0RQB-X3S113

Isolated DC-DC Converter

The 0RQB-X3S113 modules are isolated DC/DC converters that provide up to 1300 W of output power from a nominal 54 VDC input.

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

Key Features & Benefits

- 48 – 60 VDC Input
- 10.8 VDC @ 120.4 A Output
- 1/4th Brick Converter
- Isolated
- Fixed Frequency
- High Efficiency
- High Power Density
- Input Under-Voltage Lockout
- OCP/SCP
- Output Over-Voltage Protection
- Input Under-Voltage Protection
- Over Temperature Protection
- Remote On/Off
- Low Cost
- Approved to UL/CSA 62368-1
- Approved to IEC/EN 62368-1
- Class II, Category 2, Isolated DC/DC Converter (refer to IPC-9592B)

RoHS Compliant

Applications

- Networking
- Computers and Peripherals
- Telecommunications

1. MODEL SELECTION

MODEL NUMBER	OUTPUT VOLTAGE	INPUT VOLTAGE	MAX. OUTPUT CURRENT	MAX. OUTPUT POWER	TYPICAL EFFICIENCY
0RQB-X3S113G 0RQB-X3S113HG	10.8 VDC	48 – 60 VDC	120.4 A	1300 W	96.6%

PART NUMBER EXPLANATION

0	R	QB	-	X3	S	11	3	x/xx
Mounting Type	RoHS Status	Series Name		Output Power	Input Range	Output Voltage	Active Logic	Options
Through Hole Mount	RoHS	1/4th Brick		1300 W	48 – 60 V	10.8 V	Active Low	G - Pin Length 0.18", bottom heatsink horizontal direction, Tray Package HG - Pin Length 0.18", bottom heatsink vertical direction, Tray Package

2. ABSOLUTE MAXIMUM RATINGS

	PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNITS
V_I	Input Voltage Continuous		-0.3	–	65	V
V_{RM}	Remote On/Off pin Voltage		-0.3	-	16	V
V_{PG}	Power Good pin Voltage		-0.3		16	V
V_{ISO}	Isolation Voltage (input to output test voltage)		-	-	500	V
	Isolation Voltage (input to base plate test voltage)		-	-	500	V
	Isolation Voltage (base plate to output test voltage)		-	-	500	V
Ta	Ambient Temperature Long-Term	See Note 1	-30	-	85	°C
Tas	Ambient Temperature Short-Term	See Note 2	-40	-	90	°C
T_S	Storage Temperature		-40	-	100	°C
AT	Altitude		-500	-	13120	feet
RH	Humidity		10	85	90	%

Note 1: All components on the Unit meet IPC-9592 (latest revision) derating guidelines.

Note 2: (96 hours/year). Unit's component temperatures exceed IPC-9592 (latest revision) derating guidelines but not exceed component temperature ratings.

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
V_{IN}	Operating Input Voltage		48	54	60	V
I_{IMAX}	Input Current (full load)	P_O = 100% of P_{OTDP}	-	-	28	A
I_{iid}	Input Current (no load)	Input idling current, P_O = 0 W	-	130	-	mA
I_{Ioff}	Remote Off Input Current		-	10	20	mA
I_S	Input Reflected Ripple Current (rms)	See Note 1	-	5	10	mA
I_S	Input Reflected Ripple Current (pk-pk)	See Note 1	-	20	50	mA
I_C	Input Terminal Ripple Current (rms)	See Note 1	-	-	1300	mA
	Input Terminal Ripple Current over Temperature (rms)	Ta = -20 to 85°C	-	3	15	mA
C_{SE}	Internal Input Capacitance		-	16	-	uF
C_{IN}	Recommended Input Capacitor		-	100	-	uF
V_{IoffL}	Input Turn off Voltage Threshold		39	41	42.5	V
V_{IonL}	Input Turn on Voltage Threshold		42.5	44	45	V
$V_{UV(hys)}$	Hysteresis Voltage		2	-	-	V
V_{IonH}	Over-voltage Recovery Threshold		60	61	63	V
V_{IoffH}	Over-voltage Shutdown Threshold	See Note 2	61	-	64	V
$V_{OV(hys)}$	Hysteresis Voltage		3	-	-	V
	Recommended input fast acting fuse on system board	See Note 3	-	36	-	A

Note 1: Refer to section 8 for detail input capacitance and waveforms.

Note 2: Output shuts down immediately.

Note 3: This converter is not internally fused. An input line fuse must be used in application.

4. OUTPUT SPECIFICATIONS

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

	PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
V_O	Output Voltage Set Point	Vin = 54 V, P_O = 50% of P_{OTDP}	10.692	10.800	10.908	V
	Output Voltage Total Range	Vin = 48~60 V, Pout = 0~P_{OTDP}, See Note 6	10.584	-	11.016	V
	Load Regulation	Vin = 54 V, P_O = 0~100% of P_{OTDP}	-	0.02	0.07	V
	Line Regulation	Vin = 48~60V, P_O = 100% of P_{OTDP}	-	0.02	0.08	mV
	Regulation Over Temperature	Vin = 54 V, P_O = 100% of P_{OTDP}, Ta = -30 ~ 85°C	-	100	200	mV
V_{OAC}	Ripple and Noise (pk-pk)	P_O = 100% of P_{OTDP}, See Note 1	-	30	150	mV
V_{ORMS}	Ripple and Noise (rms)	P_O = 100% of P_{OTDP}, See Note 1	-	10	30	mV
	Output Ripple and Noise (pk-pk) under worst case	All operating input voltage, load and ambient temperature condition.	-	-	200	mV
I_O	Output Current Range		0	-	120.4	A
I_{OMAX}	Output DC Current Limit	See Note 2	130	-	-	A
P_{OTDP}	Output Power (TDP)	See Note 2	-	-	1300	W
t_r	Rise Time	See Note 3	-	-	15	ms
t_{s1}	Turn on Time from Vin	See Note 4	20	-	30	ms
t_{s2}	Turn on Time from RM	See Note 5	-	-	5	ms
V_{Pre}	Pre-bias Voltage		-	-	10.8	V
C_{out}	Output Capacitance	50% ceramic, 50% POSCAP.	0	750	10000	µF
V_{tr}	Load Transient Voltage Deviation	Load step 50~75~50% P_{OTDP}, di/dt = 1 A/µs. 4000 µF capacitors are near the brick output.	-	±350	-	mV
t_{tr}	Load Transient Recovery Time		-	500	-	µs

Note 1: Cout = 1x 330 uF POSCAP capacitor + 19 x 22 uF ceramic capacitor + 1 uF ceramic capacitor

Note 2: The continuous power (TDP, Thermal Design Power) is ≤ 1300 W, depending on thermal conditions.

Note 3: Defined as time between V_O at 10% of final value and V_O at 90% of final value.

Note 4: Defined as time between Vin reaching Turn-On voltage and V_O reaching 10% of final value.

Note 5: Defined as time between Remote on and V_O reaching 10% of final value.

Note 6: Over entire operating input voltage range, resistive load and temperature conditions until end of life.

