

## ISOLATED DC/DC CONVERTERS

36 Vdc - 75 Vdc Input, 15 Vdc/5 A Output



Aug. 22, 2011

*Bel Power, Inc. , a subsidiary of Bel Fuse, Inc.*

**0REB-80T15x    RoHS Compliant    PRELIMINARY    Rev.A**

### Features

- Isolated
- High Efficiency
- Fixed Frequency (300 KHz)
- High Power Density
- Low Cost
- Class 2, Category 2, Isolated DC/DC Converter (refer to IPC-9592)
- Remote On/Off)
- Input Under Voltage Protection
- Output Over Voltage Protection
- OCP/SCP
- Over Temperature Protection

### Applications

- Networking
- Computers and peripherals
- Telecommunications

### Description

The 0REB-80T15x is an isolated DC/DC converter that operates from a nominal 48 Vdc source. This converter provides up to 75W of output power. Features include remote on/off, short circuit protection, over current protection, over-temperature protection, output over-voltage protection, input under-voltage protection.

### Part Selection

Output Voltage	Input Voltage	Max. Output Current	Max. Output Power	Typical Efficiency	Model Number Active Low	Model Number Active High
15 Vdc	36 Vdc - 75 Vdc	5 A	75 W	92%	0REB-80T15L	0REB-80T150

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

### Part Number Explanation

$\frac{0}{1} \frac{R}{2} \frac{EB}{3} - \frac{80}{4} \frac{T}{5} \frac{15}{6} \frac{x}{7}$

- 1---Through hole mount
- 2---RoHS 6, change "R" to "7" means RoHS 5
- 3---Series name
- 4---Series code
- 5---Input range (36-75V)
- 6---Output voltage (15V)
- 7---Enable, "0" means active high, and "L" means active low

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## Absolute Maximum Ratings

Parameter	Min	Typ	Max	Unit	Notes
Continuous non-operating Input Voltage	-0.3	-	80	V	
Input Transient Voltage	-	-	100	V	100mS maximum
Remote On/Off	-0.3	-	18	V	
I/O isolation voltage	-	-	1500	V	
Ambient Temperature	-40	-	85	°C	
Storage Temperature	-55	-	125	°C	

**Note:** Ratings used beyond the maximum ratings may cause a reliability degradation of the converter or may permanently damage the device.

## Input Specifications

Parameter	Min	Typ	Max	Unit	Notes
Operating Input Voltage	36	48	75	V	
Input Current (full load)	-	-	2.8	A	
Input Current (no load)	-	60	100	mA	
Remote Off Input Current	-	5	10	mA	
Input Reflected Ripple Current (rms)	-	2	5	mA	With simulated source impedance of 10uH, 5Hz to 20MHz. Use a 100uF/100V electrolytic capacitor with ESR=1 ohm max, at 200KHz@25°C.
Input Reflected Ripple Current (pk-pk)	-	10	20	mA	
I <sup>2</sup> t Inrush Current Transient	-	-	1	A <sup>2</sup> s	
Turn-on Voltage Threshold	34.5	35	35.5	V	
Turn-off Voltage Threshold	33	33.5	34	V	
Other information:					
Input C-L-C filter	0.47uF-2.2uH-4.4uF			-	
Recommended input fast-acting fuse on system board	-	4	-	A	CAUTION: This converter is not internally fused. An input line fuse must be used in application.

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

Recommend a fast-acting fuse with maximum rating of 4A on system board. Refer to the fuse manufacture's datasheet for further information.

- Notes:** 1. This converter has internal C-L-C (0.47uF-2.2uH-4.4uF) filter.  
 2. All specifications are typical at 25 °C unless otherwise stated.

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## Output Specifications

Parameter	Min	Typ	Max	Unit	Notes
Output Voltage Set Point	14.85	15	15.15	V	Vin=48V, Io=50% load at 25°C ambient.
Load Regulation	-	0.1	0.2	%	Vin=48V, Io=0~100% load at 25°C ambient.
Line Regulation	-	0.1	0.2	%	Vin=36~75V, Io=100% load at 25°C ambient
Regulation Over Temperature (-40deg.C-85deg.C)	-	-	1	%	
Ripple and Noise (pk-pk)	-	60	100	mV	Vin=48V, Io=100%load at 25°C ambient, 0-20MHz BW, with a 1µF ceramic capacitor and a 100uF Electrolytic cap at output.
Ripple and Noise (rms)	-	15	30	mV	
Ripple and Noise(Pk-Pk) under worst case	-	-	150	mV	over all operating input voltage, load and ambient temperature condition
Output Current Range	0	-	5	A	
Output DC Current Limit	5.5	6	6.5	A	
Short Circuit Surge Transient	-	-	TBD	A <sup>2</sup> s	
Rise time	-	-	10	ms	
Turn on Time	-	-	40	ms	
	-	-	20	ms	
Overshoot at Turn on	-	0	3	%	
Output Capacitance	0	-	1000	uF	
Transient Response					
ΔV 50% - 75% of Max Load	-	250	300	mV	di/dt=0.1A/us, Vin=48Vdc, Ta=25°C, with a 1µF ceramic capacitor and a 100uF Electrolytic cap at output.
Settling Time	-	400	500	uS	
ΔV 75% - 50% of Max Load	-	250	300	mV	
Settling Time	-	400	500	uS	

**Note:** All specifications are typical at nominal input, full load at 25°C unless noted.

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36 Vdc - 75 Vdc Input, 15 Vdc/5 A Output



