0RQB-C5U24L

Isolated DC-DC Converter

The 0RQB-C5U24L is an isolated DC/DC converter that provides up to 150 W of output power from a wide input range (24 V and 48 V typical).

The unit is 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.

RoHS Compliant

Key Features & Benefits

- 16 / 48 / 67 VDC Input
- 24 VDC @ 6.25 A Output
- 1/4th Brick Converter
- Isolated
- Fixed Frequency
- High Efficiency
- Conformal Coated
- Input Under-Voltage Lockout
- Input Over-Voltage Lockout
- Output Over-Voltage Protection
- Over Current and Short Circuit 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

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1. MODEL SELECTION

MODEL NUMBER	OUTPUT VOLTAGE	INPUT VOLTAGE	MAX. OUTPUT CURRENT	MAX. OUTPUT POWER	TYPICAL EFFICIENCY
0RQB-C5U24LG	24 VDC	16 - 67 VDC	6.25 A	150 W	93%

PART NUMBER EXPLANATION

0	R	QB	-	C5	U	24	L	G
Mounting Type	RoHS Status	Series Name		Output Power	Input Range	Output Voltage	Active Logic	Package Type
Through Hole Mount	RoHS	DOSA Quarter Brick		150 W	16 – 67 V	24 V	Active Low, with Baseplate	Tray Package

2. ABSOLUTE MAXIMUM RATINGS

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNITS
Continuous non-operating Input Voltage		-0.5	-	80	V
Remote On/Off		-0.3	-	15	V
Current Sink	Remote on/off pin	0	-	10	mA
Isolation Voltage	Input to output	-	-	3000	V
Ambient Temperature Long-Term	Long-Term Operating. All components on the Unit meet IPC-9592 (latest revision) derating guidelines.	-40	-	85	°C
Ambient Temperature Short-Term	(96 hours/year). Unit's component temperatures exceed IPC-9592 (latest revision) derating guidelines but not exceed component temperature ratings.	-40	-	90	°C
Storage Temperature		-55	-	125	°C
Altitude		-	-	4000	m
Humidity		10	-	90	%

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	13	-	16	V
	Fully functioning for long term operation	16	-	67	V
Input Current (full load)	Vin = 48 V, Io = 6.25 A	-	3.3	-	A
Input Current (no load)	Vin = 48 V	-	102	200	mA
Remoted Off Input Current		-	20	30	mA
Input Reflected Ripple Current (rms)	Detail conditions please refer to input reflected ripple current section.	-	20	100	mA
Input Reflected Ripple Current (pk-pk)		-	50	250	mA
Under-voltage Turn on Threshold	Lockout turn on	10	11	12	V
Under-voltage Turn off Threshold	Lockout turn off, non-latching	9	10	11	V
Over-voltage Shutdown Threshold	Auto-recovery and non-latching.	73	75	77	V
Over-voltage Recovery Threshold		70	72	74	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	Vin = 48 V, Io = 100% load	23.52	24	24.48	V
Load Regulation	Vin = 48 V, Io = 0 - 6.25 A	-	-	±0.50	%
Line Regulation	Vin = 16 – 67 V, Io = 6.25 A	-	-	±0.20	%
Regulation Over Temperature	Vin = 16 – 67 V, Io = 0 - 6.25 A	-	-	±1	%
Output Voltage Trim Range		-10	-	10	%
Ripple and Noise (pk-pk)	Detail conditions please refer to output ripple and noise section.	-	-	100	mV
Ripple and Noise (RMS)		-	-	30	mV
Ripple and Noise (pk-pk) under worst case		-	-	200	mV
Output Current Range		0	-	6.25	A
Output DC Current Limit	Enter a hiccup mode, non-latching.	6.6	8	11	A
Vo OVP		27.6	30	33	V
Rise Time	Detail conditions please refer to start-up section.	-	20	60	ms
Turn-On Delay(Vin)		-	300	500	ms
Turn-On Delay(on/off)		-	35	50	ms
Overshoot at Turn on		-	0	5	%
Undershoot at Turn off		-	0	3	%
Pre-bias Voltage		0	-	3	V
Output Capacitance	Typically 100% Oscon or POSCAP	341*	-	2300	µF
Transient Response					
50% load to 75% Load	Detail conditions please refer to Transient Response section.	-	350	500	mV
Settling Time		-	350	500	µs
75% load to 50% Load		-	350	500	mV
Settling Time		-	350	500	µs

*** Note:** 1 µF ceramic capacitor, 10 µF ceramic capacitor, 330 µF aluminum electrolytic capacitor.

5. GENERAL SPECIFICATIONS

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
Efficiency	Full load	93	-	-	%
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		-	-	28	V
Weight		-	60	-	g
FIT	Calculated Per Bell Core SR-332 (Vin = 110 V, Vo = 24 V, Io = 6.25 A, 100 LFM, Ta = 40°C, FIT = 10^9/MTBF)	-	153.7	-	
MTBF		6507509	-	-	Mhrs
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	Test condition: 1 mA / 60 s, rise rate 500 VDC/s	-	-	3000	VDC
Input to Heatsink		-	-	3000	VDC
Output to Heatsink		-	-	3000	VDC
Isolation Resistance		10M	-	-	Ohm
Isolation Capacitance		-	2200	-	pF

