

QM

AC/DC Modular Power Supply Series

PMBus™ APPLICATION NOTES



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1. Overview of the PMBus™ Interface

Standard 100kHz operation

PEC (Packet Error Checking) supported

Monitoring of status - reading and clearing of fault and warning indications

Reading manufacturing related data – manufacturer id, model name, serial number & manufacturing date

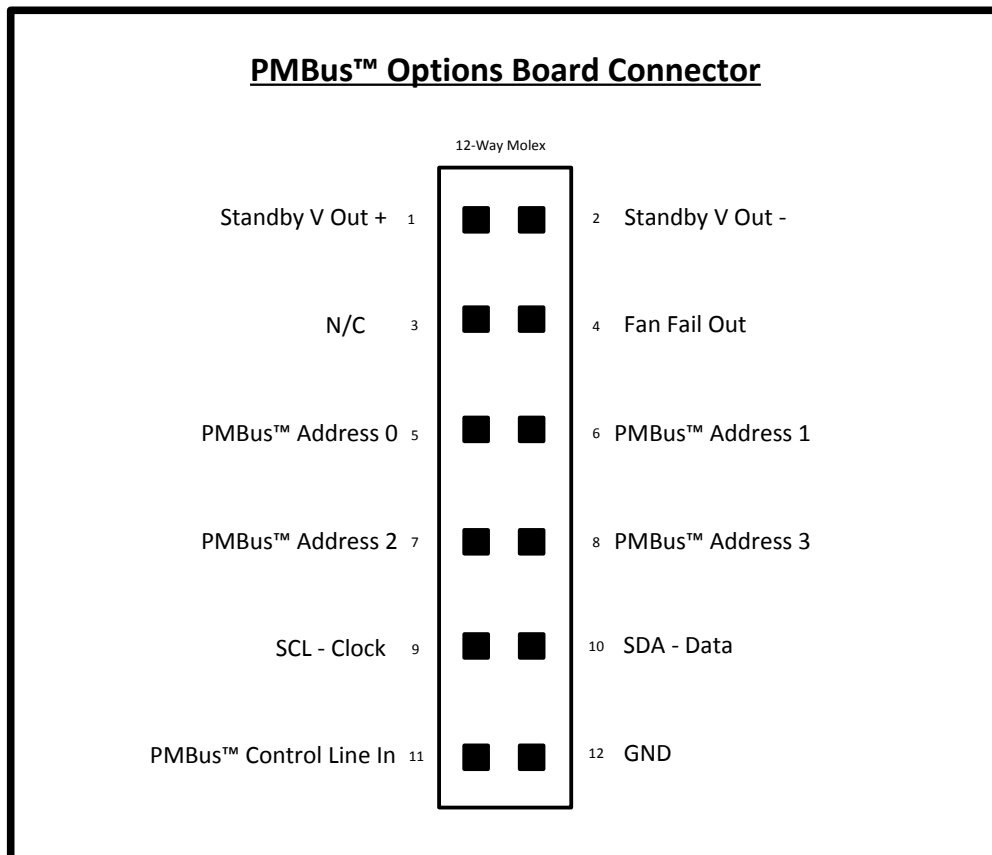
Reading of fan speeds and inlet temperature

Reading operating time and power cycle count

On/Off control of the module outputs by PMBus™ Command, PMBus™ Control Pin, or a combination of both

Up to 8 units may be connected to a single PMBus™ controller

2. Hardware Interface



3. Setting the PMBus™ Address

Each unit in a system sharing a common Bus must use a unique PMBus™ address. The address may be set by grounding the address pins on the connector. The address of the unit is then given by the following table:

A3 Grounded	A2 Grounded	A1 Grounded	A0 Grounded	Address (decimal)
✓	✓	✓	✓	100
✓	✓	✓	✗	101
✓	✓	✗	✓	102
✓	✓	✗	✗	103
✓	✗	✓	✓	104
✓	✗	✓	✗	105
✓	✗	✗	✓	106
✓	✗	✗	✗	107
✗	✓	✓	✓	108
✗	✓	✓	✗	109
✗	✓	✗	✓	110
✗	✓	✗	✗	111
✗	✗	✓	✓	112
✗	✗	✓	✗	113
✗	✗	✗	✓	114
✗	✗	✗	✗	115

By default the address lines are pulled high internally, giving a default PMBus™ address of 115.

