0RQB-D0U12
Isolated DC-DC Converter

The 0RQB-D0U12 is an isolated DC/DC converter that operates from a nominal 48 V source. This unit will provide up to 204 W of output power from a nominal 24 V or 48 V input.

This unit is designed to be highly efficient and low cost. Features include remote on/off, over current protection and over voltage protection.

These converters are provided in an industry standard quarter brick package.

Key Features & Benefits

- 18 - 75 VDC Input
- 12 VDC @ 17 A Output
- 1/4th Brick Converter
- Basic Isolation
- Baseplate
- Fixed Frequency (267 kHz)
- High Efficiency
- High Power Density
- Input Under-Voltage Lockout
- Input Over-Voltage Lockout
- Output Over-Voltage Protection
- Over Current and Short Circuit Protection
- Over Temperature Protection
- Remote On/Off
- Low Cost
- Approved to IEC/EN 62368-1
- Approved to UL/CSA 62368-1
- Class II, Category 2, Isolated DC/DC Converter (refer to IPC-9592B)

RoHS Compliant

Applications

- Networking
- Computers and peripherals
- Telecommunications

bel POWER SOLUTIONS & PROTECTION
a bel group

1. MODEL SELECTION

MODEL NUMBER	OUTPUT VOLTAGE	INPUT VOLTAGE	MAX. OUTPUT CURRENT	MAX. OUTPUT POWER	TYPICAL EFFICIENCY
0RQB-D0U12LG 0RQB-D0U120G	12 VDC	18 - 75 VDC	17 A	204 W	93%

PART NUMBER EXPLANATION

0	R	QB	-	D0	U	12	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		204 W	18 – 75 V	12 V	0 – Active High, with Baseplate L – Active Low, with Baseplate	Tray Package

2. ABSOLUTE MAXIMUM RATINGS

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNITS	SYMBOL
Continuous non-operating Input Voltage		-0.3	-	80	V	Vin
Remote On/Off		-0.3	-	18	V	-
I/O Isolation Voltage		-	-	2250	V	-
Input Transient Voltage	100 ms maximum	-	-	100	V	-
Ambient Temperature		-40	-	85	°C	Tamb
Storage Temperature		-55	-	125	°C	Tstor
Altitude		-	-	5000	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	SYMBOL
Operating Input Voltage		18	48	75	V	Vin
Input Current		-	-	15.0	A	Iin
No Load Input Current		-	200	240	mA	-
Remoted Off Input Current		-	15	25	mA	-
Input Reflected Ripple Current (rms)	With simulated source impedance of 10 uH, 5 Hz to 20 MHz. Use a 100 µF / 100 V electrolytic capacitor 100 µF, ESR < 0.2 Ω @ 100 kHz, 20°C	-	5	10	mA	-
Input Reflected Ripple Current (pk-pk)		-	30	40	mA	-
I^2t Inrush Current Transient		-	0.05	0.1	A^2S	-
Turn on Voltage Threshold		16	16.8	17.5	V	-
Turn off Voltage Threshold		14.5	15.1	15.7	V	-
Input capacitance				L-C(0.2uH-1μF-2.2μF*5)		-
Recommended input fast-acting fuse on system board		-	25	-	A	-

CAUTION: 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
Output Voltage Set Point	Vin = 48 V, Io = 50% load at 25°C ambient	11.82	12.04	12.18	V
Load Regulation		-	±20	±50	mV
Line Regulation		-	±15	±30	mV
Regulation Over Temperature		-	±100	±200	mV
Ripple and Noise (pk-pk)	Vin = 48 V, full load, 0 – 20 MHz BW, with a 1 µF ceramic capacitor and a 10 µF Tantalum cap at output	-	170	220	mV
Ripple and Noise (rms)		-	30	50	mV
Output Ripple and Noise (pk-pk) under worst case	Over entire operating input voltage range, load and ambient temperature condition	-	-	250	mV
Output Current Range		0	-	17	A
Output DC Current Limit	Hiccup mode	19	20	28	A
Short Circuit Surge Transient				5	A^2s
Rise Time		-	16	20	ms
Turn on Time	Enable form Vin	-	25	30	ms
	Enable form ON/OFF	-	25	30	ms
Overshoot at Turn on		-	0	3	%
Output Capacitance		0	-	5000	µF
Transient Response					
△V 25%~50% of Max Load	di/dt = 0.1 A/µs, Vin = 48 VDC, Ta = 25°C, with a 1 µF ceramic capacitor, a 10 µF Tantalum cap and 100 µF electrolytic cap at output	-	300	550	mV
Settling Time		-	300	400	ms
△V 50%~25% of Max Load		-	300	550	mV
Settling Time		-	300	400	ms

5. GENERAL SPECIFICATIONS

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
Efficiency	The efficiency is measured at Vin = 24 V, full load and Ta = 25°C	92.5	93.5	-	%
	The efficiency is measured at Vin = 48 V, full load and Ta = 25°C	92	93	-	-
Switching Frequency		-	267	-	kHz
MTBF	Calculated Per Bell Core SR-332 (Vin = 48 V, Vo = 12 V, Io = 80% load, Ta = 25 °C, FIT=10^9/MTBF)	-	2583496	-	hrs
FIT		-	313.1	-	-
Over Temperature Protection		-	125	130	°C
Output Over Voltage Protection	This voltage is achieved by trimming up output slowly.	-	15.1	15.5	V
Weight		-	75	-	g
Dimensions (L × W × H)			2.30 x 1.45 x 0.48		inch
			58.42 x 36.83 x 12.20		mm
Isolation Characteristics					
Input to Output		-	-	2250	V
Input to Case		-	-	1750	V
Output to Case		-	-	500	V
Isolation Resistance		10M	-	-	Ohm
Isolation Capacitance		-	3900	-	pF

6. EFFICIENCY DATA

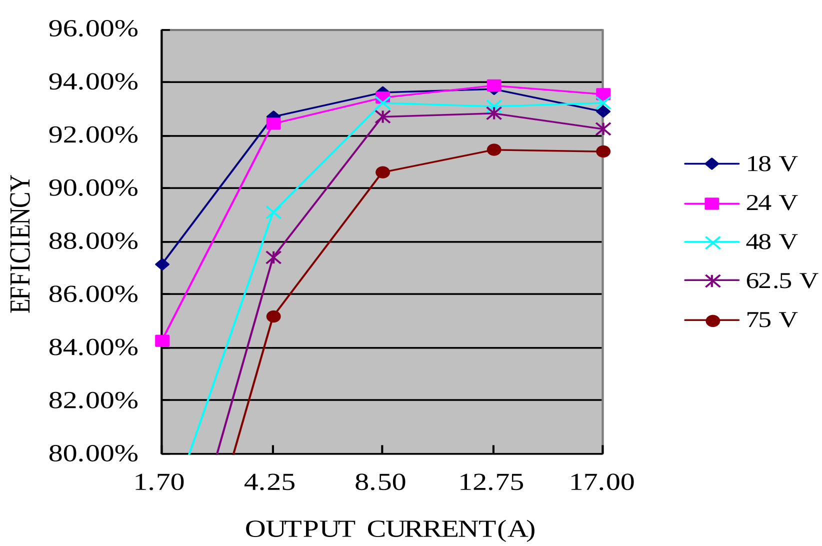


Figure 1. Efficiency data

.

