

# 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
- 1/4<sup>th</sup> 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
- Approved to UL/CSA 62368-1
- Approved to IEC/EN 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-X3S113G	10.8 VDC	48 – 60 VDC	120.4 A	1300 W	96.6%
0RQB-X3S113HG					

### 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 <sub>I</sub>	Input Voltage Continuous		-0.3	-	65	V
V <sub>RM</sub>	Remote On/Off pin Voltage		-0.3	-	16	V
V <sub>PG</sub>	Power Good pin Voltage		-0.3	-	16	V
V <sub>ISO</sub>	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
T <sub>a</sub>	Ambient Temperature Long-Term	See Note 1	-30	-	85	°C
T <sub>as</sub>	Ambient Temperature Short-Term	See Note 2	-40	-	90	°C
T <sub>s</sub>	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 do 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 <sub>IN</sub>	Operating Input Voltage	48	54	60	V
I <sub>IMAX</sub>	Input Current (full load) P <sub>O</sub> = 100% of P <sub>OTDP</sub>	-	-	28	A
I <sub>Iid</sub>	Input Current (no load) Input idling current, P <sub>O</sub> = 0 W	-	130	-	mA
I <sub>loff</sub>	Remote Off Input Current	-	10	20	mA
I <sub>S</sub>	Input Reflected Ripple Current (rms) See Note 1	-	5	10	mA
I <sub>S</sub>	Input Reflected Ripple Current (pk-pk) See Note 1	-	20	50	mA
I <sub>C</sub>	Input Terminal Ripple Current (rms) See Note 1	-	-	1300	mA
	Input Terminal Ripple Current over Temperature (rms) T <sub>a</sub> = -20 to 85°C	-	3	15	mA
C <sub>SE</sub>	Internal Input Capacitance	-	16	-	µF
C <sub>IN</sub>	Recommended Input Capacitor	-	100	-	µF
V <sub>IoffL</sub>	Input Turn off Voltage Threshold	39	41	42.5	V
V <sub>IonL</sub>	Input Turn on Voltage Threshold	42.5	44	45	V
V <sub>UV(hys)</sub>	Hysteresis Voltage	2	-	-	V
V <sub>IonH</sub>	Over-voltage Recovery Threshold	60	61	63	V
V <sub>IoffH</sub>	Over-voltage Shutdown Threshold See Note 2	61	-	64	V
V <sub>OV(hys)</sub>	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 <sub>O</sub>	Output Voltage Set Point	V <sub>in</sub> = 54 V, P <sub>O</sub> = 50% of P <sub>OTDP</sub>	10.692	10.800	10.908	V
	Output Voltage Total Range	V <sub>in</sub> = 48~60 V, P <sub>out</sub> = 0~P <sub>OTDP</sub> , See Note 6	10.584	-	11.016	V
	Load Regulation	V <sub>in</sub> = 54 V, P <sub>O</sub> = 0~100% of P <sub>OTDP</sub>	-	0.02	0.07	V
	Line Regulation	V <sub>in</sub> = 48~60V, P <sub>O</sub> = 100% of P <sub>OTDP</sub>	-	0.02	0.08	mV
	Regulation Over Temperature	V <sub>in</sub> = 54 V, P <sub>O</sub> = 100% of P <sub>OTDP</sub> , T <sub>a</sub> = -30 ~ 85°C	-	100	200	mV
V <sub>OAC</sub>	Ripple and Noise (pk-pk)	P <sub>O</sub> = 100% of P <sub>OTDP</sub> , See Note 1	-	30	150	mV
V <sub>ORMS</sub>	Ripple and Noise (rms)	P <sub>O</sub> = 100% of P <sub>OTDP</sub> , 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 <sub>O</sub>	Output Current Range		0	-	120.4	A
I <sub>OMAX</sub>	Output DC Current Limit	See Note 2	130	-	-	A
P <sub>OTDP</sub>	Output Power (TDP)	See Note 2	-	-	1300	W
t <sub>r</sub>	Rise Time	See Note 3	-	-	15	ms
t <sub>s1</sub>	Turn on Time from V <sub>in</sub>	See Note 4	20	-	40	ms
t <sub>s2</sub>	Turn on Time from RM	See Note 5	-	-	5	ms
V <sub>Pre</sub>	Pre-bias Voltage		-	-	10.8	V
C <sub>out</sub>	Output Capacitance	50% ceramic, 50% POSCAP.	0	750	10000	μF
V <sub>tr</sub>	Load Transient Voltage Deviation	Load step 50~75~50% P <sub>OTDP</sub> , di/dt = 1 A/μs. 4000 μF capacitors are near the brick output.	-	±350	-	mV
t <sub>tr</sub>	Load Transient Recovery Time		-	500	-	μs

**Note 1:** C<sub>out</sub> = 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<sub>O</sub> at 10% of final value and V<sub>O</sub> at 90% of final value.

**Note 4:** Defined as time between V<sub>in</sub> reaching Turn-On voltage and V<sub>O</sub> reaching 10% of final value.

**Note 5:** Defined as time between Remote on and V<sub>O</sub> 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
$\eta$	Efficiency	-	96.6	-	%
$f_{sw}$	Switching Frequency	-	150	-	kHz
MTBF	$V_{in} = 54\text{ V}, P_O = 80\% \text{ of } P_{OTDP}, 25^\circ\text{C}$	-	10.7	-	Mhrs
	$V_{in} = 54\text{ V}, P_O = 80\% \text{ of } P_{OTDP}, 40^\circ\text{C}$	-	6.9	-	Mhrs
	$V_{in} = 54\text{ V}, P_O = 80\% \text{ of } P_{OTDP}, 85^\circ\text{C}$	-	1	-	Mhrs
$T_P$	Over Temperature Protection	-	130	-	$^\circ\text{C}$
$V_{OV}$	Output Over Voltage Protection	-	-	15	V
G	Weight	-	87.4	-	g
Dimensions (L x W x H)			2.30 x 1.45 x 0.57		inch
			58.42 x 36.83 x 14.50		mm
<b>Isolation Characteristics</b>					
$V_{ISO}$	Input to Output	-	-	500	VDC
	Input to Case	-	-	500	VDC
	Output to Case	-	-	500	VDC
$R_{ISO}$	Isolation Resistance	10M	-	-	Ohm
$C_{IC}$	Isolation Capacitance	-	1000	2700	pF