6. EFFICIENCY DATA

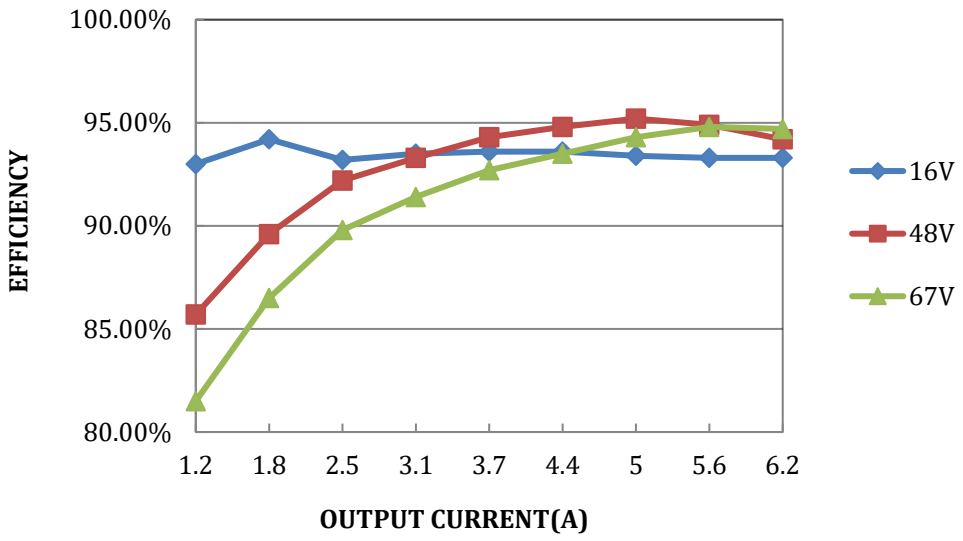

Figure 1. Efficiency data

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
Current Sink			0	-	10	mA

Recommended remote on/off circuit for active low

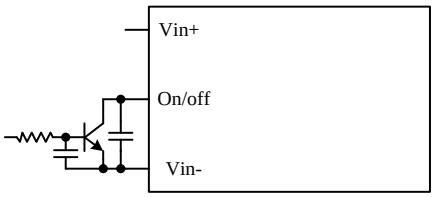

Figure 2. Control with open collector/drain circuit

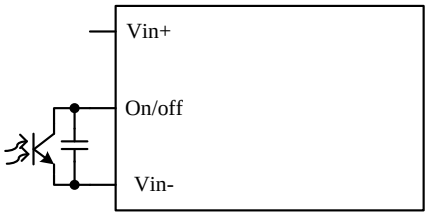

Figure 3. Control with photocoupler circuit

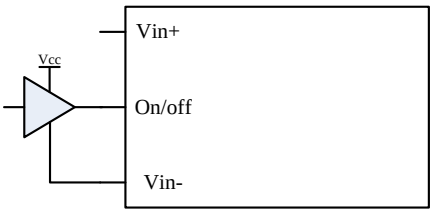

Figure 4. Control with logic circuit

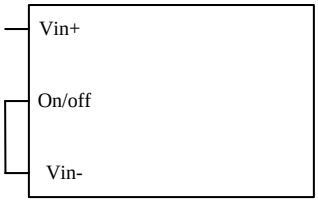

Figure 5. Permanently on

8. REMOTE SENSE

This module has remote sense compensation feature. It can minimize the effects of resistance between 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 µF 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.

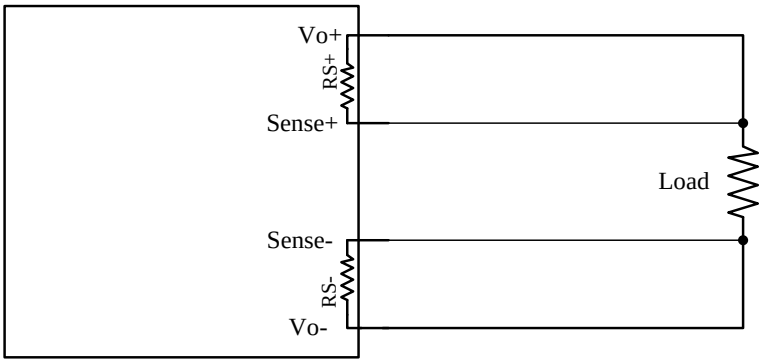

Figure 6.

