0RQB-60Q05x

Isolated DC-DC Converter

The 0RQB-60Q05x is an isolated DC/DC converter that operate from a wide input range (7 - 36 VDC) and can cover both 12 Vin and 24 Vin input range. These units will provide up to 60 W of output power. They are designed to be highly efficient and low cost. Features include remote on/off, over current protection, over voltage shut down, over temperature protection and under-voltage lockout. These converters are provided in an industry standard 1/4th brick package.

RoHS Compliant

Key Features & Benefits

- 7–36 VDC Input
- 5 VDC @ 12 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
- 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	INPUT VOLTAGE	OUTPUT VOLTAGE	MAX. OUTPUT CURRENT	MAX. OUTPUT POWER	TYPICAL EFFICIENCY
0RQB-60Q05x	7 - 36 VDC	5 VDC	12 A	60 W	92%

NOTE: Add "G" suffix at the end of the model number to indicate Tray Packaging.

PART NUMBER EXPLANATION

0	R	QB	-	60	Q	05	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		60 W	7 - 36 V	5 V	A – Active high, with baseplate B – Active low, with baseplate	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	-	36	V
Input Transient Voltage	400 ms maximum	40	-	60	V
Remote On/Off		-0.3	-	18	V
Ambient Temperature		-40	-	85	°C
Storage Temperature		-40	-	100	°C
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
Operating Input Voltage		7	24	36	V
Input Current (full load)		-	-	12	A
Input Current (no load)		-	250	300	mA
Remote Off Input Current		-	10	15	mA
Input Reflected Ripple Current (rms)	10 µH source impedance, Vin = 7 – 36 V, Io = Iomax. Refer to section 12 for detail input capacitance and waveforms.	-	20	30	mA
Input Reflected Ripple Current (pk-pk)		-	70	100	mA
Input Turn off Voltage Threshold		6	6.5	7	V
Input Turn on Voltage Threshold		6.5	7.5	8	V
Over-voltage Recovery Threshold		36	-	37	V
Over-voltage Shutdown Threshold	Output shuts down after 400 ms delay*	37.5	-	39.5	V
Over-voltage Shutdown Threshold	Output shuts down immediately.	60	-	62	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.	-	15	-	A

CAUTION: This converter is not internally fused. An input line fuse must be used in application.

*** NOTE:** The shutdown protection will not be triggered if the fault duration is less than 400 ms.

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 = 24 V, Pout = 60 W	4.925	5	5.075	V
Load Regulation	Vin = 24 V, Io = 0~100% load	-	10	20	mV
Line Regulation	Vin = 7 – 36 V, Io = 100% load	-	10	20	mV
Regulation Over Temperature	Vin = 24 V, Io = 100% load, Ta = -40~85°C	-	100	200	mV
Ripple and Noise (pk-pk)	Cout = 1000 µF minimum, approximately 50% ceramic, 50% Oscon or POSCAP.	-	-	150	mV
Ripple and Noise (rms)		-	-	30	mV
Output Current Range		0	-	12	A
Output DC Current Limit	OCP: Hiccup mode.	14	-	20	A
Rise Time	Defined as time between Vout at 10% of final value and Vout at 90% of final value.	-	-	50	ms
Turn on Time	Defined as time between Vin reaching Turn-On voltage and Vout reaching 10% of final value.	-	-	50	ms
	Defined as time between Enable and Vout reaching 10% of final value.	-	-	50	ms
Overshoot at Turn on		-	-	3	%
Output Capacitance	Typically 50% ceramic, 50% Oscon or POSCAP.	111*	1000	5000	µF
Pre-bias Voltage	All conditions	-	-	0.5	V
Transient Response					
△V 50%~75% of Max Load	0.1 A/µs, 111µF* capacitors are near the brick output.	-	200	300	mV
Settling Time		-	150	-	µs
△V 75%~50% of Max Load		-	200	300	mV
Settling Time		-	150	-	µs

*** NOTE:** 10 µF ceramic capacitor, 1µF ceramic capacitor, 100 µF POSCAP capacitor

5. OUTPUT PLOT VS INPUT

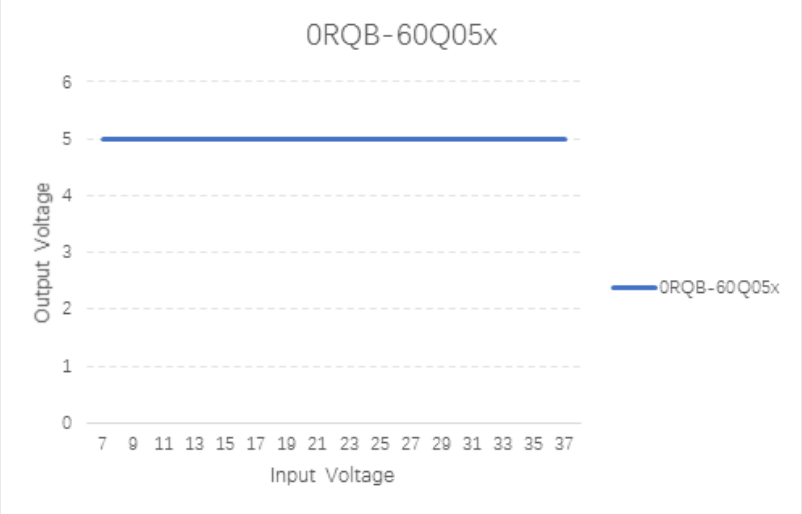


Figure 1. Output plot vs input

6. GENERAL SPECIFICATIONS

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
Efficiency	Vin = 24 V, Pout = 60 W	-	92	-	%
Switching Frequency	Primary FETs	-	200	-	kHz
Output Voltage Trim Range		4.5	-	5.5	V
Remote Sense Compensation		-	-	0.5	V
MTBF		-	4.87	-	Mhrs
Over Temperature Protection	Auto-recovery.	-	130	-	°C
Output Over Voltage Protection	Latch mode	-	-	6.5	V
Weight		-	53	-	g
Dimensions (L × W × H)		2.30 x 1.450 x 0.54 max 58.42 x 36.83 x 13.80 max			inch mm
Isolation Characteristics					
Input to Output		-	-	1500	V
Input to Baseplate		-	-	1500	V
Output to Baseplate		-	-	500	V
Isolation Resistance		10M	-	-	Ohm
Isolation Capacitance		-	1500	-	pF