5. GENERAL SPECIFICATIONS

	PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
η	Efficiency		-	96.6	-	%
f_{SW}	Switching Frequency	Primary FETs	-	150	-	kHz
	MTBF	Vin = 54 V, P_O = 80% of P_{OTDP}, 25°C	-	10.7	-	Mhrs
		Vin = 54 V, P_O = 80% of P_{OTDP}, 40°C	-	6.9	-	Mhrs
		Vin = 54 V, P_O = 80% of P_{OTDP}, 85°C	-	1	-	Mhrs
T_P	Over Temperature Protection	Auto-recovery.	-	130	-	°C
V_{OV}	Output Over Voltage Protection		-	-	15	V
G	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					
V_{ISO}	Input to Output		-	-	500	V
	Input to Case		-	-	500	V
	Output to Case		-	-	500	V
R_{ISO}	Isolation Resistance		10M	-	-	Ohm
C_{IC}	Isolation Capacitance		-	1000	2700	pF

6. TYPICAL CHARACTERISTICS

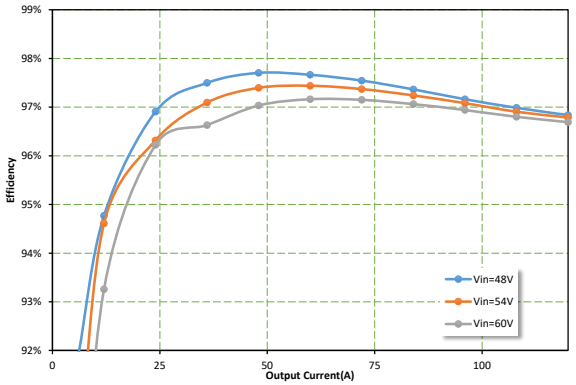

Figure 1. Efficiency

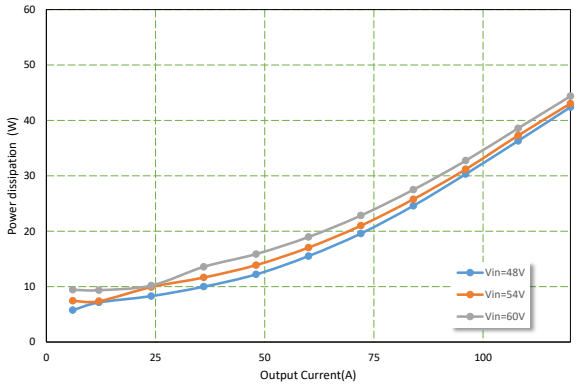

Figure 2. Power Dissipation

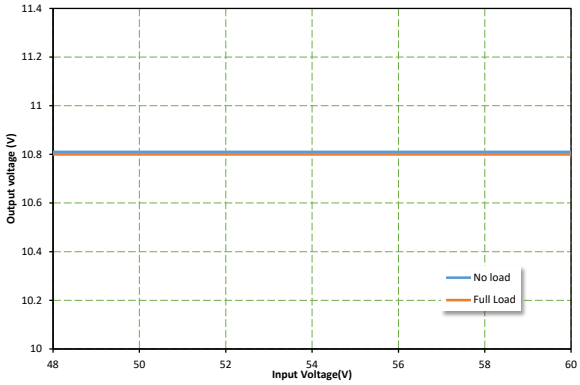

Figure 3. Line Characteristics

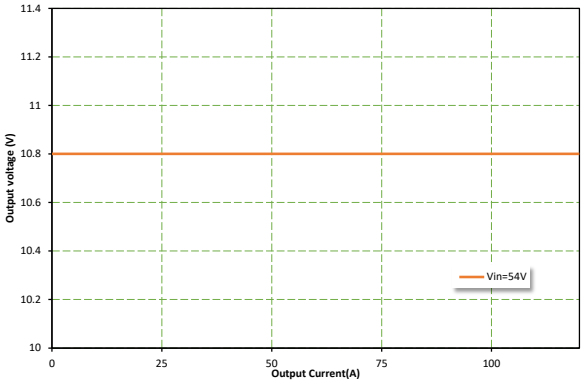

Figure 4. Load Characteristics

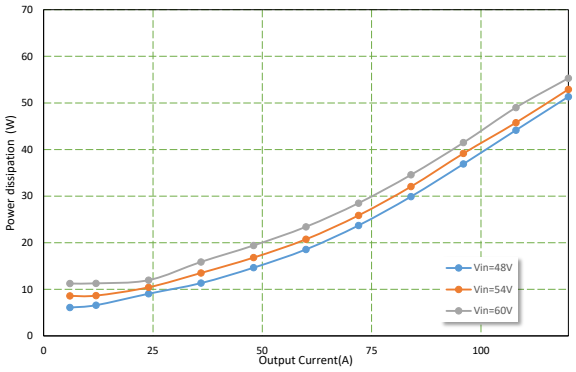

Figure 5. Power loss @ max temperature

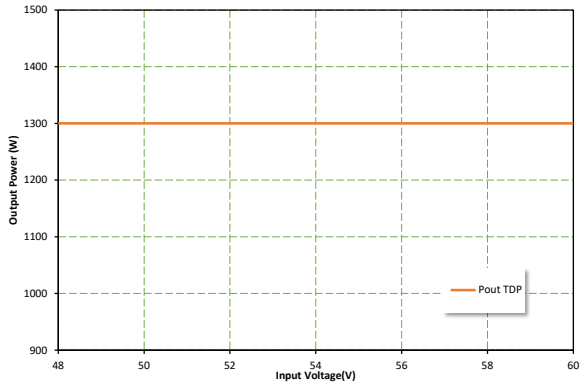

Figure 6. Available Power

7. FUNDAMENTAL CIRCUIT DIAGRAM

The product is a typical full bridge circuit design, the turn ratio of transformer is 4:1, so in theory, it is ensured that the input full range is not open loop. The relationship between input and output refer to Line Characteristics curve.

The primary side use bridge rectifier design and secondary side use full-wave rectification, it can effectively reduce the dissipation of MOSFET. In addition, C_2 can effectively prevent the failure due to transformer (T_1) magnetic bias.

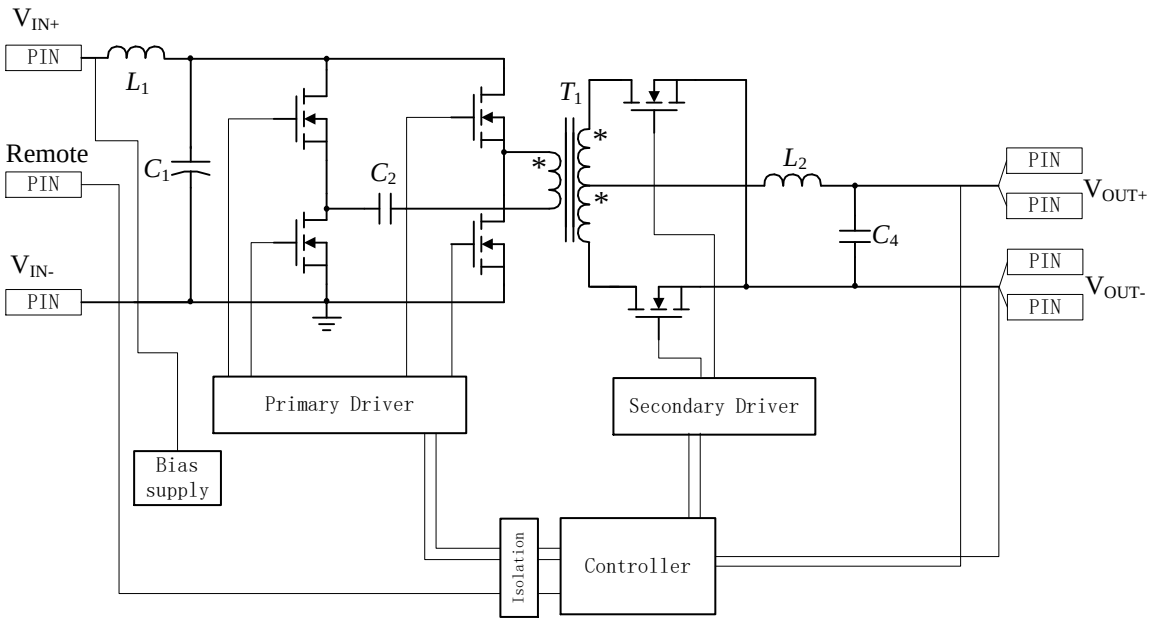

Figure 7. Block diagram

8. TYPICAL WAVEFORM

Typical Electrical Characteristics measured according to figure below.

