0RCP-H0M12

Isolated DC-DC Converter

The 0RCP-H0M12 series are isolated DC/DC converters that operate from a nominal 54 V source. These converters are intended to provide isolation and step down to generate a regulated intermediate bus for the purpose of powering non-isolated Point-of-Load (POL) converters.

These units will provide up to 600 W of output power from a nominal 54 V input with 96.7% efficiency. Features include remote on/off, short circuit protection, over current protection, over temperature protection, input under-voltage lockout, output over-voltage protection, pre-bias startup and power management bus communication.

These converters are provided in 1/8th brick package.

RoHS Compliant

Key Features & Benefits

- 48 - 60 VDC Input
- 12 VDC @ 50 A Output
- 1/8th Brick Converter
- Isolated
- High Efficiency
- High Power Density
- Fixed Frequency
- Input Under-Voltage Lockout
- OCP/SCP
- Over Temperature Protection
- Output Over-Voltage Protection
- Remote On/Off
- Power Management Bus Communications
- Approved to IEC/EN 62368-1
- Approved to CSA/UL 62368-1
- Class II, Category 2, Isolated DC/DC Converter (refer to IPC-9592B)

Applications

- Networking
- Computers and Peripherals
- Telecommunications

1. MODEL SELECTION

MODEL NUMBER	OUTPUT VOLTAGE	INPUT VOLTAGE	MAX. OUTPUT CURRENT	MAX. OUTPUT POWER	TYPICAL EFFICIENCY
0RCP-H0M12 series	12 VDC	48 - 60 VDC	50 A	600 W	96.7%

PART NUMBER EXPLANATION

0	R	CP	-	H0	M	12	x	G
Mounting Type	RoHS Status	Series Name		Output Power	Input Range	Output Voltage	Active Logic	Package Type
Through Hole Mount	RoHS	1/8th Brick		600 W	48 - 60 V	12 V	B - Active Low, with Baseplate	Tray Package

2. ABSOLUTE MAXIMUM RATINGS

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNITS
Continuous non-operating Input Voltage		-0.3	-	60	V
Transient Input Voltage (100 ms)		-0.3	-	80	V
Remote On/Off		-0.3	-	16	V
Other Pins' Voltage	CLK, DATA, ALERT, PG/C2, ADDR1, ADDR0	-0.3	-	3.6	V
Ambient Temperature, Long-Term Operating	The components on the Unit meet IPC-9592 derating guidelines	-40	-	85	°C
Altitude		-	-	5000	m
Storage Temperature		-55	-	125	°C

NOTE: Ratings used beyond the maximum ratings may cause a reliability degradation of the converter or may permanently damage the device.

3. INPUT SPECIFICATIONS

All specifications are typical at 25°C unless otherwise stated.

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
Operating Input Voltage		48	54	60	V
Input Current (full load)		-	-	13	A
Input Current (no load)		-	85	150	mA
Remote Off Input Current		-	5	10	mA
Input Reflected Ripple Current (rms)	Vin = 48-60 V, Io = 100% load, With simulated source impedance of 10 µH, 5 Hz to 20 MHz. Use a 100 µF/100 V electrolytic capacitor	-	2	6	mA
Input Reflected Ripple Current (pk-pk)		-	25	40	mA
I^2t Inrush Current Transient	Vin = 54 V, with a 100 µF/100 V input electrolytic capacitor	-	-	1	A^2s
Turn-on Voltage Threshold		44.8	46	47.5	V
Turn-off Voltage Threshold		42	43.5	45	V
Input Capacitor	100 µF/100 V AL	-	100	-	µF

CAUTION: This converter is not internally fused. An input line fuse must be used in application. Recommend a fast-acting fuse with maximum rating of 15 A on system board. Refer to the fuse manufacture's datasheet for further information.

4. OUTPUT SPECIFICATIONS

All specifications are typical at nominal input, full load at 25°C unless otherwise stated.

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
Output Voltage Set Point	Vin = 54 V, Pout = 300 W	11.88	12	12.12	V
	Vin = 48 - 60 V, Pout = 0 - 600 W	11	-	12.12	V
Load Regulation	Vin = 54 V, Io = 0~100% load	-	15	30	mV
Line Regulation	Vin = 52 - 60 V, Io = 100% load	-	15	30	mV
Regulation Over Temperature	Vin = 54 V, Io = 100% load, Ta = -40 to 85°C	-	±100	-	mV
Ripple and Noise (pk-pk)	Vin = 54 V, Io = 100% load, 0-20 MHz BW, with 1*10 µF ceramic capacitors and 1*270 µF OSCON capacitor at output	-	60	120	mV
Ripple and Noise (rms)		-	15	30	mV
Output Ripple and Noise (pk-pk) under worst case	Over entire operating input voltage range, load and ambient temperature condition	-	-	200	mV
Output Current Range		0	-	50	A
Output DC Current Limit		55	60	70	A
Rise Time		-	16	25	ms
Turn on Time	Enable from Vin to 90% of Vout	-	-	65	ms
	Enable from ON/OFF to 90% of Vout	-	-	65	ms
Pre-Bias Voltage		0	-	Vout	V
Overshoot at Turn on	Overshoot at turn on	0	-	3	%
Output Capacitance	50% ceramic + 50% OSCON	270	-	10000	µF
Transient Response					
△V 50%~75% of Max Load	di/dt = 1 A/µs, Vin = 54 VDC, with 1*10 µF ceramic capacitors and 1*270 µF OSCON capacitor at output	-	400	500	mV
Settling Time		-	100	300	µs
△V 75%~50% of Max Load		-	400	500	mV
Settling Time		-	100	300	µs

5. OUTPUT PLOT VS INPUT

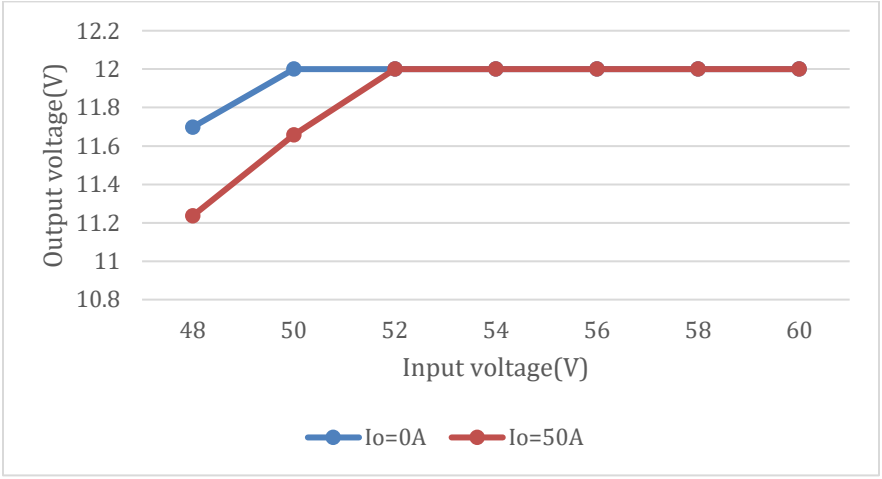


Figure 1. Output plot vs input

6. GENERAL SPECIFICATIONS

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
Efficiency	Vin = 54 V, full load	-	96.7	-	%
Switching Frequency	Primary FETs	-	200	-	kHz
Over Temperature Protection		-	135	-	°C
Output Over-Voltage Protection		-	13.5	-	V
Weight		-	50	-	g
MTBF	Calculated Per Telcordia SR-332, Issue 3 (Vin = 54 V, Po = 480 W, Ta = 40°C)	-	525	-	Mhrs
Dimensions (L × W × H)			2.30 x 0.90 x 0.57		inch
			58.42 x 22.86 x 14.50		mm
Isolation Characteristics					
Input to Output		-	-	1500	VDC
Input to Heatsink		-	-	1000	VDC
Output to Heatsink		-	-	500	VDC
Isolation Resistance		10M	-	-	Ohm
Isolation Capacitance		-	1000	-	pF