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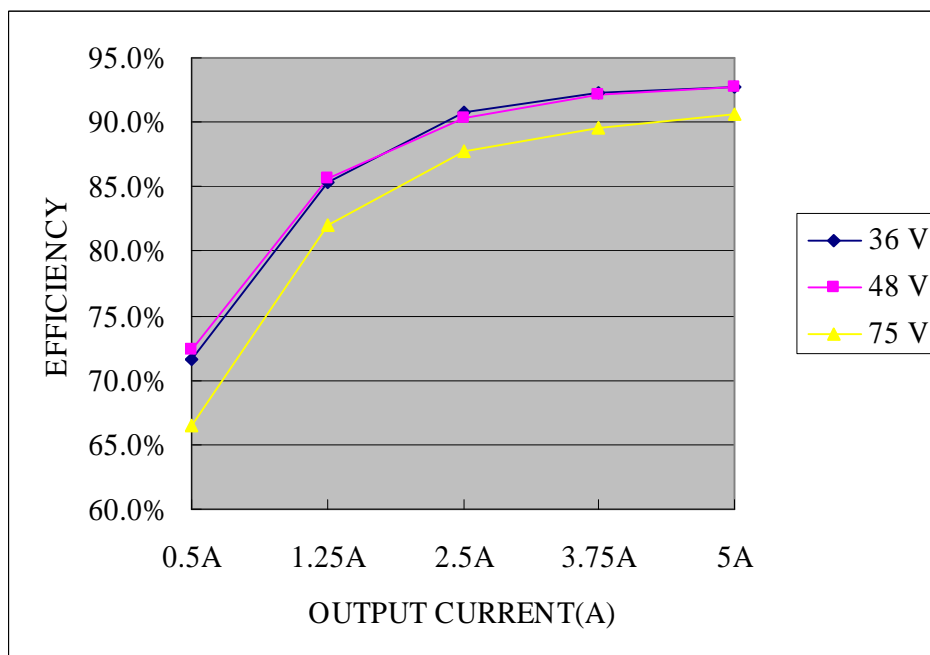
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## General Specifications

Parameter	Min	Typ	Max	Unit	Notes
Efficiency	90	92	-	%	The efficiency is measured at Vin=48V, full load and Ta=25°C.
Switching Frequency	290	300	310	kHz	
Output Voltage Trim Range	80	-	110	%	
FIT <sup>2</sup>	-	TBD	-	-	Calculated Per Bell Core SR-332 (Vin=48 V, Vo=15 V, Io=5 A, Ta = 25C, FIT=10 <sup>9</sup> /MTBF)
Over Temperature Protection	-	125	-	°C	
Over Voltage Protection(Static)	-	-	18	V	This voltage is achieved by trimming up output slowly.
Over Voltage Protection (Dynamic)	-	-	18	V	The transient over voltage is achieved by connecting the Trim pin to Vout+ pin through a 332K resistor.
Weight	-	TBD	-	g	
<b>Isolation characteristics</b>					
Input to Output	-	-	1500	V	
Isolation Resistance	10M	-	-	Ohm	
Isolation Capacitance	-	2700	-	pF	

**Note:** All specifications are typical at 25 °C unless otherwise stated.

## Efficiency Data



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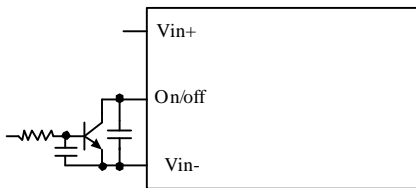
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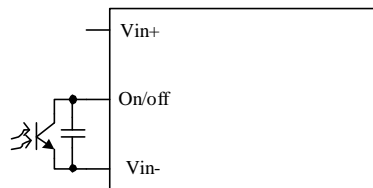
## Remote On/Off

Parameter		Min	Typ	Max	Unit	Notes
Signal Low (Unit On)	Active Low	-0.3	-	0.8	V	Remote On/Off pin is open, the module is off.
Signal High (Unit Off)		2.4	-	18	V	
Signal Low (Unit Off)	Active High	-0.3	-	0.8	V	Remote On/Off pin is open, the module is on.
Signal High (Unit On)		2.4	-	18	V	
Current Sink		0	-	1	mA	

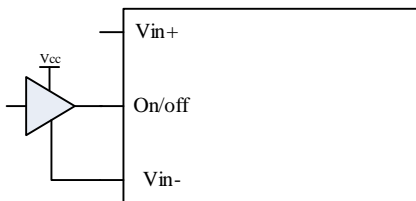
### Recommended remote on/off circuit for active low



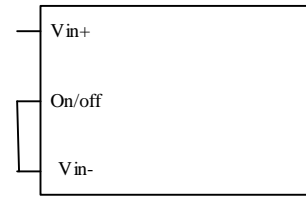
Control with open collector/drain circuit



Control with photocoupler circuit

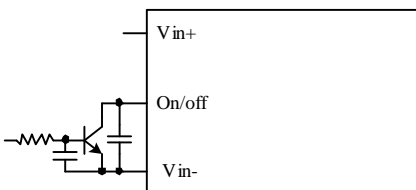


Control with logic circuit

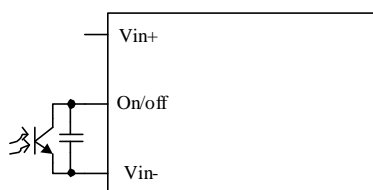


Permanently on

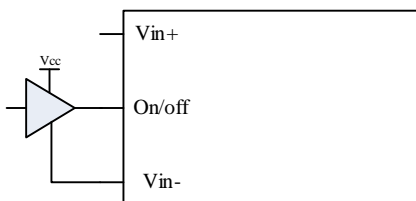
### Recommended remote on/off circuit for active high



