Intersil PMBus Command Set for Digital-DC™ Products

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Digital power design allows for optimal configuration, parametric monitoring and increased efficiency while reducing the number of power supply components. Communication with digital power devices is required to take full advantage of digital power capabilities.

The System Management Interface (SMI) Forum and the Power Management Bus Implementers Forum created a hardware interface and a command language to deal with standardization of a communication interface. This Power Management Bus (PMBus™) command language standard is a comprehensive set of commands used with the industry-standard SMBus to enhance the control and monitoring of digital power circuits and thermal management. The PMBus specification is written in two parts. The first, "Specification Part I – General Requirements Transport and Electrical Interface" on page 5 specifies the physical interface to the PMBus. It includes the SMBus communication bus as the electrical interface and protocol. The second part, "Specification Part II – Command Language" on page 5, describes the command set. This command set includes provisions for manufacturer specifiable commands and data.

Intersil Digital-DC™ (DDC) based ICs feature the implementation of PMBus in an efficient power supply controller device. The DDC™ bus is an intra-device communication bus for coordination of Intersil devices. This document describes the standard PMBus commands available in the following Intersil devices and modules that include the DDC™ bus:

- Controllers with internal drivers
  ZL2006, ZL2008, ZL6100, ZL6105
- Controllers with external drivers
  ZL2004, ZL8101
- Regulators with integrated MOSFETs
  ZL2101, ZL2103, ZL2106
- Power module controllers
  ZL9101M

Manufacturer specific commands are also described in this document. Each command description includes the parameters defined by Intersil that are necessary for its use. This document should be used in conjunction with the PMBus specification documents standard command description and Intersil application notes. The commands in this document are grouped in functional sections in similar fashion to the "PMBus Power System Management Protocol Specifications" found in the following website.

http://pmbus.org/Home

Each PMBus command is described in the following format:

<Command Name in PMBus Syntax>

Devices: <list of devices that support this command>

Command Code: <in hex>

Type: <SMBus transfer type>

Data Length in Bytes: <number>

Data Format: <PMBus data format>

Factory Value: <in hex and (decimal)>

Units: <data units>

Reference: <reference to related document or App Note>

Definition: <brief description of command's operation>

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Reference Documents

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/Home

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 application note will not readdress 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 hardwired 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

SMBUS CONTROL METHOD INTERFACE SPECIFICATION

http://www.smbus.org/specs/

This specification defines a System Management Bus (SMBus) interface for Advanced Configuration and Power Interface (ACPI).

PMBus Use Guidelines

The PMBus is a powerful tool that allows the user to optimize circuit performance by configuring devices for their application. When configuring a device in a circuit, the device should be disabled whenever most settings are changed with PMBus commands. Some exceptions to this recommendation are OPERATION, ON_OFF_CONFIG, CLEAR_FAULTS, VOUT_COMMAND, VOUT_MARGIN_HIGH, VOUT_MARGIN_LOW, and ASCCR_CONFIG. While the device is enabled any command can be read. Many commands do not take effect until after the device has been re-enabled, hence the recommendation that commands that change device settings are written while the device is disabled.

When sending the STORE_DEFAULT_ALL, STORE_USER_ALL, RESTORE_DEFAULT_ALL, and RESTORE_USER_ALL commands, it is recommended that no other commands are sent to the device for 100ms after sending STORE or RESTORE commands.

In addition, there should be a 2ms delay between repeated READ commands sent to the same device. When sending any other command, a 5ms delay is recommended between repeated commands sent to the same device.

Summary

All commands can be read at any time.

Always disable the device when writing commands that change device settings. Exceptions to this rule are commands intended to be written while the device is enabled, for example, VOUT_MARGIN_HIGH.

To be sure a change to a device setting has taken effect, write the STORE_USER_ALL command, then cycle input power and re-enable.

Intersil PMBus Commands

Control Commands

OPERATION

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x01

Type: R/W byte - Protectable

Data Length in Bytes: 1

Data Format: Custom

Factory Value: N/A

Units: N/A

Reference: Section 12.1 - PMBus Spec Part II

Definition: Sets Enable, Disable and V_{OUT} Margin modes. Please note that data values of OPERATION that force margin high or low only take effect when the MGN pin is left open (i.e., in the NOMINAL margin state).

NOTE: All margin settings are “Act on Fault” type. “Ignore Fault” settings are ignored and “Act on Fault” is used.

ON_OFF_CONFIG

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x02

Type: R/W byte - Protectable

Data Length in Bytes: 1

Data Format: Custom

Factory Value: 0x16

Units: N/A

Reference: Section 12.2 - PMBus Spec Part II

Definition: Configures the interpretation and coordination of the OPERATION command and the Enable pin (EN).

Output Commands

VOUT_MODE

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x20

Type: Read byte

Data Length in Bytes: 1

Data Format: Mode + Exponent Format Section 8.2 - PMBus Spec Part II

Factory Value: 0x13 (Linear Mode, Exponent = -13)

Units: N/A

Reference: Section 8 - PMBus Spec Part II

Definition: Preset to defined data format of V_{OUT} commands.

VOUT_COMMAND

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x21

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 8.3.1 - PMBus Spec Part II - V_{OUT} Linear Mode

Factory Value: Pin-strap setting value (V1:V0)

Units: V

Reference: Section 8 - PMBus Spec Part II - VOUT_MODE

Definition: Sets the nominal value of the output voltage.

Output voltage = VOUT_COMMAND x 2^{-13}. VOUT_COMMAND cannot be set greater than the lesser of 110% of the pin-strap setting or VOUT_MAX.

VOUT_TRIM

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x22

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Signed VOUT linear mode (see definition)

Factory Value: 0x0000

Units: V

Reference: Section 13.3 - PMBus Spec Part II - VOUT_MODE

Definition: Sets V_{OUT} trim value. The two bytes are formatted as a two's complement binary mantissa, used in conjunction with the exponent set in VOUT_MODE.

VOUT_CAL_OFFSET

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x23

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Signed V_{OUT} linear mode (see definition)

Factory Value: 0x0000

Units: V

Reference: Section 13.4 - PMBus Spec Part II - VOUT_MODE

Definition: Sets V_{OUT} calibration offset (same function as VOUT_TRIM). The two bytes are formatted as a two's complement binary mantissa, used in conjunction with the exponent set in VOUT_MODE.

NOTE: This command was previously known as VOUT_CAL.

VOUT_MAX

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x24

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 8.3.1 - PMBus Spec Part II - V_{OUT} Linear Mode

Factory Value: 1.10 x VOUT_COMMAND

Units: V

Reference: Section 13.5 - PMBus Spec Part II - VOUT_MODE

Definition: Sets the maximum possible value setting of V_{OUT}. The maximum VOUT_MAX setting is 110% of the pin-strap setting.

VOUT_MARGIN_HIGH

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x25

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 8.3.1 - PMBus Spec Part II - V_{OUT} Linear Mode

Factory Value: 1.05 x VOUT_COMMAND

Units: V

Reference: Section 13.6 - PMBus Spec Part II - VOUT_MODE

Definition: Sets the value of the V_{OUT} during a margin high.

VOUT_MARGIN_LOW

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0x26
Type: R/W word - Protectable
Data Length in Bytes: 2
Data Format: Section 8.3.1 - PMBus Spec Part II - V_{OUT} Linear Mode
Factory Value: 0.95 x VOUT_COMMAND
Units: V
Reference: Section 13.7 - PMBus Spec Part II - VOUT_MODE
Definition: Sets the value of the V_{OUT} during a margin low.

VOUT_TRANSITION_RATE

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0x27
Type: R/W word - Protectable
Data Length in Bytes: 2
Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format
Factory Value: 0xBA00 (1)
Units: V/ms
Reference: Section 13.8 - PMBus Spec Part II
Definition: Sets the transition rate during margin or other change of V_{OUT}.

VOUT_DROOP

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0x28
Type: R/W word - Protectable
Data Length in Bytes: 2
Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format
Factory Value: 0x0000
Units: mV/A
Reference: AN2034 - Configuring Current Sharing on the ZL2004 and ZL2006; PMBus Spec Part II - Section 13.9
Definition: Sets the effective load line (V/I slope) for the rail in which the device is used.

MAX_DUTY

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0x32
Type: R/W word - Protectable
Data Length in Bytes: 2
Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format
Factory Value: 0xEAF8 (95)
Units: %
Reference: Section 14.3 - PMBus Spec Part II
Definition: Sets the maximum allowable duty cycle of the switching frequency.
NOTE: MAX_DUTY should not be used to set the output voltage of the device. VOUT_COMMAND is the proper method to set the output voltage.

FREQUENCY_SWITCH

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0x33
Type: R/W word - Protectable
Data Length in Bytes: 2
Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format
Factory Value: Pin-strap setting value (SYNC)
Units: kHz
Reference: Section 14.4 - PMBus Spec Part II
Definition: Sets the switching frequency.

IOUT_CAL_GAIN

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0x38
Type: R/W word - Protectable
Data Length in Bytes: 2
Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format
Factory Value:
ZL2004, ZL2006, ZL2008, ZL6100, ZL6105, ZL8101, ZL9101: 0xC200 (2mΩ)
ZL2101, ZL2103, ZL2106: 0xE2B0 (43mΩ)
Units: mΩ
Reference: Section 14.8 - PMBus Spec Part I
Definition: Sets the effective impedance for current sensing at +25°C.
NOTE: This command was previously known as IOUT_SCALE.

IOUT_CAL_OFFSET

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0x39
Type: R/W word - Protectable
Data Length in Bytes: 2
Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format
Factory Value: 0x0000 (0A)
Units: A
Reference: Section 14.9 - PMBus Spec Part II
Definition: Sets an offset to I_{OUT} readings. Use to compensate for delayed measurements of current ramp.

XTEMP_SCALE

Devices: ZL2004, ZL2006, ZL2008, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0xD9
Type: R/W word - Protectable
Data Length in Bytes: 2
Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format
Factory Value: 0xBA00 (1)
Units: 1/°C
Reference:
Definition: Sets a scalar value that is used for calibrating the external temperature. The constant is applied in Equation 1 to produce the read value of XTEMP via the PMBus command READ_TEMPERATURE_2.
NOTE: This value must be ≥ to 1.

$$\text{READ\_TEMPERATURE\_2} = \left(\frac{\text{ExternalTemperature}}{\text{XTEMP\_SCALE}}\right) + \text{XTEMP\_OFFSET} \quad \text{(EQ. 1)}$$

XTEMP_OFFSET

Devices: ZL2004, ZL2006, ZL2008, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xDA

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: 0x8000 (0)

Units: °C

Reference:

Definition: Sets an offset value that is used for calibrating the external temperature. The constant is applied in Equation 2 to produce the read value of XTEMP via the PMBus command READ_TEMPERATURE_2.

$$READ\_TEMPERATURE\_2 = \left(\frac{ExternalTemperature}{XTEMP\_SCALE}\right) + XTEMP\_OFFSET \quad \text{(EQ. 2)}$$

Fault Limit Commands

POWER_GOOD_ON

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x5E

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 8.3.1 - PMBus Spec Part II - V_{OUT} Linear Mode

Factory Value: 0.9 x VOUT_COMMAND

Units: V

Reference: Section 15.32.1 - PMBus Spec Part II

Definition: Sets the voltage threshold for power-good indication. Power-Good asserts when the output voltage exceeds POWER_GOOD_ON and de-asserts when the output voltage is less than VOUT_UV_FAULT_LIMIT.

VOUT_OV_FAULT_LIMIT

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x40

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 8.3.1 - PMBus Spec Part II - V_{OUT} Linear Mode

Factory Value: 1.15 x VOUT_COMMAND

Units: V

Reference: Section 15.2 - PMBus Spec Part II

Definition: Sets the V_{OUT} overvoltage fault threshold.

VOUT_UV_FAULT_LIMIT

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x44

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 8.3.1 - PMBus Spec Part II - V_{OUT} Linear Mode

Factory Value: 0.85 x VOUT_COMMAND

Units: V

Reference: Section 15.6 - PMBus Spec Part II

Definition: Sets the V_{OUT} undervoltage fault threshold.