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

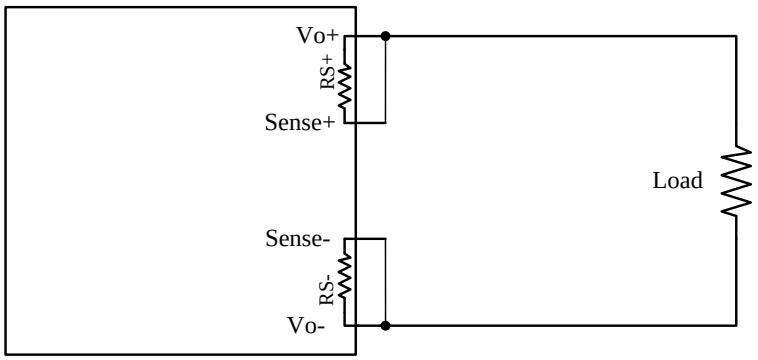

Figure 7.

9. INPUT NOISE

Input reflected ripple current

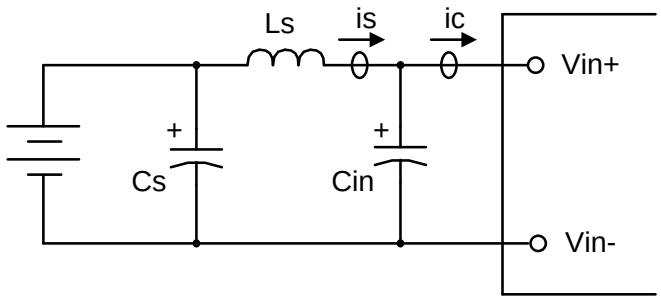

Figure 8.

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 Impedance (100 µF, ESR < 0.1 Ω @ 100 kHz, 20°C)
- Cin: Electrolytic capacitor, should be as closed as possible to the power module to damped ic ripple current and enhance stability. Recommendation: 100 µF / 100 V, ESR < 0.2 Ω @ 100 kHz, 20°C.

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

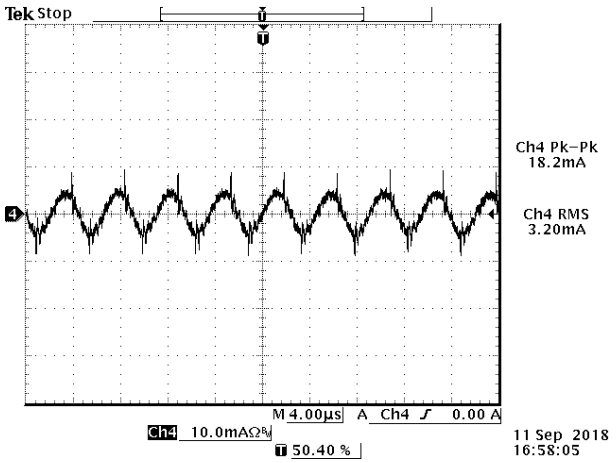

Figure 9. is (input reflected ripple current), AC component

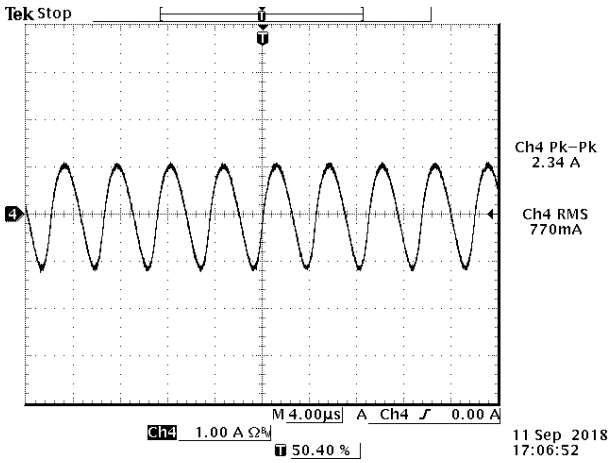

Figure 10. ic (input terminal ripple current), AC component

Test condition: Vin = 48 V, Vo = 24 V, Io = 6.25 A.

10. RIPPLE AND NOISE

Testing setup

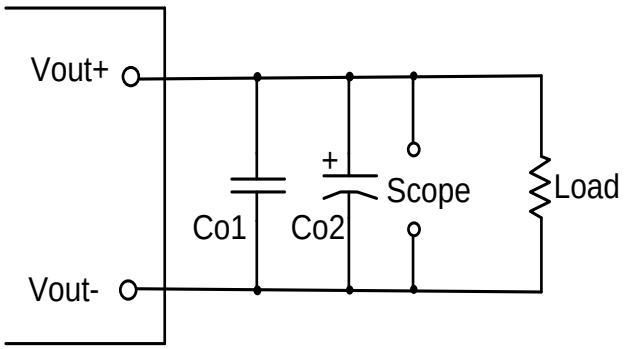

Figure 11.

Notes and values in testing:

Co1: 11 μF ceramic

Co2: 330 μF aluminum electrolytic capacitor

The capacitor should be as closed as possible to the power module to damped ripple current and enhance stability.