7. EFFICIENCY DATA

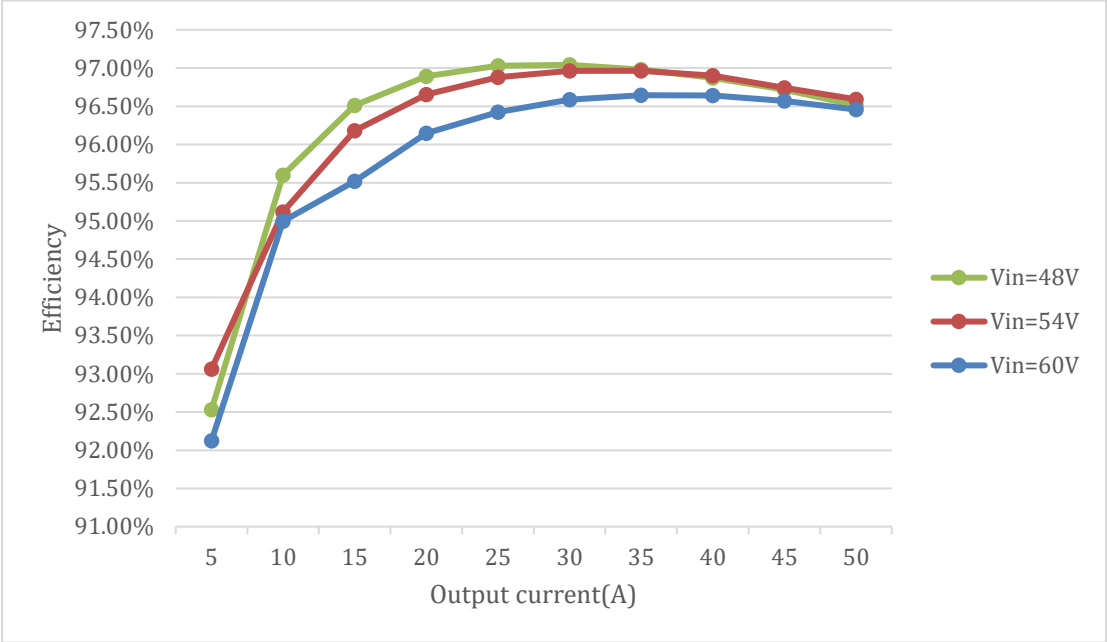


Figure 2. Efficiency

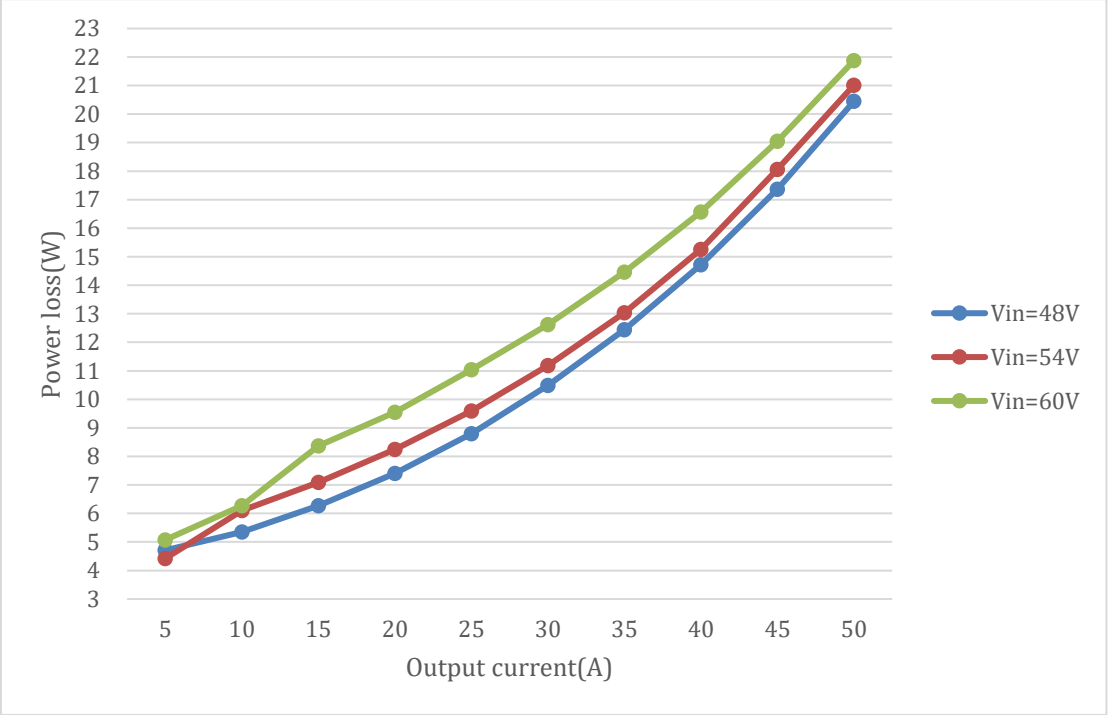


Figure 3. Power Dissipation

8. REMOTE ON/OFF

PARAMETER		DESCRIPTION	MIN	TYP	MAX	UNIT
Signal Low (Unit On)	Active Low	Remote On/Off pin is open, the module is off	-0.3	-	0.8	V
Signal High (Unit Off)			2.4	-	16	V
Current (Out of pin)		Module is on, Venable= -0.3 to 0.8 V	-	-	200	µA
		Module is off, Venable = 2.4 V	10	-	-	µA
Current (Into pin)		Remote on/off pin is pulled up to 10 V	-	-	300	µA
		Remote on/off pin is pulled up to 15 V	-	-	500	µA

Recommended remote on/off circuit for active low:

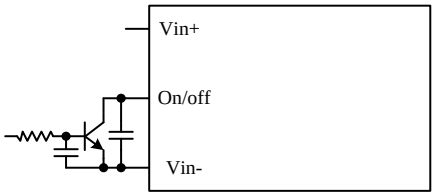


Figure 4. Control with open collector/drain circuit

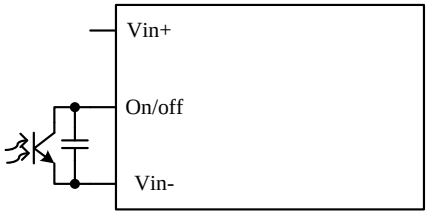


Figure 5. Control with photocoupler circuit

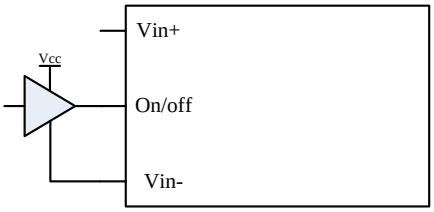


Figure 6. Control with logic circuit

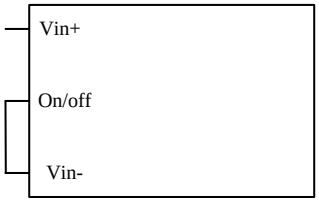


Figure 7. Permanently on

9. INPUT REFLECTED RIPPLE CURRENT

Testing setup

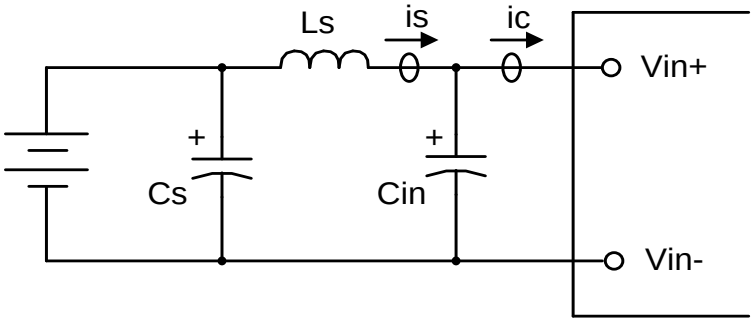


Figure 8.

Notes and values in testing:
is: Input Reflected Ripple Current
ic: Input Terminal Ripple Current
Ls: Simulated Source Impedance (10 uH)
Cs: Electrolytic capacitor, 100 µF, UVZ2A101MPD
Cin: Electrolytic capacitor, 100 µF, UVZ2A101MPD, should be as close as possible to the power module to damp ic ripple current and enhance stability.

Below measured waveforms are based on above simulated and recommended inductance and capacitance.

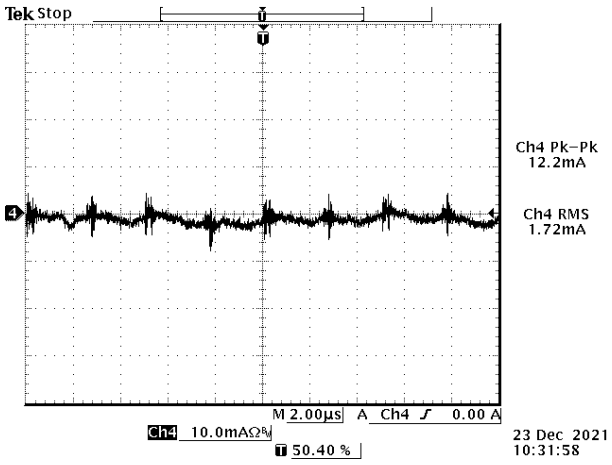


Figure 9. is (input reflected ripple current), AC component

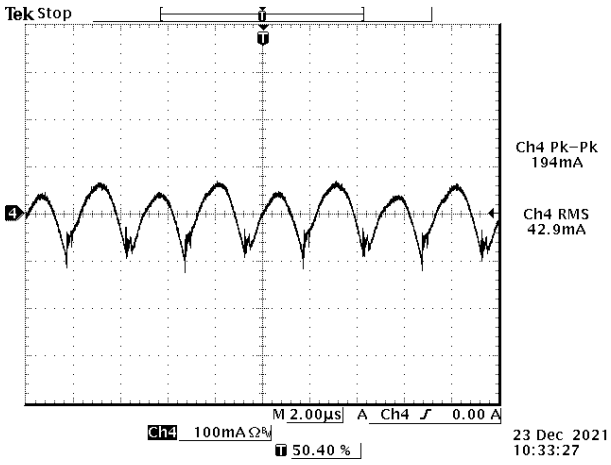


Figure 10. ic (input terminal ripple current), AC component

Test condition: 54 VDC input, 12 VDC/50 A output and Ta = 25°C, with 1*10 µF ceramic capacitors and 1*270 µF OSCON capacitor at output.