7. EFFICIENCY DATA

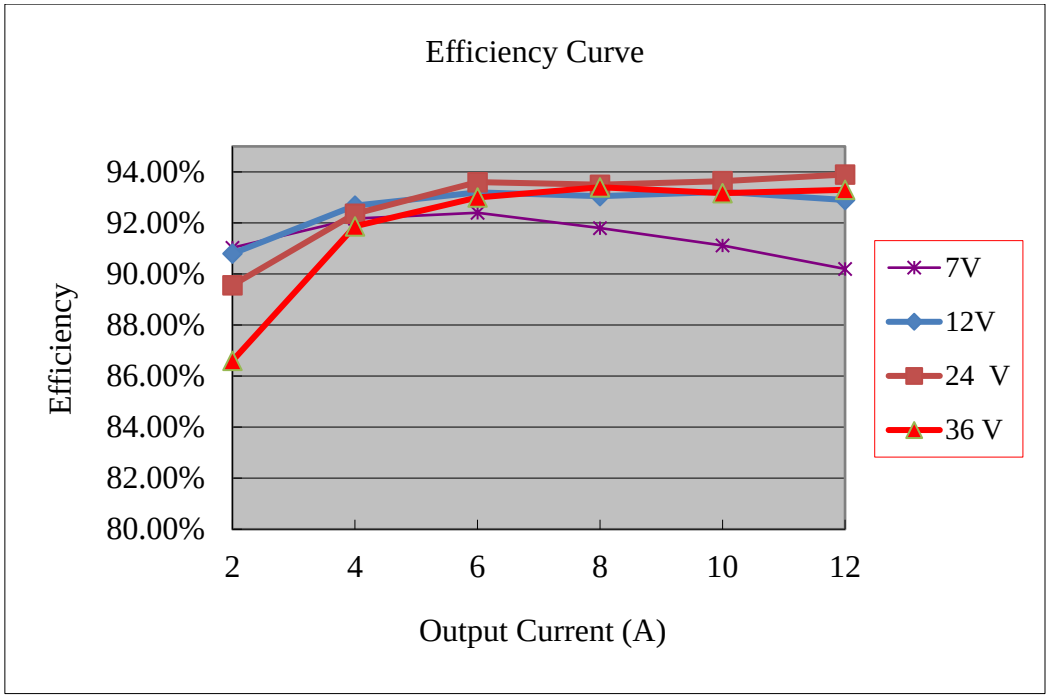


Figure 2. Efficiency data

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	-	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 Off)			2.4	-	18	V
Current (Out of pin)		Venable = -0.3 - 0.8 V	-	-	200	µA
		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			-	2.4	-	V

Recommended remote on/off circuit for active low

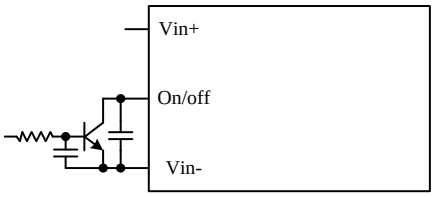


Figure 3. Control with open collector/drain circuit

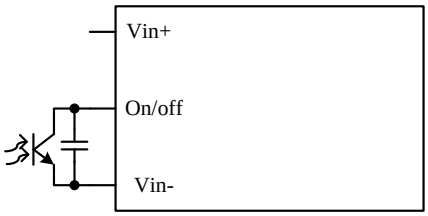


Figure 4. Control with photocoupler circuit

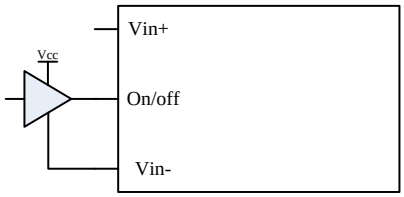


Figure 5. Control with logic circuit

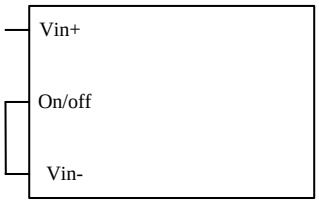


Figure 6. Permanently on

Recommended remote on/off circuit for active high

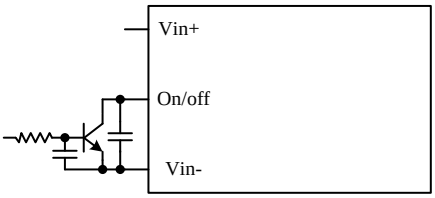


Figure 7. Control with open collector/drain circuit

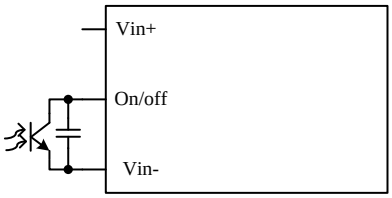


Figure 8. Control with photocoupler circuit

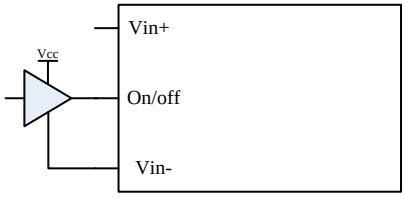


Figure 9. Control with logic circuit

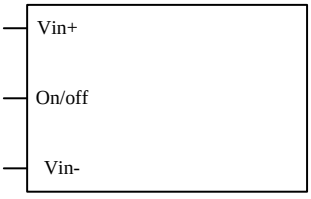


Figure 10. Permanently on

9. 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 0.5 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 0.1μF 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+ (100 ohm) from Vo+ to Sense+ and a resistor RS- (100 ohm) from Vo- to Sense- inside of this module.

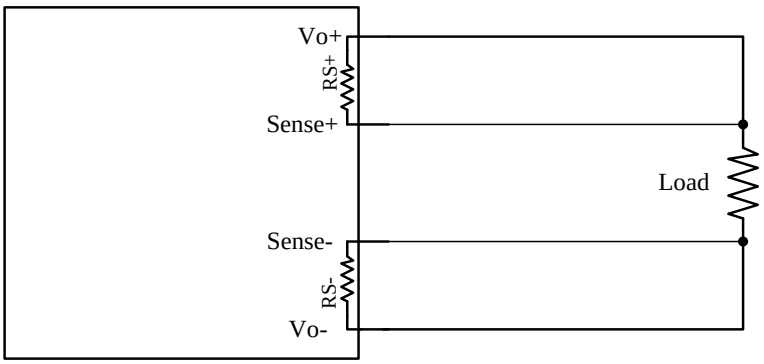


Figure 11.

