Application Report
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SBData Commands for PowerLAN™ Master Gateway Controller

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ABSTRACT

The Smart Battery Data (SBData) Interface is a list of commands that have become a standard in lithium-ion battery management applications. The bq78PL116 supports this standard command set and also includes additional commands to allow some control of its unique operation. These additional commands are called SBData Commands for the PowerLAN™ Master Gateway Controller and use standard SMBus transactions.

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1 Background

The communications protocol described in this application report uses standard SMBus transactions. See the System Management Bus Specification version 1.1 for details on this protocol. In particular, the transactions Write Word and Read Word are used. The specifics of the SMBus transactions – like timing, ACK/NACK, PEC, etc. – are not described. Transactions can be done with or without the use of the Packet Error Checking (PEC).

NOTE: This protocol is available in the bq78PL114S12 and the bq78PL116. This application report can be applied to both products with the following exceptions for the bq78PL114S12:

1. The bq78PL114S12 does not have the PASSWORD command nor an access level feature. When unlocking the device, simply use the UNLOCK command.
2. The bq78PL114S12 does not have the RESET FUSE and TOGGLE SHIP BIT commands.
3. The COMMAND and DATA registers for the bq78PL114S12 are at 0x50 and 0x51, respectively.
4. The bq78PL114S12 requires the use of PEC.

2 Protocol Description

2.1 Command and Data Registers

The SBData Commands for the PowerLAN™ Master Gateway Controller use two SBData address locations to perform tasks that are specific to the PowerLAN™ Master Gateway Controller (hereafter referred to as PowerLAN™ Gateway). The first location, called COMMAND, is used to get device status or send commands. The second location, called DATA, is used to read Parameter Data from the bq78PL116 and also load values for commands.

In the bq78PL116, these locations are COMMAND = 0x80 and DATA = 0x81. A summary of COMMAND and DATA is shown in the following tables.

Table 1. PowerLAN™ SBData Commands for bq78PL116

SBData Command	Mode	Description	Format	Size (Bytes)	Description
0x80	Read	COMMAND	Unsigned Integer	2	A read returns the device status.
0x80	Write	COMMAND	Unsigned Integer	2	A write implements one of the PowerLAN™ commands.
0x81	Read	DATA	Unsigned Integer	2	Preceded by a COMMAND write, a DATA read returns the value of the COMMAND Data
0x81	Write	DATA	Unsigned Integer	2	Followed by a COMMAND write, a DATA write sends data to Parameter associated with COMMAND.

Read and Write modes are determined by the least significant bit (LSB) of the device address byte. An LSB = 0 indicates a write, and an LSB = 1 indicates a read. The default address for the bq78PL116 is 0x16 for writes and 0x17 for reads.

2.2 PowerLAN™ Gateway Status

The status of the PowerLAN™ Gateway can be read for a variety of reasons. Reading the status of the bq78PL116 while performing transactions promotes reliable communications. Querying device status can provide error checking, indication of a locked or unlocked device, and when a command is completed. The 12 status values are described in Table 2.

Table 2. Device Status Words

Value	Description
0x0000	Ready.
0x8001	Busy.
0x8081	Invalid Command, Locked
0x808A	Invalid Command, Unlocked
0x8101	Read Error, Safety Timers
0x8102	Read Error, Safety Limits
0x8103	Read Error, Pack Configuration
0x8104	Read Error, User Command
0x8105	Write Error, Safety Timers
0x8106	Write Error, Safety Limits
0x8107	Write Error, Safety Timers
0x8200 – 0x82FF	SBData layer Errors

2.3 Commands

The commands provided in this protocol allow the user to perform the following simple tasks:

- Read and write a subset of the Parameter Set. The parameter set is described in the *bq78PL116 Technical Reference Manual* (SLUU481). The accessible parameter subset consists of Safety Rule settings, Charge Control settings, and two Configuration registers. Not all parameters are writable through SBData commands for the PowerLAN™ Gateway. See the tables later in this document for a complete listing.
- Calibration of current offset and gain and temperature offset.
- The Commit command is provided to save calibration values.
- Relearn/Initialize command is included so that changes to the parameter set can be relearned after a change.
- Reset Fuse command clears the permanent failure condition and the Fuse bit.
- Toggle Ship Bit command places bq78PL116 into the lowest power state with wake up only when the SBData pins (SBCLK, SBDAT) are pulled up.