10. RIPPLE AND NOISE WAVEFORM

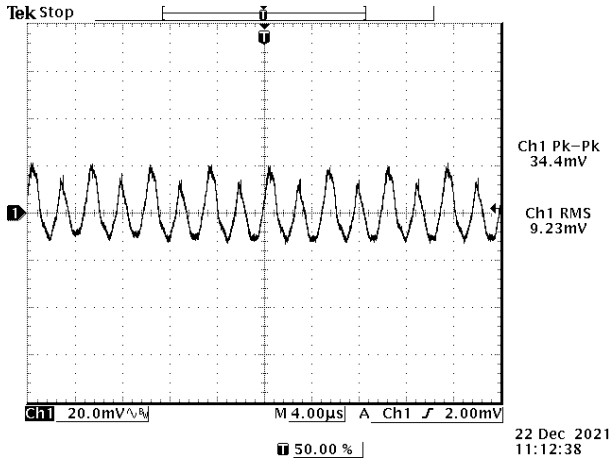


Figure 11. Ripple and noise waveform

Test condition: 54 VDC input, 12 VDC/50 A output and Ta = 25°C, with 1*10 µF ceramic capacitors and 1*270 µF OSCON capacitor at output.

11. TRANSIENT RESPONSE WAVEFORMS

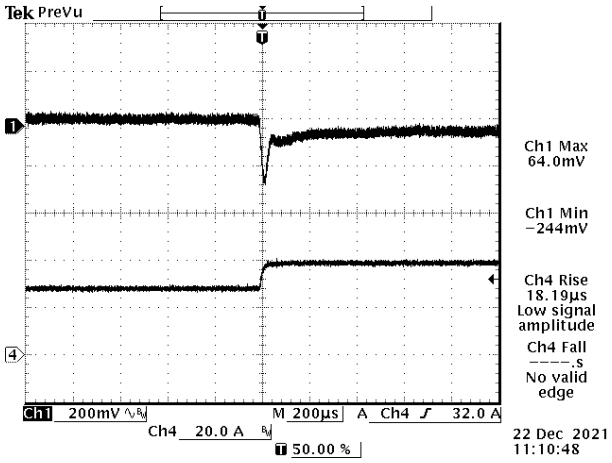


Figure 12. 50%-75% Load Transients
CH1: Vo
CH4: Io

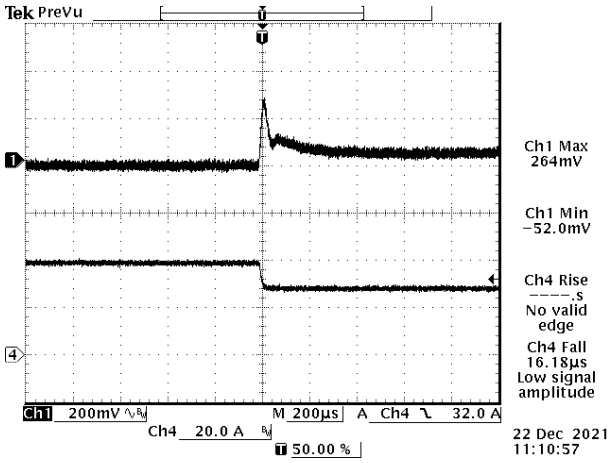


Figure 13. 75%-50% Load Transients
CH1: Vo
CH4: Io

Transient Response: Vin = 54 V @Ta = 25°C, di/dt = 1 A/us, with 1*10 µF ceramic capacitors and 1*270 µF OSCON capacitor at output.

12. INPUT UNDER-VOLTAGE LOCKOUT

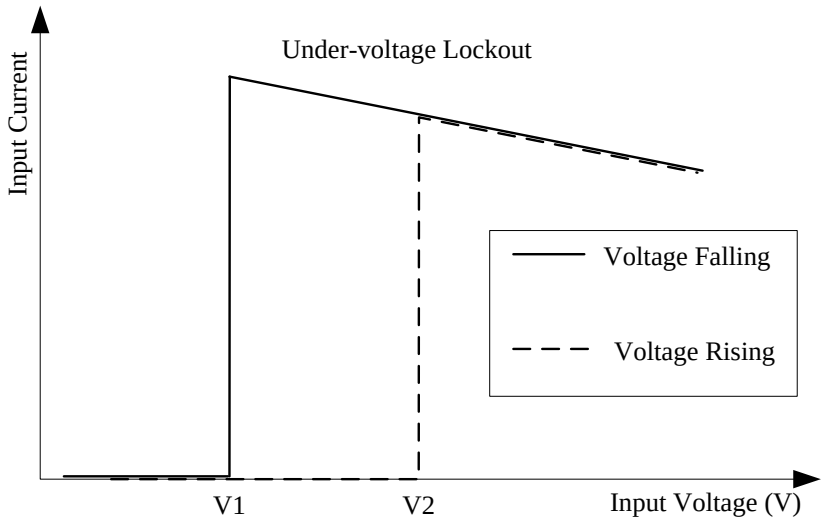


Figure 14. Input under-voltage lockout

V1 = 43.5 V

V2 = 46 V

13. STARTUP & SHUTDOWN

Turn on rise time

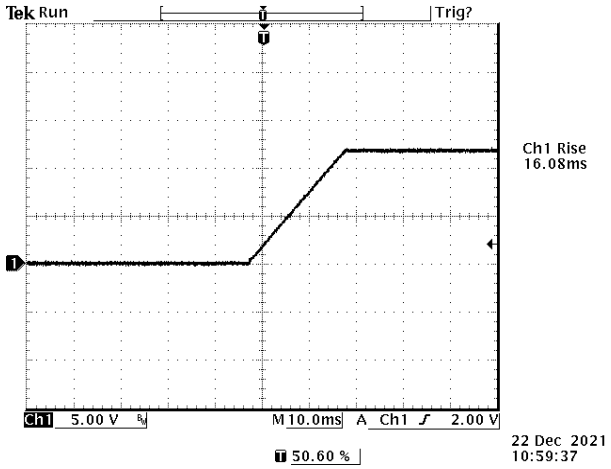


Figure 15.

CH1:Vo

Test Condition: 54 VDC input, 12 VDC/50 A output and Ta = 25°C, with 1*10 µF ceramic capacitors and 1*270 µF OSCON capacitor at output.

Turn on delay time

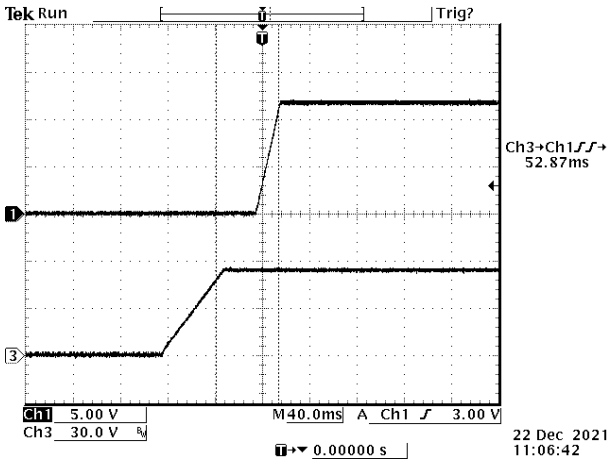


Figure 16. Startup from Vin
Ch1: Vo
Ch3: Vin

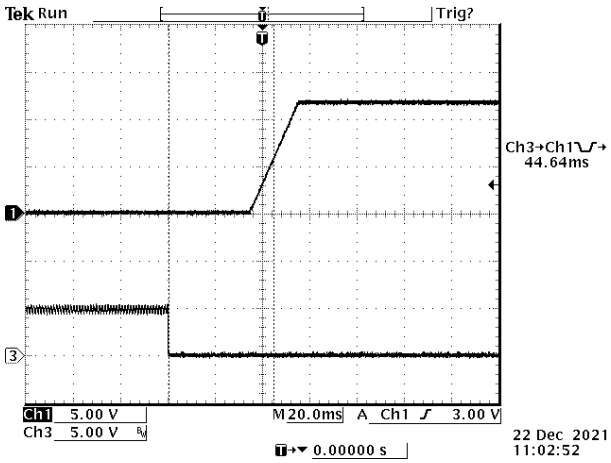


Figure 17. Startup from on/off logic low
Ch1: Vo
Ch3: on/off

Test Condition: 54 VDC input, 12 VDC/50 A output and Ta = 25°C, with 1*10 µF ceramic capacitors and 1*270 µF OSCON capacitor at output.