4. Supported PMBus™ Commands

See references [1], [2], and [3] for details of the PMBus™ command structure and transaction types.

Command Name	Command Code	Transaction Type(s)	Notes
OPERATION	01h	Read/Write Byte	
ON/OFF CONFIG	02h	Read/Write Byte	
CLEAR FAULTS	03h	Send Byte	
CAPABILITY	19h	Read Byte	
STATUS BYTE	78h	Read/Write Byte	General unit status
STATUS_FANS_1_2	81h	Read/Write Byte	Fan faults or warnings
READ TEMPERATURE	8Dh	Read Word	LINEAR11 format
READ FANSPEED 1	90h	Read Word	LINEAR11 format
READ FANSPEED 1	91h	Read Word	LINEAR11 format
PMBus™ REVISION	98h	Read Byte	
MANUFACTURER ID	99h	Read Block	ASCII string – “TDK_LAMBDA”
MANUFACTURER MODEL	9Ah	Read Block	ASCII String – “QM”
MANUFACTURE DATE	9Dh	Read Block	Special format
SERIAL NUMBER	9Eh	Read Block	ASCII string – 10 characters
RUNTIME	C4h	Read Block	Special format
POWER CYCLE COUNT	C5h	Read Block	Special format
SOFTWARE VERSION NUMBER	C6h	Read Word	Special format

More details for each command are given in the sections below.

5. Controlling the Module Outputs of the Unit

Modes of Operation

There are 6 distinct modes of operation:

1. Module outputs enabled when Input Power is present (factory default)
2. Module outputs enabled when commanded to by the PMBus™ Operation Command
3. Module outputs enabled when the PMBus™ Control Pin is HIGH
4. Module outputs enabled when the PMBus™ Control Pin is LOW
5. Module outputs enabled when commanded to by the PMBus™ Operation Command AND the PMBus™ Control Pin is HIGH
6. Module outputs enabled when commanded to by the PMBus™ Operation Command AND the PMBus™ Control Pin is LOW

The active mode of operation is selected using the On/Off Configuration Command (02h) described below. From the factory, units are programmed to default to mode (1) so that units may be used without a PMBus™ connection.

N.B. The output state of all modules fitted in a QM unit are switched together. Individual control of the separate modules within a QM unit is not possible. If multiple QM units (maximum of 8) are connected to the bus, each unit can be controlled independently.

On/Off Configuration – Command 02h

This command is used to configure the mode of operation of the unit. The read and write byte transaction types are supported. The following table shows the data bytes sent /read that indicate the available modes of operation.

Mode	Data Byte
Module outputs enabled when Input Power is present (factory default)	01h or 03h
Module outputs enabled when commanded to by the PMBus™ Operation Command	19h or 1Bh
Module outputs enabled when the PMBus™ Control Pin is HIGH	17h
Module outputs enabled when the PMBus™ Control Pin is LOW	15h
Module outputs enabled when commanded to by the PMBus™ Operation Command AND the PMBus™ Control Pin is HIGH	1Fh
Module outputs enabled when commanded to by the PMBus™ Operation Command AND the PMBus™ Control Pin is LOW	1Dh

Note that the operating mode is persistent across a power cycle of the QM unit.

Operation – Command 01h

When a unit is in an operating mode dependent upon the PMBus™ Command (modes 2, 5 and 6 above), this command is used to control the unit's module outputs (in combination with the Control

Line if required). QM units only support bit 7 of this command (On/Off State). If any other bit is set in the command data byte, the command is ignored, and a communication error is generated. The only legal commands are as follows:

Commanded State	Data Byte
Module Outputs ENABLED (ON)	80h
Module Outputs DISABLED (OFF)	00h

The commanded On/Off state is not persistent across a power cycle, and will default to OFF when input power is restored to the unit.

Control Line Operation

When a unit is in an operating mode dependent upon the PMBus™ Control Line (modes 3, 4, 5 and 6 above), the Control pin should be set HIGH or LOW as required to control the module outputs (in combination with the PMBus™ Operation Command if required).

