# 0RQB-C5W24
Isolated DC-DC Converter

The 0RQB-C5W24 series are isolated DC/DC converters that provide up to 150 W of output power from a wide input range (66 V and 110 V typical).

These units are designed to be highly efficient. Standard features include remote on/off, input under-voltage lockout, over current protection, short circuit protection and over voltage protection. Conformal coated PCB is used for environmental ruggedness.
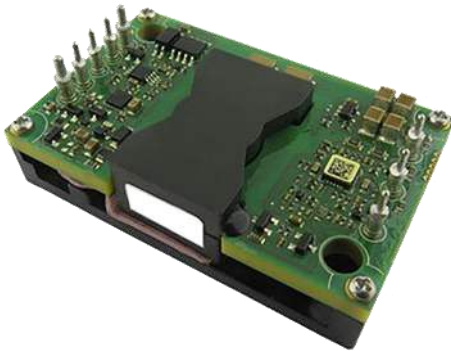
Key Features & Benefits

- 50 / 110 / 160 VDC Input
- 24 VDC @ 6.25 A Output
- 1/4th Brick Converter
- Reinforced Isolation
- Fixed Frequency
- High Efficiency
- Input Under-Voltage Lockout
- Input Over-Voltage Lockout
- OCP/SCP
- Output Over-Voltage Protection
- Over Temperature Protection
- Approved to IEC/EN 62368-1 (TBC)
- Class II, Category 2, Isolated DC/DC Converter (refer to IPC-9592B)

Applications

- Industrial
- Railways
- Telecommunications

RoHS Compliant

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1. MODEL SELECTION

MODEL NUMBER	OUTPUT VOLTAGE	INPUT VOLTAGE	MAX. OUTPUT CURRENT	MAX. OUTPUT POWER	TYPICAL EFFICIENCY
0RQB-C5W24LG 0RQB-C5W240G 0RQB-C5W24BG 0RQB-C5W24RG 0RQB-C5W24SG	24 VDC	50 - 160 VDC	6.25 A	150 W	93%

PART NUMBER EXPLANATION

0	R	QB	-	C5	W	24	x	G
Mounting Type	RoHS Status	Series Name		Output Power	Input Range	Output Voltage	Options	Package Type
Through Hole Mount	RoHS	DOSA Quarter Brick		150 W	50 – 160 V	24 V	L - Active Low, Baseplate with 2 holes, 0.57'' height 0 - Active High, Baseplate with 2 holes, 0.57'' height B - Active Low, Baseplate with 3 holes, 0.5'' height R - Active Low, Baseplate with 2 holes, 0.5'' height S - Active Low, With Flange HSK, 0.5'' height	Tray Package

2. ABSOLUTE MAXIMUM RATINGS

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNITS
Continuous non-operating Input Voltage		-0.5	-	200	V
Remote On/Off		-0.3	-	15	V
Current Sink	Remote on/off pin	0	-	10	mA
Isolation Voltage	Input to output	-	-	3000	V
Operating Temperature	Ambient temperature	-40	-	85	°C
Storage Temperature		-55	-	125	°C
Altitude		-	-	4000	m

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	Fully functioning for 100 ms operation	43	-	50	V
	Fully functioning for long term operation	50	-	160	V
Input Current (full load)	Vin = 66 V, Vo = 24 V, Io = 6.25 A	-	-	2.6	A
Input Current (no load)	Vin = 110 V, Vo = 24 V	-	50	-	mA
Remoted Off Input Current		-	2	5	mA
Input Reflected Ripple Current (rms)	Detail conditions please refer to input reflected ripple current section	-	20	-	mA
Input Reflected Ripple Current (pk-pk)		-	50	-	mA
Under-voltage Turn on Threshold	Lockout turn on	-	40	-	V
Under-voltage Turn off Threshold	Lockout turn off, non-latching	-	39	-	V
Over-voltage Shutdown Threshold	Auto-recovery and non-latching	165	170	175	V
Over-voltage Recovery Threshold		160	165	170	V

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	Test condition of the output setpoint: Vin =110 V, Io = 100% load at 25°C ambient	23.52	24	24.48	V
Load Regulation	Vin = 110 V, Io = 0 - 6.25 A	-	-	±0.50	%
Line Regulation	Vin = 50 – 160 V, Io = 6.25 A	-	-	±0.20	%
Regulation Over Temperature		-	-	±1	%
Ripple and Noise (pk-pk)	40 kHz – 100 MHz BW, with 1 µF ceramic capacitor and 220 µF bulk electrolytic at output	-	-	250	mV
Ripple and Noise (rms)		-	-	50	mV
Output Current Range		0	-	6.25	A
Output DC Current Limit	Enter a hiccup mode, non-latching	7.0	8.0	10.0	A
Rise Time	Vin = 110 V, Io = 6.25 A, with 1 µF ceramic capacitor and 220 µF bulk electrolytic at output	-	-	200	ms
Start-Up Time		-	300	500	ms
Pre-bias Start up		-	-	5	V
Overshoot at Turn on		-	0	5	%
Undershoot at Turn off		-	0	3	%
Output Capacitance	Typically, 100% Oscon or POSCAP.	220	-	2300	µF
Transient Response					
50% load to 75% Load	di/dt = 0.1 A/us, with 1 µF ceramic capacitor and 220 µF bulk electrolytic at output	-	-	800	mV
Settling Time		-	-	500	us
75% load to 50% Load		-	-	800	mV
Settling Time		-	-	500	µs

5. GENERAL SPECIFICATIONS

PARAMETER		DESCRIPTION	MIN	TYP	MAX	UNIT
Efficiency	Io = 60% – 100% Irate	T_A = 25°C	92	93	-	%
	Io = 40% - 60% Irate		90	92	-	%
Switching Frequency			-	220	-	kHz
Output Voltage Trim Range			21.6	-	26.4	V
Remote Sense Compensation			-	-	1.0	V
Over Temperature Protection		Temperature measured at the center of the baseplate, full load	-	110	-	°C
Output Over Voltage Protection		Enter a latching. non-hiccup mode	-	-	28	V
Weight		0RQB-C5W240 / 0RQB-C5W24L	-	72	-	g
		0RQB-C5W24B / 0RQB-C5W24R	-	55	-	g
		0RQB-C5W24S	-	64	-	g
FIT		Calculated Per Bell Core SR-332 (Vin = 110 V, Vo = 24 V, Io = 6.25 A, 100 LFM, Ta = 25°C, FIT=10^9/MTBF)	-	238.8	-	
MTBF			-	4.2	-	Mhrs
Dimensions (L × W × H)		0RQB-C5W240 / 0RQB-C5W24L		2.30 x 1.45 x 0.57		inch
				58.42 x 36.83 x 14.50		mm
		0RQB-C5W24B / 0RQB-C5W24R		2.30 x 1.45 x 0.50		inch
				58.42 x 36.83 x 12.70		mm
		0RQB-C5W24S		2.386 x 2.20 x 0.50		inch
				60.60 x 55.88 x 12.70		mm
Isolation Characteristics						
Input to Output			-	-	3000	Vdc
Input to Heatsink			-	-	3000	Vdc
Output to Heatsink			-	-	3000	Vdc
Isolation Resistance			10M	-	-	Ohm
Isolation Capacitance			-	2200	-	pF

6. EFFICIENCY DATA
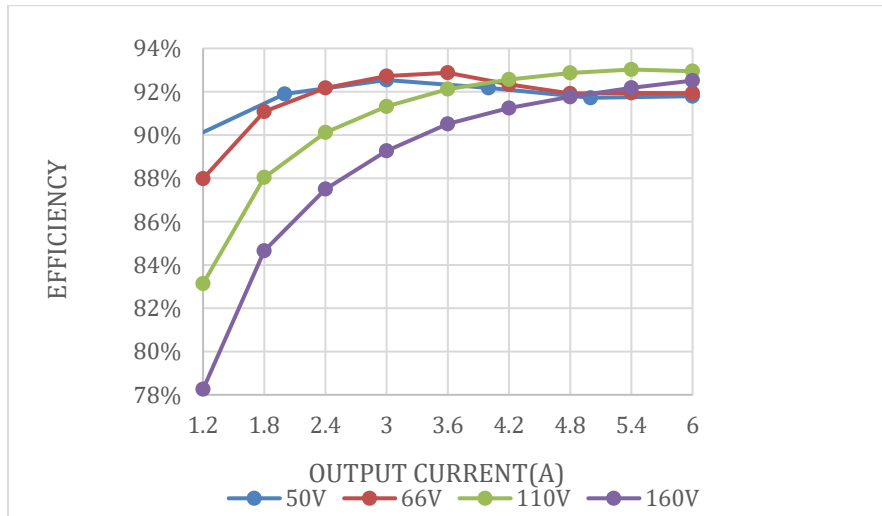
Figure 1. Efficiency data

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7. 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	-	15	V
Signal Low (Unit off)	Active high	Remote On/Off pin is open, the module is on	-0.3	-	0.8	V
Signal High (Unit On)			2.4	-	15	V
Current Sink			0	-	10	mA