6. TYPICAL CHARACTERISTICS

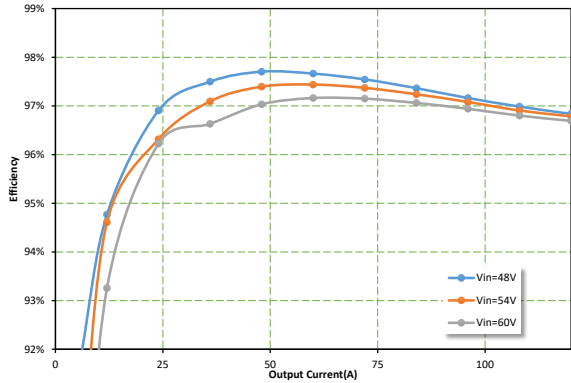


Figure 1. Efficiency

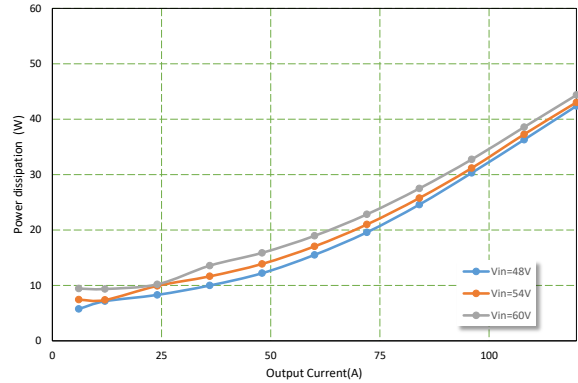


Figure 2. Power Dissipation

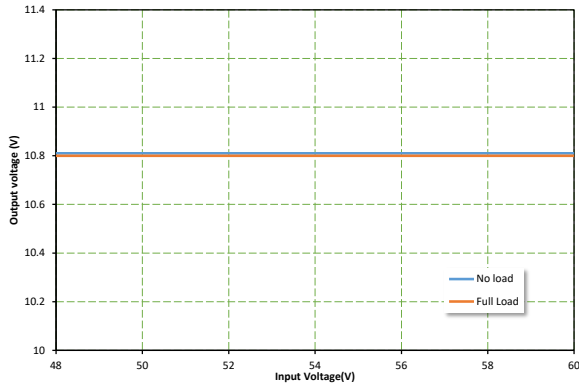


Figure 3. Line Characteristics

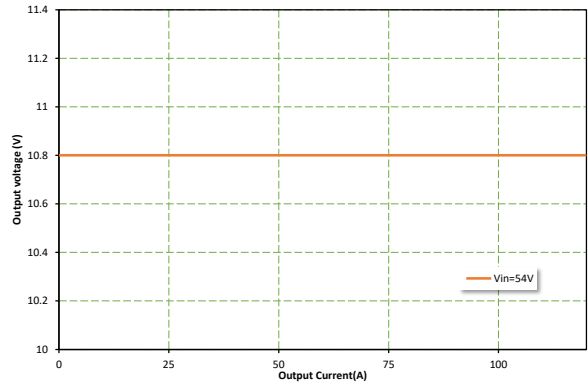


Figure 4. Load Characteristics

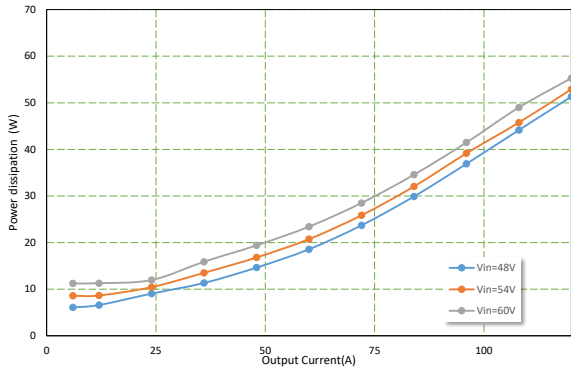


Figure 5. Power loss @ max temperature

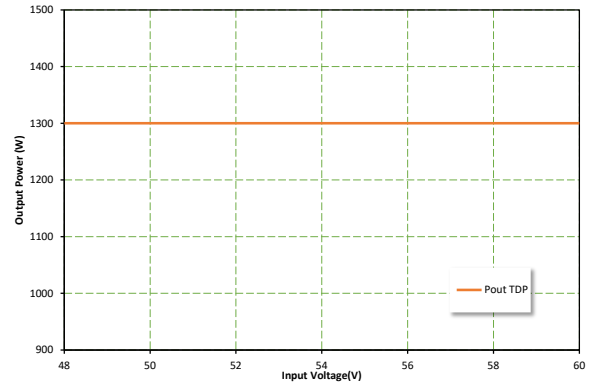


Figure 6. Available Power

**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, C2 can effectively prevent the failure due to transformer (T1) magnetic bias.