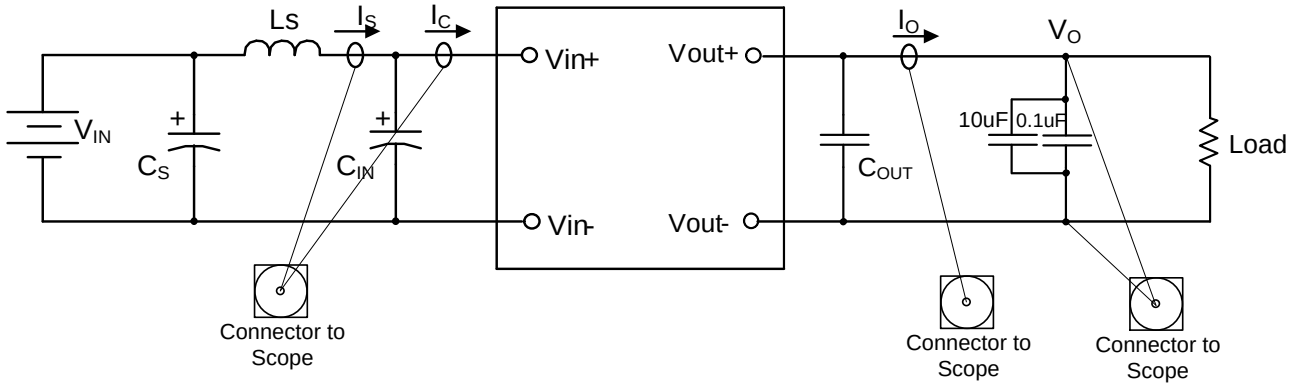

Figure 8. Test Setup

Notes and values in testing:

I_S: Input Reflected Ripple Current, measure by current probe.
I_C: Input Terminal Ripple Current, measure by current probe.
I_O: Output Current, measure by current probe.
V_O: Output Voltage. Measure by voltage probe.
Ls: Simulated Source Impedance (12 µH).
C_S: Offset possible source Impendence (100 µF, ESR < 0.2 Ω @ 100 kHz).
C_{IN}: Electrolytic capacitor, should be as close as possible to the power module to damp IC ripple current and enhance stability. Refer to the input specifications chapter TYP value of C_{IN}.
C_{OUT}: Refer to the output specifications chapter TYP value of C_{OUT}.
V_{IN}: Typical input 54 V.

To improve the accuracy of measurement, a short ground loop is used for measurement, and place 10 uF and 0.1 uF capacitors near the measuring point, use 20 MHz bandwidth for measurement. The correct probe technique is shown in figure below.

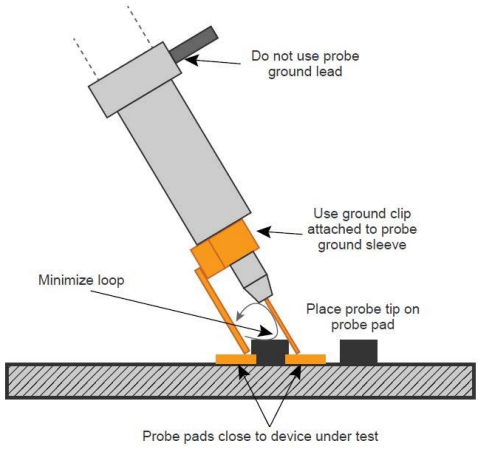

Figure 9. Input reflected ripple current.

