

## ISOLATED DC/DC CONVERTERS

18 Vdc - 75 Vdc Input 3.3 Vdc /20 A Output, 1/8 Brick



Mar. 24, 2010

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

ORCY-65U03x

RoHS Compliant

Rev.E

### Features

- Isolated
- High Efficiency
- High Power Density
- Fixed Frequency (260 kHz)
- Low Cost
- Input Under-Voltage Lockout
- Input Over-Voltage Lockout
- Class 1, Category 2, Isolated DC/DC Converter (refer to IPC-9592)
- UL60950-1 Recognized (UL/cUL) (Pending)
- Output Over-Voltage Shutdown
- Output Voltage Trim
- OCP/SCP
- Over Temperature Protection
- Remote On/Off
- Positive/Negative Remote Sense
- Basic Insulation



### Applications

- Networking
- Computers and peripherals
- Telecommunications

### Description

The ORCY-65U03x is part of the isolated dc/dc converters that operates from a wide input range (18 Vdc - 75 Vdc) and can cover both 24 Vin and 48 Vin input range. These units will provide up to 66 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 1/8 brick package.

### Part Selection

Output Voltage	Input Voltage	Max. Output Current	Max. Output Power	Typical Efficiency	Model Number Active High	Model Number Active Low
3.3 Vdc	18 Vdc - 75 Vdc	20 A	66 W	90%	ORCY-65U033	ORCY-65U03L

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

### Part Number Explanation

0 R CY - 65 U 03 x  
1 2 3 4 5 6 7

1---Through hole

2---RoHS 6, change "R" to "7" means RoHS 5

3---Series name

4---Series code

5---Input range (18-75V)

6---Output voltage 3.3V

7--- Option, "x" of the model part number to be 0-9, A-Z, which will represent the special request of customer.

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## Absolute Maximum Ratings

Parameter	Min	Typ	Max	Unit	Notes
Continuous Input Voltage	-0.3	-	80	V	
Input Transient Voltage	-	-	100	V	100 mS 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	18	24/48	75	V	
Input Current (full load)	-	4.3	5.0	A	
Input Current (no load)	-	65	100	mA	
Remote Off Input Current	-	10	15	mA	
Input Reflected Ripple Current (rms)	-	7	10	mA	Tested with simulated source impedance of 10 uH, 5 Hz to 20 MHz; use a 100 uF/100 V electrolytic capacitor with ESR = 1 ohm max. at 200 kHz at 25 °C.
Input Reflected Ripple Current (pk-pk)	-	30	50	mA	
I <sup>2</sup> t Inrush Current Transient	-	0.05	0.1	A <sup>2</sup> s	
Turn-on Voltage Threshold	16	16.8	17.5	V	
Turn-off Voltage Threshold	15	15.8	16.5	V	
Input Over Voltage Lockout	76	78	80	V	

**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 8A on system board. Refer to the fuse manufacture's datasheet for further information.

- Notes:**
1. This converter has internal C-L-C (0.47uF-1.0uH-0.47uF+2.2uF) filter.
  2. For recommended external input filter, please refer to **Safety** section.
  3. All specifications are typical at 25 °C unless otherwise stated.

## Output Specifications

Parameter	Min	Typ	Max	Unit	Notes
Output Voltage Set Point	3.234	3.3	3.366	V	Vin=48V, Io=50% load
Load Regulation	-	±3.3	±10	mV	
Line Regulation	-	±3.3	±10	mV	
Regulation Over Temperature (-40deg.C-85deg.C)	-	±10	±33	mV	
Ripple and Noise (pk-pk)	-	50	80	mV	0-20 MHz BW, with a 1µF ceramic capacitor and a 10uF Tantalum cap at output.
Ripple and Noise (rms)	-	15	25	mV	
Ripple and Noise (pk-pk) under worst case	-	-	150	mV	over all operating input voltage, load and temperature conditions.

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### Output Specifications (continued)

Parameter	Min	Typ	Max	Unit	Notes	
Output Current Range	0	-	20	A		
Output DC Current Limit	23	-	35	A		
Short Circuit Surge Transient	-	3	5	A <sup>2</sup> s		
Rise Time	-	5	-	mS		
Turn on Time	10	15	30	mS	Ton(Enable form Vin)	
	10	20	30	mS	Ton(Enable form ON/OFF)	
Overshoot at Turn on	-	0	3	%		
Output Capacitance	0	-	4800	uF		
<b>Transient Response</b>						
ΔV50%~75% of Max Load	Overshoot	-	150	250	mV	di/dt=0.1A/us, Vin=48Vdc, Ta=25°C, with a 1μF ceramic capacitor and a 10uF Tantalum cap at the output.
	Settling Time	-	200	350	uS	
ΔV75%~50% of Max Load	Overshoot	-	150	250	mV	
	Settling Time	-	200	350	uS	

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

### General Specifications

Parameter	Min	Typ	Max	Unit	Notes
Efficiency	88	90	-	%	Vin=48V, full load
	86	88	-	%	Vin=24V, full load
Switching Frequency	240	260	280	kHz	
Output Voltage Trim Range	90	-	110	%Vo	This voltage is achieved by trimming up output slowly
Over Temperature Protection	-	125	-	°C	
Over Voltage Protection(Static)	-	4.1	-	V	
Weight	-	40	-	g	
FIT	TBD			-	Calculated Per Bell Core SR-332 (Vin=48 V, Vo=3.3 V, Io=16 A, Ta = 25 °C, FIT=10 <sup>9</sup> /MTBF)
Dimensions	2.30 x 0.90 x 0.50 58.42 x 22.76 x 12.72			-	
<b>Isolation characteristics</b>					
Input to Output	-	-	1500	V	
Input to Case	-	-	1500	V	
Output to Case	-	-	500	V	
Isolation Resistance	10M	-		ohm	
Isolation Capacitance	-	1500	-	pF	

