

This application note is applicable to the following members of the **D1U54-D-450-12-HxxC** Series.

Standard PMBus™

- To Ensure successful interrogation via PMBus™ interface, the host System must be PEC (Packet Error Checking) enabled. For details, refer to PMBus™ Power Systems Management Protocol Part 1 – General Requirements Rev 1.2.
- [Linear data format](#) is used for all supported parameters as denoted in the following command list table.
- A minimum of 300µs delay between transactions (between the STOP of one command and the START of the next command) is recommended for robust communications.
- Note: The PMBus™ slave controller does “clock stretch” on ACK or NAK.

Device Details

Power Supply Controllers

Vendor	MFG Part Number	Package	Description
Microchip Technology Inc.	DSPIC33EP64GS506T-I/PT	TQFP64	(Secondary) IC Dig SMT Microcontroller dsPIC33 64kB 8kB 70MHz
	DSPIC33EP32GS202T-I/MM	QFN28	(Primary) IC Dig SMT Microcontroller dsPIC33 32kB 2kB 70m

Power Supply External EEPROM

Vendor	MFG Part Number	Package	Description
Microchip Technology Inc.	24AA024T-I/MSG	MSOP8	IC Dig SMT EEPROM CMOS Serial I2C AT24CXX

Device Addressing Methods

There are two methods whereby the three lower order address bits of the seven bit address structure of the internal addressable devices can be assigned (for the secondary microcontroller and the EEPROM device A0, A1 & A2; see the PMBus™ standard). These are as follows:

1. Using the ADDR signal pin (Pin# A3) in digital mode by either:
 - a. Un-terminating (leaving open circuit); this will set a default setting of “111” for the last three addressable bits (A0, A1 & A2) of the seven bit address byte.
 - b. Terminating the pin to RTN/ground (Pin numbers A2/B2); this method will set a default address of “000” for the last three addressable bits (A0, A1 & A2) of the address byte.
2. Using the ADDR signal pin (Pin# A3) in analogue mode by connection of an external resistance to RTN/ground (pin numbers A2/B2). For the possible external resistance values this will result in the following address combinations:

HEX Address Combinations by Analogue Method; ADDR External Resistance Values		
ADDR External Resistance to RTN/Ground (KΩ; ±5% Tolerance)	Power Module Secondary Main Controller (Serial Slave Address)*	Power Module EEPROM (Serial Slave Address)*
0.82	0xB0	0xA0
2.7	0xB2	0xA2
5.6	0xB4	0xA4
8.2	0xB6	0xA6
15	0xB8	0xA8
27	0xBA	0xAA
56	0xBC	0xAC
180	0xBE	0xAE

*D1U54-D-450-12-HxxC adapt a “7-bit left shifted” device addressing; the EEPROM addressing follows a similar convention (commences at base address 0xA0); the lowest order bit of the address is the Read/Write bit. It is assumed that the Read Write bit is set to logic “0” (for addresses shown in the table above).

PMBus™ Commands

Command Code (Hex)	Command Name	Read / Write	Page	Format	# of Bytes	Bit #	Bit Name	Definition	Supported
00	PAGE	R/W	All		1			Command to provide ability to configure, control & monitor multiple parameters such as outputs and temperatures sensors	YES
01	OPERATION	R/W	All	Bit Flags	1	5:0	Link to returned results	Set output margin high/low voltages	NO
						7:6		Turn the unit on/off in conjunction with digital input from PSON_H	YES
02	ON_OFF_CONFIG Link to returned results example	Send	All	Bit Flags	1	0	ON_OFF_DELAY	Set when Turn off immediately (default) / 0 = Use delay @ turn-off	YES
						1	ON_OFF_POLARITY	Set when Power on processing is active high (default)	YES
						2	USE_CONTROL	Set when Use CONTROL pin for on/off power processing (default)	YES
						3	USE_OPERATION	Set when Use OPERATION command for on/off power processing (default)	YES
						4	USE_CNTL_AND_OP	Set when Use both CONTROL pin & OPERATION command (default)	YES
						5	RESERVED		NO
						6	RESERVED		NO
7	RESERVED		NO						
03	CLEAR_FAULTS	W	All		0		Write only command clears all faults that have been set in all the STATUS_XXXX registers simultaneously	YES	
04	PHASE	R/W	All		1		Command to provide the ability to configure, control, and monitor multiple phases on one PMBus unit.	NO	
05	PAGE_PLUS_WRITE	Block Write	All		Var.		Command used to set the page within a device, send a command, and send the data for the command in one packet	YES	
06	PAGE_PLUS_READ	Block Write / Block Read Process Call	All		Var.		Command used to set the page within a device, send a command, and read the data returned by the command in one packet	NO	
10	WRITE_PROTECT	R/W	All		1		Command to provide ability to configure, control & monitor multiple outputs	YES	
11	STORE_DEFAULT_ALL	Send	All		0		Command instructs PMBus device to copy contents of Operating Memory to matching NVM	NO	
12	RESTORE_DEFAULT_ALL	Send	All		0		Command instructs PMBus device to copy contents of NVM to matching Operating Memory	NO	
13	STORE_DEFAULT_CODE	W	All		1		Command instructs the PMBus device to copy the parameter whose Command Code matches value in the data byte, from Operating Memory to matching NVM	NO	
14	RESTORE_DEFAULT_CODE	W	All		1		Command instructs the PMBus device to copy the parameter whose Command Code matches value in the data byte, from NVM to matching Operating Memory	NO	
15	STORE_USER_ALL	Send	All		0		Command instructs the PMBus device to copy the entire contents of Operating Memory to matching NVM	NO	
16	RESTORE_USER_ALL	Send	All		0		Command instructs the PMBus device to copy the entire contents of NVM to matching Operating Memory	NO	
17	STORE_USER_CODE	W	All		1		Command instructs the PMBus device to copy the parameter whose Command Code matches value in the data byte from Operating Memory to matching NVM User Store memory	NO	
18	RESTORE_USER_CODE	W	All		1		Command instructs the PMBus device to copy the parameter whose Command Code matches value in the data byte from NVM to matching Operating Memory Store memory	NO	

Command Code (Hex)	Command Name	Read / Write	Page	Format	# of Bytes	Bit #	Bit Name	Definition	Supported
19	CAPABILITY	R	All	Bit Flags	1	0:3	RESERVED		NO
						4	SMBALERT_L	Set when device has SMBALERT_L pin which supports the SMBus Alert Response protocol	YES
						6:5	MAX_BUS_SPEED	01 = Max supported bus speed = 400kHz; 00 Max supported bus speed = 100kHz	NO
						7	PEC	Set when packet error checking is supported	YES
1A	QUERY	Block Write / Block Read Process Call	All	Bit Flags	1	1:0	RESERVED		NO
						4:2	DATA_FORMAT	PMBus 1.2 Spec Section 11.13 Table 8.	YES
						5	READ_SUPPORT	1 = Supported ; 0 = Not Supported	YES
						6	WRITE_SUPPORT	1 = Supported ; 0 = Not Supported	YES
						7	COMMAND_SUPPORT	1 = Supported ; 0 = Not Supported	YES
1B	SMBALERT_MASK	Block Write / Block Read Process Call	All		2			Command may be used to prevent a warning or fault condition from asserting the SMBALERT# signal	YES
20	VOUT_MODE More about VOUT_MODE	R	0	Bit Flags	1			Single data byte sets the READ_VOUT sensor to linear mode data format and supplies N exponent for translation to volts PMBus Spec - Part II - Revision 1.2 - Sections 8.1-8.3	YES
20	VSTBY_MODE	R	1	Bit Flags	1			Single data byte sets the READ_VSTBY sensor to linear mode data format and supplies N exponent for translation to volts PMBus Spec - Part II - Revision 1.2 - Sections 8.1-8.3	YES
21	VOUT_COMMAND	R/W	0	Linear Data Format	2			Manual override main output setpoint command - Voltage range setting 11.5V - 12.75V Command speed formatted in Linear as per command 0x8B - VOUT_COMMAND	YES
21	VSTBY_COMMAND	R/W	1	Linear Data Format	2			Manual override standby output setpoint command - Voltage range setting x. Command speed formatted in Linear as per command 0x8B - VOUT_COMMAND	NO
22	VOUT_TRIM	R/W	0	Linear Data Format	2			Command used to apply a fixed offset voltage to the output voltage command value	NO
23	VSTBY_TRIM	R/W	1	Linear Data Format	2			Command used to apply a fixed offset voltage to the output voltage command value	NO
23	VOUT_CAL_OFFSET	R/W	0	Linear Data Format	2			Command used to apply a fixed offset voltage to the output voltage command value	NO
23	VSTBY_CAL_OFFSET	R/W	1	Linear Data Format	2			Command used to apply a fixed offset voltage to the output voltage command value	NO
24	VOUT_MAX	R/W	0	Linear Data Format	2			Command sets upper limit output voltage can be set regardless of other command/combination	NO
24	VSTBY_MAX	R/W	1	Linear Data Format	2			Command sets upper limit output voltage can be set regardless of other command/combination	NO
25	VOUT_MARGIN_HIGH	R/W	0	Linear Data Format	2			Load the unit with the voltage to which the output is to be changed when the OPERATION command set to "Margin High"	NO
25	VSTBY_MARGIN_LOW	R/W	1	Linear Data Format	2			Load the unit with the voltage to which the output is to be changed when the OPERATION command set to "Margin High"	NO
26	VOUT_MARGIN_HIGH	R/W	0	Linear Data Format	2			Load the unit with the voltage to which the output is to be changed when the OPERATION command set to "Margin Low"	NO
26	VSTBY_MARGIN_LOW	R/W	1	Linear Data Format	2			Load the unit with the voltage to which the output is to be changed when the OPERATION command set to "Margin Low"	NO
27	VOUT_TRANSITION_RATE	R/W	0	Linear Data Format	2			Command sets the rate in mV/μs at which the output should change voltage	NO
27	VSTBY_TRANSITION_RATE	R/W	1	Linear Data Format	2			Command sets the rate in mV/μs at which the output should change voltage	NO