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	-	18	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	-	18	V
Current Sink			0	-	1	mA

Recommended remote on/off circuit for active low

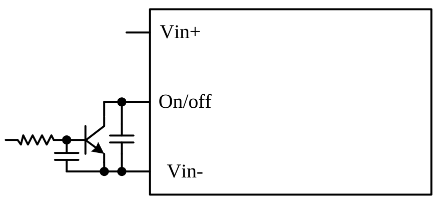


Figure 2. Control with open collector/drain circuit

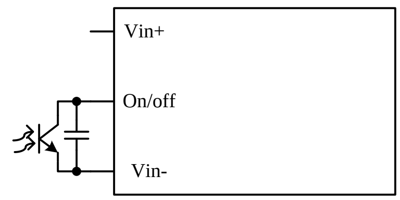


Figure 3. Control with photocoupler circuit

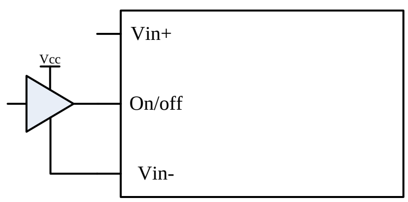


Figure 4. Control with logic circuit

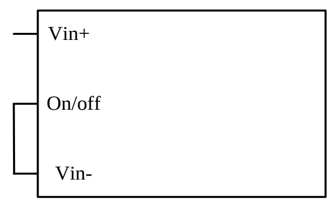


Figure 5. Permanently on

Recommended remote on/off circuit for active high

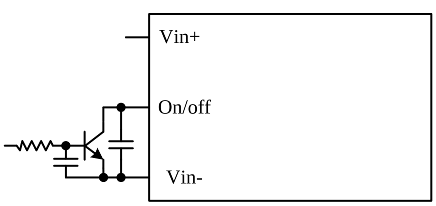


Figure 6. Control with open collector/drain circuit

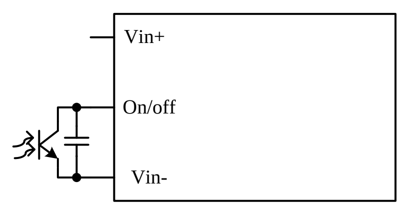


Figure 7. Control with photocoupler circuit

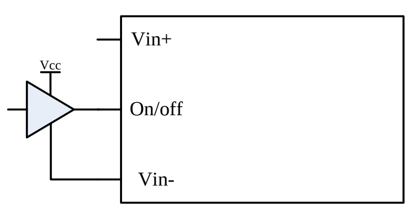


Figure 8. Control with logic circuit

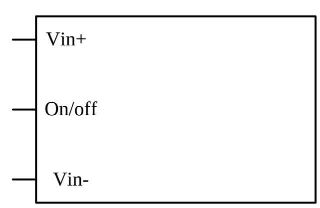


Figure 9. Permanently on

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 10% of 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 10% of 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 0.1µF 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+ (30.1ohm) from Vo+ to Sense+ and a resistor RS- (30.1 ohm) from Vo- to Sense- inside of this module.

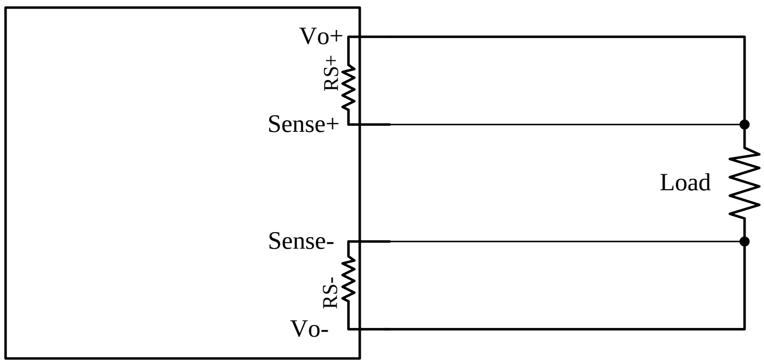


Figure 10.

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

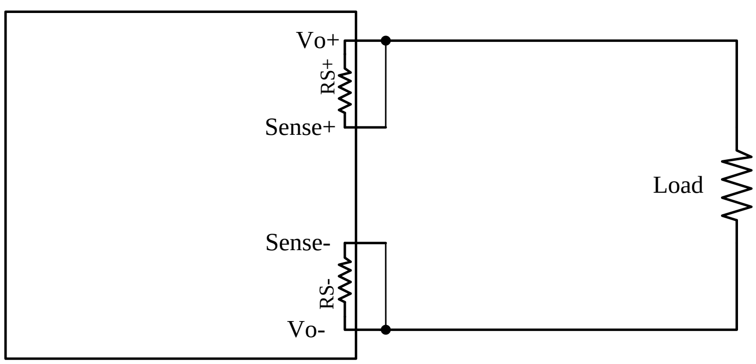


Figure 11.

9. RIPPLE AND NOISE WAVEFORM

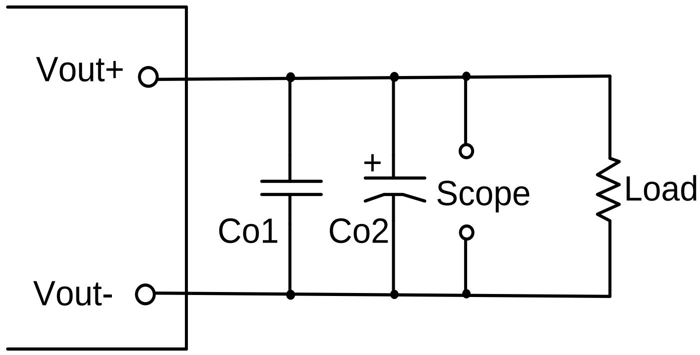


Figure 12.

Notes and values in testing.
Co1: 1 µF ceramic capacitor
Co2: 10 µF Tan cap.
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.

