0RQB-X0S10
Isolated DC-DC Converter

The 0RQB-X0S10 series are isolated DC/DC converters that operate from a nominal 50/54 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 1000 W of output power from a nominal 50/54 VDC input. The output of the converters has the droop function which allow the modules operating in parallel with high output current sharing precision.

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

RoHS Compliant

Key Features & Benefits

- 45-57 VDC Input
- 10.4 VDC @ 96.2 A Output
- 1/4th Brick Converter
- 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 60950-1
- Approved to UL/CSA 60950-1
- 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-X0S10BG 0RQB-X0S10NG	10.4 VDC	45 - 57 VDC	96.2 A	1000 W	97.3%

PART NUMBER EXPLANATION

0	R	QB	-	X0	S	10	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		1000 W	45 – 57 V	10.4 V	B – Active Low, with Baseplate, PG pin diameter is 20mil N – Active Low, with Baseplate, PG pin diameter is 40mil	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.	-5	-	85	°C
	Short-Term Operating (96 hours/year). Unit's component temperatures exceed IPC-9592 (latest revision) derating guidelines but not exceed component temperature ratings.	-20	-	90	°C
Storage Temperature		-40	-	100	°C
Altitude		-500	-	13120	feet

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		45	50 / 54	57	V
Input Current (full load)		-	-	25	A
Input Current (no load)		-	130	-	mA
Remote Off Input Current		-	10	-	mA
Input Reflected Ripple Current (rms)	10 µH source impedance, Vin = 45 – 57 V, Io = Io max. Refer to section 12 for detail input capacitance and waveforms.	-	-	10	mA
Input Reflected Ripple Current (pk-pk)		-	-	50	mA
Input Terminal Ripple Current (rms)		-	-	1000	mA
Input terminal ripple current over Temperature (rms)	Ta = -5 to 85°C	-	3	15	mA
Input Turn on Voltage Threshold		42.5	44	45.0	V
Input Turn off Voltage Threshold		39	41	42.5	V
Over-voltage Shutdown Threshold	Output shuts down after 20ms delay. *	58	-	61	V
	Output shuts down immediately.	61	-	64	V
Over-voltage Recovery Threshold		57	-	58	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.	-	28	-	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 = 500 W	10.55	10.6	10.65	V
	Vin = 45 - 57 V	10.3	-	11	V
	Over entire operating input voltage range (45 to 57 V), resistive load, and temperature conditions until end of life	9.90	10.6	11.40	V
Load Regulation	Vin = 52 V, Io = 0 ~ 100% load	-	0.4	0.53	V
Line Regulation	Vin = 45 – 57 V, Io = 100% load	-	30	40	mV
Regulation Over Temperature	Vin = 50 V, Io = 100% load, Ta = -20 to 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	-	96.2	A
Output DC Current Limit		107	-	-	A
Rise Time		-	-	-	15
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.	-	-	5	ms
Overshoot at Turn on		-	-	3	%
Output Capacitance	Approximately 50% ceramic, 50% Oscon or POSCAP *	0	-	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		-	-	-	µs
△V 75%~50% of Max Load		-	-	350	mV
Settling Time		-	-	-	µs

*** NOTE:** Recommended minimum output capacitance greater than 1000 µF to enhance reliability.

5. OUTPUT PLOT VS INPUT

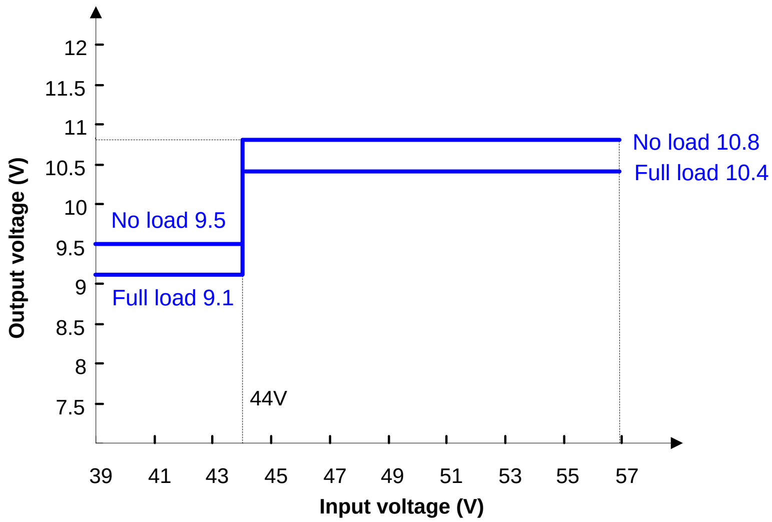

Figure 1. Output plot vs input

PARAMETER	MIN	TYPICAL	MAX	UNIT
Turn on Voltage Threshold	42.5	44	45	V
Turn off Voltage Threshold	39	41	42.5	V

6. GENERAL SPECIFICATIONS

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
Efficiency		-	97.3	-	%
Switching Frequency	Primary FETs	-	150	-	kHz
MTBF		2	6	-	Mhrs
Over Temperature Protection	Auto-recovery.	-	130	-	°C
Output Over Voltage Protection		-	-	13.5	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