Command Code (Hex)	Command Name	Read / Write	Page	Format	# of Bytes	Bit #	Bit Name	Definition	Supported
28	VOUT_DROOP	R/W	0	Linear Data Format	2			Command sets the rate (mV/A) which output voltage decreases (or increases) with increasing (or decreasing) output current (in Adaptive Voltage Positioning/passive current sharing)	NO
28	VSTBY_DROOP	R/W	1	Linear Data Format	2			Command sets the rate (mV/A) which output voltage decreases (or increases) with increasing (or decreasing) output current (in Adaptive Voltage Positioning/passive current sharing)	NO
29	VOUT_SCALE_LOOP	R/W	0	Linear Data Format	2			PMBus Spec - Part II - Revision 1.2 - Section 13.10	NO
29	VSTBY_SCALE_LOOP	R/W	1	Linear Data Format	2			PMBus Spec - Part II - Revision 1.2 - Section 13.10	NO
2A	VOUT_SCALE_MONITOR	R/W	0	Linear Data Format	2			PMBus Spec - Part II - Revision 1.2 - Section 13.11	NO
2A	VSTBY_SCALE_MONITOR	R/W	1	Linear Data Format	2			PMBus Spec - Part II - Revision 1.2 - Section 13.11	NO
30	COEFFICIENTS	Block Write / Block Read Process Call	All		5			Command used to retrieve the m, b and R coefficients needed by data in the DIRECT format	NO
31	POUT_MAX	R/W	All	Linear Data Format	2			Commands sets output power (watts) which unit starts regulating in constant power mode	NO
32	MAX_DUTY	R/W	All	Linear Data Format	2			Command sets maximum duty cycle (%) of the unit's powerconversion stage	NO
33	FREQUENCY_SWITCH	R/W	All	Linear Data Format	2			Command sets switching frequency (kHz) of a PMBus device	NO
35	VIN_ON	R/W	All	Linear Data Format	2			Command sets value of input voltage (Vdc/Vrms) at which unit should start power conversion	NO
36	VIN_OFF	R/W	All	Linear Data Format	2			Command sets value of input voltage (Vdc/Vrms) at which unit should stop power conversion	NO
37	INTERLEAVE	R/W	All	Bit Flags	2			PMBus Spec - Part II - Revision 1.2 - Section 14.7	NO
38	IOUT_CAL_GAIN	R/W	All	Linear Data Format	2			Command used to set the ratio of the voltage at the current sense pins to the sensed current	NO
39	IOUT_CAL_OFFSET	R/W	All	Linear Data Format	2			Command used to null out any offsets in the output current sensing circuit	NO
3A	FAN_CONFIG_1_2	R	All	Bit Flags	1	0	FAN_2_TACH_PULSES	Fan 2 Tachometer pulses per revolution (lower bit)	NO
						1	FAN_2_TACH_PULSES	Fan 2 Tachometer pulses per revolution (upper bit)	NO
						2	FAN_2_SETTING_MODE	Set when fan is commanded in RPM (Clear when fan is commanded in Duty Cycle)	NO
						3	FAN_2_INSTALLATION	Set when fan is installed in position 2	NO
						4	FAN_1_TACH_PULSES	Fan 1 Tachometer pulses per revolution (lower bit)	YES
						5	FAN_1_TACH_PULSES	Fan 1 Tachometer pulses per revolution (upper bit)	YES
						6	FAN_1_SETTING_MODE	Set when fan is commanded in RPM (Clear when fan is commanded in Duty Cycle)	YES
						7	FAN_1_INSTALLATION	Set when fan is installed in position 1	YES
3B	FAN_COMMAND_1 Link to more details	R/W	All	Linear Data Format	2		Manual fan override command fan speed value in Duty Cycle Command speed formatted in Linear as per command 0x90 - READ_FAN_SPEED_1	YES	
3C	FAN_COMMAND_2	R/W	All	Linear Data Format	2		Manual fan override command fan speed value in Duty Cycle Command speed formatted in Linear as per command 0x91 - READ_FAN_SPEED_2	NO	

Command Code (Hex)	Command Name	Read / Write	Page	Format	# of Bytes	Bit #	Bit Name	Definition	Supported
3D	FAN_CONFIG_3_4	R	All	Bit Flags	1	0	FAN_4_TACH_PULSES	Fan 4 Tachometer pulses per revolution (lower bit)	NO
						1	FAN_4_TACH_PULSES	Fan 4 Tachometer pulses per revolution (upper bit)	NO
						2	FAN_4_SETTING_MODE	Set when fan is commanded in RPM (Clear when fan is commanded in Duty Cycle)	NO
						3	FAN_4_INSTALLATION	Set when fan is installed in position 4	NO
						4	FAN_3_TACH_PULSES	Fan 3 Tachometer pulses per revolution (lower bit)	NO
						5	FAN_3_TACH_PULSES	Fan 3 Tachometer pulses per revolution (upper bit)	NO
						6	FAN_3_SETTING_MODE	Set when fan is commanded in RPM (Clear when fan is commanded in Duty Cycle)	NO
						7	FAN_3_INSTALLATION	Set when fan is installed in position 3	NO
3E	FAN_COMMAND_3	R/W	All	Linear Data Format	2		Manual fan override command fan speed value in Duty Cycle Command speed formatted in Linear as per command 0x92 - READ_FAN_SPEED_3	NO	
3F	FAN_COMMAND_4	R/W	All	Linear Data Format	2		Manual fan override command fan speed value in Duty Cycle Command speed formatted in Linear as per command 0x93 - READ_FAN_SPEED_4	NO	
40	VOUT_OV_FAULT_LIMIT	R	0	Linear Data Format	2		Main Output Overvoltage Fault Limit	YES	
40	VSTBY_OV_FAULT_LIMIT	R	1	Linear Data Format	2		Standby(Auxilliary) Output Overvoltage Fault Limit	NO	
41	VOUT_OV_FAULT_RESPONSE	R	0	Bit Flags	1		Main Output Overvoltage Fault Response Actions	YES	
41	VSTBY_OV_FAULT_RESPONSE	R	1	Bit Flags	1		Standby(Auxilliary) Output Overvoltage Fault Response Actions	NO	
42	VOUT_OV_WARN_LIMIT	R	0	Linear Data Format	2		Main Output Overvoltage Warning Limit	YES	
42	VSTBY_OV_WARN_LIMIT	R	1	Linear Data Format	2		Standby(Auxilliary) Output Overvoltage Warning Limit	NO	
43	VOUT_UV_WARN_LIMIT	R	0	Linear Data Format	2		Main Output Undervoltage Warning Limit	YES	
43	VSTBY_UV_WARN_LIMIT	R	1	Linear Data Format	2		Standby(Auxilliary) Output Undervoltage Warning Limit	NO	
44	VOUT_UV_FAULT_LIMIT	R	0	Linear Data Format	2		Main Output Undervoltage Fault Limit	YES	
44	VSTBY_UV_FAULT_LIMIT	R	1	Linear Data Format	2		Standby(Auxilliary) Output Undervoltage Fault Limit	NO	
45	VOUT_UV_FAULT_RESPONSE	R	0	Bit Flags	1		Main Output Undervoltage Fault Response Actions	YES	
45	VSTBY_UV_FAULT_RESPONSE	R	1	Bit Flags	1		Standby(Auxilliary) Output Undervoltage Fault Response Actions	NO	
46	IOUT_OC_FAULT_LIMIT	R	0	Linear Data Format	2		Main Output Overcurrent Fault Limit	YES	
46	ISTBY_OC_FAULT_LIMIT	R	1	Linear Data Format	2		Standby(Auxilliary) Output Overcurrent Fault Limit	YES	
47	IOUT_OC_FAULT_RESPONSE	R	0	Bit Flags	1		Main Output Overcurrent Fault Response Actions	YES	
47	ISTBY_OC_FAULT_RESPONSE	R	1	Bit Flags	1		Standby(Auxilliary) Output Overcurrent Fault Response Actions	YES	
48	IOUT_OC_LV_FAULT_LIMIT	R	0	Linear Data Format	2		Main Output Overcurrent Foldback Fault Limit	NO	
48	ISTBY_OC_LV_FAULT_LIMIT	R	1	Linear Data Format	2		Standby(Auxilliary) Output Overcurrent Foldback Fault Limit	NO	
49	IOUT_OC_LV_FAULT_RESPONSE	R	0	Bit Flags	1		Main Output Overcurrent Foldback Fault Response Actions	NO	
49	ISTBY_OC_LV_FAULT_RESPONSE	R	1	Bit Flags	1		Standby(Auxilliary) Output Overcurrent Foldback Fault Response Actions	NO	
4A	IOUT_OC_WARN_LIMIT	R	0	Linear Data Format	2		Main Output Overcurrent Warning Limit	YES	
4A	ISTBY_OC_WARN_LIMIT	R	1	Linear Data Format	2		Standby(Auxilliary) Output Overvoltage Warning Limit	YES	

[Example of returned parameters](#)