IOUT_OC_FAULT_LIMIT

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x46

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: Pin-strap setting value. ZL6100, ZL2006 (ILIM1:ILIM0); ZL2004 (ILIM)

Units: A

Reference: Section 15.8 - PMBus Spec Part II

Definition: Sets the I_{OUT} peak overcurrent fault threshold. For down-slope sensing, this corresponds to the first current sample after the Current Sense Blanking Time has expired during the (1-D) time interval. For up-slope sensing, this corresponds to the last current sample of the D time interval. This feature shares the OC fault bit operation (in STATUS_IOUT) and OC fault response with IOUT_AVG_OC_FAULT_LIMIT.

IOUT_AVG_OC_FAULT_LIMIT

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xE7

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: 1 x IOUT_OC_FAULT_LIMIT

Units: A

Reference:

Definition: Sets the I_{OUT} average overcurrent fault threshold. For down-slope sensing, this corresponds to the average of all the current samples taken during the (1-D) time interval, excluding the Current Sense Blanking time (which occurs at the beginning of the 1-D interval). For up-slope sensing, this corresponds to the average of all the current samples taken during the D time interval, excluding the Current Sense Blanking time (which occurs at the beginning of the D interval). This feature shares the OC fault bit operation (in STATUS_IOUT) and OC fault response with IOUT_ OC_FAULT_LIMIT.

IOUT_UC_FAULT_LIMIT

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x4B

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: -1 x IOUT_OC_FAULT_LIMIT

Units: A

Reference: Section 15.13 - PMBus Spec Part II

Definition: Sets the I_{OUT} valley undercurrent fault threshold. For down-slope sensing, this corresponds to the last current sample of the (1-D) time interval. For up-slope sensing, this corresponds to the first current sample of the D time interval, excluding the Current Sense Blanking time (which occurs at the beginning of the D interval). This feature shares the UC fault bit operation (in STATUS_IOUT) and UC fault response with IOUT_AVG_UC_FAULT_LIMIT.

IOUT_AVG_UC_FAULT_LIMIT

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xE8

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: 1 x IOUT_UC_FAULT_LIMIT

Units: A

Reference:

Definition: Sets the I_{OUT} average undercurrent fault threshold. For down-slope sensing, this corresponds to the average of all the current samples taken during the (1-D) time interval, excluding the Current Sense Blanking time (which occurs at the beginning of the 1-D interval). For up-slope sensing, this corresponds to the average of all the current samples taken during the D time interval, excluding the Current Sense Blanking time (which occurs at the beginning of the D interval). This feature shares the UC fault bit operation (in STATUS_IOUT) and UC fault response with IOUT_ UC_FAULT_LIMIT.

OT_FAULT_LIMIT

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0x4F
Type: R/W word - Protectable
Data Length in Bytes: 2
Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format
Factory Value: 0xEBE8 (+125°C)
Units: °C
Reference: Section 15.17 - PMBus Spec Part II
Definition: Sets the over-temperature fault threshold. Note that the temperature must drop below OT_WARN_LIMIT to clear this fault.

OT_WARN_LIMIT

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0x51
Type: R/W word - Protectable
Data Length in Bytes: 2
Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format
Factory Value: 0xEB70 (+110°C)
Units: °C
Reference: Section 15.19 - PMBus Spec Part II
Definition: Sets the over-temperature warning threshold. Also used as the hysteresis threshold for OT faults.

UT_WARN_LIMIT

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0x52
Type: R/W word - Protectable
Data Length in Bytes: 2
Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format
Factory Value: 0xDC40 (-30°C)
Units: °C
Reference: Section 15.20 - PMBus Spec Part II
Definition: Sets the under-temperature warning threshold. Also used as the hysteresis threshold for UT faults.

UT_FAULT_LIMIT

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0x53
Type: R/W word - Protectable
Data Length in Bytes: 2
Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format
Factory Value: 0xE530 (-45°C)
Units: °C
Reference: Section 15.21 - PMBus Spec Part II
Definition: Sets the under-temperature fault threshold. Note that the temperature must rise above UT_WARN_LIMIT to clear this fault.

VIN_OV_FAULT_LIMIT

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0x55
Type: R/W word - Protectable
Data Length in Bytes: 2
Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format
Factory Value: 0xD380 (14V)
Units: V
Reference: Section 15.23 - PMBus Spec Part II
Definition: Sets the VIN overvoltage fault threshold.

VIN_OV_WARN_LIMIT

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x57

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: 0xD360 (13.5V)

Units: V

Reference: Section 15.25 - PMBus Spec Part II

Definition: Sets the V_{IN} overvoltage warning threshold.

VIN_UV_WARN_LIMIT

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x58

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: 1.03 x VIN_UV_FAULT_LIMIT

Units: V

Reference: Section 15.26 - PMBus Spec Part II

Definition: Sets the V_{IN} undervoltage warning threshold. If a VIN_UV_FAULT occurs, the input voltage must rise above VIN_UV_WARN_LIMIT to clear the fault, which provides hysteresis to the fault threshold.

VIN_UV_FAULT_LIMIT

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x59

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: Pin-strap setting value (UVLO)

Units: V

Reference: Section 15.27 - PMBus Spec Part II

Definition: Sets the VIN undervoltage fault threshold.

MFR_VMON_OV_FAULT_LIMIT

Devices: ZL2004, ZL8101, ZL9101

Command Code: 0xF5

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: 0xD300 (12V)

Units: V

Definition: Sets the V_{MON} overvoltage fault threshold. A V_{MON} parameter equals 16 times the voltage applied to the VMON pin. The V_{MON} overvoltage warn limit is automatically set to 90% of this fault value.

MFR_VMON_UV_FAULT_LIMIT

Devices: ZL2004, ZL8101, ZL9101

Command Code: 0xF6

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: 0xCA80 (5V)

Units: V

Definition: Sets the V_{MON} undervoltage fault threshold. A V_{MON} parameter equals 16x the voltage applied to the VMON pin. The V_{MON} undervoltage warn limit is automatically set to 110% of this fault value.

Fault Response Commands

All Intersil devices' fault responses, including current faults, are defined by Table 1. This table describes the specifics for the Intersil devices. If a device is used in a current sharing rail, the device will not attempt a retry until the entire current share rail attempts a retry following a disable event.

TABLE 1. Intersil DEVICE SPECIFICATIONS

BITS	DESCRIPTION	VALUE	MEANING
7:6	Response: For all modes set by Bits [7:6], the device: • Pulls SALRT low • Sets the related fault bit in the status registers. Fault bits are only cleared by the CLEAR_FAULTS command.	00	Continuous operation. (Ignore fault)
		01	Delay, Disable and Retry Delay time is specified by Bits [2:0] and the delay time unit specified for that particular fault. If the fault condition is still present at the end of the delay time, the unit retries according to the setting in Bits [5:3].
		10	Disable and Retry according to the setting in Bits [5:3].
		11	The device's output is disabled while the fault is present. Operation resumes and the output is enabled when the fault condition no longer exists.
5:3	Retry Setting	000	No Retry. The output remains disabled.
		001 to 110	The PMBus device attempts to restart the number of times set by these bits. The minimum number is 1 and the maximum number is 6. If the device fails to restart in the allowed number of retries, it disables the output and remains disabled. The time between the start of each attempt to retry is set by the value in Bits [2:0] along with the delay time unit specified for that particular fault.
		111	The PMBus device attempts retry continuously until it is commanded to disable (by the Enable pin or OPERATION command), input power is removed, or another fault condition causes the unit to shut down.
2:0	Retry Time and Delay Time	000 to 111	This time count is used for both the amount of time between retry attempts and for the amount of time a rail is to delay its response after a fault is detected. The retry time and delay time units are defined by the type of fault within each device.

NOTE: The delay time is the time between restart attempts

VOUT_OV_FAULT_RESPONSE

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x41

Type: R/W byte - Protectable

Data Length in Bytes: 1

Data Format: Section 10.5.1 - Custom (PMBus Spec Part II)

Factory Value: 0xBF (Retry always, max delay)

Units: Retry time = 8.2ms/LSB, Delay = 10ms/LSB

Reference: Section 15.3 - PMBus Spec Part II and Table 1.

Definition: Configures the V_{OUT} overvoltage fault response. Note that the two most significant bits can be written as 01 or 00. However, upon an overvoltage fault, these two bits will be set to 1:0 (i.e., Bits (7:6) = 1:0). Thus an overvoltage fault cannot be set to be ignored.

VOUT_UV_FAULT_RESPONSE

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x45

Type: R/W byte - Protectable

Data Length in Bytes: 1

Data Format: Section 10.5.1 - Custom (PMBus Spec Part II)

Factory Value: 0xBF (Retry always, max delay)

Units: Retry time = 8.2ms/LSB, Delay = 10ms/LSB

Reference: Section 15.7 - PMBus Spec Part II and Table 1

Definition: Configures the V_{OUT} undervoltage fault response.

MFR_IOUT_OC_FAULT_RESPONSE

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xE5

Type: R/W byte - Protectable

Data Length in Bytes: 1

Data Format: Section 10.5.1 - Custom (PMBus Spec Part II)

Factory Value: 0xBF (Retry always, max delay)

Units: Retry time = 8.2ms/LSB, Delay = 10ms/LSB

Reference: Section 15.3 - PMBus Spec Part II and Table 1 on page 14

Definition: Configures the I_{OUT} overcurrent fault response. The command format is the same as the PMBus standard responses for voltage and temperature faults except that it sets the overcurrent status bit.

Note: The delay time is the time between restart attempts.

MFR_IOUT_UC_FAULT_RESPONSE

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xE6

Type: R/W byte - Protectable

Data Length in Bytes: 1

Data Format: Section 10.5.1 - Custom (PMBus Spec Part II)

Factory Value: 0xBF (Retry always, max delay)

Units: Retry time = 8.2ms/LSB, Delay = 10ms/LSB

Reference: Section 15.7 - PMBus Spec Part II and Table 1 on page 14

Definition: Configures the I_{OUT} undercurrent fault response. The command format is the same as the PMBus standard responses for voltage and temperature faults except that it sets the undercurrent status bit.

Note: The delay time is the time between restart attempts

OT_FAULT_RESPONSE

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x50

Type: R/W byte - Protectable

Data Length in Bytes: 1

Data Format: Section 10.5.1 - Custom (PMBus Spec Part II)

Factory Value: 0xBF (Retry always, max delay)

Units: Retry time = 32ms/LSB, Delay = 80ms/LSB

Reference: Section 15.18 - PMBus Spec Part II and Table 1 on page 14

Definition: Configures the over-temperature fault response.

Note: The delay time is the time between restart attempts

UT_FAULT_RESPONSE

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x54

Type: R/W byte - Protectable

Data Length in Bytes: 1

Data Format: Section 10.5.1 - Custom (PMBus Spec Part II)

Factory Value: 0xBF (Retry always, max delay)

Units: Retry time = 32ms/LSB, Delay = 80ms/LSB

Reference: Section 15.22 - PMBus Spec Part II and Table 1 on page 14

Definition: Configures the undertemperature fault response.

Note: The delay time is the time between restart attempts

VIN_OV_FAULT_RESPONSE

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0x56
Type: R/W byte - Protectable
Data Length in Bytes: 1
Data Format: Section 10.5.1 - Custom (PMBus Spec Part II)
Factory Value: 0xBF (Retry always, max delay)
Units: Retry time = 8.2ms/LSB, Delay = 10ms/LSB
Reference: Section 15.24 - PMBus Spec Part II and Table 1 on page 14
Definition: Configures the V_{IN} overvoltage fault response.
Note: The delay time is the time between restart attempts

VIN_UV_FAULT_RESPONSE

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0x5A
Type: R/W byte - Protectable
Data Length in Bytes: 1
Data Format: Section 10.5.1 - Custom (PMBus Spec Part II)
Factory Value: 0xBF (Retry always, max delay)
Units: Retry time = 8.2ms/LSB, Delay = 10ms/LSB
Reference: Section 15.28 - PMBus Spec Part II and Table 1 on page 14
Definition: Configures the V_{IN} undervoltage fault response.
Note: The delay time is the time between restart attempts

VMON_OV_FAULT_RESPONSE

Devices: ZL2004, ZL8101, ZL9101
Command Code: 0xF8
Type: R/W byte - Protectable
Data Length in Bytes: 1
Data Format: Section 10.5.1 - Custom (PMBus Spec Part II)
Factory Value: 0xBF (Retry always, max delay)
Units: Retry time = 8.2ms/LSB, Delay = 10ms/LSB
Reference: Section 15.24 - PMBus Spec Part II and Table 1 on page 14
Definition: Configures the V_{MON} overvoltage fault response.
Note: The delay time is the time between restart attempts

VMON_UV_FAULT_RESPONSE

Devices: ZL2004, ZL8101, ZL9101
Command Code: 0xF9
Type: R/W byte - Protectable
Data Length in Bytes: 1
Data Format: Section 10.5.1 - Custom (PMBus Spec Part II)
Factory Value: 0xBF (Retry always, max delay)
Units: Retry time = 8.2ms/LSB, Delay = 10ms/LSB
Reference: Section 15.24 - PMBus Spec Part II and Table 1 on page 14
Definition: Configures the V_{MON} undervoltage fault response.
Note: The delay time is the time between restart attempts

OVUV_CONFIG

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xD8

Type: R/W byte - Protectable

Data Length in Bytes: 1

Data Format: Custom (See Table 2)

Factory Value: 0x80

Units: N/A

Reference:

Definition: Configures the output voltage OV and UV fault detection feature as given in Table 2.