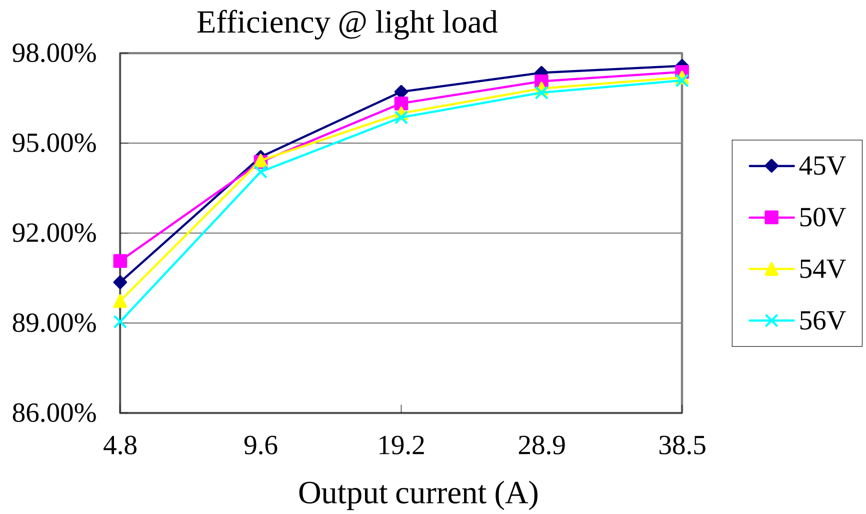

Figure 2. Efficiency at light load

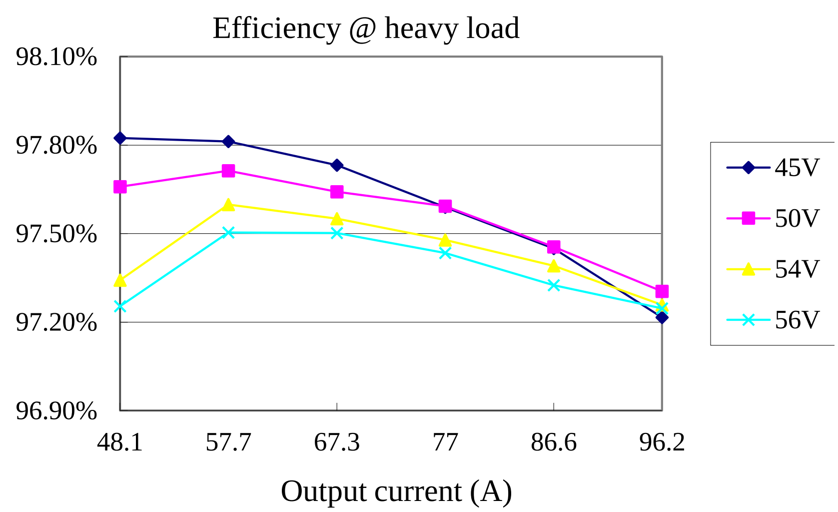

Figure 3. Efficiency at heavy load

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

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

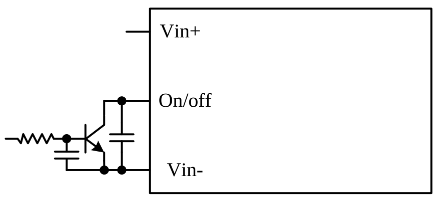

Figure 4. Control with open collector/drain circuit

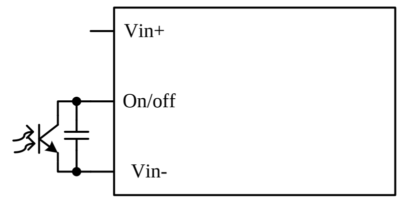

Figure 5. Control with photocoupler circuit

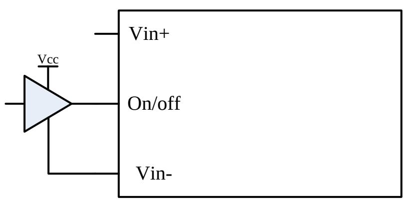

Figure 6. Control with logic circuit

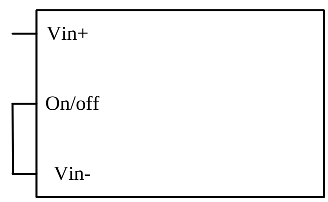

Figure 7. Permanently on

9. RIPPLE AND NOISE WAVEFORM

Testing setup

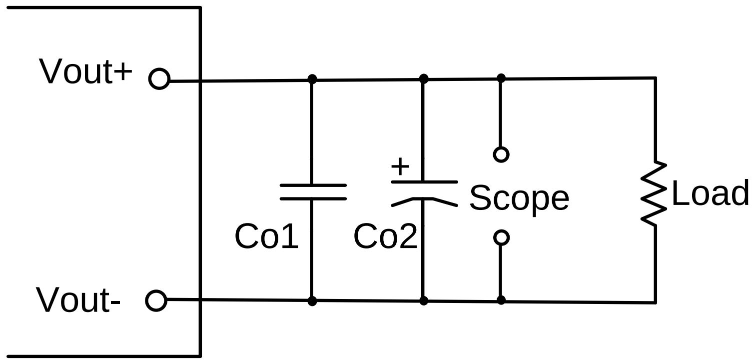

Figure 8.

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 damp ripple current and enhance stability.

Below measured waveforms are based on above capacitance.

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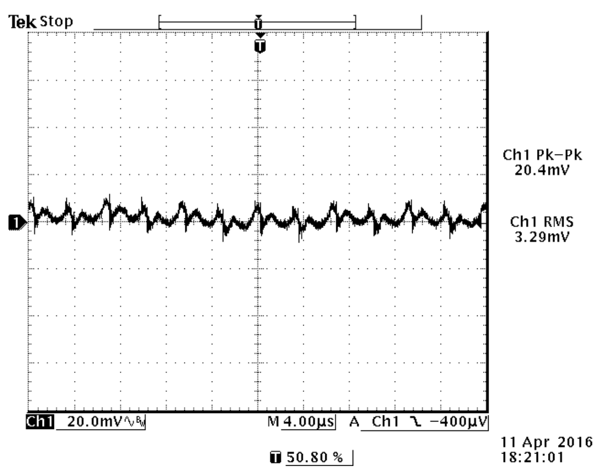


Figure 9. Ripple and noise waveform

Note: Ripple and noise, 50 VDC input, 1000 W output, Ta = 25 °C, with Cout = 3100 μF (50% ceramic, 50% POSCAP).