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

# ISOLATED DC/DC CONVERTERS

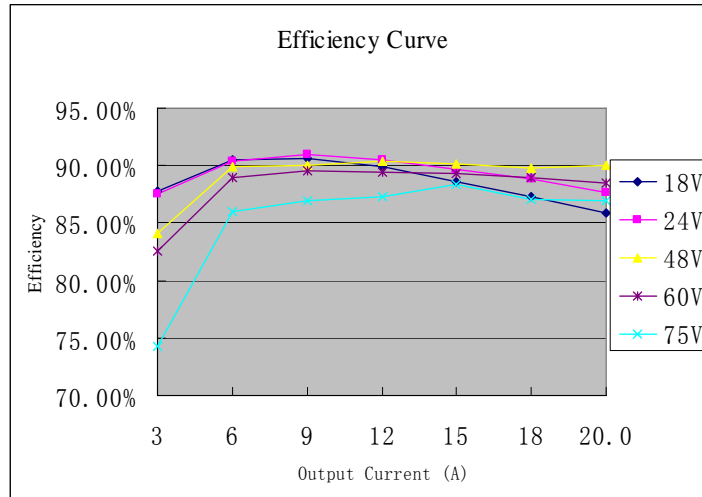
18 Vdc - 75 Vdc Input 3.3 Vdc /20 A Output, 1/8 Brick



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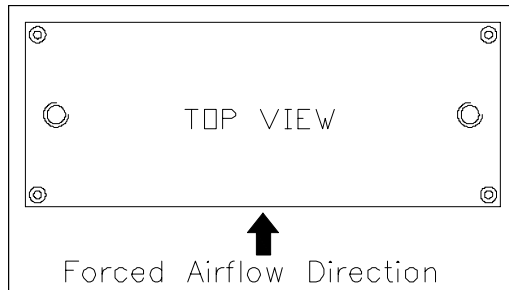
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## Efficiency Data

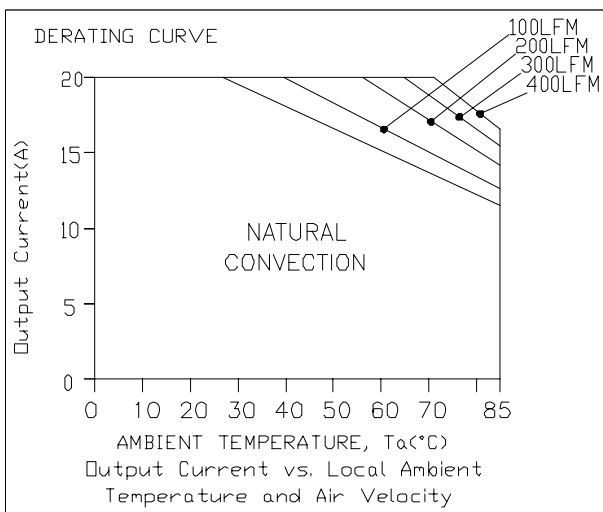


## Thermal Derating Curves

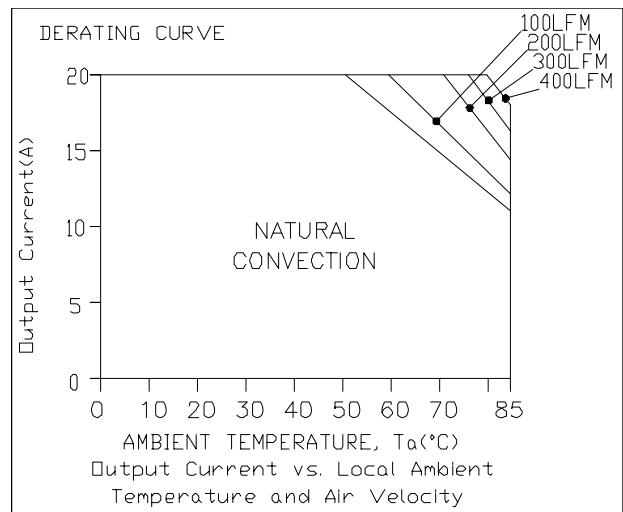
Maximum junction temperature of semiconductors derated to 120 degree C.



Derating curve under 18V input



Derating curve under 24V input



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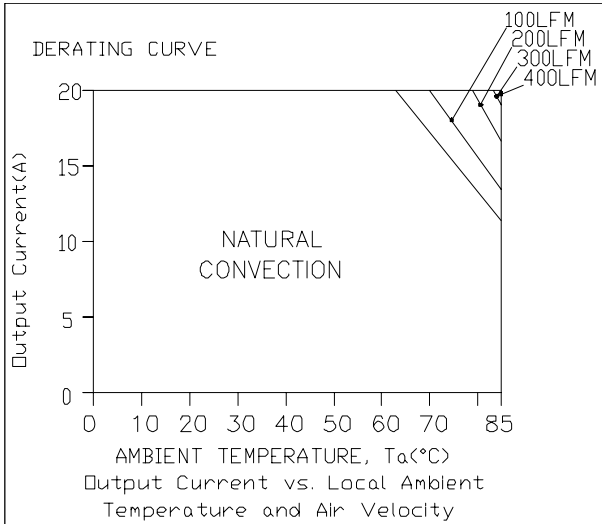


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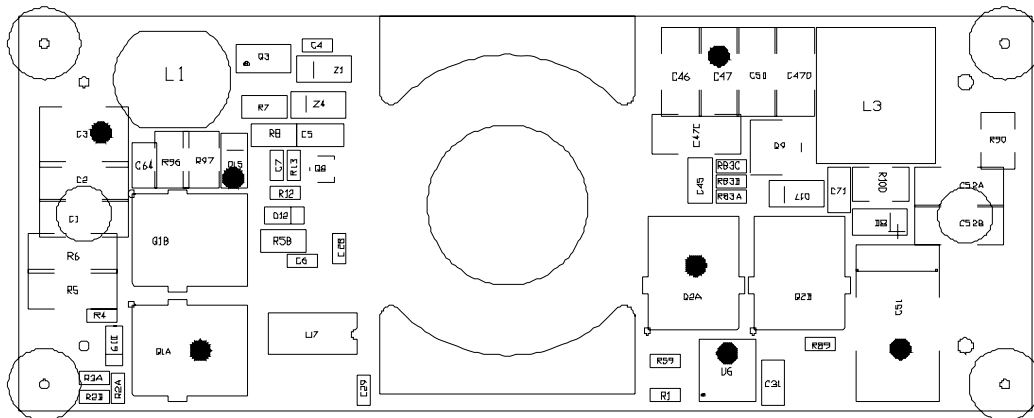
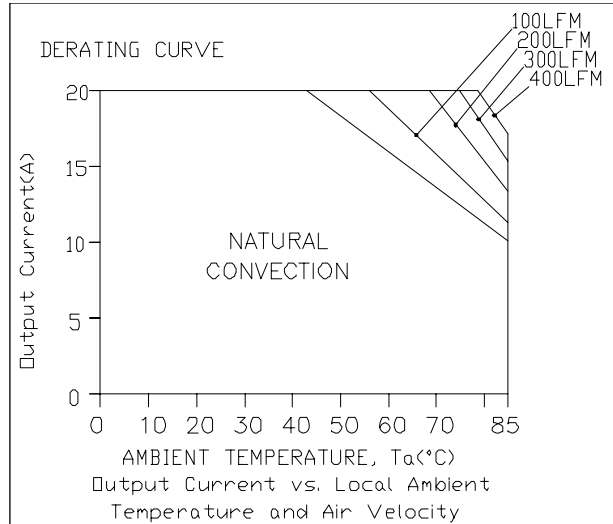
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## Thermal Derating Curves (continued)