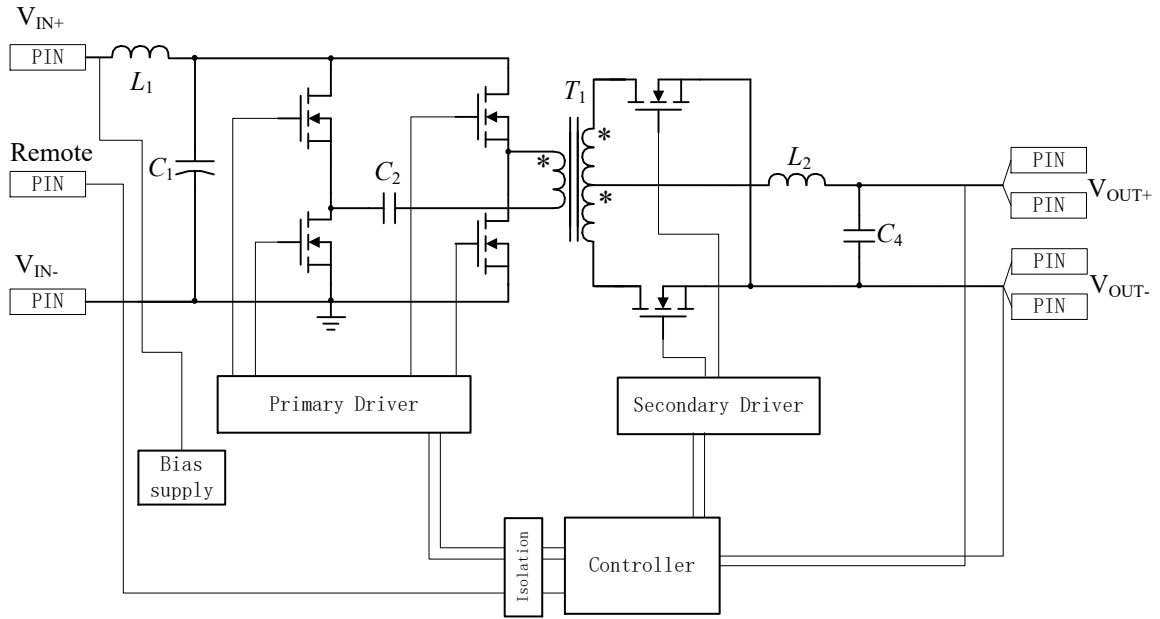


Figure 7. Block diagram

## 8. TYPICAL WAVEFORM

Typical Electrical Characteristics measured according to figure below.

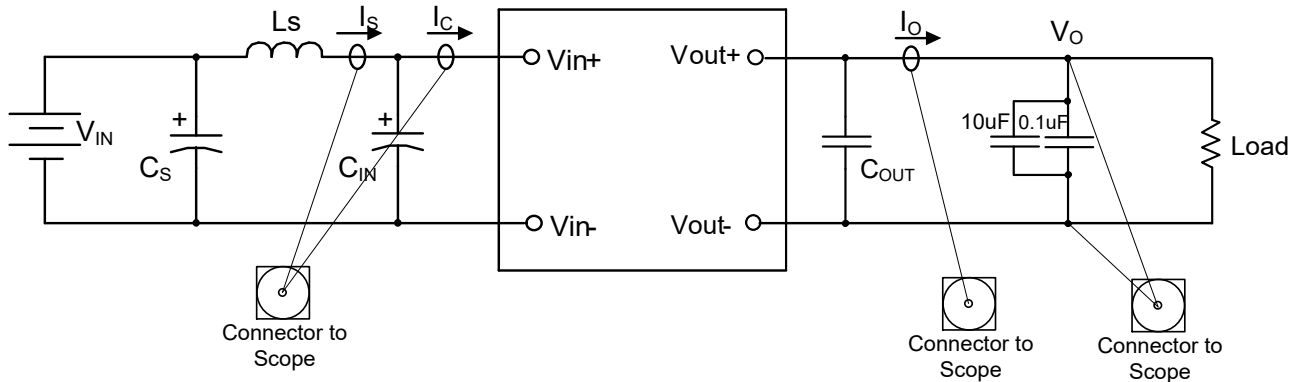


Figure 8. Test Setup

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.

$L_S$ : Simulated Source Impedance (12  $\mu$ H).

$C_S$ : Offset possible source Impedance (100  $\mu$ F, ESR < 0.2  $\Omega$  @ 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.

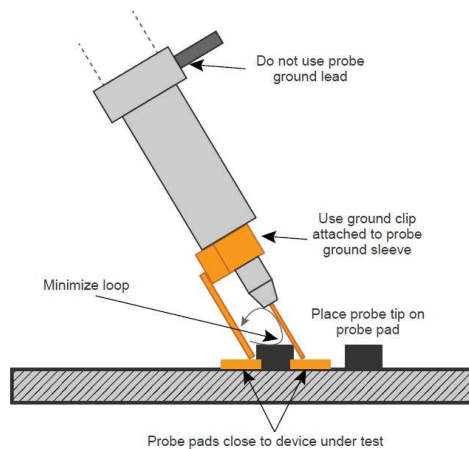


Figure 9. Input reflected ripple current.