10. TRANSIENT RESPONSE WAVEFORMS

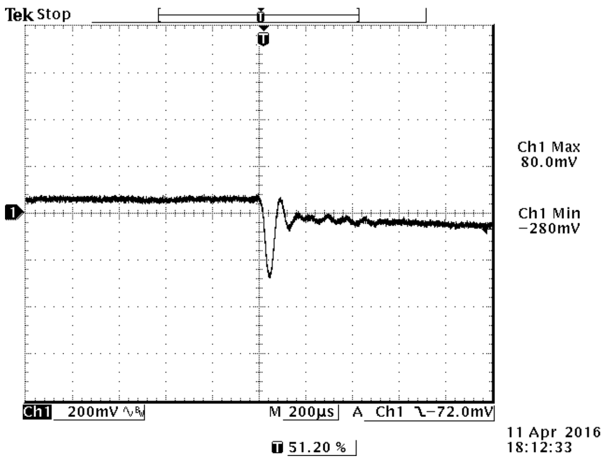


Figure 10. 50%-75% Load Transients at Vin = 50 V @ Ta = 25°C

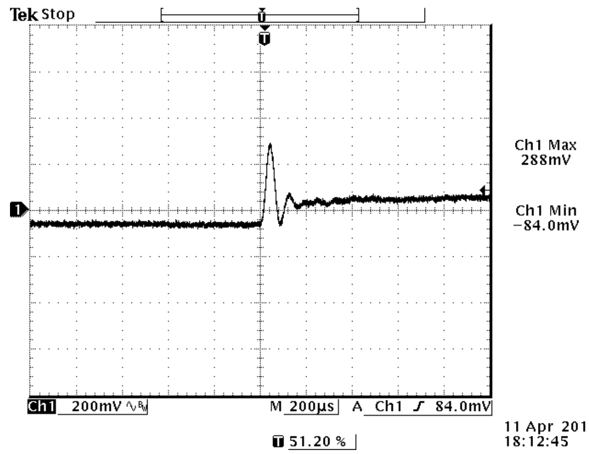


Figure 11. 75%-50% Load Transients at Vin = 50 V @ Ta = 25°C

11. INPUT NOISE

Input reflected ripple current

Test setup

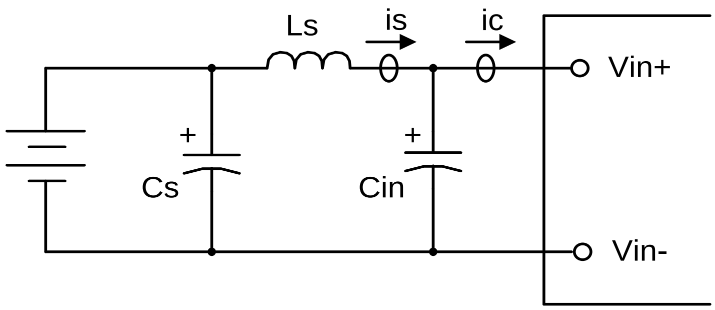


Figure 12.

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 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.

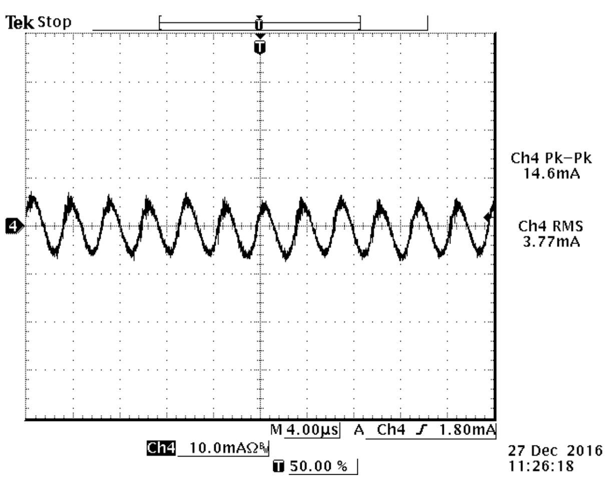


Figure 13. is (input reflected ripple current), AC component

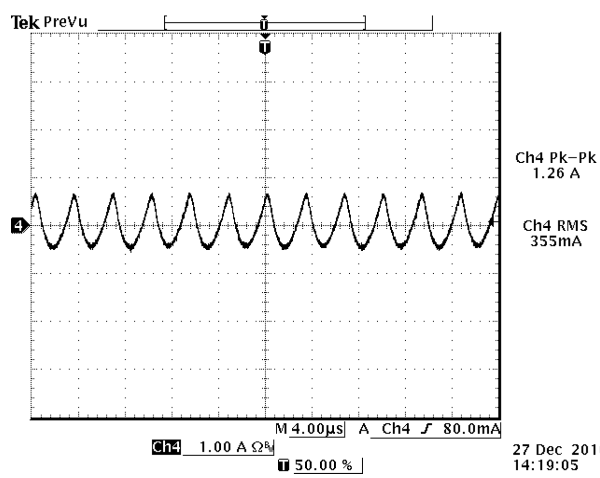


Figure 14. ic (input terminal ripple current), AC component

Test condition: 50 VDC input, 10.4 VDC/96.2 A output and Ta = 25 °C, with 30 * 100 μF ceramic capacitor and 3200 μF AL. cap at output.

12. STARTUP & SHUTDOWN

Rise time

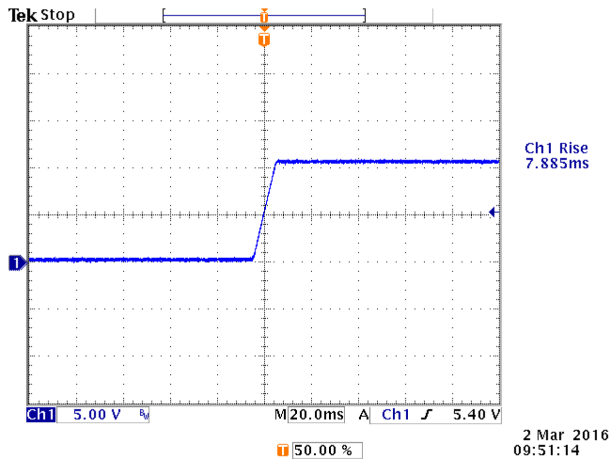


Figure 15.

Test Condition: Vin = 50 V, Po = 1000 W, with 30 * 100 μF ceramic capacitor and 3200 μF AL. cap at output.

