PMBus Commands

Standard PMBus Commands

All data passed over the PMBus interface uses PEC per the PMBus specification v 1.1 definition. DIRECT data formatting is used for all passed parameters. The m, b, and R coefficients may be obtained from the Data Format table at the end of this application note. It is strongly recommended to make full use of the PEC byte to validate all transactions and repeat if not validated. Block reads (whereby the loose byte received denotes the remaining bytes to be clocked out) are not supported on this 2100W D1U power supply. A minimum 100 μsec delay between transactions (between START and STOP bits) is recommended for robust PMBus communications.

Command Code	Command Name	Transaction Type	Number of data bytes	Comment
0x01	OPERATION	Write	1	Turns on/off power supply. Command argument determines ON/OFF
0x03	CLEAR_FAULTS	Write	0	Clears fault data
0x3A	FAN_CONFIG_1_2	Read	1	
0x3B	FAN_COMMAND_1*	Write	2	Speed set in duty cycle. Value of 1024 = 100% duty cycle. Value of 0 = 0% duty cycle. Minimum fan speed overridden by internal safety concerns.
0x3C	FAN_COMMAND_2*	Write	2	Speed set in duty cycle. Value of 1024 = 100% duty cycle. Value of 0 = 0% duty cycle. Minimum fan speed overridden by internal safety concerns.
0x74	TEST_OUTPUT_ORING	Write	1	Tests output ORing. Use only bit 0 (Lsb). If it's set to 1, test ORING in progress or if it 0, test is complete.
0x80	LINE_RANGE	Read	1	0x00 = Low Line Mode. 0x01 = High Line Mode.
0x88	READ_VIN	Read	2	Read input voltage
0x89	READ_IIN	Read	2	Read input current
0x8B	READ_VOUT	Read	2	Read output voltage
0x8C	READ_IOUT	Read	2	Read output current
0x8D	READ_TEMPERATURE_1	Read	2	Read outlet temperature
0x8E	READ_TEMPERATURE_2	Read	2	Read inlet temperature
0x8F	READ_TEMPERATURE_3	Read	2	Read heatsink temperature (transformer)
0x90	READ_FAN SPEED_1	Read	2	Read RPM Fan 1
0x91	READ_FAN SPEED_2	Read	2	Read RPM Fan 2
0x96	READ_POUT	Read	2	Read Output Power
0x97	READ_PIN	Read	2	Read Input Power
0x98	PMBUS_REVISION	Read	1	Read PMBus revision

* FAN_COMMAND_2 is identical to FAN_COMMAND_1. When the user issues these commands together, the actual fan speed change is made based on the values in last command. Each command changes the speed of both fans; the fan speeds cannot be independently controlled.

Non-standard PMBus commands

The following custom commands may also be used in addition to the supported standard commands. When reading data using the custom commands, the byte order is least significant byte first, most significant byte last. The bit order is most significant bit first, least significant bit last. A minimum 100 μsec delay between transactions (between START and STOP bits) is recommended for robust communications.

Command Code	Command Name	Transaction Type	Number of data bytes	Comment
0xE0	CONTROL_LEDS	Read/Write	1	Turn ON/OFF individual or all LEDs. The argument should specify any or all 3 LEDs
0xE1	EEPROM_WRITE_ENABLE	Read/Write	1	Controls EEPROM write protect
0xE2	READ_FIRMWARE_REVISION	Read	6	Read vendor specific firmware revision.
0xE3	READ_HOURS_USED	Read	3	Read hours used in 1 hour per bit resolution
0xE4	READ_STATUS_DATA	Read	19	Read all status data, details in following table
0xE5	READ_FAULT_DATA	Read	3	Read all fault/warning data, details in following table
0xE6	FAULT_DATA_WRITE_ENABLE	Read/Write	1	Enables fault simulation

Non-standard PMBus commands (continued)

0xE0: CONTROL_LEDS

bit	Description
7	unused
6	unused
5	LED fault override, 1 = host control, 0 = self control
4	LED fault, 1 = on, 0 = 0ff, if bit 5 = 1
3	LED out override, 1 = host control, 0 = self control
2	LED out, 1 = on, 0 = 0ff, if bit 3 = 1
1	LED in override, 1 = host control, 0 = self control
0	LED in, 1 = on, 0 = 0ff, if bit 1 = 1

Above mechanism requires each power supply to check only the override bit before possibly changing the LED state, 2 checks per LED.

0xE1: EEPROM_WRITE_ENABLE

- Data byte = 0 will disable EEPROM writes
- Data byte = 1 will enable EEPROM writes
- All other data will be ignored

0xE2: READ_FIRMWARE_REVISION

This command will read out six bytes of data, indicating internal firmware revision. (The first two bytes are the Primary microcontroller Version/Revision. The next two bytes are the Floating Microcontroller Version/Revision. The last two bytes indicate the Secondary microcontroller Version/Revision.) This command does not support block read; user must clock out six bytes. The primary firmware bytes are reserved and will read 0x00, 0x00 for the D1U4CS-D-2100-xx-HA3xC product.