Shutdown

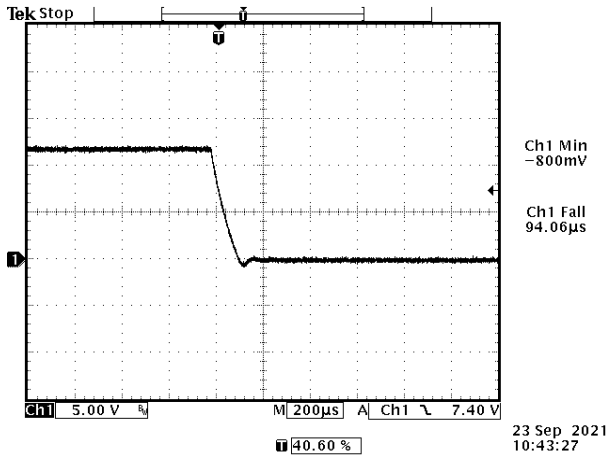


Figure 18. Shutdown from Venable

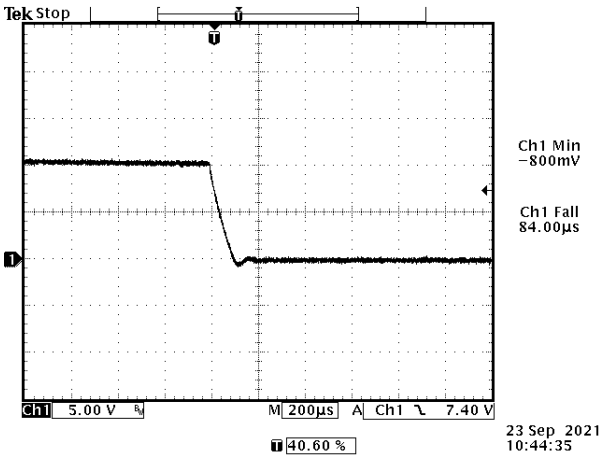


Figure 19. Shutdown from Vin

Test Condition: 54 VDC input, 12 VDC/50 A output and Ta = 25°C, with 1*10 µF ceramic capacitors and 1*270 µF OSCON capacitor at output.

14. OVER CURRENT PROTECTION

To provide protection in a fault output overload condition, the module is equipped with internal current-limiting circuitry which can endure current limiting for a few milliseconds. If the over current condition persists beyond a few milliseconds, the module will shut down into hiccup mode and restart once every 500 ms. The module operates normally when the output current goes into specified range. The typical average output current is 0.1 A during hiccup.

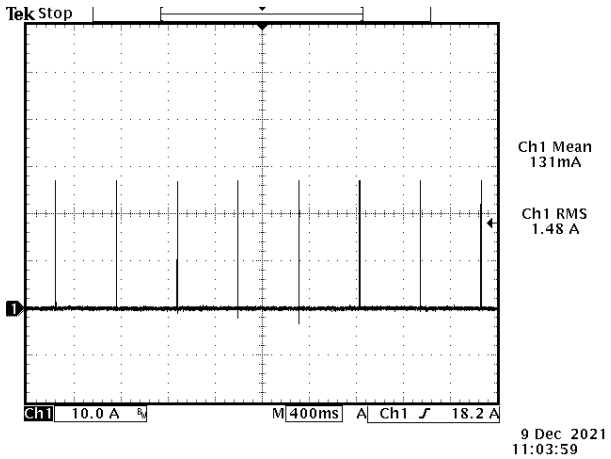


Figure 20. Output current waveform@ Vin = 54 V

15. THERMAL DERATING CURVE

Thermal Considerations

New high power architectures require an accurate thermal design. Design engineers have to optimize the module working conditions and ensure reliable operation. Convection cooling is the common mode to cool down the module. Heat transfer is dependent on a test setup and it is important to characterize the module in an environment similar to existent electronic applications. Reported thermal data reflects real operating conditions because the values are physically measured in a wind tunnel.

Thermal Test Setup

A module in electronic cards is typically located in a busy area without relevant space around it. To simulate a real condition and avoid turbulence we add a cover with defined dimensions. The distance has to be 6.35 mm (0.25 inch) from the top of the module and 6.35 mm (0.25 inch) on the left and right side of the module. The values reflect most of the real applications and it is a common procedure in the power module market. Ambient temperature and airflow are measured in front of the module at the distance of 76.2 mm (3 inch).

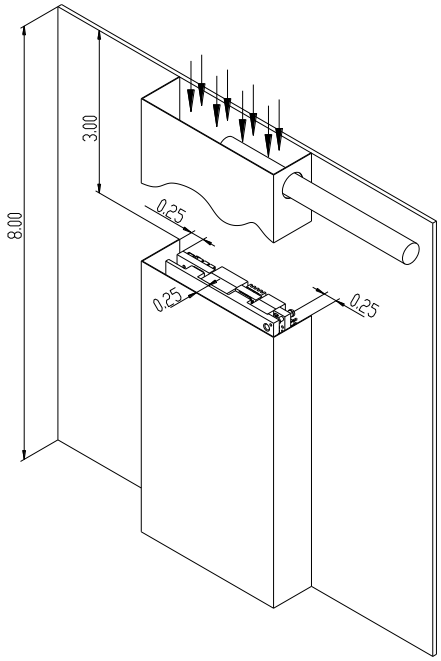


Figure 21. Thermal test setup

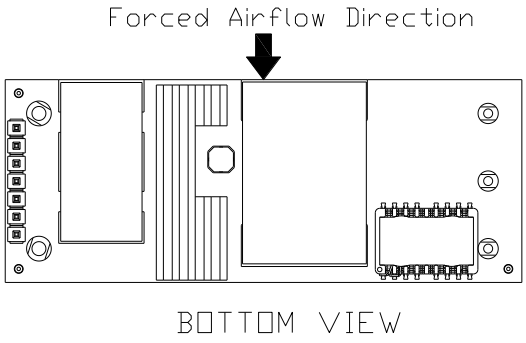


Figure 22. Airflow direction

Tests setup drawing all measured in inch.

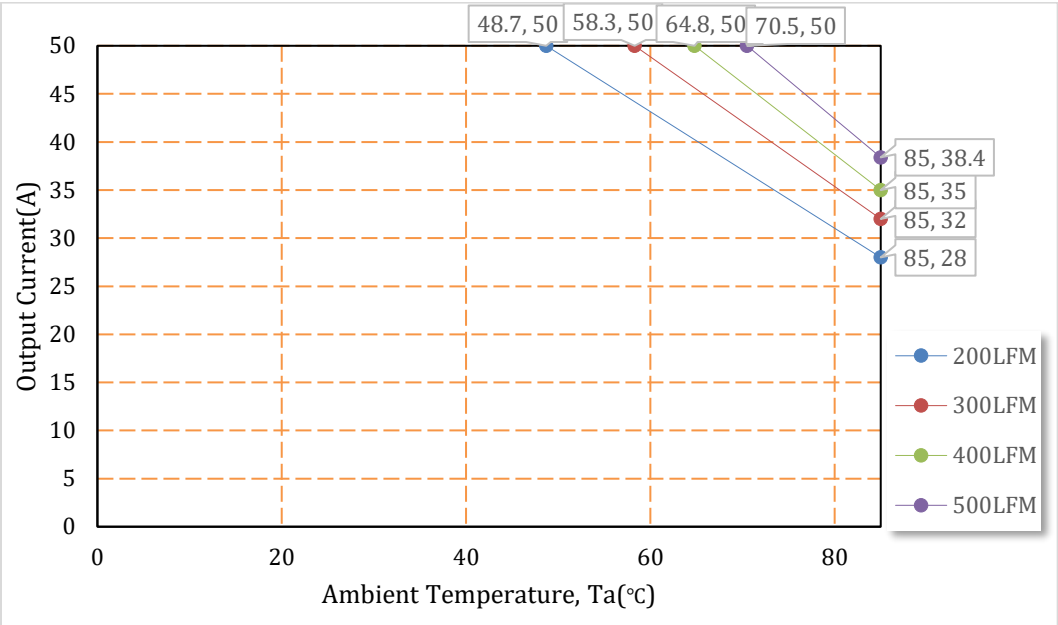


Figure 23.

Note: Output power vs. ambient temperature and air velocity @ Vin = 52 V (Transverse Orientation, airflow from Vin+ to Vin-).