TABLE 2. OV AND UV FAULT DETECTION FEATURE CONFIGURATION

BITS	PURPOSE	VALUE	DESCRIPTION
7	Controls how an OV fault response shutdown sets the output driver state	0	An OV fault does not enable the low-side power device
		1	An OV fault enables the low-side power device
6:4	Reserved	-	
3:0	Defines the number of consecutive limit violations required to declare an OV or UV fault	N	N+1 consecutive OV or UV violations initiate a fault response

Time Setting Commands

TON_DELAY

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x60

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value:

ZL6100, ZL2006: Pin-strap setting value (DLY1:DLY0)

ZL2004: Pin-strap setting value (SS)

Units: ms

Reference: Section 16.1 - PMBus Spec Part II

Definition: Sets the delay time from ENABLE to start of V_{OUT} rise. The delay time setting can range from 0ms up to 500s, in steps of 125ns. Refer to device datasheet for specified accuracy.

TON_RISE

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x61

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: Pin-strap setting value (SS)

Units: ms

Reference: Section 16.2 - PMBus Spec Part II

Definition: Sets the rise time of V_{OUT} after ENABLE and TON_DELAY. The rise time setting can range from 0ms to 200ms, in steps of 12.5µs. Refer to device datasheet for specified accuracy.

TOFF_DELAY

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x64

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: 1 x TON_DELAY

Units: ms

Reference: Section 16.5 - PMBus Spec Part II

Definition: Sets the delay time from DISABLE to start of V_{OUT} fall. The delay time setting can range from 0ms up to 500s, in steps of 125ns. Refer to device datasheet for specified accuracy.

TOFF_FALL

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x65

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: 1 x TON_RISE

Units: ms

Reference: Section 16.6 - PMBus Spec Part II

Definition: Sets the fall time for V_{OUT} after DISABLE and TOFF_DELAY. The fall time setting can range from 0ms to 200ms, in steps of 12.5µs. Refer to device datasheet for specified accuracy.

POWER_GOOD_DELAY

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xD4

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: Pin-strap setting value 1 x TON_RISE

Units: ms

Reference:

Definition: Sets the delay applied between the output exceeding the PG threshold (POWER_GOOD_ON) and asserting the PG pin. The factory value is equal to TON_RISE. The delay time can range from 0ms up to 500s, in steps of 125ns. A 1ms minimum configured value is recommended to apply proper debounce to this signal.

Status Commands

CLEAR_FAULTS

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x03

Type: Send Byte

Data Length in Bytes: 0

Data Format: N/A

Factory Value: N/A

Units: N/A

Reference: Section 15.1 - PMBus Spec Part II

Definition: Clears fault indications.

STATUS_BYTE

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0x78
Type: Read byte
Data Length in Bytes: 1
Data Format: Custom
Factory Value: 0x00
Units: N/A
Reference: Section 17.1 - PMBus Spec Part II
Definition: Returns an abbreviated status for fast reads.

STATUS_WORD

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0x79
Type: Read word
Data Length in Bytes: 2
Data Format: Custom
Factory Value: 0x0000
Units: N/A
Reference: Section 17.2 - PMBus Spec Part II
Definition: Returns the general status information used to indicate subsequent status to be read for more detail.

STATUS_VOUT

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0x7A
Type: Read byte
Data Length in Bytes: 1
Data Format: Custom
Factory Value: 0x00
Units: N/A
Reference: Section 17.3 - PMBus Spec Part II
Definition: Returns the V_{OUT} specific status.

STATUS_IOUT

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0x7B
Type: Read byte
Data Length in Bytes: 1
Data Format: Custom
Factory Value: 0x00
Units: N/A
Reference: Section 17.4 - PMBus Spec Part II
Definition: Returns the I_{OUT} specific status.

STATUS_INPUT

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0x7C
Type: Read byte
Data Length in Bytes: 1
Data Format: Custom
Factory Value: 0x00
Units: N/A
Reference: Section 17.5 - PMBus Spec Part II
Definition: Returns specific status specific to the input.

STATUS_TEMPERATURE

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0x7D
Type: Read byte
Data Length in Bytes: 1
Data Format: Custom
Factory Value: 0x00
Units: N/A
Reference: Section 17.6 - PMBus Spec Part II
Definition: Returns the temperature specific status.

STATUS_CML

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0x7E
Type: Read byte
Data Length in Bytes: 1
Data Format: Custom
Factory Value: 0x00
Units: N/A
Reference: Section 17.7 - PMBus Spec Part II
Definition: Returns the Communication, Logic and Memory specific status.

STATUS_MFR_SPECIFIC

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x80

Type: Read byte

Data Length in Bytes: 1

Data Format: Custom

Factory Value: 0x00

Units: N/A

Reference: Section 17.9 - PMBus Spec Part II

Definition: Returns the Communication, Logic and Memory specific status. VMON fault and warning bits only apply to the ZL2004. The VMON warn thresholds are set according to Equations 3 and 4:

$$\text{VMON\_UV Warn Limit} = 110\% \times \text{VMON\_UV\_FAULT\_LIMIT} \quad \text{(EQ. 3)}$$

$$\text{VMON\_OV Warn Limit} = 90\% \times \text{VMON\_OV\_FAULT\_LIMIT} \quad \text{(EQ. 4)}$$

TABLE 3.

BIT	FAULT MEANING
7	Reserved
6	Reserved
5	VMON UV Warning
4	VMON OV Warning
3	External Switching Period Fault (t_{SW}); indicates loss of external SYNC clock.
2	Reserved
1	VMON UV Fault
0	VMON OV Fault

Monitor Commands

READ_VIN

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x88

Type: Read word

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: N/A

Units: V

Reference: Section 18.1 - PMBus Spec Part II

Definition: Returns the input voltage reading. The device will NACK this command when not enabled and not in the USER_CONFIG monitor mode.

READ_VOUT

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x8B

Type: Read word

Data Length in Bytes: 2

Data Format: Section 8.3.1 - PMBus Spec Part II - VOUT Linear Mode

Factory Value: N/A

Units: V

Reference: Section 18.4 - PMBus Spec Part II

Definition: Returns the output voltage reading. The device will NACK this command when not enabled and not in the USER_CONFIG monitor mode.

READ_IOUT

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x8C

Type: Read word

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: N/A

Units: A

Reference: Section 18.5 - PMBus Spec Part II

Definition: Returns the output current reading. The device will NACK this command when not enabled and not in the USER_CONFIG monitor mode.

READ_TEMPERATURE_1

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x8D

Type: Read word

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: N/A

Units: °C

Reference: Section 18.6 - PMBus Spec Part II

Definition: Returns the temperature reading internal to the device. The device will NACK this command when not enabled and not in the USER_CONFIG monitor mode.

READ_TEMPERATURE_2

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x8E

Type: Read word

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: N/A

Units: °C

Reference: Section 18.6 - PMBus Spec Part II

Definition: Returns the reading from the external temperature device connected to XTEMP. The device will NACK this command when not enabled and not in the USER_CONFIG monitor mode.

READ_DUTY_CYCLE

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x94

Type: Read word

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: N/A

Units: %

Reference: Section 18.9 - PMBus Spec Part II

Definition: Returns the target duty cycle during the ENABLE state. The device will NACK this command when not enabled and not in the USER_CONFIG monitor mode.

READ_FREQUENCY

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x95

Type: Read word

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: N/A

Units: kHz

Reference: Section 18.10 - PMBus Spec Part II

Definition: Returns the measured operating switch frequency. The device will NACK this command when not enabled and not in the USER_CONFIG monitor mode.

MFR_READ_VMON

Devices: ZL2004, ZL8101, ZL9101

Command Code: 0xF7

Type: Read word

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: N/A

Units: V

Definition: Returns the value equal to 16x the voltage applied to the VMON pin. Devices will NACK this command when not enabled or not in the monitor mode (see "USER_CONFIG" on page 28).

SNAPSHOT_CONTROL

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xF3

Type: R/W byte

Data Length in Bytes: 1

Data Format: Custom

Factory Value: N/A

Units: N/A

Definition:

Writing a 1 will cause the device to copy the current SNAPSHOT values from flash to the 32-byte SNAPSHOT command parameter.

Writing a 2 will cause the device to write the current SNAPSHOT values to a set location in flash.

All other values will be ignored.

SNAPSHOT

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0xEA
Type: Block Read
Data Length in Bytes: 32
Data Format: Custom
Factory Value: N/A
Units: N/A
Definition: The SNAPSHOT command is a 32-byte read-back of parametric and status values.

TABLE 4.

BYTE NUMBER	VALUE	FORMAT
31:22	Reserved	0x00
21	Manufacturer Specific Status Byte	Byte
20	CML Status Byte	Byte
19	Temperature Status Byte	Byte
18	Input Status Byte	Byte
17	I_{OUT} Status Byte	Byte
16	V_{OUT} Status Byte	Byte
15:14	Switching Frequency	Linear Data Format
13:12	External Temperature	Linear Data Format
11:10	Internal Temperature	Linear Data Format
9:8	Duty Cycle	Linear Data Format
7:6	Peak Current	Linear Data Format
5:4	Load Current	Linear Data Format
3:2	V_{OUT}	V_{OUT} linear mode
1:0	V_{IN}	Linear Data Format

Identification Commands

DEVICE_ID

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0xE4
Type: Block Read
Data Length in Bytes: 16
Data Format: ASCII
Factory Value: <part number/die revision/firmware revision>
Units: N/A
Reference: N/A
Definition: Returns the 16-byte (character) device identifier string.

PMBUS_REVISION

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x98

Type: Read byte

Data Length in Bytes: 1

Data Format: Hex

Factory Value: <revision implemented>

Units: N/A

Reference: Section 22.1 - PMBus Spec Part II

Definition: Returns the revision of the PMBus implemented in the device.

MFR_ID

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x99

Type: Block R/W - Protectable

Data Length in Bytes: User defined

Data Format: ASCII

Factory Value: Null

Units: N/A

Reference: Section 22.2 - PMBus Spec Part II

Definition: Sets a user defined identification. The sum total of characters in MFR_ID, MFR_MODEL, MFR_REVISION, MFR_LOCATION, MFR_DATE, MFR_SERIAL and USER_DATA_00 plus one byte per command cannot exceed 128 characters. This limitation includes multiple writes of this command before a STORE command. To clear multiple writes, perform a RESTORE, write this command then perform a STORE/RESTORE.

MFR_MODEL

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x9A

Type: Block R/W - Protectable

Data Length in Bytes: User defined

Data Format: ASCII

Factory Value: Null

Units: N/A

Reference: Section 22.2.2 - PMBus Spec Part II

Definition: Sets a user defined model. The sum total of characters in MFR_ID, MFR_MODEL, MFR_REVISION, MFR_LOCATION, MFR_DATE, MFR_SERIAL and USER_DATA_00 plus one byte per command cannot exceed 128 characters. This limitation includes multiple writes of this command before a STORE command. To clear multiple writes, perform a RESTORE, write this command then perform a STORE/RESTORE.