Below measured waveforms are based on above capacitance.

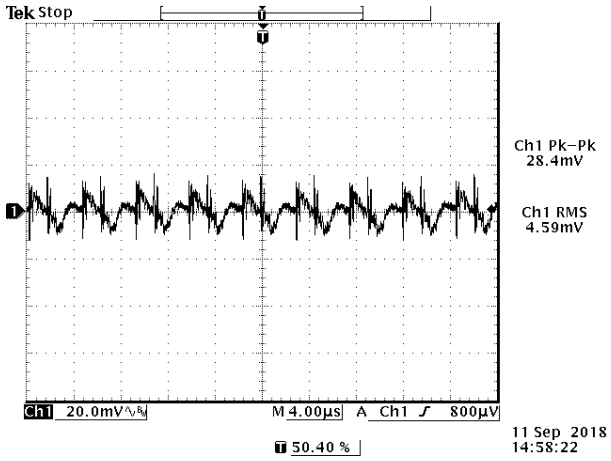

Figure 12.

Test condition: Vin = 48 V, Vo = 24 V, Io = 6.25 A.

11. TRANSIENT RESPONSE

Testing setup

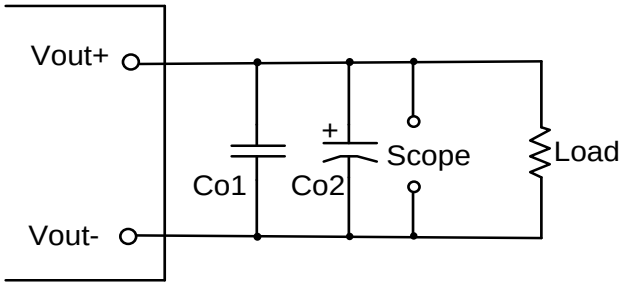

Figure 13.

Notes and values in testing:
Co1: 11 µF ceramic
Co2: 330 µF aluminum electrolytic capacitor
The capacitor should be as closed as possible to the power module to damped ripple current and enhance stability.

Below measured waveforms are based on above capacitance.

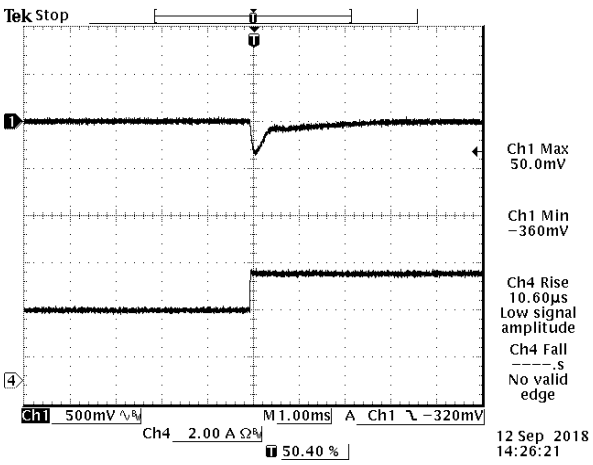

Figure 14. 50% -75%

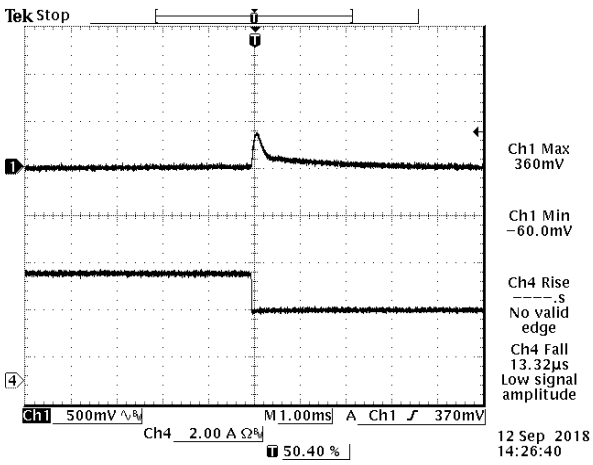

Figure 15. 75%-50%

Test condition: Vin = 48 V, Vo = 24 V.