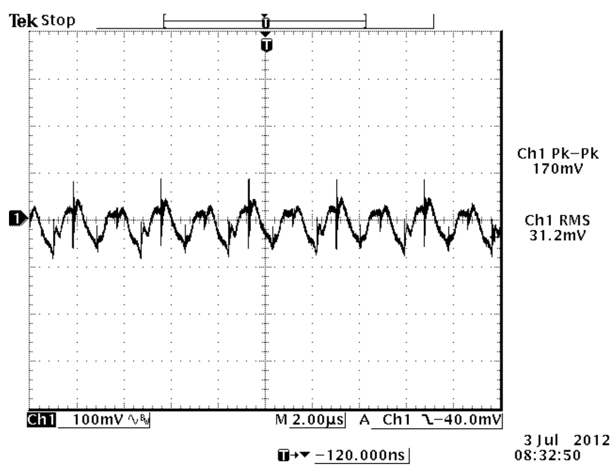


Figure 13.

Note: Ripple and noise, 48 VDC input, 17 A output, Ta = 25 °C, with 1 µF ceramic and 10 µF Tan cap.

10. TRANSIENT RESPONSE WAVEFORM

Transient Response: di/dt = 0.1 A/μs, a 1 μF ceramic capacitor, a 10 μF Tantalum cap and 100 μF electrolytic cap at output.