## Input Noise

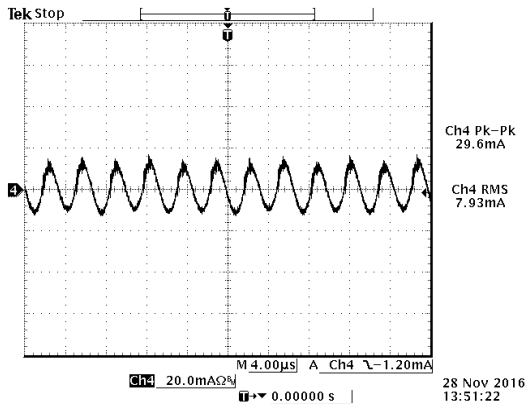


Figure 10.  $I_S$ ,  $P_O = 100\%$  of  $P_{OTDP}$

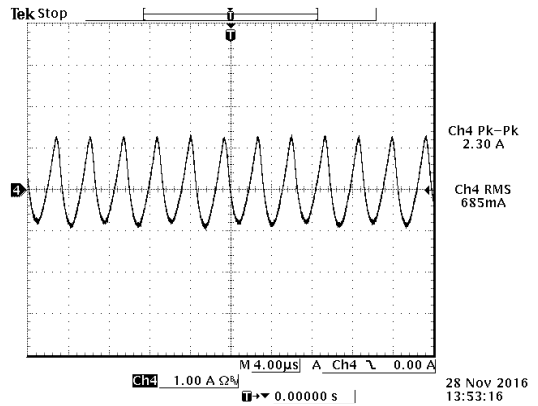


Figure 11.  $I_C$ ,  $P_O = 100\%$  of  $P_{OTDP}$

## Output Noise

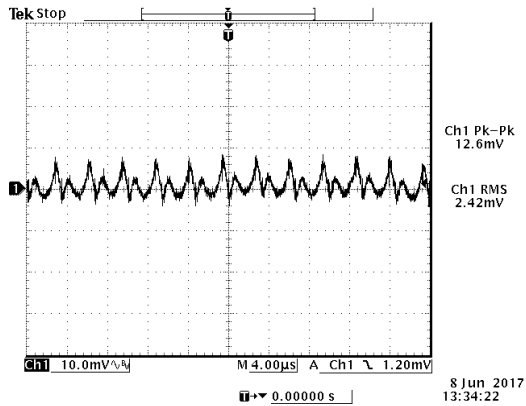


Figure 12.  $V_{OAC}$ ,  $P_O = 0\%$  of  $P_{OTDP}$

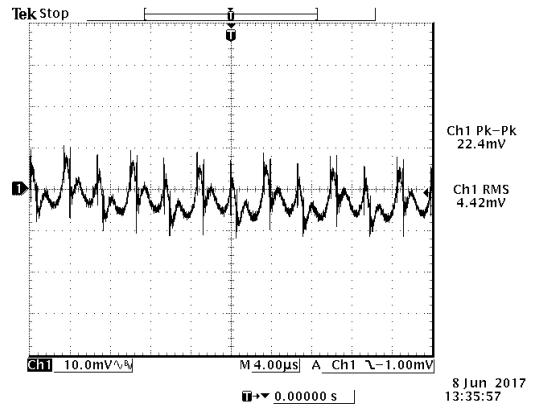


Figure 13.  $V_{OAC}$ ,  $P_O = 100\%$  of  $P_{OTDP}$

## Load Transient

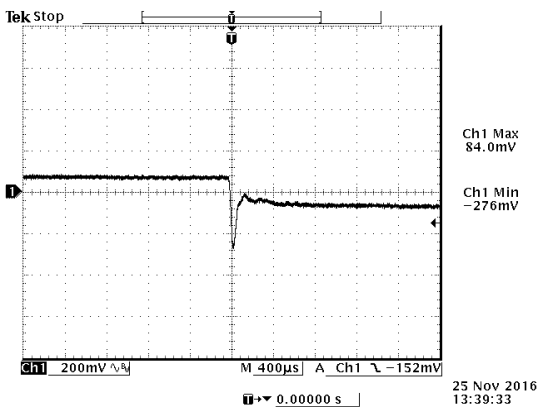


Figure 14.  $V_{tr}$ , 50%-75% Load Transients

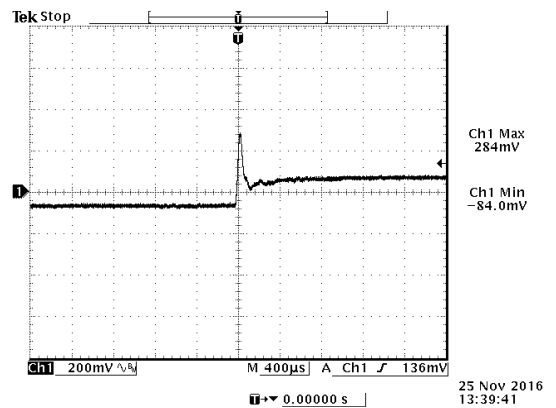


Figure 15.  $V_{tr}$ , 75%-50% Load Transients

Startup and Shutdown

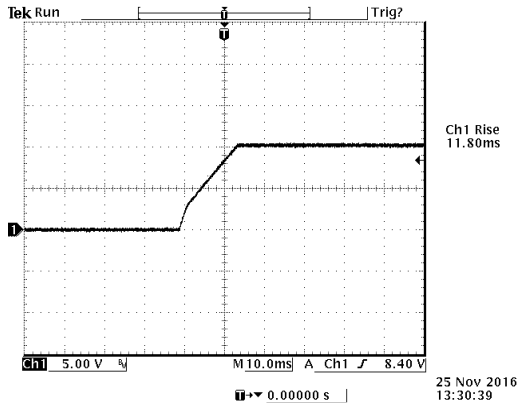


Figure 16. Startup,  $P_O = 100\%$  of  $P_{OTDP}$

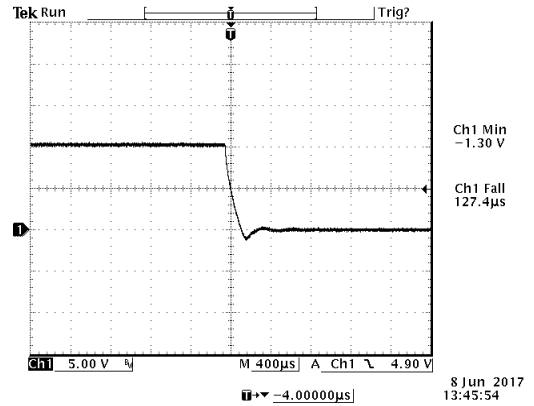


Figure 17. Shutdown,  $P_O = 100\%$  of  $P_{OTDP}$

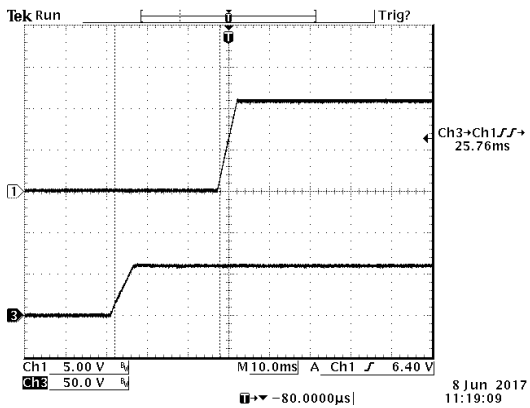


Figure 18. Startup from  $V_{in}$ ,  $P_O = 100\%$  of  $P_{OTDP}$

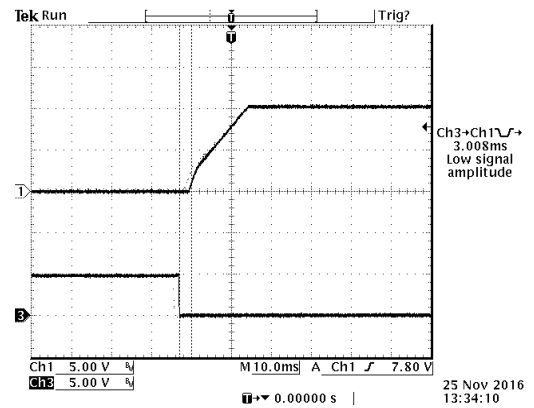


Figure 19. Startup from on/off,  $P_O = 100\%$  of  $P_{OTDP}$

9. REMOTE ON/OFF

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
V <sub>RML</sub>	Signal Low	-0.3	-	0.8	V
V <sub>RMH</sub>	Signal High	2.4	-	16	V
I <sub>RML</sub>	Source Current	V <sub>REMOTE</sub> = 0 V	-	150	uA
I <sub>RML</sub>	Source Current	V <sub>REMOTE</sub> = 2.4 V	-	100	uA
I <sub>RMH</sub>	Sink Current	V <sub>REMOTE</sub> = 10 V	-	-300	uA
I <sub>RMH</sub>	Sink Current	V <sub>REMOTE</sub> = 16 V	-	-500	uA
V <sub>RMF</sub>	Open circuit voltage	-	12	15	V