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.

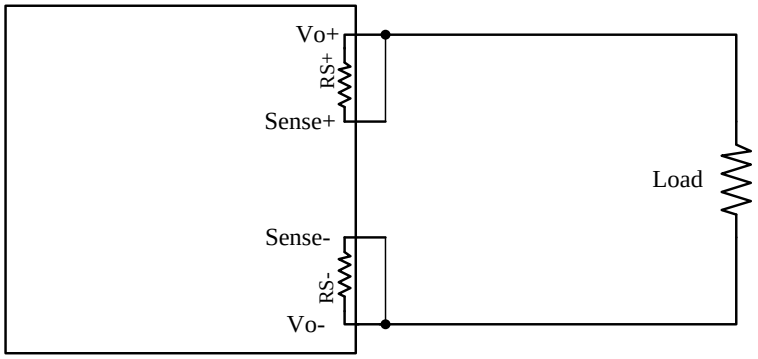


Figure 12.

10. INPUT NOISE

Input reflected ripple current

Testing Setup

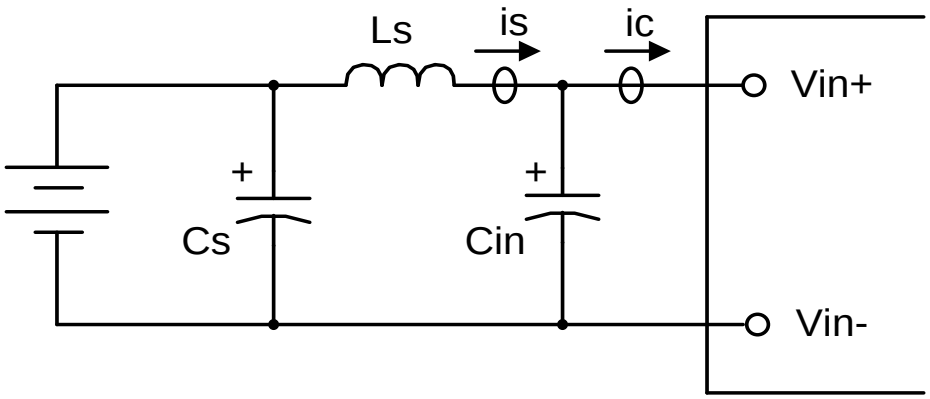


Figure 13.

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 closed as possible to the power module to swallow ic ripple current and help with 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.

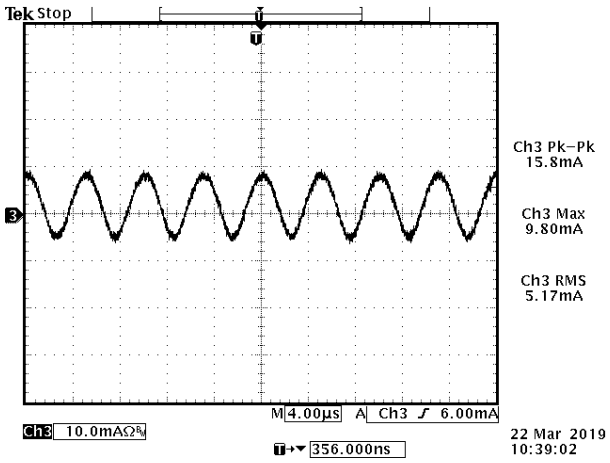


Figure 14. Is (input reflected ripple current), AC component

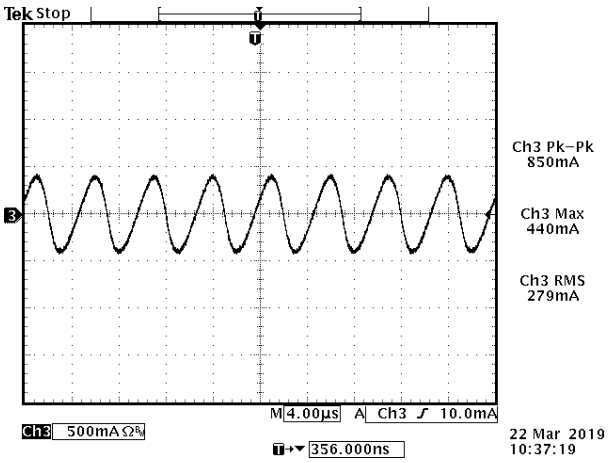


Figure 15. ic (input terminal ripple current), AC component

Test condition: 24 VDC input, 12 A output, Ta = 25 °C, with Cout = 11μF ceramic capacitor, 100 μF POSCAP capacitor

11. RIPPLE AND NOISE

Testing setup

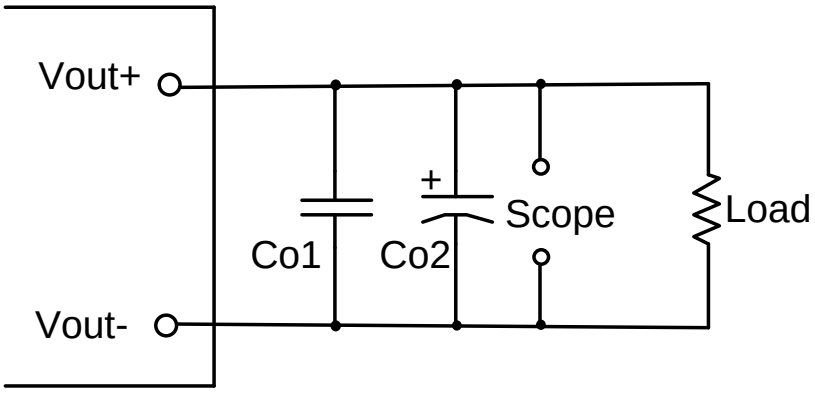


Figure 16.

Notes and values in testing.
Co1: 10 µF ceramic capacitor and 1 µF ceramic capacitor
Co2: 100 µF POSCAP capacitor
The capacitor should be as closed as possible to the power module to to damped ic ripple current and enhance stability.