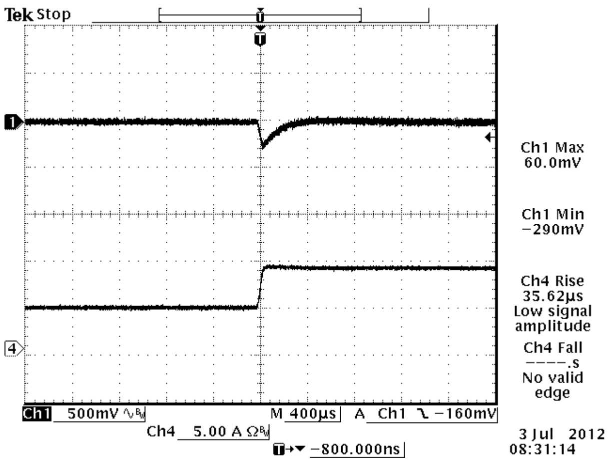


Figure 14. Vout = 12 V, 25%-50% Load Transients at Vin = 48 V @ Ta = 25 °C

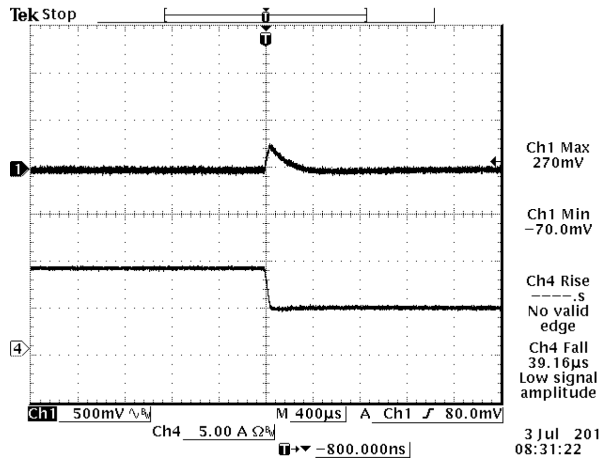


Figure 15. Vout = 12 V, 50%-25% Load Transients at Vin = 48 V @ Ta = 25°C

11. STARTUP & SHUTDOWN

Rise time

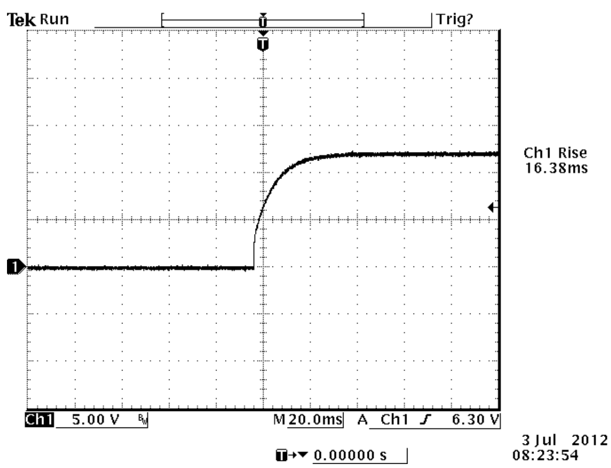


Figure 16. Rise time

***Test Condition:** Vin = 48 V, Full Load.*

Startup time

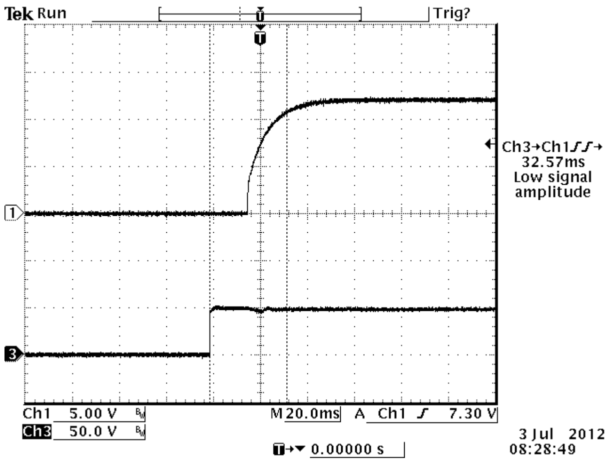


Figure 17. Startup from Vin

Test Condition: *Vin = 48 V, Full Load.*

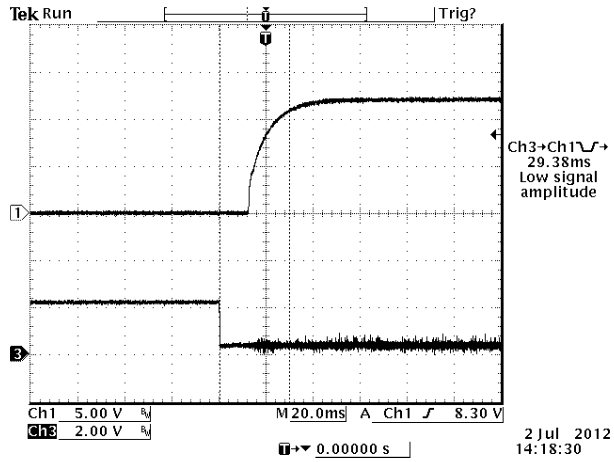


Figure 18. Startup from Enable

Test Condition: *Vin = 48 V, Full Load.*

Shut down

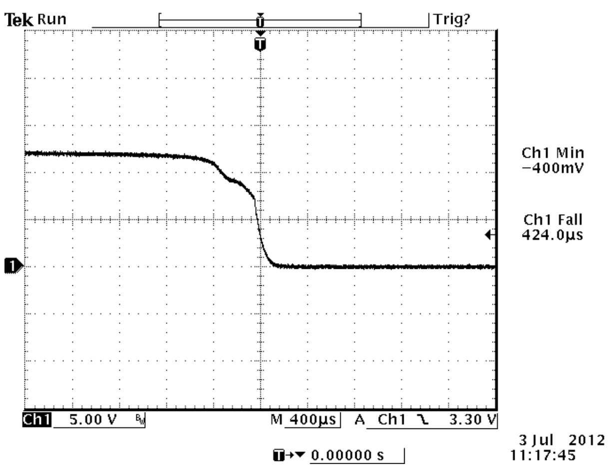


Figure 19. Shutdown from Vin

Test condition: *Vin = 48 V, Full Load.*

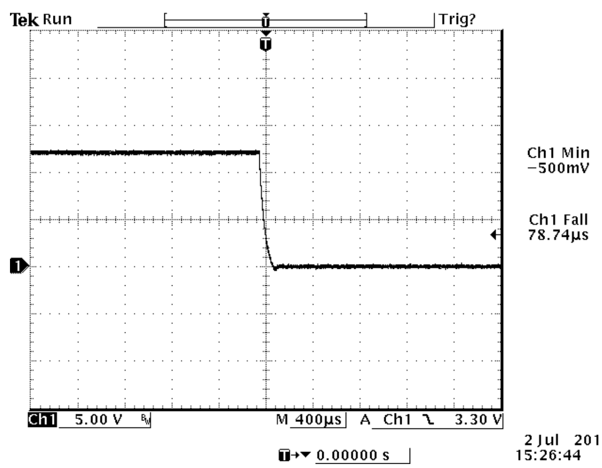


Figure 20. Shutdown from Enable

Test condition: *Vin = 48 V, Full Load.*

Asia-Pacific +86 755 298 85888
Europe, Middle East +353 61 225 977
North America +1 408 785 5200

12. 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 and restart once every 1 s. The module operates normally when the output current goes into specified range. The typical average output current is 20 A during hiccup.

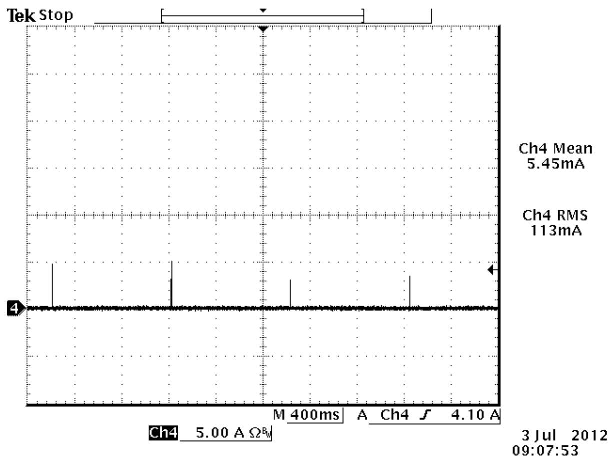


Figure 21. Over current protection

Test condition: *Vin = 48 V, Full Load*

13. INPUT UNDER-VOLTAGE LOCKOUT

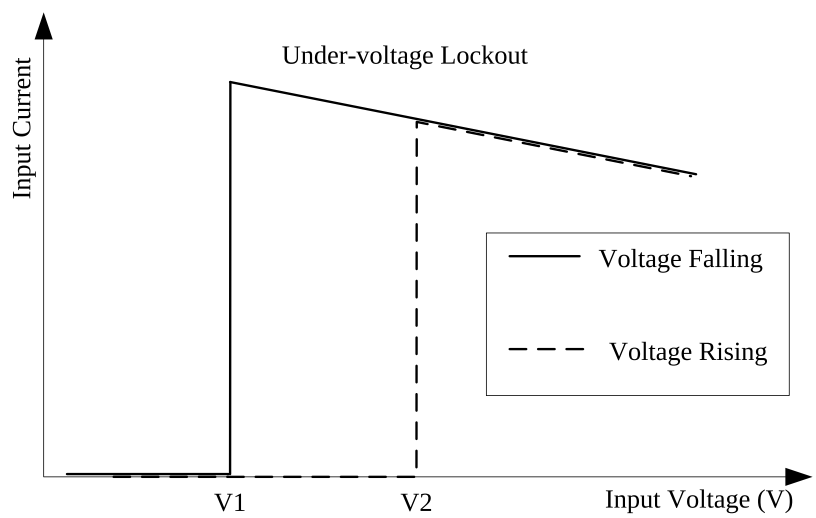


Figure 22. Input under-voltage lockout

V1 = 15.1 V

V2 = 16.8 V

14. OVER VOLTAGE PROTECTION

Latch off:

The output over voltage protection consists of circuitry that monitors the voltage on the output terminals. If the voltage on the output terminals exceeds the over voltage protection threshold, the module will shut down into latch off mode. The over voltage latch can be reset by either cycling the input power or toggling the on/off signal for one second at least.

Test setup:

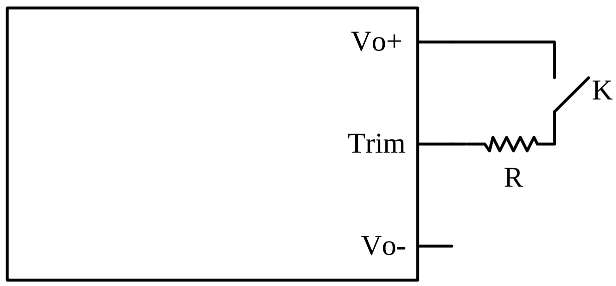


Figure 23. Test setup

R = 150 kΩ

Waveform:

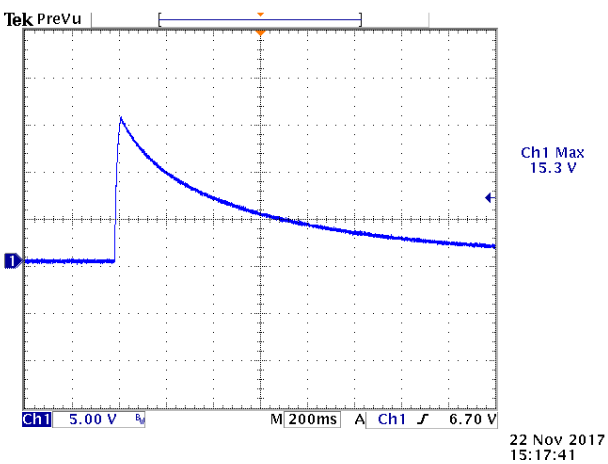


Figure 24. Start up into OVP

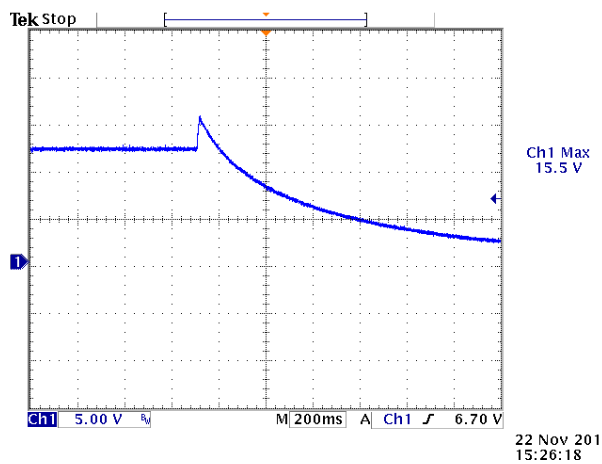


Figure 25. Normal working into OVP

CH1: Output voltage waveform

15. OVER TEMPERATURE PROTECTION

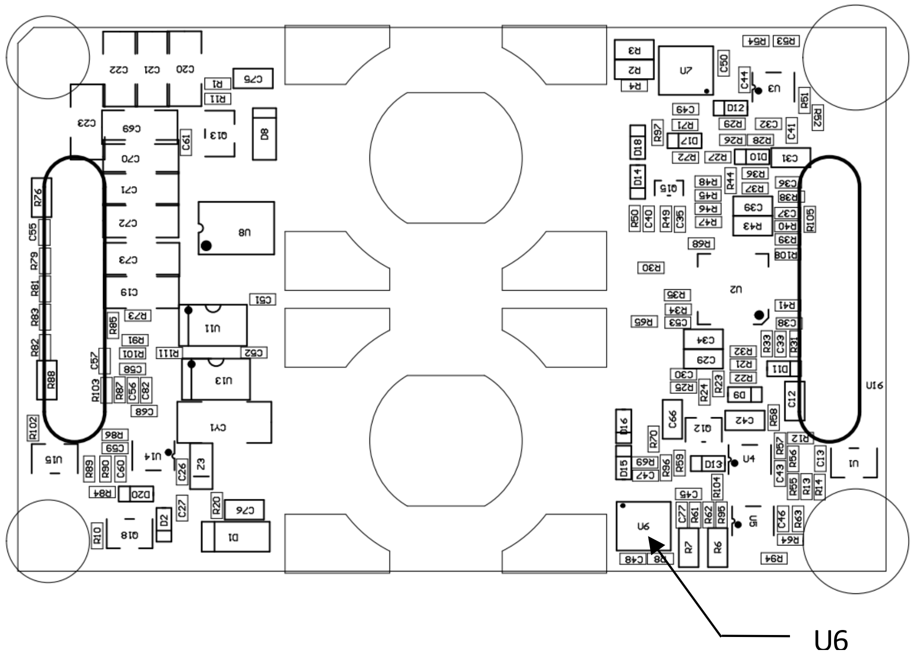


Figure 26. Temperature reference points on bottom side

The OTP is achieved by thermistor RT and the threshold is set at 125°C in non-latch mode; the hottest component U6 reaches 120°C with 200 LFM air flow correspondingly. It will restart automatically when the temperature falls to 100°C. The protecting point will be varied a little under different conditions (air flow, ambient temperature, input voltage, load...).

16. TRIM

Equations for calculating the trim resistor are shown below. The Trim Down resistor should be connected between the Trim pin and Sense (-) pin. The Trim Up resistor should be connected between the Trim pin and the Sense (+). Only one of the resistors should be used for any given application.

Minimum trim down voltage is 10.8 V.

Maximum trim up voltage is 13.2 V.

The total voltage increased by trim and remote sense should not exceed 10% of the nominal output voltage.

Trim down test circuit

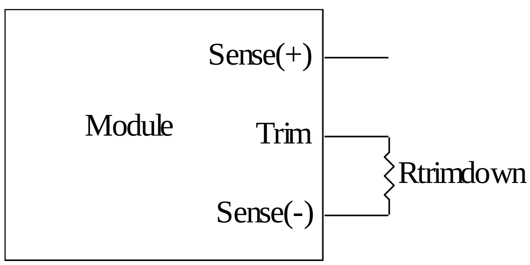


Figure 27. Trim down test circuit

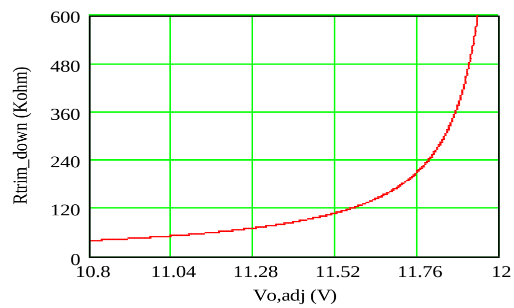


Figure 28. Trim down curve

$$Rtrimdown = \frac{511}{|delta|} - 10.22[k\Omega]$$

Trim up test circuit

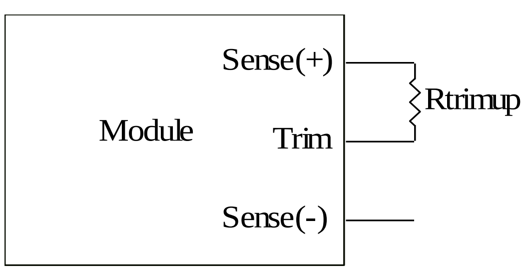


Figure 29. Trim up test circuit

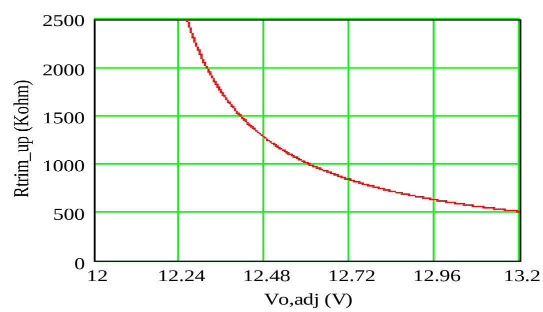


Figure 30. Trim up curve

$$Rtrimup = \frac{(100 + delta) \cdot Vo \cdot 5.11 - 626}{1.225 \cdot delta} - 10.22[k\Omega]$$

$$delta = \frac{(Vo\_req - Vo)}{Vo} \times 100[\%]$$

Note: Output voltage Vo = 12.036 V, Vo_req = Desired(trimmed) output voltage[V].

17. THERMAL DERATING CURVE

Maximum junction temperature of semiconductors derated to 120 °C.