Command Code (Hex)	Command Name	Read / Write	Page	Format	# of Bytes	Bit #	Bit Name	Definition	Supported
4B	IOUT_UC_FAULT_LIMIT	R	0	Linear Data Format	2			Main Output Undercurrent Fault Limit	NO
4B	ISTBY_UC_FAULT_LIMIT	R	1	Linear Data Format	2			Standby(Auxilliary) Output Undercurrent Fault Limit	NO
4C	IOUT_UC_FAULT_RESPONSE	R	0	Bit Flags	1			Main Output Undercurrent Fault Response Actions	NO
4C	ISTBY_UC_FAULT_RESPONSE	R	1	Bit Flags	1			Standby(Auxilliary) Output Undercurrent Fault Response Actions	NO
4F	AIRFLOW_1_OT_FAULT_LIMIT	R	0	Linear Data Format	2			Airflow 1 Overtemperature Fault Limit	YES
4F	AIRFLOW_2_OT_FAULT_LIMIT	R	1	Linear Data Format	2			Hotspot 1 Overtemperature Fault Limit	YES
4F	HOTSPOT_1_OT_FAULT_LIMIT	R	2	Linear Data Format	2			Airflow 2 Overtemperature Fault Limit	YES
4F	HOTSPOT_2_OT_FAULT_LIMIT	R	3	Linear Data Format	2			Hotspot 2 Overtemperature Fault Limit	YES
50	AIRFLOW_1_OT_FAULT_RESPONS E	R	0	Bit Flags	1			Airflow 1 Overtemperature Fault Response Actions	YES
50	HOTSPOT_1_OT_FAULT_RESPONS E	R	1	Bit Flags	1			Hotspot 1 Overtemperature Fault Response Actions	YES
50	AIRFLOW_2_OT_FAULT_RESPONS E	R	2	Bit Flags	1			Airflow 2 Overtemperature Fault Response Actions	YES
50	HOTSPOT_2_OT_FAULT_RESPONS E	R	3	Bit Flags	1			Hotspot 2 Overtemperature Fault Response Actions	YES
51	AIRFLOW_1_OT_WARN_LIMIT	R	0	Linear Data Format	2			Airflow 1 Overtemperature Warning Limit	YES
51	AIRFLOW_2_OT_WARN_LIMIT	R	1	Linear Data Format	2			Hotspot 1 Overtemperature Warning Limit	YES
51	HOTSPOT_1_OT_WARN_LIMIT	R	2	Linear Data Format	2			Airflow 2 Overtemperature Warning Limit	YES
51	HOTSPOT_2_OT_WARN_LIMIT	R	3	Linear Data Format	2			Hotspot 2 Overtemperature Warning Limit	YES
52	AIRFLOW_1_UT_FAULT_LIMIT	R	0	Linear Data Format	2			Airflow 1 Undertemperature Fault Limit	NO
52	AIRFLOW_2_UT_FAULT_LIMIT	R	1	Linear Data Format	2			Hotspot 1 Undertemperature Fault Limit	NO
52	HOTSPOT_1_UT_FAULT_LIMIT	R	2	Linear Data Format	2			Airflow 2 Undertemperature Fault Limit	NO
52	HOTSPOT_2_UT_FAULT_LIMIT	R	3	Linear Data Format	2			Hotspot 2 Undertemperature Fault Limit	NO
53	AIRFLOW_1_UT_FAULT_RESPONS E	R	0	Bit Flags	1			Airflow 1 Undertemperature Fault Response Actions	NO
53	AIRFLOW_2_UT_FAULT_RESPONS E	R	1	Bit Flags	1			Hotspot 1 Undertemperature Fault Response Actions	NO
53	HOTSPOT_1_UT_FAULT_RESPONS E	R	2	Bit Flags	1			Airflow 2 Undertemperature Fault Response Actions	NO
53	HOTSPOT_2_UT_FAULT_RESPONS E	R	3	Bit Flags	1			Hotspot 2 Undertemperature Fault Response Actions	NO
55	VIN_OV_FAULT_LIMIT	R	All	Linear Data Format	2			Input Overvoltage Fault Limit	YES
56	VIN_OV_FAULT_RESPONSE	R	All	Bit Flags	1			Input Overvoltage Fault Response Actions	YES
57	VIN_OV_WARN_LIMIT	R	All	Linear Data Format	2			Input Overvoltage Warning Limit	YES
58	VIN_UV_WARN_LIMIT	R	All	Linear Data Format	2			Input Undervoltage Warning Limit	YES
59	VIN_UV_FAULT_LIMIT	R	All	Linear Data Format	2			Input Undervoltage Fault Limit	YES
5A	VIN_UV_FAULT_RESPONSE	R	All	Bit Flags	1			Input Undervoltage Fault Response Actions	YES
5B	IIN_OC_FAULT_LIMIT	R	All	Linear Data Format	2			Input Overcurrent Fault Limit	YES
5C	IIN_OC_FAULT_RESPONSE	R	All	Bit Flags	1			Input Overcurrent Fault Response Actions	YES
5D	IIN_OC_WARN_LIMIT	R	All	Linear Data Format	2			Input Overcurrent Warning Limit	YES
5E	POWER_GOOD_ON	R	All	Linear Data Format	2			Power Good On Main Output Voltage Limit	YES
5F	POWER_GOOD_OFF	R	All	Linear Data Format	2			Power Good Off Main Output Voltage Limit	YES

Example of returned parameters

Command Code (Hex)	Command Name	Read / Write	Page	Format	# of Bytes	Bit #	Bit Name	Definition	Supported	
60	TON_DELAY	R	All	Linear Data Format	2		Example of returned parameters	Sets the time (mSec) from when a start condition is received (as programmed by the ON_OFF_CONFIG command) until the output voltage starts to rise	NO	
61	TON_RISE	R	All	Linear Data Format	2			Sets the time (mSec) from when the output starts to rise until the voltage has entered the regulation band.	NO	
62	TON_MAX_FAULT_LIMIT	R	All	Linear Data Format	2			Command sets an upper limit (mSec) on how long the unit can attempt to power up the output without reaching the output undervoltage fault limit	NO	
63	TON_MAX_FAULT_RESPONSE	R	All	Bit Flags	1			Command instructs the device on what action to take in response to a TON_MAX fault	NO	
64	TOFF_DELAY	R	All	Linear Data Format	2			Sets the time (mSec) from a stop condition is received (as programmed by the ON_OFF_CONFIG command) until the unit stops transferring energy to the output	NO	
65	TOFF_FALL	R	All	Linear Data Format	2			Sets the time (mSec) from the end of the turn-off delay time until the voltage is commanded to zero.	NO	
66	TOFF_MAX_WARN_LIMIT	R	All	Linear Data Format	2			Command sets an upper limit(mSec), on how long unit can attempt to power down output without reaching 12.5% of the output voltage programmed at the time the unit is turned off	NO	
68	POUT_OP_FAULT_LIMIT	R	All	Linear Data Format	2			Output Overpower Fault Limit	YES	
69	POUT_OP_FAULT_RESPONSE	R	All	Bit Flags	1			Output Overpower Fault Response Actions	YES	
6A	POUT_OP_WARN_LIMIT	R	All	Linear Data Format	2			Output Overpower Warning Limit	YES	
6B	PIN_OP_WARN_LIMIT	R	All	Linear Data Format	2			Input Overpower Warning Limit	YES	
78	STATUS_BYTE	R/W	All	Bit Flags	1	0		NONE_F_W	Set when a fault not listed in [7:1] occurred	NO
						1		CML_F	Set when a communications, memory, or logic fault has occurred	YES
						2	TEMPERATURE_F_W	Set when an overtemperature fault or warning has occurred	YES	
						3	INPUT_UV_F	Set when an input undervoltage fault has occurred	YES	
						4	OUTPUT_OC_F	Set when an output overcurrent fault has occurred	YES	
						5	OUTPUT_OV_F	Set when an output overvoltage fault has occurred	YES	
						6	UNIT_OFF	Set when unit not providing power to the output	YES	
						7	BUSY_F	Assserted when device busy and unable to respond fault	YES	

Command Code (Hex)	Command Name	Read / Write	Page	Format	# of Bytes	Bit #	Bit Name	Definition	Supported
79	STATUS_WORD	R	All	Bit Flags	2	0	NONE_F_W	Set when a fault not listed in [7:1] occurred	NO
						1	CML_F	Set when a communications, memory, or logic fault has occurred	YES
						2	TEMPERATURE_F_W	Set when an overtemperature fault or warning has occurred	YES
						3	INPUT_UV_F	Set when an input undervoltage fault has occurred	YES
						4	OUTPUT_OC_F	Set when an output overcurrent fault has occurred	YES
						5	OUTPUT_OV_F	Set when an output overvoltage fault has occurred	YES
						6	UNIT_OFF	Set when unit not providing power to the output	YES
						7	BUSY_F	Asserted when device busy and unable to respond fault	YES
						8	UNKNOWN_F_W	Set when a fault not listed in [15:1] has occurred	NO
						9	STATUS_OTHER_F_W	Set when a bit in command STATUS_OTHER set	NO
						10	FANS_F_W	Set when a fan fault or warning has occurred	YES
						11	POWER_GOOD_L	Set when the POWER_GOOD signal is negated	YES
						12	MFR_SPECIFIC_F_W	Manufacturer specific fault or warning has occurred	YES
						13	INPUT_F_W	Set when an Input voltage/current/power fault or warning has occurred	YES
						14	IOUT_POUT_F_W	Set when an output current / output power fault or warning has occurred	YES
15	VOUT_F_W	Set when an output voltage fault or warning has occurred	YES						
7A	STATUS_VOUT	R/W	0	Bit Flags	1	0	VOUT_TRACKING_E	Set when an error in the output voltage during power-up/down has occurred	NO
						1	TON_MAX_W	Set when the output turn-on timing has exceeded the TON_MAX warning timing	NO
						2	TON_MAX_F	Set when the output turn-on timing has exceeded the TON_MAX fault timing	NO
						3	VOUT_MAX_F	Set when the output is set higher than the commanded VOUT_MAX limit	NO
						4	VOUT_UV_F	Set when an output undervoltage fault has occurred	YES
						5	VOUT_UV_W	Set when an output undervoltage warning has occurred	YES
						6	VOUT_OV_W	Set when an output overvoltage warning has occurred	YES
						7	VOUT_OV_F	Set when an output overvoltage fault has occurred	YES
7A	STATUS_VSTBY	R/W	1	Bit Flags	1	0	VOUT_TRACKING_E	Set when an error in the output voltage during power-up/down has occurred	NO
						1	TON_MAX_W	Set when the output turn-on timing has exceeded the TON_MAX warning timing	NO
						2	TON_MAX_F	Set when the output turn-on timing has exceeded the TON_MAX fault timing	NO
						3	VOUT_MAX_F	Set when the output is set higher than the commanded VOUT_MAX limit	NO
						4	VOUT_UV_F	Set when an output undervoltage fault has occurred	NO
						5	VOUT_UV_W	Set when an output undervoltage warning has occurred	YES
						6	VOUT_OV_W	Set when an output overvoltage warning has occurred	YES
						7	VOUT_OV_F	Set when an output overvoltage fault has occurred	YES