MFR_REVISION

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x9B

Type: Block R/W - Protectable

Data Length in Bytes: User defined

Data Format: ASCII

Factory Value: Null

Units: N/A

Reference: Section 22.2.3 - PMBus Spec Part II

Definition: Sets a user defined revision. The sum total of characters in MFR_ID, MFR_MODEL, MFR_REVISION, MFR_LOCATION, MFR_DATE, MFR_SERIAL and USER_DATA_00 plus one byte per command cannot exceed 128 characters. This limitation includes multiple writes of this command before a STORE command. To clear multiple writes, perform a RESTORE, write this command then perform a STORE/RESTORE.

MFR_LOCATION

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x9C

Type: Block R/W - Protectable

Data Length in Bytes: User defined

Data Format: ASCII

Factory Value: Null

Units: N/A

Reference: Section 22.2.4 - PMBus Spec Part II

Definition: Sets a user defined location identifier. The sum total of characters in MFR_ID, MFR_MODEL, MFR_REVISION, MFR_LOCATION, MFR_DATE, MFR_SERIAL and USER_DATA_00 plus one byte per command cannot exceed 128 characters. This limitation includes multiple writes of this command before a STORE command. To clear multiple writes, perform a RESTORE, write this command then perform a STORE/RESTORE.

MFR_DATE

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x9D

Type: Block R/W - Protectable

Data Length in Bytes: User defined

Data Format: ASCII

Factory Value: Null

Units: N/A

Reference: Section 22.2.5 - PMBus Spec Part II

Definition: Sets a user defined date. The sum total of characters in MFR_ID, MFR_MODEL, MFR_REVISION, MFR_LOCATION, MFR_DATE, MFR_SERIAL and USER_DATA_00 plus one byte per command cannot exceed 128 characters. This limitation includes multiple writes of this command before a STORE command. To clear multiple writes, perform a RESTORE, write this command then perform a STORE/RESTORE.

MFR_SERIAL

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x9E

Type: Block R/W - Protectable

Data Length in Bytes: User defined

Data Format: ASCII

Factory Value: Null

Units: N/A

Reference: Section 22.2.6 - PMBus Spec Part II

Definition: Sets a user defined serialized identifier. The sum total of characters in MFR_ID, MFR_MODEL, MFR_REVISION, MFR_LOCATION, MFR_DATE, MFR_SERIAL and USER_DATA_00 plus one byte per command cannot exceed 128 characters. This limitation includes multiple writes of this command before a STORE command. To clear multiple writes, perform a RESTORE, write this command then perform a STORE/RESTORE.

USER_DATA_00

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xB0

Type: Block R/W - Protectable

Data Length in Bytes: User defined

Data Format: ASCII

Factory Value: Null

Units: N/A

Reference: Section 23 - PMBus Spec Part II

Definition: Sets a user defined data. The sum total of characters in MFR_ID, MFR_MODEL, MFR_REVISION, MFR_LOCATION, MFR_DATE, MFR_SERIAL and USER_DATA_00 plus one byte per command cannot exceed 128 characters. This limitation includes multiple writes of this command before a STORE command. To clear multiple writes, perform a RESTORE, write this command then perform a STORE/RESTORE.

Other Configuration Commands

MFR_CONFIG

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xD0

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Custom

Factory Value:

ZL2006, ZL6100: 0xAA01 (Bits 15:8 and 5:4 set by ILIM1 pin-strap)
ZL2008, ZL6105: 0xAA04 (Bits 5:4 set by CFG2 pin-strap)
ZL2004, ZL8101, ZL9101: 0x6A15 (Bits 5:4 set by ILIM1 pin-strap in ZL8101, ZL9101)

ZL2101, ZL2103, ZL2106: 0x4A01

Definition: Configures several manufacturer-level features. The data field is defined in Table 5.

TABLE 5.

BITS	PURPOSE	VALUE	DESCRIPTION
15:11	Current Sense Blanking Delay	D	Sets the delay, D, in 32ns steps
10:8	Current Sense Fault Count	C	Sets the number of consecutive OC or UC violations required for a fault to 2C+1.
7	Enable XTEMP Measurements	0	No temperature measurements are performed on XTEMP
		1	Temperature measurements are performed on XTEMP
6	Temperature Sensor Control (Note 1)	0	The internal temperature sensor is used for warning and fault checks
		1	An external 2N3904 NPN on XTEMP is used for warning and fault checks
5:4	Current Sense Control	00	Current sense uses GND-referenced, down-slope sense (Note 2)
		01	Current sense uses VOUT-referenced, down-slope sensing (Note 3)
		10	Current sense uses VOUT-referenced, up-slope sensing (Note 3)
		11	Reserved
3	NLR During Ramp	0	Wait for PG
		1	Always on
2	Alternate Ramp Control (Note 4)	0	Alternate ramp disabled
		1	Alternate ramp enabled
1	PG Pin Output Control	0	PG is open drain
		1	PG is push-pull
0	SYNC Pin Output Control	0	SYNC is open drain
		1	SYNC is push-pull

NOTES:

1. When selecting XTEMP (Bit 6), be sure to have the XTEMP enabled in Bit 7.
2. Not available on ZL2004.
3. Not available on the ZL2101, ZL2103, or ZL2106.
4. Only available on ZL2006. Always enabled on all other devices.

USER_CONFIG

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101
Command Code: 0xD1
Type: R/W word - Protectable
Data Length in Bytes: 2
Data Format: Custom
Factory Value: 0x0000 (bits 6:5 set by CFG pin-strap setting)
Units: N/A
Reference:
Definition: Configures several user-level features. The data field is defined Table 6. This command overrides the CONFIG pin settings.

TABLE 6.

BITS	PURPOSE	VALUE	DESCRIPTION
15:14	Minimum Duty Cycle	N	Sets the minimum duty cycle ((N+1)/(2^8)) during a ramp when “Minimum Duty Cycle” (Bit 13) is enabled. For example, if minimum duty cycle input N is set to 3, the minimum duty cycle is $(3+1)/(2^8) = (1/64)$.
13	Minimum Duty Cycle Control	0	Minimum duty cycle is disabled
		1	Minimum duty cycle is enabled
12	Alternate Ramp Down	0	Output follows TOFF_FALL ramp time
		1	Output is set to high impedance/open mode during ramp down VOUT_UV threshold is reached
11	SYNC Time-Out Enable	0	SYNC output remains on after device is disabled
		1	SYNC turns off 500ms after device is disabled
10	Reserved	-	Reserved
9	PID Feed-Forward Control	0	PID Coefficients are corrected for VDD variation
		1	PID Coefficients are not corrected for VDD variations
8	Fault Spreading Mode	0	If sequencing is disabled, this device will ignore faults from other devices. If sequencing is enabled, the devices will sequence down from the failed device outward.
		1	Faults received from any device selected by the DDC_GROUP command will cause this device to shut down immediately.
7	SMBus Transmit Clk Rate	0	SMBus transmit is always disabled in DDC devices
6	SYNC Utilization Control	0	Auto-configure using the SYNC pin and FREQUENCY_SWITCH parameter
		1	Switch using the SYNC input
5	SYNC Output Control	0	Configure the SYNC pin as an input-only
		1	Drive the switch clock out of SYNC when using the internal oscillator
4	SMBus Transmit Inhibit	0	SMBus transmit is always disabled in DDC devices
3	SMBus Timeout Inhibit	0	SMBus transmit is always disabled in DDC devices
2	OFF Low-Side Control	0	The low-side drive is off when device is disabled
		1	The low-side drive is on when device is disabled
1:0	Standby Mode	00	Enter low-power mode when device is disabled (no READ_xxxx data available)
		01	Monitor for faults when device is disabled (READ_xxxx data available)
		10	Reserved
		11	Monitor for faults using pulsed mode. (READ_xxxx data available upon read command)

MISC_CONFIG

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xE9

Type: R/W word – Protectable

Data Length in Bytes: 2

Data Format: Custom

Factory Value:

ZL2004, ZL8101, ZL9101: 0x0000 (bits 11:10 set by ILIM pin-strap)

ZL2006, ZL2008, ZL6100, ZL6105: 0x0000

ZL2004, ZL8101, ZL9101: 0x6A15 (bits 5:4 set by ILIM1 pin-strap in ZL8101, ZL9101)

ZL2101, ZL2103, ZL2106: 0x4A01

Definition: This command sets options pertaining to advanced features. The format of this command is shown in Table 7.

TABLE 7.

DEVICE(s)	BITS	PURPOSE	VALUE	DESCRIPTION	
All	15	Broadcast Margin (see DDC_CONFIG)	0	Disabled	
			1	Enabled	
All	14	Broadcast Enable (see DDC_CONFIG)	0	Disabled	
			1	Enabled	
ZL2004, ZL2006, ZL6100, ZL9101	13	Adaptive Compensation Enable	0	Disabled	
			1	Enabled	
ZL2008, ZL6105		Phase Enable Select	0	Use PH_EN pin to add/drop current-share phases.	
			1	Use PHASE_CONTROL command to add/drop phases.	
ZL2101, ZL2103, ZL2106, ZL8101		Reserved	0	Reserved	
All	12	Reserved	0	Reserved	
ZL2004, ZL8101, ZL9101	11:10	I-Sense Gain Factor	00	DCR = 25mV, $r_{DS(ON)}$ = 25mV	($r_{DS(ON)}$ current sense not available on ZL2004.)
			01	DCR = 35mV, $r_{DS(ON)}$ = 50mV	
			10	DCR = 50mV, $r_{DS(ON)}$ = 100mV	
			11	Reserved	
ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105		Reserved	00	Reserved	
ZL2004, ZL2006, ZL6100, ZL9101	9	Adaptive Compensation Update Rate	M	Taps are updated every (9*M + 3) ms	
ZL2008, ZL2101, ZL2103, ZL2106, ZL6105, ZL8101		Reserved	0	Reserved	
ZL2008	8	I_{OUT} Blanking Delay and IOUT_OMEGA_OFFSET Calibration Calculations	0	Disabled	
			1	Enabled	
ZL2004, ZL2006, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101		Reserved	0	Reserved	
ZL2004, ZL2006, ZL2008,ZL2103, ZL2106, ZL6100, ZL9101	7	Precise Ramp-Up Delay	0	Monitor mode enabled creating a more accurate delay time. This mode also enables certain circuits that may affect standby power.	
			1	Normal, low standby power, delay operation	
ZL2101, ZL6105, ZL8101			X	Enabled when Auto-Comp is enabled, disabled when Auto-Comp is disabled and the device is in Low-Power Standby Mode	

TABLE 7. (Continued)

DEVICE(s)	BITS	PURPOSE	VALUE	DESCRIPTION
ZL2004, ZL2006, ZL2008, ZL6100, ZL6105, ZL8101, ZL9101	6	Diode Emulation	0	Disabled
			1	Enabled, enter diode emulation at light loads to improve efficiency
ZL2101, ZL2103, ZL2106		Reserved	0	Reserved
ZL2004, ZL2006, ZL2101, ZL2103, ZL2106, ZL6100, ZL8101, ZL9101	5:3	Adaptive Compensation Half-Ripple Current Factor	N	Determines upper load point for Adaptive Compensation: $I_{LOAD2} = C * I_{RIPPLE}/2$, where $C = 2^{(N+1)} + 1$, as shown below: N: 0 1 2 3 4 5 6 7 C: 3 5 9 17 33 65 129 257
ZL2008, ZL6105		Reserved	0	Reserved
ZL2006, ZL2008, ZL6100, ZL6105	2	Minimum GL Pulse	0	Disabled
			1	Enabled, GL pulse width limited to 10% * t_{SW} minimum during diode emulation.
ZL2004, ZL2101, ZL2103, ZL2106, ZL8101, ZL9101		Reserved	0	Reserved
All	1	Snapshot	0	Disabled
			1	Enabled
ZL2004, ZL2006, ZL2008, ZL6100	0	Adaptive Frequency	0	Disabled, f_{SW} fixed
			1	Enabled
ZL2101, ZL2103, ZL2106, ZL6105, ZL8101, ZL9101		Reserved	0	Reserved

PID_TAPS

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xD5

Type: Block R/W - Protectable

Data Length in Bytes: 9

Data Format: Custom

Factory Value:

ZL2006, ZL2008, ZL6100: Pin-strap setting value (FC1:FC0)

ZL2004, ZL2103, ZL2106, ZL9101: Pin-strap setting value (FC)

ZL2101, ZL6105, ZL8101:

Auto Comp Off, taps stored – (A,B,C) = stored values

Auto Comp Off, no taps stored – (A,B,C) correspond to (G,Q,fn) = (20dB, 2, fsw/10)

Auto Comp On – (A,B,C) = Auto Comp results

Units: N/A

Reference: AN2035 – Compensation Using CompZL™

Definition: For all devices except the ZL2008, this command configures the control loop compensator coefficients. For the ZL2008, these are the baseline taps used as a multiplier for calculating PID_TAPS_CALC, and should not be changed.