Products have 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:

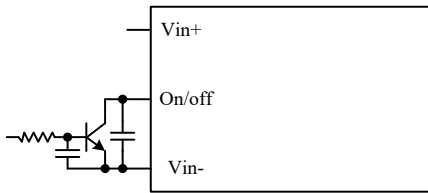


Figure 20. Control with open collector/drain circuit

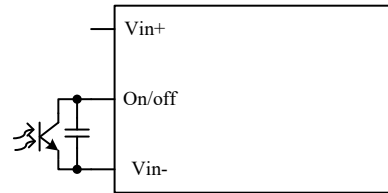


Figure 21. Control with photocoupler circuit

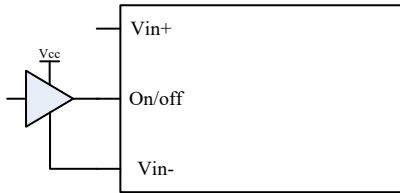


Figure 22. Control with logic circuit

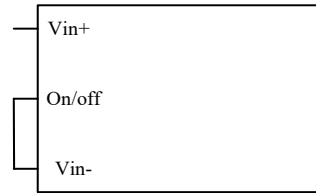


Figure 23. Permanently on

## 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**

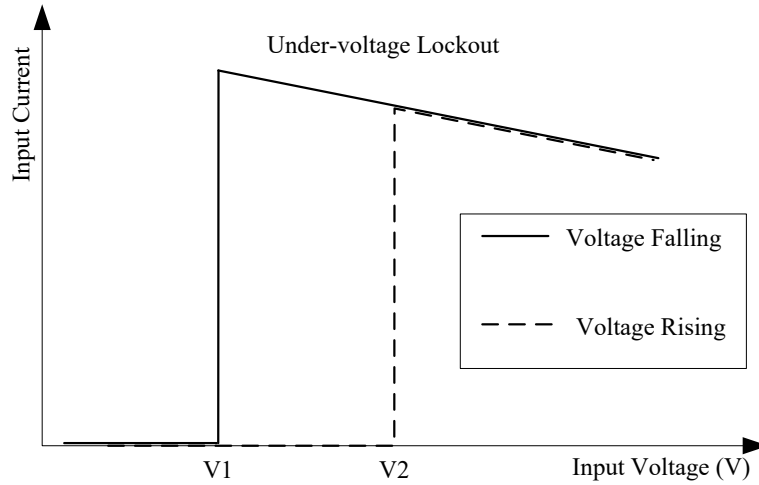


Figure 24. Input under-voltage lockout.

V1 = 41 V; V2 = 44 V

**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.

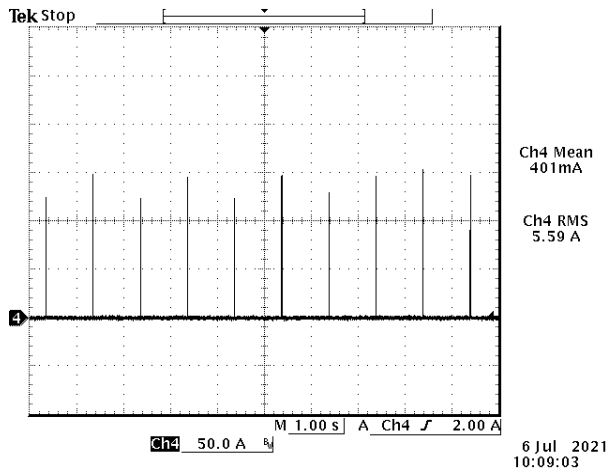


Figure 25. Over current protection

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.

