PMBus™
Application Profile for
DC-DC Point of Loads

Revision 1.0

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REVISION HISTORY

REV	DATE	DESCRIPTION	EDITED BY
0.0	10/27/2016	First Draft.	Travis Summerlin Texas Instruments Incorporated
0.1	11/03/2016	First Beta release created at the PMBus Specification Working Group meeting in Austin, TX.	Travis Summerlin Texas Instruments Incorporated
0.2	02/02/2017	Second Beta release for adopter feedback	Travis Summerlin Texas Instruments Incorporated
1.0	03/01/2017	First Official release	Travis Summerlin Texas Instruments Incorporated

Table Of Contents

Table Of Figures

No table of figures entries found.

Table Of Tables

1. Introduction

This application profile defines commonly used sub-sets of PMBus commands that are appropriate for DC-DC Points of Load.

For more information, please see the System Management Interface Forum Web site: www.powerSIG.org.

1.1. Application Profile Scope

1.1.1. What Is Included

There are three nested levels of this application profile. Each successive level is a superset of its predecessor.

1.1.1.1. Level 0

Level 0 is focused on simple control with On/Off, VOUT and simple status reporting defined.

1.1.1.2. Level 1

Level 1 adds telemetry and more status reporting definitions.

1.1.1.3. Level 2

Level 2 adds non-volatile memory, margining, fault limits, sequencing and more status reporting definitions.

1.1.2. What Is Not Included

The Application Profile is not a new specification. This profile defines subsets of commands and command options that are specified within the PMBus Specification documents.

1.2. Application Profile Changes Since The Last Revision

A summary of the changes since the last revision are shown in Appendix 1.

1.3. Where To Send Feedback And Comments

Please send all comments by email to: techquestions@smiforum.org.

2. Related Documents

2.1. Scope

There should be no conflicts between this document and any of the reference documents.

Referenced documents apply only to the extent of specific reference.

The latest version and all amendments of the referenced documents at the time the device releases to manufacturing apply unless otherwise stated in the device datasheet.

2.2. Applicable Documents

Applicable documents include information that is, by extension, part of this specification.

[A01] *PMBus™ Power System Management Protocol, Part I, General Requirements, Transport And Electrical Interface*, System Management Interface Forum, Revision 1.3.1, March 2015

[A02] *PMBus™ Power System Management Protocol, Part II, Command Language*, System Management Interface Forum, Revision 1.3.1, March 2015

[A03] *PMBus Power System Management Protocol, Part III, AVSBus*, System Management Interface Forum, Revision 1.3.1, March 2015

[A04] *System Management Bus (SMBus) Specification*, System Management Interface Forum, Version 2.0, 03 August 2000

[A05] *System Management Bus (SMBus) Specification*, System Management Interface Forum, Version 3.0, 21 December 2014

[A06] *I²C-bus specification and user manual*, Revision 6, NXP Semiconductors, 4 April 2014

[A07] ISO/IEC 8859-1:1998*, 8-bit single-byte coded graphic character sets -- Part 1: Latin alphabet No. 1*, and all corrigenda, amendments published through the date of release of this specification.

2.3. Reference Documents

Reference documents have background or supplementary information to this specification. They do not include requirements or specifications that are considered part of this document.

[R01] PMBus Application Note AN001, *Using The ZONE_READ And ZONE_WRITE Protocols*

3. Compliance

3.1. Principles for compliance

The goal of this application profile is to create a clearly defined set of options within the scope of the PMBus specification that will allow users to re-use software/firmware without modification with all devices that are compliant to a common application profile.

3.1.1. Commands

To be compliant, all commands options must be implemented in accordance with the given profile definition.

3.1.2. Operation

The device must support all aspects of the supported application profile for normal operation using only command settings specified in the supported profile. No command setting outside the supported profile can be required to be modified for normal operation. Additional command settings can be instantiated and available for use, but they must be preconfigured to a state that allows the device to be fully functional without ever being used during normal operation.

