte	<b>Factory Value:</b>	N/A
<b>Description/Notes:</b>	<p>This command restores all PMBus commands to their factory values in working memory (volatile RAM). For commands that are set by external resistor, sending RESTORE_MAXIM_ALL restores the value set by the external resistance detected at initialization.</p> <p>The RESTORE_MAXIM_ALL command can only be sent when the output is disabled.</p>		

## Trademarks

PMBus is a trademark of SMIF, Inc.

PowerTool is a trademark of Maxim Integrated Products, Inc.

## Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	8/17	Initial release	—
1	4/19	Removed customer-facing nonvolatile memory functions. Corrected VOUT_OV_FAULT_LIMIT and VOUT_UV_FAULT_LIMIT values to match data sheet EC Table. Updated INTERLEAVE pin-strap resistance values. Removed support for bit 0 of STATUS_CML. Minor corrections to VOUT_COMMAND and TELEMETRY_DATA commands.	All

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