0RQB-X5M12
Isolated DC-DC Converter

The 0RQB-X5M12 series are isolated DC/DC converters that operate from a nominal 54 Vdc 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 1500 W of output power from a nominal 54 Vdc input.

These converters are provided in 1/4th brick package.

RoHS Compliant

Key Features & Benefits

- 48-60 VDC Input
- 12 VDC 125 A Output
- Isolated
- Fixed Frequency
- High Efficiency
- High Power Density
- Input Under-Voltage Lockout
- OCP/SCP
- Output Over-Voltage Protection
- Over Temperature Protection
- Remote On/Off
- Power Good Indication
- Approved to IEC/EN 62368-1
- Approved to UL/CSA 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
0RQB-X5M12BG 0RQB-X5M12PG	12 VDC	48 – 60 VDC	125 A	1500 W	97.3%

PART NUMBER EXPLANATION

0	R	QB	-	X5	M	12	x	G
Mounting Type	RoHS Status	Series Name		Output Power	Input Range	Output Voltage	Active Logic	Package Type
Through Hole Mount	RoHS	1/4th Brick		1500 W	48 – 60 V	12 V	B - Active Low, with Baseplate, without Droop P - Active Low, with Baseplate, with Droop	Tray Package

2. ABSOLUTE MAXIMUM RATINGS

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNITS
Input Voltage Continuous	Input over voltage protection will shut down the output voltage when the input voltage exceeds threshold level. See Over-voltage Shutdown Threshold in Input Specification.	-0.3	-	60	V
Remote On/Off		-0.3	-	16	V
Ambient Temperature	Long-Term Operating. All components on the Unit meet IPC-9592 (latest revision) derating guidelines.	-20	-	85	°C
Altitude		-500	-	16404	feet
Storage Temperature		-40	-	100	°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)		-	-	33	A
Input Current (no load)		-	130	150	mA
Remote Off Input Current		-	10	20	mA
Input Reflected Ripple Current (rms)	10 µH source impedance, Vin = 52 – 57 V, Io = Io max. Refer to section 12 for detail input capacitance and waveforms.	-	15	30	mA
Input Reflected Ripple Current (pk-pk)		-	70	100	mA
Input Terminal Ripple Current (rms)		-	1000	1500	mA
Input Terminal Ripple Current over Temperature (rms)	Ta = -20 to 85°C	-	3	15	mA
Input Turn off Voltage Threshold		42.5	44	45	V
Input Turn on Voltage Threshold		46	47	48	V
Over-Voltage Recovery Threshold		60	61	63	V
Over-Voltage Shutdown Threshold	Output shuts down immediately.	64	65	67	V
Recommended input fast-acting fuse on system board	CAUTION: This converter is not internally fused. An input line fuse must be used in application.	45	-	-	A

CAUTION: This converter is not internally fused. An input line fuse must be used in application.

* The shutdown protection will not be triggered if the fault duration is less than 20 ms, but Power Good signal will de-assert.

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 = 52 V, Pout = 725 W	11.88	12	12.12	V
Load Regulation without Droop	Vin = 52 V, Io = 0~100% load	-	0.01	0.02	V
Load Regulation with Droop	Vin = 52 V, Io = 0~100% load	-	0.4	0.5	V
Line Regulation	Vin = 52 – 57 V, Io = 100% load	-	10	30	mV
Regulation Over Temperature	Vin = 52 V, Io = 100% load, Ta = -20 ~ 85°C	-	100	-	mV
Ripple and Noise (pk-pk)	Cout = 750 µF minimum, approximately 50% ceramic, 50% Oscon or POSCAP.	-	-	150	mV
Ripple and Noise (rms)		-	-	30	mV
Output Current Range		0	-	125	A
Output DC Current Limit	OCP: Hiccup mode.	130	-	-	A
Peak Output Power	Power consumption during 10 ms	1560	-	-	W
Rise Time	Defined as time between Vout at 10% of final value and Vout at 90% of final value.	-	-	20	ms
Turn on Time	Defined as time between Vin reaching Turn-On voltage and Vout reaching 10% of final value.	20	-	30	ms
	Defined as time between Enable and Vout reaching 10% of final value.	-	-	10	ms
Overshoot at Turn on		-	-	3	%
Output Capacitance	Typically, 50% ceramic, 50% Oscon or POSCAP.	270	3200	6250	µF
Transient Response					
△V 50%~75% of Max Load	1 A/µs, 4000 µF capacitors are near the brick output.	-	350	-	mV
Settling Time		-	500	-	µs
△V 75%~50% of Max Load		-	350	-	mV
Settling Time		-	500	-	µs

5. OUTPUT PLOT VS INPUT

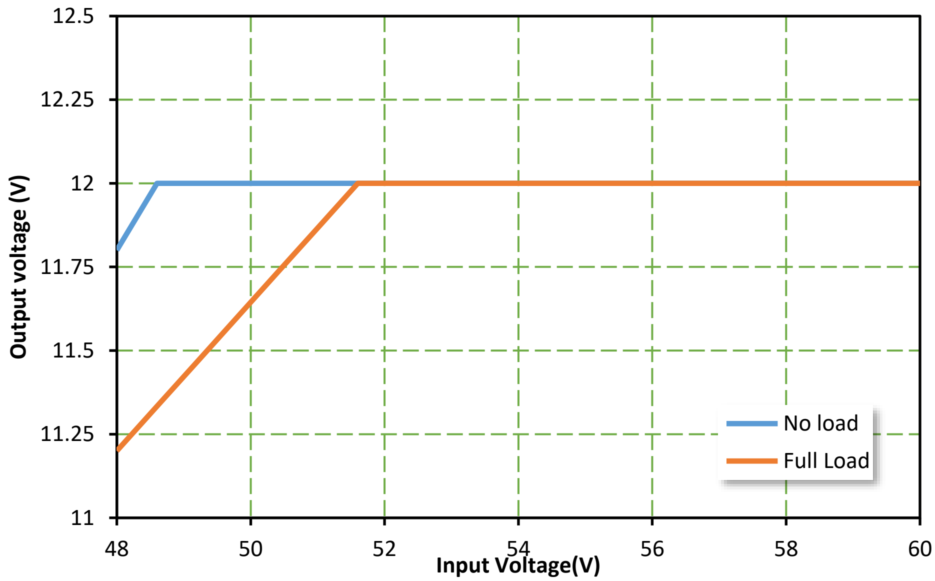

Figure 1. Input Voltage vs Output Voltage, without droop (0RQB-X5M12BG)