Recommended remote on/off circuit for active low
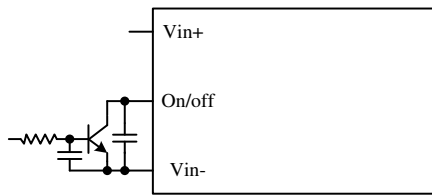
Figure 2. Control with open collector/drain circuit
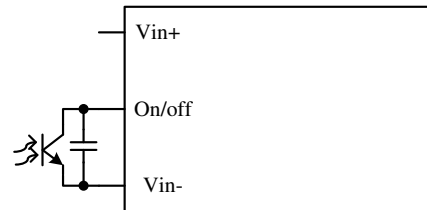
Figure 3. Control with photocoupler circuit
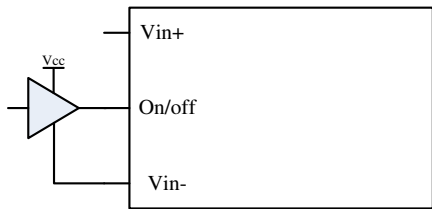
Figure 4. Control with logic circuit
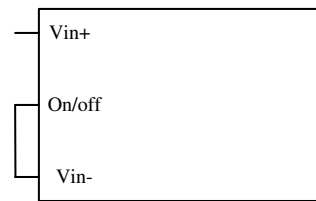
Figure 5. Permanently on

Recommended remote on/off circuit for active high
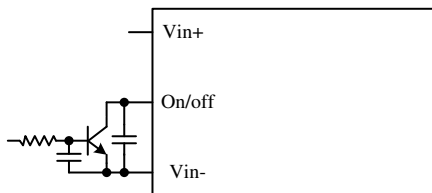
Figure 6. Control with open collector/drain circuit
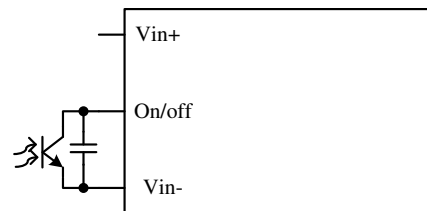
Figure 7. Control with photocoupler circuit
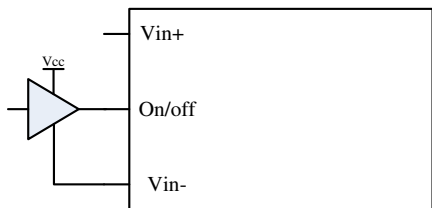
Figure 8. Control with logic circuit
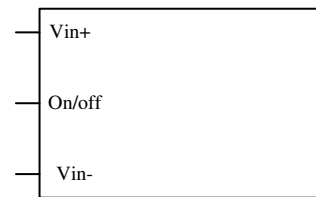
Figure 9. Permanently on

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8. REMOTE SENSE

This module has remote sense compensation feature. It can minimize the effects of resistance between module's output and load in system layout and facilitate accurate voltage regulation at load terminals or other selected point.

1. The remote sense lines carry very little current and hence do not require a large cross-sectional area.

2. This module compensates for a maximum drop of 1.0 V at the nominal output voltage.

3. If the unit is already trimmed up, the available remote sense compensation range should be correspondingly reduced. The total voltage increased by trim and remote sense should not exceed 1.0 V at the nominal output voltage.

4. When using remote sense compensation, all the resistance, parasitic inductance and capacitance of the system are incorporated within the feedback loop of this module which can make an effect on the module's compensation, affecting the stability and dynamic response. A 0.1 uF ceramic capacitor can be connected at the point of load to de-couple noise on the sense wires.

5. Recommend the connection of remote sense compensation as below figure. There are a resistor RS+ (100 ohm) from Vo+ to Sense+ and a resistor RS- (100 ohm) from Vo- to Sense- inside of this module.
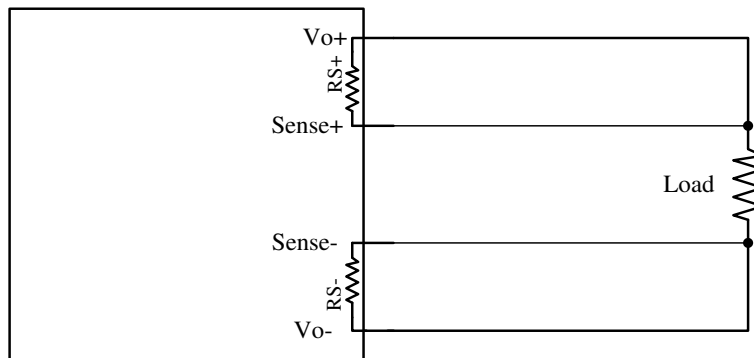
Figure 10.

6. If not using remote sense compensation, please connect sense directly to output at module's pin, that is, to connect sense+ to Vo+ and sense- to Vo- at module's pin, the shorter the better. See below figure.
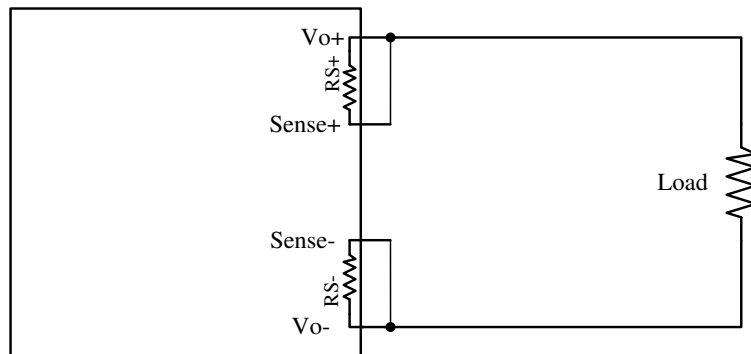

Figure 11.

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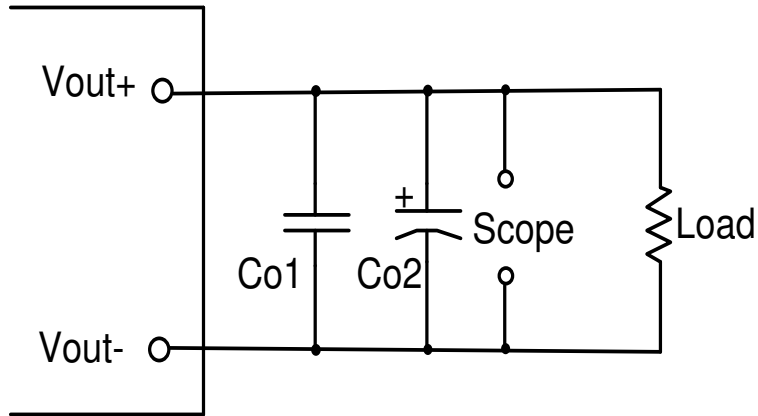## 9. RIPPLE AND NOISE

Testing setup:

Figure 12.

Notes and values in testing:
  Co1: 1 uF ceramic + 100 uF polymer
  Co2: 220 uF Al
  The capacitor should be as close as possible to the power module to damp ripple current and enhance stability.

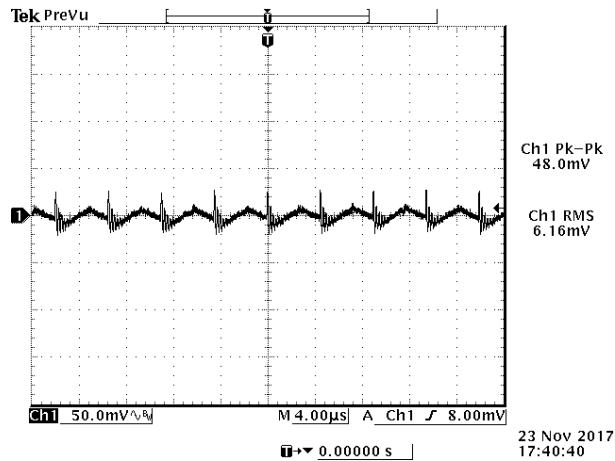Below measured waveforms are based on above capacitance.