Command Code (Hex)	Command Name	Read / Write	Page	Format	# of Bytes	Bit #	Bit Name	Definition	Supported
7B	STATUS_IOUT	R/W	0	Bit Flags	1	0	POUT_OP_W	Set when an output overpower warning has occurred	YES
						1	POUT_OP_F	Set when an output overpower fault has occurred	YES
						2	POWER_LIMIT_MODE	Set when the unit has entered output power limiting mode	NO
						3	CURRENT_SHARE_F	Set when an output current share fault has occurred	NO
						4	IOUT_UC_W	Set when an output undercurrent fault has occurred	NO
						5	IOUT_OC_W	Set when an output overcurrent warning has occurred	YES
						6	IOUT_OC_SHUTDOWN	Set when an output overcurrent and low voltage shutdown fault has occurred	YES
						7	IOUT_OC_F	Set when an output overcurrent fault has occurred	YES
7B	STATUS_ISTBY	R/W	1	Bit Flags	1	0	POUT_OP_W	Set when an output overpower warning has occurred	NO
						1	POUT_OP_F	Set when an output overpower fault has occurred	NO
						2	POWER_LIMIT_MODE	Set when the unit has entered output power limiting mode	NO
						3	CURRENT_SHARE_F	Set when an output current share fault has occurred	NO
						4	IOUT_UC_W	Set when an output undercurrent fault has occurred	NO
						5	IOUT_OC_W	Set when an output overcurrent warning has occurred	YES
						6	IOUT_OC_SHUTDOWN	Set when an output overcurrent and low voltage shutdown fault has occurred	YES
						7	IOUT_OC_F	Set when an output overcurrent fault has occurred	YES
7C	STATUS_INPUT	R/W	All	Bit Flags	1	0	PIN_OP_W	Set when an input overpower warning has occurred	YES
						1	IIN_OC_W	Set when an input overcurrent warning has occurred	YES
						2	IIN_OC_F	Set when an input overcurrent fault has occurred	YES
						3	VIN_UV_OFF	Set when the Unit is OFF for insufficient input voltage	YES
						4	VIN_UV_F	Set when an input undervoltage fault has occurred	NO
						5	VIN_UV_W	Set when an input undervoltage warning has occurred	YES
						6	VIN_OV_W	Set when an input overvoltage warning has occurred	YES
						7	VIN_OV_F	Set when an input overvoltage fault has occurred	YES
7D	STATUS_TEMPERATURE	R/W	All	Bit Flags	1	0	RESERVED	Reserved	NO
						1	RESERVED	Reserved	NO
						2	RESERVED	Reserved	NO
						3	RESERVED	Reserved	NO
						4	TEMPERATURE_UT_F	Set when an undertemperature fault has occurred	NO
						5	TEMPERATURE_UT_W	Set when an undertemperature warning has occurred	NO
						6	TEMPERATURE_OT_W	Set when an overtemperature warning has occurred	YES
						7	TEMPERATURE_OT_F	Set when an overtemperature fault has occurred	YES

Command Code (Hex)	Command Name	Read / Write	Page	Format	# of Bytes	Bit #	Bit Name	Definition	Supported
7E	STATUS_CML	R/W	All	Bit Flags	1	0	OTHER_MEMORY_F	Set when another memory or logic fault has occurred	NO
						1	OTHER_COMM_F	Set when a communication fault not listed in [7:3] has occurred (example: UART or SPI)	YES
						2	RESERVED	Reserved	NO
						3	PROCESSOR_F	Set when a processor fault is detected	NO
						4	MEMORY_F	Set when a memory fault is detected (example: Checksum errors during bootloader)	NO
						5	PEC_ERROR_F	Set when a packet error checking (PEC) failed has occurred	YES
						6	DATA_ERROR_F	Set when invalid or unsupported data is received	YES
						7	COMMAND_ERROR_F	Set when an invalid or unsupported command is received	YES
7F	STATUS_OTHER	R/W	All	Bit Flags	1	0	RESERVED	Reserved	NO
						1	ORING_OUTPUT_F	Set when output ORing device fault occurs	NO
						2	ORING_INPUT_B_F	Set when input B ORing device fault occurs	NO
						3	ORING_INPUT_A_F	Set when input A ORing device fault occurs	NO
						4	FUSE_INPUT_B_F	Set when input B fuse/breaker fault occurs	NO
						5	FUSE_INPUT_A_F	Set when input A fuse/breaker fault occurs	NO
						6	RESERVED	Reserved	NO
						7	RESERVED	Reserved	NO
80	STATUS_MFR_SPECIFIC	R/W	All	Bit Flags	1	0	RESERVED	Reserved	NO
						1	VBUS_SOFTSTART_F	Set when the primary boost output bus does not reach regulation in specified time	YES
						2	VINT_RANGE_W	Set when an internal voltage (VCC2, VCC4, or VDD) out-of-range warning has occurred	NO
						3	VINT_RANGE_F	Set when an internal voltage (VCC2, VCC4, or VDD) out-of-range fault has occurred	YES
						4	VBUS_UV_F	Set when the primary boost output bus undervoltage fault has occurred	YES
						5	VBUS_UV_W	Set when the primary boost output bus undervoltage warning has occurred	YES
						6	VBUS_OV_W	Set when the primary boost output bus overvoltage warning has occurred	YES
						7	VBUS_OV_F	Set when the primary boost output bus overvoltage fault has occurred	YES
81	STATUS_FANS_1_2	R/W	All	Bit Flags	1	0	FAN_AIRFLOW_W	Airflow warning	NO
						1	FAN_AIRFLOW_F	Airflow fault	NO
						2	FAN_2_OVERRIDE	Fan 2 speed overridden	NO
						3	FAN_1_OVERRIDE	Fan 1 speed overridden	YES
						4	FAN_2_W	Fan 2 warning	NO
						5	FAN_1_W	Fan 1 warning	YES
						6	FAN_2_F	Fan 2 fault	NO
						7	FAN_1_F	Fan 1 fault	YES
82	STATUS_FANS_3_4	R/W	All	Bit Flags	1	0	FAN_AIRFLOW_W	Airflow warning	NO
						1	FAN_AIRFLOW_F	Airflow fault	NO
						2	FAN_4_OVERRIDE	Fan 4 speed overridden	NO
						3	FAN_3_OVERRIDE	Fan 3 speed overridden	NO
						4	FAN_4_W	Fan 4 warning	NO
						5	FAN_3_W	Fan 3 warning	NO
						6	FAN_4_F	Fan 4 fault	NO
						7	FAN_3_F	Fan 3 fault	NO
86	READ_EIN	BLOCK READ	All	PMBus Spec 18.13	5		Input Energy Consumption Sensor	YES	
87	READ_EOUT	BLOCK READ	All	PMBus Spec 18.13	5		Output Energy Consumption Sensor	YES	
88	READ_VIN	R	All	Linear Data Format	2		Input Voltage Sensor Reading	YES	
89	READ_IIN	R	All	Linear Data Format	2		Input Current Sensor Reading	YES	
8A	READ_VCAP	R	All	Linear Data Format	2		PFC Output Voltage Sensor Reading	YES	
8B	READ_VOUT	R	0	Linear Data Format	2		Main Output Voltage Sensor Reading	YES	
8B	READ_VSTBY	R	1	Linear Data Format	2		Standby(Auxilliary) Output Voltage Sensor Reading	YES	

Command Code (Hex)	Command Name	Read / Write	Page	Format	# of Bytes	Bit #	Bit Name	Definition	Supported
8C	READ_IOUT	R	0	Linear Data Format	2			Main Output Current Sensor Reading	YES
8C	READ_ISTBY	R	1	Linear Data Format	2			Standby(Auxilliary) Output Current Sensor Reading	YES
8D	READ_TEMPERATURE_1	R	0	Linear Data Format	2			Airflow 1 Temperature Sensor Reading	YES
8E	READ_TEMPERATURE_2	R	1	Linear Data Format	2			Airflow 2 Temperature Sensor Reading	YES
8F	READ_TEMPERATURE_3	R	2	Linear Data Format	2			Hotspot 1 Temperature Sensor Reading	YES
8F	READ_TEMPERATURE_3	R	3	Linear Data Format	2			Hotspot 2 Temperature Sensor Reading	YES
90	READ_FAN_SPEED_1	R	All	Linear Data Format	2			Fan 1 Speed Sensor Reading	YES
91	READ_FAN_SPEED_2	R	All	Linear Data Format	2			Fan 2 Speed Sensor Reading	NO
92	READ_FAN_SPEED_3	R	All	Linear Data Format	2			Fan 3 Speed Sensor Reading	NO
93	READ_FAN_SPEED_4	R	All	Linear Data Format	2			Fan 4 Speed Sensor Reading	NO
94	READ_DUTY CYCLE	R	All	Linear Data Format	2			Command returns the duty of the PMBus device's main power converter in percent	NO
95	READ_FREQUENCY	R	All	Linear Data Format	2			Command returns the switching frequency of PMBus device's main power converter in KHz	NO
96	READ_POUT	R	All	Linear Data Format	2			Output Power Sensor Reading	YES
97	READ_PIN	R	All	Linear Data Format	2			Input Power Sensor Reading	YES
98	PMBUS_REVISION	R	All	HEX	1			PMBus Specification Revision	YES
99	MFR_ID	BLOCK READ	All	Ascii Text Block	10			Power Supply Company Name	YES
9A	MFR_MODEL	BLOCK READ / BLOCK WRITE	All	Ascii Text Block	32 Max			Power Supply Model Number	YES
9B	MFR_REVISION	BLOCK READ	0	Ascii Text Block	17			Power Supply Firmware Revision	YES
9B	MFR_REVISION	BLOCK READ	1	Ascii Text Block	17			Power Supply Firmware Revision	YES
9B	MFR_REVISION	BLOCK READ	2	Ascii Text Block	17			Power Supply Firmware Revision	NO
9C	MFR_LOCATION	BLOCK READ / BLOCK WRITE	All	Ascii Text Block	16 Max			Power Supply Manufacture Location	YES
9D	MFR_DATE	BLOCK READ / BLOCK WRITE	All	Ascii Text Block	16 Max			Power Supply Manufacture Date	YES
9E	MFR_SERIAL	BLOCK READ / BLOCK WRITE	All	Ascii Text Block	16 Max			Power Supply Serial Number	YES
9F	APP_PROFILE SUPPORT	BLOCK READ	All		Var			Command provides a mean for a host to determine which PMBus Applications Profiles, and the revision of those profiles, that the device supports	YES
A0	MFR_VIN_MIN	R	All	Linear Data Format	2			Power Supply Input Voltage Minimum Specification	YES
A1	MFR_VIN_MAX	R	All	Linear Data Format	2			Power Supply Input Voltage Maximum Specification	YES
A2	MFR_IIN_MAX	R	All	Linear Data Format	2			Power Supply Input Current Maximum Specification	YES
A3	MFR_PIN_MAX	R	All	Linear Data Format	2			Power Supply Input Power Maximum Specification	YES
A4	MFR_VOUT_MIN	R	All	Linear Data Format	2			Power Supply Main Output Voltage Minimum Specification	YES