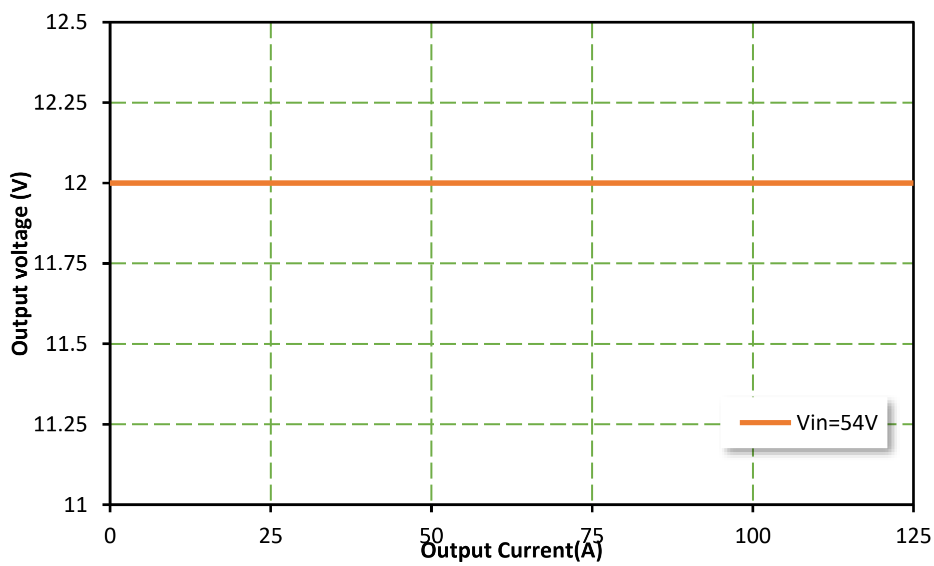

Figure 2. Output Current vs Output Voltage, without droop (0RQB-X5M12BG)

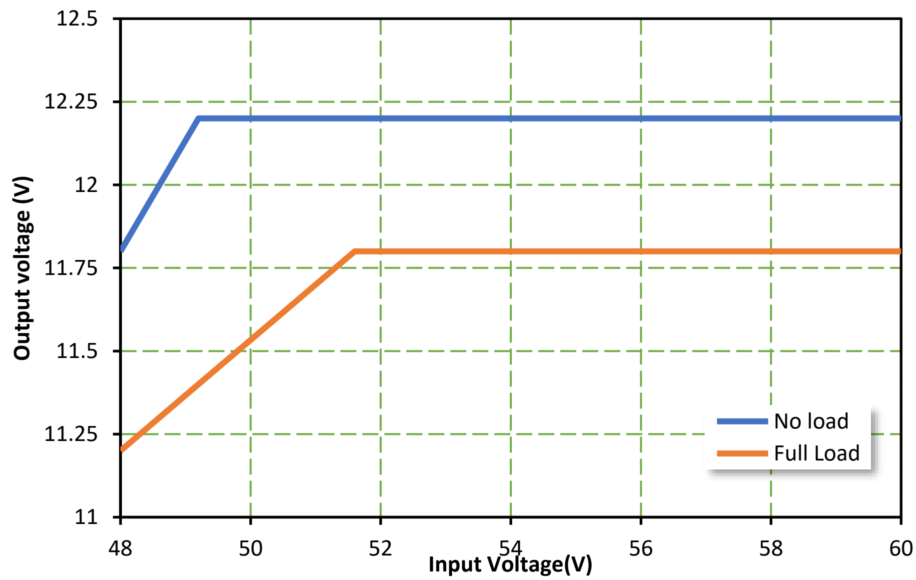

Figure 3. Input Voltage vs Output Voltage, with droop (0RQB-X5M12PG)

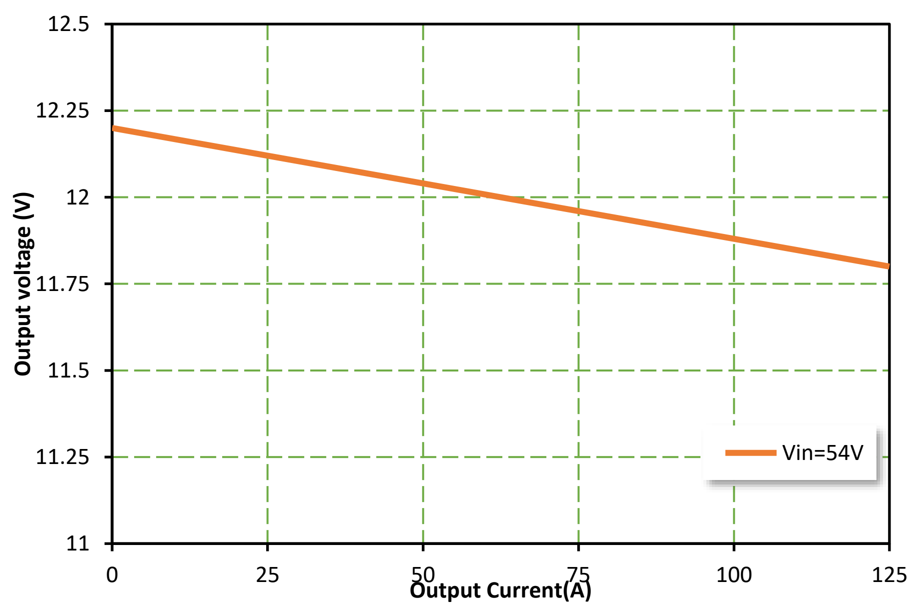

Figure 4. Output Current plot vs Output Voltage, with droop (0RQB-X5M12PG)

6. GENERAL SPECIFICATIONS

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
Efficiency		-	97.3	-	%
Switching Frequency	Primary FETs	-	150	-	kHz
MTBF		-	-	-	Mhrs
Over Temperature Protection	Auto-recovery.	-	130	-	°C
Output Over Voltage Protection		-	-	15	V
Weight		-	87.4	-	g
Dimensions (L × W × H)		2.30 x 1.45 x 0.57			inch
		58.42 x 36.83 x 14.50			mm
Isolation Characteristics					
Input to Output		-	-	500	V
Isolation Resistance		10M	-	-	Ohm
Isolation Capacitance		-	1000	-	pF