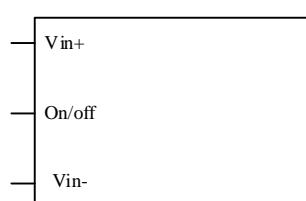
Control with open collector/drain circuit



Control with photocoupler circuit



Control with logic circuit



Permanently on

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## Output Trim Equations

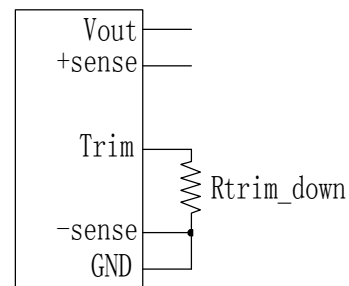
Equations for calculating the trim resistor are shown below. The Trim Down resistor should be connected between the Trim pin and Sense (-) pin. The Trim Up resistor should be connected between the Trim pin and the Sense (+). Only one of the resistors should be used for any given

Minimum trim down voltage is 12V

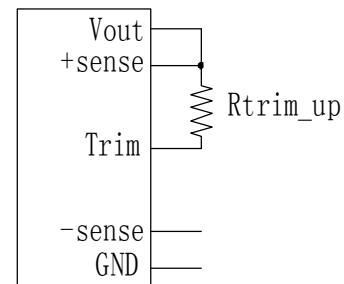
Maximum trim up voltage is 16.5V.

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

$$R_{trimdown} = \frac{511}{\Delta\%} - 10.2[k\Omega]$$



$$R_{trimup} = \frac{5.11 \times V_o \times (100 + \Delta\%)}{1.225 \times \Delta\%} - \frac{510}{\Delta\%} - 10.2[k\Omega]$$

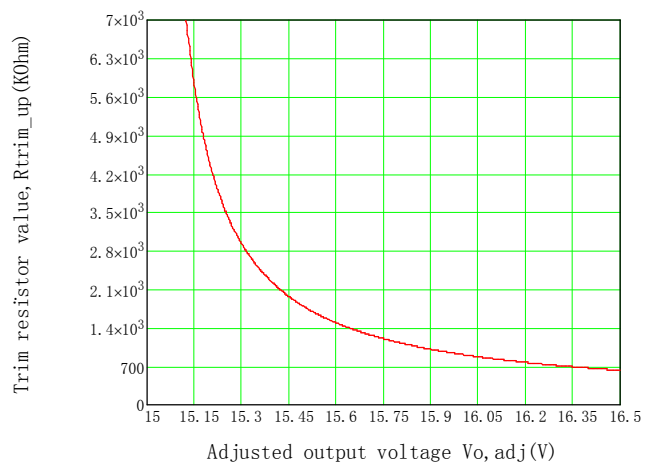
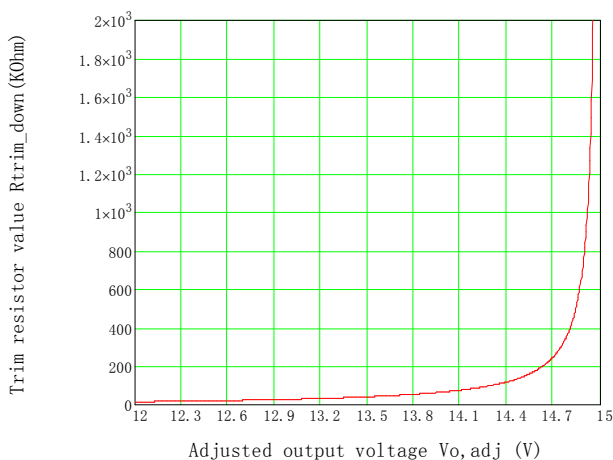


Note:

$$\Delta\% = \left| \frac{V_{DES} - V_o}{V_o} \right| \times 100$$

Vo\_req=Desired (trimmed) output voltage [V]

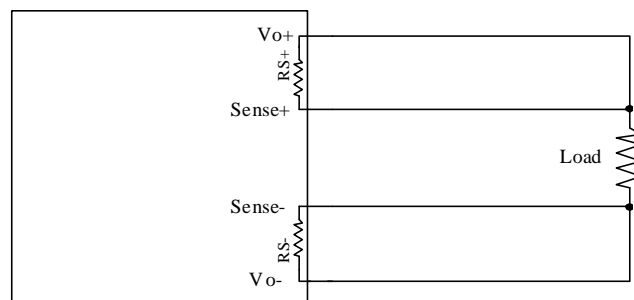
Output voltage Vo=15.000 V



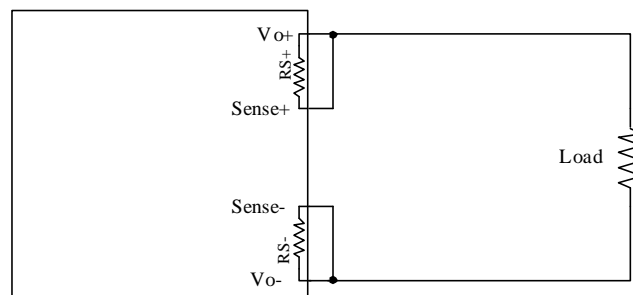
## Remote Sense

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

1. The remote sense lines carries 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. This can make an effect on the module's compensation, affecting the stability and dynamic response. A 0.1uF 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+ (51.1 ohm) from Vo+ to Sense+ and a resistor RS- (51.1 ohm) from Vo- to Sense- inside of this module.