Below measured waveforms are based on above capacitance.

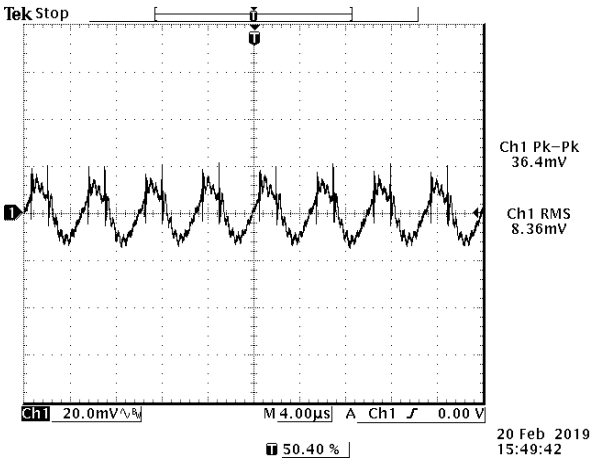


Figure 17.

Test condition: 24 VDC input, 12 A output, Ta = 25 °C, with Cout = 11 µF ceramic capacitor, 100 µF POSCAP capacitor

12. TRANSIENT RESPONSE

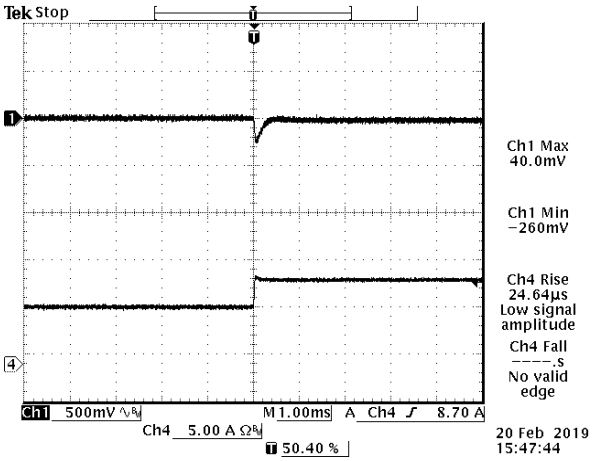


Figure 18. 50%-75% Load Transients at Vin = 24V@Ta = 25°C

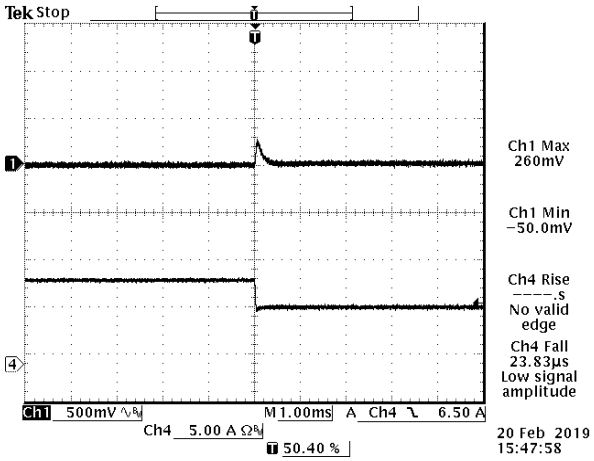


Figure 19. 75%-50% Load Transients at Vin = 24 V @ Ta = 25°C

Test condition: 24 VDC input, Ta = 25 °C, with Cout = 11 µF ceramic capacitor, 100 µF POSCAP capacitor

13. STARTUP & SHUTDOWN

Rise time

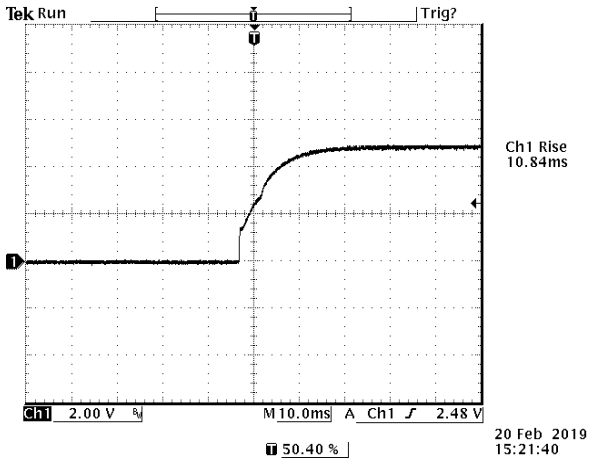


Figure 20. Rise time

Test condition: 24 VDC input, 12 A output, Ta = 25 °C, with Cout = 11 µF ceramic capacitor, 100 µF POSCAP capacitor

Startup time

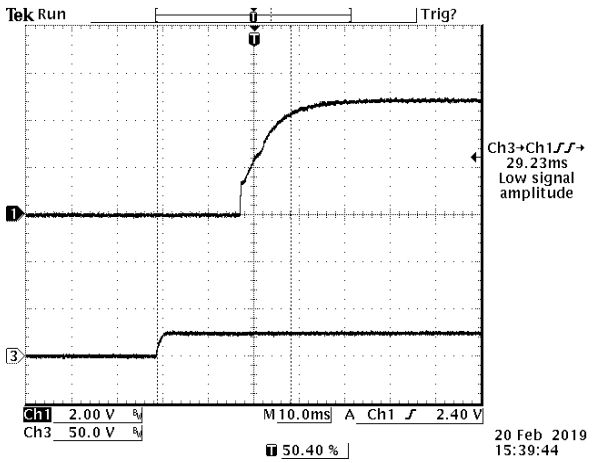


Figure 21. Startup from Vin
Ch1: Vo
Ch3: Vin

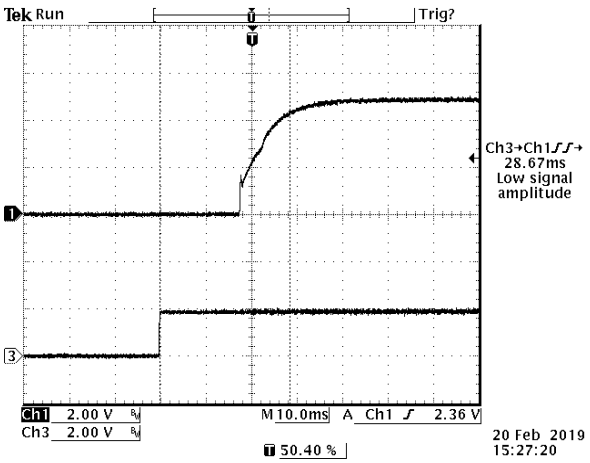


Figure 22. Startup from on/off
Ch1: Vo
Ch3: on/off

Test condition: 24 VDC input, 12 A output, Ta = 25 °C, with Cout = 11 µF ceramic capacitor, 100 µF POSCAP capacitor