Startup time

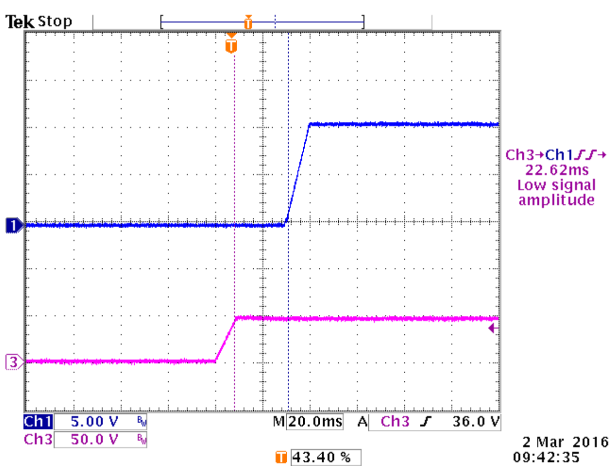


Figure 16. Startup from Vin
Ch1: Vo
Ch3: Vin

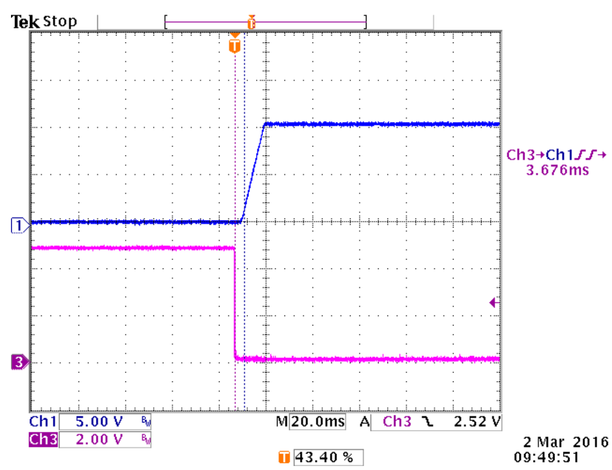


Figure 17. Startup from on/off
Ch1: Vo
Ch3: on/off

Test Condition: Vin=50 V, Po=1000 W, with 30 * 100 μF ceramic capacitor and 3200 μF AL. cap at output.

Shutdown

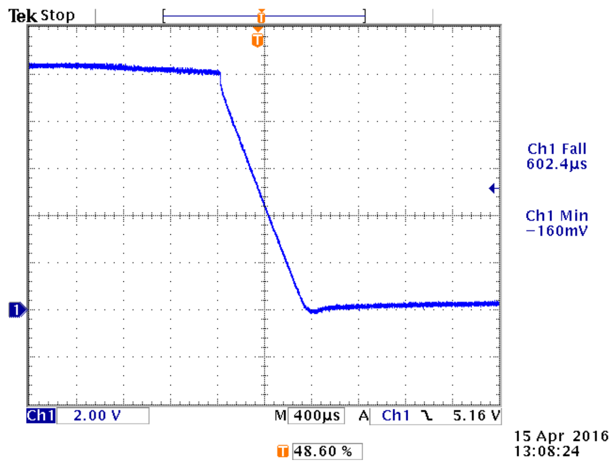


Figure 18.

Test Condition: Vin = 50 V, Po = 1000 W, with 30 * 100 µF ceramic capacitor and 3200 µF AL. cap at output.

13. INPUT UNDER-VOLTAGE LOCKOUT

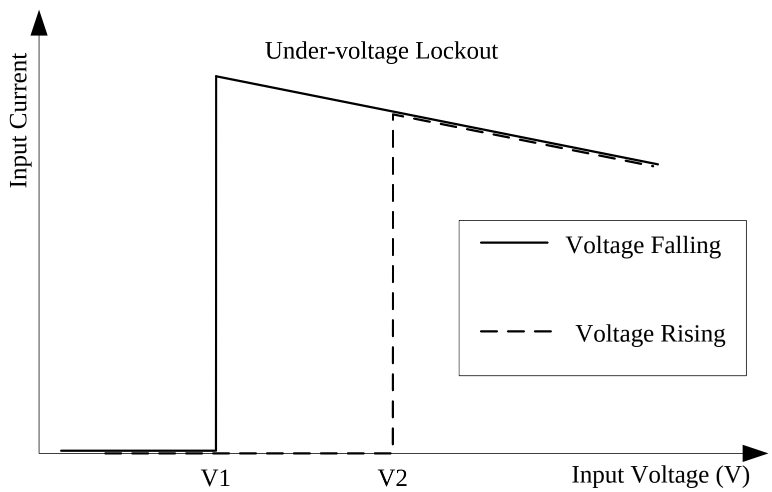


Figure 19.
V1 = 41 V
V2 = 44 V

14. 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 indicats good when Vin is within operating range and indicats bad ~20ms before unit is shut-down due to UV or OV	42.5	-	45	V
Input Voltage High (trigger limits) Rising		58	-	61	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

15. THERMAL DERATING CURVE

Hot spot location and allowed maximum temperature:

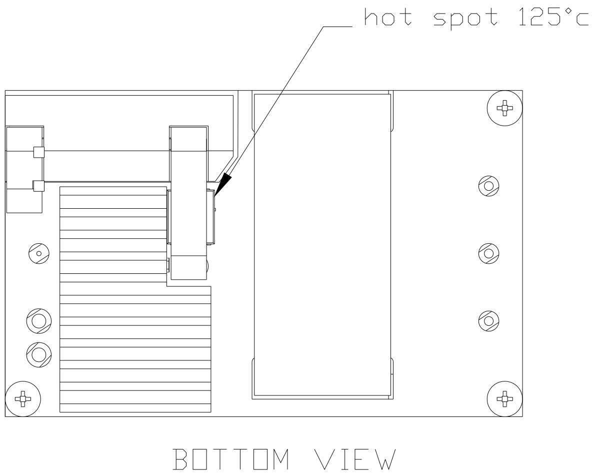


Figure 20. Module Bottom View

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 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).