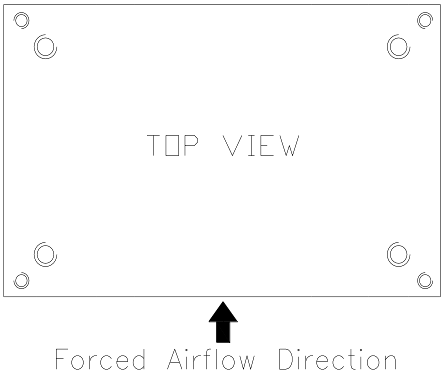


Figure 31. Airflow direction

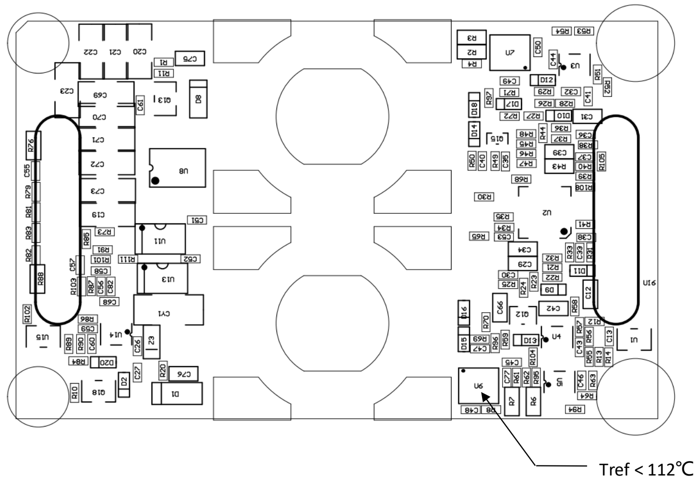
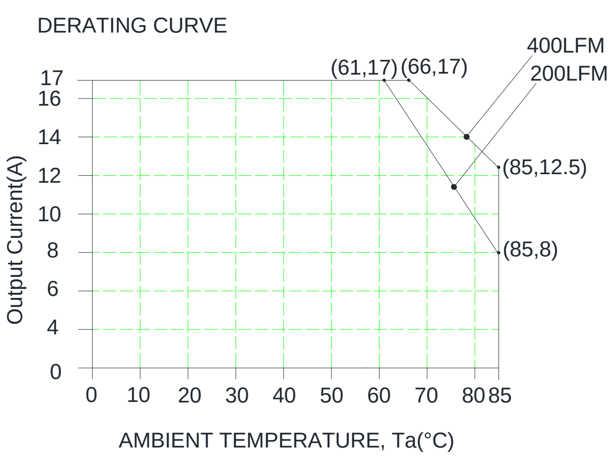