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Input Noise

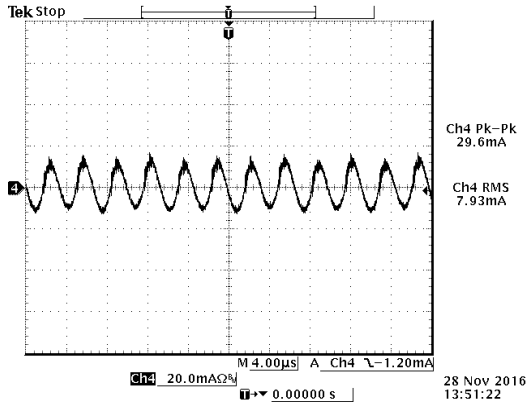

Figure 10. I_S, P_O = 100% of P_{OTDP}

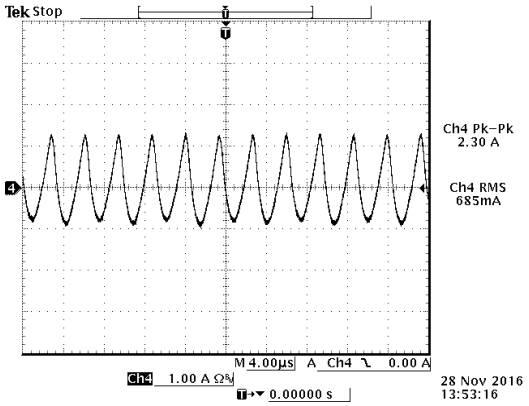

Figure 11. I_C, P_O = 100% of P_{OTDP}

Output Nois

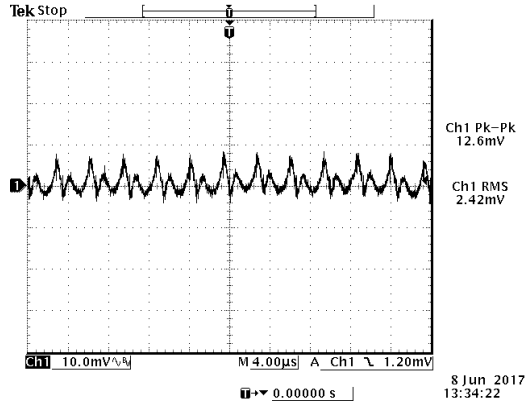

Figure 12. V_{OAC}, P_O = 0% of P_{OTDP}

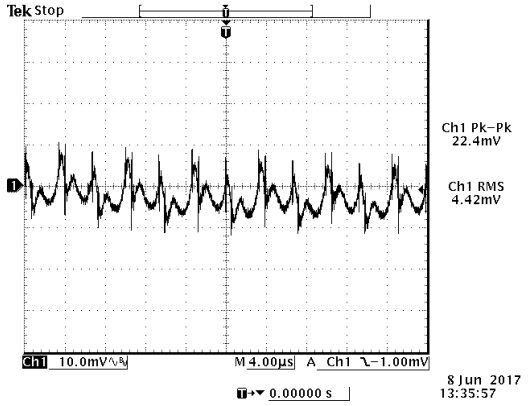

Figure 13. V_{OAC}, PO = 100% of P_{OTDP}

Load Transient

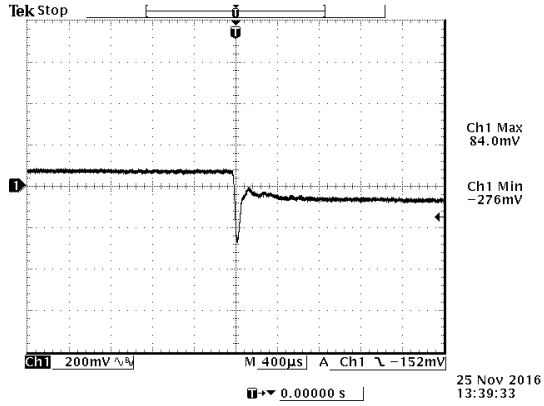

Figure 14. V_{tr}, 50%-75% Load Transients

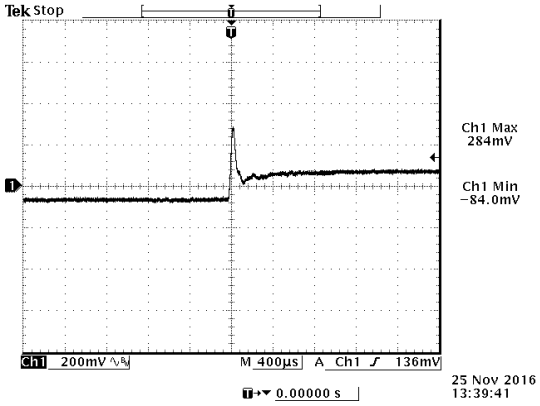

Figure 15. V_{tr}, 75%-50% Load Transients

Startup and Shutdown

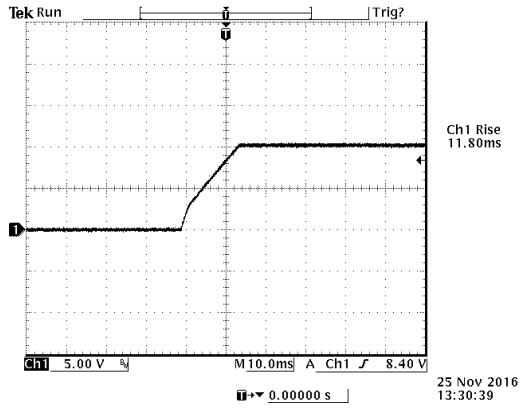

Figure 16. Startup, P_O = 100% of P_{OTDP}

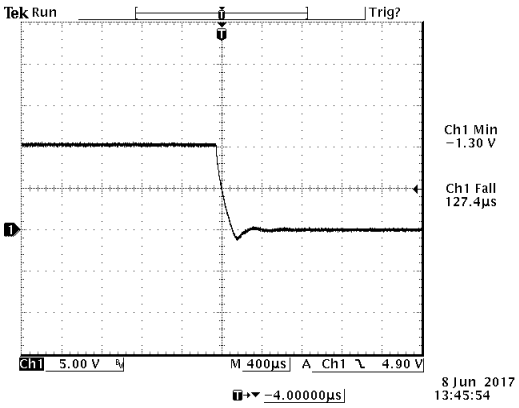

Figure 17. Shutdown, P_O = 100% of P_{OTDP}

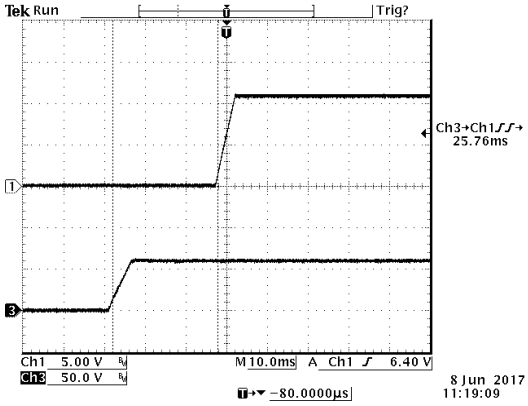

Figure 18. Startup from Vin, P_O = 100% of P_{OTDP}

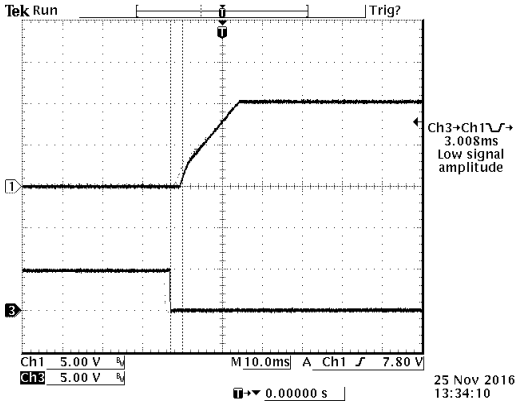

Figure 19. Startup from on/off, P_O = 100% of P_{OTDP}

9. REMOTE ON/OFF

	PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
V_{RML}	Signal Low	Remote On/Off pin is open, the module is off.	-0.3	-	0.8	V
V_{RMH}	Signal High		2.4	-	16	V
I_{RML}	Source Current	V_{REMOTE} = 0 V	-	-	150	uA
I_{RML}	Source Current	V_{REMOTE} = 2.4 V	10	-	100	uA
I_{RMH}	Sink Current	V_{REMOTE} = 10 V	-	-	-300	uA
I_{RMH}	Sink Current	V_{REMOTE} = 16 V	-	-	-500	uA
V_{RMF}	Open circuit voltage		-	12	15	V

Products has a remote-control function referenced to the primary negative input connection (VIN-), with negative and positive logic options available. Remote on/off function allows the product to be turned on/off by an external device like a semiconductor or mechanical switch. Remote on/off pin has an internal pull up resistor to internal 10~12 V. External device must provide a minimum required sink current > 0.15 mA to guarantee a voltage not higher than maximum voltage of Signal low (VRML)on the Remote on/off pin.

Recommended remote on/off circuit for active low.

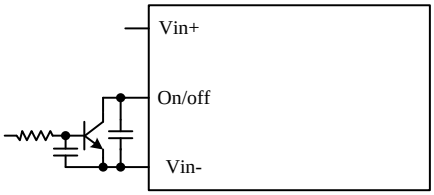

Figure 20. Control with open collector/drain circuit

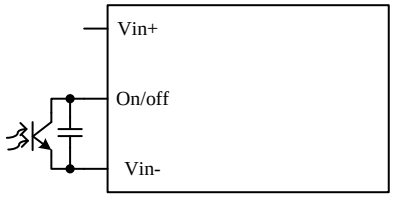

Figure 21. Control with photocoupler circuit

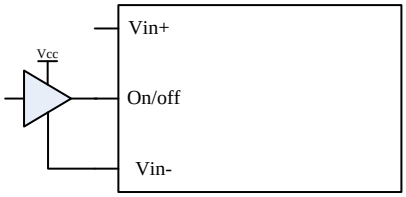

Figure 22. Control with logic circuit

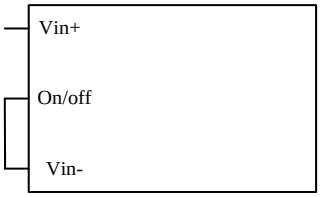

Figure 23. Permanently on

10. 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	-	45	V
Input Voltage High (trigger limits) Rising		61	-	64	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
Over Temperature Warning	For OT Warning, the PG signal will toggle as an impulse wave.		10 °C below OTP threshold		°C
OT Warning PG Signal Frequency		90	100	110	kHz
OT Warning PG Signal Duty Cycle		47.5	50	52.5	%