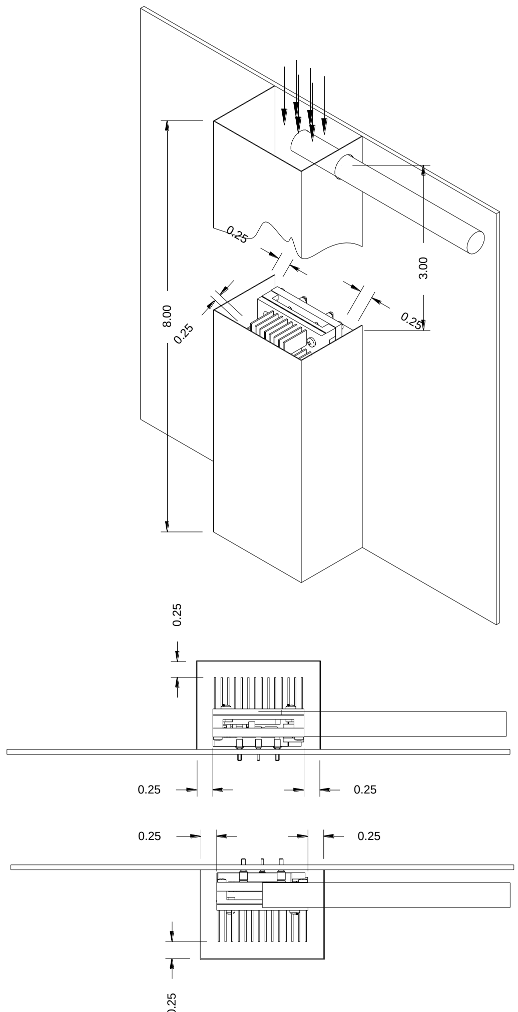


Figure 21. 0RQB-X0S10x + External heatsink

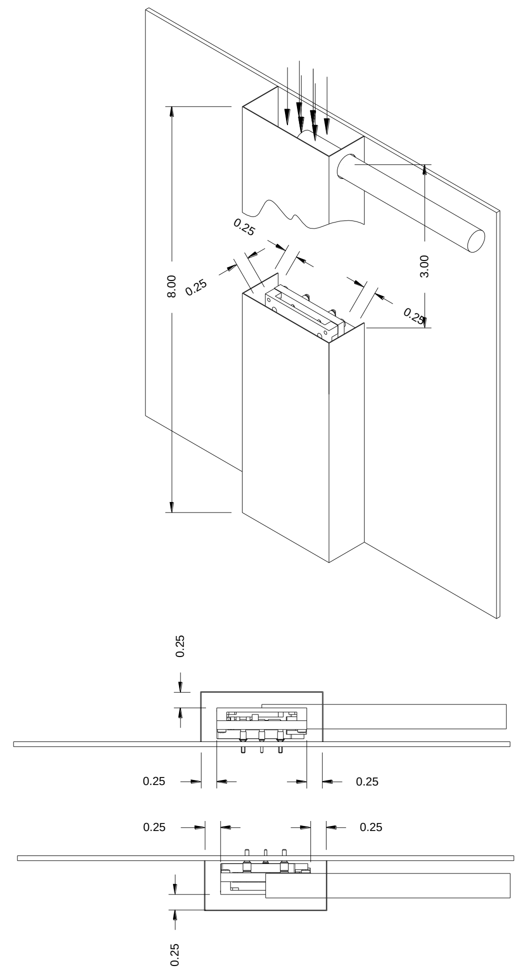


Figure 22. 0RQB-X0S10x

Test setup drawing all measures are in inch.
*The size of external heatsink is 2.30” x 1.45” x 0.61”, recommended model number: S08CAA02 from ALPHA.

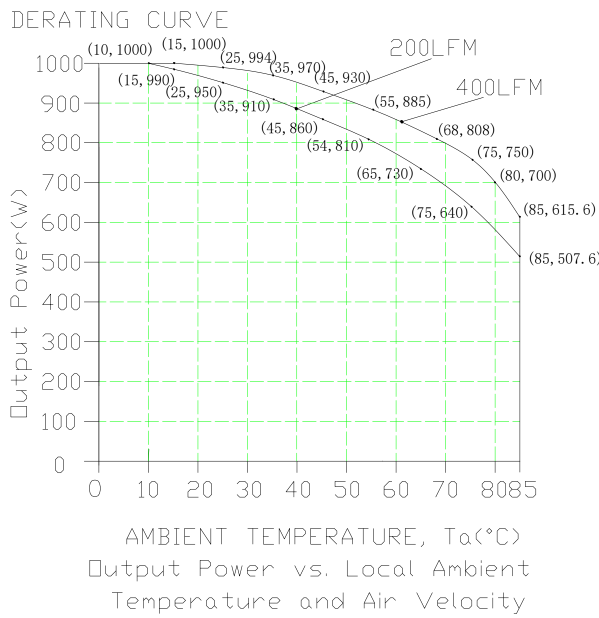


Figure 23. Figure 11. For 0RQB-X0S10x with Baseplate

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

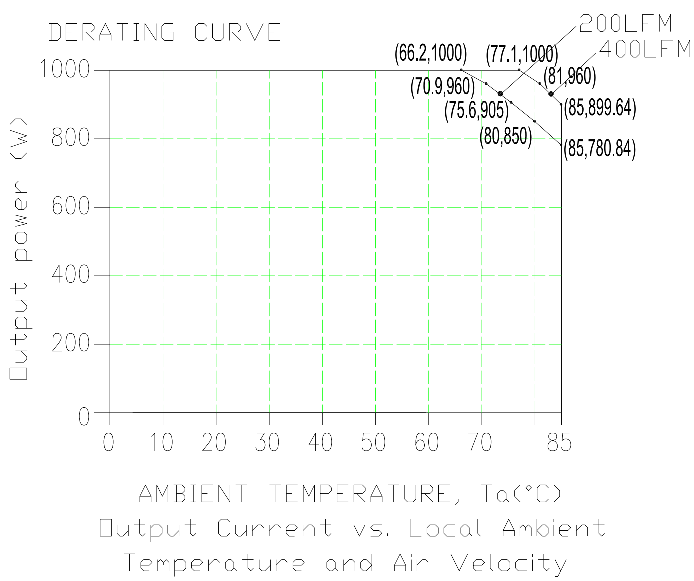


Figure 24. For 0RQB-X0S10x with Baseplate and external Heatsink

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

Heatsink information: S08CAA02 from ALPHA.

16. SOLDERING INFORMATION

The 0RQB-X0S10B/ 0RQB-X0S10N 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 10seconds. 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.