Table 3 shows the listing of the SBData Commands for the PowerLAN™ Gateway.

Table 3. SBData Commands for PowerLAN™ Gateway

Command Name	Command Value	Description
POWERPUMP ENABLE	0x180F	Clear bit 15 of System Control to enable PowerPump™ technology
POWERPUMP DISABLE	0x190F	Set bit 15 of System Control to disable PowerPump™ technology
UNLOCK	0x1A91	Unlock device for 60 seconds of access to SBData Commands for PowerLAN™ Gateway. After this time, the device is locked unless another SBData Command for the PowerLAN™ Gateway is sent.
LOCK	0x1A19	Lock device from access to SBData Commands for PowerLAN™ Gateway. A locked device only prevents access to SBData commands for the PowerLAN™ Gateway
PASSWORD	0x1Bii	Write word (two bytes) to password register. Valid values for ii are 00–03.
CURRENT CAL ZERO	0x2000	Calibrate current offset.
CURRENT CAL GAIN	0x2001	Calibrate current gain.
TEMP CAL	0x2002	Calibrate Temperature sensors.

Table 3. SBData Commands for PowerLAN™ Gateway (continued)

Command Name	Command Value	Description
COMMIT	0x2003	Commit data to flash.
RELEARN INITIALIZE	0x2007	Relearn/Initialize command.
RESET FUSE	0x200B	Clear the permanent failure condition (FUSE); clear SPROT output.
TOGGLE SHIP BIT	0x2010	Toggle the ship mode bit.
WRITE TIMER	0x21ii	Write the value of a Safety Timer[ii] = parameter 0x00pp.
WRITE THRESHOLD	0x22jj	Write the value of a Safety Limit[jj] = parameter PPpp.
READ TIMER	0x23ii	Read Safety Timer [ii] through Least Significant Byte (LSB) of DATA.
READ THRESHOLD	0x24jj	Read Safety Limit [jj] through DATA.

2.3.1 PASSWORD (Seal/Unseal)

The PASSWORD command writes the password two bytes at a time. The bq78PL116 can be configured so that user access is restricted. This historically has been referred to as sealing or unsealing the pack in TI Battery Management devices (bq20zxx). The three access levels are shown in Table 4.

Table 4. bq78PL116 User Access Levels

Level	Description
0	Access to SBData commands 0x00 to 0x23 and 0x3C to 0x59
1	Level 0 Access and Access to Extended SBData commands for PowerLAN™ Gateway (0x80, 0x81)
2	Level 0 & 1 Access and full access to bq78PL116. (default)

The default setting is access level 2 and the password for each level is blank (empty). Without implementation of the access level passwords, any user with bqWizard™ software and access to the SMBus pins on the bq78PL116 battery pack can interrogate the device, change parameter settings, and copy the flash contents (.dat file). If the user wishes to implement data flash security, passwords for access levels 1 and 2 must be assigned. Password programming is initially done using the bqWizard™ software and then later saved in the production clone file (.dat), also known as *golden flash file*.

Passwords are strings consisting of eight characters. Password values are created in the bqWizard™ software. When providing password values in the SBData commands for the PowerLAN™ Gateway, the ASCII representation of the string characters is used.