The PID algorithm implements the following Z-domain function in Equation 5:

$$\frac{A + Bz^{-1} + Cz^{-2}}{1 - z^{-1}} \quad \text{(EQ. 5)}$$

The coefficients A, B, and C are represented using a pseudo-floating point format similar to the V_{OUT} parameters (with the addition of a sign bit), defined as Equation 6:

$$A = (-1)^{S} \bullet 2^{E} \bullet M \quad \text{(EQ. 6)}$$

Where M is a two-byte unsigned mantissa, S is a sign-bit, and E is a 7-bit two's-complement signed integer. The 9-byte data field is defined in Table 8. S is stored as the MSB of the E byte.

TABLE 8.

BYTE	PURPOSE	DEFINITION
8	Tap C - E	Coefficient C exponent + S
7	Tap C - M [15:8]	Coefficient C mantissa, high-byte
6	Tap C - M [7:0]	Coefficient C mantissa, low-byte
5	Tap B - E	Coefficient B exponent + S
4	Tap B - M [15:8]	Coefficient B mantissa, high-byte
3	Tap B - M [7:0]	Coefficient B mantissa, low-byte
2	Tap A - E	Coefficient A exponent + S
1	Tap A - M [15:8]	Coefficient A mantissa, high-byte
0	Tap A - M [7:0]	Coefficient A mantissa, low-byte

NOTE: Data bytes are transmitted on the PMBus in the order of Byte 0 through Byte 8.

PID_TAPS_ADAPT

Devices: ZL2004, ZL2006, ZL6100, ZL9101

Command Code: 0xF2

Type: Block R/W - Protectable

Data Length in Bytes: 9

Data Format: Custom (see "PID_TAPS" on page 31).

Factory Value:

ZL2006, ZL6100: Pin-strap setting value (FC1:FC0)

ZL2004, ZL9101: Pin-strap setting value (FC)

Units: N/A

Reference: AN2035 – Compensation Using CompZL™

Definition: The PID_TAPS_ADAPT command is set to the calculated taps for an average load current equal to a multiple of one-half of the ripple current. The command follows the same format as the PID_TAPS (see "PID_TAPS" on page 31) and is used by the adaptive compensation algorithm over varying load.

The algorithm uses a linear interpolation to adjust operating Taps A, B, and C, with respect to the average load current. Two optimal sets of taps are required. One set of taps corresponds to $I_{RIPPLE}/2$, which is configured by the PID_TAPS command, while the other set is configured by the PID_TAPS_ADAPT command and corresponds to c*Iripple/2 where c is the Half-Ripple Factor, $(2^{(N+1)} + 1)$, and is configured using the Adaptive Compensation Half-Ripple Factor field (N, bits 5:3) in MISC_CONFIG.

PID_TAPS_CALC

Devices: ZL2008

Command Code: 0xF2

Type: Block R/W - Protectable

Data Length in Bytes: 9

Data Format: Custom (see "PID_TAPS" on page 31).

Factory Value: Pin-strap setting value (FC1:FC0)

Units: N/A

Reference: AN2035 – Compensation Using CompZL™; ZL2008 Datasheet

Definition: The ZL2008 pinstrap settings are used as indexes into lookup tables to determine factors to multiply times the baseline taps in PID_TAPS. The result of these operations may be read back in PID_TAPS_CALC, and are used to configure the control loop compensator coefficients. The user may override this feature by saving his preferred taps in PID_TAPS_CALC in the User or Default Store. Tables for specifying compensation coefficients by pinstrap are shown in the ZL2008 Datasheet.

IOUT_OMEGA_OFFSET

Devices: ZL2008

Command Code: 0xBE

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: 0

Units: N/A

Reference:

Definition: If the current sense element (ex: LS FET for $r_{DS(ON)}$-sensing or RC filter capacitor for DCR-sensing) has significant parasitic series inductance in the package or layout, an offset in measured current results from the inductive-divider with the output filter inductor. This measurement offset is proportional to output voltage and inversely proportional to the current sense element resistance.

$$I_{OUT,\ measurement\ offset} = \frac{V_{out}}{IOUT\_CAL\_GAIN(m\Omega)} \cdot IOUT\_OMEGA\_OFFSET$$

An offset factor, IOUT_OMEGA_OFFSET, may be calculated as the inductive divider ratio.

$$IOUT\_OMEGA\_OFFSET = \frac{Lcs_{pkg}}{Lcs_{pkg} + L_{out}}$$

A value of zero for IOUT_OMEGA_OFFSET effectively disables the inductive-divider measured current offset calculation.

INDUCTOR

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xD6

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Section 7.1 - PMBus Spec Part II - Linear Data Format

Factory Value: 0xB23D (0.56µH)

Units: µH

Reference: AN2035 – Compensation Using CompZL™

Definition: Informs the device of circuit's inductor value. This is used in adaptive algorithm calculations relating to the inductor ripple current.

NLR_CONFIG

Devices: ZL2004, ZL2006, ZL2008, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xD7

Type: Block R/W - Protectable

Data Length in Bytes: 4

Data Format: Custom

Factory Value:

ZL6100, ZL2006: Pin-strap setting value (FC1:FC0)

ZL2004: Pin-strap setting value (FC)

Units: N/A

Reference: AN2032 - NLR Configuration for DDC Products

Definition: Configures the Nonlinear Response (NLR) control parameters. The 4-byte data field is defined in Table 9. Not available on the ZL2101, ZL2103, or ZL2106.

TABLE 9.

BITS	PURPOSE	VALUE	DESCRIPTION
31:30	Outer threshold multiplier	O	Sets multiplier of inner threshold for outer threshold setting, O * LI and O * UI
29:27	NLR comparator threshold: Loading-Inner	LI	Sets inner threshold for a loading event to ~0.5% * (LI + 1) * V_{OUT}
26:24	NLR comparator threshold: Unloading-Inner	UI	Sets inner threshold for an unloading event to ~0.5% * (UI + 1) * V_{OUT}
23:20	Loading-Outer Threshold Maximum Correction Time	LOT	Sets outer threshold, maximum correction time for a loading event to LOT * t_{SW}/64 (s)
19:16	Loading-Inner Threshold Maximum Correction Time	LIT	Sets inner threshold, maximum correction time for a loading event to LIT * t_{SW}/64 (s)
15:12	Unloading-Outer Threshold Maximum Correction Time	UOT	Sets outer threshold, maximum correction time for an unloading event to UOT * t_{SW}/64 (s)
11:8	Unloading-Inner Threshold Maximum Correction Time	UIT	Sets inner threshold, maximum correction time for an unloading event to UIT * t_{SW}/64 (s)
7:4	Load Blanking time control	LB	Sets NLR blanking time for a loading event as described in Table 10.
3:0	Unload Blanking time control	UB	Sets NLR blanking time for an unloading event as described in Table 10.

TABLE 10. LOADING/UNLOADING BLANKING TIMES

LB OR UB	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
t_{SW}/64 UNITS	1	2	3	5	9	17	33	49	65	81	97	129	161	177	193	225

TEMPCO_CONFIG

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xDC

Type: R/W byte - Protectable

Data Length in Bytes: 1

Data Format: Custom

Factory Value: ZL2006, ZL2004 0x2C (4400ppm/°C) (see Note 5)

Definition: Configures the correction factor and temperature measurement source when performing temperature coefficient correction for current sense. Current sense scale is corrected for external FET controllers and the current sense offset is corrected for internal FET controllers. The command parameter has the following format as shown in Table 11.

To determine the hex value of the Tempco Correction factor (TC) for current scale of a power stage using $r_{DS(ON)}$ current sensing, first determine the temperature coefficient of resistance for the conductor, α. This is found with Equation 7:

$$\alpha = \frac{R_{REF} - R}{R_{REF}(T_{REF} - T)} \quad \text{(EQ. 7)}$$

Where: R = Conductor resistance at temperature “T”

R_{REF} = Conductor resistance at reference temperature T_{REF}

α = Temperature coefficient of resistance for the conductor material

T = Temperature measured by temperature sensor, in °C

T_{REF} = Reference temperature that α is specified at for the conductor material

After α is determined, convert the value in units of 100ppm/°C. This is done with Equation 8:

This value is then converted to a hex value.

$$TC = \frac{\alpha \times 10^6}{100} \quad \text{(EQ. 8)}$$

Note: TEMPCO_CONFIG values are applied as negative correction to a positive temperature coefficient.

TABLE 11.

BITS	PURPOSE	VALUE	DESCRIPTION
7	Selects the temp sensor source for tempco correction (Note 6)	0	Selects the internal temperature sensor
		1	Selects the XTEMP pin for temperature measurements (2N3904 junction typical)
6:0	Sets tempco correction in units of 100ppm/°C for IOUT_CAL_GAIN and 100µA/ °C for IOUT_CAL_OFFSET	TC	$R_{SEN\ (EXT\ rDSON\ and\ DCR)}$ = IOUT_CAL_GAIN x (1+TC x (T-25)) where R_{SEN} = resistance of sense element
			$R_{SEN\ (INT\ FET)}$ = IOUT_CAL_OFFSET x (1+TC x 10^{-4} x (T-25)) where R_{SEN} = resistance of sense element

NOTES:

5. Typical temperature coefficients are ~3900ppm/°C (0x27) for copper and ~4800ppm/°C (0x30) for silicon.
6. When selecting XTEMP (bit 7), be sure to have the XTEMP enabled in MFR_CONFIG, bit 7.

AUTO_COMP_CONTROL

Devices: ZL2101, ZL6105, ZL8101

Command Code: 0xBD

Type: Send Byte - Protectable

Data Length in Bytes: 0

Data Format: N/A

Factory Value: N/A

Units: N/A

Reference:

Definition: Causes the Auto Comp algorithm to initiate, if the Auto Comp feature is enabled in AUTO_COMP_CONFIG.

AUTO_COMP_CONFIG

Devices: ZL2101, ZL6105, ZL8101

Command Code: 0xBC

Type: R/W byte - Protectable

Data Length in Bytes: 1

Data Format: Custom

Factory Value:

ZL6105: Pin-strap setting value (FC1:FC0)

ZL2101, ZL8101: Pin-strap setting value (FC)

Units: N/A

Reference: Device datasheets

Definition: Controls configuration of Auto Compensation features. The data field is defined in Table 12.

TABLE 12.

BITS	PURPOSE	VALUE	DESCRIPTION
7:4	Auto Comp Gain Percentage	G	Scale the Gain of the Auto-Compensation results by a factor of (G+1)*10%, where 0 ≤ G ≤ 9. G = 0 yields lowest jitter; G = 9 yields tightest transient response.
3	Power Good Assertion	0	Use PG_DELAY
		1	Assert PG after Auto-Comp completes
2	Auto Comp Store	0	Do not store Auto-Comp results
		1	Store Auto-Comp results for use on future ramps
1:0	Auto Comp Mode	0	Off (Disabled). Compensation stored in PID_TAPS will be used.
		1	Once (results are storable)
		2	Repeat every ~1 second (only the first results are storable)
		3	Repeat every ~1 minute (only the first results are storable)

DEADTIME

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xDD

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Custom – two 2's complement bytes

Factory Value:

ZL2004: 0x0808; ZL2006: 0x3C20; ZL2101, ZL2103, ZL2106: 0x101C;

ZL2008, ZL6100, ZL6105, ZL8101, ZL9101: 0x0000;

Units: ns

Reference: N/A

Definition: Sets the non-overlap between PWM transitions using a 2-byte data field. The most-significant byte controls the high-side to low-side dead time value as a single 2's-complement signed value in units of ns. The least-significant byte controls the low-side to high-side dead time value. Positive values imply a non-overlap of the FET drive on-times. Negative values imply an overlap of the FET drive on-times. The default value of the maximum dead time for the adaptive dead time algorithm is 60ns. Writing a value to this command immediately before writing the DEADTIME_CONFIG command will set a new maximum for the adaptive dead time algorithm. The device will operate at the dead time values written to this command when adaptive dead time is disabled.