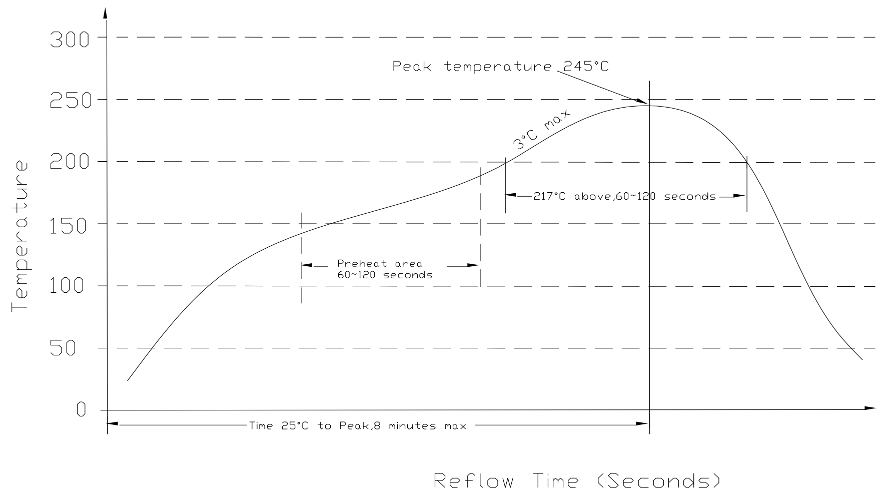


Figure 25. Soldering temperature

17. MSL RATING

The 0RQB-X0S10B/ 0RQB-X0S10N modules have a MSL rating of 3.

18. STORAGE AND HANDLING

The 0RQB-X0S10B/ 0RQB-X0S10N 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.

19. 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 @ 120~125°C for a minimum of 4 hours (preferably 24 hours) before reflow soldering. Our packaging tray can only withstand temperature of 70°C max.

20. MECHANICAL DIMENSIONS

0RQB-X0S10B OUTLINE

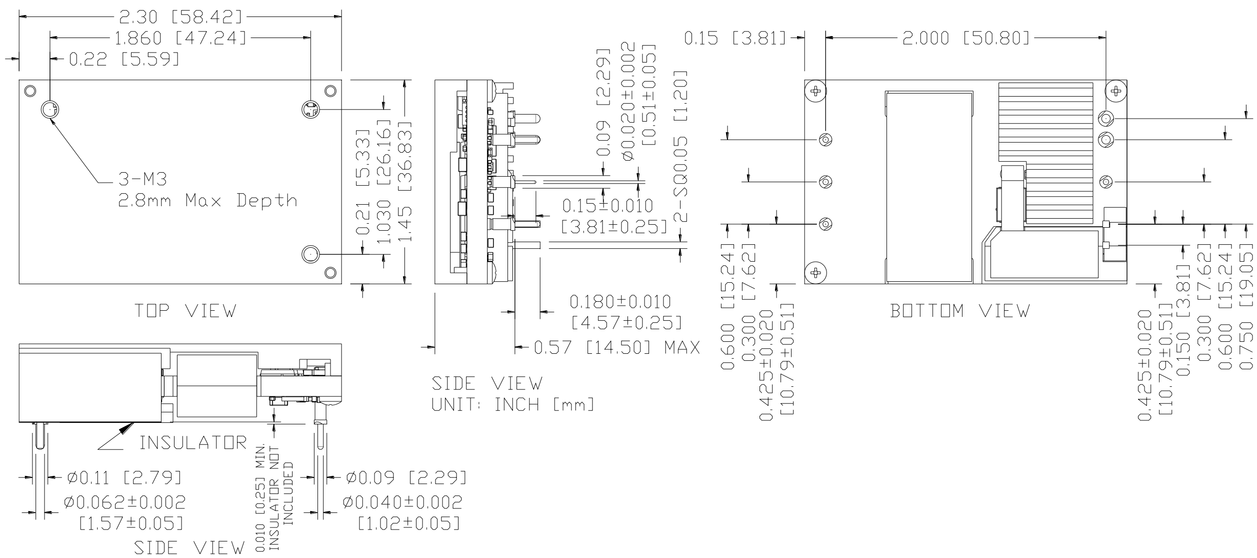


Figure 26. 0RQB-X0S10B outline

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 +/-0.020 inch [0.51 mm].
   x.xxx +/-0.010 inch [0.25 mm]..

0RQB-X0S10B PIN DEFINITIONS

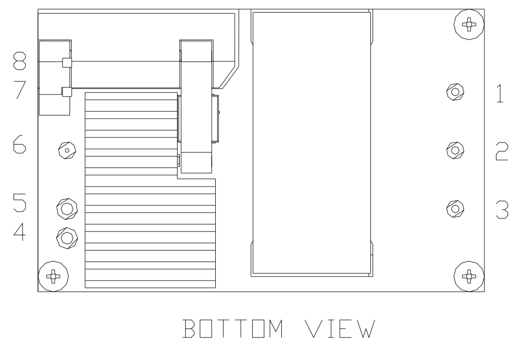


Figure 27. 0RQB-X0S10B Pins

PIN	FUNCTION	FUNCTION	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 input	0.062”
5	Vout(-)	Negative input	0.062”
6	PGOOD	Power-Good	0.02”
7	Vout(+)	Positive output	SQ0.05"
8	Vout(+)	Positive output	SQ0.05"