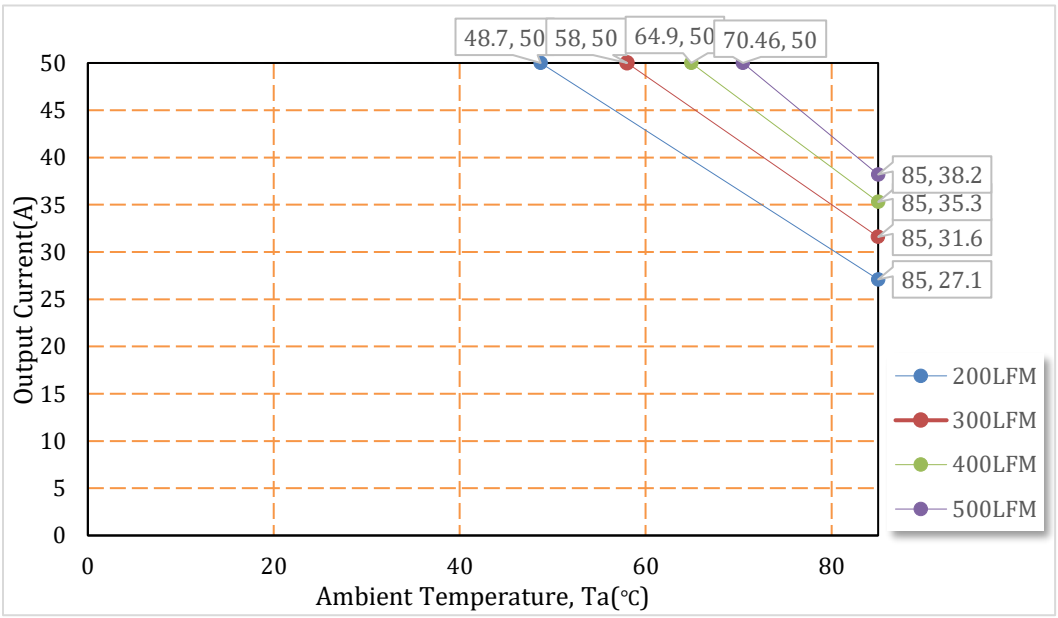


Figure 24.

Note: Output current vs. ambient temperature and air velocity @Vin = 54 V (Transverse Orientation, airflow from Vin+ to Vin-).

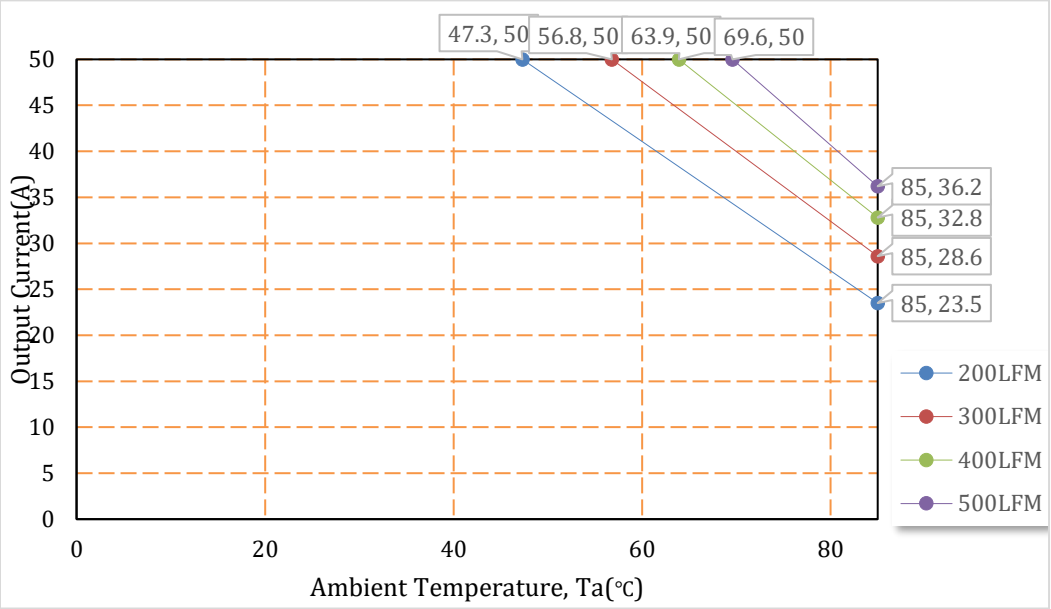


Figure 25.

Note: Output current vs. ambient temperature and air velocity @Vin = 60 V (Transverse Orientation, airflow from Vin+ to Vin-).

16. POWER MANAGEMENT BUS

POWER MANAGEMENT BUS DIGITAL FEATURE DESCRIPTION

The module supports Power Management Bus to be monitored, controlled and configured by the system. More detailed Power Management Bus information can be found in the Power Management Bus Power Management Protocol Specification, Part I and part II, revision 1.3, which is shown in the System Management Interface Forum Web site: www.powerSIG.org. The supported Power Management Bus commands of the module are listed below in the Supported POWER MANAGEMENT BUS Commands section below.

The module supports four Power Management Bus signal lines: Data (DATA pin), Clock (CLK pin), SMBALERT (ALERT pin, optional), Control (C2 pin, optional), and two Address lines: ADDR0 and ADDR1.

Connection for the Power Management Bus interface should follow the High-Power DC specifications given in section 3.1.3 in the SMBus specification V3.0 or the Low Power DC specifications in section 3.1.2. The complete SMBus specification is shown in http://smbus.org.

SMBALERT protocol is also supported by the module. SMBALERT line is also a wired-AND signal, by which the module can alert the POWER MANAGEMENT BUS master via pulling the SMBALERT pin to an active low. There is only one way that the master and the module response to the alert of SMBALERT line. The master will communicate with the slave module using the programmed address and using the various READ_STATUS commands to find the cause for the SMBALERT. The CLEAR_FAULTS command will clear the SMBALERT.

The module also supports the Packet Error Checking (PEC) protocol. It can check the PEC byte provided by the Power Management Bus master, and include a PEC byte in all messages transmitted back to the master.

POWER MANAGEMENT BUS ADDRESSING

The Module has flexible Power Management Bus addressing capability. When connect different resistor from ADDR0 and ADDR1 pin to GND pin, 64 possible addresses can be acquired. The address is in the form of octal digits; Each pin offers one octal digit, and then combine together to form the decimal address as shown in below.

Address = 8 * ADDR1 + ADDR0

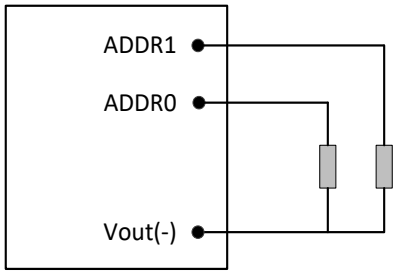


Figure 26.

Octal Digit	Resistor (Kohm)
0	10
1	15.4
2	23.7
3	36.5
4	54.9
5	84.5
6	130
7	200

Corresponded to each octal digit, the requested resistor values are shown below, and +/-1% resistors accuracy can be accepted. If there are any resistances exceeding the requested range, address 64 will be return. 0-12 and 40, 44, 45, and 55 in decimal address cannot be used, since they are reserved according to the Power Management Bus specifications, and which will also return address 64.

NOTE: Power Management Bus communication is only supported when vin normal and remote on.

POWER MANAGEMENT BUS APPLICATION CIRCUIT

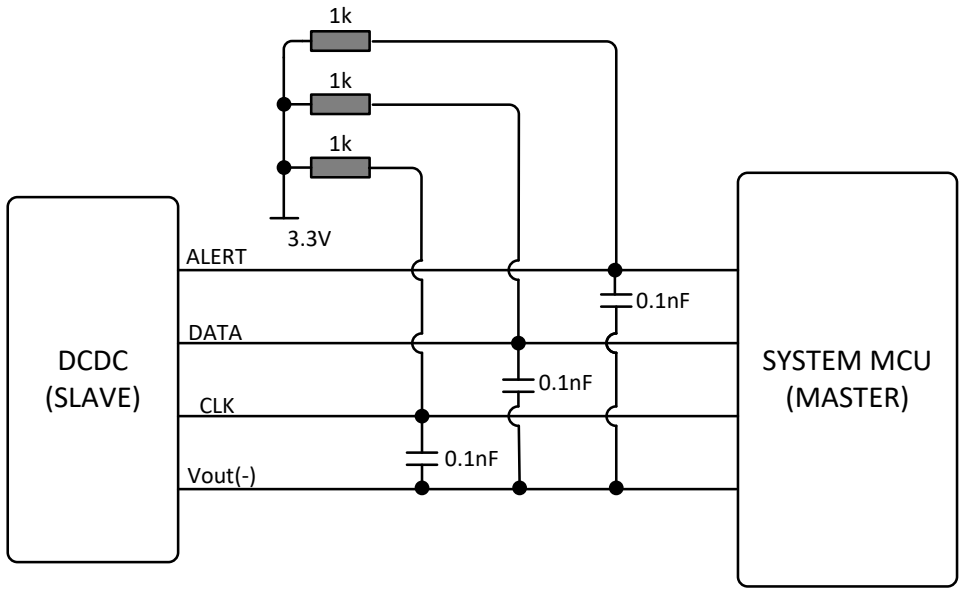


Figure 27. Power Management Bus Application Circuit

PARAMETER	NOTES	MIN	NOM	MAX	UNITS
Logic Input Low (VIL)	1	0	-	0.8	V
Logic Input High (VIH)	1	2.1	-	3.3	V
Logic Output Low (VOL)	2	-	-	0.65	V
Logic Output High (VOH)	3	2.3	-	-	V
Power Management Bus Operating Frequency Range	-	-	100/400	-	kHz
Output Current Reading Accuracy	4	-6	-	+6	%
	5	-1.5	-	+1.5	A
Output Voltage Reading Accuracy	-	-2	-	+2	%
Input Voltage Reading Accuracy	-	-4	-	+4	%
Temperature Reading Accuracy	-	-5	-	+5	°C