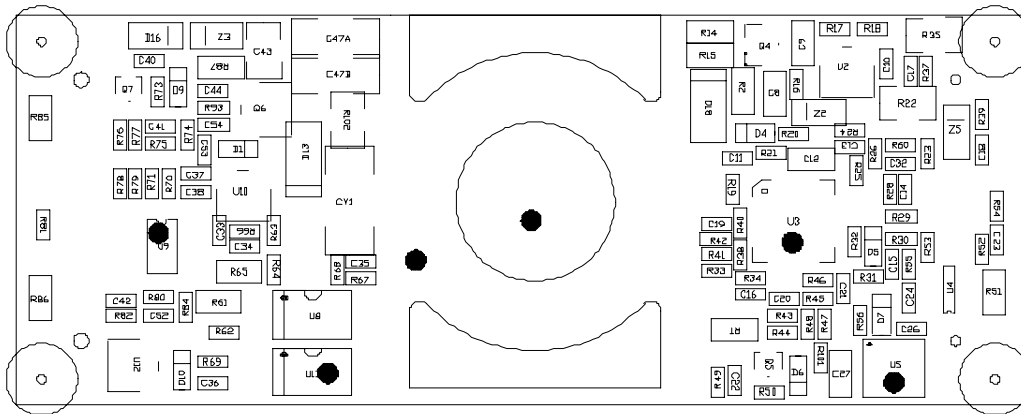
Derating curve under 48V input



Derating curve under 75V input



Temperature reference points on top side



Temperature reference points on bottom side

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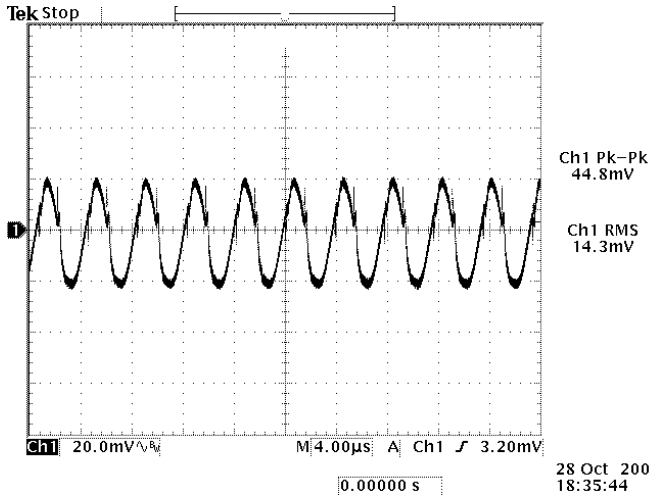
18 Vdc - 75 Vdc Input 3.3 Vdc /20 A Output, 1/8 Brick



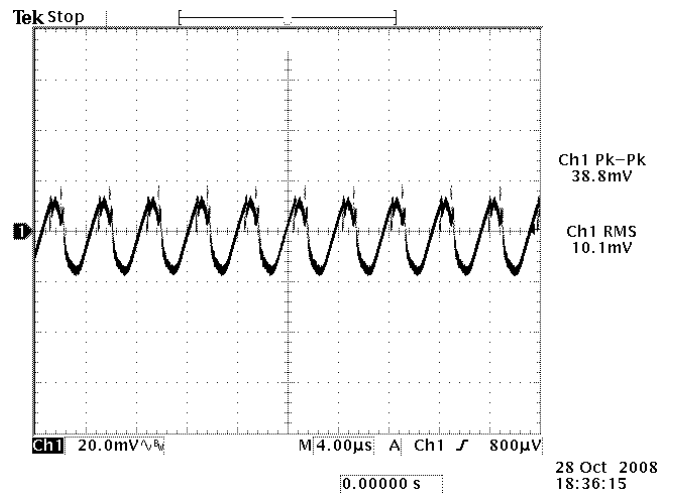
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## Ripple and Noise Waveform