7. EFFICIENCY DATA

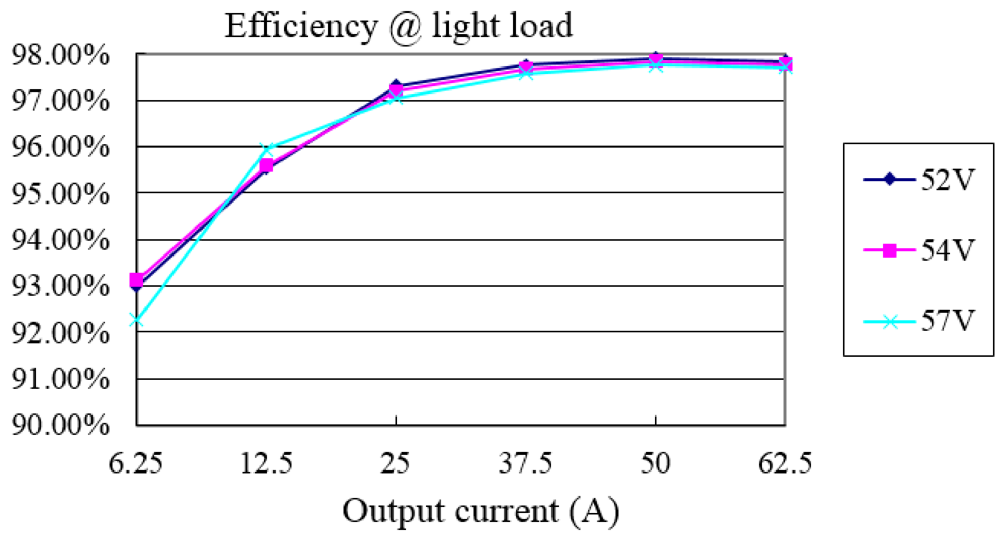

Figure 5. Efficiency vs Output Current (light load)

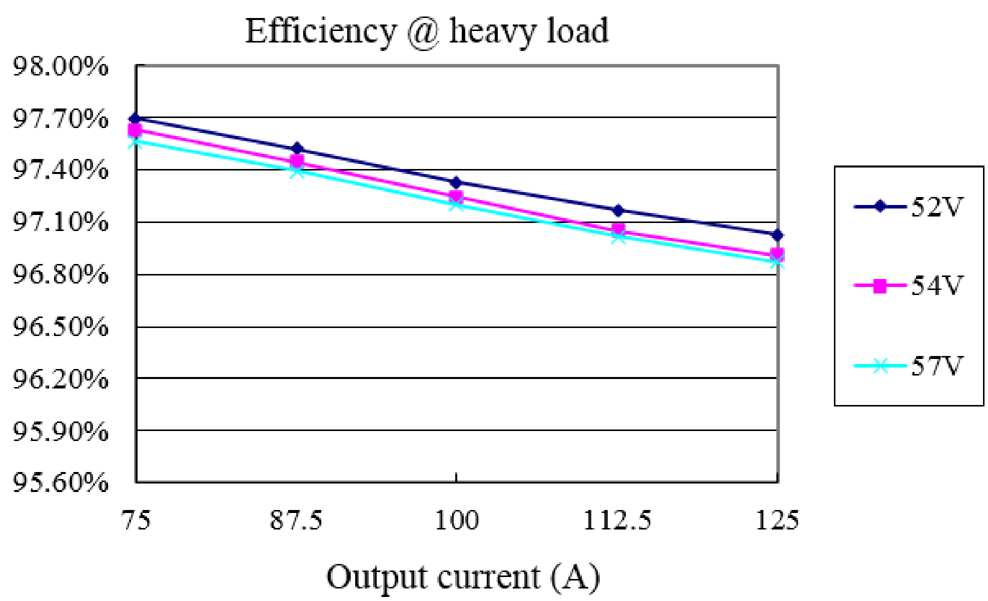

Figure 6. Efficiency vs Output Current (heavy load)

NOTE: The efficiency is measured at Ta = 25°C.

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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
Open Circuit Voltage			-	-	15	V

Recommended remote on/off circuit for active low:

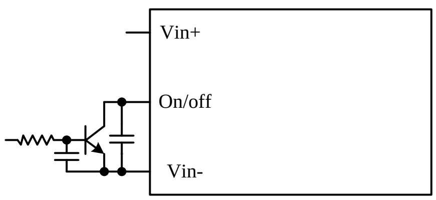

Figure 7. Control with open collector/drain circuit

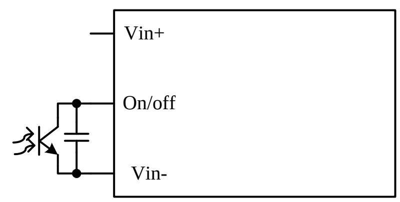

Figure 8. Control with photocoupler circuit

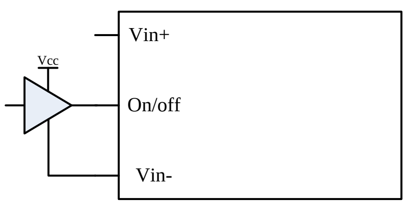

Figure 9. Control with logic circuit

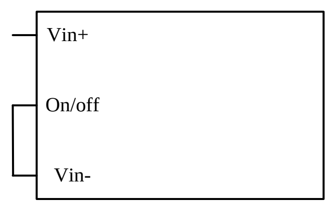

Figure 10. Permanently on

9. RIPPLE AND NOISE WAVEFORM

Testing setup

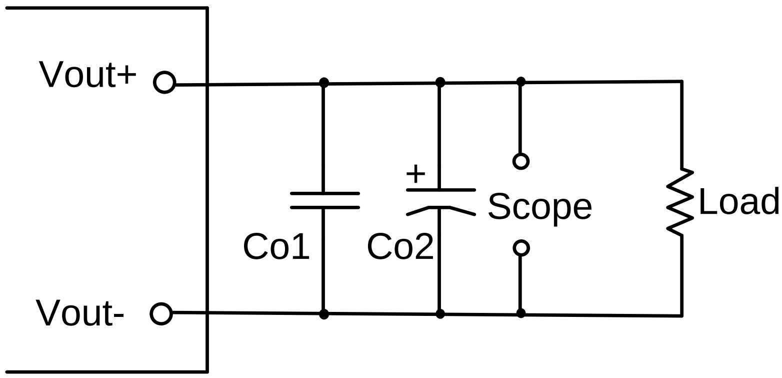

Figure 11.

Notes and values in testing.