2.3.2 LOCK/UNLOCK

SBData commands for the PowerLAN™ Gateway in Table 3 are locked from use (except LOCK, UNLOCK, POWERPUMP ENABLE, POWERPUMP DISABLE). This means that use of the commands requires that the UNLOCK command be issued prior to command usage. If passwords are assigned, the UNLOCK command must be proceeded by the PASSWORD command.

The LOCK/UNLOCK feature also includes a timeout. The Unlocked condition expires after 60 seconds if the UNLOCK command is not sent.

2.3.3 POWERPUMP DISABLE/ENABLE

The most significant bit (MSB) of the System Control parameter, bit 15, is used to enable or disable PowerPump™ operation. If bit 15 of this register is 1, the PowerPump™ operation is disabled. If it is zero, the PowerPump™ operation is enabled. The POWERPUMP ENABLE and POWERPUMP DISABLE commands clear or set bit 15 of the System Control register, respectively.

All the other bits in the System Control parameter have no function and must always remain as zero. This means System Control can only be 0x8000 or 0x0000.

2.3.4 CURRENT CAL GAIN/ CURRENT CAL ZERO/TEMP CAL

The commands CURRENT CAL ZERO and CURRENT CAL GAIN permit the calibration of the current measurement system. The command TEMP CAL permits calibration of the temperature sensors in the system. The bq78PL116 has one device sensor and up to four external sensors.

The typical production flow is to calibrate and program flash of the device (.dat file load) using the bq78PL11x API. However, an alternative production flow is available where loose bq78PL116 devices have their flash programmed in a test circuit with a 48QFN socket using the bq78PL11x API and then later are inserted onto each production PCB assembly. The bq78PL116 current measurement and temperature measurement systems then are calibrated using the CURRENT CAL GAIN, CURRENT CAL ZERO, and TEMP CAL commands.

Calibration of the temperature measurement system must be established prior to current calibration. Update to calibration values must always be followed by a COMMIT command.

2.3.5 COMMIT

The COMMIT command is used to save calibration values to flash after the calibration commands are used. This is the only use for the COMMIT command.

2.3.6 RELEARN/INITIALIZE

The RELEARN/INITIALIZE command is used to reload parameters that are not updated during normal firmware system flow and to reset the major firmware subsystems. It also clears long-term counters, transfers bq76PL102 voltage calibration data, and updates Relative State of Charge (RSOC) based on present cell voltages.

Typical usage of this command is after any changes are made to the Hardware Configuration parameter. It is also used to reset the gas gauge timers in order to trigger a Qmax update. See the *bq78PL116 Technical Reference Manual* (SLUU481) for more details.

2.3.7 RESET FUSE

The RESET FUSE command is used to clear the permanent failure condition that can be entered when certain Second Level Safety Rules are activated. A permanent failure causes all of the pack disconnect control pins (DSG, CHG, and PRE) to permanently go to zero, thereby permanently shutting off the battery pack.

2.3.8 TOGGLE SHIP MODE BIT

Ship mode operation is intended for the time between production and initial usage. Entrance and exit are intended to only happen once. This mode allows for lowest power consumption during long periods of initial storage.

2.3.9 WRITE TIMER

Use the WRITE TIMER (0x21ii) command to change the value of the Safety Timers. See Table 5 for a description of the timers. The ii in the command code represents one of the entries in Table 3 (ii = 0, 1, 2, 3, …).

The new word value of the safety timer is written to DATA (0x81). Because the timers are only one byte long, the top byte of the word value is always 0x00 making the word format appear as 0x00tt. Then, WRITE TIMER is written to COMMAND (0x80) in order to write the value 0x00tt.

2.3.10 WRITE THRESHOLD

Use the WRITE THRESHOLD (0x22jj) command to change the value of the Safety Thresholds. See Table 6 for description of these parameters. The jj in the command code represents one of the entries in Table 3 (jj = 0, 1, 2, 3, …).

2.3.11 READ TIMER

Use the READ TIMER (0x23ii) command to read the value of the Safety Timers. See Table 5 for description of timers. The ii in the command code represents one of the entries in Table 3 (ii = 0, 1, 2, 3, …).