12. STARTUP & SHUTDOWN

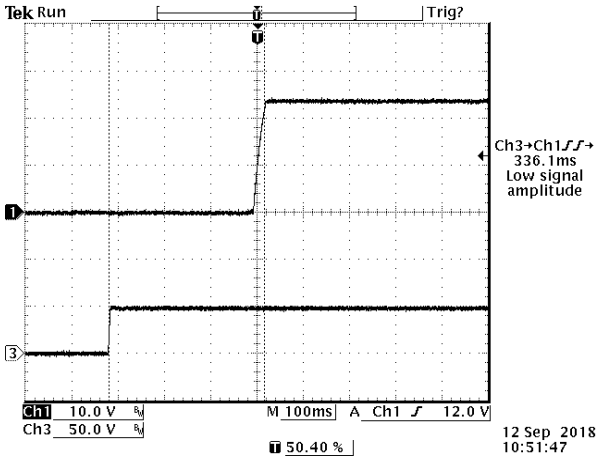

Figure 16. Start up from Vin

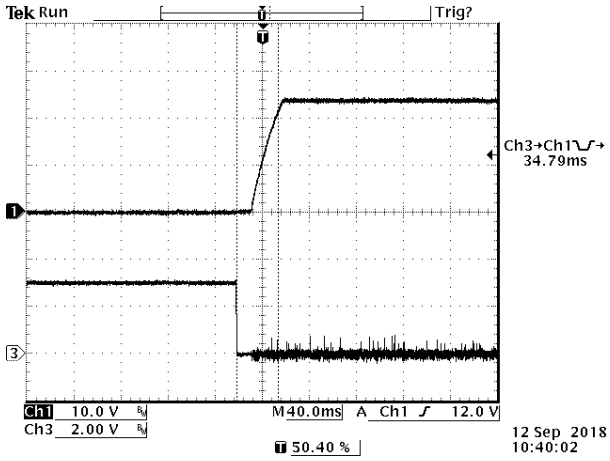

Figure 17. Start up from on/off

Test condition: Vin = 48 V, Vo = 24 V, Io = 6.25 A, Cout = 11 µF ceramic + 330 µF aluminum electrolytic capacitor.

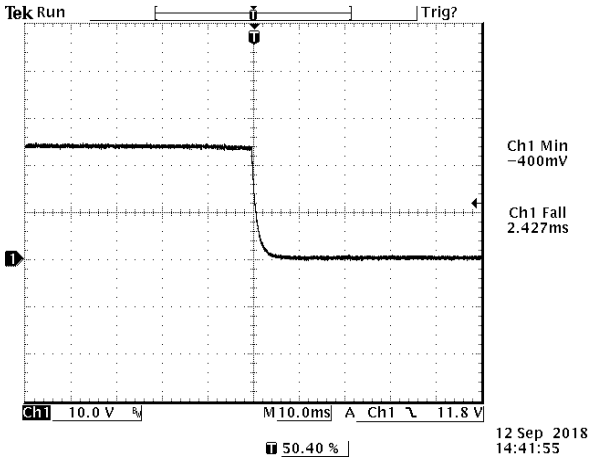

Figure 18. Shutdown from Vin

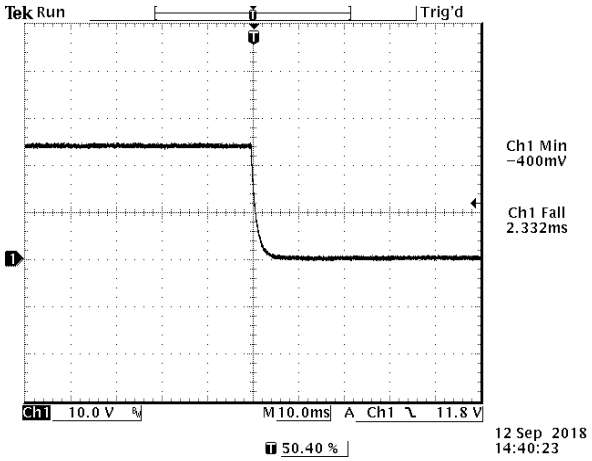

Figure 19. Shutdown from on/off

Test condition: Vin = 48 V, Vo = 24 V, Io = 6.25 A, Cout = 11 µF ceramic + 330 µF aluminum electrolytic capacitor.

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.