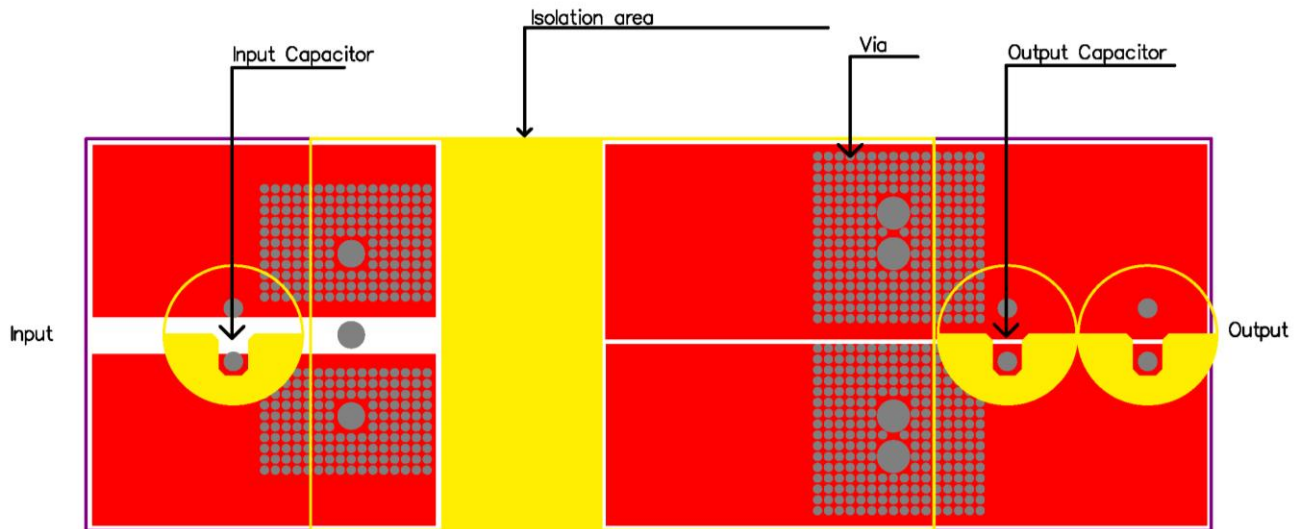


Figure 26. recommendation of motherboard layout

**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**

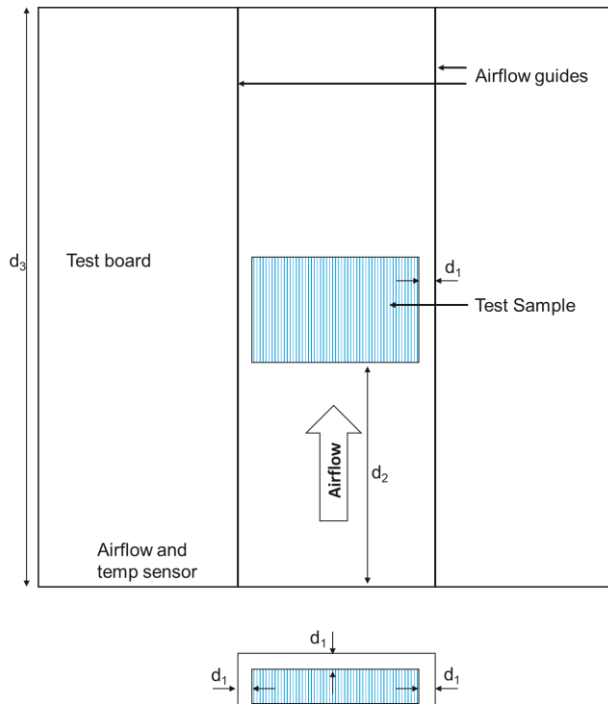


Figure 27. Thermal test setup, Airflow from Vo- to Vo+

d<sub>1</sub>: 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<sub>2</sub>: Ambient temperature and airflow are measured in front of the module at the distance of 76.2 mm (3 inch).

d<sub>3</sub>: 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<sub>IN</sub>: 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.



Asia-Pacific  
+86 755 298 85888

EMEA  
+353 61 531 820

North America  
+1 866 513 2839

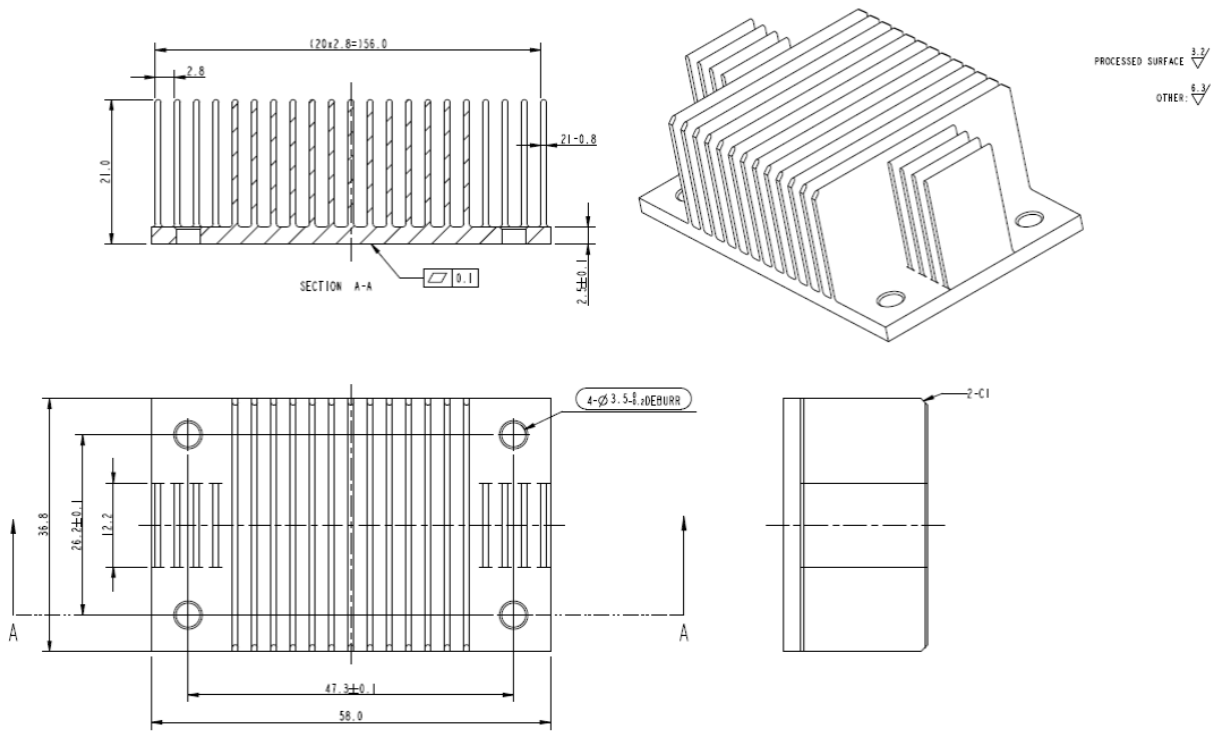


Figure 28. Heatsink with short slot for Airflow from Vo- to Vo+

Hot spot location and allowed maximum temperature.