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.



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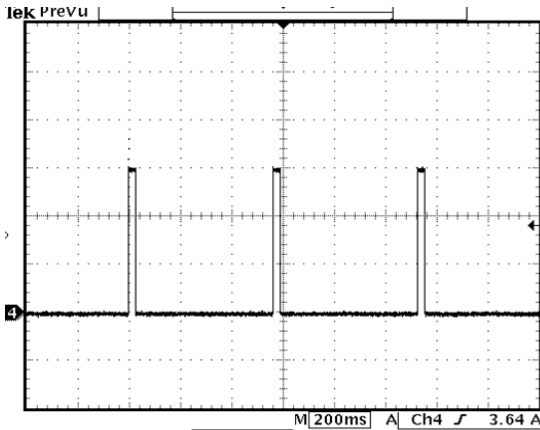


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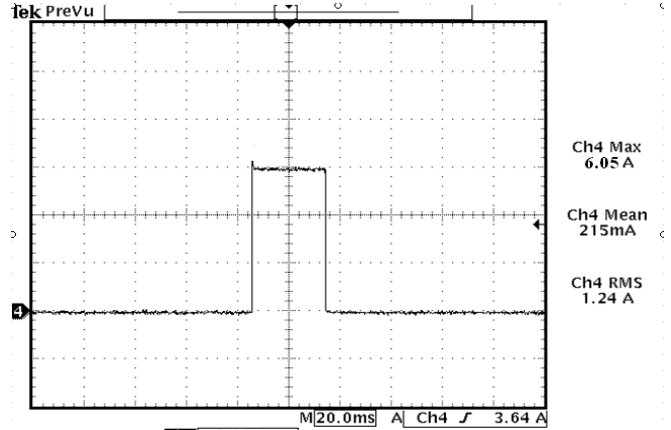
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## Over Current Protection

To provide protection in a fault output overload condition, the module is equipped with internal current-limiting circuitry and can endure current limiting for a few milli-seconds. If the overcurrent condition persists beyond a few milliseconds, the module will shut down into hiccup mode and restart once every 500mS. The module operates normally when the output current goes into specified range. The typical average output current is 215mA during hiccup.



Vin=48V



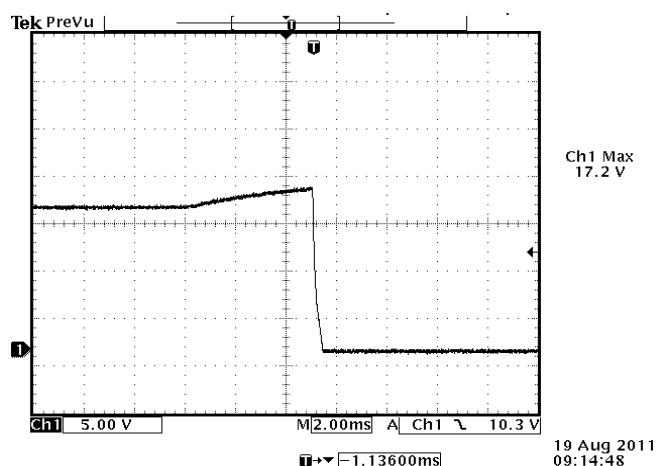
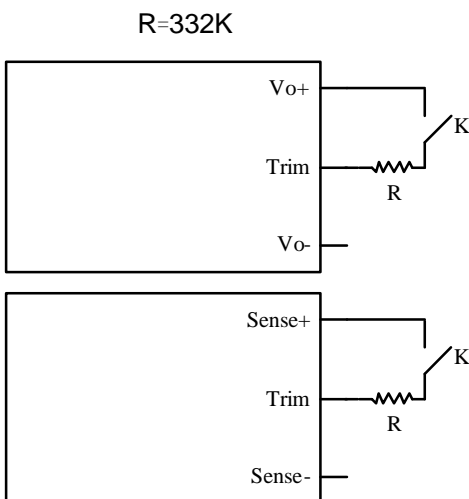
Expansion of on time portion of above figure  
CH4: Output current waveform

## Over Voltage Protection

The output overvoltage 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 shutdown.

Test setup:

Waveform: CH1: Output voltage waveform





# ISOLATED DC/DC CONVERTERS

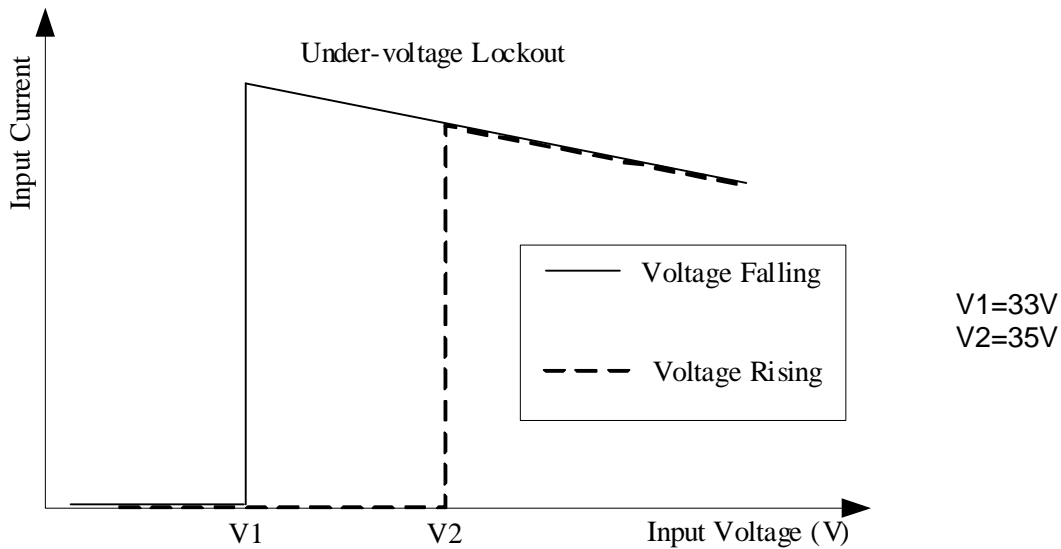
36 Vdc - 75 Vdc Input, 15 Vdc/5 A Output



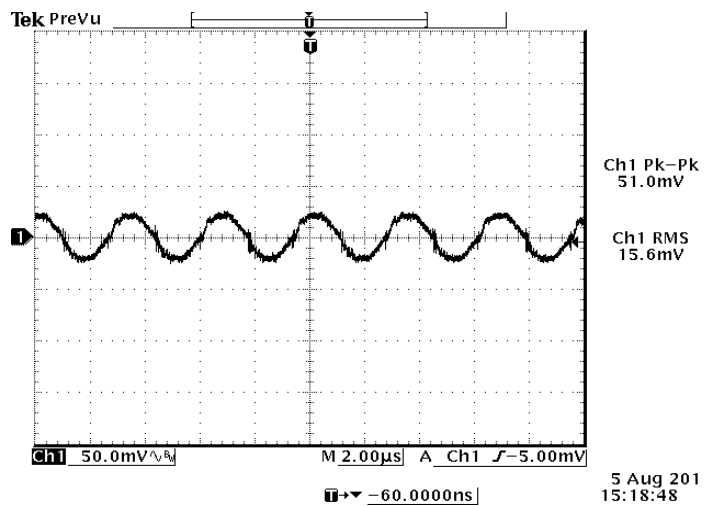
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## Input Under-voltage Lockout



## Ripple and Noise Waveform



48Vdc input, 15Vdc/5A output

**Note:** Ripple and noise at full load, with a 1µF ceramic cap and a 100µF electrolytic cap at output, Ta=25 deg C.

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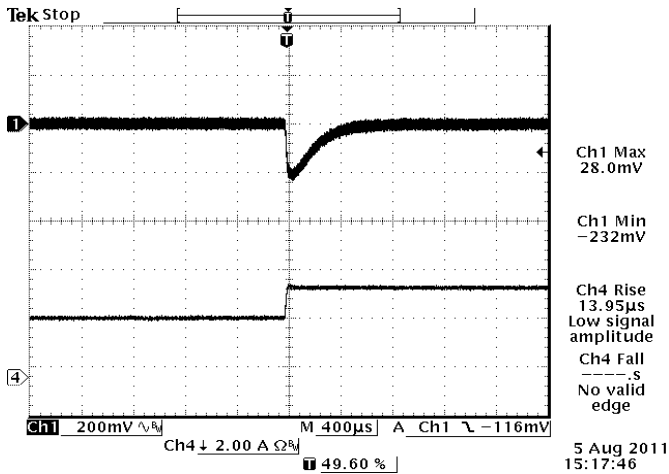
36 Vdc - 75 Vdc Input, 15 Vdc/5 A Output



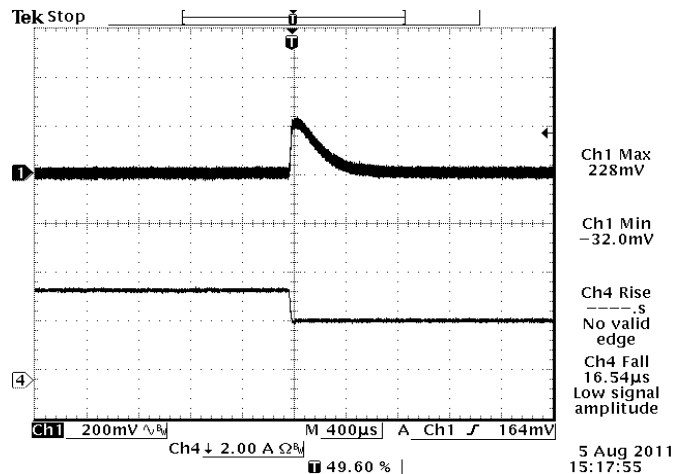
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## Transient Response Waveforms