6. Reading Status from the Unit - Errors and Warnings

The status of a unit can be determined through a hierarchy of status bytes. Interrogation of a unit starts with reading the Status Byte. Read and Write transactions are supported to the status bytes – writes are used to clear transitory status indicators. If a condition is persistent, a cleared indicator will immediately re-indicate. Bits for unsupported features are always returned as 0.

Status Byte – Command 78h

The following bits of the Status Byte are supported:

Bit Number	Meaning when Bit Set
7	Not Supported
6	Module Outputs are OFF
5	Not Supported
4	Not Supported
3	UV Fault
2	Over Temperature Fault
1	PMBus™ Communication Fault
0	None of the above (this indicates a Fan Fault or Warning has been generated – Read the STATUS_FANS_1_2 status byte for further details)

Read and write byte transactions are supported. To clear an indicator, write a 1 to the relevant bit. Clearing bit 0 will clear all bits in the STATUS_FANS_1_2 byte.

STATUS_FANS_1_2 Status Byte – Command 81h

The following bits of the STATUS_FANS_1_2 status byte are supported:

Bit Number	Meaning when Bit Set
7	Fan1 Fault – Fan 1 running too slow or stopped
6	Fan2 Fault – Fan 2 running too slow or stopped
5	Fan1 Warning – Fan 1 running too fast – check for blockage
4	Fan2 Warning – Fan 2 running too fast - check for blockage
3	Not Supported
2	Not Supported
1	Not Supported
0	Not Supported

Read and write byte transactions are supported. To clear an indicator, write a 1 to the relevant bit. If all bits are clear, bit 0 of the main status byte (command 78h) is also cleared.

Clear Faults – Command 03h

Send byte transaction type. This command is used to clear all fault or warning indications in a single transaction. If conditions are persistent, the errors or warnings will immediately re-indicate.

7. Reading Data from the Unit

Read Temperature – Command 8Dh

Read word transaction type. The temperature is returned in LINEAR11 format. The temperature value is in Celsius.

Read Fan speed 1 – Command 90h

Read word transaction type. The fan speed is returned in LINEAR11 format. The value is in units of RPM. If no fan is fitted this will return 0.

Read Fan speed 2 – Command 91h

Read word transaction type. The fan speed is returned in LINEAR11 format. The value is in units of RPM. If one or no fans are fitted this will return 0.

Manufacturer ID – Command 99h

Read Block transaction type. The value is returned as an ACSII string, and is always equal to "TDK_LAMBDA".

Model ID – Command 9Ah

Read Block transaction type. The value is returned as an ACSII string, and is always equal to "QM".

Manufacture Date – Command 9Dh

Read Block transaction type. The value is returned in 3 bytes as follows:

Byte 1 = Day of Month (1-31)

Byte 2 = Month of Year (1-12 representing January to December)

Byte 3 = Year (16-99 representing 2016 – 2099)

Serial Number – Command 9Eh

Read Block transaction type. The value is returned as a 10 character ACSII string.

Runtime – Command C4h

Read Block transaction type. The data is returned as a 32-bit unsigned value as follows:

Byte 1 = Least Significant Byte

Byte 2 = 2nd Least Significant Byte

Byte 3 = 2nd Most Significant Byte

Byte 4 = Most Significant Byte

Note that the value represents the time the unit has been powered up, which may not equal the time that module outputs have been enabled. The value is in units of ¼ hours e.g. a value of 13 represents 3.25 hours.

Power Cycle Count – Command C5h

Read Block transaction type. The data is returned as a 32-bit unsigned value as follows:

Byte 1 = Least Significant Byte

Byte 2 = 2nd Least Significant Byte

Byte 3 = 2nd Most Significant Byte

Byte 4 = Most Significant Byte

Note that the value represents the number of times that power has been cycled to the unit.

S/W Version Number – Command C6h

Read Word transaction type. The version number is expressed as a major and minor pair as follows:

Byte 1 = Major version number (unsigned value 0-255)

Byte 2 = Minor version number (unsigned value 0-255)

The version number is usually expressed as “<major>.<minor>”.