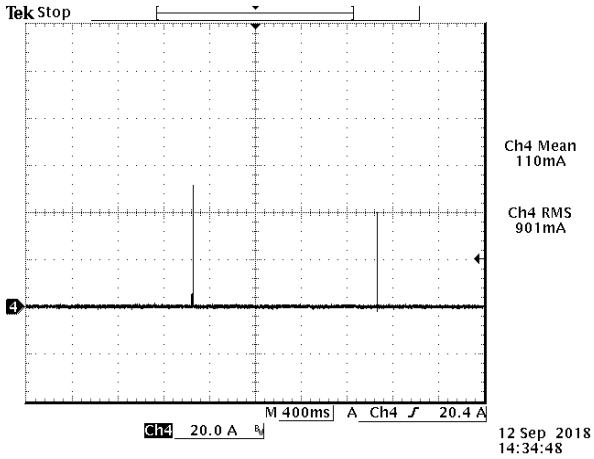

Figure 20. Over current protection

14. INPUT UNDER-VOLTAGE LOCKOUT

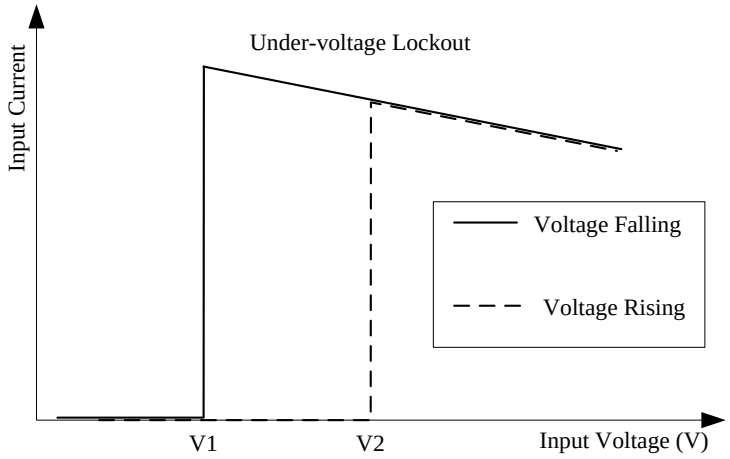

Figure 21. Input under-voltage lockout

V1 = 9 V

V2 = 11 V

15. TRIM

0RQB-C5U24L Trim Resistor Calculate

Trim down test circuit

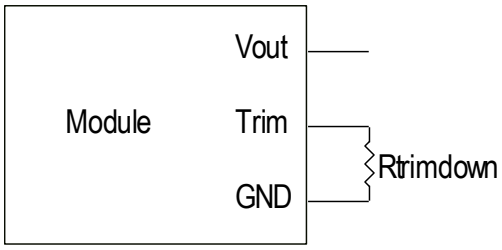

Figure 22. Trim down test circuit

$$R_{trimdown} = \frac{Vo\_req}{24 - Vo\_req} - 1[k\Omega]$$

Trim up test circuit

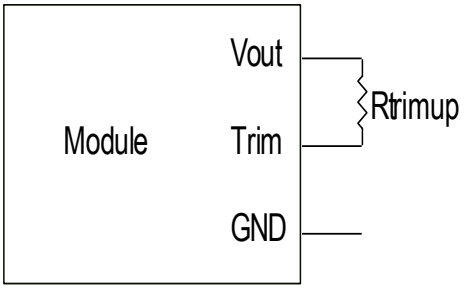

Figure 23. Trim up test circuit

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

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

16. THERMAL DERATING CURVES

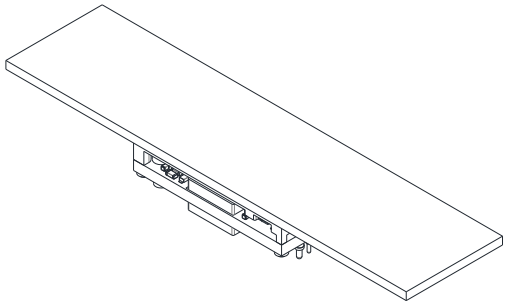

Figure 24. Test setup

Test setup: Vin = 48 V, 0 LFM, external HSK Dimension: 158 mm x 38 mm x 6 mm.

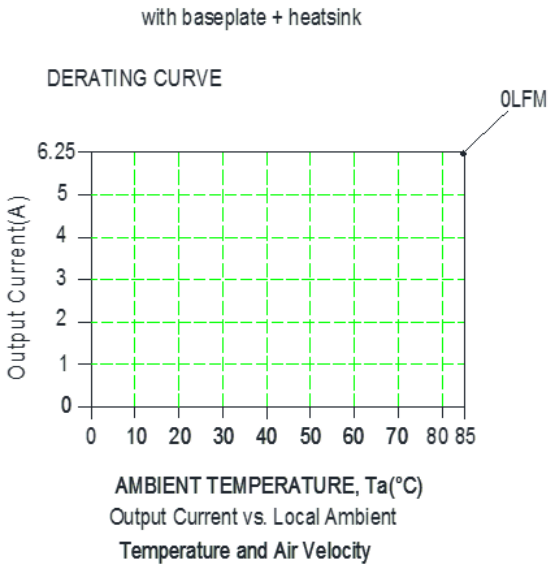

Figure 25. Thermal derating curve

17. SAFETY & EMC

Safety:

TBC

EMC:

Compliance to EN 55032 class A (both peak and average) with the following inductive and capacitive filter

Test Setup:

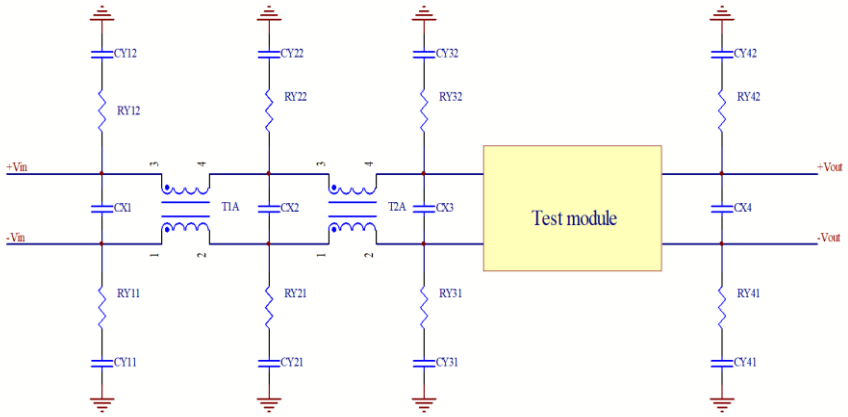

Figure 26.