Vout= 15V 50%-75% Load Transients

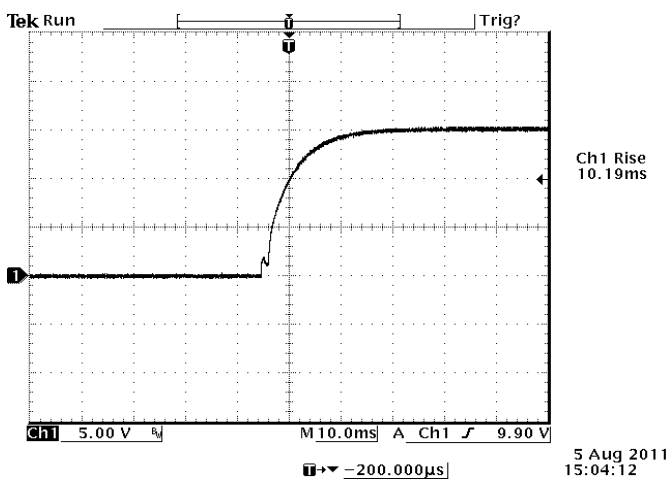


Vout= 15V 75%-50% Load Transients

**Note:** Transient Response :di/dt=0.1A/uS, 1uF ceramic cap and 100uF electrolytic cap at output.

## Startup & Shutdown

### Rise Time



Vin=48V, Vo=15V, Io=5A

# ISOLATED DC/DC CONVERTERS

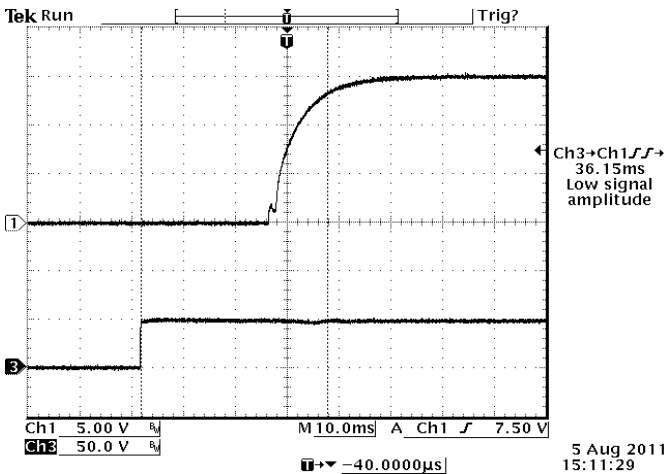
36 Vdc - 75 Vdc Input, 15 Vdc/5 A Output



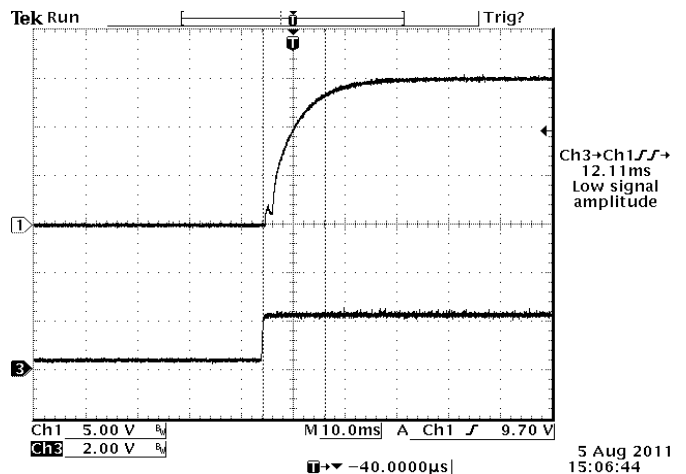
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## Startup time



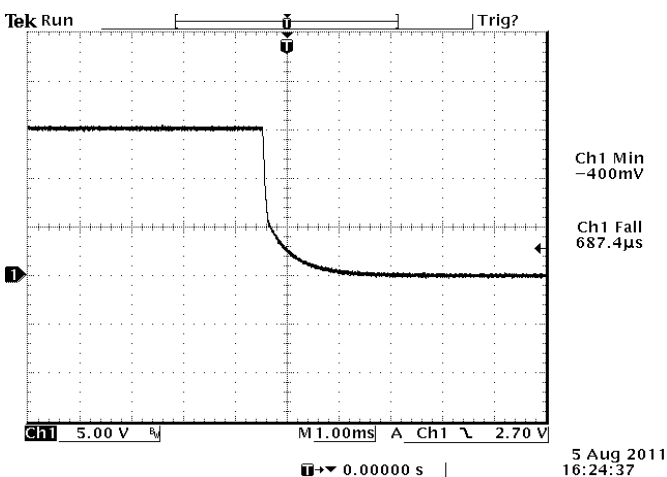
Startup from Vin  
Ch1: Vo  
Ch3: Vin  
Vin=48V, Vo=15V, Io=5A