3.2. Testing

It is incumbent on the device manufacturer to ensure compliance to this profile. It is incumbent on the users to verify compliance to a profile.

4. Hardware

4.1. SMBus Transport

PMBus devices must use the System Management Bus (SMBus), Version 2.0 [A04] or later [A05], for transport, with the extensions and exceptions listed below.

4.2. Bus Speed

All PMBus devices must support operation at 100 kHz as described in the SMBus specification [A04]. Support for operation at higher bus speeds, as described in the SMBus specification [A05] is optional for PMBus devices.

If a PMBus device supports operation above 100 kHz, the device must support the CAPABILITY command.

System SMBus masters must support clock stretching.

4.3. SMBALERT#

The SMBALERT# signal is required for Level 1 and Level 2 of this application profile.

The SMBALERT# signal is described in the SMBus specification [A04][A05].

4.4. Control Signal (CONTROL)

The Control Signal is not required for this application profile. A pre-configuration of the ON_OFF_CONFIG command settings may be required to be compliant to this application profile (see section 3.1.1).

The Control Signal (CONTROL) and the ON_OFF_CONFIG command settings are described in the PMBus Specification [A01].

5. Commands

5.1. Command Handling Recommendations

5.1.1. Preserving Bit Settings

When changing command data that consist of discrete bit structures:

- Read the command data
- Modify only the data bits to be changed that are contained in this application profile
- Write the modified data back

This will prevent invalid data for bits not supported by this application profile.

5.1.2. Preserving Scaling of Linear Numbers

For devices using fixed numerical exponents in a given command:

- Read the command first
- Extract the exponent
- Use the extracted exponent when writing to that command

5.1.3. Data Read Back

The data from a read command following a write of the command data may not be exactly equal to the written data due to a device's internal implementation. Refer to PMBus Specification Part II Section 7.8 and 7.9 [A02].

5.1.4. Alert Response Address (ARA)

Alert Response Address support is required for devices that support the Level 2 profile.

5.1.5. Address Resolution Protocol (ARP)

Address Resolution Protocol is not required for devices that support this application profile.

5.1.6. Group Command Protocol

Group Command Protocol is not required for devices that support this application profile.

5.1.7. ZONE_READ and ZONE_WRITE

ZONE_READ, ZONE_WRITE and associated commands are not required for devices that support this application profile.

5.2. Table of Commands

Table 1 Commands in each profile

For some commands in this table use a bit mask to indicate the profile requirements for each individual bit whether it is only readable, readable and writable or optional. The legend for the mask is indicated in the notes immediately following the table.

Command Code	Command Name	Level 0 Profile	Level 1 Profile	Level 2 Profile
00h	PAGE	*Only required for multi-page devices*		
01h	OPERATION	WXXX_XXXX	WXXX_XXXX	WWWW_XXXX
02h	ON_OFF_CONFIG	XXXX_WXXX	XXXX_WXXX	XXXX_WXXW
03h	CLEAR_FAULTS	P	P	P
11h	STORE_DEFAULT_ALL			L
12h	RESTORE_DEFAULT_ALL			L
15h	STORE_USER_ALL			P
16h	RESTORE_USER_ALL			P
19h	CAPABILITY	*Only required for bus speed > 100kHz*		
20h	VOUT_MODE	RRRR_RRRR	RRRR_RRRR	RRRR_RRRR
21h	VOUT_COMMAND	P	P	P
25h	VOUT_MARGIN_HIGH			P
26h	VOUT_MARGIN_LOW			P
35h	VIN_ON			P
36h	VIN_OFF			P
40h	VOUT_OV_FAULT_LIMIT			P
44h	VOUT_UV_FAULT_LIMIT			P
46h	IOUT_OC_FAULT_LIMIT			P
51h	OT_WARN_LIMIT			P
60h	TON_DELAY			P
61h	TON_RISE			P
64h	TOFF_DELAY			P
65h	TOFF_FALL			P
78h	STATUS_BYTE *(STATUS_WORD Low Byte)*	XRRR_XRRX	XRRR_XRRX	XRRR_XRRX
79h	STATUS_WORD *(Only High Byte shown)*	RRXX_RXXX	RRXX_RXXX	RRXX_RXXX