Figure 13. Ripple and noise

Test condition: Vin = 110 V, Vo = 24 V, Io = 6 A, Cout = 1 uF ceramic + 100 uF polymer + 220 uF Al.

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10. INPUT NOISE

Input reflected ripple current
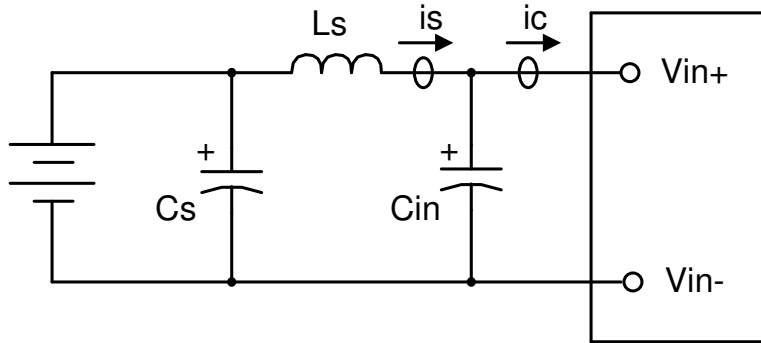
Figure 14.

Notes and values in testing.

is: Input Reflected Ripple Current

ic: Input Terminal Ripple Current

Ls: Simulated Source Impedance (12 µH)

Cs: Offset possible source Impedance (220 µF, ESR < 0.1 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/200 V, ESR < 0.2 Ω @ 100 kHz, 20°C.

Below measured waveforms are based on above simulated and recommended inductance and capacitance.
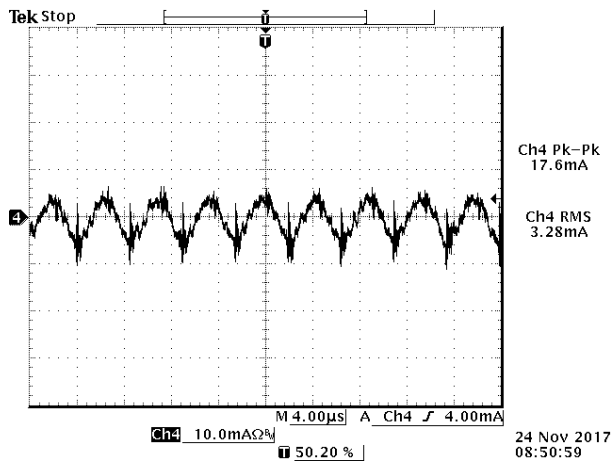
Figure 15. is (input reflected ripple current), AC component
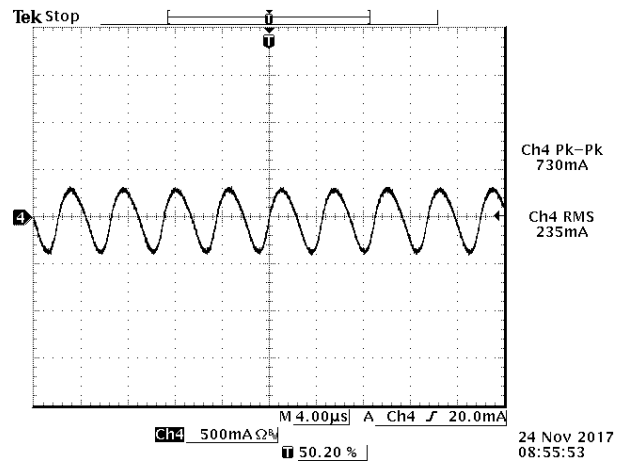
Figure 16. ic (input terminal ripple current), AC component

Test condition: Vin = 110 V, Vo = 24 V, Io = 6 A, Cout = 1 uF ceramic + 100 uF polymer + 220 uF Al.

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11. TRANSIENT RESPONSE
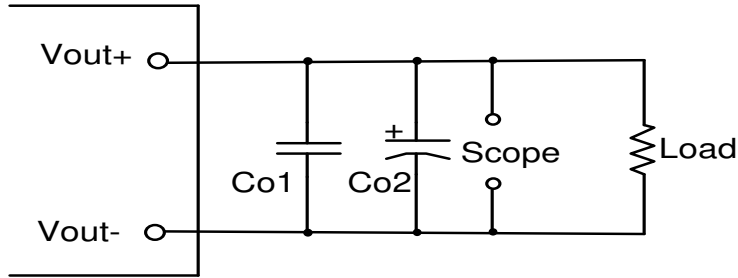
Testing setup

Figure 17.

Notes and values in testing.
   Co1: 1 uF ceramic + 100 uF polymer
   Co2: 220 uF Al
   The capacitor should be as close as possible to the power module to damp ripple current and enhance stability.

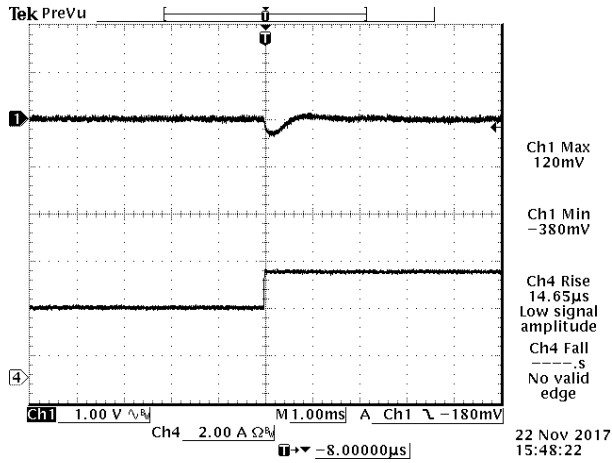Below measured waveforms are based on above capacitance.

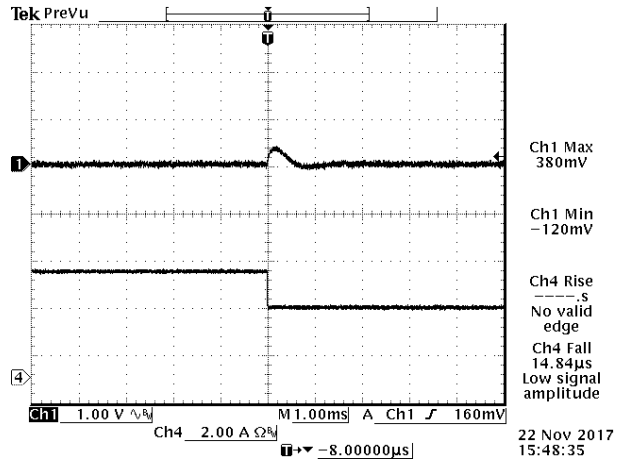*Figure 18. 10. Transient response 50% -75%*

Figure 19. Transient response 75%-50%

Test condition: Vin = 110 V, Vo = 24 V, Io = 6 A, di/dt = 2.5 A/us, Cout = 1 uF ceramic + 100 uF polymer + 220 uF Al.

12. STARTUP & SHUTDOWN

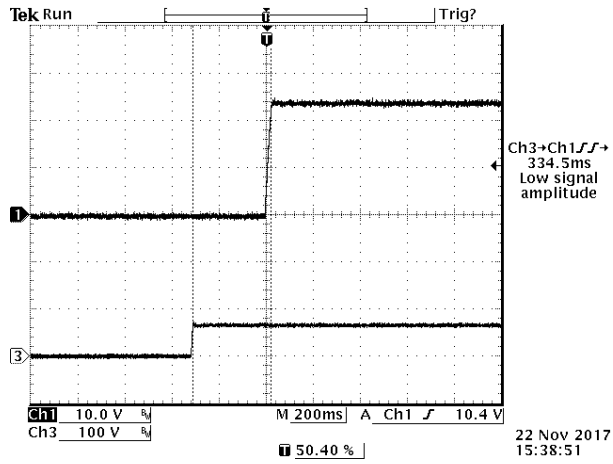

Figure 20. Start up from Vin
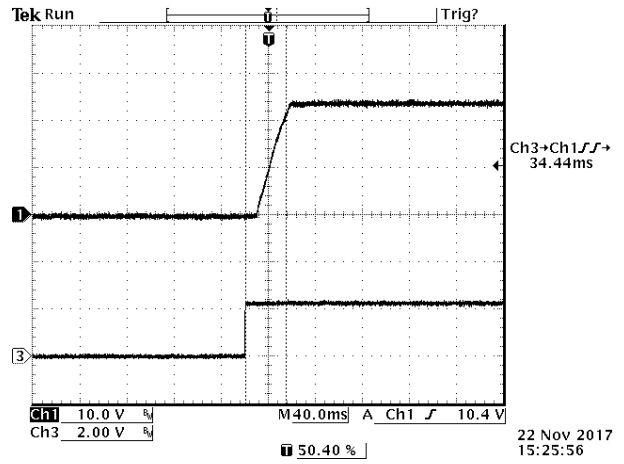
Figure 21. Start up from on/off (Active High)