11. INPUT UNDER-VOLTAGE LOCKOUT

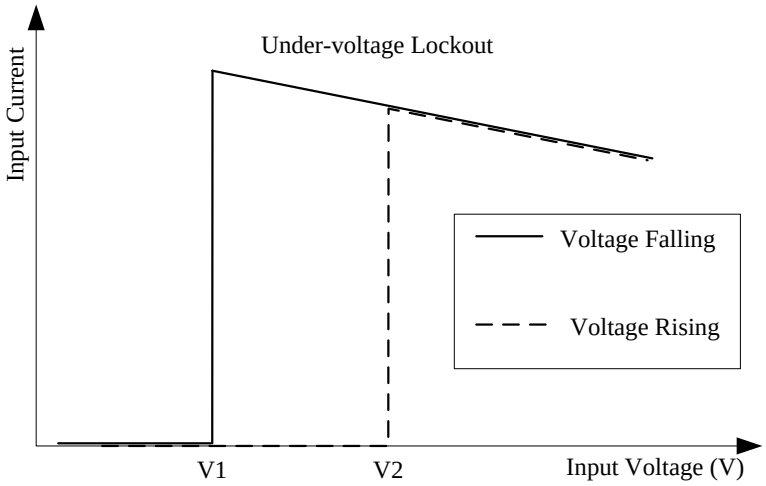

Figure 24. Input under-voltage lockout.

V1 = V_{loffL}; V2 = V_{lonL}

12. 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 1000 ms. The module operates
normally when the output current goes into specified range.

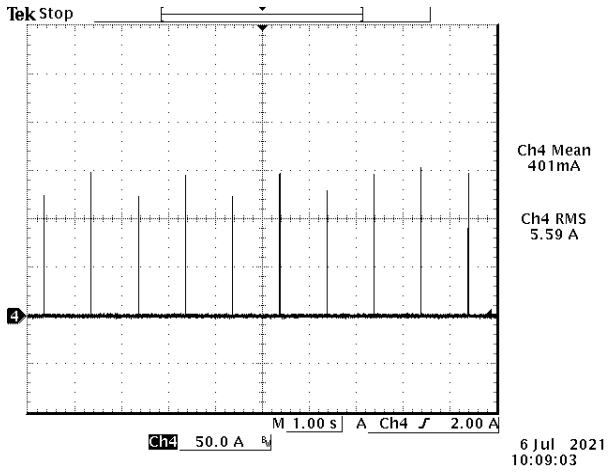

Figure 25. Over current protection
Vin = 54 V @ Ta = 25°C

13. LAYOUT RECOMMENDATIONS

The heat dissipation performance of the product depends not only on the heatsink of the product, but also on the layout of the motherboard in application. The motherboard is often large and can act as a good heatsink, power product can transfer heat to the motherboard through the pin. Therefore, good thermal conductivity should be ensured between the power product and the motherboard. Therefore, it is recommended to use multi-layer PCB for motherboard, expand the area of input and output as much as possible, and place many through holes around input and output pins. At the same time, it is an isolation product, so the layout of the motherboard must fully consider the isolation area. Here is a recommendation of motherboard layout.

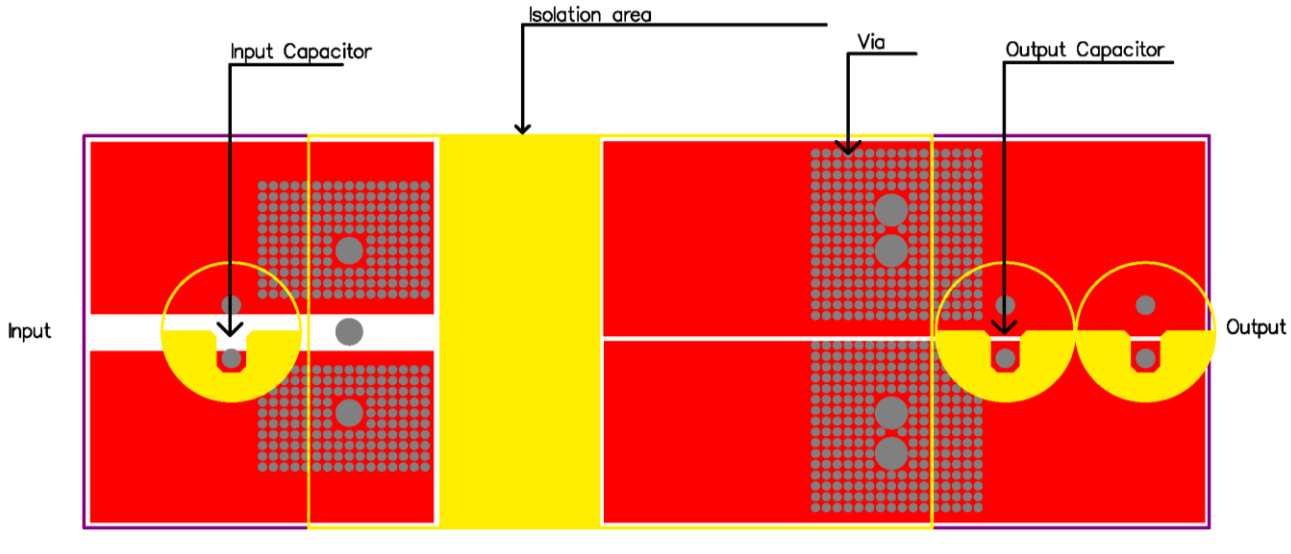

Figure 26. recommendation of motherboard layout

14. THERMAL DERATING CURVES

The product is designed for different thermal environments, and sufficient cooling environment must be provided to ensure reliable operation. High power output requires external cooling, such as heatsink or cold wall.

If an additional heatsink is used, the teeth and slots at the top of the heatsink should not collide with the wind, that is, the direction of teeth and slots at the top of the heatsink should parallel to the direction of the wind blowing. If the design of the product is changed, for example, the direction of the wind is rotated by 90 degrees, the teeth and slots at the top of the heatsink should be redesigned to ensure the same thermal performance. Typical thermal measured according to figure below.

THERMAL TEST SETUP

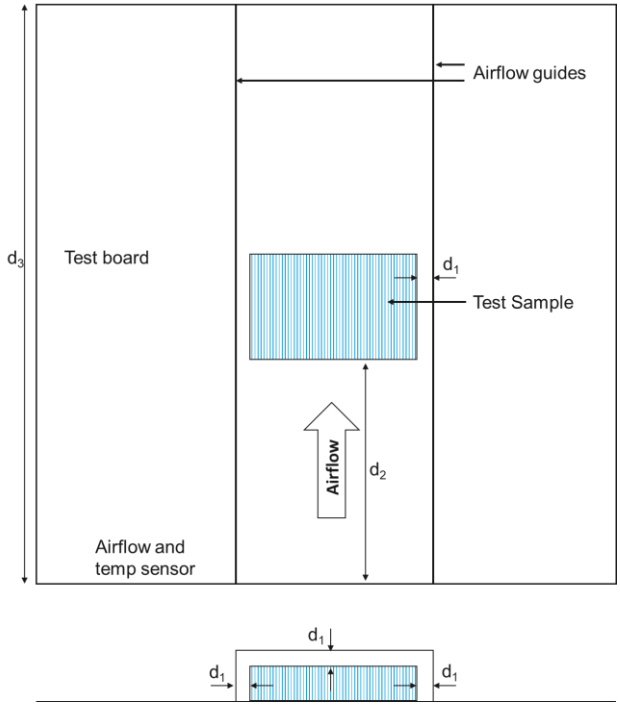

Figure 27. Thermal test setup, Airflow from Vo- to Vo+

d_1: The distance is 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.

d_2: Ambient temperature and airflow are measured in front of the module at the distance of 76.2 mm (3 inch).

d_3: Product is tested on an 8”×8”, Internal 105 um (3 oz), outside 70 um (2 oz), 6-layer test board mounted in a wind tunnel.