Command Code	Command Name	Level 0 Profile	Level 1 Profile	Level 2 Profile
7Ah	STATUS_VOUT			RXXR_XXXX
7Dh	STATUS_TEMPERATURE			RRXX_XXXX
7Eh	STATUS_CML		RRRX_XXRX	RRRR_XXRX
8Bh	READ_VOUT		P	P
8Ch	READ_IOUT		P	P
8Dh	READ_TEMPERATURE_1		P	P
98h	PMBUS_REVISION		P	P
99h	MFR_ID	L	L	L
ADh	IC_DEVICE_ID	P	P	P

L = Legacy device support. See Command Profile Descriptions in section 5.3.

P = Command settings must be implemented in compliance with the PMBus specification [A02].

R = Read Only bit. The corresponding function must be implemented.

W = Readable and Writable bit. The corresponding function must be implemented and controllable using this bit.

X = Optional bit therefore must not be required to be changed for application profile compliance.

Blank cells in the table indicate that the listed command is not included in that profile level.

5.3. Command Profile Descriptions

5.3.1. PAGE

Multi-page devices may require page commands to communicate the commands in this profile. Implementation must be compliant to the PMBus Specification Part II [A02]. The command is not required for non-paged devices.

5.3.2. OPERATION

OPERATION Command Bit [7] (ON/OFF State) is required for devices with all levels of this application profile.

OPERATION Command Bits [6:4] (Turn Off Behavior [6], Voltage Command Source [5:4]) are required for devices with Level 2 of this application profile.

The remaining bits are optional and therefore must not be required to be changed for application profile compliance.

5.3.3. ON_OFF_CONFIG

ON_OFF_CONFIG Command Bit [3] (Serial Bus control) is required for devices with all levels of this application profile.

ON_OFF_CONFIG Command Bit [0] (Control pin action) is required for devices with Level 2 of this application profile.

The remaining bits are optional and therefore must not be required to be changed for application profile compliance.

5.3.4. CLEAR_FAULTS

This command is required for devices with all levels of this application profile. Command options must be implemented in compliance with the PMBus specification.

5.3.5. STORE_DEFAULT_ALL

This command supports legacy devices (See 5.3.7 description).

5.3.6. RESTORE_DEFAULT_ALL

This command supports legacy devices (See 5.3.8 description).

5.3.7. STORE_USER_ALL

Devices with Level 2 of this application profile must support memory commands. If writing STORE_USER_ALL is NACK'd indicating that STORE_USER_ALL and RESTORE_USER_ALL is not supported then STORE_DEFAULT_ALL and RESTORE_DEFAULT_ALL must be supported.

5.3.8. RESTORE_USER_ALL

Devices with Level 2 of this application profile must support memory commands. If writing RESTORE_USER_ALL is NACK'd indicating that RESTORE_USER_ALL and STORE_USER_ALL is not supported then RESTORE_DEFAULT_ALL and STORE_DEFAULT_ALL must be supported.

5.3.9. CAPABILITY

This command is only required if the device supports bus speeds greater than 100 kHz (i.e. CAPABILITY Command Bits [6:5] are not equal to 00b.)

PEC support is required for devices with all levels of this Application Profile, regardless of whether CAPABILITY is supported.