Startup from on/off  
Ch1: Vo  
Ch3: on/off  
Vin=48V, Vo=15V, Io=5A

## Startup & Shutdown (continued)

### Shutdown



Vin=48V, Vo=15V, Io=5A

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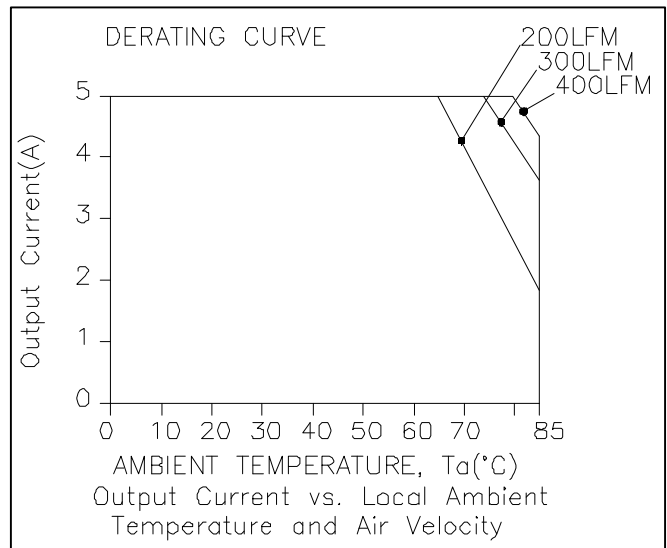
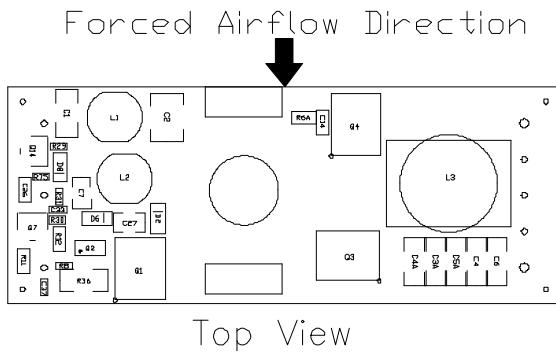
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## Thermal Derating Curve

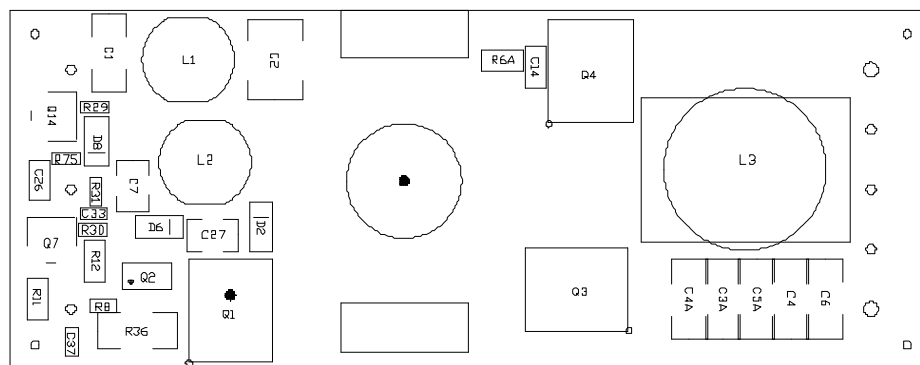
The OTP is achieved by thermistor R12 and the threshold is set at 125C in non-latch mode; the hottest component Q1 reaches 125C with 100LFM air flow correspondingly. It will restart automatically when the temperature falls down to 100C. The protecting point will be varied a little under different conditions (air flow, ambient temperature, input voltage, load...).

Maximum junction temperature of semiconductors derated to 120 degree C.



Derating curve under normal input

## Thermal Derating Curve (continued)



Top View

Temperature reference points on top side

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## Safety & EMC

### Safety

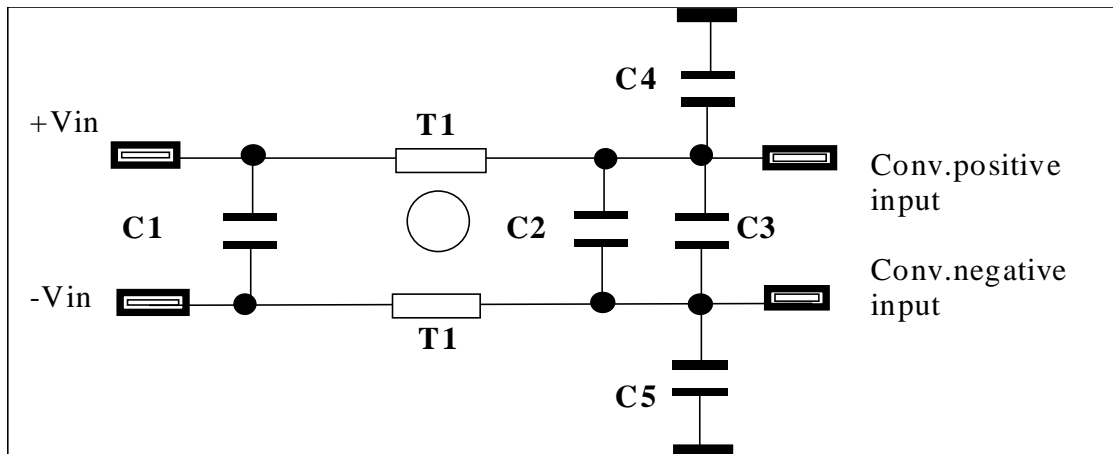
1. Material flammability UL94V-0
2. TUV Certification EN60950-1
3. UL Certification UL60950-1

### EMC

1. Surge IEC61000-4-5
2. DC-DIP IEC61000-4-29
3. Conductive EMI EN55022 class A

Compliance to EN55022 class A (both q.peak and average) with the following inductive and capacitive filter

Setup:



Item	Designator	Parameter	Vendor	Vendor P/N
1	C1	1uF/100V, ceramic	Murata	GRM32ER72A105KA01L
2	C2	0.1uF/100V, ceramic	TDK	C3216X7R2A104K
3	C3	220uF/100V, AL cap	Nichicon	UHE2A221MHD6
4	C4	22nF/1000V, ceramic +0.022uF/250V, safety	Johanson Epcos	631S41W223KV4E B32022B3223+
5	C5	22nF/1000V, ceramic +0.022uF/250V, safety	Johanson Epcos	631S41W223KV4E B32022B3223+
6	T1	1.3mH, common mode	Pulse	P0402NL