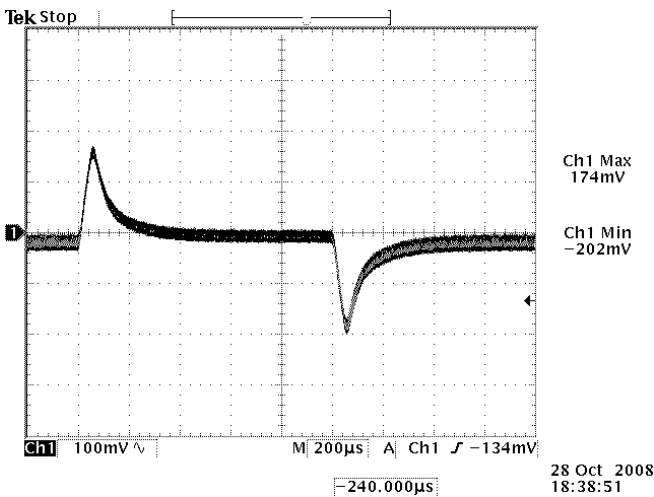
24 Vdc input, 3.3Vdc/20A output



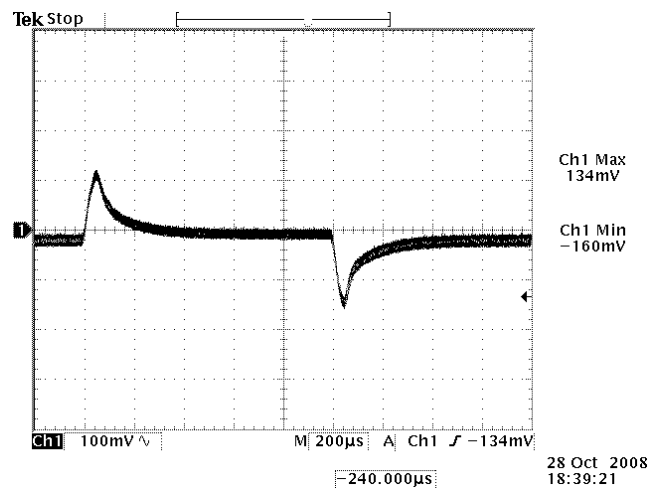
48 Vdc input, 3.3Vdc/20A output

**Note:** Ripple and Noise at full load,  $T_a=25^\circ\text{C}$ , with a  $1\mu\text{F}$  ceramic capacitor and a  $10\mu\text{F}$  Tantalum cap at the output.

## Transient Response Waveforms



50%-75%-50% Load Transients at  $V_{in}=24\text{V}$



50%-75%-50% Load Transients at  $V_{in}=48\text{V}$

**Note:** Transient Response at  $di/dt=0.1\text{A}/\mu\text{s}$ ,  $T_a=25^\circ\text{C}$ , with  $1\mu\text{F}$  ceramic cap and  $10\mu\text{F}$  Tantalum cap at output.

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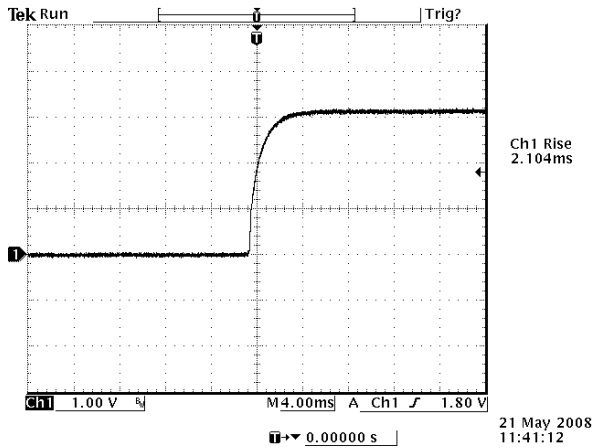


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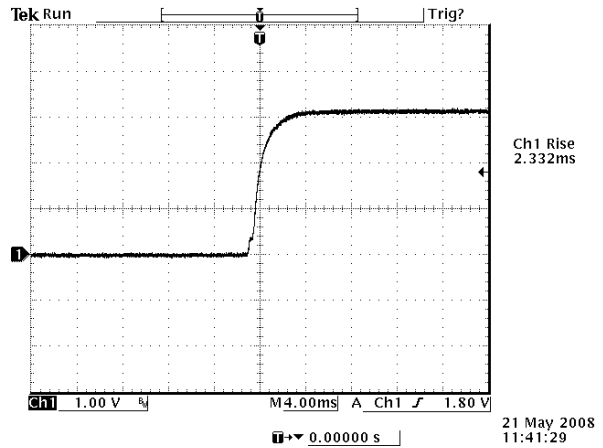
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## Startup & Shutdown

### Rise Time

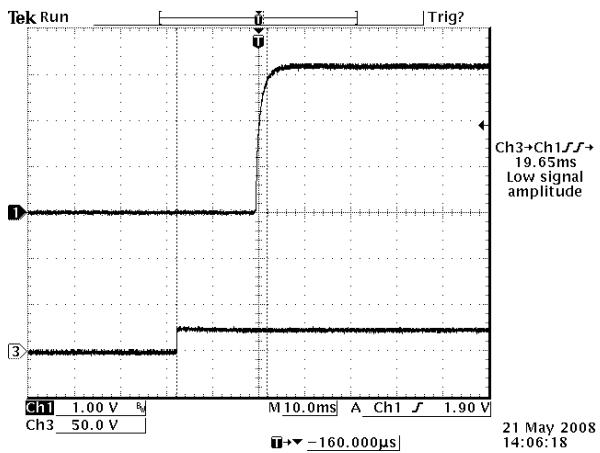


Vout= 3.3V full load at Vin=24V@Ta=25°C

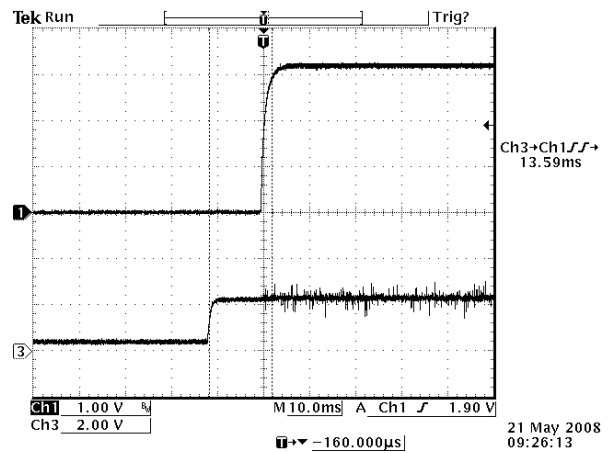


Vout= 3.3V full load at Vin=48V@Ta=25°C

### Startup time



Startup from Vin  
Ch1: Vo, Ch3: Vin  
Vout= 3.3V full load at Vin=24V@Ta=25°C



Startup from on/off  
Ch1: Vo, Ch3: on/off  
Vout= 3.3V full load at Vin=24V@Ta=25°C