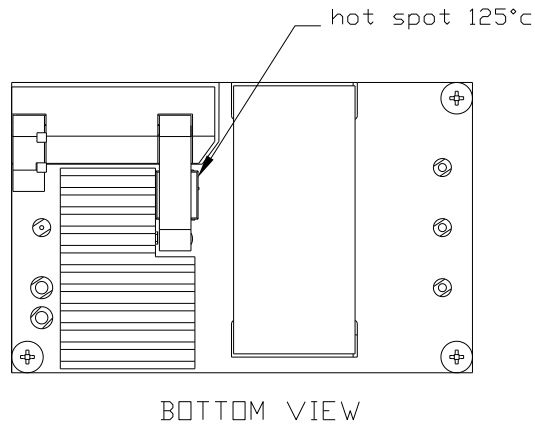


Figure 29. Module Bottom View hot spot

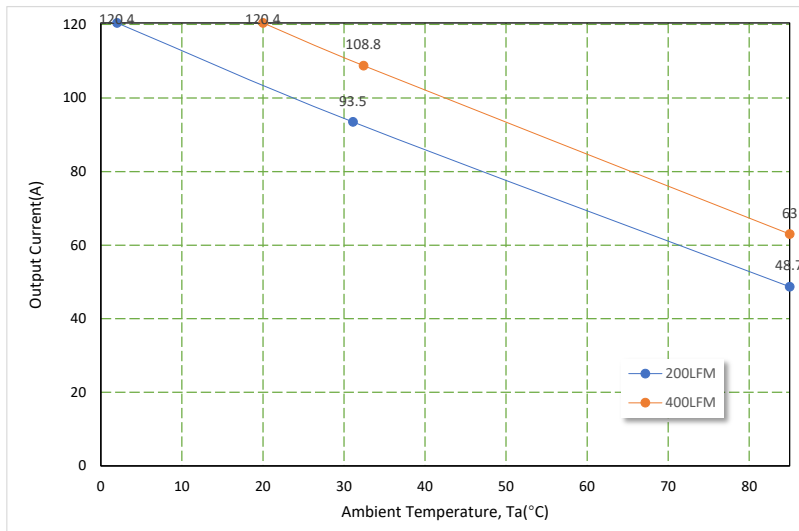


Figure 30. Output Power Derating – Baseplate, Airflow from Vo- to Vo+

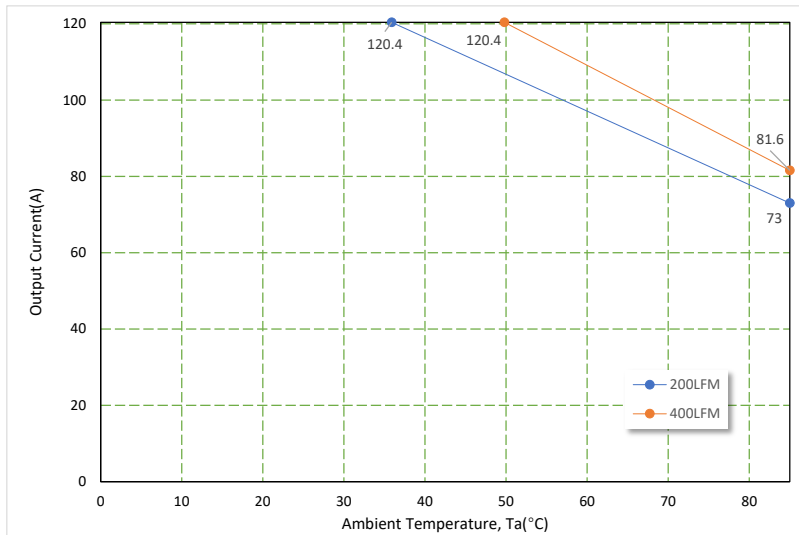


Figure 31. Output Power Derating – Heatsink, Airflow from Vo- to Vo+

## 15. MECHANICAL DIMENSIONS

### ORQB-X3S113G OUTLINE

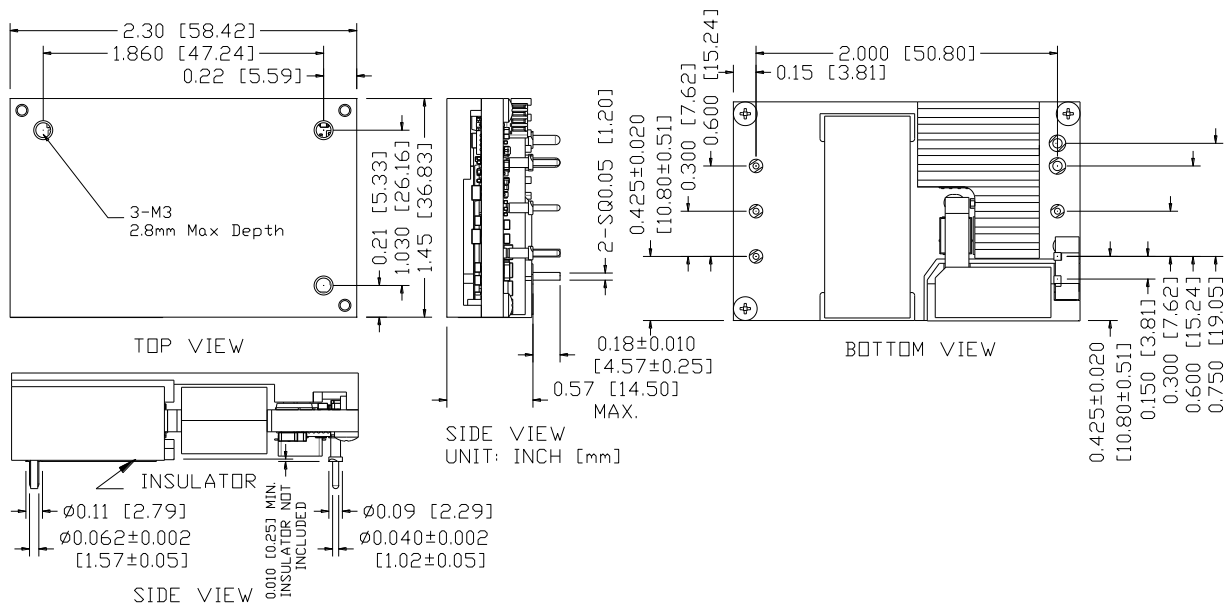


Figure 32. ORQB-X3S113G outline

**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 °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].

## ORQB-X3S113HG OUTLINE

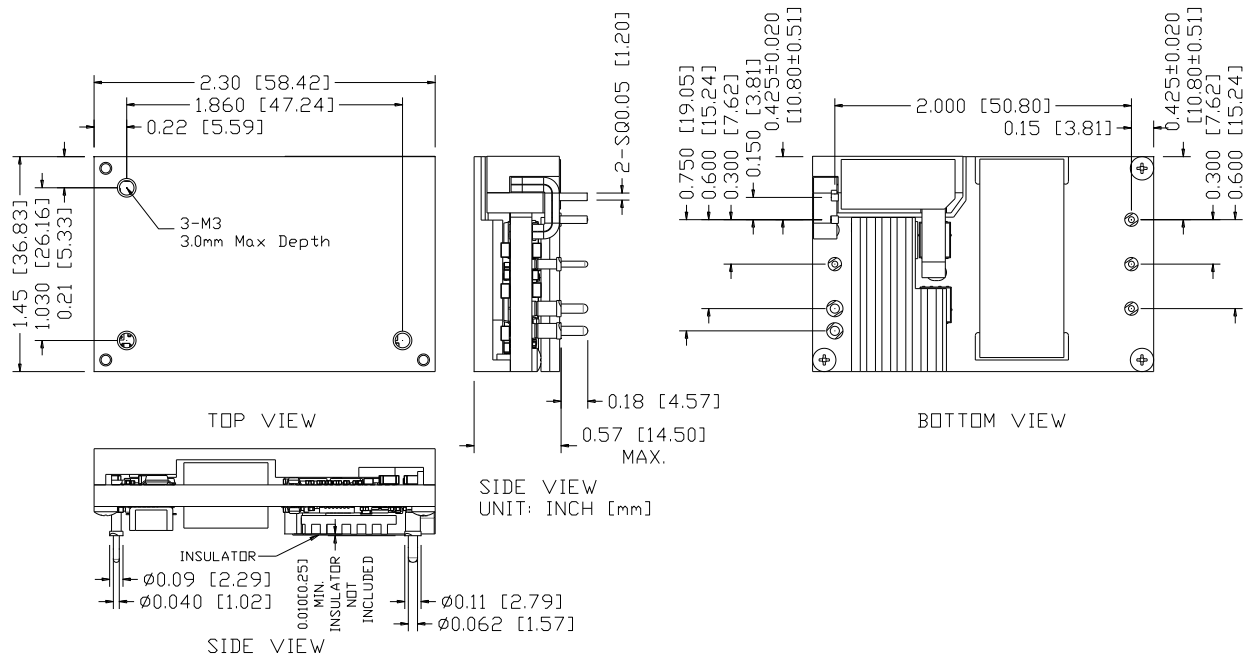


Figure 33. ORQB-X3S113HG outline

**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**

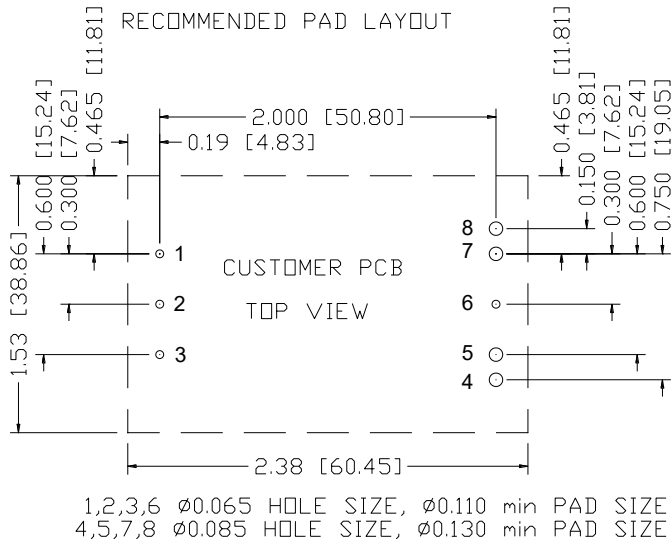


Figure 34. Recommended Pad Layout-1