2.3.12 READ THRESHOLD

Use the READ THRESHOLD (0x24jj) command to read the value of the Safety Thresholds. See Table 6 for description of these parameters. The jj in the command code represents one of the entries in Table 3 (jj = 0, 1, 2, 3, …).

Table 5. Safety Parameter Timers (Write 0x21ii or Read 0x23ii)

Index (ii)	Name	Units (Hexadecimal)
0x00	COV Time	Seconds
0x01	CUV Time	Seconds
0x02	POV Time	Seconds
0x03	PUV Time	Seconds
0x04	Over Current Charge Tier 1 Recovery	Seconds
0x05	Over Current Charge Tier 1 Time	Seconds
0x06	Over Current Discharge Tier 1 Recovery	Seconds
0x07	Over Current Discharge Tier 1 Time	Seconds
0x08	Over Current Charge Tier 2 Recovery	Seconds
0x09	Over Current Charge Tier 2 Time	Seconds
0x0A	Over Current Discharge Tier 2 Recovery	Seconds
0x0B	Over Current Discharge Tier 2 Time	Seconds
0x0C	Hardware Over Current Charge Recovery	Seconds
0x0D	Hardware Over Current Discharge Recovery	Seconds
0x0E	Hardware Over Current Short Circuit Recovery	Seconds
0x0F	EUV Time	Seconds
0x10	Over Temperature Charge Time	Seconds RDTE
0x11	Over Temperature Discharge Time	Seconds RDTE
0x12	Host Watchdog TimeOut	Seconds RDTE
0x13	SOV Time	Seconds RDTE
0x14	Reserved	--
0x15	SOC Charge Time	Seconds RDTE
0x16	SOC Discharge Time	Seconds RDTE
0x17	SOT Charge Time	Seconds RDTE
0x18	SOT Discharge Time	Seconds RDTE
0x19	Open Temperature Sensor Time	Seconds RDTE
0x1A	FET Fail Time	Seconds RDTE
0x1B	Fuse Fail Time	Seconds RDTE
0x1C	VLAN Fail Time	Seconds RDTE
0x1D	Current Measurement Fail Time	Seconds RDTE
0x1E	Charge Completion Time	Seconds RDTE
0x1F	Charge Completion FET Activation Time	Seconds RDTE
0x20	Discharge Completion Time	Seconds
0x21	Discharge Completion FET Activation Time	Seconds
0x22	Board Over Temperature Time	Seconds RDTE
0x23	Reserved	--
0x24	FD Set Voltage Time	Seconds
0x25	TDA Set Voltage Time	Seconds

Table 5. Safety Parameter Timers (Write 0x21ii or Read 0x23ii) (continued)

Index (ii)	Name	Units (Hexadecimal)
0x26	Discharge Under Temperature Time	Seconds RDTE
0x27	OCA activation time	Seconds RDTE

Table 6. Safety Parameter Thresholds (Write 0x22jj or Read 0x24jj)