V_{IN}: 56 V

Airflow: test at 200 LFM, 400 LFM

Test without heatsink (baseplate only) or use external heatsink which size is 2.30”×1.45”×0.83”, and the teeth and slots at the top of the heatsink show as follow.

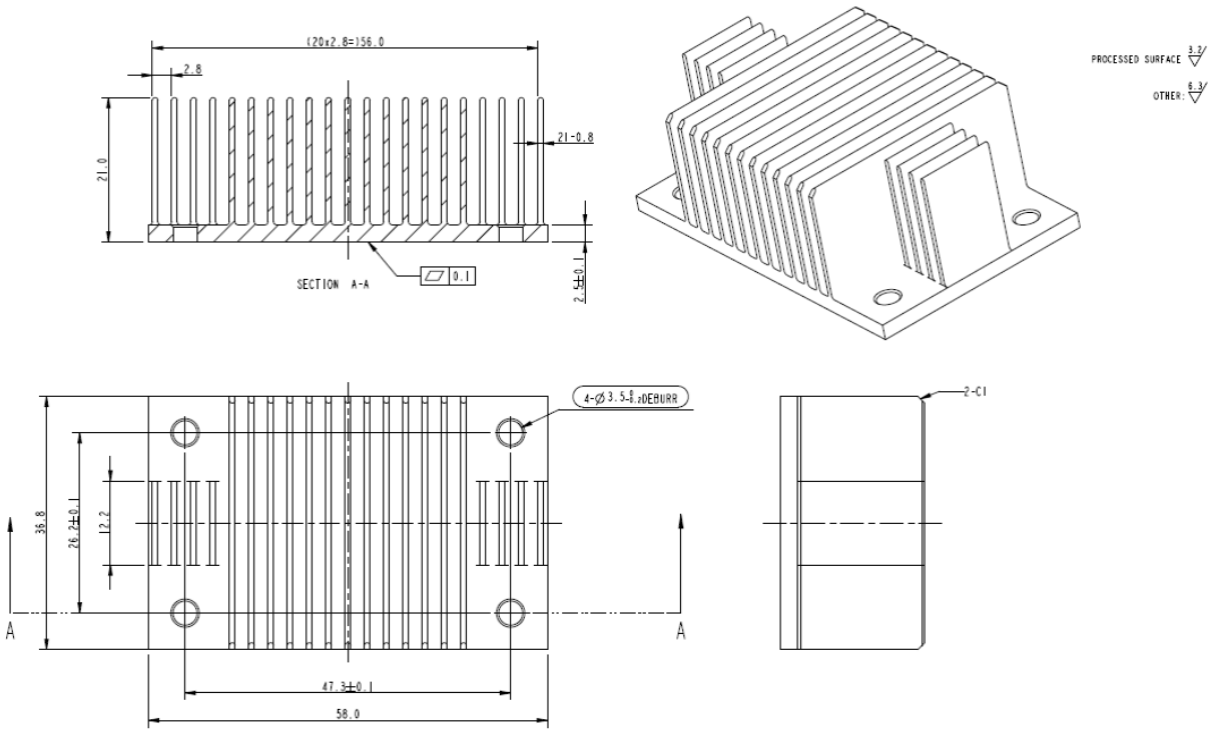

Figure 28. Heatsink with short slot for Airflow from Vo- to Vo+

Hot spot location and allowed maximum temperature.

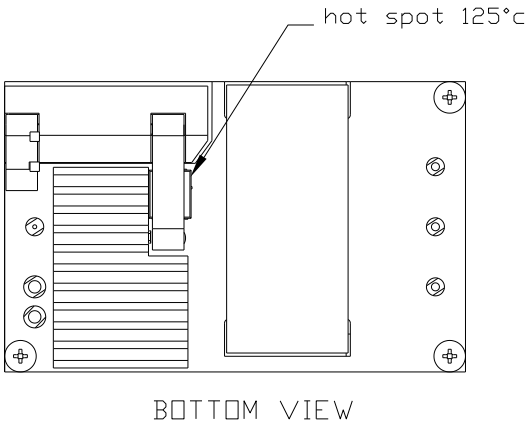

Figure 29. Module Bottom View hot spot

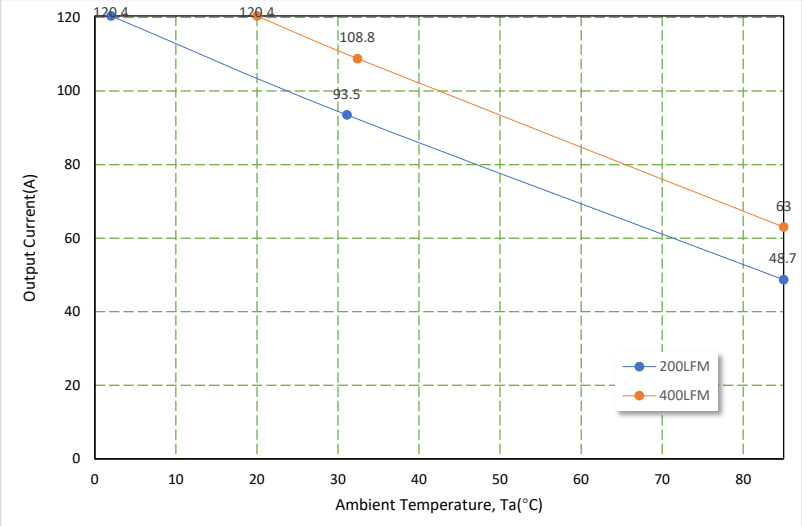

Figure 30. Output Power Derating – Baseplate, Airflow from Vo- to Vo+

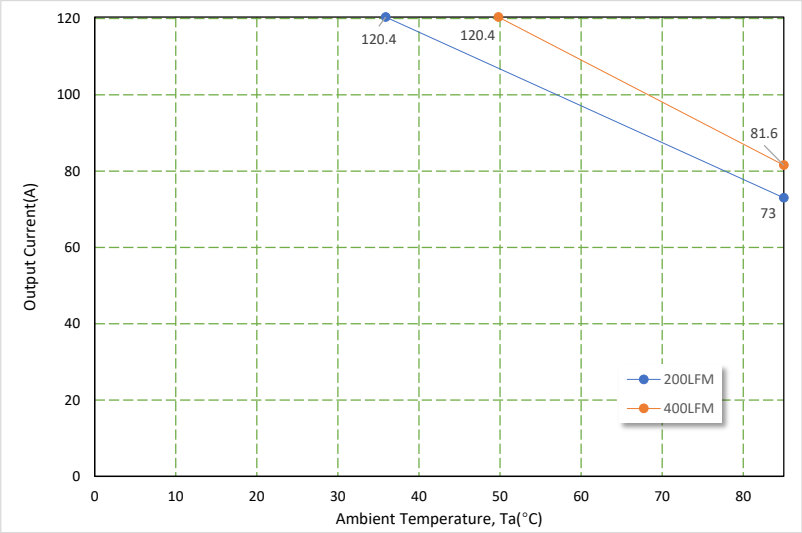

Figure 31. Output Power Derating – Heatsink, Airflow from Vo- to Vo+

15. SOLDERING INFORMATION

The modules are designed to be compatible with a reflow soldering process. The suggested Pb-free solder paste is Sn/Ag/Cu (SAC). The recommended reflow profile using Sn/Ag/Cu solder is shown in the following. Recommended reflow peak temperature is 245°C while the part can withstand peak temperature of 260°C maximum for 10 seconds. This profile should be used only as a guideline. Many other factors influence the success of SMT reflow soldering. Since your production environment may differ, please thoroughly review these guidelines with your process engineers.