Co1: 3100 µF ceramic capacitor

Co2: NIL

The capacitor should be as close as possible to the power module to effectively damp ripple current and enhance stability.

Below measured waveforms are based on above capacitance.

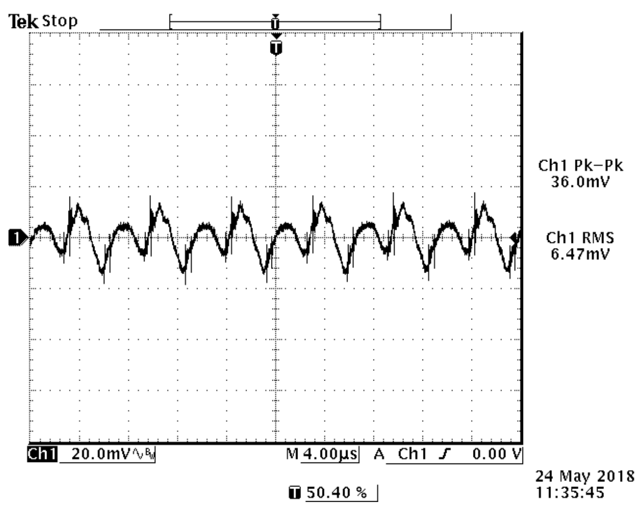

Figure 12.

NOTE: Ripple and noise, 52 VDC input, 1500 W output, Ta = 25 °C, with Cout = 3100 µF (50% ceramic, 50% POSCAP).

10. TRANSIENT RESPONSE WAVEFORM

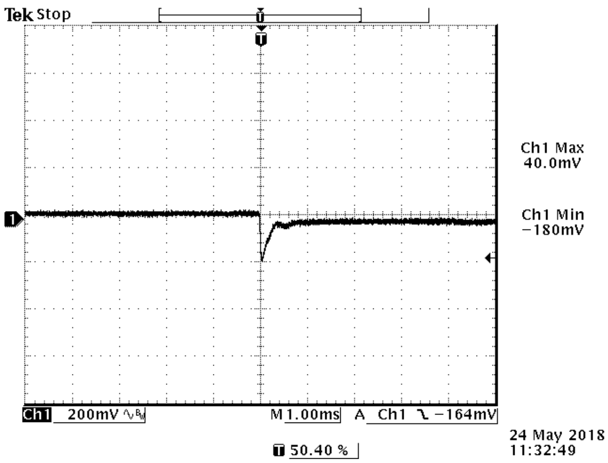

Figure 13. 50%-75% Load Transients at Vin = 52 V @ Ta = 25°C

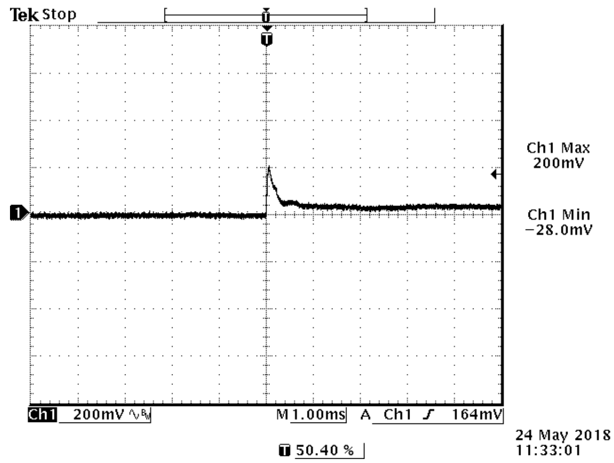

Figure 14. 75%-50% Load Transients at Vin = 52 V @ Ta = 25 °C

11. INPUT NOISE WAVEFORM

Input reflected ripple current

Testing Setup:

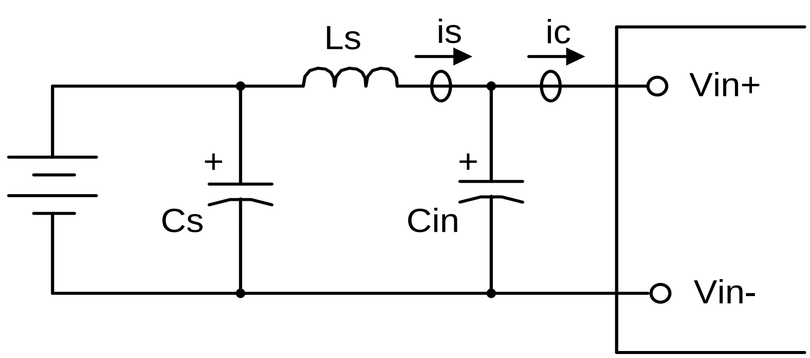

Figure 15. Input reflected ripple current

Notes and values in testing:

is: Input Reflected Ripple Current
ic: Input Terminal Ripple Current
Ls: Simulated Source Impedance (10 µH)
Cs: Offset possible source Impendence (100 µF, ESR < 0.2 Ω @ 100 kHz, 20 °C)
Cin: Electrolytic capacitor, should be as close as possible to the power module to effectively damp ic ripple current and enhance stability. Recommendation: 100 µF, ESR < 0.2 Ω @ 100 kHz, 20 °C.

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

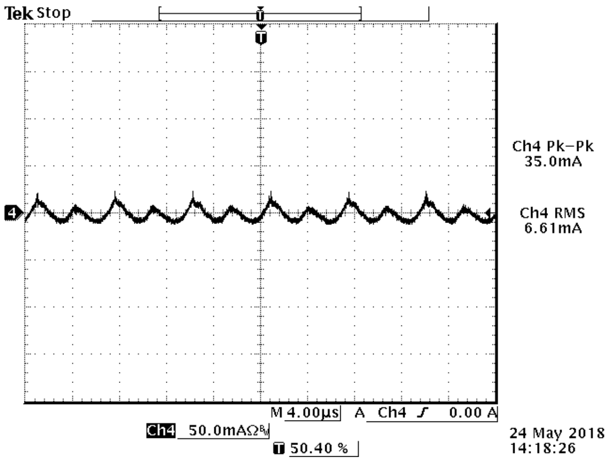

Figure 16. is (input reflected ripple current), AC component

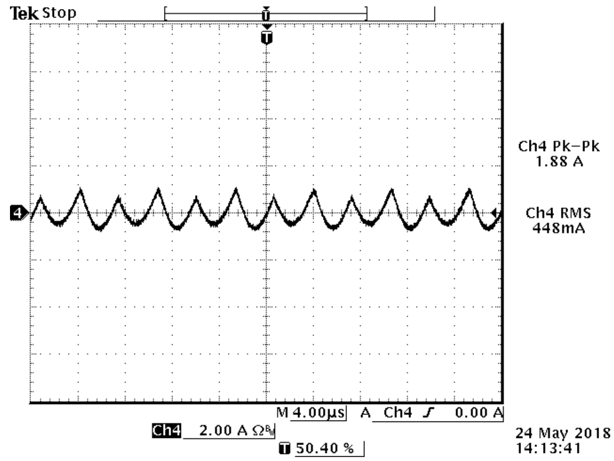

Figure 17. ic (input terminal ripple current), AC component

Test condition: 52 VDC input, 12 VDC / 125 A output @ Ta = 25°C, with 30 * 100 µF ceramic capacitor & 3200 µF AL. cap at output.