Shut down

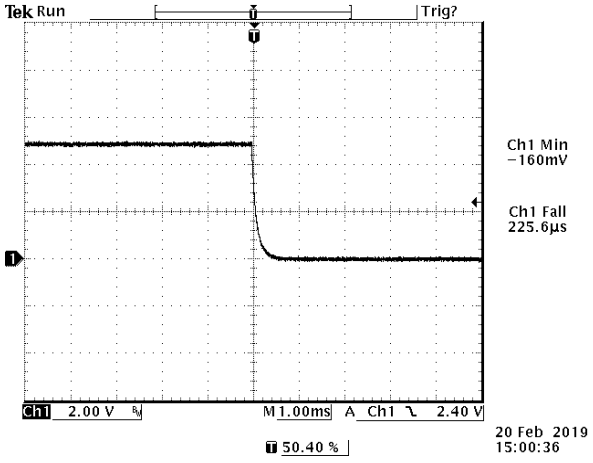


Figure 23.

Test condition: 24 VDC input, 12 A output, Ta = 25 °C, with Cout = 11 µF ceramic capacitor, 100 µF POSCAP capacitor

14. 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 milli-seconds. 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 16 A during hiccup.

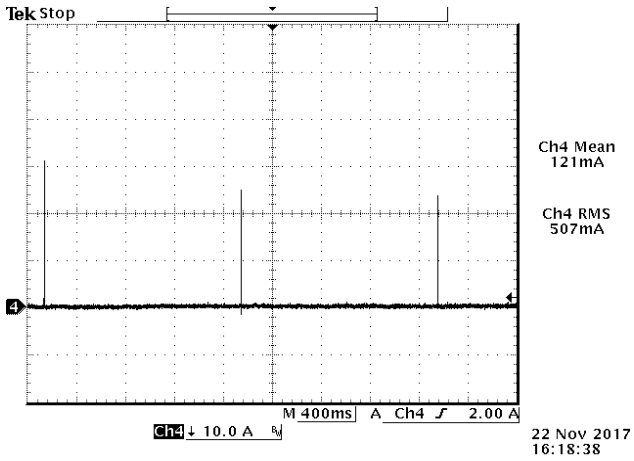


Figure 24. Over current protection

15. INPUT UNDER-VOLTAGE LOCKOUT

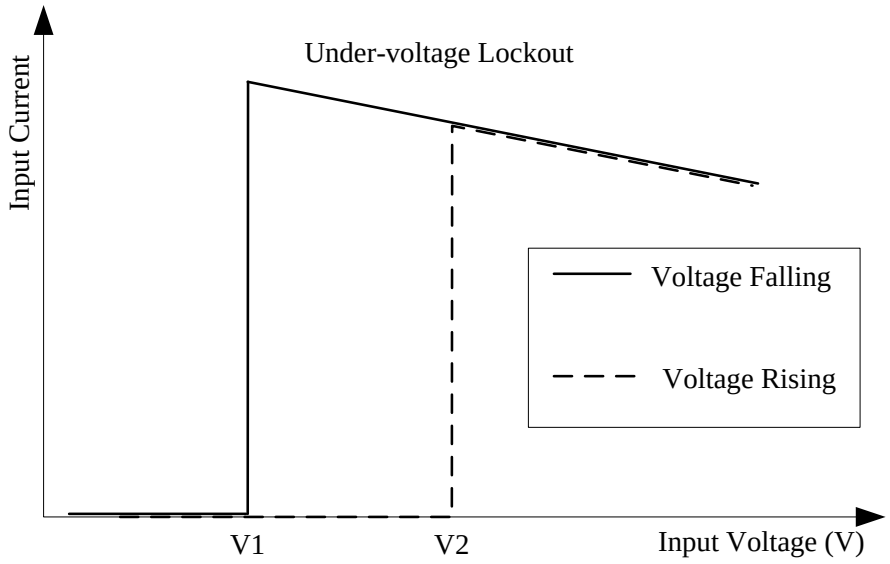


Figure 25. Input under-voltage lockout
V1 = 6.5 V
V2 = 7.5 V

16. THERMAL DERATING CURVES

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).

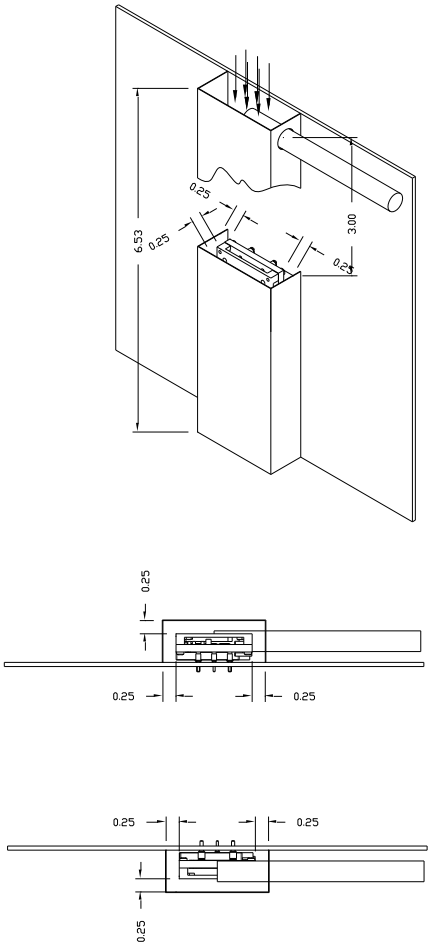


Figure 26. Thermal test setup

Test setup drawing all measures are in inch.