Notes	
1	DATA, CLK pin
2	DATA, ALERT, CLK pin; IOL = 4 mA
3	DATA, ALERT, CLK pin; IOH = -4 mA
4	Vin = 54 V, Io = 50% ~ 100% of Iomax
5	Vin = 54 V, Io = 5% ~ 50% of Iomax

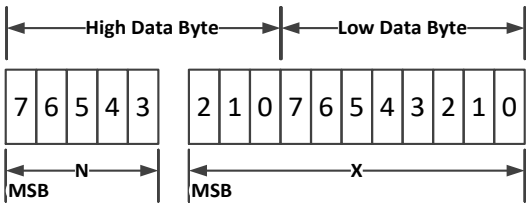
BLACK BOX

Black Box function is supported which has 10K erase cycles. Vin UVLO and Vin OVP event may not accurately record in black box. Black box only stores at the first fault event until next Vin power cycle or remote on/off cycle. 20 history information are stored in flash memory and each history information has 32 record content which is shown as below. EVENT# is the history event offset value. Every 20 history event store operation erase the flash once.

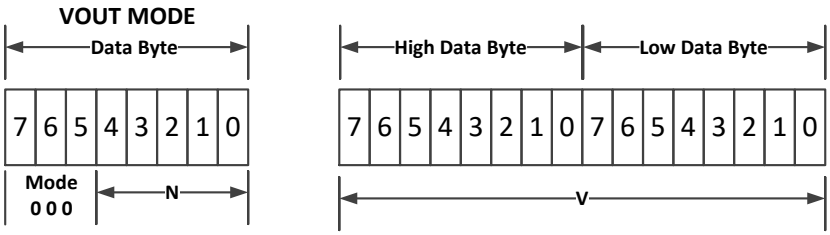
ADDRESS OFFSET	CONTENT
0	EVENT#
1	STATUS_WORD_HIGH_BYTE
2	STATUS_WORD_LOW_BYTE
3	STATUS_VOUT
4	STATUS_IOUT
5	STATUS_INPUT
6	STATUS_TEMPERATURE
7	STATUS_CML
8	VIN_DATA_HIGH_BYTE
9	VIN_DATA_LOW_BYTE
10	VOUT_DATA_HIGH_BYTE
11	VOUT_DATA_LOW_BYTE
12	IOUT_DATA_HIGH_BYTE
13	IOUT_DATA_LOW_BYTE
14	TEMPERATURE_DATA_HIGH_BYTE
15	TEMPERATURE_DATA_LOW_BYTE
16	FAULT_TIME_FIRST_BYTE
17	FAULT_TIME_SECOND_BYTE
18	FAULT_TIME_THIRD_BYTE
19	FAULT_TIME_FOURTH_BYTE
20~31	N/A

POWER MANAGEMENT BUS DATA FORMAT

For commands which is except to the output voltage, including input voltage, output current, temperature, PWM frequency, duty cycle, the controller will use the 2-byte linear format as defined by the Power Management Bus system management protocol. The linear data format contains 2 bytes which include a 5-bit two's complement exponent and an 11-bit two's complement mantissa as below. The transmitted value Y is reported as the form $Y = X*2^N$.



For example, to set the over temperature fault threshold 130 deg C by OT_FAULT_LIMIT command, the read/write data can be calculated refer to below: the binary number of N is 0, whose decimal number is 0.
$X = T_{OTP}/2^{(0)} = 130$, whose binary is 0b00010000010.
Combine X and N, the binary is 0b0000000010000010. The hexadecimal of OT_FAULT_LIMIT is 0x0082.
The output voltage parameters use the Power Management Bus Vout linear format. The data format is shown below.



The voltage will be in the form $Voltage = V*2^N$. The Mantissa and exponent in this equation will be read and reported using 3 bytes. The first byte is the VOUT_MODE byte which will always contain 000 in the 3 MSB's. The 5 LSB's are the exponent. The exponent N is fixed and equals -10. The other 2 bytes N will contain the Mantissa. In the above format N is a 5-bit two's complement binary integer and V is a 16-bit unsigned binary integer. All 16 bits are reported to be compatible with the Power Management Bus protocol.
For example, to set Vout to 12V by VOUT_COMMAND, the read/write data can be calculated refer to below process:
$V = Vout/2^{(-10)} = 12/2^{(-10)} \approx 12288$
Convert the decimal to hexadecimal format is 0x3000. So the VOUT_COMMAND is 0x3000.

SUPPORTED POWER MANAGEMENT BUS COMMANDS

The main Power Management Bus commands described in the Power Management Bus 1.3 specification are supported by the module. Partial Power Management Bus commands are fully supported; Partial Power Management Bus commands have difference with the definition in Power Management Bus 1.3 specification. All the supported Power Management Bus commands are detailed summarized in the below table.

COMMAND	CODE	COMMAND DESCRIPTION	TYPE	DATA FORMAT	DEFAULT VALUE	DATA UNITS	NOTE
OPERATION	0x01	Configures the operational state of the module	R/W byte	Bit field	0x80	/	1
CLEAR_FAULTS	0x03	Clear any fault bits that have been set	Send byte	/	/	/	/
WRITE_PROTECTION	0x10	Set or Clear the bit of Write protection	R/W byte	Bit field	0x80	/	1
RESTORE_DEFAULT_ALL	0x12	Restore the factory settings to the non-volatile memory	Write	/	/	/	5
STORE_DEFAULT_ALL	0x15	Store the current settings to the non-volatile memory	Write	/	/	/	5
VOUT_MODE	0x20	Vo data format	Read byte	mode + exponent	0x15	/	/
VOUT_COMMAND	0x21	Set the output voltage normal value	R/W word	Vout linear	12.0	Volts	/
VOUT_MAX	0x24	Set an upper limit on the output voltage the module can command	Read word	Vout linear	12.5	Volts	/
VOUT_MARGIN_HIGH	0x25	Set the output voltage margin high value	Read word	Vout linear	12.5	Volts	/
VOUT_MARGIN_LOW	0x26	Set the output voltage margin low value	Read word	Vout linear	10	Volts	/
VOUT_MIN	0x2B	Set a lower limit on the output voltage the module can command	Read word	Vout linear	9.5	Volts	/
MAX_DUTY	0x32	Set the maximum duty cycle	Read word	Linear	50	%	/
FREQUNCY_SWITCH	0x33	Set the primary side switching frequency	Read word	Linear	200	kHz	/
VOUT_OV_FAULT_LIMIT	0x40	Set the output over voltage fault threshold	R/W word	Vout linear	13.5	Volts	4
VOUT_OV_FAULT_RESPONSE	0x41	Instructs what action to take in response to an output overvoltage fault	Read byte	Bit field	0x80	/	1
IOUT_OC_FAULT_LIMIT	0x46	Set the output overcurrent fault threshold	R/W word	Linear	60	A	3,4
IOUT_OC_FAULT_RESPONSE	0x47	Instructs what action to take in response to an output overcurrent fault	Read byte	Bit field	0xF8	/	1
OT_FAULT_LIMIT	0x4F	Set the over temperature fault threshold	R/W word	Linear	130	Deg C	3,4
OT_FAULT_RESPONSE	0x50	Instructs what action to take in response to an over temperature fault	Read byte	Bit field	0xB8	/	1
MFR_C1_C2_CONFIG	0x6C	Configure C2 pin function	R/W byte	Bit field	0x00	/	1
MFR_C2_CONFIG	0x6D	Configure C2 pin logic	R/W byte	Bit field	0x00	/	1
MFR_PGOOD_POLARITY	0x6E	Configure power good logic	R/W byte	Bit field	0x00	/	1
STATUS_WORD	0x79	Returns the information with a summary of the unit's fault condition	Read word	Bit field	0	/	1,6
STATUS_VOUT	0x7A	Returns the information with a summary of the unit's output voltage condition	Read byte	Bit field	0	/	1,6
STATUS_IOUT	0x7B	Returns the information with a summary of the unit's output current condition	Read byte	Bit field	0	/	1,6
STATUS_TEMPERATURE	0x7D	Returns the information with a summary of the unit's temperature condition	Read byte	Bit field	0	/	1,6
STATUS_CML	0x7E	Returns the information with a summary of the unit's communication condition	Read byte	Bit field	0	/	1,6
READ_VIN	0x88	Returns the input voltage of the module	Read word	Linear	/	Volts	/
READ_VOUT	0x8B	Returns the output voltage of the module	Read word	Vout Linear	/	Volts	/
READ_IOUT	0x8C	Returns the output current of the module	Read word	Linear	/	A	/
READ_TEMPERATURE_1	0x8D	Returns the temperature of the module	Read	Linear	/	Deg C	/