If the CAPABILITY command is implemented, then it will be READ_ONLY, and used as follows:

- The CAPABILITY Command Bit [7] (Packet Error Correction) is required for devices with all levels of this application profile.
- The CAPABILITY Command Bits [6:5] (Maximum Bus Speed) is required for devices with all levels of this application profile.
- The CAPABILITY Command Bit [4] (SMBALERT#) is required for devices with all levels of this application profile. Since SMBALERT# is required for devices with Level 2, this bit shall be set to 1b for devices that support Level 2 of this application profile.
- The CAPABILITY Command Bit [3] (Numeric Format) is required for devices with all levels of this application profile.
- The CAPABILITY Command Bit [2] (AVSBus Support) is required for devices with all levels of this application profile.
- The remaining bits are optional and therefore must not be required to be changed for application profile compliance.

5.3.10. VOUT_MODE

VOUT_MODE Command Bits [7:0] are required (READ ONLY) for devices with all levels of this application profile.

5.3.11. VOUT_COMMAND

VOUT_COMMAND Command Bits [15:0] are required for devices with all levels of this application profile.

5.3.12. VOUT_MARGIN_HIGH

This command is only required for devices with Level 2 of this application profile. Command options must be implemented in compliance with the PMBus specification.

5.3.13. VOUT_MARGIN_LOW

This command is only required for devices with Level 2 of this application profile. Command options must be implemented in compliance with the PMBus specification.

5.3.14. VIN_ON

This command is only required for devices with Level 2 of this application profile. Command options must be implemented in compliance with the PMBus specification.

5.3.15. VIN_OFF

This command is only required for devices with Level 2 of this application profile. Command options must be implemented in compliance with the PMBus specification.

5.3.16. VOUT_OV_FAULT_LIMIT

This command is only required for devices with Level 2 of this application profile. Command options must be implemented in compliance with the PMBus specification.

5.3.17. VOUT_UV_FAULT_LIMIT

This command is only required for devices with Level 2 of this application profile. Command options must be implemented in compliance with the PMBus specification.

5.3.18. IOUT_OC_FAULT_LIMIT

This command is only required for devices with Level 2 of this application profile. Command options must be implemented in compliance with the PMBus specification.

5.3.19. OT_WARN_LIMIT

This command is only required for devices with Level 2 of this application profile. Command options must be implemented in compliance with the PMBus specification.

5.3.20. TON_DELAY

This command is only required for devices with Level 2 of this application profile. Command options must be implemented in compliance with the PMBus specification.

5.3.21. TON_RISE

This command is only required for devices with Level 2 of this application profile. Command options must be implemented in compliance with the PMBus specification.

5.3.22. TOFF_DELAY

This command is only required for devices with Level 2 of this application profile. Command options must be implemented in compliance with the PMBus specification.

5.3.23. TOFF_FALL

This command is only required for devices with Level 2 of this application profile. Command options must be implemented in compliance with the PMBus specification.

5.3.24. STATUS_BYTE

STATUS_BYTE Command Bit [7] (Busy) must not be required for application profile compliance.

STATUS_BYTE Command Bit [6] (OFF) is required (READ ONLY) for devices supporting any level of this application profile.

STATUS_BYTE Command Bit [5] (VOUT_OV_FAULT) is required (READ ONLY) for devices supporting any level of this application profile.

STATUS_BYTE Command Bit [4] (IOUT_OC_FAULT) is required (READ ONLY) for devices supporting any level of this application profile.

STATUS_BYTE Command Bit [3] (VIN_UV_FAULT) must not be required for application profile compliance.

STATUS_BYTE Command Bit [2] (TEMPERATURE) is required (READ ONLY) for devices supporting any level of this application profile.

STATUS_BYTE Command Bit [1] (CML) is required (READ ONLY) for devices supporting any level of this application profile.

STATUS_BYTE Command Bit [0] (NONE_OF_THE_ABOVE) must not be required for application profile compliance.

5.3.25. STATUS_WORD

STATUS_WORD Command Bit [15] (VOUT) is required (READ ONLY) for devices supporting any level of this application profile.

STATUS_WORD Command Bit [14] (IOUT/POUT) is required (READ ONLY) for devices supporting any level of this application profile.

STATUS_WORD Command Bit [13] (INPUT) must not be required for application profile compliance.