Test condition: Vin = 66 V, Vo = 24 V, Io = 6 A, Cout = 1 uF ceramic + 100 uF polymer + 220 uF Al.
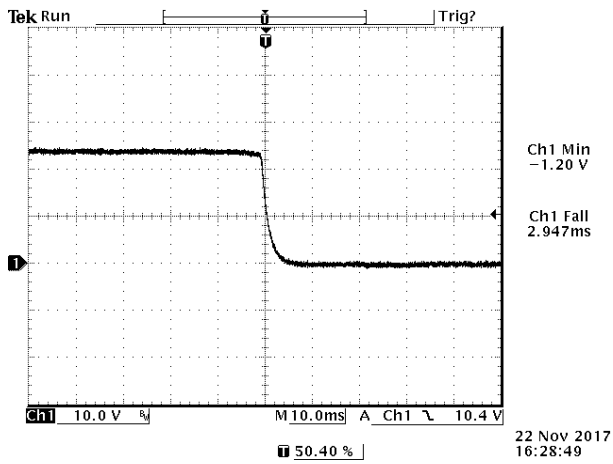

Figure 22. Shutdown from Vin
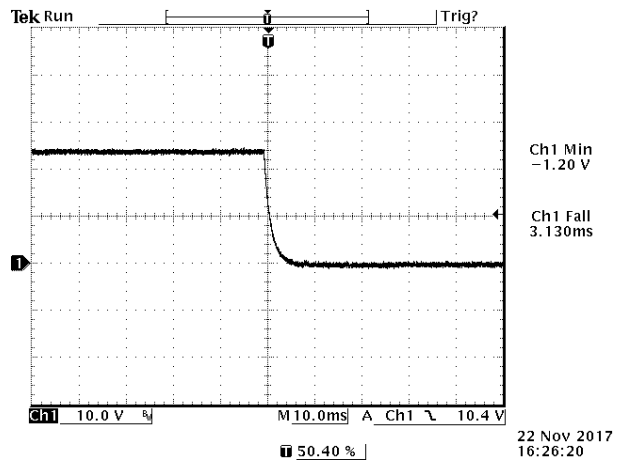
Figure 23. Shutdown from on/off (Active High)

Test condition: Vin = 66 V, Vo = 24 V, Io = 6 A, Cout = 1 uF ceramic + 100 uF polymer + 220 uF Al.

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13. OVER CURRENT PROTECTION

To provide protection in a fault output overload condition, the module is equipped with internal current-limiting circuitry which can endure current limiting for a few milliseconds. If the over current condition persists beyond a few milliseconds, the module will shut down into hiccup mode. The module operates normally when the output current goes into specified range. The typical average output current is 0.12 A during hiccup.
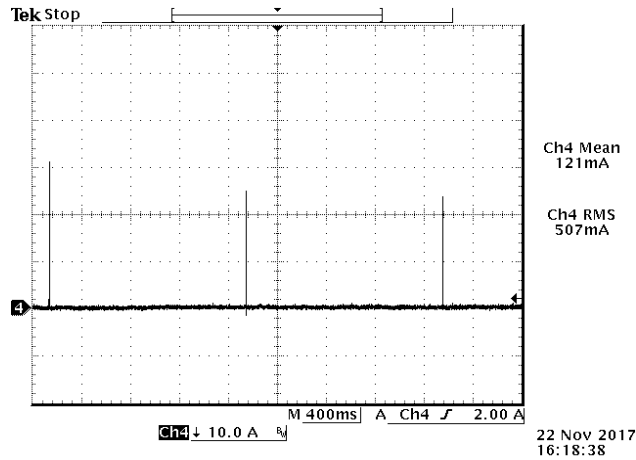
Figure 24. Over current protection
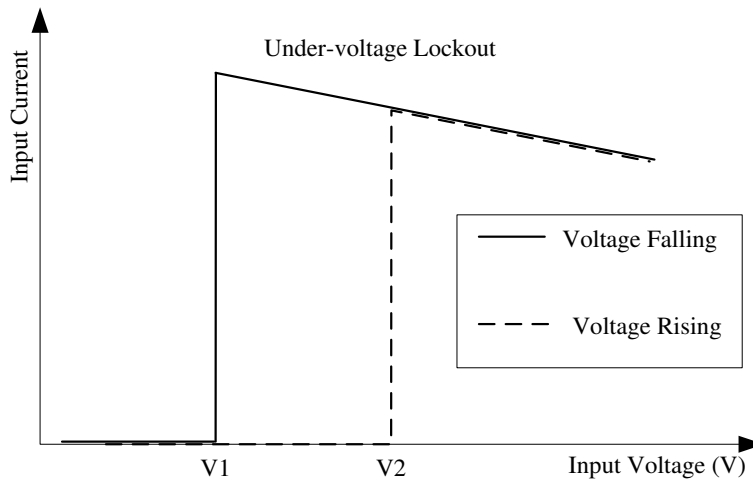
14. INPUT UNDER-VOLTAGE LOCKOUT

Figure 25. Input under-voltage lockout
V1=39V
V2=40V

15. TRIM

0RQB-C5W24 series Trim Resistor Calculation
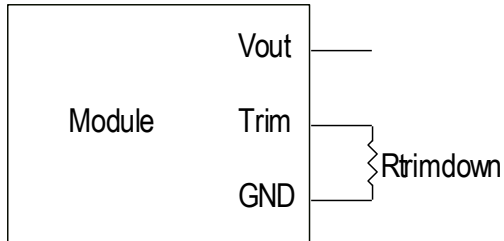
Trim down test circuit

Figure 26. Trim down test circuit

$$R_{trimdown} = \frac{Vo\_req}{24 - Vo\_req} - 1\,[k\,\Omega]$$
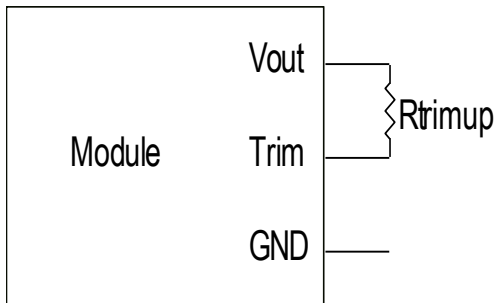
Trim up test circuit

Figure 27. Trim up test circuit

$$R_{trimup} = \frac{1 - 0.051875}{0.051876 - 1.24 / Vo\_req} - 1\,[k\,\Omega]$$

Note: Vo_req=Desired(trimmed) output voltage[V].

16. THERMAL DERATING CURVE

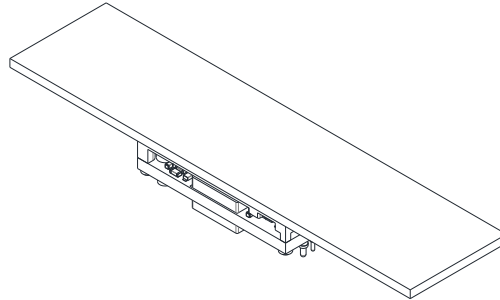**Test setup:** Vin = 110 V, 0 LFM, external HSK Dimension: 158 x 38 x 6 mm.