Example: 0x00, 0x00, 0x01, 0x02, 0x01, 0x02 (Primary reserved; floating ver. 1 rev. 2; secondary ver. 1 rev. 2)

0xE3: READ_HOURS_USED

The HOURS_USED is stored with 1 hour/bit resolution in non-volatile memory. First byte returned from the power supply is the MSB, followed by the middle byte, last by the LSB. This command does not support block reads.

0xE4: READ_STATUS_DATA

The Read_Status_Data commands return 19 bytes of data which represent the current PSM status. The PMBus Direct sensors use the m, b, and R coefficients as specified below (see the Data Format section for more details). The HOURS_USED sensor is an unsigned 24-bit valve with 1 hour/bit resolution, which is stored in non-volatile memory.

Description	Format	Byte	Weight	Bit Format								M	B	R
PIN	PMBus Direct (10-bit unsigned)	0	LSB	D7	D6	D5	D4	D3	D2	D1	D0	3654	0	-4
		1	MSB	0	0	0	0	0	0	D9	D8			
POUT	PMBus Direct (10-bit unsigned)	2	LSB	D7	D6	D5	D4	D3	D2	D1	D0	3654	0	-4
		3	MSB	0	0	0	0	0	0	D9	D8			
VIN	PMBus Direct (10-bit unsigned)	4	LSB	D7	D6	D5	D4	D3	D2	D1	D0	12788	0	-3
		5	MSB	0	0	0	0	0	0	D9	D8			
IIN	PMBus Direct (10-bit unsigned)	6	LSB	D7	D6	D5	D4	D3	D2	D1	D0	14614	0	-3
		7	MSB	0	0	0	0	0	0	D9	D8			
TEMPERATURE_2 (inlet)	PMBus Direct (10-bit unsigned)	8	LSB	D7	D6	D5	D4	D3	D2	D1	D0	639	6394	-2
		9	MSB	0	0	0	0	0	0	D9	D8			
TEMPERATURE_1 (outlet)	PMBus Direct (10-bit unsigned)	10	LSB	D7	D6	D5	D4	D3	D2	D1	D0	639	6394	-2
		11	MSB	0	0	0	0	0	0	D9	D8			
VOUT	PMBus Direct (10-bit unsigned)	12	LSB	D7	D6	D5	D4	D3	D2	D1	D0	D2	D1	D0
		13	MSB	0	0	0	0	0	0	D9	D8			
IOUT	PMBus Direct (10-bit unsigned)	14	LSB	D7	D6	D5	D4	D3	D2	D1	D0	D2	D1	D0
		15	MSB	0	0	0	0	0	0	D9	D8			
HOURS_USED	PMBus Direct (24-bit unsigned)	16	LSB	H7	H6	H5	H4	H3	H2	H1	H0	H2	H1	H0
		17		H15	H14	H13	H12	H11	H10	H9	H8			
		18	MSB	H23	H22	H21	H20	H19	H18	H17	H16			

Non-standard PMBus commands (continued)

0xE5: READ_FAULT_DATA

Faults are represented by 3 Bytes. Below are the bit definitions of each of the 3 bytes. An interrupt will be generated when a bit changes. The interrupt will be cleared after the fault data has been read. (This includes the PEC byte with the 0xE5 read.)

The following table shows the bit values for the different fault conditions. Note that the fault values are latched until they are cleared by 0x03 CLEAR_FAULTS command for all supported faults.