Command Code (Hex)	Command Name	Read / Write	Page	Format	# of Bytes	Bit #	Bit Name	Definition	Supported
A5	MFR_VOUT_MAX	R	All	Linear Data Format	2			Power Supply Main Output Voltage Maximum Specification	YES
A6	MFR_IOUT_MAX	R	All	Linear Data Format	2			Power Supply Main Output Current Maximum Specification	YES
A7	MFR_POUT_MAX	R	All	Linear Data Format	2			Power Supply Output Power Maximum Specification	YES
A8	MFR_TAMBIENT_MAX	R	All	Linear Data Format	2			Power Supply Operating Ambient Temperature Maximum Specification	YES
A9	MFR_TAMBIENT_MIN	R	All	Linear Data Format	2			Power Supply Operating Ambient Temperature Minimum Specification	YES
AA	MFR_EFFICIENCY_LL	R	All	Linear Data Format	2			Power Supply Low-Line Input Voltage Specification	YES
				Linear Data Format	2			Power Supply Low-Line Low Power Specification	YES
				Linear Data Format	2			Power Supply Low-Line Low Power Efficiency Specification	YES
				Linear Data Format	2			Power Supply Low-Line Medium Power Specification	YES
				Linear Data Format	2			Power Supply Low-Line Medium Power Efficiency Specification	YES
				Linear Data Format	2			Power Supply Low-Line High Power Specification	YES
				Linear Data Format	2			Power Supply Low-Line High Power Efficiency Specification	YES
AB	MFR_EFFICIENCY_HL	R	All	Linear Data Format	2			Power Supply High-Line Input Voltage Specification	YES
				Linear Data Format	2			Power Supply High-Line Low Power Specification	YES
				Linear Data Format	2			Power Supply High-Line Low Power Efficiency Specification	YES
				Linear Data Format	2			Power Supply High-Line Medium Power Specification	YES
				Linear Data Format	2			Power Supply High-Line Medium Power Efficiency Specification	YES
				Linear Data Format	2			Power Supply High-Line High Power Specification	YES
				Linear Data Format	2			Power Supply High-Line High Power Efficiency Specification	YES
AC	MFR_PIN_ACCURACY	R	All	Linear Data Format	2			Command returns the accuracy (%) of the value returned by the READ_PIN command	YES
AD	IC_DEVICE_ID	BLOCK READ	All	Ascii Text Block	32 Max			Command used to set or read the type or part number of IC embedded within a PMBus that is used for the PMBus interface	YES
AE	IC_DEVICE_REV	BLOCK READ	All	Ascii Text Block	32 Max			Command is used set or read the revision of the IC whose type or part number is set or read with the IC_DEVICE_ID command	NO
B0	USER_DATA_00	R/W	All	Ascii Text Block	24			Customer text data block 00	NO
B1	USER_DATA_01	R/W	All	Ascii Text Block	24			Customer text data block 01	NO
B2	USER_DATA_02	R/W	All	Ascii Text Block	24			Customer text data block 02	NO
B3	USER_DATA_03	R/W	All	Ascii Text Block	24			Customer text data block 03	NO
C0	MFR_MAX_TEMP_1	R	All	Linear Data Format	2			Maximum temperature (degC) associated with READ_TEMPERATURE_1 - Inlet	YES
C1	MFR_MAX_TEMP_2	R	All	Linear Data Format	2			Maximum temperature (degC) associated with READ_TEMPERATURE_2 - Outlet	YES
C2	MFR_MAX_TEMP_3	R	0	Linear Data Format	2			Maximum temperature (degC) associated with READ_TEMPERATURE_3 - Hotspot 1	YES
C2	MFR_MAX_TEMP_3	R	1	Linear Data Format	2			Maximum temperature (degC) associated with READ_TEMPERATURE_3 - Hotspot 2	YES

Command Code (Hex)	Command Name	Read / Write	Page	Format	# of Bytes	Bit #	Bit Name	Definition	Supported
E0	PS_STATUS	R	All	Bit Flags	2	0	CALIBRATION	Set when the unit is in Calibration mode	YES
						1	VSTBY_SELECT	Set when Vstby set to 5V; de-Set when Vstby set to 3.3V	NO
						2	PS_KILL	Set when the PS_KILL pin is defeated and the unit is properly seated in the chassis	YES
						3	VIN_OK	Set when the input voltage is within operating specification	YES
						4	VIN_RANGE	Set when input voltage range is high; de-Set when input voltage range is low	YES
						5	PFC_BUS	Set when the PFC BUS is within operating specification	YES
						6	PS_ON	Set when the PS_ON logic set to enable the main output	YES
						7	POWER_GOOD	Set when main output power delivered to unit is OK; mirrors the digital output signal	YES
						8	POWER_DOWN	Set when bootloader is taking control and the main output and PFC need to be shutdown	YES
						9	BOOTLOAD_COMPLETED	Set when the bootloader has completed and system reset needs to be Set	YES
						10	UNUSED		NO
						11	UNUSED		NO
						12	UNUSED		NO
						13	UNUSED		NO
						14	WARNING	Set when power supply warning has occurred; tracks 'WARNING' status LED	YES
15	FAULT	Set when power supply fault has occurred; tracks 'FAULT' status LED	YES						
E1	EEPROM_WP	R/W	All	Integer	1		Link to returned results	Byte to enable (write 0x9A) or disable (write 0x56) writes to the external EEPROM	YES
E2	READ_HOURS_USED	BLOCK READ	All	Linear Data Format	3			Power Supply Accumulated Main Output Power-On Hours	YES
EE	PMBUS_CONFIG Link to default settings	R/W	All	Bit Flags	2	0	DATA_FORMAT	0 = Linear data format 1 = Direct data format	NO
						1	SMBALERT_L	0 = SMBALERT_L implemented & supported 1 = SMBALERT not implemented	YES
						2	MAX_BUS_SPEED	0 = 100kHz 1 = 400kHz	NO
						3	PEC	0 = PEC not supported 1 = PEC supported	YES
						4:7	RESERVED		NO
						8:15	CMD_KEY	Command activation/verification key = 0x5A	YES
EF	LED_CONTROL	R	All	Bit Flags	1	0:2	LED_MODE	LED mode change bits	YES
						3:6	RESERVED		NO
						7	LED_CONTROL	LED manual/auto control toggle bit	NO
F0	READ_RESETS	R	All	Bit Flags	2		RCON register status flags for troubleshooting	YES	
				Bit Flags	2		RCON2 register status flags for troubleshooting		
F8	BOOTLOAD_RESTART	R/W	All	HEX	1		Bootloader completion and application restart request command	YES	
FA	BOOTLOAD_REQUEST	R/W	All	Ascii Text Block	6		Bootloader request command	YES	
FB	BOOTLOAD_STATUS	R	All	Bit Flags	2	0	BOOTLOADING_PRI	Set when primary uC bootloading in process	YES
						1	BOOTLOADING_FLOAT	Set when floating uC bootloading in process	YES
						2	BOOTLOADING_SEC	Set when secondary uC bootloading in process	YES
						3	BOOTLOADED_PRI	Set when primary uC bootloading completed; reset required	YES
						4	BOOTLOADED_FLOAT	Set when floating uC bootloading completed; reset required	YES
						5	BOOTLOADED_SEC	Set when secondary uC bootloading completed; reset required	YES
						6	RESET_PRI	Set when primary uC reset	YES
						7	RESET_FLOAT	Set when floating uC reset	YES
						8	RESET_SEC	Set when secondary uC reset	YES
						9	RESERVED		NO
						10	RESERVED		NO
						11	RESERVED		NO
						12	RESERVED		NO
						13	RESERVED		NO
						14	RESERVED		NO
15	RESERVED		NO						

The following tables represent examples of returned results and response that can be expected and are presented to assist the designer in interpreting the results of the unit under test. Actual results will vary depending upon the specific model under test. For example, an HA4C model will have different overtemperature parameters for faults and warning than HA3C, due to airflow direction differences.