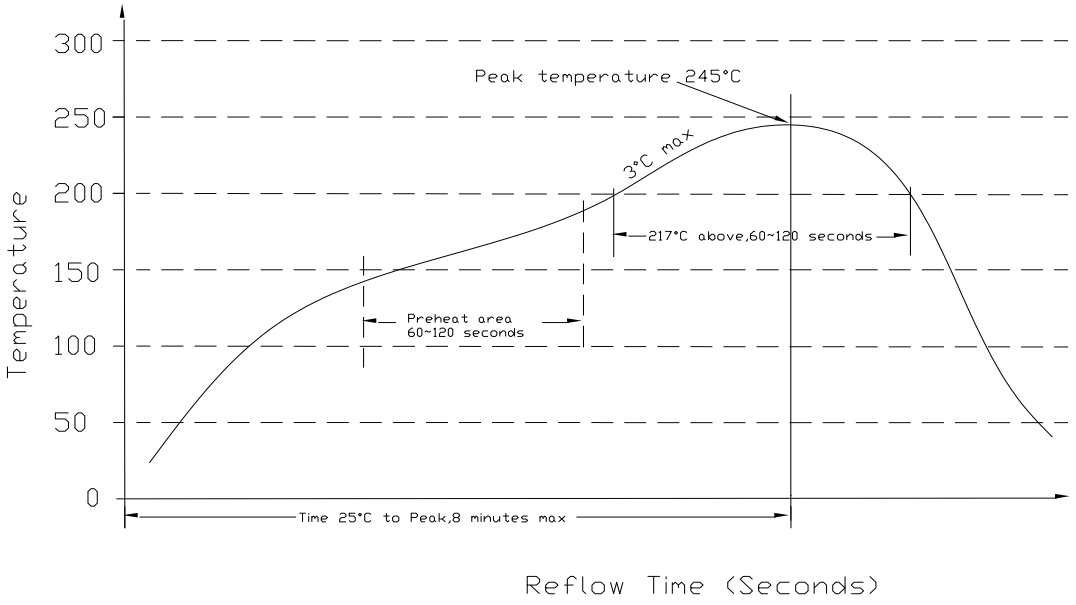

Figure 32. Soldering temperature

16. MSL RATING

The modules have a MSL rating of 3.

17. STORAGE AND HANDLING

The modules are designed to be compatible with J-STD-033 Rev: A (Handling, Packing, Shipping and Use of Moisture /Reflow Sensitive surface Mount devices). Moisture barrier bags (MBB) with desiccant are applied. The recommended storage environment and handling procedure is detailed in J-STD-033.

18. PRE-BAKING

This component has been designed, handled, and packaged ready for pb-free reflow soldering. If the assembly shop follows J-STD-033 guidelines, no pre-bake of this component is required before being reflowed to a PCB. However, if the J-STD-033 guidelines are not followed by the assembler, Bel recommends that the modules should be pre-baked @ 120~150°C for a minimum of 4 hours (preferably 24 hours) before reflow soldering.

19. MECHANICAL DIMENSIONS

0RQB-X3S113G OUTLINE

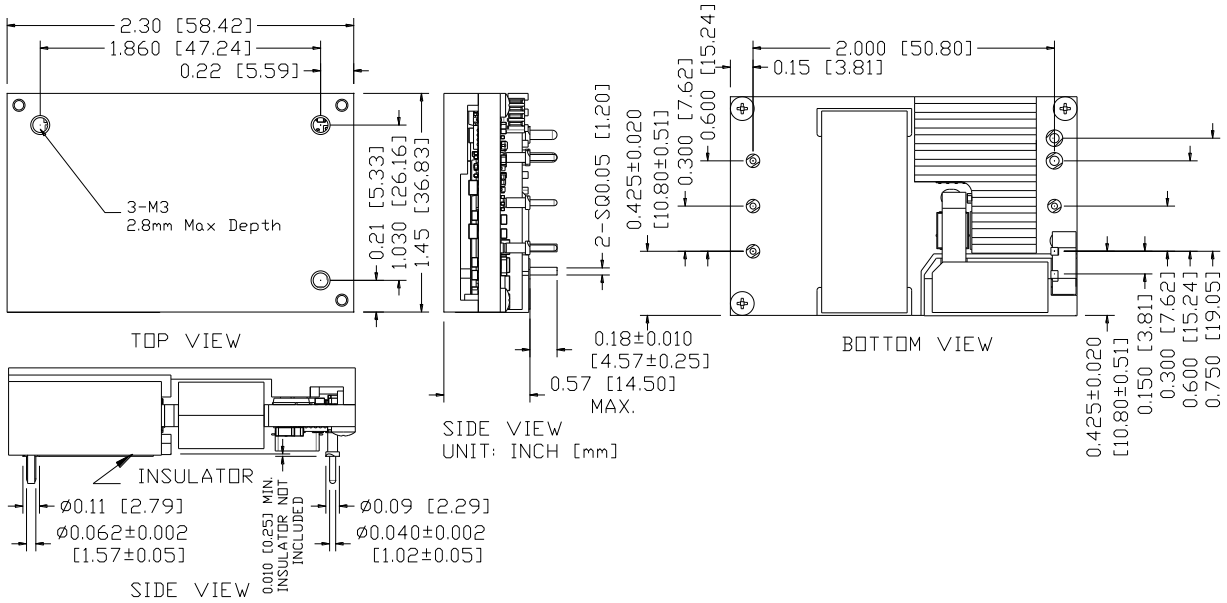

Figure 33. 0RQB-X3S113G outline

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 ºC 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].