COMMAND	CODE	COMMAND DESCRIPTION	TYPE	DATA FORMAT	DEFAULT VALUE	DATA UNITS	NOTE
			word				
READ_POUT	0x96	Returns the output power of the module	Read word	Linear	/	W	/
POWER MANAGEMENT BUS_REVISION	0x98	Reads the revision of the Power Management Bus	Read byte	Bit field	0x33	/	1
MFR_ID	0x99	Reads the ID of the manufacture	Read block	ASCII	BELF	/	/
FIRMWARE_REV	0x9B	Reads the revision of the firmware	Read block	ASCII	A1	/	7
BLACKBOX_EN	0xDF	Enable or disable the black box overwrite function	Read byte	Bit field	0x01	/	1
READ_HISTORY EVENTS	0xE0	Read history event from black box	Read block	Bit field	/	/	1
SET_HISTORY_EVENT_OFFSET	0xE1	Set history event offset	R/W byte	Bit field	/	/	1

NOTES:

1. Refer to below detailed command description.
2. OPERATION command controls module on/off.
3. Before write operation, it is necessary to read the register data and parse out the corresponding linear format N value, then convert write value based on N.
4. To ensure that the product works properly, the adjustment range of the protection limit value is limited, when the set value exceeds the upper or lower limits, the lower limit value is automatically set. The following table shows the upper and lower limits.

COMMAND	CODE	THE LOW LIMIT	THE UPPER LIMIT
VOUT_OV_FAULT_LIMIT	0x40	10	14
IOUT_OC_FAULT_LIMIT	0x46	20	70
OT_FAULT_LIMIT	0x4F	120	135

5. Read or write this command, PSU will shut down until next vin power cycle.
6. ALL the fault bits set in all the status registers remain set, even if the fault condition is removed or corrected, until one of the following occur:
   1) A remote off then remote on cycle;
   2) The device receives a CLEAR_FAULTS command;
   3) Vin power is removed from the module.
7. The default value will be updated as the firmware version is updated, but the data format remains the same.

OPERATION (0x01)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7	Turn the module on/off	1	On	1
		0	Off	
6	Reserved	/	/	0
5:4	Control the source of the output voltage command	00	VOUT_COMMAND	00
		01	VOUT_MARGIN_LOW	
		10	VOUT_MARGIN_HIGH	
		11	/	
3:0	Reserved	/	/	0000

WRITE_PROTECTION (0x10)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7	Enable / Disable the protection	1	Protection is enabled	1
		0	Protection is disabled	
6:0	Reserved	/	/	0000000

VOUT_OV_FAULT_RESPONSE (0x41)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7:6	Response when fault happens	00-01	/	10
		10	The module shuts down and response according to the retry setting in bits [5:3]	
		11	/	
5:3	Retry setting	000	Module does not attempt to restart until a RESET signal or OPERATION command, or Bias power is removed	000
		001-110	/	
		111	Attempts to restart continuously until it is commanded off	
2:0	Reserved	/	/	000

IOUT_OC_FAULT_RESPONSE (0x47)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7:6	Response when fault happens	00-10 11	/ The module shuts down and response according to the retry setting in bits [5:3]	11
5:3	Retry setting	000 001-110 111	Module does not attempt to restart until a RESET signal or OPERATION command, or Bias power is removed / Attempts to restart continuously until it is commanded off	111
2:0	Reserved	/	/	000

OT_FAULT_RESPONSE (0x50)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7:6	Response when fault happens	00-01 10 11	/ The module shuts down and response according to the retry setting in bits [5:3] /	10
5:3	Retry setting	000 001-110 111	Module does not attempt to restart until a RESET signal or OPERATION command, or Bias power is removed / Attempts to restart continuously until it is commanded off	111
2:0	Reserved	/	/	000

MFR_C1_C2_CONFIG (0x6C)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7:4	Reserved	/	/	/
3:0	Pin configuration	0000 0010	C2 pin: POWER_GOOD C2 pin: ON/OFF (Secondary)	0000

MFR_C2_CONFIG (0x6D)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7:2	Reserved	/	/	/
1	ON/OFF Configuration	1 0	And- Primary and secondary side on/off C2 pin signal is ignored	0
0	Secondary Side ON/OFF logic	1 0	Positive Logic (High level enable: input > 2.64V) Negative Logic (Low level enable: input < 0.66V)	0

MFR_PGOOG_POLARITY (0x6E)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7:1	Reserved	/	/	/
0	Power Good Logic	1 0	Positive PGOOD logic Negative PGOOD logic	0000

STATUS_WORD (0x79)				
HIGH BYTE				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7	VOUT	1	An output voltage fault has occurred	0
		0	Not occurred	
6	IOUT/POUT	1	An output current or output power fault has occurred	0
		0	Not occurred	
5	INPUT (Not supported)	1	An input overvoltage fault has occurred	0
		0	Not occurred	
4	Reserved	/	/	0
3	Power_Good	1	Power_Good signal is negated	0
		0	Power_Good signal is ok	
2:1	Reserved	/	/	00
0	UNKNOWN	1	A fault type not given in bits [15:1] of the SATUS_WORD has been detected	0
		0	Not occurred	
LOW BYTE				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7	Busy	1	A fault was declared because the device was busy and unable to respond	0
		0	Not occurred	
6	Off	1	This bit is asserted if the unit is not providing power to the output, regardless of the reason, including simply not being enabled	0
		0	Not occurred	
5	VOUT_OV_FAULT	1	An output overvoltage fault has occurred	0
		0	Not occurred	
4	IOUT_OC_FAULT	1	An output overcurrent fault has occurred	0
		0	Not occurred	
3	VIN_UV_FAULT (Not supported)	1	An input under voltage fault has occurred	0
		0	Not occurred	
2	TEMPERATURE	1	A temperature fault has occurred	0
		0	Not occurred	
1	CML	1	A communication, memory or logic fault has occurred	0
		0	Not occurred	
0	NONE_OF_THE_ABOVE	1	A fault not listed in bits [7:1] of this byte has occurred	0
		0	Not occurred	

STATUS_VOUT (0x7A)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7	VOUT_OV_FAULT	1	Occurred	0
		0	Not occurred	
6:5	Reserved	/	/	00
4	VOUT_UV_FAULT	1	Occurred	0
		0	Not occurred	
3:0	Reserved	/	/	0000

STATUS_IOUT (0x7B)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7	IOUT_OC_FAULT	1 0	Occurred Not occurred	0
6:0	Reserved	/	/	0000000

STATUS_TEMPERATURE (0x7D)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7	OT_FAULT	1 0	Occurred Not occurred	0
6:0	Reserved	/	/	0000000

STATUS_CML (0x7E)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7	Invalid or unsupported command received	1 0	Occurred Not occurred	0
6	Invalid or unsupported data received	1 0	Occurred Not occurred	0
5:0	Reserved	/	/	000000

POWER MANAGEMENT BUS_REVISION (0x98)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7:4	Indicate the revision of Power Management Bus Specification Part I to which the device is compliant	0000 0001 0010 0011	1.0 1.1 1.2 1.3	1.3
3:0	Indicate the revision of Power Management Bus Specification Part II to which the device is compliant	0000 0001 0010 0011	1.0 1.1 1.2 1.3	1.3

BLACKBOX_EN (0xDF)				
Bit number	**Purpose**	**Bit value**	**Meaning**	**Default settings**
7:1	Reserved	/	/	0000000
0	Enable/Disable the black box overwrite function	1 0	Overwrite function is enabled Overwrite function is disabled	1

Note: if overwrite function is disabled, black box only records 20 times faults, then it will lock and no more faults will be recorded. If overwrite function is enabled. When fault log is full, the new fault will overwrite all the previous fault, and recount from history event offset value 1

HISTORY EVENT READ

0xE1 command: Write the offset value to slave to decide which history event for read.

0XE0 command: Read the history data after 0xE1 command.

READ HISTORY EVENT OFFSET (0xE1)

Send read command 0xE1 and read one byte, it will return the next history event log offset value x.