Limits and Response, D1U54-D-450-12-HA4C, 5VSB, B-F Airflow

Link back to: [command list](#)

Command Code (Hex)	Command Name	Read / Write	Page	Format	# of Bytes	Units	Scaling Coefficients				Bit #	Reading	Comments
							N	m	R	b			
40	VOUT_OV_FAULT_LIMIT	R	0	Linear Data Format	2	Vdc	-6					14	Vout mode
40	VSTBY_OV_FAULT_LIMIT	R	1	Linear Data Format	2	Vdc	-7					12	Not supported – PSU hardware protected, refer to Datasheet for limits
41	VOUT_OV_FAULT_RESPONSE	R	0	Bit Flags	1						2:0	0	Delay Time - None
											5:3	0	Retry Setting - Unit does not attempt to restart & output remains disabled until fault clear
											7:6	3	Response - Output disabled while fault is present & remains disabled until fault cleared (COh returned)
41	VSTBY_OV_FAULT_RESPONSE	R	1	Bit Flags	1						2:0	0	Delay Time - None
											5:3	0	Retry Setting - Unit does not attempt to restart & output remains disabled until fault clear
											7:6	3	Response - Output disabled while fault is present & remains disabled until fault cleared
42	VOUT_OV_WARN_LIMIT	R	0	Linear Data Format	2	Vdc	-6					13.5	
42	VSTBY_OV_WARN_LIMIT	R	1	Linear Data Format	2	Vdc	-7					11	Not supported
43	VOUT_UV_WARN_LIMIT	R	0	Linear Data Format	2	Vdc	-6					11.4	
43	VSTBY_UV_WARN_LIMIT	R	1	Linear Data Format	2	Vdc	-7					9	Not supported
44	VOUT_UV_FAULT_LIMIT	R	0	Linear Data Format	2	Vdc	-6					10.9	
44	VSTBY_UV_FAULT_LIMIT	R	1	Linear Data Format	2	Vdc	-7					8.41	Not supported
45	VOUT_UV_FAULT_RESPONSE	R	0	Bit Flags	1						2:0	0	Delay Time - None
											5:3	0	Retry Setting - Unit does not attempt to restart & output remains disabled until fault clear
											7:6	3	Response - Output disabled while fault is present & remains disabled until fault cleared
45	VSTBY_UV_FAULT_RESPONSE	R	1	Bit Flags	1						2:0	0	Delay Time - None
											5:3	0	Retry Setting - Unit does not attempt to restart & output remains disabled until fault clear
											7:6	3	Response - Output disabled while fault is present & remains disabled until fault cleared

Command Code (Hex)	Command Name	Read / Write	Page	Format	# of Bytes	Units	Scaling Coefficients				Bit #	Reading	Comments
							N	m	R	b			
46	IOUT_OC_FAULT_LIMIT	R	0	Linear Data Format	2	Adc	-4					46.5	
46	ISTBY_OC_FAULT_LIMIT	R	2	Linear Data Format	2	Adc	-7					2.6	
47	IOUT_OC_FAULT_RESPONSE	R	0	Bit Flags	1						2:0	0	Delay Time - None
											5:3	7	Retry Setting - Unit does not attempt to restart & output remains disabled until fault clear, after several retry attempts
											7:6	3	Response - Continuous restart (self-recovery) for several retries
47	ISTBY_OC_FAULT_RESPONSE	R	2	Bit Flags	1						2:0	0	Delay Time - None
											5:3	7	Response - Continuous restart (self-recovery)
											7:6	3	Response - Output disabled while fault is present & remains disabled until fault cleared
4A	IOUT_OC_WARN_LIMIT	R	0	Linear Data Format	2	Adc	-4					42.5	
4A	ISTBY_OC_WARN_LIMIT	R	2	Linear Data Format	2	Adc	-7					2.3	
4F	AIRFLOW_1_OT_FAULT_LIMIT	R	0	Linear Data Format	2	°C	0					75	Secondary Airflow - Inlet
4F	AIRFLOW_2_OT_FAULT_LIMIT	R	1	Linear Data Format	2	°C	0					110	Primary Airflow – Outlet
4F	HOTSPOT_1_OT_FAULT_LIMIT	R	2	Linear Data Format	2	°C	0					130	Secondary Hotspot - Main output hotspot
4F	HOTSPOT_2_OT_FAULT_LIMIT	R	3	Linear Data Format	2	°C	0					120	Primary Hotspot - PFC
50	AIRFLOW_1_OT_FAULT_RESPONSE	R	0	Bit Flags	1						2:0	0	Delay Time - None
											5:3	0	Retry Setting - Unit does not attempt to restart & output remains disabled until fault clear
											7:6	3	Response - Output disabled while fault is present & remains disabled until fault cleared
50	AIRFLOW_2_OT_FAULT_RESPONSE	R	1	Bit Flags	1						2:0	0	Delay Time - None
											5:3	0	Retry Setting - Unit does not attempt to restart & output remains disabled until fault clear
											7:6	3	Response - Output disabled while fault is present & remains disabled until fault cleared
50	HOTSPOT_1_OT_FAULT_RESPONSE	R	2	Bit Flags	1						2:0	0	Delay Time - None
											5:3	0	Retry Setting - Unit does not attempt to restart & output remains disabled until fault clear
											7:6	3	Response - Output disabled while fault is present & remains disabled until fault cleared

Command Code (Hex)	Command Name	Read / Write	Page	Format	# of Bytes	Units	Scaling Coefficients				Bit #	Reading	Comments
							N	m	R	b			
50	HOTSPOT_2_OT_FAULT_RESPONSE	R	3	Bit Flags	1						2:0	0	Delay Time - None
											5:3	0	Retry Setting - Unit does not attempt to restart & output remains disabled until fault clear
											7:6	3	Response - Output disabled while fault is present & remains disabled until fault cleared
51	AIRFLOW_1_OT_WARN_LIMIT	R	0	Linear Data Format	2	°C	0					70	Secondary Airflow - Inlet
51	AIRFLOW_2_OT_WARN_LIMIT	R	1	Linear Data Format	2	°C	0					105	Primary Airflow – Outlet
51	HOTSPOT_1_OT_WARN_LIMIT	R	2	Linear Data Format	2	°C	0					125	Secondary Hotspot - Main output hotspot
51	HOTSPOT_2_OT_WARN_LIMIT	R	3	Linear Data Format	2	°C	0					115	Primary Hotspot - PFC
55	VIN_OV_FAULT_LIMIT	R	0	Linear Data Format	2	Vrms	-1					76	Recoverable
56	VIN_OV_FAULT_RESPONSE	R	0	Bit Flags	1						2:0	0	Delay Time - None
											5:3	0	Retry Setting - Unit does not attempt to restart & output remains disabled until fault clear
											7:6	3	Response - Output disabled while fault is present & remains disabled until fault cleared
57	VIN_OV_WARN_LIMIT	R	0	Linear Data Format	2	Vrms	-1					74	Recoverable
58	VIN_UV_WARN_LIMIT	R	0	Linear Data Format	2	Vrms	-1					40	Recoverable
59	VIN_UV_FAULT_LIMIT	R	0	Linear Data Format	2	Vrms	-1					38	Recoverable
5A	VIN_UV_FAULT_RESPONSE	R	0	Bit Flags	1						2:0	0	Delay Time - None
											5:3	0	Retry Setting - Unit does not attempt to restart & output remains disabled until fault clear
											7:6	3	Response - Output disabled while fault is present & remains disabled until fault cleared
5B	IIN_OC_FAULT_LIMIT	R	0	Linear Data Format	2	Arms	-7					22	
5C	IIN_OC_FAULT_RESPONSE	R	0	Bit Flags	1						2:0	0	Delay Time - None
											5:3	0	Retry Setting - Unit does not attempt to restart & output remains disabled until fault clear
											7:6	3	Response - Output disabled while fault is present & remains disabled until fault cleared
5D	IIN_OC_WARN_LIMIT	R	0	Linear Data Format	2	Arms	-7					16	
5E	POWER_GOOD_ON	R	0	Linear Data Format	2	Vdc	-6					10.9	Vout mode
5F	POWER_GOOD_OFF	R	0	Linear Data Format	2	Vdc	-6					10.9	Vout mode

Command Code (Hex)	Command Name	Read / Write	Page	Format	# of Bytes	Units	Scaling Coefficients				Bit #	Reading	Comments
							N	m	R	b			
68	POUT_OP_FAULT_LIMIT	R	0	Linear Data Format	2	Watts	0					570	
69	POUT_OP_FAULT_RESPONSE	R	0	Bit Flags	1						2:0	0	Delay Time - None
											5:3	0	Retry Setting - Unit does not attempt to restart & output remains disabled until fault clear
											7:6	0	Response - Output disabled while fault is present & remains disabled until fault cleared
6A	POUT_OP_WARN_LIMIT	R	0	Linear Data Format	2	Watts	0					510	
6B	PIN_OP_WARN_LIMIT	R	0	Linear Data Format	2	Watts	0					640	POUT_OP_WARN_LIMIT / 0.84

SENSOR DATA AND RESOLUTION: D1U54P-W-450-12- HA4C
[Link Back to: command 88](#)