T1A	CX1	RY11	RY12	CY11	CY12
T2A	CX2	RY21	RY22	CY21	CY22
2mH	1μF				
	CX3	RY31	RY32	CY31	CY32
	1μF+2*100μF AL	0R	0R	4.7nF*6	4.7nF*6
	CX4	RY41	RY42	CY41	CY42

NOTE: The filter is outside the module.

Positive:

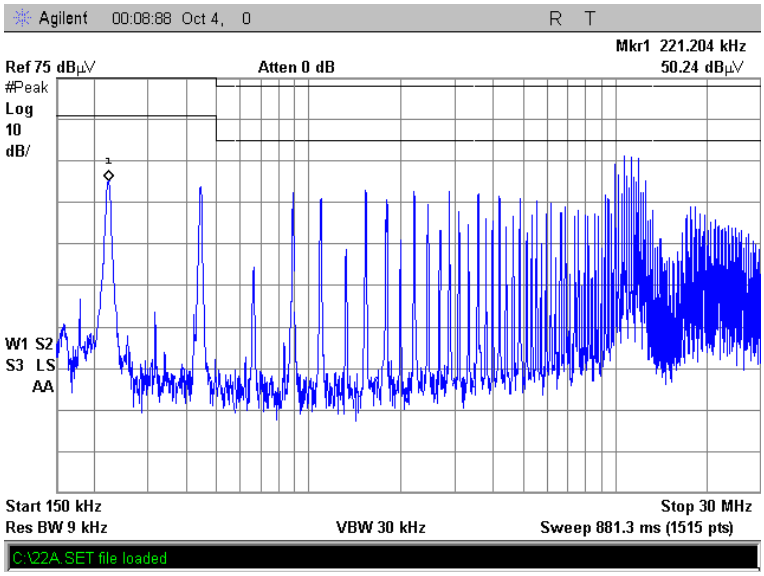

Figure 27.

Negative:

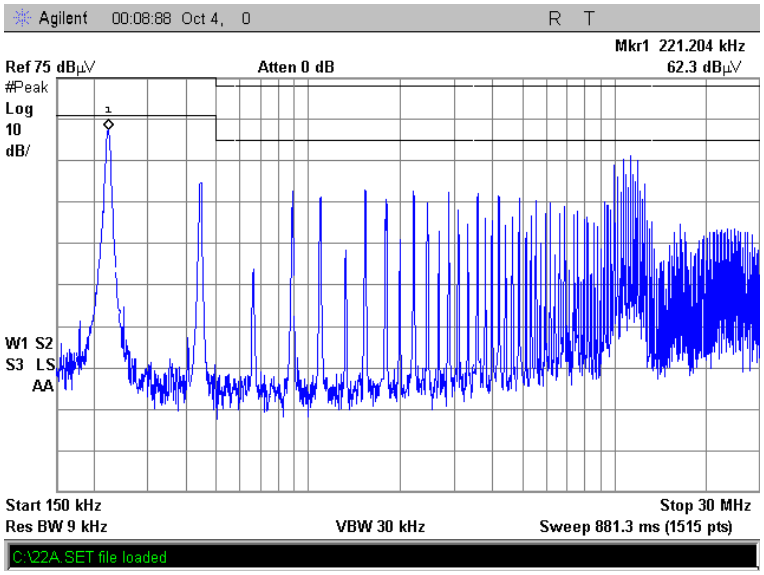

Figure 28.