Figure 28. Thermal test setup

DERATING CURVE

AMBIENT TEMPERATURE, Ta(°C)
Output Current vs. Local Ambient
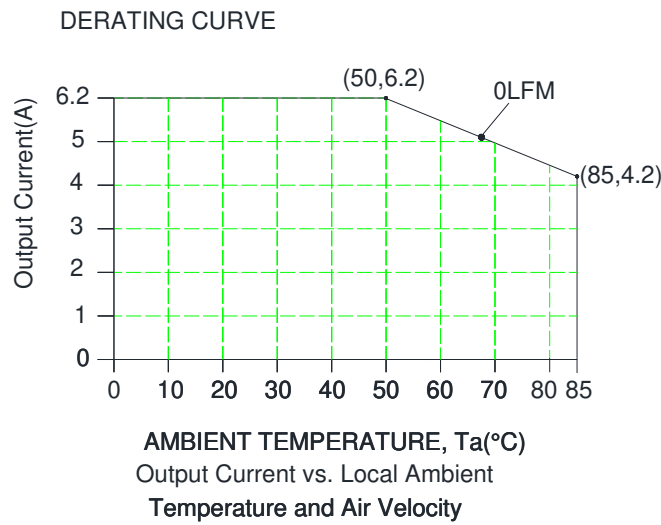**Temperature and Air Velocity**

Figure 29. Thermal derating curve

17. SAFETY & EMC

Safety:

TBC

EMC:

Compliance to EN55032 class A (both peak and average) with the following inductive and capacitive filter

Test Setup:
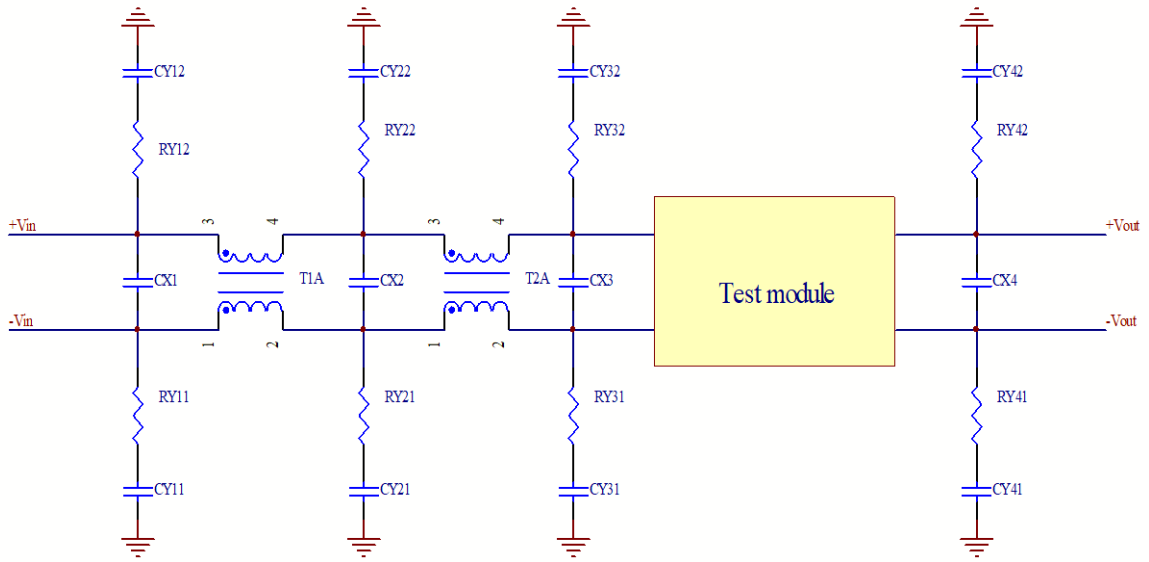
Figure 30.

T1A	CX1	RY11	RY12	CY11	CY12
T2A	CX2	RY21	RY22	CY21	CY22
2.5mH	1uF				
	CX3	RY31	RY32	CY31	CY32
	1uF+330uF AL	0R	0R	4.7nF	4.7nF
	CX4	RY41	RY42	CY41	CY42

Positive:

Figure 31.

Negative:

Figure 32.

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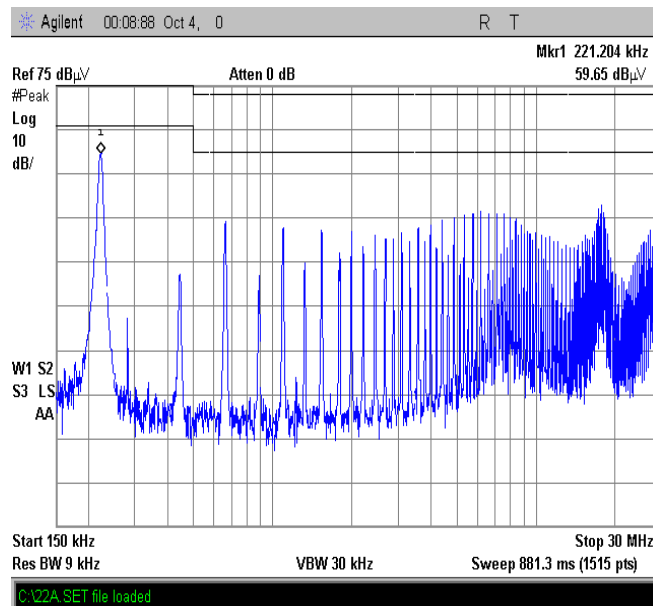
18. MECHANICAL DIMENSIONS

0RQB-C5W240/L OUTLINE

Figure 33. 0RQB-C5W240/L 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 ℃ for less than 5 seconds.
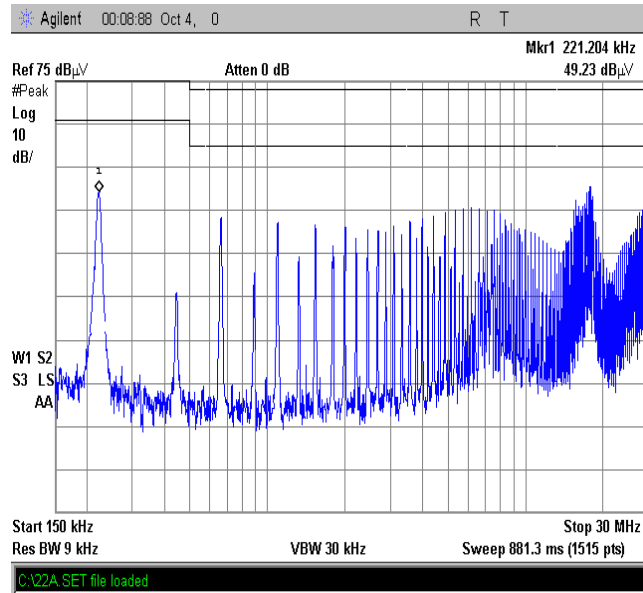
NOTES:

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-C5W240/L PIN DEFINITIONS

BOTTOM VIEW

Figure 34. 0RQB-C5W240/L Pins

PIN	FUNCTION	PIN	FUNCTION
1	Vin (+)	5	Sense (-)
2	On/off	6	Trim
3	Vin (-)	7	Sense (+)
4	Vout (-)	8	Vout (+)

0RQB-C5W240/L RECOMMENDED PAD LAYOUT

output curcuit only
No component and circuit permitted
input circuit only

CUSTOMER PCB
TOP VIEW

Figure 35. 0RQB-C5W240/L Recommended pad layout-1

RECOMMENDED PAD LAYOUT

CUSTOMER PCB
TOP VIEW

2-Ø0.197 [Ø5.00]
REF.
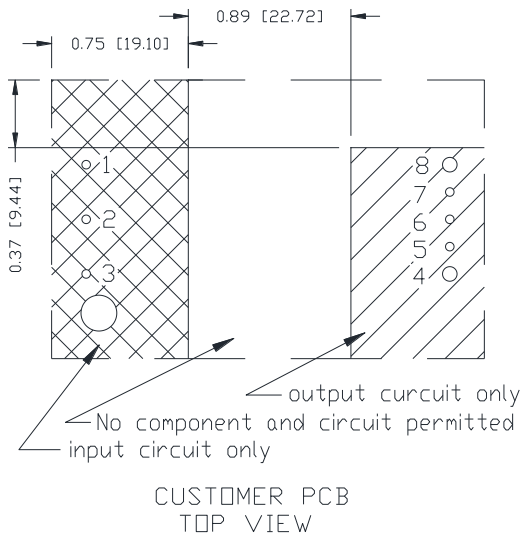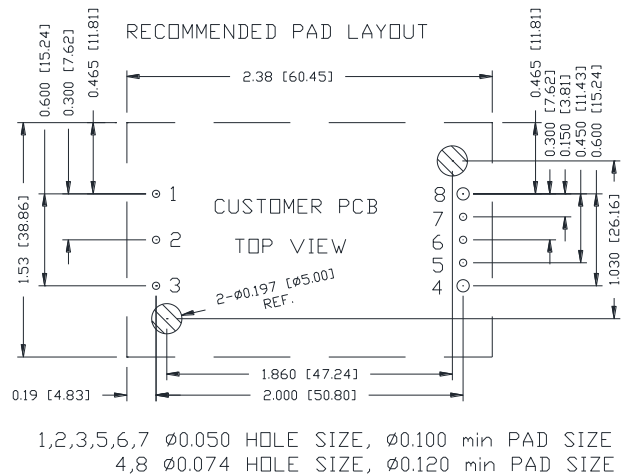
1,2,3,5,6,7 Ø0.050 HOLE SIZE, Ø0.100 min PAD SIZE
4,8 Ø0.074 HOLE SIZE, Ø0.120 min PAD SIZE