DEADTIME_CONFIG

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xDE

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Custom

Factory Value:

ZL2004: 0x8484; ZL2101, ZL2103, ZL2106: 0x8288;

ZL2006, ZL2008, ZL6100, ZL6105, ZL8101, ZL9101: 0x0404;

Units: N/A

Reference: N/A

Definition: Configures the dead time optimization mode. Also sets the minimum dead time value for the adaptive dead time mode range. The data field is described in Table 13.

TABLE 13.

BITS	PURPOSE	VALUE	DESCRIPTION
15	Sets the high to low transition dead time mode	0	Adaptive HIGH to LOW dead time control
		1	Freeze the HIGH to LOW dead time.
14:8	Sets the minimum HIGH to LOW dead time of the dynamic mode range	H	Limits the minimum allowed HIGH to LOW dead time to H x 2ns (signed)
7	Sets the low to high transition dead time mode	0	Adaptive LOW to HIGH dead time control
		1	Freezes the LOW to HIGH dead time
6:0	Sets the minimum LOW to HIGH dead time of the dynamic mode range	L	Limits the minimum allowed LOW to HIGH dead time to L x 2ns (signed)

DEADTIME_MAX

Devices: ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xBF

Type: R/W Word - Protectable

Data Length in Bytes: 2

Data Format: Custom

Factory Value:

ZL2008, ZL6100, ZL6105, ZL8101, ZL9101: 0x3838

ZL2101, ZL2103, ZL2106: 0x2424

Units: N/A

Reference: N/A

Definition: Sets the maximum dead time value for the adaptive dead time mode range. The data field is described in Table 14.

TABLE 14.

BITS	PURPOSE	VALUE	DESCRIPTION
15	N/A	0	
14:8	Sets the maximum HIGH to LOW dead time of the dynamic mode range	H	Limits the maximum allowed HIGH to LOW dead time to H x 2ns (signed)
7	N/A	0	
6:0	Sets the maximum LOW to HIGH dead time of the dynamic mode range	L	Limits the maximum allowed LOW to HIGH dead time to L x 2ns (signed)

Group Commands

SEQUENCE

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xE0

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Custom

Factory Value: Pin-strap setting value (CFG)

Units: N/A

Reference:

Definition: Identifies the Rail DDC ID of the prequel and sequel rails when performing multi-rail sequencing. The device will enable its output (using the programmed delay values in Table 15) when its EN or OPERATION enable state, as defined by ON_OFF_CONFIG, is set and the prequel device has issued a power-good event on the DDC bus. The device will disable its output (using the programmed delay values) when the sequel device has issued a power-down event on the DDC bus.

TABLE 15.

BITS	PURPOSE	VALUE	DESCRIPTION
15	Prequel Enable	0	Disable, no prequel preceding this rail
		1	Enable, prequel to this rail is defined by bits 12:8
14:13	Reserved	0	Reserved
12:8	Prequel Rail DDC ID	0 to 31 (0x00 to 0x1F)	Set to the Rail DDC ID of the rail that should precede this device's rail in a sequence order.
7	Sequel Enable	0	Disable, no sequel following this rail
		1	Enable, sequel to this rail is defined by bits 4:0
6:5	Reserved	0	Reserved
4:0	Sequel Rail DDC ID	0 to 31 (0x00 to 0x1F)	Set to the Rail DDC ID of the rail that should follow this device's rail in a sequence order.

The data field is a two-byte value. The most-significant byte contains the 5-bit Rail DDC ID of the prequel device. The least-significant byte contains the 5-bit Rail DDC ID of the sequel device. The most significant bit of each byte contains the enable of the prequel or sequel mode. This command overrides the corresponding sequence configuration set by the CONFIG pin settings.

TRACK_CONFIG

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xE1

Type: R/W byte - Protectable

Data Length in Bytes: 1

Data Format: Custom

Factory Value:

ZL2006, ZL6100: 0x01

ZL2004, ZL2008, ZL2101, ZL2103, ZL2106, ZL6105: Pin-strap setting value (SS)

Units: N/A

Reference:

Definition: Configures the voltage tracking modes of the device. The data field is described in Table 16.

TABLE 16.

BITS	PURPOSE	VALUE	DESCRIPTION
7	Enables Voltage Tracking	0	Tracking is disabled
		1	Tracking is enabled
6:3	Reserved	-	Reserved
2	Controls the Tracking Ratio	0	Output tracks 100% of VTRK
		1	Output tracks 50% of VTRK
1	Controls Upper Track Limit	0	Output is limited by target voltage
		1	Output is limited by VTRK pin
0	Controls Ramp-Up Behavior	0	The output is not allowed to track VTRK down before power-good
		1	The output is allowed to track VTRK down before power-good

INTERLEAVE

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x37

Type: R/W word - Protectable

Data Length in Bytes: 2

Data Format: Custom

Factory Value:

Default Group Number: 0 (0x00)

Default Number in Group: 16 (0x00)

Default Position in Group: Four LSB's of SMBus address

Units: N/A

Reference: Section 14.7 - PMBus Spec Part I; AN2034 - Configuring Current Sharing on the ZL2004 and ZL2006

Definition: Configures the phase offset of a device that is sharing a common SYNC clock with other devices. Note that for Intersil devices, a value of 0 for the Number in Group field is interpreted as 16, to allow for phase spreading groups of up to 16 devices.

For current sharing rails, INTERLEAVE is used to set the initial phase of the rail. The current share devices then automatically distribute their phase relative to the INTERLEAVE setting. Refer to AN2034 for phase control rules of a current share rail.

TABLE 17.

BITS	PURPOSE	VALUE	DESCRIPTION
15:12	Reserved	0	Reserved
11:8	Group Number	0 to 15	Sets a number to a group of interleaved rails
7:4	Number in Group	16, 1 to 15 (0 = 16)	Sets the number of rails in the group A value of 0 is interpreted as 16
3:0	Position in Group	0 to 15	Sets position of the device's rail within the group

ISHARE_CONFIG

Devices: ZL2004, ZL2006, ZL2008, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xD2

Type: R/W Word - Protectable

Data Length in Bytes: 2

Data Format: Custom

Factory Value:

ZL2004, ZL2006, ZL6100, ZL8101, ZL9101: Pin-strap setting value (CFG)

ZL2008, ZL6105: Pin-strap setting value (CFG0)

Units: N/A

Reference: AN2034 - Configuring Current Sharing on the ZL2004 and ZL2006

Definition: Configures the device for current sharing communication over the DDC bus. The command format is described in Table 18.

TABLE 18.

BITS	PURPOSE	VALUE	DESCRIPTION
15:8	IShare DDC ID	0 to 31 (0x00 to 0x1F)	Sets the current share rail's DDC ID for each device within a current share rail. Set to the same DDC ID as in DDC_CONFIG. This DDC ID is used for sequencing and fault spreading when used in a current share rail.
7:5	Number of Members (Note 7)	0 to 7	Number of devices in current share rail -1. Example: 3 device current share rail, use 3 – 1 = 2
4:2	Member Position	0 to 7	Position of device within current share rail
1	Reserved	0	Reserved
0	I-Share Control	1	Device is a member of a current share rail
		0	Device is not a member of a current share rail

NOTE:

7. The following devices are appropriate for use in applications from one to seven phases: ZL2008E, ZL9101, ZL8101, ZL9117, ZL6105

PHASE_CONTROL

Devices: ZL2004, ZL2006, ZL2008, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xF0

Type: R/W Byte - Protectable

Data Length in Bytes: 1

Data Format: Custom

Factory Value: 0x00

Units: N/A

Reference: AN2034 - Configuring Current Sharing on the ZL2004 and ZL2006

Definition: This command controls Phase adding/dropping when the device is setup for current sharing. If data written to this command is 0x01, the device phase is considered active while a value of 0x00 will be interpreted as disabled or dropped phase. Any other value written to this command will be ignored.

DDC_CONFIG

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xD3

Type: R/W Word - Protectable

Data Length in Bytes: 2

Data Format: Custom

Factory Value: Broadcast Group: 0; DDC ID: Lowest five bits of the SMBus Address.

Units: N/A

Reference:

Definition: Configures the DDC bus

TABLE 19.

BITS	PURPOSE	VALUE	DESCRIPTION
15:13	Reserved	0	Reserved
12:8	Broadcast Group	0 to 31	Group number used for broadcast events. (i.e., Broadcast Enable and Broadcast Margin) Set this number to the same value for all rails/devices that should respond to each other's broadcasted event. This function is enabled by the bits 15 and 14 in the MISC_CONFIG command.
7:6	Reserved	0	Reserved
5	DDC TX Inhibit	1	DDC Transmission Inhibited
		0	DDC Transmission Enabled
4:0	DDC ID	0 to 31	Sets the rail's DDC ID for sequencing and fault spreading. For the current-sharing applications, set this value the same as the ID value in ISHARE_CONFIG for all devices in the current sharing rail.

DDC_GROUP

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xE2

Type: R/W Block - Protectable

Data Length in Bytes: 4

Data Format: Custom

Factory Value: 0x00000000

Units: N/A

Reference:

Definition: This command sets which rail DDC IDs should be listened to for fault spreading information. The data sent is a 4-byte, 32-bit, bit vector where every bit represents a rail's DDC ID. A bit set to 1 indicates a device DDC ID to which the configured device will respond upon receiving a fault spreading event. In this vector, bit 0 of byte 0 corresponds to the rail with DDC ID 0. Following through, Bit 7 of byte 3 corresponds to the rail with DDC ID 31.

Note: The device/rail's own DDC ID should not be set within the DDC_GROUP command for that device/rail.

All devices in a current share rail must shutdown for the rail to report a shutdown.

If fault spread mode is enabled in USER_CONFIG (Bit 8 set to 1), the device will immediately shut down if one of its DDC_GROUP members fail. The device/rail will attempt its configured restart only after all devices/rails within the DDC_GROUP have cleared their faults.

If fault spread mode is disabled in USER_CONFIG (Bit 8 cleared to 0), the device will perform a sequenced shutdown as defined by the SEQUENCE command setting. The rails/devices in a sequencing set only attempt their configured restart after all faults have cleared within the DDC_GROUP. If fault spread mode is disabled and sequencing is also disabled, the device will ignore faults from other devices and stay enabled.

Supervisory Commands

STORE_DEFAULT_ALL

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x11

Type: Send Byte

Data Length in Bytes: 0

Data Format: N/A

Factory Value: N/A

Units: N/A

Reference: Section 11.2 - PMBus Spec Part II

Definition: Stores, at the DEFAULT level, all PMBus values that were written since the last restore command. To clear the DEFAULT store, perform a RESTORE_FACTORY then STORE_DEFAULT_ALL. To add to the DEFAULT store, perform a RESTORE_DEFAULT_ALL, write commands to be added, then STORE_DEFAULT_ALL. Wait 20ms after a STORE command.

RESTORE_DEFAULT_ALL

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x12

Type: Send Byte

Data Length in Bytes: 0

Data Format: N/A

Factory Value: N/A

Units: N/A

Reference: Section 11.3 - PMBus Spec Part I

Definition: Restores PMBus settings that were stored using STORE_DEFAULT_ALL. Command performed at power up. Security level is changed to level 1 following this command.

STORE_USER_ALL

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x15

Type: Send Byte

Data Length in Bytes: 0

Data Format: N/A

Factory Value: N/A

Units: N/A

Reference: Section 11.6 - PMBus Spec Part I

Definition: Stores, at the USER level, all PMBus values that were changed since the last restore command. To clear the USER store, perform a RESTORE_FACTORY then STORE_USER_ALL. To add to the USER store, perform a RESTORE_USER_ALL, write commands to be added, then STORE_USER_ALL. Wait 20ms after a STORE command.