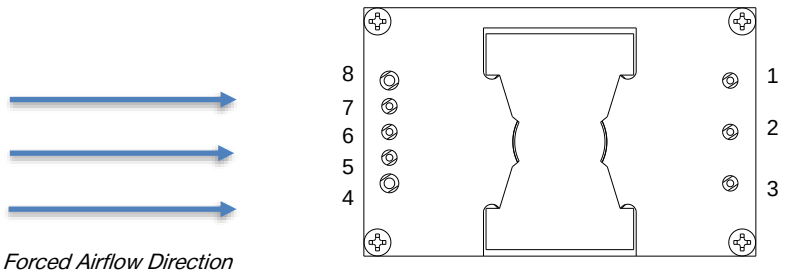


Figure 27. Airflow direction

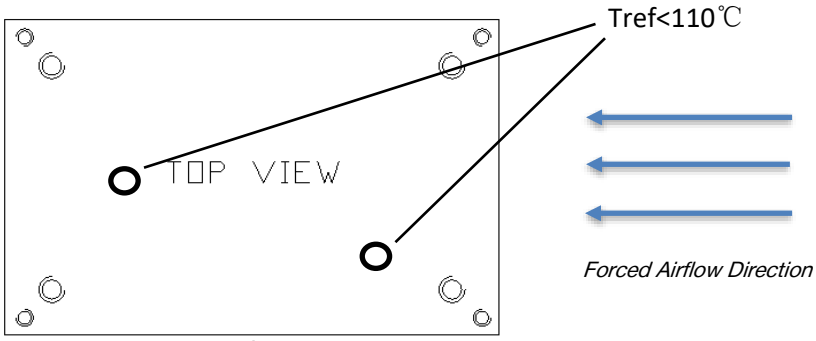


Figure 28. Temperature reference points on top side

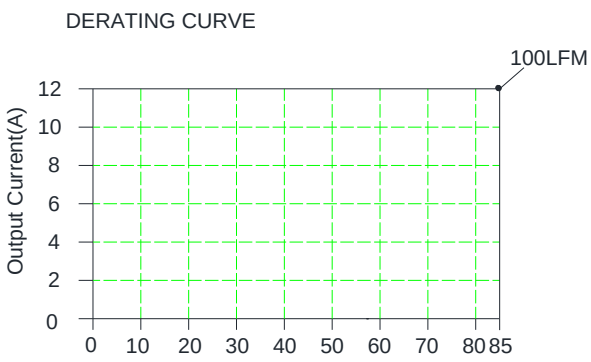


Figure 29. Derating curve @Vin = 12V

Note: Output Current vs. ambient temperature and air velocity @ Vin = 12 V (Longitudinal Orientation, airflow from Vout to Vin).

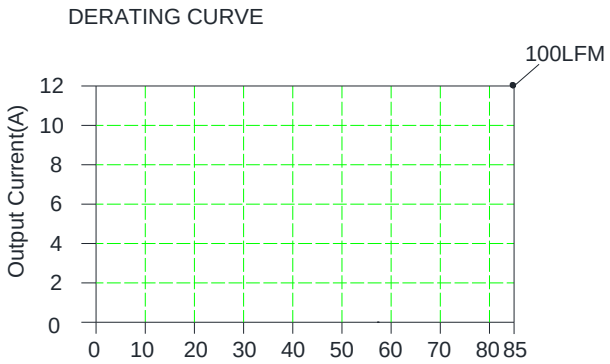


Figure 30. Derating curve @Vin = 24V

Note: Output Current vs. ambient temperature and air velocity @ Vin = 24 V (Longitudinal Orientation, airflow from Vout to Vin).

17. SAFETY & EMC

Safety:

cCSAus certification to UL/CSA 62368-1

Nemko certification to EN 62368-1

CB certification to IEC/EN 62368-1

EMC:

1. Conductive EMI: EN 55032 class A

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

Test setup:

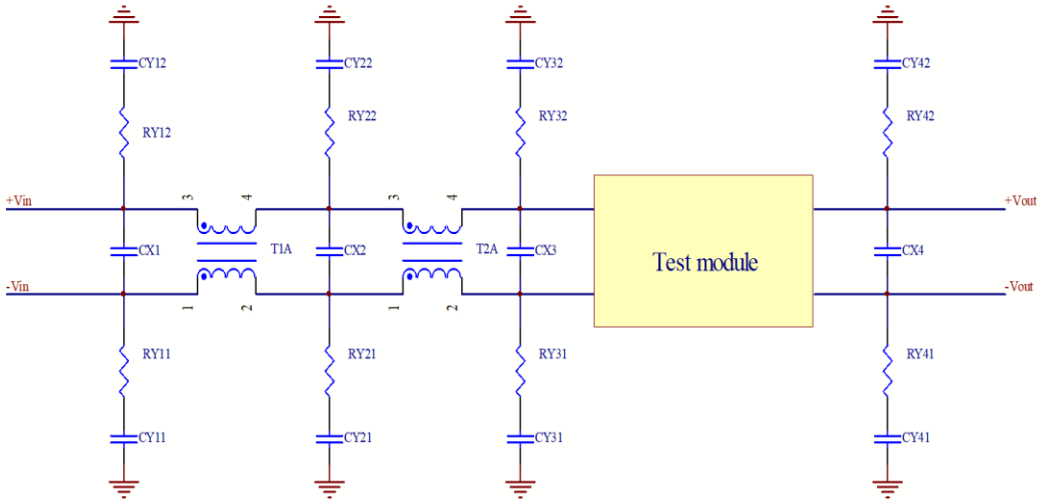


Figure 31.