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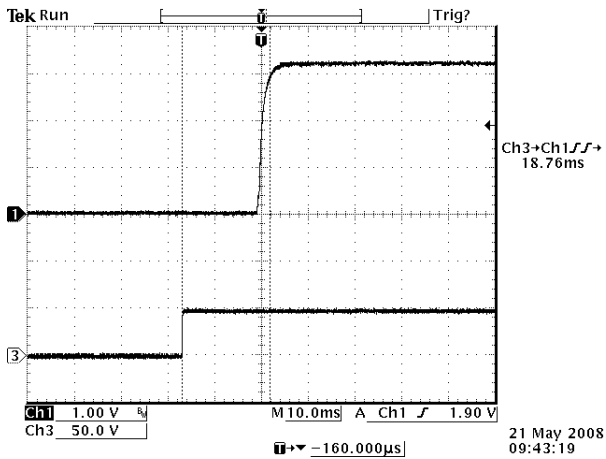


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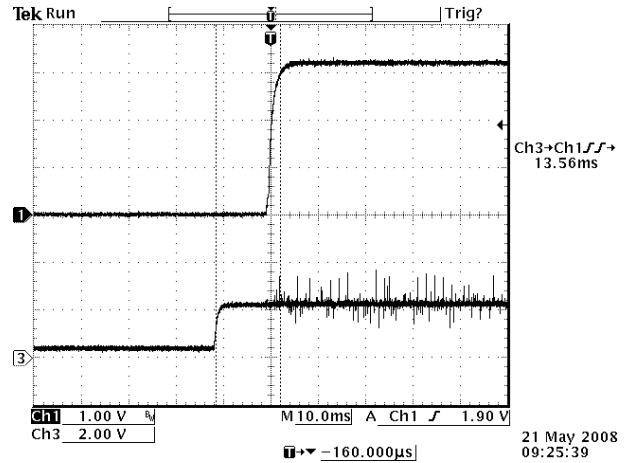
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## Startup & Shutdown (continued)

### Startup time (continued)

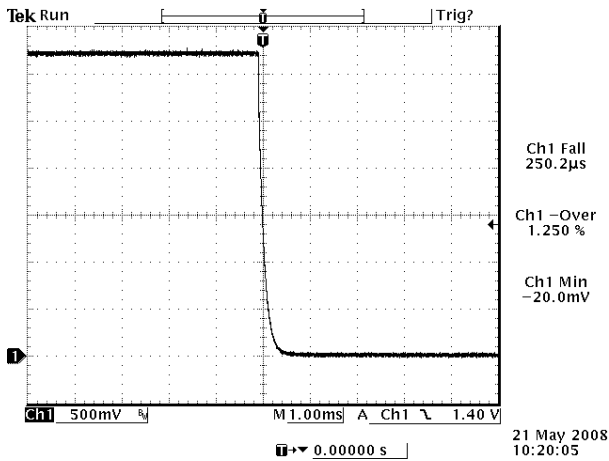


Startup from Vin  
Ch1: Vo, Ch3: Vin  
Vout= 3.3V full load at Vin=48V@Ta=25°C

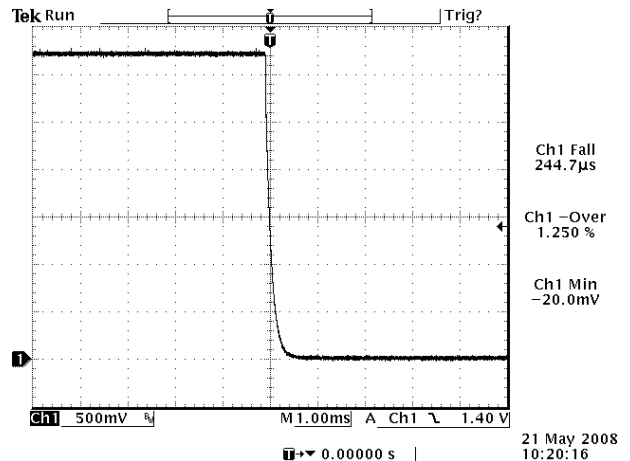


Startup from on/off  
Ch1: Vo, Ch3: on/off  
Vout= 3.3V full load at Vin=48V@Ta=25°C

### Shutdown



Vout= 3.3V full load at Vin=24V@Ta=25°C



Vout= 3.3V full load at Vin=48V@Ta=25°C



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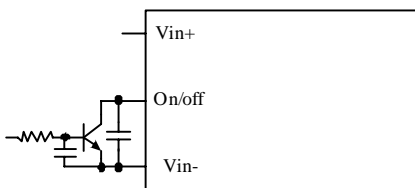
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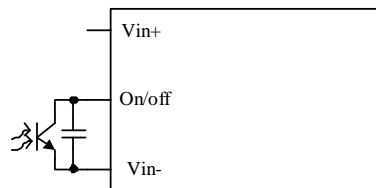
## Remote On/Off

Parameter		Min	Typ	Max	Unit	Notes
Signal Low (Unit On)	Active Low	-0.3	-	0.8	V	0RCY-65U03L. The remote on/off pin open, Unit off.
Signal High (Unit Off)		2.4	-	18	V	
Signal Low (Unit Off)	Active High	-0.3	-	0.8	V	0RCY-65U033. The remote on/off pin open, Unit on.
Signal High (Unit On)		2.4	-	18	V	
Current Sink		0	-	0.75	mA	

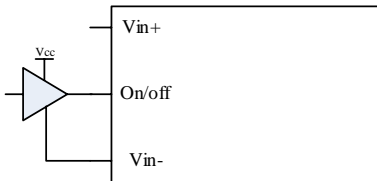
### Recommended remote on/off circuit for active low



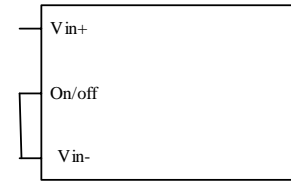
Control with open collector/drain circuit



Control with photocoupler circuit

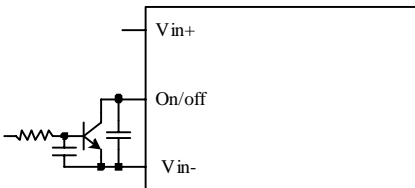


Control with logic circuit

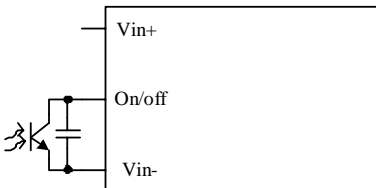


Permanently on

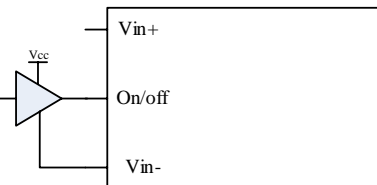
### Recommended remote on/off circuit for active high



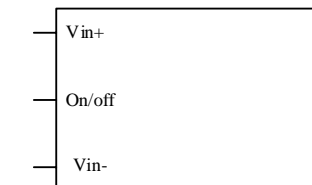
Control with open collector/drain circuit



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 application.