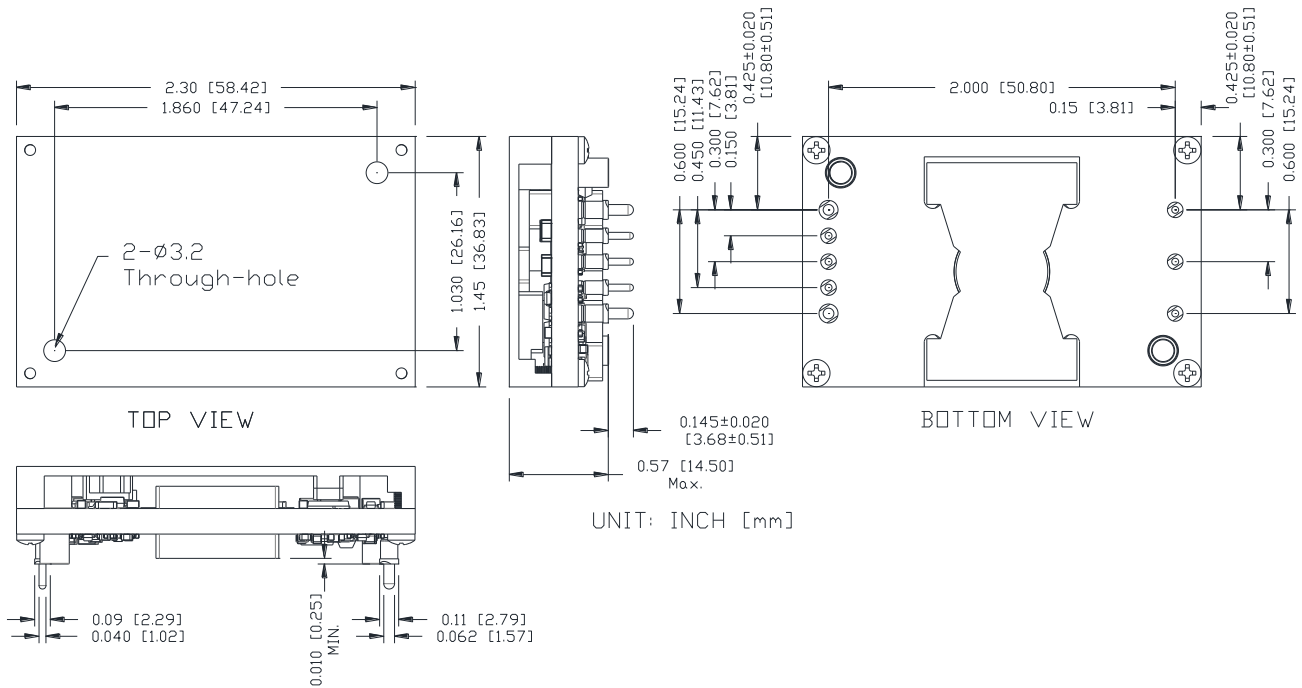*Figure 36. 0RQB-C5W240/L Recommended pad layout-2*

0RQB-C5W24B OUTLINE
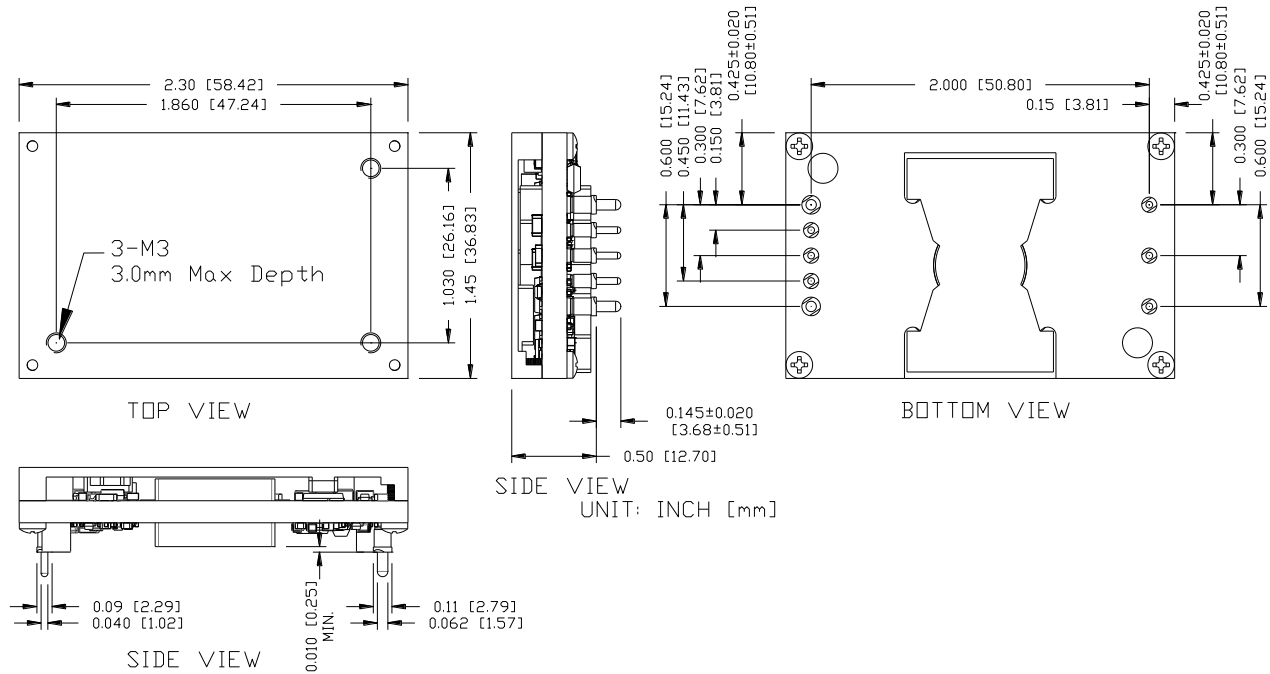
Figure 37. 0RQB-C5W24B Outline

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 inches; Tolerances: x.xx +/-0.02 inch [0.51 mm]. x.xxx +/-0.010 inch [0.25 mm].
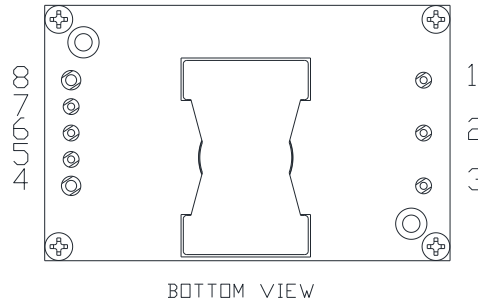
0RQB-C5W24B PIN DEFINITIONS

BOTTOM VIEW

Figure 38. 0RQB-C5W24B Pins

PIN	FUNCTION	PIN	FUNCTION
1	Vin (+)	5	Sense (-)
2	On/off	6	Trim
3	Vin (-)	7	Sense (+)
4	Vout (-)	8	Vout (+)

0RQB-C5W24B RECOMMENDED PAD LAYOUT

0.89 [22.72]

0.75 [19.10]

0.37 [9.44]

output curcuit only
No component and circuit permitted
input circuit only

CUSTOMER PCB
TOP VIEW

Figure 39. 0RQB-C5W24B Recommended pad layout -1

RECOMMENDED PAD LAYOUT

0.600 [15.24]
0.300 [7.62]
0.465 [11.81]

2.38 [60.45]

0.465 [11.81]
0.150 [3.81]
0.300 [7.62]
0.450 [11.43]
0.600 [15.24]

1.53 [38.86]

CUSTOMER PCB
TOP VIEW

0.19 [4.83]   2.000 [50.80]