0RQB-X3S113HG OUTLINE

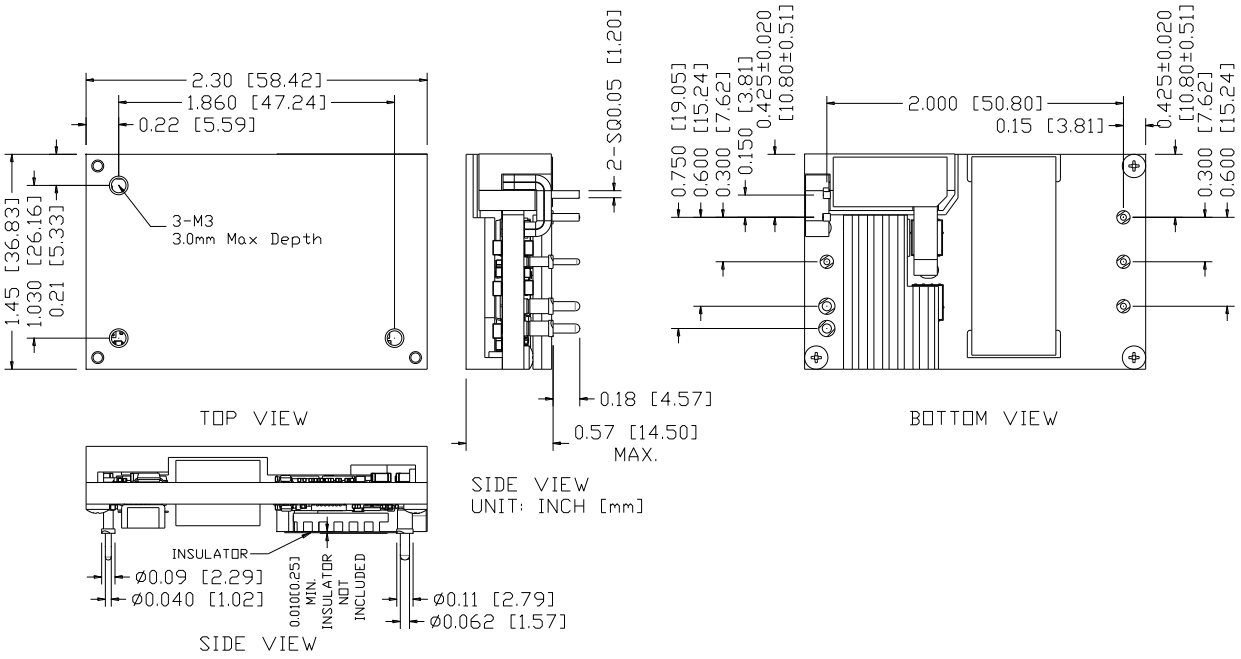

Figure 34. 0RQB-X3S113HG outline

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].

RECOMMENDED PAD LAYOUT

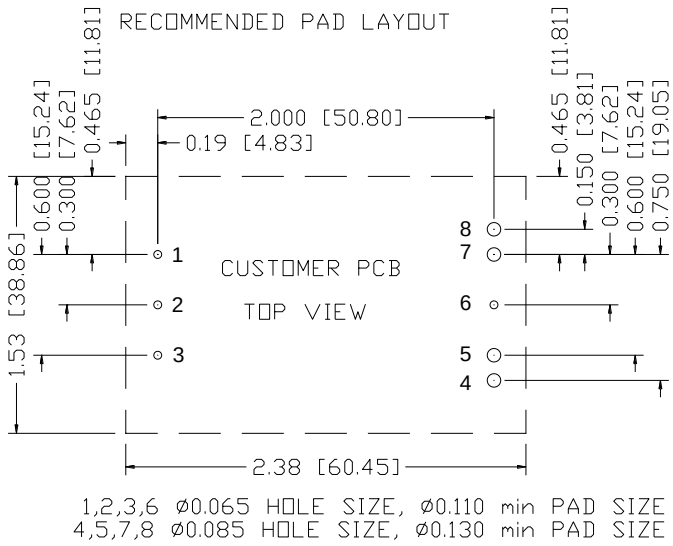

Figure 35. Recommended Pad Layout-1

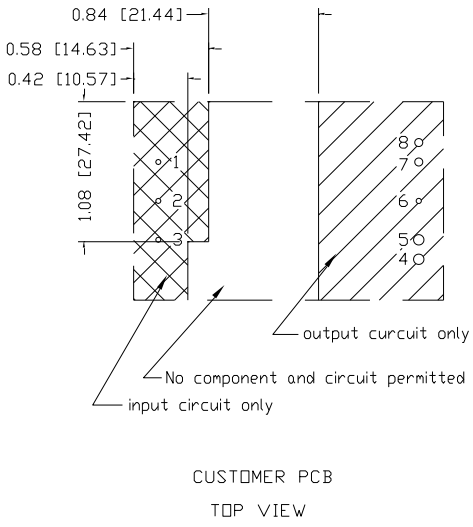

Figure 36. Recommended Pad Layout-2

PIN DEFINITIONS

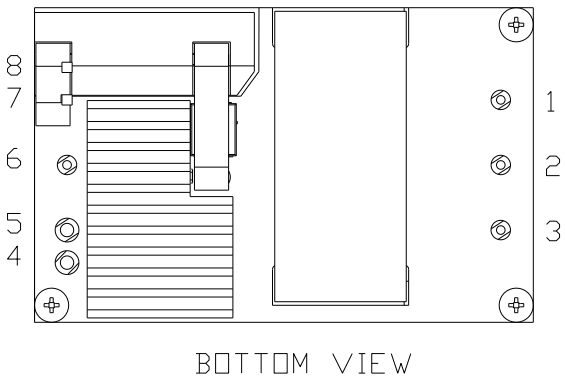

Figure 37. 0RQB-X3S113G Pins

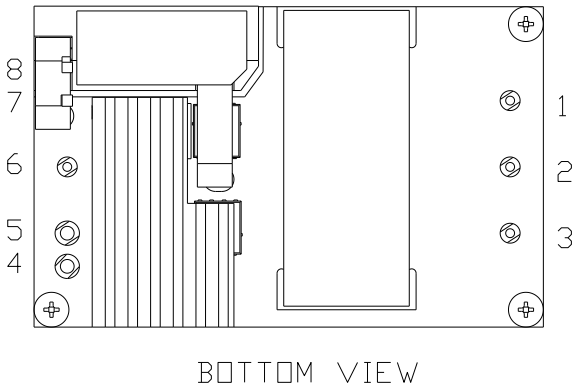

Figure 38. 0RQB-X3S113HG Pins

PIN	FUNCTION	PIN SIZE
1	Vin (+)	0.04"
2	ON/OFF	0.04"
3	Vin (-)	0.04"
4	Vout (-)	0.062"

PIN	FUNCTION	PIN SIZE
5	Vout (-)	0.062"
6	PGOOD	0.04"
7	Vout (+)	SQ0.05"
8	Vout (+)	SQ0.05"

20. 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 shutdown 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 1000ms.
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 shutdown 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 ~20C 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 shutdown and auto-restart once the input voltage is within the limited range which is stated in the input spec table previously.

21. REVISION HISTORY

DATE	REVISION	CHANGES DETAIL	APPROVAL
2017-02-16	AA	First release.	J.Yan
2017-07-14	AA	Update the MD.	J.Yan
2018-04-10	AB	Update the MD.	F.Tao
2019-12-24	AC	Update the MD, add P/N:0RQB-X3S113H.	J.Yao
2020-03-09	AD	Delete conformal coated.	J.Yao
2020-11-13	AE	Update weight.	J.Yao
2021-02-09	AF	Update safety certificate.	J.Yao
2021-05-21	AG	Add object ID. Update MTBF.	J.Yao
2021-08-03	AH	Update thermal test result, Add more module information. Add P/N: 0RQB-X3S113HG. Delete P/N: 0RQB-X3S113H.	J.Yao

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

NUCLEAR AND MEDICAL APPLICATIONS - Products are not designed or intended for use as critical components in life support systems, equipment used in hazardous environments, or nuclear control systems.
TECHNICAL REVISIONS - The appearance of products, including safety agency certifications pictured on labels, may change depending on the date manufactured. Specifications are subject to change without notice.