Index (jj)	Name	Units (Hexadecimal)
0x00	COV Threshold	mV
0x01	COV Recovery	mV
0x02	COV High Temperature Threshold	mV
0x03	COV High Temperature Adjust	Kelvin
0x04	CUV Threshold	mV
0x05	CUV Recovery	mV
0x06	POV Threshold	mV
0x07	POV Recovery	mV
0x08	PUV Threshold	mV
0x09	PUV Recovery	mV
0x0A	Over Current Charge Tier 1 Threshold	mA
0x0B	Over Current Discharge Tier 1 Threshold	mA
0x0C	Over Current Charge Tier 2 Threshold	mA
0x0D	Over Current Discharge Tier 2 Threshold	mA
0x0E	HSC Max Attempts	Integer
0x0F	HOC Max Attempts	Integer
0x10	Hardware Over Current Charge Threshold	Integer
0x11	Hardware Over Current Charge Time	Integer
0x12	Hardware Over Current Discharge Threshold	Integer
0x13	Hardware Over Current Discharge Time	Integer
0x14	Hardware Short Circuit Threshold	Integer
0x15	Hardware Short Circuit Time	Integer
0x16	EUV Threshold	mV
0x17	EUV Recovery	mV
0x18	OT Charge Threshold	mV
0x19	OT Charge Recovery	mV
0x1A	OT Discharge Threshold	mV
0x1B	OT Discharge Recovery	mV
0x1C	SOV Threshold	mV
0x1D	Cell Imbalance Current	mA
0x1E	Cell Imbalance Fail Voltage	mV
0x1F	Cell Imbalance Time	Seconds
0x20	Cell Imbalance SOC Inhibit Threshold	%
0x21	SOC Charge Threshold	mA
0x22	SOC Discharge Threshold	mA
0x23	SOT Charge Threshold	Kelvin
0x24	SOT Discharge Threshold	Kelvin
0x25	Open Temperature Sensor Threshold	Kelvin
0x26	Reserved	--
0x27	Fuse Fail Limit	mA
0x28	IGR Limit	Integer
0x29	IGR Fail Count	Integer

Table 6. Safety Parameter Thresholds (Write 0x22jj or Read 0x24jj) (continued)

Index (jj)	Name	Units (Hexadecimal)
0x2A	IGR Ratio Limit	Integer
0x2B	IGR Ratio Fail Count	Integer
0x2C	Rate Limit Threshold	Integer
0x2D	Rate Limit Activation Count	Integer
0x2E	Charge Inhibit Temperature Low	Kelvin
0x2F	Charge Inhibit Recovery Temperature Low	Kelvin
0x30	Charge Inhibit Temperature High	Kelvin
0x31	Charge Inhibit Recovery Temperature High	Kelvin
0x32	Pre-charge Temperature	Kelvin
0x33	Pre-charge Voltage	mV
0x34	Pre-charge Voltage Timeout	Seconds RDTE
0x35	Charge Suspend Temperature Low	Kelvin
0x36	Charge Suspend Recovery Temperature Low	Kelvin
0x37	Charge Suspend Temperature High	Kelvin
0x38	Charge Suspend Recovery Temperature High	Kelvin
0x39	HOC Max Attempts	Hardware over current max tries
0x3A	Charge Completion Time	Seconds RDTE
0x3B	Reserved	Reserved
0x3C	Reserved	--
0x3D	Reserved	--
0x3E	Reserved	--
0x3F	Reserved	--
0x40	Reserved	--
0x41	Charge Completion Pack Voltage Qualifier	mV
0x42	Charge Completion Taper Current Qualifier	mV
0x43	Discharge Completion Pack Voltage Qualifier	mV
0x44	FD Clear SOC Threshold	%
0x45	FD Clear Voltage	mV
0x46	FC Clear SOC Threshold	%
0x47	FC Set SOC Threshold	%
0x48	Hardware Configuration	Bit Wise Defined
0x49	Reserved	--
0x4A	Minimum cell differential for balancing	mV
0x4B	Transition to idle current	mA
0x4C	Transition to idle time	Seconds
0x4D	Transition to Discharge Current	mA
0x4E	Transition to Charge Current	mA
0x4F	Reserved	--
0x50	Current Delta	mA
0x51	Sense Resistance	Micro Ohms (Read Only)
0x52	FCC Learn Qualifier	%
0x53	Cycle Fade	%
0x54	Min OCV Slope	mV/% RSOC
0x55	OCV Idle Qualifier	Minutes
0x56	Stale FCC Timeout	Minutes
0x57	Reserved	--
0x58	Hardware LP Discharge	Integer

Table 6. Safety Parameter Thresholds (Write 0x22jj or Read 0x24jj) (continued)