12. STARTUP & SHUTDOWN

Rise time

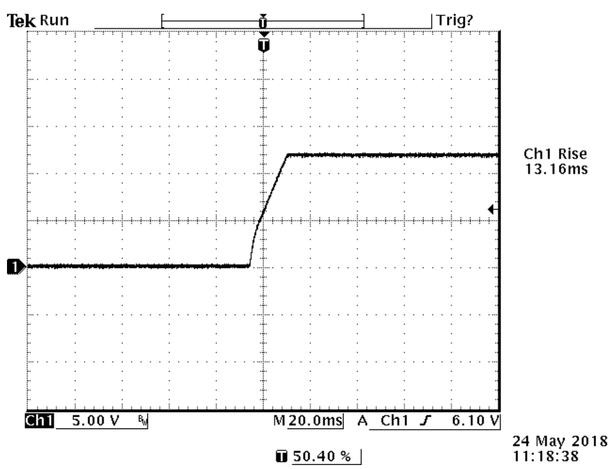

Figure 18. Rise Time

Test Condition: Vin = 52 V, Po = 1500 W, with 30 * 100 µF ceramic capacitor and 3200 µF AL. cap at output.

Startup time

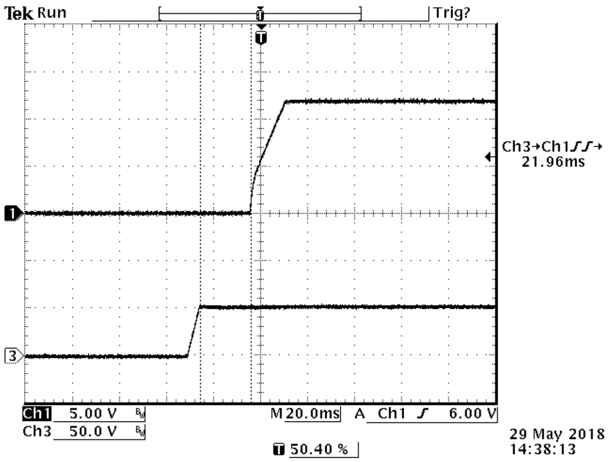

Figure 19. Startup from Vin
Ch1: Vo
Ch3: Vin

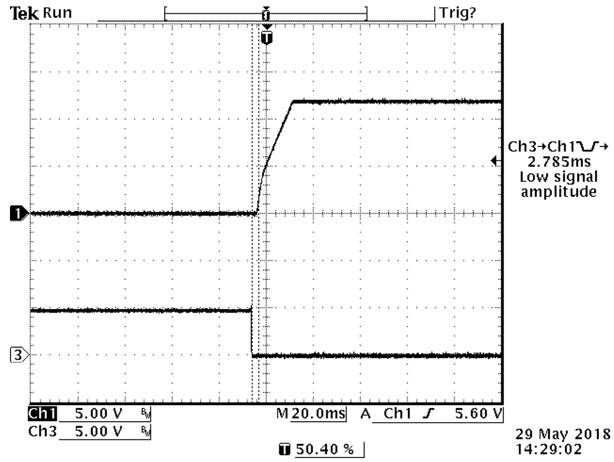

Figure 20. Startup from on/off
Ch1: Vo
Ch3: on/off

Test Condition: Vin = 52 V, Po = 1500 W, with 30 * 100 μF ceramic capacitor and 3200 μF AL. cap at output.

Shut down

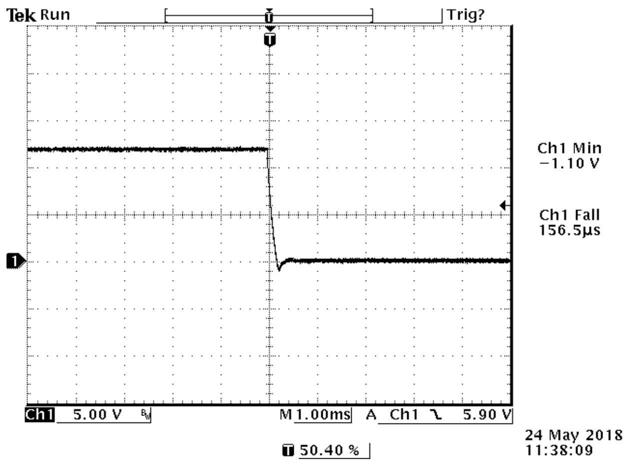

Figure 21. Shut Down

Test Condition: Vin = 52 V, Po = 1500 W, with 30 * 100 μF ceramic capacitor and 3200 μF AL. cap at output.

13. OVER CURRENT PROTECTION

To provide protection in a fault output overload condition, the module is equipped with internal over current protection circuitry. If the over current condition occurs, the module will shut down into hiccup mode and restart once every 250 ms. The module operates normally when the output current goes into specified range.