STATUS_WORD Command Bit [12] (MFR_SPECIFIC) must not be required for application profile compliance.

STATUS_WORD Command Bit [11] (PG_STATUS#) is required (READ ONLY) for devices supporting any level of this application profile.

STATUS_WORD Command Bit [10] (FANS) must not be required for application profile compliance.

STATUS_WORD Command Bit [9] (OTHER) must not be required for application profile compliance.

STATUS_WORD Command Bit [8] (UNKNOWN) must not be required for application profile compliance.

STATUS_WORD Command Bits [7:0] are STATUS_BYTE Command Bits [7:0] (See section 5.3.24.)

5.3.26. STATUS_VOUT

STATUS_VOUT Command Bit [7] (VOUT_OV_FAULT) is required for devices supporting Level 2 of this application profile.

STATUS_VOUT Command Bit [6] (VOUT_OV_WARNING) must not be required for application profile compliance.

STATUS_VOUT Command Bit [5] (VOUT_UV_WARNING) must not be required for application profile compliance.

STATUS_VOUT Command Bit [4] (VOUT_UV_FAULT) is required for devices supporting Level 2 of this application profile.

STATUS_VOUT Command Bit [3] (VOUT_MAX_MIN) must not be required for application profile compliance.

STATUS_VOUT Command Bit [2] (TON_MAX_FAULT) must not be required for application profile compliance.

STATUS_VOUT Command Bit [1] (TOFF_MAX_WARNING) must not be required for application profile compliance.

STATUS_VOUT Command Bit [0] (VOUT Tracking Error) must not be required for application profile compliance.

5.3.27. STATUS_TEMPERATURE

STATUS_TEMPERATURE Command Bit [7] (OT_FAULT) is required for devices supporting Level 2 of this application profile.

STATUS_TEMPERATURE Command Bit [6] (OT_WARNING) is required for devices supporting Level 2 of this application profile.

STATUS_TEMPERATURE Command Bits [5:0] must not be required for application profile compliance.

5.3.28. STATUS_CML

STATUS_CML Command Bit [7] (Invalid or unsupported command received) is only required for devices supporting Level 1 or 2 of this application profile.

STATUS_CML Command Bit [6] (Invalid or unsupported data received) is only required for devices supporting Level 1 or 2 of this application profile.

STATUS_CML Command Bit [5] (Packet Error Check failed) is only required for devices supporting Level 1 or 2 of this application profile.

STATUS_CML Command Bit [4] (Memory fault detected) is only required for devices supporting Level 2 of this application profile.

STATUS_CML Command Bits [3:2] must not be required for application profile compliance.

STATUS_CML Command Bit [1] (Other CML) is only required for devices supporting Level 1 or 2 of this application profile.

STATUS_CML Command Bit [0] must not be required for application profile compliance.

5.3.29. READ_VOUT

This command is only required for devices with Level 1 or 2 of this application profile. Command options must be implemented in compliance with the PMBus specification.

5.3.30. READ_IOUT

This command is only required for devices with Level 1 or 2 of this application profile. Command options must be implemented in compliance with the PMBus specification.

5.3.31. READ_TEMPERATURE_1

This command is only required for devices with Level 1 or 2 of this application profile. Command options must be implemented in compliance with the PMBus specification.

5.3.32. PMBUS_REVISION

This command is only required for devices with Level 1 or 2 of this application profile. Command options must be implemented in compliance with the PMBus specification.

5.3.33. MFR_ID

This command is for legacy devices only. See 5.3.34 description.

5.3.34. IC_DEVICE_ID

Devices must support an identification command. If reading IC_DEVICE_ID is NACK'd indicating that IC_DEVICE_ID is not supported then the legacy MFR_ID must be supported.

Appendix 1 - Summary Of Changes

DISCLAIMER: The section is provided for reference only and for the convenience of the reader. No suggestion, statement or guarantee is made that the description of the changes listed below is sufficient to design a device compliant with this document.