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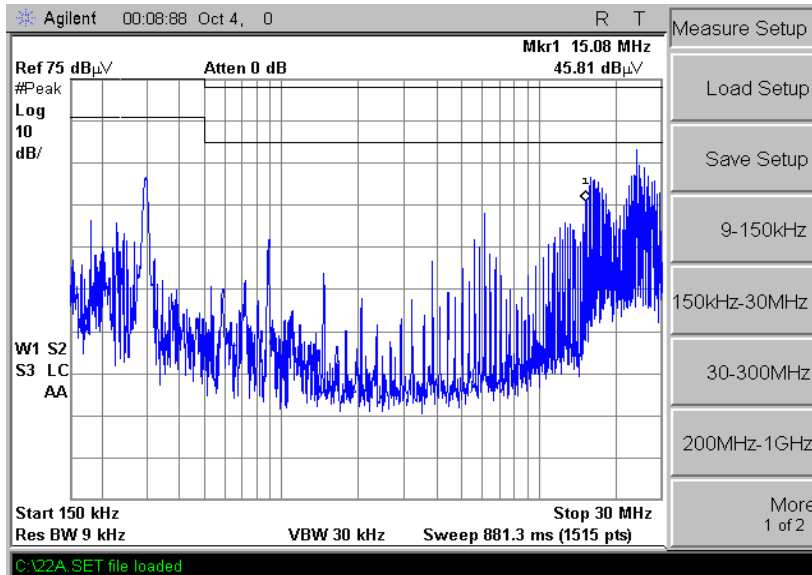


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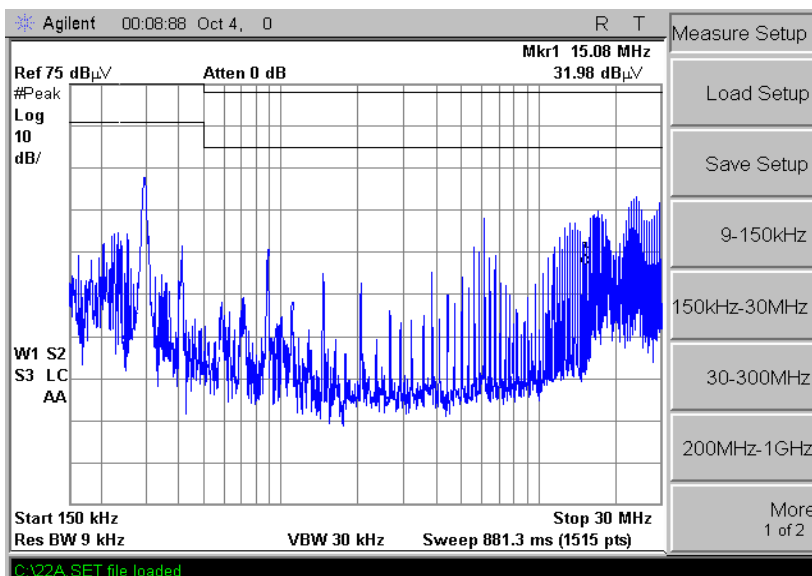
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## Safety & EMC (continued)

Positive:



Negative:



# ISOLATED DC/DC CONVERTERS

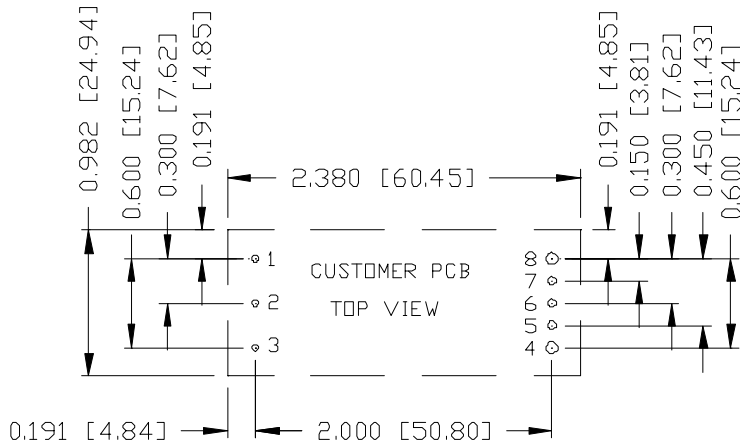
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## Mechanical Outline



1,2,3,5,6,7  $\phi$ 0.047 HOLE SIZE,  $\phi$ 0.08 min PAD SIZE  
4,8  $\phi$ 0.07 HOLE SIZE,  $\phi$ 0.10 min PAD SIZE



BOTTOM VIEW

1	Vin(+)	0.04"
2	RC	0.04"
3	Vin(-)	0.04"
4	Vout(-)	0.062"
5	RS(-)	0.04"
6	TRIM	0.04"
7	RS(+)	0.04"
8	Vout(+)	0.062"

**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.**

# ISOLATED DC/DC CONVERTERS

36 Vdc - 75 Vdc Input, 12 Vdc/6.5 A Output



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## Revision History

Date	Revision	Changes Detail	Approval
2011-8-22	A	First release	JZ Wang

### RoHS Compliance

Complies with the European Directive 2002/95/EC, calling for the elimination of lead and other hazardous substances from electronic products.



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#### CORPORATE

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