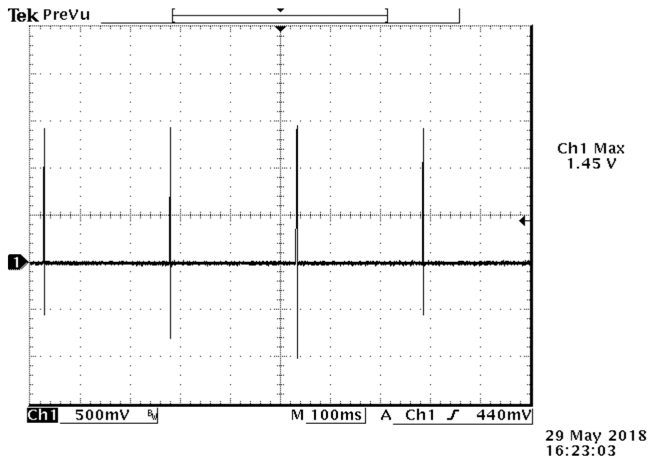

Figure 22. Over current protection
Vin = 52 V @Ta = 25 °C
CH1: Output Voltage

14. INPUT UNDER-VOLTAGE LOCKOUT

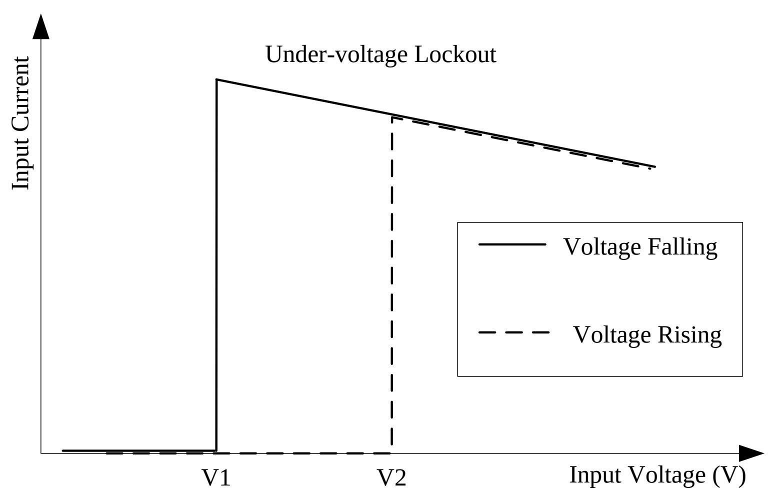

Figure 23. Input under-voltage lockout
V1 = 44 V
V2 = 47 V

15. THERMAL DERATING CURVE

Hot spot location and allowed maximum temperature:

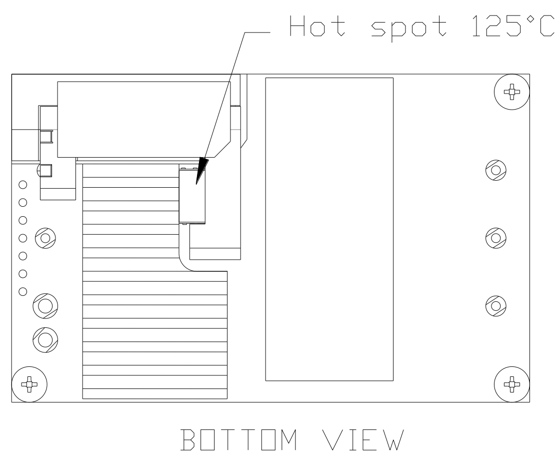

Figure 24. Hot spot in module bottom view

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 the 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 must 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).