18. MECHANICAL DIMENSIONS

OUTLINE

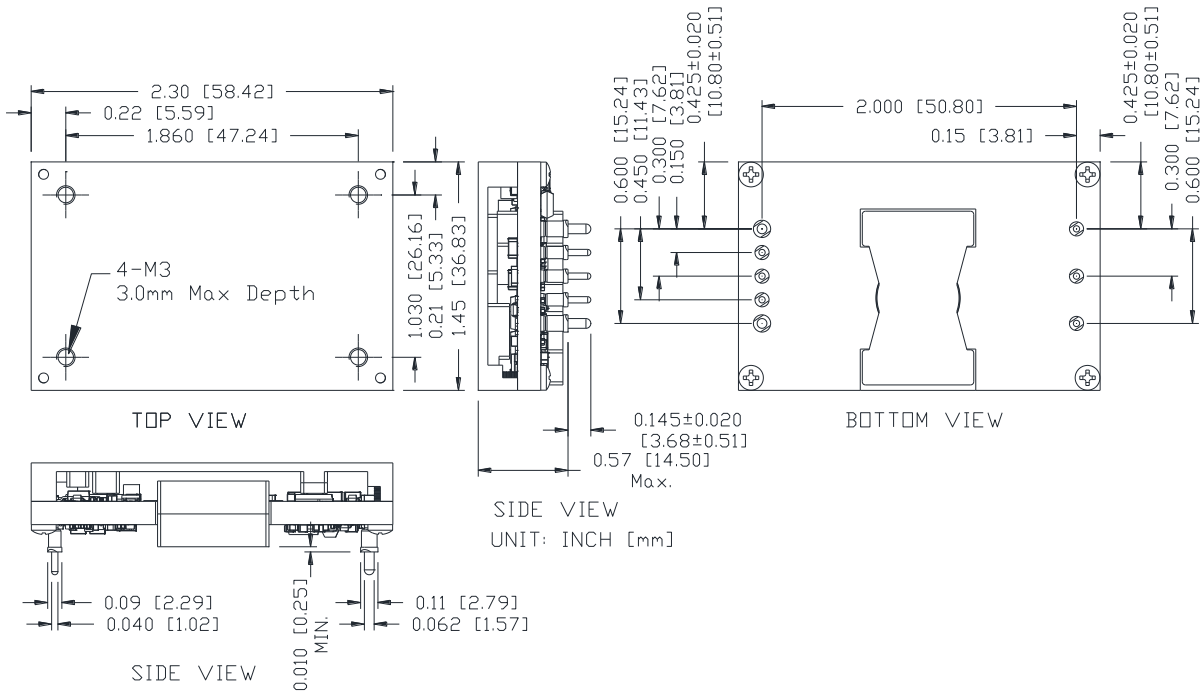

Figure 29. Outline

NOTE: This module is recommended and compatible with Pb-Free Wave Soldering and must be soldered using a peak solder temperature of no more than 260 °C for less than 5 seconds.

NOTES:

1） All Pins: Material - Copper Alloy;
Finish – Tin plated.

2） Un-dimensioned components are shown for visual reference only.

3） All dimensions in inch [mm]; Tolerances: x.xx +/-0.02 inch [0.51 mm]. x.xxx +/-0.010 inch [0.25 mm].

PIN DEFINITIONS

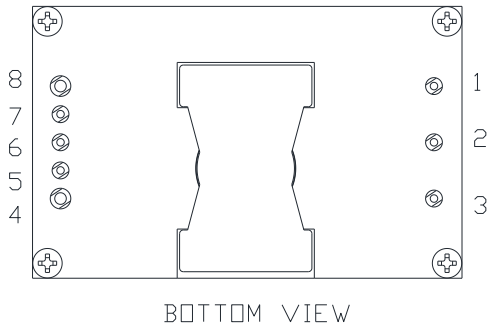

Figure 30. Pins

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

RECOMMENDED PAD LAYOUT

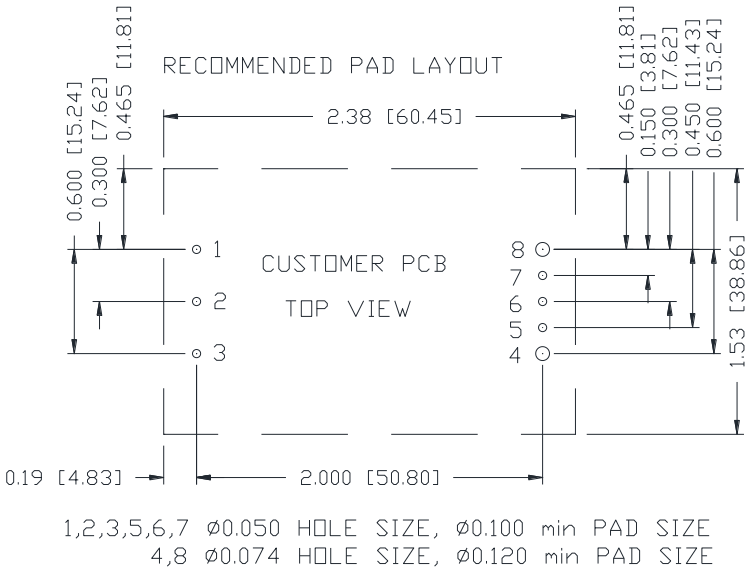

Figure 31. Recommended pad layout

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

20. REVISION HISTORY

DATE	REVISION	CHANGES DETAIL	APPROVAL
2018-06-07	AA	First release	J.Yao
2018-09-17	AB	Update input spec, output spec, start up and shut down, MD	J.Yao
2019-03-12	AC	Update MAX value of parameter	J.Yao
2019-09-04	AD	Update Ripple and Noise, Output Current Limit, start up, Turn-On Delay	J.Yao
2020-08-26	AE	Add module photo	J.Yao
2021-05-14	AF	Add object ID.	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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