Command Code (Hex)	Command Name	Description	Page	Format	Units	Scaling Coefficients				Raw Sensor		PMBus Reporting Sensor		
						N	m	R	b	Full-scale / Range	Resolution	Full-scale / Range	Resolution	Accuracy
88	READ_VIN	Input Voltage Sensor Reading	All	Linear Data Format	Vrms	-1				327.93	0.3206	511.5	0.5	+ / - 2% of Reporting Full-Scale
89	READ_IIN	Input Current Sensor Reading	All	Linear Data Format	Arms	-7				17.86	0.0175	7.99	0.0078	+ / - 5% of Reporting Full-Scale
8A	READ_VCAP	PFC Output Voltage Sensor Reading	All	Linear Data Format	Vdc	-1				463	0.4526	511.50	0.5000	+ / - 2% of Reporting Full-Scale
8B	READ_VOVT	Main Output Voltage Sensor Reading	0	Linear Data Format	Vdc	-6				14.79	0.0145	15.98	0.0156	+ / - 2% of Reporting Full-Scale
8B	READ_VSTBY	Standby(Auxiliary) Output Voltage Sensor Reading	1	Linear Data Format	Vdc	-7				6.02	0.0059	7.992	0.00781	+ / - 2% of Reporting Full-Scale
8C	READ_IOVT	Main Output Current Sensor Reading	0	Linear Data Format	Adc	-4				50.58	0.0494	63.94	0.063	+ / - 2% of Reporting Full-Scale
8C	READ_ISTBY	Standby(Auxiliary) Output Current Sensor Reading	1	Linear Data Format	Adc	-7				6.05	0.0059	7.992	0.00781	+ / - 2% of Reporting Full-Scale
8D	READ_TEMPERATURE_1	Temperature Sensor Reading - Inlet (Secondary Side)	All	Linear Data Format	°C	0				-40 to 150		-40 to 150	1	+ / - 5°C
8E	READ_TEMPERATURE_2	Temperature Sensor Reading - Outlet (Primary Side)	All	Linear Data Format	°C	0				-40 to 150		-40 to 150	1	+ / - 5°C
8F	READ_TEMPERATURE_3	Temperature Sensor Reading - Main Output Hotspot (Secondary Side)	0	Linear Data Format	°C	0				-40 to 150		-40 to 150	1	+ / - 5°C
8F	READ_TEMPERATURE_3	Temperature Sensor Reading - PFC Hotspot (Primary Side)	1	Linear Data Format	°C	0				-40 to 150		-40 to 150	1	+ / - 5°C
90	READ_FAN_SPEED_1	Fan 1 Speed Sensor Reading	All	Linear Data Format	RPM	5				16,000		32736	32	+ / - 5% of Reporting Full-Scale
96	READ_POVT	Output Power Sensor Reading	All	Linear Data Format	Watts	0						1023	1	+ / - 5% of Reporting Full-Scale
97	READ_PIN	Input Power Sensor Reading	All	Linear Data Format	Watts	0						1023	1	+ / - 5% of Reporting Full-Scale
E2	READ_POWER_ON_HOURS	Accumulated Main Output Power-On Hours	All	Linear Data Format	Hours	0				~1,900 (Years)		~1,900 (Years)	1	+ / - 3%

MANUFACTURER'S GENERAL PARAMETRIC DATA D1U54P-W-450-12- HA4C
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Link back to: [command list](#)

Command Code (h)	Page	Command Name	Value (Real World)	Units	N	Value (d)	Notes
A0	0	MFR_VIN_MIN	40.5	V	-3	324	
A1	0	MFR_VIN_MAX	72	V	-3	576	
A2	0	MFR_IIN_MAX	11.5	A	-5	368	
A3	0	MFR_PIN_MAX	450	W	0	450	
A4	0	MFR_VOUT_MIN	11.88	V	-6	760	V-Out Mode
A5	0	MFR_VOUT_MAX	12.13	V	-6	776	V-Out Mode
A6	0	MFR_IOUT_MAX	37.5	A	-4	600	
A4	1	MFR_VSTBY_MIN	4.76	V	-7	609	
A5	1	MFR_VSTBY_MAX	5.24	V	-7	671	
A6	1	MFR_ISTBY_MAX	4	A	-7	512	
A7	0	MFR_POUT_MAX	450	W	0	450	
A8	0	MFR_TAMBIENT_MAX	50	C	0	50	
A9	0	MFR_TAMBIENT_MIN	-5	C	0	2043	
AA	0	MFR_EFFICIENCY_LL_LENGTH	14			E	
		MFR_EFFICIENCY_LL_VIN	48	V	-3	384	
		MFR_EFFICIENCY_LL_POUT1	90	W	0	90	
		MFR_EFFICIENCY_LL_EFF1	0.92	%	-10	942	
		MFR_EFFICIENCY_LL_POUT2	225	W	0	225	
		MFR_EFFICIENCY_LL_EFF2	0.93	%	-10	952	
		MFR_EFFICIENCY_LL_POUT3	450	W	0	450	
AB	0	MFR_EFFICIENCY_HL_LENGTH	14				
		MFR_EFFICIENCY_HL_VIN	48	V	-3	384	
		MFR_EFFICIENCY_HL_POUT1	90	W	0	90	
		MFR_EFFICIENCY_HL_EFF1	-0.92	%	-10	-942	
		MFR_EFFICIENCY_HL_POUT2	225	W	0	225	
		MFR_EFFICIENCY_HL_EFF2	0.93	%	-10	952	
		MFR_EFFICIENCY_HL_POUT3	450	W	0	450	
		MFR_EFFICIENCY_HL_EFF3	0.9	%	-10	922	

OPERATION COMMAND CODE 01 HEX

 Link Back to Commands: [command 01](#)

Bit # / Bit Description								Valid Values		Power Supply On/Off Mode
7	6	5	4	3	2	1	0	Dec	Hex	
On/off 1	On/off 0	Margin on/off/high/low 1	Margin on/off/high/low 0	Margin fault control 1	Margin fault control 0	not used	not used			
0	0	x	x	x	x	x	x	0 - 63	0 - 3F	Disable power supply when OPERATION command supported
1	0	x	x	x	x	x	x	128 - 191	80 - BF	Enable power supply when OPERATION command supported (Default)

ON/OFF COMMAND CODE 02 HEX

 Link Back to Command list: [command 02](#)

Bit # / Bit Description								Valid Values		Power Supply On/Off Mode
7	6	5	4	3	2	1	0	Dec	Hex	
reserved	reserved	Reserved	CONTROL pin / OPERATION command PS on/off	OPERATION command on/off	CONTROL pin on/off	CONTROL pin polarity	CONTROL pin action			
0	0	0	1	0	1	0	1	21	15	Control pin only ; active low polarity
0	0	0	1	0	1	1	1	23	17	Control pin only ; active high polarity
0	0	0	1	1	0	x	1	25 or 27	19 or 1B	Operation command only
0	0	0	1	1	1	0	1	29	1D	Operation command and control pin ; active low polarity
0	0	0	1	1	1	1	1	31	1F	Operation command and control pin; active high polarity

External EEPROM write protect settings:

 Link back to command list: [E1](#)

Bit # / Bit Description								Valid Values		Read / Write	FRU EEPROM Write Protect CONTROL
7	6	5	4	3	2	1	0	Dec	Hex		
WP Control Bit 7	WP Control Bit 6	WP Control Bit 6	WP Control Bit 4	WP Control Bit 3	WP Control Bit 2	WP Control Bit 1	WP Control Bit 0				
1	0	0	1	1	0	1	0	154	9A	Read / Write	EEPROM write protect enabled - write to device not allowed
1	0	1	0	1	1	0	0	86	56	Read / Write	EEPROM write protect disabled - write to device allowed

PMBUS Configuration Defaults (Note: changes to configuration requires power supply restart)

Link back to: [command EE](#)

Bit # / Bit Description															Read / Write	PMBus Configuration	
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1			0
CMD Key Bit 7	CMD Key Bit 6	CMD Key Bit 5	CMD Key Bit 4	CMD Key Bit 3	CMD Key Bit 2	CMD Key Bit 1	CMD Key Bit 0	R e s.	R e s.	R e s.	R e s.	P E C	Bus Speed	SMBALERT	Data Format		
0	1	0	1	1	0	1	0	X	X	X	X	0	0	0	0	Read	1.No PEC Support 2.100kHz 3. SMBALERT supported 4. Linear Data format
0	1	0	1	1	0	1	0	X	X	X	X	0	0	0	1	Read	1.No PEC Support 2.100kHz 3. SMBALERT supported 4. Direct Data format
0	1	0	1	1	0	1	0	X	X	X	X	0	0	1	0	Read	1.No PEC Support 2.100kHz 3. No SMBALERT support 4. Linear Data format
0	1	0	1	1	0	1	0	X	X	X	X	0	0	1	1	Read	1.No PEC Support 2.100kHz 3. No SMBALERT support 4. Direct Data format
0	1	0	1	1	0	1	0	X	X	X	X	0	1	0	0	Read	1.No PEC Support 2.400kHz 3. SMBALERT supported 4. Linear Data format
0	1	0	1	1	0	1	0	X	X	X	X	0	1	0	1	Read	1.No PEC Support 2.400kHz 3. SMBALERT supported 4. Direct Data format
0	1	0	1	1	0	1	0	X	X	X	X	0	1	1	1	Read	1.No PEC Support 2.400kHz 3. No SMBALERT support 4. Direct Data format
0	1	0	1	1	0	1	0	X	X	X	X	1	0	0	0	Read	1.PEC supported 2.100kHz 3. SMBALERT supported 4. Linear Data format
0	1	0	1	1	0	1	0	X	X	X	X	1	0	0	1	Read	1.PEC supported 2.100kHz 3. SMBALERT supported 4. Direct Data format
0	1	0	1	1	0	1	0	X	X	X	X	1	0	1	0	Read	1.PEC supported 2.100kHz 3. No SMBALERT support 4. Linear Data format
0	1	0	1	1	0	1	0	X	X	X	X	1	0	1	1	Read	1.PEC supported 2.100kHz 3. No SMBALERT support 4. Direct Data format
0	0	0	0	0	0	0	0	X	X	X	X	1	1	0	0	Read	1.PEC supported 2.400kHz 3. SMBALERT supported 4. Linear Data format DEFAULT
0	1	0	1	1	0	1	0	X	X	X	X	1	1	0	1	Read	1.PEC supported 2.400kHz 3. SMBALERT supported 4. Direct Data format
0	1	0	1	1	0	1	0	X	X	X	X	1	1	1	0	Read	1.PEC supported 2.400kHz 3. No SMBALERT support 4. Linear Data format
0	1	0	1	1	0	1	0	X	X	X	X	1	1	1	1	Read	1.PEC supported 2.400kHz 3. No SMBALERT support 4. Direct Data format