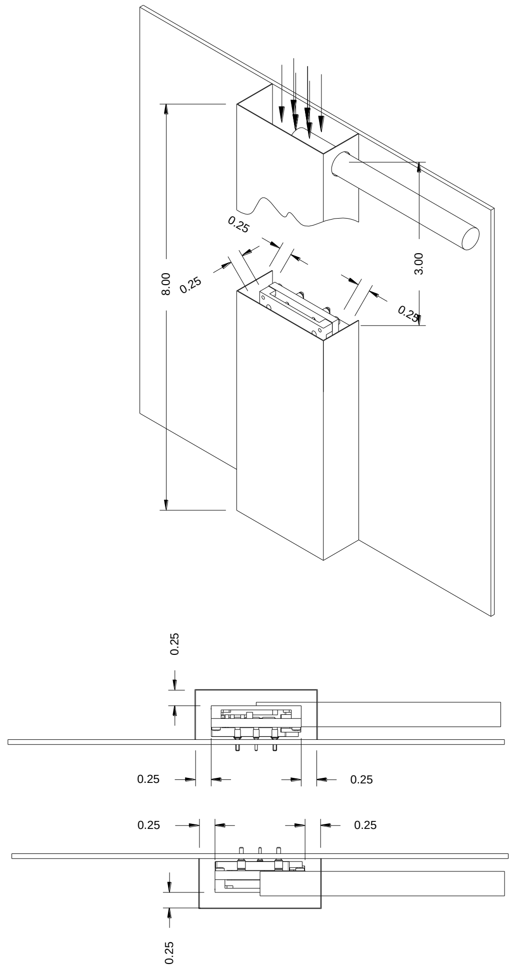

Figure 25. 0RQB-X5M12 series

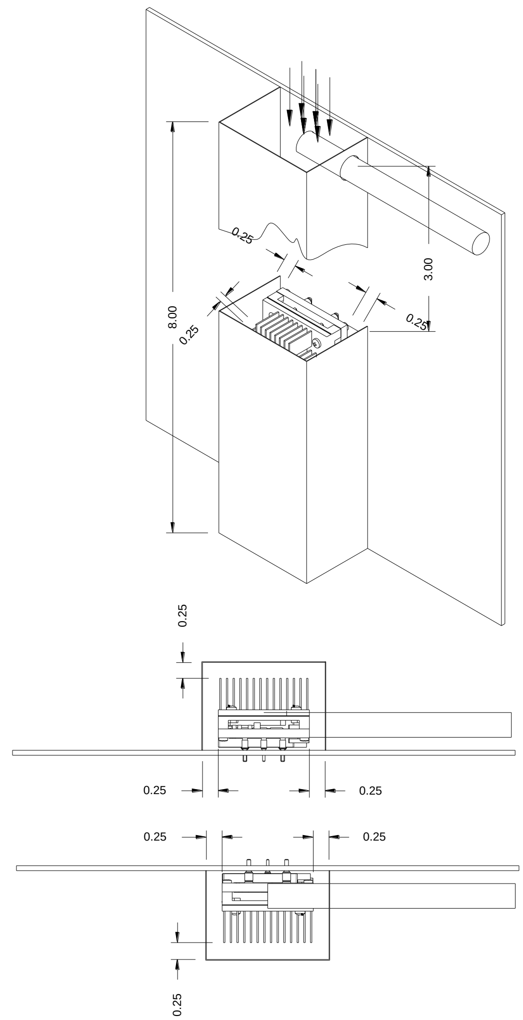

Figure 26. 0RQB-X5M12 series + External heatsink

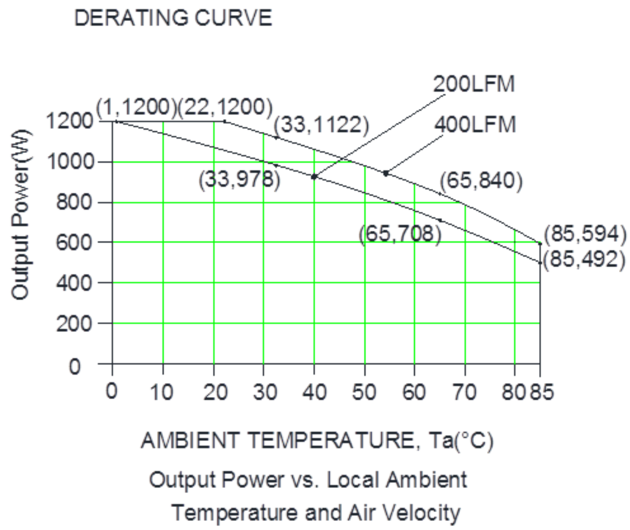

Figure 27. For 0RQB-X5M12 series

NOTE: Output power vs. ambient temperature and air velocity @Vin = 57 V (Longitudinal Orientation, airflow from Vout to Vin).

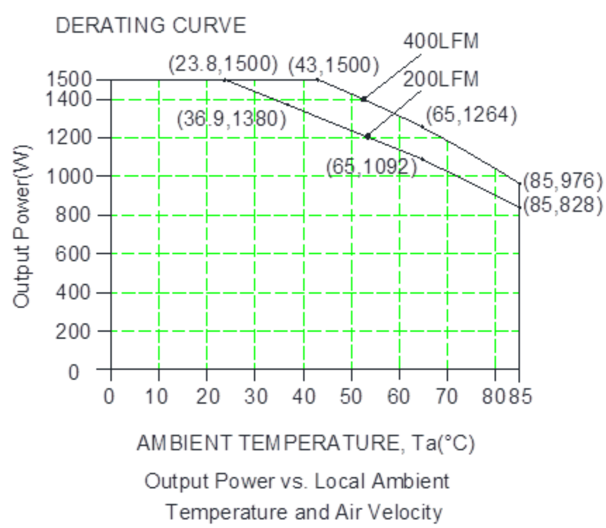

Figure 28. For 0RQB-X5M12 series + External heatsink

NOTE: Output power vs. ambient temperature and air velocity @Vin = 57 V (Longitudinal Orientation, airflow from Vout to Vin).

16. POWER GOOD

1. The Power Good signal is a non-latching open-collector output that is Low during normal operation and is pulled High when any of the following conditions occur:

- Over-Temperature
- Over-Current
- Vout is outside of the DC Output Band while Vin is within the Vin Operating Range
- In Parallel configuration, Vin is within operating range, no Vout due to one of the units not operational.
- Vin is outside of the Vin Operating Range

2. The Power Good signal is referenced to Vout(-).

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
Output Voltage Low (trigger limits)		8.2	-	8.6	V
Output Voltage High (trigger limits)		12.6	-	13.1	V
Input Voltage Low (trigger limits) Rising	PG signal indicates good when Vin is within operating range and indicates bad ~20 ms before unit is shut-down due to UV or OV	42.5	-	48	V
Input Voltage High (trigger limits) Rising		63	-	67	V
Hysteresis		-	1	-	V
High State Voltage		0	-	5.5	V
High State Leakage Current (into Pin)		0	-	10	µA
Low State Voltage		0	-	0.8	V
Low State Current (into Pin)		0	-	5	mA
Power Good Signal De-assert Response Time	Duration between the fault occurring and the Power-Good Signal de-asserting	0	-	3	ms
Power Good Signal Assert Response Time	Duration between unit powering up with no faults and the Power Good Signal asserting	0	-	3	ms
Power Good Signal Duration	Duration the Power-Good signal stays de-asserted if a transient fault occurs	200	-	600	ms

17. MECHANICAL DIMENSIONS

OUTLINE

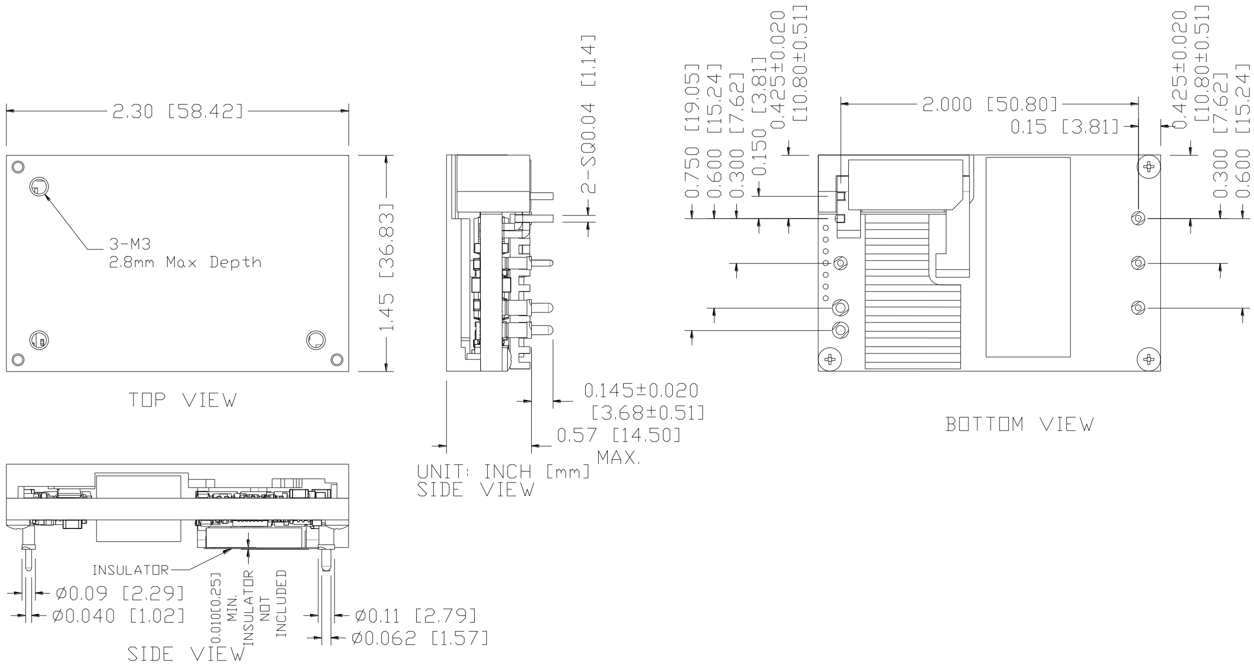

Figure 29. Outline

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 in [0.51 mm].
x.xxx +/-0.010 in [0.25 mm].