8. Miscellaneous Commands

Capability – Command 19h

Read byte transaction type. The value returned represents the capability of the PMBus™ implementation. A fixed value is returned by QM units of 80h. This indicates:

- PEC Supported
- 100kHz Max Speed
- SMBAlert Not Supported
- Numeric Format LINEAR11
- AVSBus™ Not Supported

PMBus™ Revision – Command 98h

Read byte transaction type. The value returned represents the PMBus™ revision supported. A fixed value is returned by QM units of 33h. This indicates that the units support PMBus™ version 1.3.

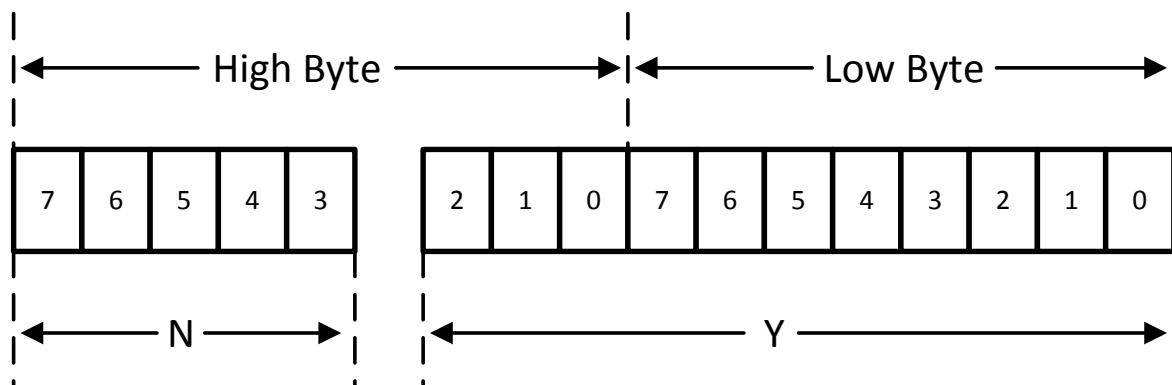
9. LINEAR11 Data Format

Temperature and Fan Speed queries use the LINEAR11 format described below:

The LINEAR11 format is a two byte value with:

- An 11-bit two's complement mantissa (Y)
- A 5-bit two's complement exponent (N)

The format is as follows:



The value represented by the format is given by: $\text{Value} = Y \times 2^N$

10. Recommended Operation

Following a command or query to a unit, the Status Byte should be read to determine if a communication error occurred during the transaction. If a communication error occurred (as indicated by Bit 1 of the Status Byte being set) it should be assumed that the command was not actioned, or the data returned is not valid. The communication error status should then be cleared by writing a 1 to Bit 1 of the Status Byte, followed by a read of the Status Byte to check that it's clear. The command or query should then be repeated and the Status Byte rechecked until no error is reported during the transaction.

11. General Notes

SMBAlert is not supported.

The PMBus™ Group Command is not supported.

PEC (Packet Error Checking) is supported and should be used.

If simultaneous control of the module outputs from multiple QM units is required, this may be achieved using the PMBus™ Control Pin which may be routed to all units. It should be noted that due to differences in module output start-up times, precise synchronisation cannot be guaranteed.

QM units operate as a slave in single master systems only.

A maximum of 8-units may be connected to the bus, each unit must have a unique PMBus™ address.

12. Recommended PMBus™ Interface Adapter

The following USB to PMBus™ adapter is recommended:

Manufacturer: Texas Instruments

Manufacturer Part Number: USB-TO-GPIO

This is available from many suppliers, for example:

Farnell order Code: 1901883

Digi-Key Part Number: 296-23114-ND

RS Stock Number: 819-7562

Mouser Part Number: 595-USB-TO-GPIO

13. References

Ref[1]: System Management Bus (SMBus) Specification. Version 3.0, 20 Dec 2014.

Ref[2]: PMBus™ Power System Management Protocol Specification Part 1 – General Requirements, Transport And Electrical Interface. Revision 1.3.1, 13th March 2015.

Ref[3]: PMBus™ Power System Management Protocol Specification Part II – Command Language. Revision 1.3.1, 13th March 2015.