START	DEVICE ADDRESS & W	COMMAND (0xE1)	REPEATED START	DEVICE ADDRESS & R

EVENT LOG OFFSET VALUE	PEC	STOP

SET HISTORY EVENT OFFSET (0xE1)

Then send write command 0xE1 and write the offset value X-1 to read back the last history event. The maximum value of the offset is 20, if the history data is large than 20, it will recount from 1.

READ_HISTORY EVENTS [0xE0]

START	DEVICE ADDRESS & W	COMMAND (0XE0)	REPEATED START	DEVICE ADDRESS & R	Byte Count=20	EVENT#

STATUS_WORD_HIGH_BYTE	STATUS_WORD_LOW_BYTE	STATUS_VOUT	STATUS_IOUT	STATUS_INPUT

STATUS_TEMPERATURE	STATUS_CML	VIN_DATA_HIGH_BYTE	VIN_DATA_LOW_BYTE	VOUT_DATA_HIGH_BYTE

VOUT_DATA_LOW_BYTE	IOUT_DATA_HIGH_BYTE	IOUT_DATA_LOW_BYTE	TEMPERATURE_DATA_HIGH_BYTE

TEMPERATURE_DATA_LOW_BYTE	FAULT_TIME_FIRST_BYTE	FAULT_TIME_SECOND_BYTE

FAULT_TIME_THIRD_BYTE	FAULT_TIME_FOURTH_BYTE	PEC	STOP

17. POWER GOOD AND SECONDARY SIDE REMOTE CONTROL

The power good pin 6 (PG/C2) indicates when the product is ready to provide regulated output voltage to the load. During ramp-up and during a fault condition, PG is held low. By default, PG is asserted high after the output has ramped to a voltage above 10.5 V. The power good pin should have a pull up resistor to the voltage not higher than 3.6 V and max current sunk into the pin should not be larger than 50 mA.

This pin could also be configured as secondary side remote-control pin if not using as power good. Use MFR_C1_C2_CONFIG(0x6C) to switch between Power Good and ON/OFF function and MFR_C2_CONFIG(0x6D) to set the ON/OFF logic, find more details in Power Management Bus section.

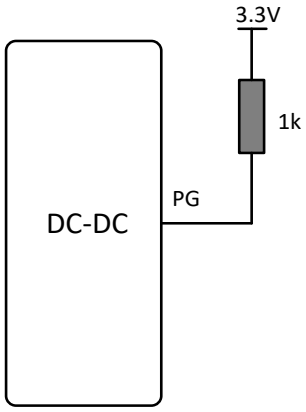


Figure 28. Power good configuration

18. MECHANICAL DIMENSIONS

OUTLINE

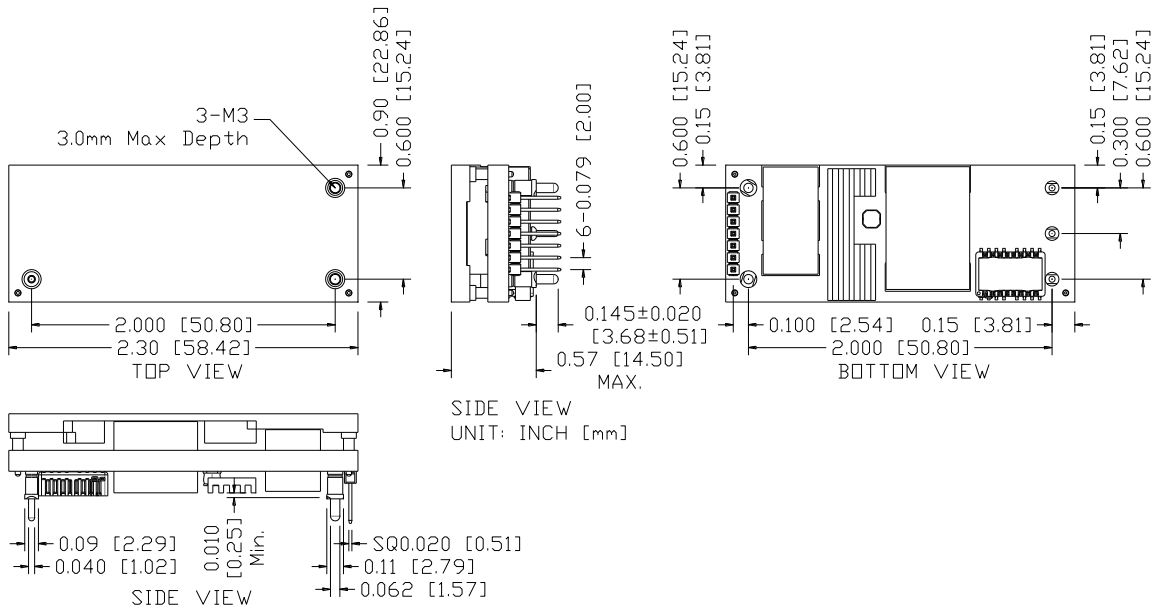


Figure 29. Outline

NOTE: This module is recommended and compatible with Pb-Free Wave Soldering and must be soldered using a peak solder temperature of no more than 260 °C for less than 5 seconds.

NOTES:

1）All Pins: Material - Copper Alloy;
Finish – Tin plated.
2）Un-dimensioned components are shown for visual reference only.
3）All dimensions in inch [mm]; Tolerances: x.xx +/-0.02 inch [0.51 mm]. x.xxx +/-0.010 inch [0.25 mm].

PIN DEFINITIONS

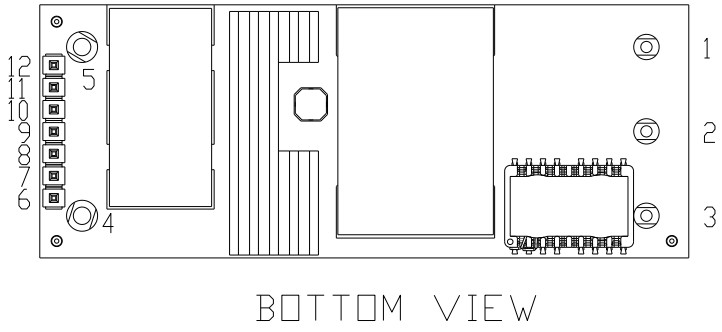


Figure 30. Pins

PIN	FUNCTION	PIN SIZE	PIN	FUNCTION	PIN SIZE
1	Vin (+)	0.04”	7	Vout (-)	SQ0.020
2	ON/OFF	0.04”	8	DATA	SQ0.020
3	Vin (-)	0.04”	9	ALERT	SQ0.020
4	Vout (-)	0.062”	10	CLK	SQ0.020
5	Vout (+)	0.062”	11	ADDR1	SQ0.020
6	C2	SQ0.020	12	ADDR0	SQ0.020

NOTE: C2 is set as Power Good by default.

RECOMMENDED PAD LAYOUT

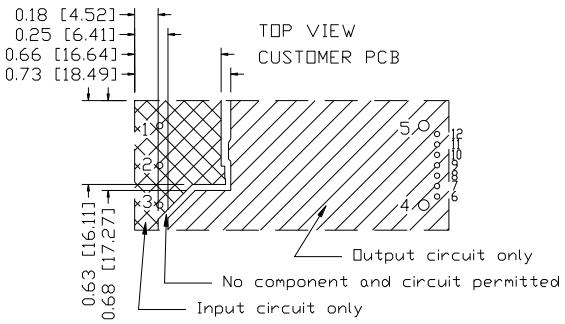


Figure 31. Recommended pad layout-1

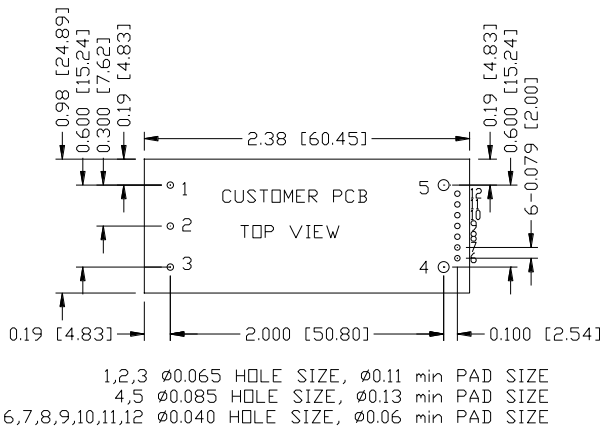


Figure 32. Recommended pad layout-2

19. REVISION HISTORY

DATE	REVISION	CHANGES DETAIL	APPROVAL
2023-05-31	AA	Add recommended pad layout drawing. Update power management bus command list. Update altitude to 5000m.	XF.Jiang
2024-04-29	AB	Add safety certificate. Update power management bus information.	XF.Jiang
2024-07-23	AC	Image replacement.	XF.Jiang

For more information on these products consult: tech.support@psbel.com

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