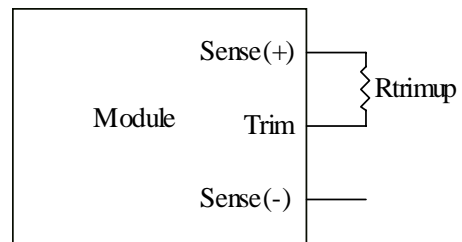
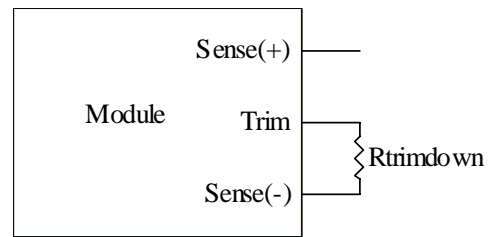
Minimum trim down voltage is 2.97V

Maximum trim up voltage is 3.63V.

The total voltage increased by trim and remote sense should not exceed 5% of the nominal output voltage.

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

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

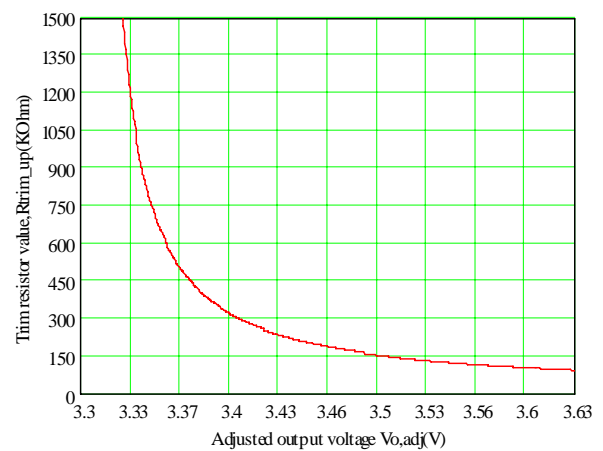
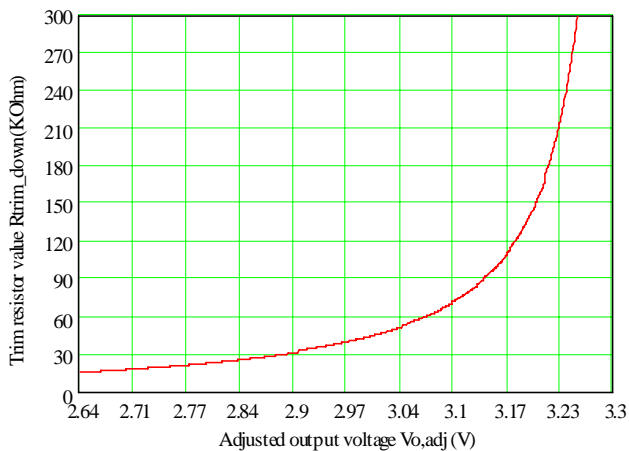


**Note:**

$$\delta = \frac{(V_o_{req} - V_o)}{V_o} \times 100 [\%]$$

$V_o_{req}$ =Desired (trimmed) output voltage [V]

Output voltage  $V_o$ =3.3 V



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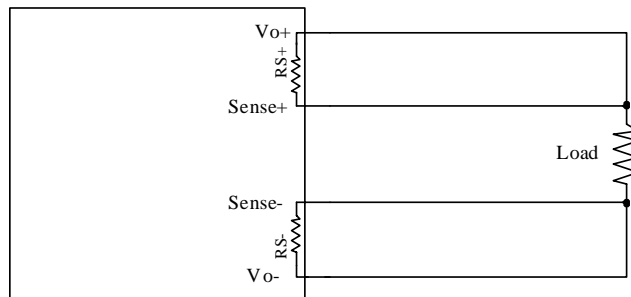
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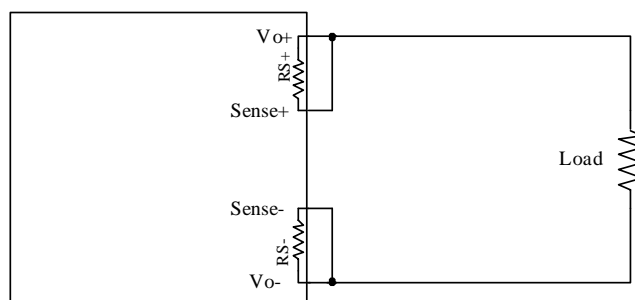
### Remote Sense

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. It 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+ (30.1 ohm) from Vo+ to Sense+ and a resistor RS- (10.5 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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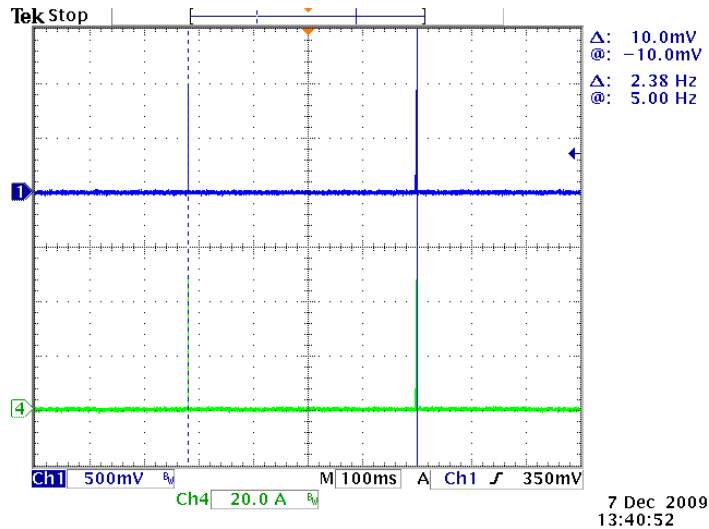