Index (jj)	Name	Units (Hexadecimal)
0x59	Hardware LP Discharge Duration	Integer
0x5A	Hardware LP Charge Threshold	Integer
0x5B	Hardware LP Charge Duration	Integer
0x5C	EPD Pump Time	Cycle Counts
0x5D	EPD Write Time	Cycle Counts
0x5E	Default Charging Current	mA
0x5F	Default Charging Voltage	mV
0x60	Capacity Algorithm	Bit Wise Defined
0x61	User Rate	mA
0x62	Precharge Current	mA
0x63	Reserved	--
0x64	Reserved	--
0x65	Reserved	--
0x66	Reserved	--
0x67	Board Over Temperature	Kelvin
0x68	Board Over Temperature Recovery	Kelvin
0x69	TDA Clear SOC Threshold	%
0x6A	TCA Clear SOC Threshold	%
0x6B	Pre-charge Recovery	mV
0x6C	FD Set SOC Threshold	%
0x6D	FD Set Voltage	mV
0x6E	TDA Set SOC Threshold	%
0x6F	TCA Set SOC Threshold	%
0x70	TDA Set Volt	mV
0x71	TDA Clear Volt	mV
0x72	Discharge Under Temperature Threshold	Kelvin
0x73	Discharge Under Temperature Recovery	Kelvin
0x74	OCA Set Voltage	mV
0x75	Reserved	--
0x76	System Control	Bit Wise Defined
0x77	Display Driver Frequency	Hz

3 Usage

3.1 SMBus Read/Write Word

Most if not all the SBData Commands for the PowerLAN™ Gateway involve the use of the SMBus transactions called Read Word and Write Word. They can be conducted with or without Packet Error Checking (PEC). See the SMBus Specification Rev 1.1 for complete details on how the SMBus protocol works.

3.1.1 SMBus Read Word

The SMBus Read Word with PEC is shown here for convenience. Consult the full SMBus Specification for complete explanation of this transaction. PEC usage is not required.

The following notations are used in this discussion:

- [S] = Start Bit (SMBDAT transition low, clock high)
- [P] = Stop Bit (SMBCLK transition high, clock high)
- [R] = Read Bit (1)
- [W] = Write Bit (0)
- [ACK] = Acknowledge
- [NACK] = Not acknowledge
- [PEC] = Packet Error Checking byte

Table 7. SMBus Read Word With PEC

Bits	1	7	1	1	8	1	8	1	8	8	1	1
	S	ADDRESS	W	ACK	COMMAND	ACK	DATA LSB	ACK	DATA MSB	PEC	ACK	P

3.1.2 SMBus Write Word

The SMBus Write Word with PEC is shown here for convenience. Consult the full SMBus Specification for complete explanation of this transaction. PEC usage is not required.

Table 8. SMBus Write Word With PEC

Bits	1	7	1	1	8	1	8	1	8	8	1	1
	S	ADDRESS	W	ACK	COMMAND	ACK	DATA LSB	ACK	DATA MSB	PEC	ACK	P

3.2 Read Device Status

The PowerLAN™ Gateway status is queried with a SMBus Read Word command to register 0x80.

3.2.1 Read 0x80 (BUSY Status Is Returned in Example):

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	1	ACK	1000 0000	ACK	0000 0001	ACK	1000 0000	ACK	P

3.3 Unlock a Password-Protected Device

Unlocking a password-protected device requires four pairs of SMBus Write Word transactions followed by a single SMBus Write Word transaction. The password in this example is “POWERLAN”. The ASCII representation of POWERLAN, in hexadecimal, is 50, 4F, 57, 45, 52, 4C, 41, 4E. It is described as follows:

3.3.1 Write 0x504F (“PO”) to 0x81 and Then Write 0x1B00 to 0x80:

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0001	ACK	0100 1111	ACK	0101 0000	ACK	P

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0000	ACK	0000 0000	ACK	0001 1011	ACK	P