ITEM	DESIGNATION	PARAMETER	VEND	VENDOR P/N	QTY
1	CX1	CAP;POLYPROPYLENE;FILM;X2;0.47µF;20%;305V;Pitch15mm;-40 to+110°C;	FARATRONIC	C42Q2474M6SC000	4
2	CX2	NOT USED			
3	CX3	100µF,100V,AL-Cap	RUBYCON	100ZLH100MEFC10X20	2
4	CX4	POSCAP SMD 100µF 16V +/-20% 50mR CASE D3 MLCC CAP X7R 10µF +/-10% 16V 1206 CHIP CAP X7R 1µF +/-10% 16V 0805	SANYO VENKEL MURATA	16TQC100M C1206X7R160-106KNE GRM21BR71C105KA01L	1 1 1
5	T1A	1mH,20Amax	ITG	C20200-21	1
6	T2A	NOT USED			
7	RY11	NOT USED			
8	RY12	NOT USED			
9	RY21	CHIP RES TKF 0R +/-5% 0.25W 1206	SEI	RMCF1206ZT0R00	1
10	RY22	CHIP RES TKF 0R +/-5% 0.25W 1206	SEI	RMCF1206ZT0R00	1
11	RY31	NOT USED			
12	RY32	NOT USED			
13	RY41	NOT USED			
14	RY42	NOT USED			
15	CY11	NOT USED			
16	CY12	NOT USED			
17	CY21	CAP;CERAMIC;X1/Y2;4.7nF;20%;250V;PITCH 7.5mm; -25to+105°C;	MURATA	DE2E3KY472MA3BM02	1
18	CY22	CAP;CERAMIC;X1/Y2;4.7nF;20%;250V;PITCH 7.5mm; -25to+105°C;	MURATA	DE2E3KY472MA3BM02	1
19	CY31	NOT USED			
20	CY32	NOT USED			
21	CY41	NOT USED			
22	CY42	NOT USED			

Positive:

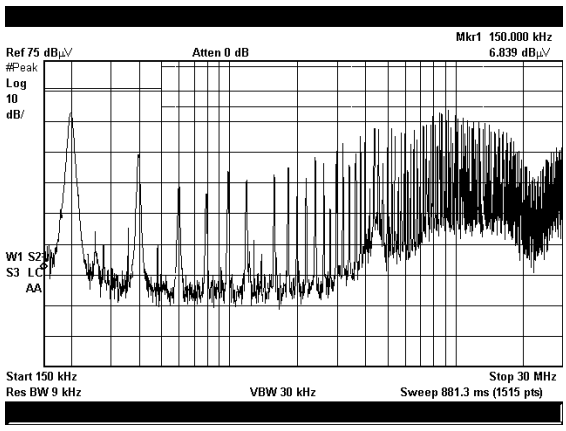


Figure 32.

Negative:

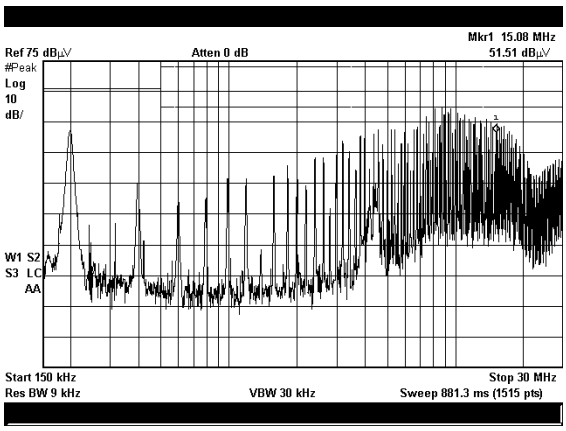


Figure 33.