0RQB-X0S10B RECOMMENDED PAD LAYOUT

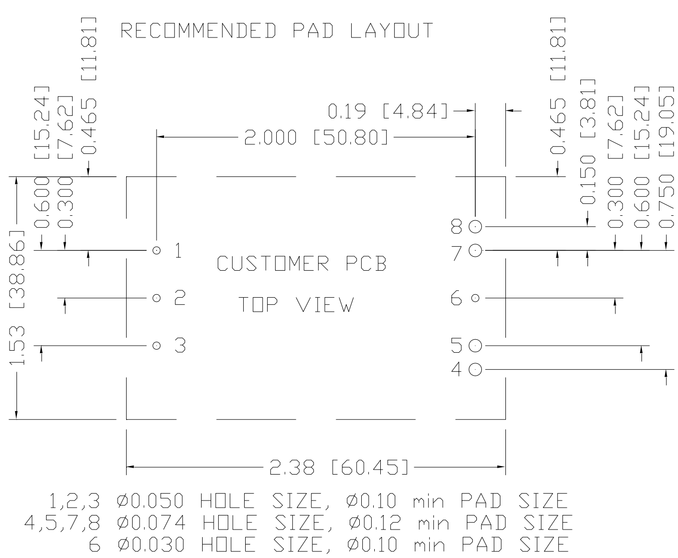


Figure 28. 0RQB-X0S10B recommended pad layout

0RQB-X0S10N OUTLINE

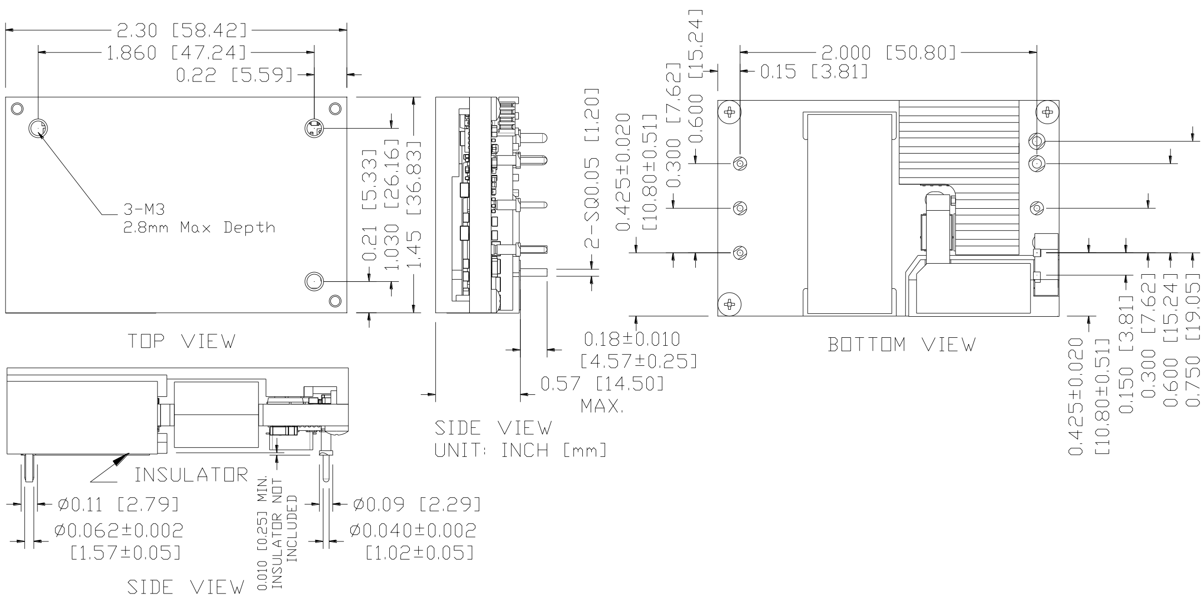


Figure 29. 0RQB-X0S10N outline

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 +/-0.020 inch [0.51 mm].
   x.xxx +/-0.010 inch [0.25 mm].

0RQB-X0S10N PIN DEFINITIONS

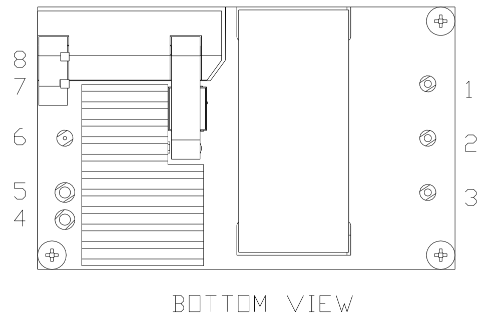


Figure 30. 0RQB-X0S10N Pins

PIN	FUNCTION	FUNCTION	FUNCTION
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 input	0.062”
5	Vout(-)	Negative input	0.062”
6	PGOOD	Power-Good	0.04”
7	Vout(+)	Positive output	SQ0.05"
8	Vout(+)	Positive output	SQ0.05"

0RQB-X0S10N RECOMMENDED PAD LAYOUT

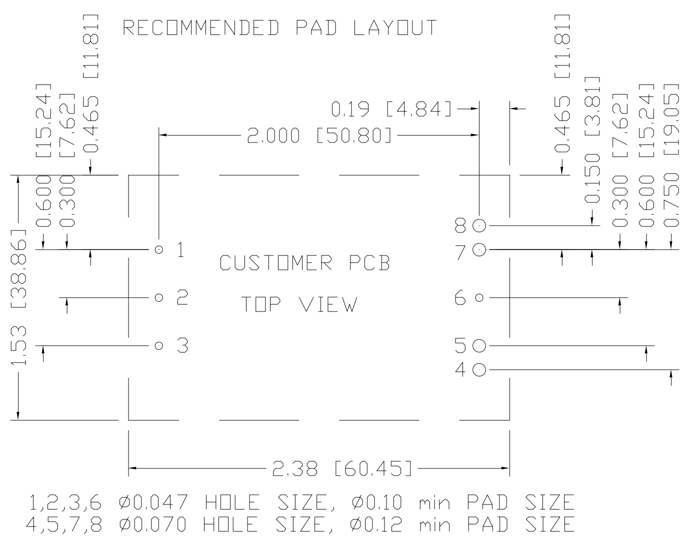


Figure 31. 0RQB-X0S10N recommended pad layout

0RQB-X0S10N / 0RQB-X0S10B RECOMMENDED PAD LAYOUT FOR CUSTOMER PCB

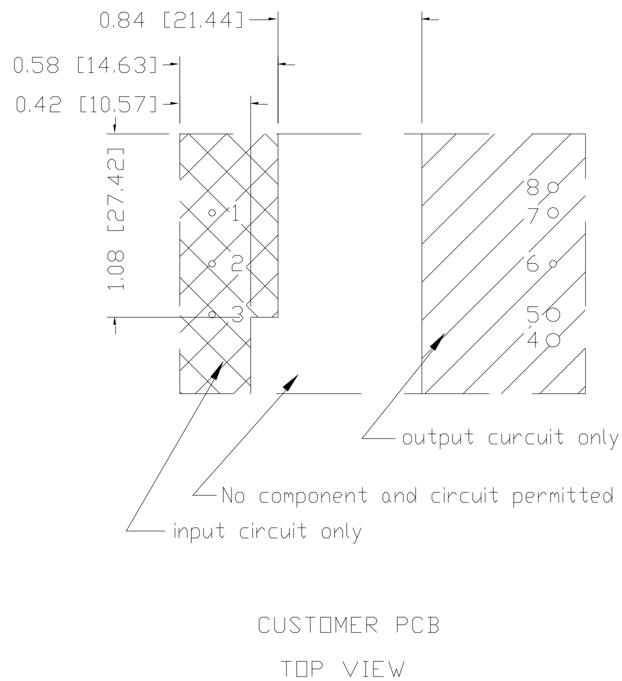


Figure 32. 0RQB-X0S10x Recommended pad layout for customer PCB

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 +/-0.020 inch [0.51 mm].
   x.xxx +/-0.010 inch [0.25 mm].