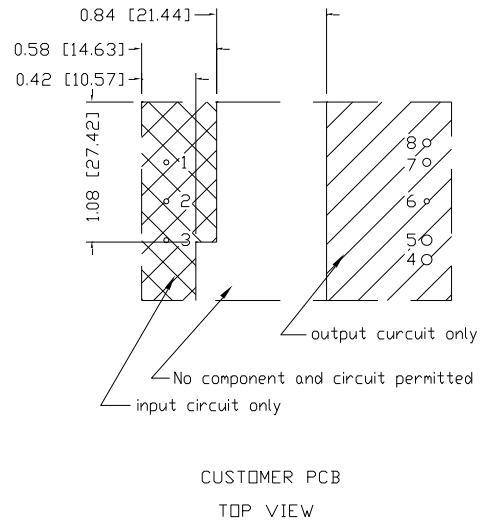


Figure 35. Recommended Pad Layout-2

**PIN DEFINITIONS**

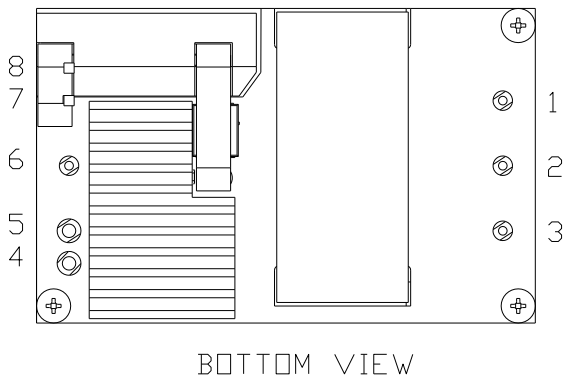


Figure 36. 0RQB-X3S113G Pins

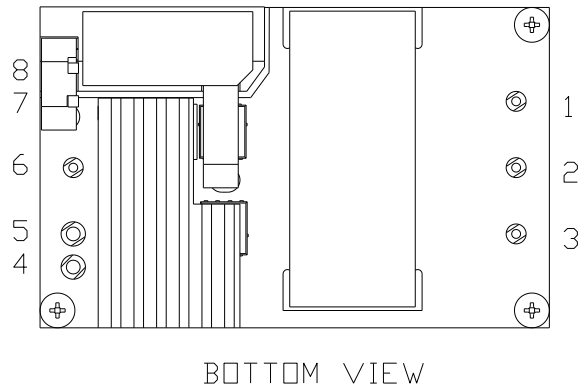


Figure 37. 0RQB-X3S113HG Pins

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"

## 16. 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.



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## 17. 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
2023-11-27	AJ	Update turn on time max value from 30 to 40ms.	XF.Jiang

For more information on these products consult: [powersupport@belf.com](mailto:powersupport@belf.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.



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