3.3.2 Write 0x5745 (“WE”) to 0x81 and Then Write 0x1B01 to 0x80:

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0001	ACK	0100 0101	ACK	0101 0111	ACK	P

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0000	ACK	0000 0001	ACK	0001 1011	ACK	P

3.3.3 Write 0x524C (“RL”) to 0x81 and Then Write 0x1B02 to 0x80:

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0001	ACK	0100 1100	ACK	0101 0010	ACK	P

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0000	ACK	0000 0010	ACK	0001 1011	ACK	P

3.3.4 Write 0x414E (“AN”) to 0x81 and Then Write 0x1B03 to 0x80:

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0001	ACK	0100 1110	ACK	0100 0001	ACK	P

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0000	ACK	0000 011	ACK	0001 1011	ACK	P

3.3.5 Write 0x1A91 to 0x80 to UNLOCK the bq78PL116’s SBData Commands for PowerLAN™ Gateway.

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0000	ACK	0000 011	ACK	0101 1011	ACK	P

If the password is blank (default), only preceding step 5 needs to be performed.

NOTE: All explanations from here forward assume that the bq78PL116 is unlocked and has a Ready Status. The user must make use of the Read Device Status procedure to ensure that communications are effective.

3.4 Lock a Device

Locking a device can happen automatically if more than one minute passes without the occurrence of any SBData Commands for the PowerLAN™ Gateway. To intentionally lock the device, perform the following:

3.4.1 Write 0x1A19 to 0x81:

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0000	ACK	0001 1001	ACK	0101 1010	ACK	P

3.5 Read a Safety Parameter Timer

Reading a Safety Parameter Timer value from those listed in Table 5 requires that a SMBus Write Word command be sent using a properly indexed (ii) parameter code through register 0x80. Then, the value is read back using a SMBus Read Word command and register 0x81. Only the LSB of the returned word is used because all timer values are only one byte.

3.5.1 Write 0x23ii to 0x80 (0x2300 = Read COV Time):

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0000	ACK	0000 0000	ACK	0010 0011	ACK	P

3.5.2 Read 0x81 (Default Result for COV Time is 0x02):

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0001	ACK	0000 0010	ACK	0000 0000	ACK	P

3.6 Read a Safety Parameter Threshold

Reading a Safety Parameter Threshold value from those listed in Table 6 requires that a SMBus Write Word command be sent using a properly indexed (ii) parameter code through register 0x80. Then, the value is read back using a SMBus Read Word command and register 0x81.

3.6.1 Write 0x24ii to 0x80 (0x2400 = Read COV Threshold):

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0000	ACK	0000 0010	ACK	0010 0100	ACK	P

3.6.2 Read 0x81 (Default Result for COV Threshold is 0x109A):

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0001	ACK	1001 1010	ACK	0001 0000	ACK	P

3.7 Write a Safety Parameter Timer

Writing a Safety Parameter Timer value listed in Table 5 requires that the threshold value be written to 0x81 using a SMBus Write Word command. Then, the properly indexed command value is written to 0x80 using a SMBus Write Word command.

3.7.1 Write 0x0004 to 0x81 (COV Time = 4 seconds):

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0001	ACK	0000 0100	ACK	0000 0000	ACK	P

3.7.2 Write 0x21ii to 0x80 (COV Time Command = 0x2100):

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0000	ACK	0000 0100	ACK	0010 0001	ACK	P

3.8 Write a Safety Parameter Threshold

Writing a Safety Parameter Threshold value listed in Table 6 requires that the threshold value be written to 0x81 using a SMBus Write Word command. Then, the properly indexed command value is written to 0x80 using a SMBus Write Word command.