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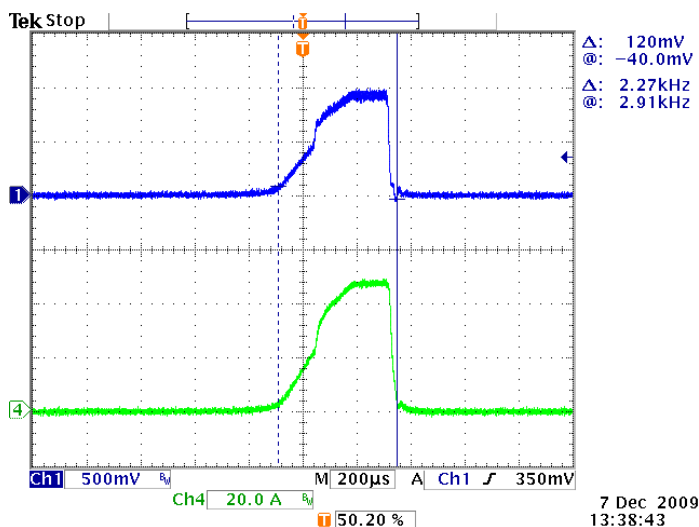
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## Over Current Protection

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 400mS. The module operates normally when the output current goes into specified range. The typical average output current is 5A during hiccup.



CH1: Output voltage waveform  
CH4: output current waveform  
Test at: 48Vdc input, with a Rout (0.022ohm)



Expansion of on time portion of above figure

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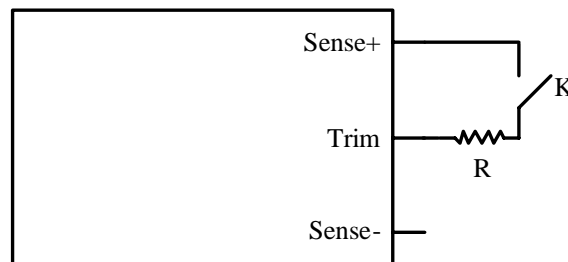
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## Over Voltage Protection

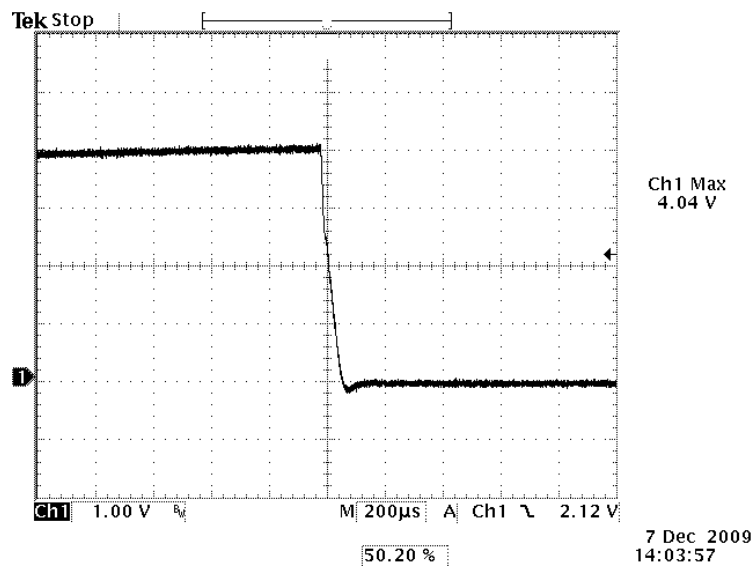
The output overvoltage protection consists of circuitry that monitors the voltage on the output terminals. If the voltage on the output terminals exceeds the over voltage protection threshold, the module will shutdown into hiccup mode and restart once every 400mS. The module operates normally when the fault is cleared.

**Note:** Due to maximum duty cycle limit, output voltage can not be trimmed up to OVP set point in low line input.

Test setup:



R=36k ohm



CH1: Output voltage waveform

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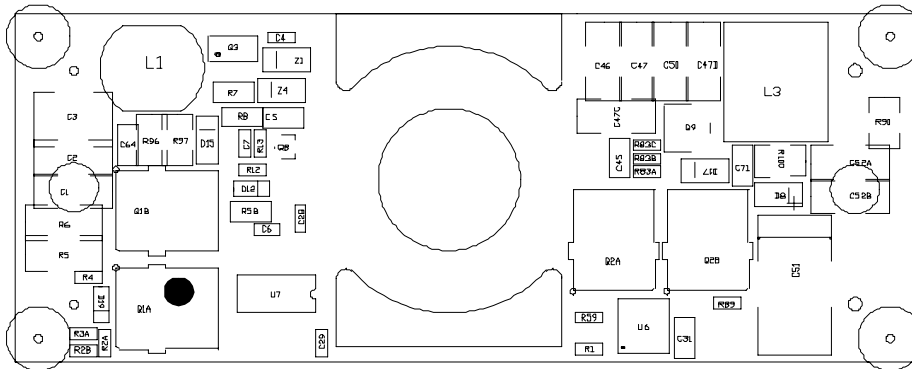


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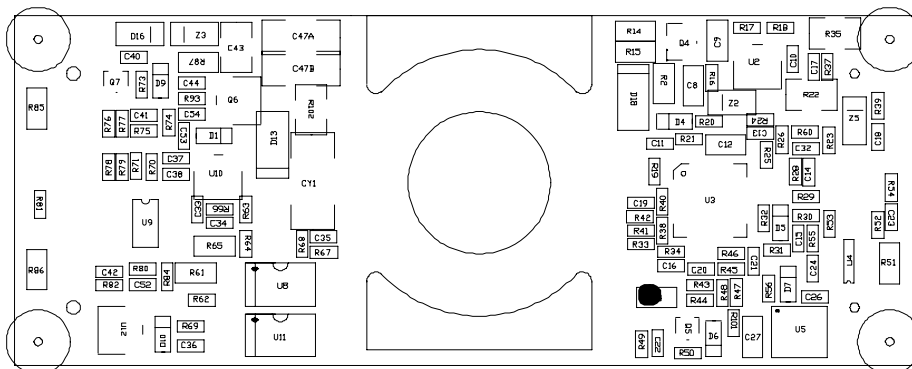
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## Over Temperature Protection

The OTP is achieved by thermistor RT 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...).