1,2,3,5,6,7 Ø0.050 HOLE SIZE, Ø0.100 min PAD SIZE
4,8 Ø0.074 HOLE SIZE, Ø0.120 min PAD SIZE
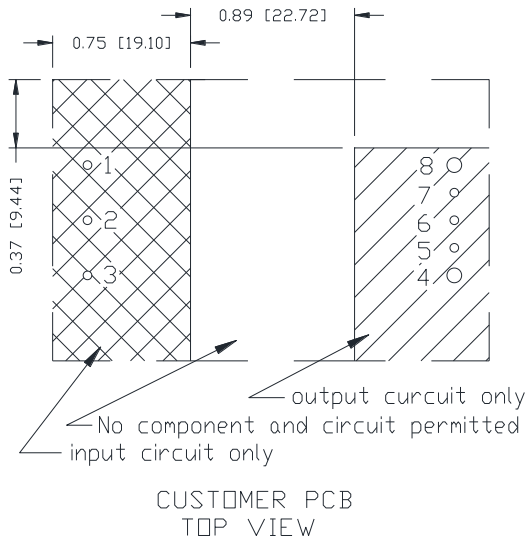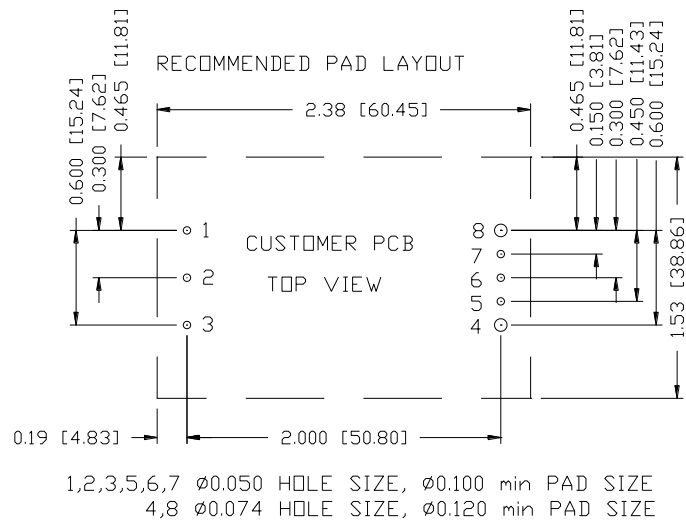
Figure 40. 0RQB-C5W24B Recommended pad layout -2

0RQB-C5W24R OUTLINE

2.30 [58.42]
1.860 [47.24]

2-∅3.2
Through-hole

1.030 [26.16]
1.45 [36.83]

TOP VIEW

0.600 [15.24]
0.450 [11.43]
0.300 [7.62]
0.150 [3.81]
0.425±0.020 [10.80±0.51]

0.145±0.020 [3.68±0.51]

0.50 [12.70]

SIDE VIEW
UNIT: INCH [mm]

2.000 [50.80]
0.15 [3.81]

0.425±0.020 [10.80±0.51]
0.300 [7.62]
0.600 [15.24]

BOTTOM VIEW

0.09 [2.29]
0.040 [1.02]

0.010 [0.25]
MIN.

0.11 [2.79]
0.062 [1.57]

SIDE VIEW

Figure 41. 0RQB-C5W24R 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-C5W24

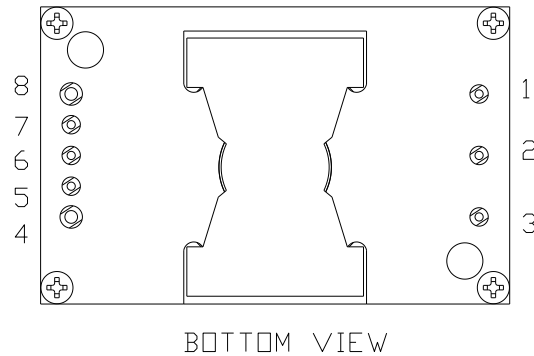## 0RQB-C5W24R PIN DEFINITIONS

Figure 42. 0RQB-C5W24R Pins

PIN	FUNCTION	PIN	FUNCTION
1	Vin (+)	5	Sense (-)
2	On/off	6	Trim
3	Vin (-)	7	Sense (+)
4	Vout (-)	8	Vout (+)