RESTORE_USER_ALL

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0x16

Type: Send Byte

Data Length in Bytes: 0

Data Format: N/A

Factory Value: N/A

Units: N/A

Reference: Section 11.7 - PMBus Spec Part I

Definition: Restores PMBus settings that were stored using STORE_USER_ALL. Command performed at power up. Security level is changed to Level 1 following this command.

RESTORE_FACTORY

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xF4

Type: Send Byte /Protectable

Data Length in Bytes: 0

Data Format: N/A

Factory Value: N/A

Units: N/A

Reference:

Definition: Restores the device to the hard-coded factory values and pin-strap definitions. The device retains the DEFAULT and USER stores for restoring. Security level is changed to Level 1 following this command.

BLANK_PARAMS

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xEB

Type: Block Read

Data Length in Bytes: 16

Data Format: Custom

Factory Value: 0xFF...FF

Units: N/A

Reference:

Definition: Returns a 16-byte string which indicates which parameter values were either retrieved by the last RESTORE operation or have been written since that time. Reading BLANK_PARAMS immediately after a restore operation allows the user to determine which parameters are stored in that store. A one indicates the parameter is not present in the store and has not been written since the RESTORE operation. The mapping of PMBus commands to bits in BLANK_PARAMS is unique for each device type. Contact the factory for the BLANK_PARAMS bit-map for your device type, if needed.

PRIVATE_PASSWORD

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xFB

Type: Block R/W

Data Length in Bytes: 9

Data Format: Custom

Factory Value: 0x000000000000000000

Units: N/A

Reference: AN2031 - Writing Configuration Files for Intersil Devices

Definition: Sets the private password string. Password strings have the same format as the MFR_ID parameters.

PUBLIC_PASSWORD

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xFC

Type: Block R/W

Data Length in Bytes: 4

Data Format: Custom

Factory Value: 0x00000000

Units: N/A

Reference: AN2031 - Writing Configuration Files for Intersil Devices

Definition: Sets the public password string.

UNPROTECT

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xFD

Type: Block R/W

Data Length in Bytes: 32

Data Format: Custom

Factory Value: 0xFF...FF

Units: N/A

Reference: AN2031 -Writing Configuration Files for Intersil Devices

Definition: Sets a 256-bit (32-byte) parameter which identifies which commands are to be protected against write-access at lower security levels. Each bit in this parameter corresponds to a command according to the command's code. The command with a code of 00h (PAGE) is protected by the least-significant bit of the least-significant byte, followed by the command with a code of 01h and so forth. Note that all possible commands have a corresponding bit regardless of whether they are protectable or supported by the device. Clearing a command's UNPROTECT bit indicates that write-access to that command is only allowed if the device's security level has been raised to an appropriate level. Although the UNPROTECT command is writeable at any security level, it only takes effect when it is stored in the Default or User store (storing in the Default store requires a security level of 3, and storing in the User store requires a security level of 2 or higher).

SECURITY_LEVEL

Devices: ZL2004, ZL2006, ZL2008, ZL2101, ZL2103, ZL2106, ZL6100, ZL6105, ZL8101, ZL9101

Command Code: 0xFA

Type: Read Byte

Data Length in Bytes: 1

Data Format: Hex

Factory Value: 0x01

Units: N/A

Reference: AN2031 - Writing Configuration Files for Intersil Devices

Definition: The device provides write protection for individual commands. Each bit in the UNPROTECT parameter controls whether its corresponding command is writeable (commands are always readable). If a command is not writeable, a password must be entered in order to change its parameter (i.e., to enable writes to that command). There are two types of passwords, public and private. The public password provides a simple lock-and-key protection against accidental changes to the device. It would typically be sent to the device in the application prior to making changes. Private passwords allow commands marked as non-writeable in the UNPROTECT parameter to be changed. Private passwords are intended for protecting factory-installed configurations and would not typically be used in the application. Each store (USER and DEFAULT) can have its own UNPROTECT string and private password. If a command is marked as non-writeable in the DEFAULT UNPROTECT parameter (its corresponding bit is cleared), the private password in the DEFAULT Store must be sent in order to change that command. If a command is writeable according to the Default UNPROTECT parameter, it may still be marked as non-writeable in the User Store UNPROTECT parameter. In this case, the User private password can be sent to make the command writeable.

The device supports four levels of security. Each level is designed to be used by a particular class of users, ranging from module manufacturers to end users, as discussed below. Levels 0 and 1 correspond to the public password. All other levels require a private password. Writing a private password can only raise the security level. Writing a public password will reset the level down to 0 or 1. Figure 1 on page 44 shows the algorithm used by the device to determine if a particular command write is allowed.

Security Level 3 – Module Vendor

Level 3 is intended primarily for use by Module vendors to protect device configurations in the Default Store. Clearing a UNPROTECT bit in the Default Store implies that a command is writeable only at Level 3 and above. The device's security level is raised to Level 3 by writing the private password value previously stored in the Default Store. To be effective, the module vendor must clear the UNPROTECT bit corresponding to the STORE_DEFAULT_ALL and RESTORE_FACTORY commands. Otherwise, Level 3 protection is ineffective since the entire store could be replaced by the user, including the enclosed private password.

Security Level 2 – User

Level 2 is intended for use by the end user of the device. Clearing a UNPROTECT bit in the User Store implies that a command is writeable only at Level 2 and above. The device's security level is raised to Level 2 by writing the private password value previously stored in the User Store. To be effective, the user must clear the UNPROTECT bit corresponding to the STORE_USER_ALL, RESTORE_DEFAULT_ALL, STORE_DEFAULT_ALL, and RESTORE_FACTORY commands. Otherwise, Level 2 protection is ineffective since the entire store could be replaced, including the enclosed private password.

Security Level 1 – Public

Level 1 is intended to protect against accidental changes to ordinary commands by providing a global write-enable. It can be used to protect the device from erroneous bus operations. It provides access to commands whose UNPROTECT bit is set in both the Default and User Store. Security is raised to Level 1 by writing the public password stored in the User Store using the PUBLIC_PASSWORD command. The public password stored in the Default Store has no effect.

Security Level 0 - Read-Only Mode

Level 0 implies that only commands which are always writeable (namely, PUBLIC_PASSWORD, PRIVATE_PASSWORD, and UNPROTECT) are available. This represents the lowest authority level and hence the most protected state of the device. The level can be reduced to 0 by using PUBLIC_PASSWORD to write any value which does not match the stored public password.

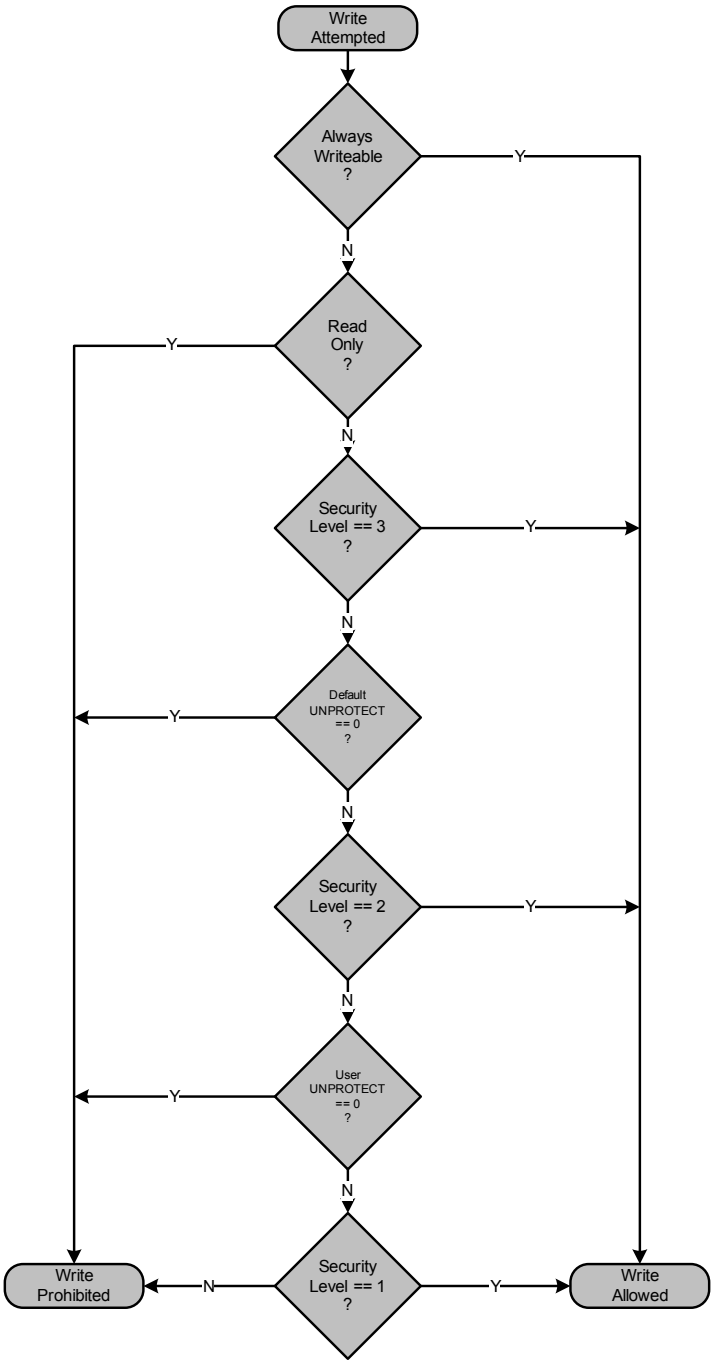

FIGURE 1. ALGORITHM USED TO DETERMINE WHEN A COMMAND IS WRITEABLE

Glossary

Protectable: The data available in these commands are protectable. The UNPROTECT command is used for the protect function.

Linear Format: The linear format is defined in the PMBus specification as a two byte value consisting of an exponent and a mantissa.

V_{OUT} linear mode format: The V_{OUT} format is defined in the PMBus specification for a number of V_{OUT} command modes. Intersil devices use the linear V_{OUT} mode with an exponent of -13, resulting in V_{OUT} command voltage = (V_{OUT} command data) x 2^{-13}.

Custom Format: The custom format describes the command data as being a collection of single bits or sets of bits.