3.8.1 Write 0x1068 to 0x81 (COV Threshold = 4200mV):

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0001	ACK	0110 1000	ACK	0001 0000	ACK	P

3.8.2 Write 0x22ii to 0x80 (COV Time Command = 0x2200):

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0000	ACK	0000 0100	ACK	0010 0001	ACK	P

3.9 Enable PowerPump™ Circuitry

Enabling PowerPump™ circuitry requires a SMBus Word Write to the 0x80 register.

3.9.1 Write 0x180F to 0x80:

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0000	ACK	0000 1111	ACK	0001 1000	ACK	P

3.10 Disable PowerPump™ Circuitry

Disabling PowerPump™ circuitry requires a SMBus Word Write to the 0x80 register.

3.10.1 Write 0x190F to 0x80:

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0000	ACK	0000 1111	ACK	0001 1001	ACK	P

3.11 Current Zero Offset Calibration

Calibration of the current measurement system for offset is done using a single SBData Word Write to register 0x80. Prior to executing this command, ensure that no current is flowing in the sense resistor. Continue to ensure zero current flow until after the status of the device is returned to READY (0x0000). Maintain power to the device until the COMMIT command can be executed. The COMMIT command must be executed in order for the calibration to be recorded. The COMMIT command must be executed in order for the calibration to be recorded.

3.11.1 Write 0x2000 to 0x80:

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0000	ACK	0000 0000	ACK	0010 0000	ACK	P

3.12 Current Gain Calibration

Calibration of the current measurement system for gain is done using a SBData Word Write to register 0x81 to load the value of current (in mA) present in the resistor. Then, a SBData Word write to register 0x80 is used to issue the gain calibration. Prior to executing this command, ensure that a known current is flowing in the sense resistor. Continue to have this current to flow until after the status of the device is returned to READY (0x0000). Maintain power to the device until the COMMIT command can be executed. The COMMIT command must be executed in order for the calibration to be recorded.

3.12.1 Write 0x07D0 to 0x81 (Current = 2000 mA):

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0001	ACK	1101 0000	ACK	0000 0111	ACK	P

3.12.2 Write 0x2001 to 0x80:

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0000	ACK	0000 0001	ACK	0010 0000	ACK	P

3.13 Temperature Offset Calibration

Calibration of the temperature measurement system for offset is done using a SBData Word Write to register 0x81 to load the value of ambient temperature (in °K). Then, a SBData Word write to register 0x80 is used to issue the offset calibration. Maintain power to the device until the COMMIT command can be executed. The COMMIT command must be executed in order for the calibration to be recorded.

3.13.1 Write 0x012A to 0x81 (Temperature = 25°C or 298°K):

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0001	ACK	0010 1010	ACK	0000 0001	ACK	P

3.13.2 Write 0x2002 to 0x80:

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0000	ACK	00000 0010	ACK	0010 0000	ACK	P

3.14 Commit Calibration Data

The COMMIT command is used to write the calibration information to flash memory for permanent storage. Execution of the commit command requires a SMBus Write Word to register 0x80.

3.14.1 Write 0x2003 to 0x80:

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0000	ACK	0000 0011	ACK	0010 0000	ACK	P

3.15 Clear Permanent Failure Condition (FUSE)

Clearing the permanent failure condition, or Fuse, requires a single SMBus Word Write to the 0x80 register.

3.15.1 Write 0x200B to 0x80:

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0000	ACK	0000 1011	ACK	0010 0000	ACK	P

3.16 Set Ship Mode

Setting the device into ship mode requires a single SMBus Word Write to the 0x80 register.

3.16.1 Write 0x2010 to 0x80:

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0000	ACK	0001 0000	ACK	0010 0000	ACK	P

3.17 Relearn/Initialize

Issuing a RELEARN/INITIALIZE command requires a single SMBus Word Write to the 0x80 register.

3.17.1 Write 0x2007 to 0x80:

Bits	1	7	1	1	8	1	8	1	8	1	1
	S	0001 011	0	ACK	1000 0000	ACK	0000 0111	ACK	0010 0000	ACK	P

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