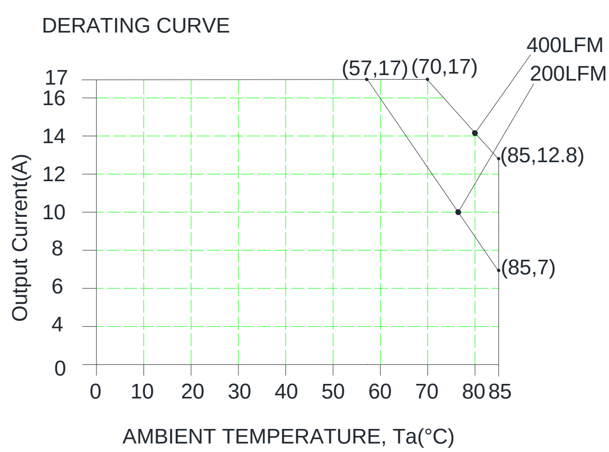
Figure 32. Hot point

Derating curve under normal input



Output Current vs. Local Ambient
Temperature and Air Velocity

Figure 33. Thermal derating curve @ Vin = 18 V



Output Current vs. Local Ambient
Temperature and Air Velocity

Figure 34. Thermal derating curve @ Vin = 24 V

tech.support@psbel.com
belfuse.com/power-solutions

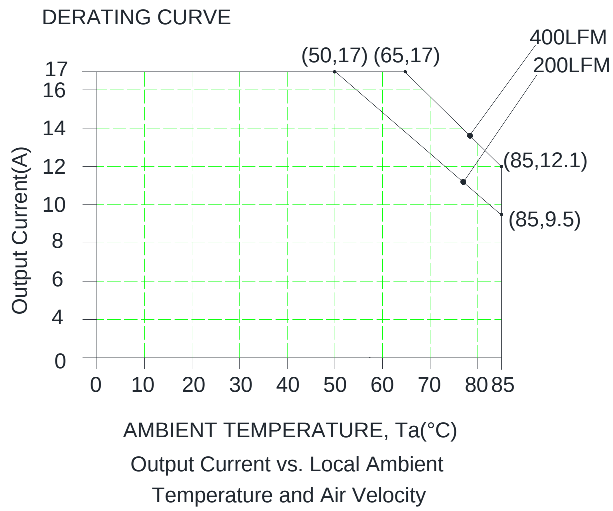


Figure 35. Thermal derating curve @ Vin = 48 V

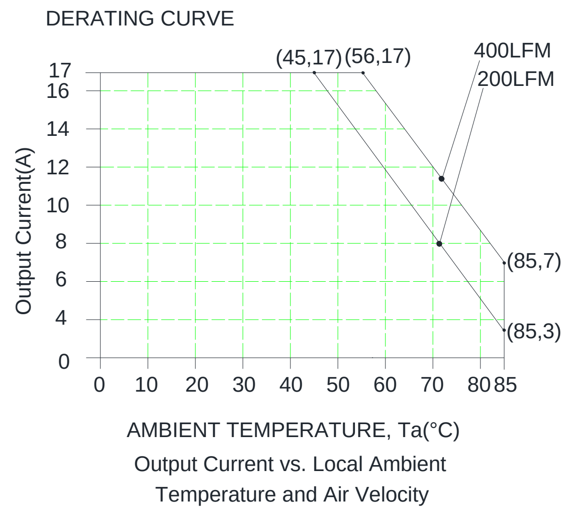


Figure 36. Thermal derating curve @ Vin = 75 V

18. SCH

Fundamental Circuit Diagram

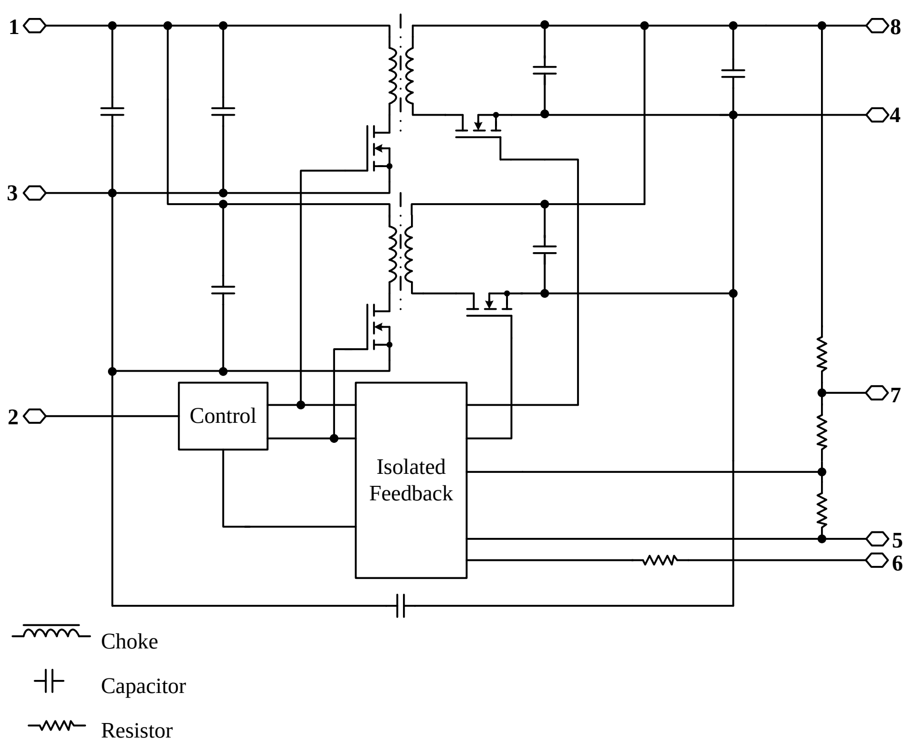


Figure 37. Fundamental Circuit Diagram

19. SAFETY & EMC

Safety:

Material flammability: UL94V-0

Safety approved to IEC/EN 62368-1

Safety approved to UL/CSA 62368-1

EMC:

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

Test Setup:

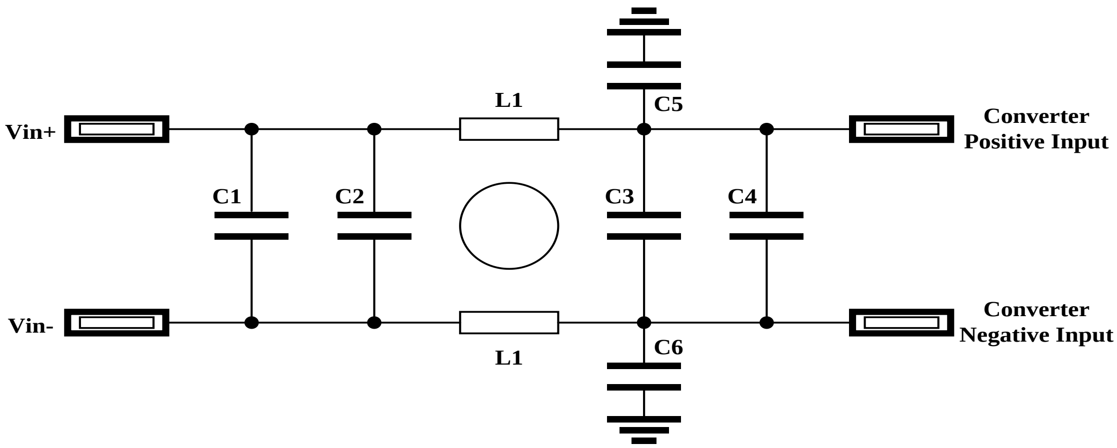


Figure 38.

ITEM	DESIGNATOR	PARAMETER	VENDOR	VENDOR P/N
1	C1	2.2μF/100V		
2	C2	2.2μF/100V		
3	C3	100μF/100V*2		
4	C4	2.2μF/100V*2		
5	C5	22nF/250V Y cap		
6	C6	22nF/250V Y cap		
7	L1	880uH common mode		

Positive:

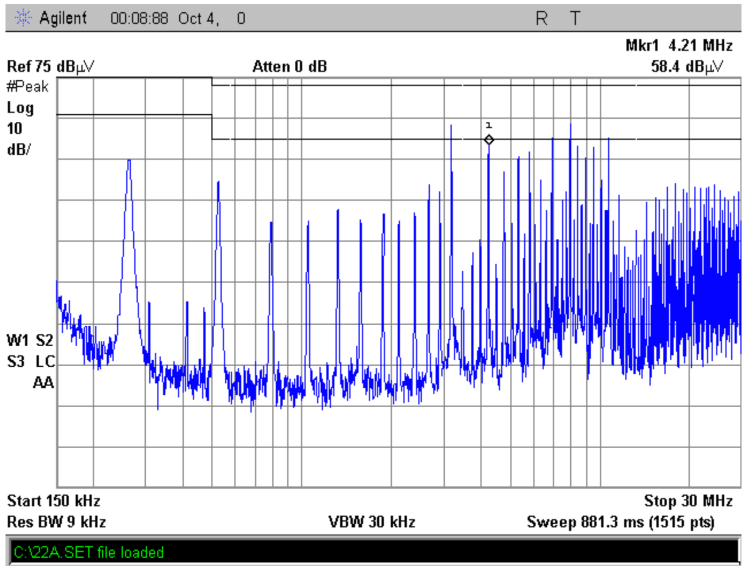


Figure 39.

Negative:

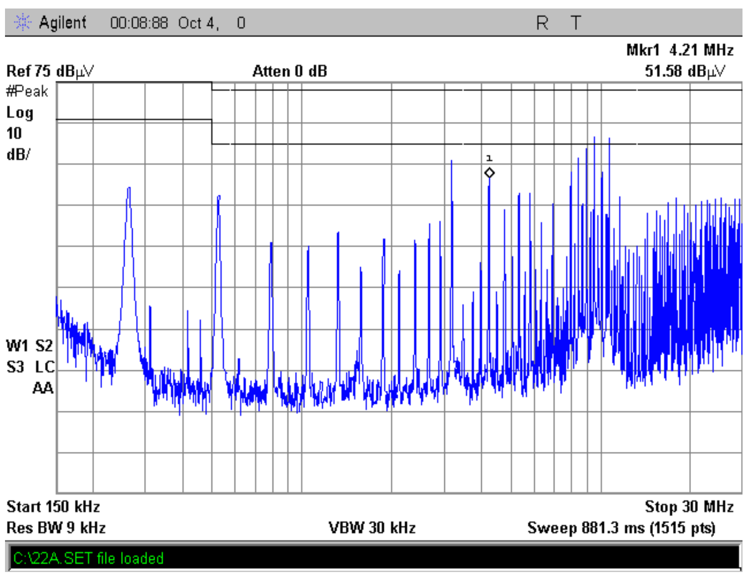


Figure 40.