Quick Reference Table

PMBUS COMMAND	COMMAND CODE	DATA BYTES	PMBUS DATA FORMAT	DATA UNITS	TYPE	FACTORY VALUE HEX (DEC)	AN2033 SECTION
OPERATION	0x01	1	CUSTOM		R/W byte	N/A	page 6
ON_OFF_CONFIG	0x02	1	CUSTOM		R/W byte	0x16	page 6
CLEAR_FAULTS	0x03	0	N/A		Send byte	N/A	page 18
STORE_DEFAULT_ALL	0x11	0	N/A		Send byte	N/A	page 41
RESTORE_DEFAULT_ALL	0x12	0	N/A		Send byte	N/A	page 41
STORE_USER_ALL	0x15	0	N/A		Send byte	N/A	page 41
RESTORE_USER_ALL	0x16	0	N/A		Send byte	N/A	page 41
VOUT_MODE	0x20	1	CUSTOM		Read byte	0x13	page 6
VOUT_COMMAND	0x21	2	VOUT LINEAR	V	R/W word	V1:V0 pins	page 6
VOUT_TRIM	0x22	2	SIGNED VOUT LINEAR	V	R/W word	0x0000 (0)	page 7
VOUT_CAL_OFFSET	0x23	2	SIGNED VOUT LINEAR	V	R/W word	0x0000 (0)	page 7
VOUT_MAX	0x24	2	VOUT LINEAR	V	R/W word	1.1 x VOUT_COMMAND	page 7
VOUT_MARGIN_HIGH	0x25	2	VOUT LINEAR	V	R/W word	1.05 x VOUT_COMMAND	page 7
VOUT_MARGIN_LOW	0x26	2	VOUT LINEAR	V	R/W word	0.95 x VOUT_COMMAND	page 8
VOUT_TRANSITION_RATE	0x27	2	LINEAR	V/ms	R/W word	0xBA00 (1.0)	page 8
VOUT_DROOP	0x28	2	LINEAR	mV/A	R/W word	0x0000 (0)	page 8
MAX_DUTY	0x32	2	LINEAR	%	R/W word	0xEAF8 (95)	page 8
FREQUENCY_SWITCH	0x33	2	LINEAR	kHz	R/W word	SYNC pin	page 9
INTERLEAVE	0x37	2	CUSTOM		R/W word	0x01 (SA1:SA0)	page 38
IOUT_CAL_GAIN	0x38	2	LINEAR	mV/A	R/W word	0xC200 (2)	page 9
IOUT_CAL_OFFSET	0x39	2	LINEAR	A	R/W word	0	page 9
VOUT_OV_FAULT_LIMIT	0x40	2	VOUT LINEAR	V	R/W word	1.15 x VOUT_COMMAND	page 10
VOUT_OV_FAULT_RESPONSE	0x41	1	CUSTOM		R/W byte	0xBF	page 14
VOUT_UV_FAULT_LIMIT	0x44	2	VOUT LINEAR	V	R/W word	0.85 x VOUT_COMMAND	page 10
VOUT_UV_FAULT_RESPONSE	0x45	1	CUSTOM		R/W byte	0xBF	page 14
IOUT_OC_FAULT_LIMIT	0x46	2	LINEAR	A	R/W word	ILIM pin(s)	page 11
IOUT_UC_FAULT_LIMIT	0x4B	2	LINEAR	A	R/W word	-1 x IOUT_OC_FAULT_LIMIT	page 11
OT_FAULT_LIMIT	0x4F	2	LINEAR	C	R/W word	0xEBE8 (125)	page 12
OT_FAULT_RESPONSE	0x50	1	CUSTOM		R/W byte	0xBF	page 15
OT_WARN_LIMIT	0x51	2	LINEAR	C	R/W word	0xEB70 (110)	page 12
UT_WARN_LIMIT	0x52	2	LINEAR	C	R/W word	0xDC40 (-30)	page 12
UT_FAULT_LIMIT	0x53	2	LINEAR	C	R/W word	0xE530 (-45)	page 12
UT_FAULT_RESPONSE	0x54	1	CUSTOM		R/W byte	0xBF	page 15
VIN_OV_FAULT_LIMIT	0x55	2	LINEAR	V	R/W word	0xD380 (14)	page 12
VIN_OV_FAULT_RESPONSE	0x56	1	CUSTOM		R/W byte	0xBF	page 16
VIN_OV_WARN_LIMIT	0x57	2	LINEAR	V	R/W word	0xD360 (13.5)	page 13
VIN_UV_WARN_LIMIT	0x58	2	LINEAR	V	R/W word	1.03 x VIN_UV_FAULT_LIMIT	page 13

Quick Reference Table (Continued)

PMBUS COMMAND	COMMAND CODE	DATA BYTES	PMBUS DATA FORMAT	DATA UNITS	TYPE	FACTORY VALUE HEX (DEC)	AN2033 SECTION
VIN_UV_FAULT_LIMIT	0x59	2	LINEAR	V	R/W word	UVLO	page 13
VIN_UV_FAULT_RESPONSE	0x5A	1	CUSTOM		R/W byte	0xBF	page 16
POWER_GOOD_ON	0x5E	2	VOUT LINEAR	V	R/W word	0.9 x VOUT_COMMAND	page 10
TON_DELAY	0x60	2	LINEAR	ms	R/W word	DLY pin(s)	page 17
TON_RISE	0x61	2	LINEAR	ms	R/W word	SS pin(s)	page 17
TOFF_DELAY	0x64	2	LINEAR	ms	R/W word	1 x TON_DLY	page 18
TOFF_FALL	0x65	2	LINEAR	ms	R/W word	1 x TON_RISE	page 18
STATUS_BYTE	0x78	1	CUSTOM		Read byte	N/A	page 19
STATUS_WORD	0x79	2	CUSTOM		Read word	N/A	page 19
STATUS_VOUT	0x7A	1	CUSTOM		Read byte	N/A	page 19
STATUS_IOUT	0x7B	1	CUSTOM		Read byte	N/A	page 19
STATUS_INPUT	0x7C	1	CUSTOM		Read byte	N/A	page 20
STATUS_TEMPERATURE	0x7D	1	CUSTOM		Read byte	N/A	page 20
STATUS_CML	0x7E	1	CUSTOM		Read byte	N/A	page 20
STATUS_MFR_SPECIFIC	0x80	1	CUSTOM		Read byte	N/A	page 21
READ_VIN	0x88	2	LINEAR	V	Read word	N/A	page 21
READ_VOUT	0x8B	2	VOUT LINEAR	V	Read word	N/A	page 22
READ_IOUT	0x8C	2	LINEAR	A	Read word	N/A	page 22
READ_TEMPERATURE_1	0x8D	2	LINEAR	C	Read word	N/A	page 22
READ_TEMPERATURE_2	0x8E	2	LINEAR	C	Read word	N/A	page 22
READ_DUTY_CYCLE	0x94	2	LINEAR	%	Read word	N/A	page 23
READ_FREQUENCY	0x95	2	LINEAR	kHz	Read word	N/A	page 23
PMBUS_REVISION	0x98	1	HEX		Read byte	N/A	page 25
MFR_ID	0x99		ASCII		Block R/W	<null>	page 25
MFR_MODEL	0x9A		ASCII		Block R/W	<null>	page 25
MFR_REVISION	0x9B		ASCII		Block R/W	<null>	page 26
MFR_LOCATION	0x9C		ASCII		Block R/W	<null>	page 26
MFR_DATE	0x9D		ASCII		Block R/W	<null>	page 26
MFR_SERIAL	0x9E		ASCII		Block R/W	<null>	page 26
AUTO_COMP_CONFIG	0xBC	1	CUSTOM		R/W byte	FC pin(s)	page 35
AUTO_COMP_CONTROL	0xBD	0			Send byte	FC pin(s)	page 34
IOUT_OMEGA_OFFSET	0xBE	2	LINEAR		R/W word	0	page 32
DEADTIME_MAX	0xBF		CUSTOM		R/W word	Device-specific	page 36
USER_DATA_00	0xB0		ASCII		Block R/W	<null>	page 27
MFR_CONFIG	0xD0	2	CUSTOM		R/W word	ILIM1 pin	page 27
USER_CONFIG	0xD1	2	CUSTOM		R/W word	CFG pin	page 28
ISHARE_CONFIG	0xD2	2	CUSTOM		R/W word	0x0000	page 39
DDC_CONFIG	0xD3	2	CUSTOM		R/W word	5-bit LSB of SMBus Address	page 40
POWER_GOOD_DELAY	0xD4	2	LINEAR	ms	R/W word	SS pin(s) (TON_RISE)	page 18
PID_TAPS	0xD5	9	CUSTOM		Block R/W	FC pin(s)	page 31
INDUCTOR	0xD6	1	LINEAR		R/W byte	VO pin	page 33
NLR_CONFIG	0xD7	2	CUSTOM		R/W word	FC1	page 33
OVUV_CONFIG	0xD8	1	CUSTOM		R/W byte	0x80	page 17

Quick Reference Table (Continued)

PMBUS COMMAND	COMMAND CODE	DATA BYTES	PMBUS DATA FORMAT	DATA UNITS	TYPE	FACTORY VALUE HEX (DEC)	AN2033 SECTION
XTEMP_SCALE	0xD9	2	LINEAR	C	R/W word	0xBA00 (1)	page 9
XTEMP_OFFSET	0xDA	2	LINEAR	C	R/W word	0x0000 (0)	page 10
TEMPCO_CONFIG	0xDC	1	CUSTOM		R/W byte	0x2C	page 34
DEADTIME	0xDD	2	CUSTOM	ns	R/W word	0x3C3C	page 35
DEADTIME_CONFIG	0xDE	2	CUSTOM		R/W word	0x0505	page 36
SEQUENCE	0xE0	2	CUSTOM		R/W word	CFG pin	page 37
TRACK_CONFIG	0xE1	1	CUSTOM		R/W byte	SS1 pin	page 38
DDC_GROUP	0xE2	4	CUSTOM		Block R/W	0x00000000	page 40
DEVICE_ID	0xE4	16	ASCII		Block read	N/A	page 24
MFR_IOUT_OC_FAULT_RESPONSE	0xE5	1	CUSTOM		R/W byte	0xBF	page 15
MFR_IOUT_UC_FAULT_RESPONSE	0xE6	1	CUSTOM		R/W byte	0xBF	page 15
IOUT_AVG_OC_FAULT_LIMIT	0xE7	2	LINEAR	A	R/W word	IOUT_OC_FAULT_LIMIT	page 11
IOUT_AVG_UC_FAULT_LIMIT	0xE8	2	LINEAR	A	R/W word	IOUT_UC_FAULT_LIMIT	page 11
MISC_CONFIG	0xE9	2	CUSTOM		R/W word		page 29
SNAPSHOT	0xEA	32	CUSTOM		Block read		page 24
BLANK_PARAMS	0xEB	16	CUSTOM		Block read	0xFF..FF	page 42
PHASE_CONTROL	0xF0	1	CUSTOM		R/W byte		page 39
PID_TAPS_ADAPT	0xF2	9	CUSTOM		Block R/W	FC pin(s)	page 32
PID_TAPS_CALC	0xF2	9	CUSTOM		Block R/W	FC pin(s)	page 32
SNAPSHOT_CONTROL	0xF3	1	CUSTOM		R/W byte		page 23
RESTORE_FACTORY	0xF4	0	N/A		Send byte	N/A	page 42
MFR_VMON_OV_FAULT_LIMIT	0xF5	2	LINEAR	V	R/W word	0xD300 (12)	page 13
MFR_VMON_UV_FAULT_LIMIT	0xF6	2	LINEAR	V	R/W word	0xCA80 (5)	page 13
MFR_READ_VMON	0xF7	2	LINEAR	V	R/W word	N/A	page 23
VMON_OV_FAULT_RESPONSE	0xF8	1	CUSTOM		R/W byte	0xBF	page 16
VMON_UV_FAULT_RESPONSE	0xF9	1	CUSTOM		R/W byte	0xBF	page 16
SECURITY_LEVEL	0xFA	1	HEX		Read byte	N/A	page 43
PRIVATE_PASSWORD	0xFB	9	ASCII		Block R/W	0x000000000000000000	page 42
PUBLIC_PASSWORD	0xFC	4	ASCII		Block R/W	0x00000000	page 42
UNPROTECT	0xFD	32	CUSTOM		Block R/W	0xFF...FF	page 43

NOTE: “Factory Values” refers to hard coded values or pin-strap values that are loaded upon a “FACTORY_RESTORE”.

Related Tools and Documentation

DOCUMENT	DESCRIPTION
AN2015	Current Protection and Measurement
AN2031	Writing Configuration Files for Intersil Digital Power
AN2032	NLR Configuration for DDC Products
AN2034	Configuring Current Sharing on the ZL2004 and ZL2006
AN2035	Compensation Using CompZL™

Revision History

DATE	REV. #	COMMENT
May 2008	1.0	Initial release
August 2008	1.1	Added SEQUENCE command table Corrected ISHARE_CONFIG and INTERLEAVE command descriptions Updated TEMPCO_CONFIG command Added “not while enabled” notes to certain commands Corrected INTERLEAVE command table Clarified Precise ramp bits in MISC_CONFIG
October 2008	1.2	Added ZL2103 and ZL2106 references Corrected MFR_CONFIG: bit 2, ‘1’ = Enabled Added “DCR” descriptor to TC calculation in TEMPCO_CONFIG Removed SMBus control bits 4 and 7 in USER_CONFIG Added note 1 to TEMPCO_CONFIG Corrected DEADTIME factory initial values
June 4, 2009	AN2033.0	Conversion from Word to Frame. Issued AN2033. Applied all Intersil Standards. Rev 0 marks New document.
December 2009	AN2033.1	Product additions and PMBus command updates for AN2033.
April 2011	AN2033.2	Product additions and PMBus command updates for AN2033.
September 29, 2011	AN2033.3	Product additions and PMBus command updates for AN2033.
March 21, 2016	AN2033.4	Replaced Zilker with Intersil throughout document. Applied Intersil’s new standards. Removed ZL8100 and ZL9101A references. Added “PMBus Use Guidelines” and “Summary” on page 5.

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