18. TRIM

Trim Resistor Calculate

Trim down test circuit

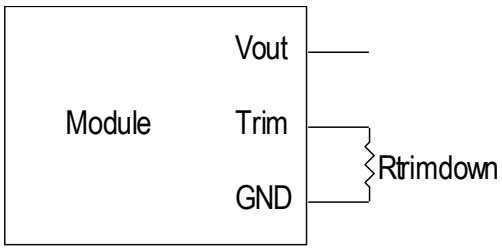


Figure 34. Trim down test circuit

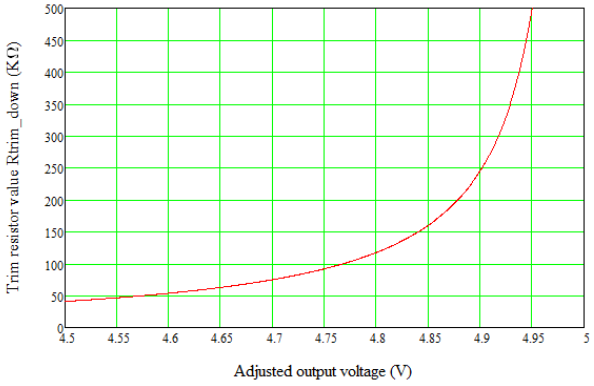


Figure 35. Trim down curve

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

Trim up test circuit

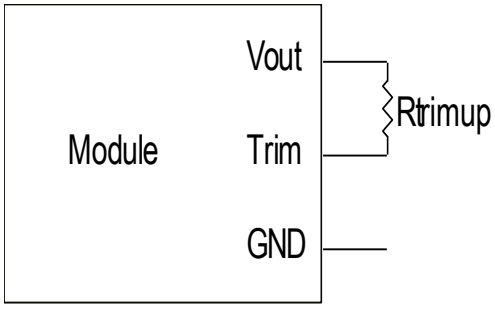


Figure 36. Trim up test circuit

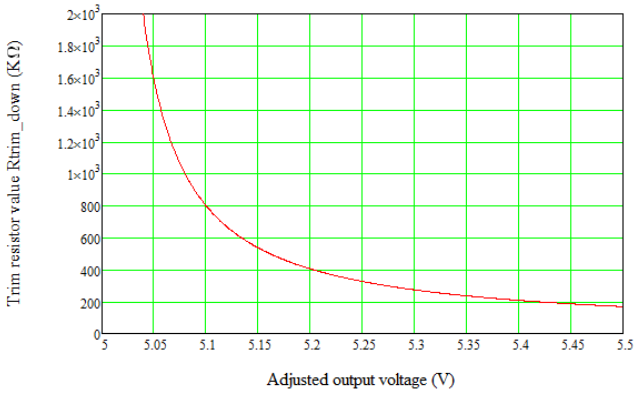


Figure 37. Trim up curve

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

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

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

Output voltage Vo = 5.000 V

19. MECHANICAL DIMENSIONS

OUTLINE

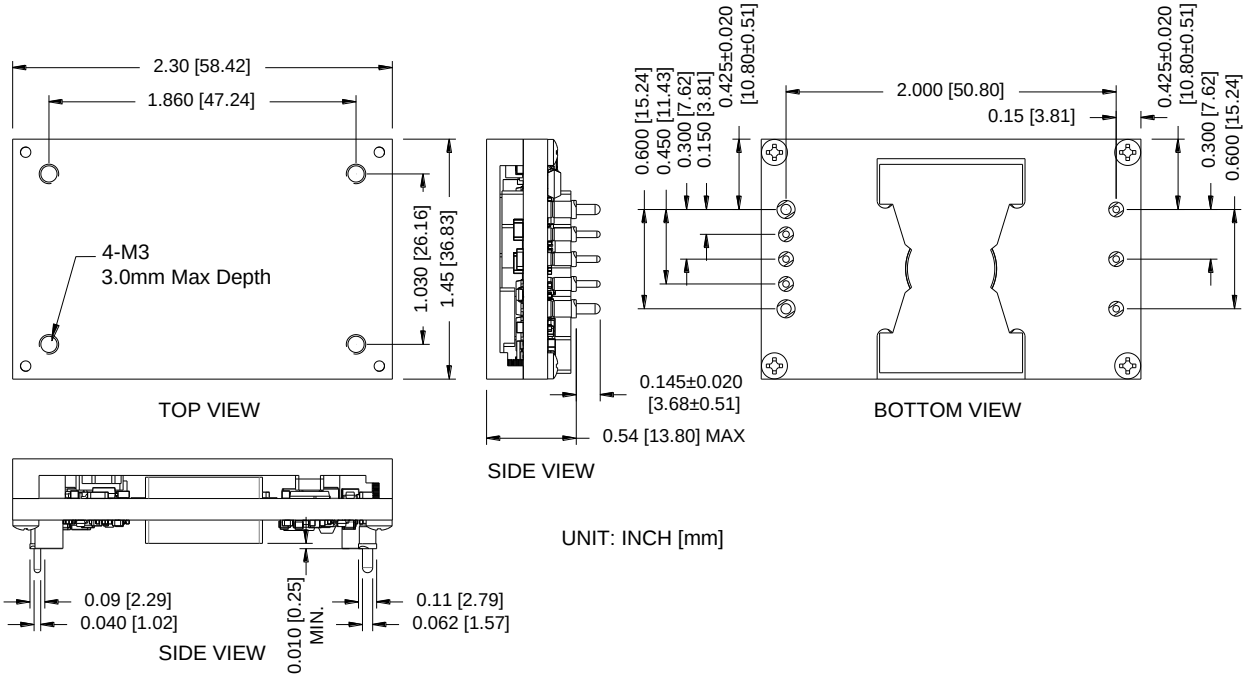


Figure 38. Outline

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 inches; Tolerances: x.xx +/-0.02 in [0.51 mm].
   x.xxx +/-0.010 in [0.25 mm].

PIN DEFINITIONS

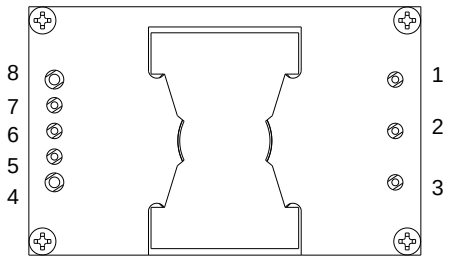
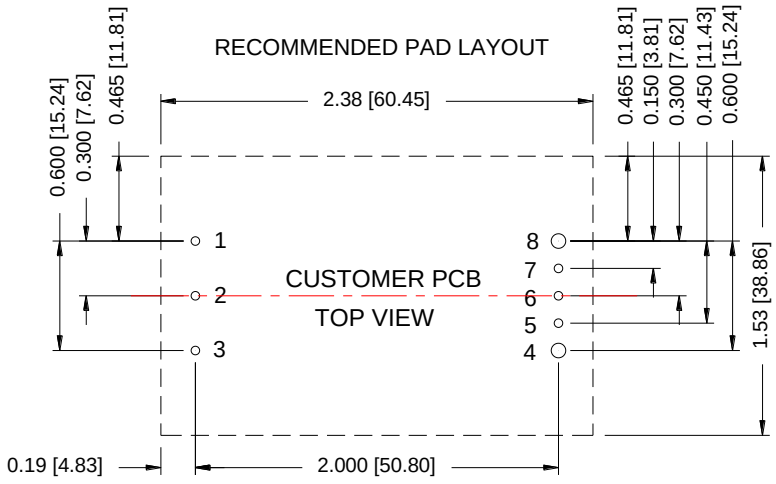


Figure 39. Pins

PIN	FUNCTION	DESCRIPTION	PIN SIZE
1	Vin (+)	Positive input	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 output	0.06”
5	Sen (-)	Negative sense	0.04”
6	Trim	Trim	0.04”
7	Sen (+)	Positive sense	0.04”
8	Vout (+)	Positive output	0.06”

RECOMMENDED PAD LAYOUT



1 2 3 5 6 7 HOLES SIZE Φ0.050 &PAD SIZE Φ0.100 MIN
4 8 HOLES SIZE Φ0.074 &PAD SIZE Φ0.120 MIN

Figure 40. Recommended pad layout

20. FEATURE DISCRIPTIONS

Output over current protection

The module is equipped with internal output current limiting circuitry, and can endure limiting current continuously. If the output current exceeds the limited value, the module will 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 stay in the hiccup mode if the fault condition remains present. The hiccup interval time is 800 ms.

For latch mode, the module will latch off once shut down. The latch mode can be reset by cycling the input power.

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 shut down and auto restart once the temperature is lower than the protection threshold by ~20°C hysteresis.

For latch mode, the module will latch off once shut down. The latch mode can be reset by cycling the input power.

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.

21. REVISION HISTORY

DATE	REVISION	CHANGES DETAIL	APPROVAL
2018-10-25	AA	First release	J.Yao
2019-02-22	AB	Update MD	J.Yao
2019-03-20	AC	Update input transient voltage, input current, turn on time, efficiency, switching frequency, remote on/off, wave of efficiency data, ripple and noise, transient response, input noise, start up & shut down, OCP, Safety & EMC, Trim, Add pre-bias voltage.	J.Yao
2019-06-18	AD	Add model photo	F.Tao
2019-10-15	AE	Update Output DC Current Limit, MTBF, Weight, and add temperature reference points on top side.	J.Yao
2019-12-05	AF	Add safety certificate and altitude	F.Tao
2021-04-29	AG	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.
TECHNICAL REVISIONS - The appearance of products, including safety agency certifications pictured on labels, may change depending on the date manµFactured. Specifications are subject to change without notice.