PIN DEFINITIONS

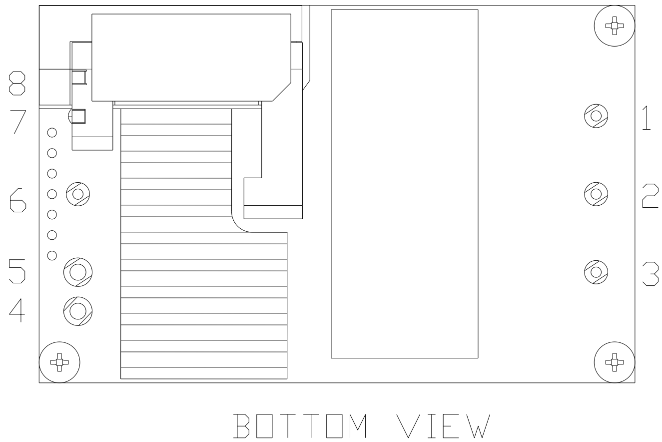

Figure 30. Pins

PIN	FUNCTION	DESCRIPTION	PIN SIZE
1	Vin (+)	Positive input voltage	0.04”
2	ON/OFF	Input to turn converter on and off, referenced to Vin(-)	0.04”
3	Vin (-)	Negative input	0.04”
4	Vout (-)	Negative output	0.062”
5	Vout (-)	Negative output	0.062”
6	PGOOD	Power-Good	0.04”
7	Vout (+)	Positive output	SQ0.05"
8	Vout (+)	Positive output	SQ0.05"

RECOMMENDED PAD LAYOUT

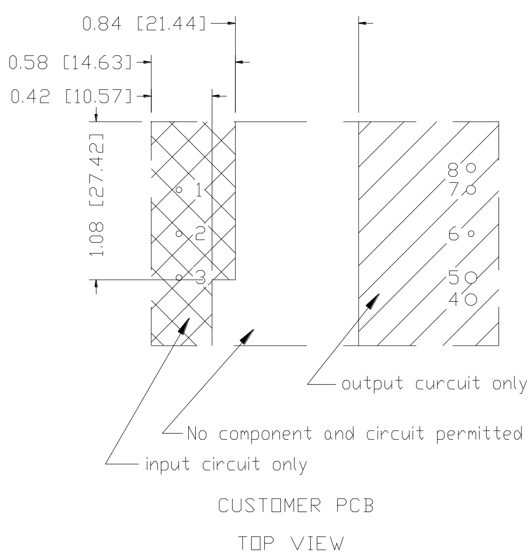

Figure 31. Recommended Pad Layout-1

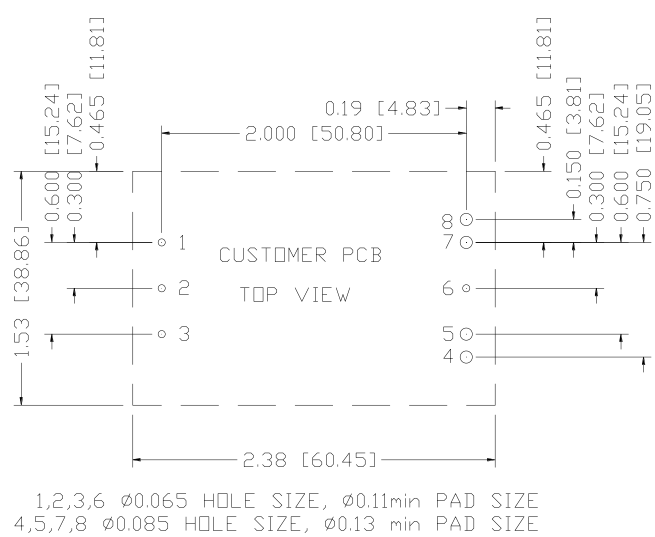

Figure 32. Recommended Pad Layout-2

18. FEATURE DISCRIPTIONS

Output over current protection

The module is equipped with internal output current limiting circuitry, and can endure limiting current continuously. If the output current exceeds the limited value, the module will shut down and enter either hiccup mode or latch mode, which is stated in the output spec table previously.

For hiccup mode, the module will try to restart after shutdown. If the over current situation still exists, the module will shut down continuously until this fault condition is cleared. The hiccup interval time is 250 ms.

For latch mode, the module will latch off once shutdown. The latch mode can be reset by cycling the input power or resetting the remote on/off pin.

Over temperature protection

The module is equipped with internal over temperature protection circuitry to safeguard against thermal damage. If the maximum device reference temperature exceeds the limited value, the module will shut down and enter either auto-recovery mode or latch mode, which is stated in the general spec table previously.

For auto-recovery mode, the module will keep monitoring the reference temperature after shutdown and auto restart once the temperature is lower than the protection threshold by ~20°C hysteresis.

For latch mode, the module will latch off once shutdown. The latch mode can be reset by cycling the input power or resetting the remote on/off pin.

Under/Over input voltage protection

The module is equipped with internal input UVLO and OVLO protection. If the input voltage is below the UV threshold or above the OV threshold, the module will shut down and auto-restart once the input voltage is within the limited range which is stated in the input spec table previously.

19. REVISION HISTORY

DATE	REVISION	CHANGES DETAIL	APPROVAL
2018-05-18	AA	First release.	J.Yao
2018-09-18	AB	Update TD curve.	J.Yao
2018-10-24	AC	Update Input/Output Specifications.	J.Yao
2018-12-10	AD	Update Input voltage range. Add Peak output power Specifications.	J.Yao
2019-02-25	AE	Update Vin turn on/off and output plot vs input.	J.Yao
2019-03-19	AF	Remove the Power Good pin.	J.Yao
2019-05-30	AG	Increase maximum output power.	J.Yao
2020-08-21	AH	Delete preliminary watermark.	J.Yao
2021-02-09	AI	Add safety certificate and recommended pad layout.	J.Yao
2021-03-31	AJ	Add object ID.	J.Yao
2021-12-15	AK	Add power good information. Update mechanical dimensions for adding power good pin.	J.Yao
2022-05-27	AM	Add new PN 0RQB-X5M12PG. Update altitude max value.	J.Yao

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