LED CONTROL

Link back to command EF: [CMD EF BACK](#)

Bit # / Bit Description								Dec	Hex	Read / Write	LED Status & Control
7	6	5	4	3	2	1	0				
CONTROL Bit	reserved	reserved	reserved	reserved	LED Mode Bit 2	LED Mode Bit 1	LED Mode Bit 0				
Page 0 - INPUT LED											
0	0	0	0	0	0	0	0	0	0	Read	Auto - LED off -Default
0	0	0	0	0	0	0	1	1	1	Read	Auto - LED solid green – Default
0	0	0	0	0	0	1	0	2	2	Read	Auto - LED blinking green – Default
0	X	X	X	X	X	X	X	0 - 127	0 - 7F	Write	Set to Auto LED control
1	0	0	0	0	0	0	0	128	80	Read / Write	Set to Manual - LED off
1	0	0	0	0	0	0	1	129	81	Read / Write	Set to Manual - LED solid green
1	0	0	0	0	0	1	0	130	82	Read / Write	Set to Manual - LED blinking green
Page 1 - OUTPUT LED											
0	0	0	0	0	0	0	0	0	0	Read	Auto - LED off – Default
0	0	0	0	0	0	0	1	1	1	Read	Auto - LED solid green – Default
0	0	0	0	0	0	1	0	2	2	Read	Auto - LED blinking green – Default
0	0	0	0	0	0	1	1	3	3	Read	Auto - LED solid red – Default
0	0	0	0	0	1	0	0	4	4	Read	Auto - LED blinking red – Default
0	0	0	0	0	1	0	1	5	5	Read	Auto - LED solid yellow – Default
0	0	0	0	0	1	1	0	6	6	Read	Auto - LED blinking yellow – Default
0	X	X	X	X	X	X	X	0 - 127	0 - 7F	Write	Set to Auto LED control
1	0	0	0	0	0	0	0	128	80	Read / Write	Set to Manual - LED off
1	0	0	0	0	0	0	1	129	81	Read / Write	Set to Manual - LED solid green
1	0	0	0	0	0	1	0	130	82	Read / Write	Set to Manual - LED blinking green
1	0	0	0	0	0	1	1	131	83	Read / Write	Set to Manual - LED solid red
1	0	0	0	0	1	0	0	132	84	Read / Write	Set to Manual - LED blinking red
1	0	0	0	0	1	0	1	133	85	Read / Write	Set to Manual - LED solid yellow
1	0	0	0	0	1	1	0	134	86	Read / Write	Set to Manual - LED blinking yellow

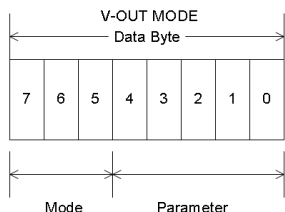
Command Code 20h (V_Out mode) returned results:

Link back to [command 20](#)

V-OUT Mode Protocol:

Commanding and/or reading output voltage requires two steps and applies to this product except as noted:

- 1) CMD_20 (V-OUT MODE) defines which of the three formats (LINEAR, VID OR DIRECT) is used:



Mode definition			Returned results for CMD_20h				
Mode	Bits (7:5)	Bits (4:0) (Parameter)	Command Code (Hex)	Command Name	Value	Bit#	Value
Linear (Default)	000b	Five bit two's complement exponent for the mantissa delivered as the data bytes for an output voltage command. Bits 4:0 returned= 11010b = N=-6 (Default)	20	VOUT_MODE	1Ah	Bit 7	0
						Bit 6	0
						Bit 5	0
						Bit 4	1
						Bit 3	1
						Bit 2	0
						Bit 1	1
						Bit 0	0

- 2) The Command Bytes, or mantissa can then be used to calculate real world values for the output voltage commands and parameters:

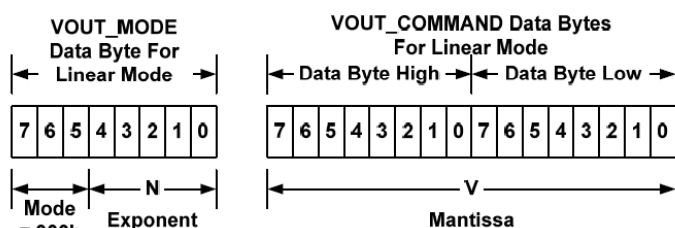


Figure 6. Linear Format Data Bytes

The Mode bits are set to 000b.

The Voltage, in volts, is calculated from the equation:

$$Voltage = V \cdot 2^N$$

Where:

Voltage is the parameter of interest in volts;

V is a 16 bit unsigned binary integer; and

N is a 5 bit two's complement binary integer.

All other parameters and commands use Linear mode and associated real world values are calculated as follows:

Link back to [front page](#)

Linear Data Format

The Linear Data Format is typically used for commanding and reporting the parameters such as (but not only) the following:

- Output Current,
- Input Voltage,
- Input Current,
- Operating Temperatures,
- Time (durations), and
- Energy Storage Capacitor Voltage.

The Linear Data Format is a two byte value with:

- An 11 bit, two's complement mantissa and
- A 5 bit, two's complement exponent (scaling factor).

The format of the two data bytes is illustrated in Figure 4.

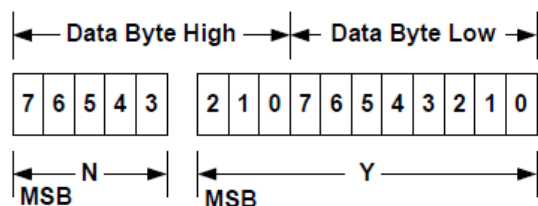


Figure 4. Linear Data Format Data Bytes

The relation between Y , N and the "real world" value is:

$$X = Y \cdot 2^N$$

Where, as described above:

X is the "real world" value;

Y is an 11 bit, two's complement integer; and

N is a 5 bit, two's complement integer.

Devices that use the Linear format must accept and be able to process any value of N .

Manual Fan speed control: Command Code 3Bh (**FAN_COMMAND_1**) [Link Back to Fan Command](#)

Manual fan speed control via PMBus™ is a linear data mode two byte command, speed expressed as fan duty cycle. This table below contains the manual fan speed command data in 1% increments, for illustration purposes.

The power supply automatically cancels manual fan speed control and enters automatic fan speed control by any of the following conditions or methods:

- 1) Writing the command "03h"(CLEAR_FAULTS).
- 2) Any overtemperature fault or warning (manual fan speed control mode can be resumed after the faults and warnings have ended)
- 3) Recycling of AC input voltage
- 4) Toggling PS_ON signal
- 5) Issuing a fan command that is outside the normal maximum limits, i.e., writing a fan speed of 110% duty cycle.

CMD 3B(h)				"Fan_COMMAND_1" (2 bytes)				CMD 3B(h)				"Fan_COMMAND_1" (2 bytes)				CMD 3B(h)				"Fan_COMMAND_1" (2 bytes)			
% Duty Cycle	MSB(h)	LSB(h)	n(d)	% Duty Cycle	MSB(h)	LSB(h)	n(d)	% Duty Cycle	MSB(h)	LSB(h)	n(d)	% Duty Cycle	MSB(h)	LSB(h)	n(d)	% Duty Cycle	MSB(h)	LSB(h)	n(d)				
0	B0	0	-10	26	B1	A	-10	51	B2	A	-10	76	B2	9	-10								
1	B0	A	-10	27	B1	14	-10	52	B2	14	-10	77	B2	14	-10								
2	B0	14	-10	28	B1	E1	-10	53	B2	1E	-10	78	B2	1E	-10								
3	B0	1F	-10	29	B1	29	-10	54	B2	28	-10	79	B2	28	-10								
4	B0	29	-10	30	B1	33	-10	55	B2	33	-10	80	B3	32	-10								
5	B0	33	-10	31	B1	3D	-10	56	B2	3D	-10	81	B3	3D	-10								
6	B0	3D	-10	32	B1	47	-10	57	B2	47	-10	82	B3	47	-10								
7	B0	48	-10	33	B1	52	-10	58	B2	51	-10	83	B3	51	-10								
8	B0	52	-10	34	B1	5C	-10	59	B2	5C	-10	84	B3	5B	-10								
9	B0	5C	-10	35	B1	66	-10	60	B2	66	-10	85	B3	66	-10								
10	B0	66	-10	36	B1	70	-10	61	B2	70	-10	86	B3	70	-10								
11	B0	71	-10	37	B1	7B	-10	62	B2	7A	-10	87	B3	7A	-10								
12	B0	7B	-10	38	B1	85	-10	63	B2	84	-10	88	B3	84	-10								
13	B0	85	-10	39	B1	8F	-10	64	B2	8F	-10	89	B3	8E	-10								
14	B0	8F	-10	40	B1	99	-10	65	B2	99	-10	90	B3	99	-10								
15	B0	99	-10	41	B1	A3	-10	66	B2	A3	-10	91	B3	A3	-10								
16	B0	A4	-10	42	B1	AE	-10	67	B2	AD	-10	92	B3	AD	-10								
17	B0	AE	-10	43	B1	B8	-10	68	B2	B8	-10	93	B3	B7	-10								
18	B0	B8	-10	44	B1	C2	-10	9	B2	C2	-10	94	B3	C2	-10								
19	B0	C2	-10	45	B1	CC	-10	70	B2	CC	-10	95	B3	CC	-10								
20	B0	CD	-10	46	B1	D7	-10	71	B2	D6	-10	96	B3	D6	-10								
21	B0	D7	-10	47	B1	E1	-10	72	B2	E1	-10	97	B3	E0	-10								
22	B0	E1	-10	48	B1	EB	-10	73	B2	EB	-10	98	B3	EB	-10								
23	B0	EB	-10	49	B1	F5	-10	74	B2	F5	-10	99	B3	F5	-10								
24	B0	F6	-10	50	B2	0	-10	75	B2	FF	-10	100	B3	FF	-10								
25	B1	0	-10																				

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