Byte	Bit	Function	Bit state	Fault detection criteria	Input OK LED	Output OK LED	Fault LED	Fault Sig	INT$_X$ Sig.
0	7	Reserved							
0	6	Reserved							
0	5	Reserved							
0	4	Reserved							
0	3	Reserved							
0	2	PEC error	0 ②	CLEAR_FAULTS written with correct PEC byte	n/c	n/c	n/c	H	H
			1	Invalid PEC byte written	n/c	n/c	n/c	H	L
0	1	Vout out of range	0 ②	Conversion active, internal Vout $\geq$ 48.95 and $\leq$ 56.23	n/c	ON	OFF	H	L
			1	Conversion active, internal Vout outside above range	n/c	ON	ON	L	L
0	0	Vin out of range	0 ②	Vin $\geq$ 72.6 AND $\leq$ 43.5	ON	ON	n/c	H	H
			1	Vin $\geq$ 75.0 OR $\leq$ 38.5	BLINK	OFF	n/c	H	L
1	7	Power limited	0 ②	PSU in normal mode, no OCP hiccup	n/c	n/c	n/c	H	H
			1	Main output in overcurrent hiccup mode ①	n/c	BLINK ①	n/c	H	L ①
1	6	Thermal sensor fault	0 ②	No shorted thermal sensor detected	n/c	n/c	OFF	H	H
			1	One or more thermal sensors shorted	n/c	n/c	ON	L	L
1	5	Fault induced shutdown	0 ②	PSU in normal mode	n/c	ON	OFF	H	H
			1	Unknown failure / OR-ing failure / 52V-to-5V short	n/c	OFF	ON	L	L
1	4	Input stage OT ③	0 ②	Inlet temperature $\leq$ 55°C	n/c	ON	OFF	H	H
			1	Inlet temperature $\geq$ 65°C for > 5 sec	n/c	OFF	ON	L	L
1	3	OV shutdown	0 ②	External Vout < 57.6	n/c	ON	OFF	H	H
			1	External Vout > 58	n/c	OFF	ON	L	L
1	2	OT warning	0 ②	Xfmr $\leq$ 115°C AND Outlet $\leq$ 80°C AND Inlet $\leq$ 55°C	n/c	n/c	n/c	H	H
			1	Xfmr $\geq$ 120°C OR Outlet $\geq$ 85°C OR Inlet $\geq$ 65°C	n/c	n/c	n/c	H	L
1	1	OT shutdown	0 ②	[Input Stage OT] = 0 AND [Output Stage OT] = 0	n/c	ON	OFF	H	H
			1	[Input Stage OT] = 1 OR [Output Stage OT] = 0	n/c	OFF	ON	L	L
1	0	OC shutdown	0 ②	No OC shutdown , no output in OC	n/c	ON	OFF	H	H
			1	Main output OC shutdown ④ OR Standby in OC	n/c	OFF ④	ON ④	L ④	L ④
2	7	OR-ing fault	0 ②	TEST_OUTPUT_ORING (0x74) test passed	n/c	n/c	ON	H	H
			1	TEST_OUTPUT_ORING (0x74) test failed	n/c	n/c	OFF	L	L
2	6	Output power bad (Reserved)							
2	5	No input detected	0 ②	Input voltage $\geq$ 30 AND internal bias voltage $\geq$ 10.6	ON	n/c	n/c	H	H
			1	Input voltage < 30 AND internal bias voltage < 7	OFF	n/c	n/c	H	L
2	4	LED test fault (Reserved)							
2	3	Fan fault	0 ②	Fans > 3 kRPM for > 1 sec, tachs and power OK	n/c	n/c	ON	H	H
			1	Any fan < 3 kRPM OR (Bad tach/PWM/power)	n/c	n/c	OFF	L	L
2	2	Output enable pin HI	0 ②	OUT_ENABLE_L pin is L	n/c	ON	n/c	H	H
			1	OUT_ENABLE_L pin is H	n/c	OFF	n/c	H	L
2	1	Output stage OT	0 ②	Xfmr $\leq$ 85°C AND OR-ing $\leq$ 115°C	n/c	ON	OFF	H	H
			1	Xfmr $\geq$ 125°C OR OR-ing $\geq$ 125°C	n/c	OFF	ON	L	L
2	0	5V out of range	0 ②	Internal Vstandby $\geq$ 4.9 AND $\leq$ 5.5	n/c	n/c	OFF	H	H
			1	Internal Vstandby $\leq$ 5.65 OR $\geq$ 4.8 ③	n/c	n/c	ON	L	L

Non-standard PMBus commands (continued)

0xE5: READ_FAULT_DATA (continued)

	Notes
n/c	No change
INT$_X$	Currently active interrupt signal (function of the PCA)
①	If the overload condition lasts > 30 hiccups, hiccupping mode and [Power limited = 1] are held for 30 hiccups, then [OC shutdown = 1] takes over
②	Fault bits are sticky and will stay as 1 (even if conditions clear) until a CLEAR_FAULTS command is sent
③	Standby OVP latches the output off; OCP is hiccup operation
④	[OC shutdown = 1] occurs only after 30 hiccups and [Power limited = 1]

0xE6: FAULT_DATA_WRITE_ENABLE

Writing a 0x00 as the command byte disables writes to FAULT_DATA (0xE5). Writing a 0x01 as the command byte enables writes to FAULT_DATA (0xE5) as a simulation tool.

Data Format

Following table represents recommended use of m, b and R values for different parameters. The parameter conventions are according to the PMBus standard specification:

X = Calculated "real" world value in appropriate units like Volt, Amp or Celsius

Y = Two-byte PMBus DIRECT integer value received from PMBus device

M = Slope coefficient

B = Offset

R = Exponent

PMBus DIRECT formula: $X = \dfrac{1}{M}(Y \cdot 10^{-R} - b)$

Command	Required Range	M	B	R	Minimum Value (X @ Y_min)	Maximum Value (X @ Y_max)	Value (X) resolution per bit
READ_VIN READ_VOUT	0 to 80 V	12788	0	-3	0	79.997	0.0782
READ_IIN READ_IOUT	0 to 70 A	14614	0	-3	0	70.001	0.0684
READ_TEMPERATURE_1 READ_TEMPERATURE_2 READ_TEMPERATURE_3	-10 to 150 C	639	6394	-2	-10.006	150.088	0.1564
READ_FAN_SPEED_1 READ_FAN_SPEED_2	0 to 22,000 RPM	4650	0	-5	0	22000	21.5
READ_POUT READ_PIN	0 to 2799.672 W	3654	0	-4	0	2799.7	2.74
FAN_COMMAND_1 FAN_COMMAND_2	0 to 100%	1023	0	-2	0	100	0.09775

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