21. PACKAGE INFORMATION

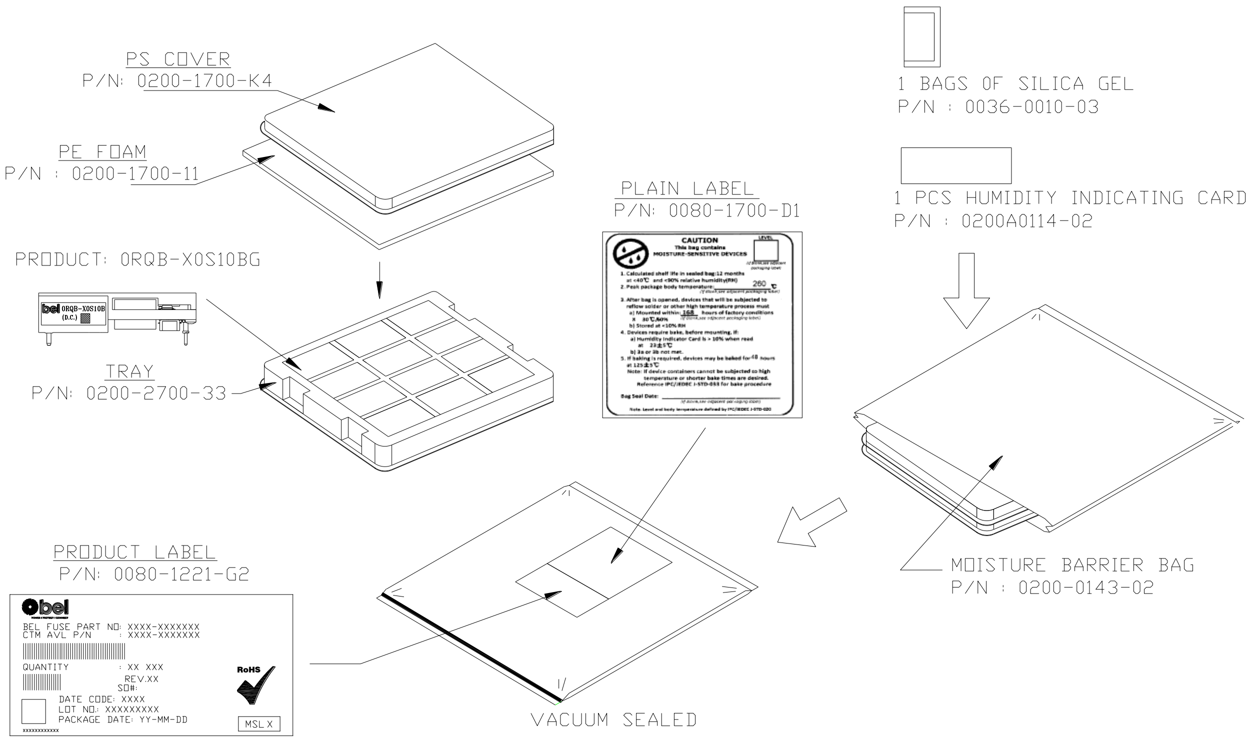
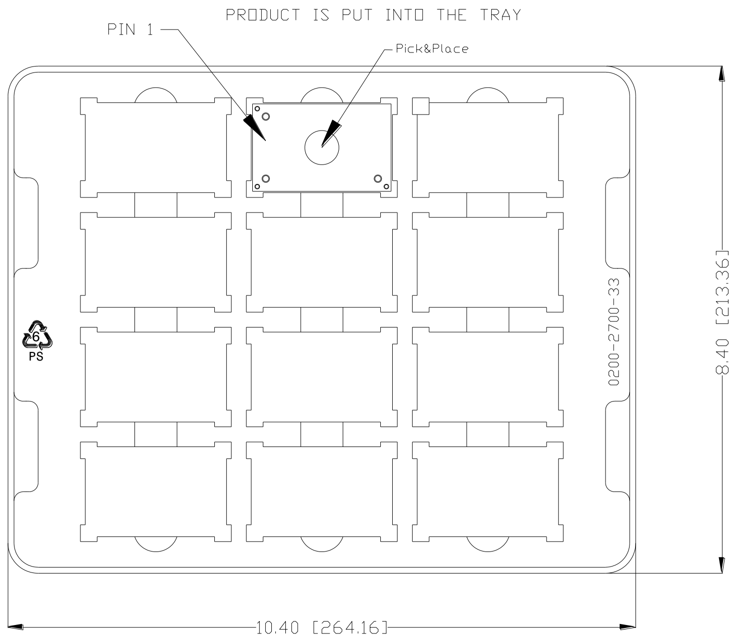


Figure 33. Package information-1



Standard Packing: 12pcs/tray, 6tray/box

Figure 34. Package information-2

22. FEATURE DISCRIPTIONS

Output over current protection

The module is equipped with internal output current limiting circuitry which 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 shutting down. 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 shut down. 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 ~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 shut down and auto-restart once the input voltage is within the limited range which is stated in the input spec table previously.

23. REVISION HISTORY

DATE	REVISION	CHANGES DETAIL	APPROVAL
2016-05-12	A	First release	J.Yan
2016-06-29	B	Update Ambient Temperature; TD	J.Yan
2016-07-15	C	Update TD	J.Yan
2016-10-28	AD	Update Part selection and Mechanical Outline	J.Yan
2017-02-13	AE	Update Abs Max, input specs, output specs, output plot VS input, TD	J.Yan
2017-11-09	AF	Add performance data at 58.5Vin and protection feature description.	J.Yan
2018-01-09	AG	Add Soldering information and packaging details.	J.Yan
2018-04-09	AH	Update MD for 0RQB-X0S10N.	F.Tao
2019-06-18	AI	Update safety certification and Output Capacitance.	F.Tao
2020-10-15	AJ	Delete preliminary watermark. Update output over voltage protection.	XF.Jiang
2021-02-09	AK	Update safety certificate.	XF.Jiang
2021-05-24	AL	Add object ID. Update thermal test setup drawings for correcting the height.	XF.Jiang

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.