0RQB-C5W24R RECOMMENDED PAD LAYOUT
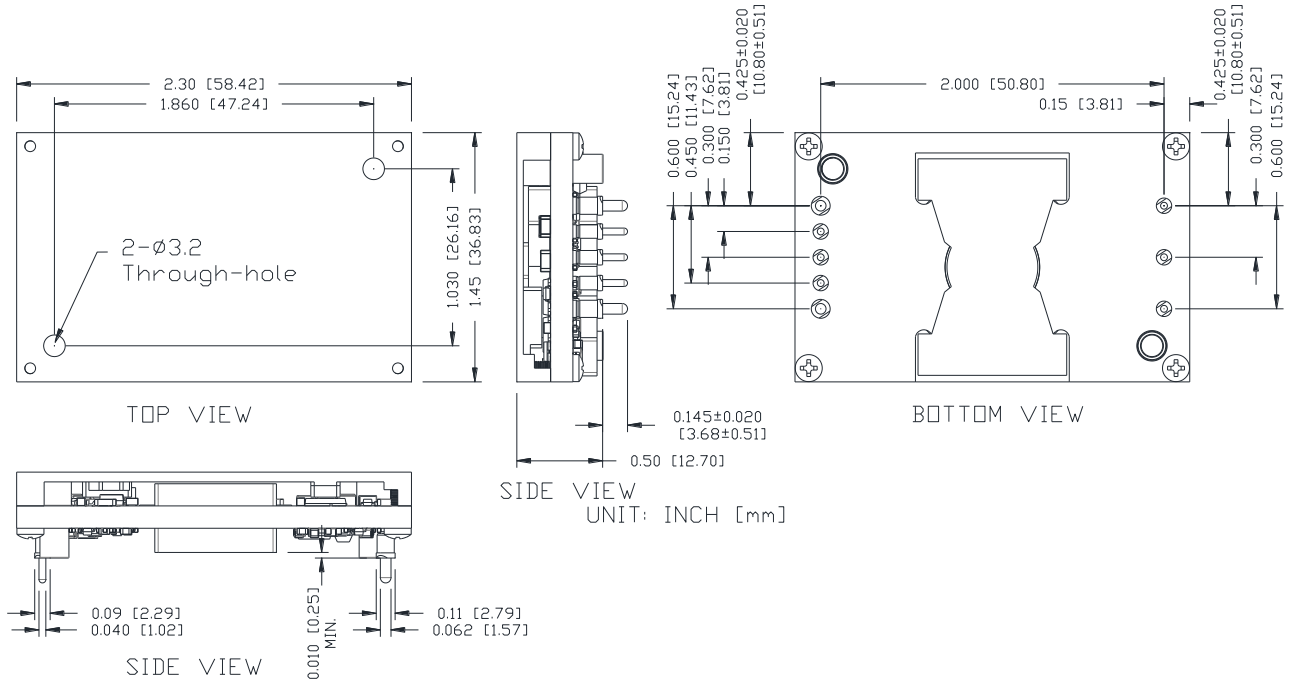

Figure 43. 0RQB-C5W24R Recommended pad layout-1

Figure 44. 0RQB-C5W24R Recommended pad layout-2

BCD.20037_AJ
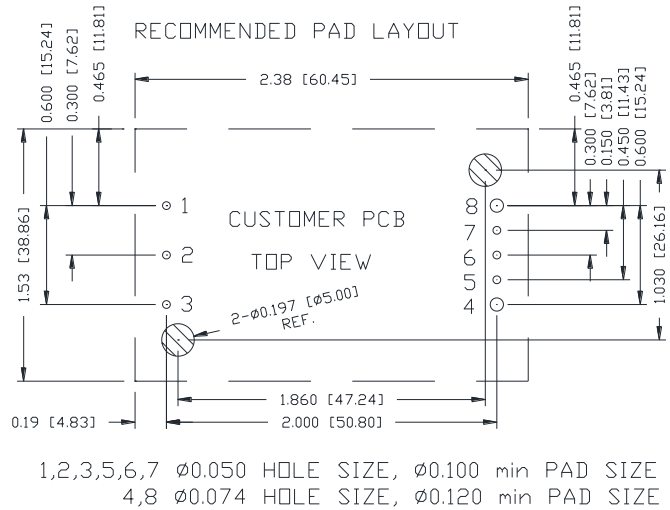
0RQB-C5W24S OUTLINE
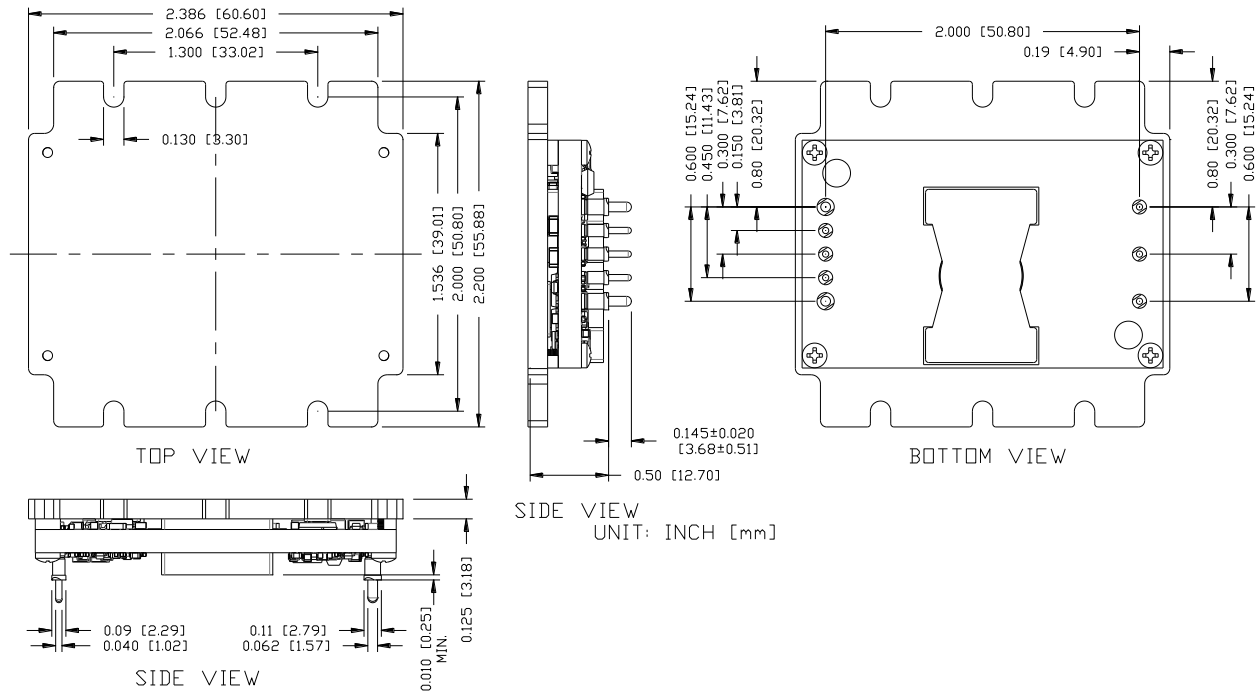
Figure 45. 0RQB-C5W24S Outline

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].
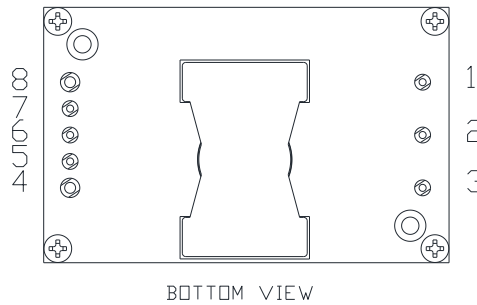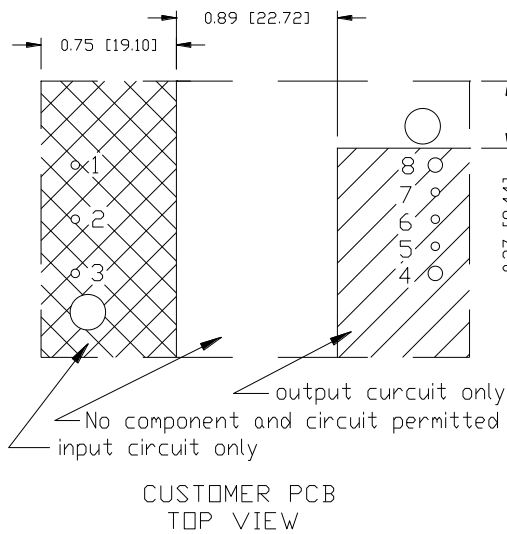
0RQB-C5W24S PIN DEFINITIONS
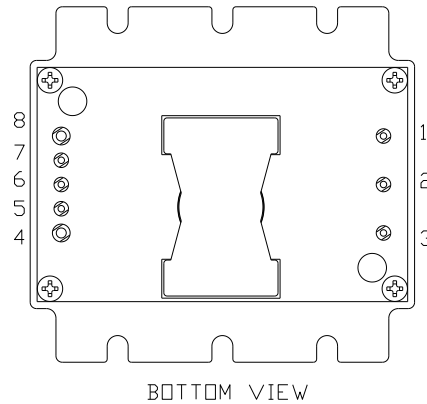
Figure 46. 0RQB-C5W24S Pins

PIN	FUNCTION	PIN	FUNCTION
1	Vin (+)	5	Sense (-)
2	On/off	6	Trim
3	Vin (-)	7	Sense (+)
4	Vout (-)	8	Vout (+)

0RQB-C5W24S RECOMMENDED PAD LAYOUT

Figure 47. 0RQB-C5W24S Recommended pad layout-1


Figure 48. 0RQB-C5W24S Recommended pad layout-2

19. FEATURE DISCRPTION

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.

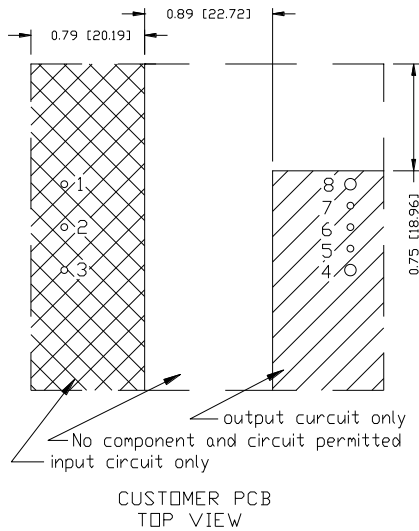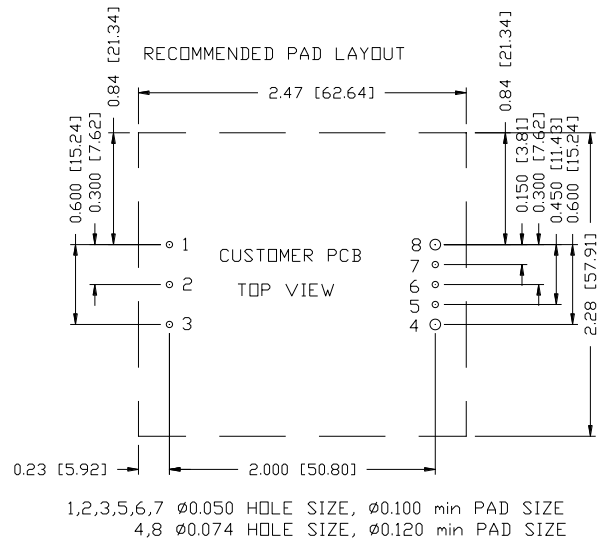For hiccup mode, the module will try to restart after shutdown. If the over current situation still exists, the module will shut down continuously until this fault condition is cleared. The hiccup interval time is 800ms.

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.

Output over voltage protection

The module is equipped with internal over output voltage protection, monitoring the module output terminal voltage all the way. If the output voltage exceeds the limited value, the module will shut down and enter either hiccup mode or latch mode, which is stated in the general spec table previously.

For hiccup mode, the module will try to restart after shutdown. If the over voltage situation still exists, the module will shut down continuously until this fault condition is cleared.

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 ~10C 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.

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20. REVISION HISTORY

DATE	REVISION	CHANGES DETAIL	APPROVAL
2017-08-14	AA	First release	J.Yan
2017-12-06	AB	Update the Input Specs, Output Specs, NR, Input noise, TR, Startup & Shutdown, OCP and TRIM	J.Yan
2018-06-20	AC	Update Part Number Explanation and MD	J.Yao
2018-06-26	AD	Update MD, Output Spec, Absolute Maximum Ratings and General Spec	J.Yao
2018-09-11	AE	Update TD	J.Yao
2018-10-23	AF	Add 0RQB-C5W24B	J.Yao
2019-10-24	AG	Add feature reinforced isolation	J.Yao
2021-04-14	AH	Add object ID, module photo and recommended pad layout.	J.Yao
2021-06-24	AJ	Add 0RQB-C5W24R and 0RQB-C5W24S. Update EMC form and part number explanation.	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.
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