20. MECHANICAL DIMENSIONS

OUTLINE

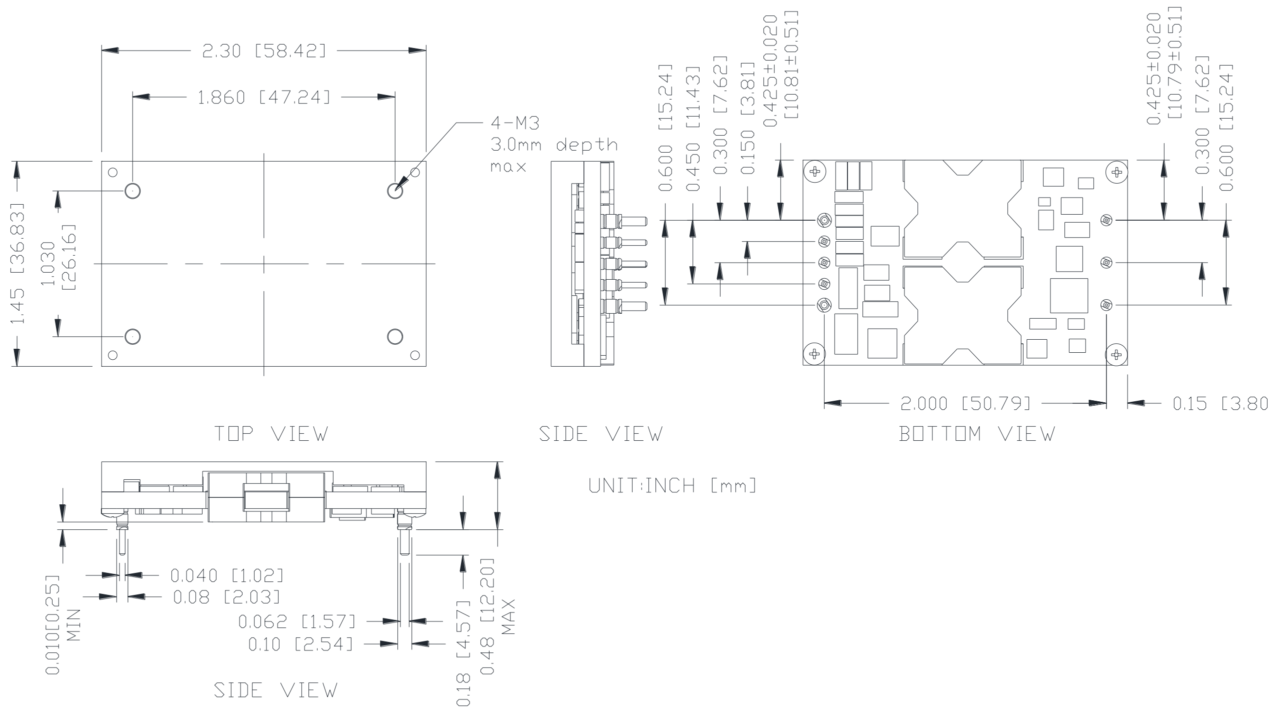


Figure 41. Outline

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 –3 micro inches Gold over 40 micro inches minimum Nickel plating.

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

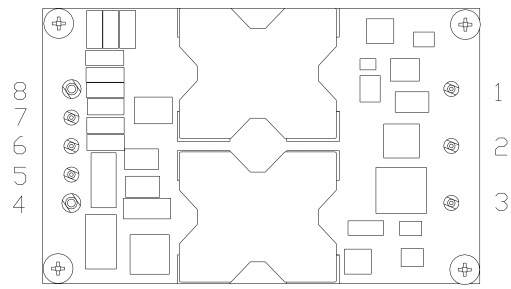


Figure 42. Pins

PIN	FUNCTION	PIN	FUNCTION
1	Vin (+)	5	Sense (-)
2	ON/OFF	6	TRIM
3	Vin (-)	7	Sense (+)
4	Vout (-)	8	Vout (+)

RECOMMENDED PAD LAYOUT

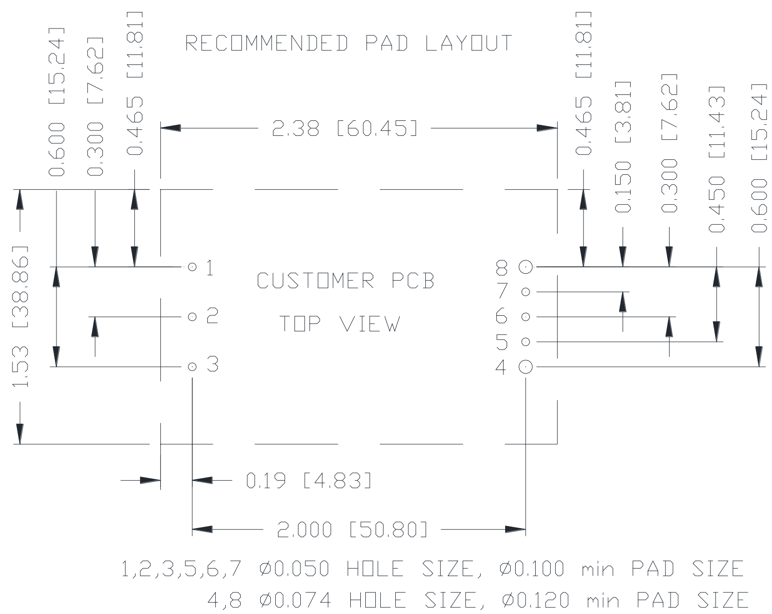


Figure 43. Recommended pad layout

21. REVISION HISTORY

DATE	REVISION	CHANGES DETAIL	APPROVAL
2010-08-18	PA	First release	XF.Jiang
2010-10-13	PB	1.Output Ripple and Noise(Pk-Pk); 2. Input capacitance. 3.Output Ripple and Noise(Pk-Pk) under worst case; 4. Transient Response; 5. Efficiency 6. Switching Frequency	XF.Jiang
2012-11-09	C	1.Update Input capacitance, Output Ripple and Noise, OCP, Rise time, Transient Response, Efficiency, Switching Frequency, UVLO; 2.add graph of TD, NR, TR, Start up, Shutdown, OCP	XF.Jiang
2012-12-04	D	Update picture, setpoint, Remote off input current, shutdown	XF.Jiang
2013-01-22	E	Update I/O Isolation Voltage, Turn-off Voltage Threshold and Isolation characteristics	XF.Jiang
2017-11-23	AF	Update Abs Max, MTBF, TD, OVP, OTP, Safety & EMC, and update to new version	XF.Jiang
2018-07-30	AG	Update the MD	XF.Jiang
2019-06-18	AH	Update to new form	XF.Jiang
2020-03-02	AI	Update thermal derating curve	XF.Jiang
2020-05-13	AJ	Add altitude. Update thermal derating curve.	XF.Jiang
2020-08-07	AK	Add safety certificate	XF.Jiang
2021-05-18	AL	Add object ID. Update recommended pad layout.	XF.Jiang

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