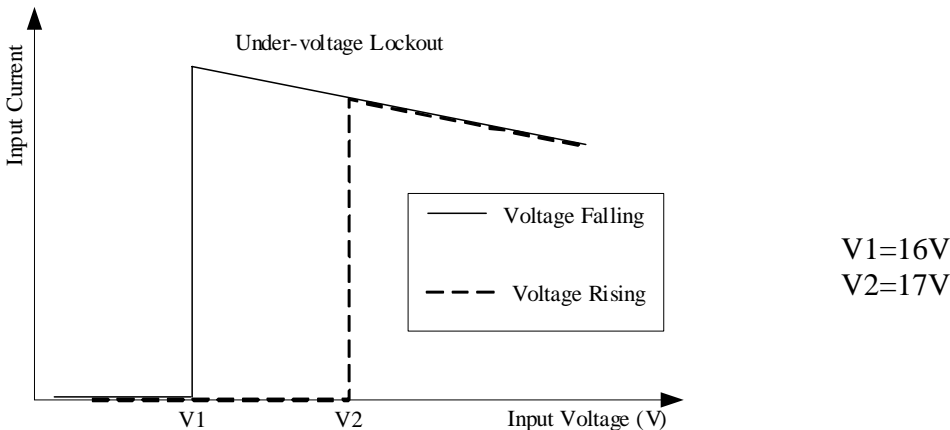


The hottest component on the top side: Q1



The thermistor on the bottom side: RT

## Input Under-voltage Lockout



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## Safety & EMC

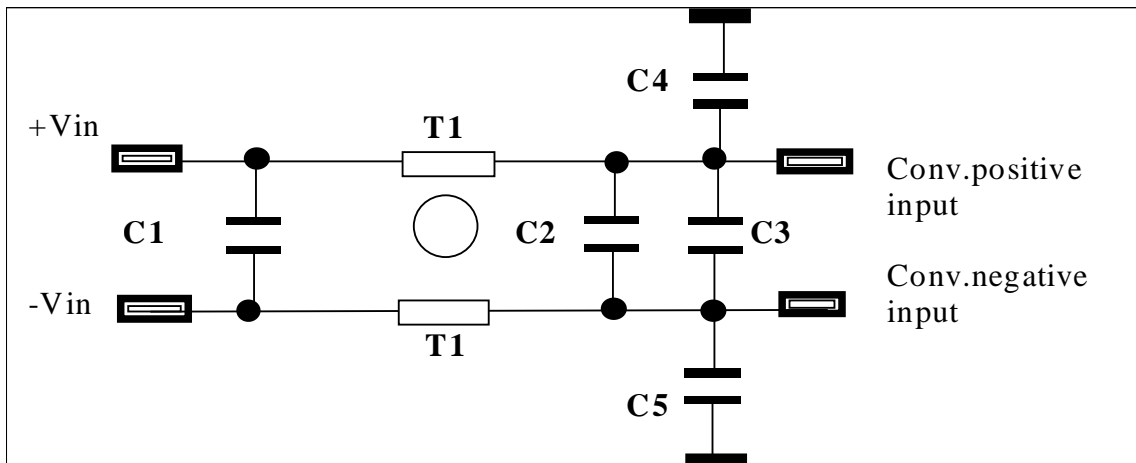
### Safety

1. Material flammability UL94V-0
2. 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



Item	Designator	Parameter	Vendor	Vendor P/N
1	C1	2.2uF/100V,ceramic	Murata	GRF32ER72A225KA11L
2	C2	47uF/100V, AL cap	Nichicon	UUJ2A470MNL1MS
3	C3	100uF/100V, AL cap	Nichicon	UVZ2A101MPD
4	C4	1000pF/2000V,ceramic	Johanson	202R18W102KV4E-****-RC
5	C5	1000pF/2000V,ceramic	Johanson	202R18W102KV4E-****-RC
6	T1	1.3mH, common mode	Pulse	P0402NL

# ISOLATED DC/DC CONVERTERS

18 Vdc - 75 Vdc Input 3.3 Vdc /20 A Output, 1/8 Brick

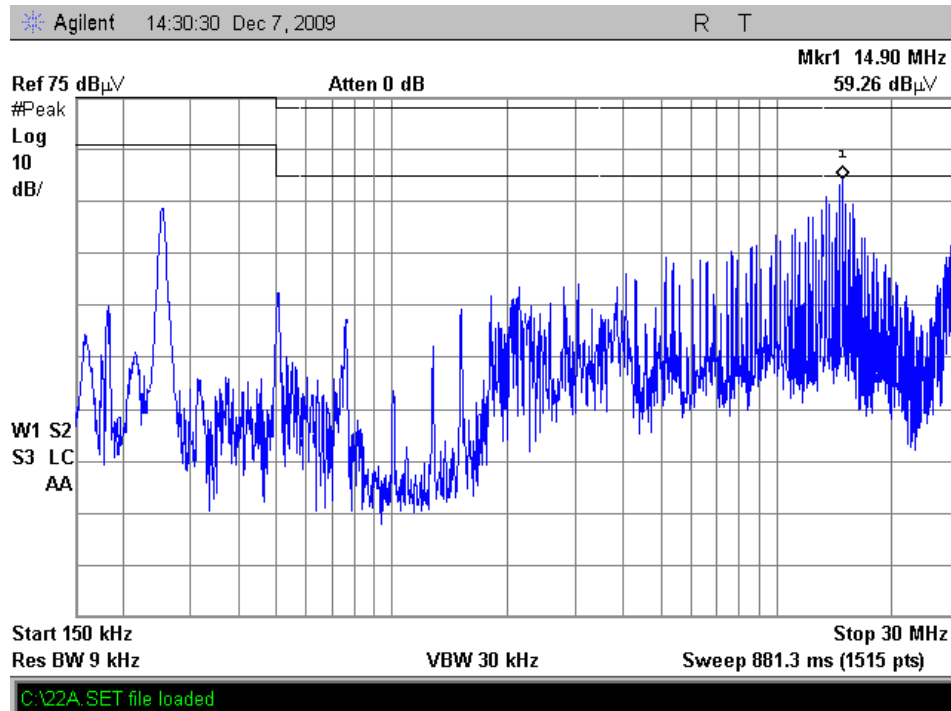


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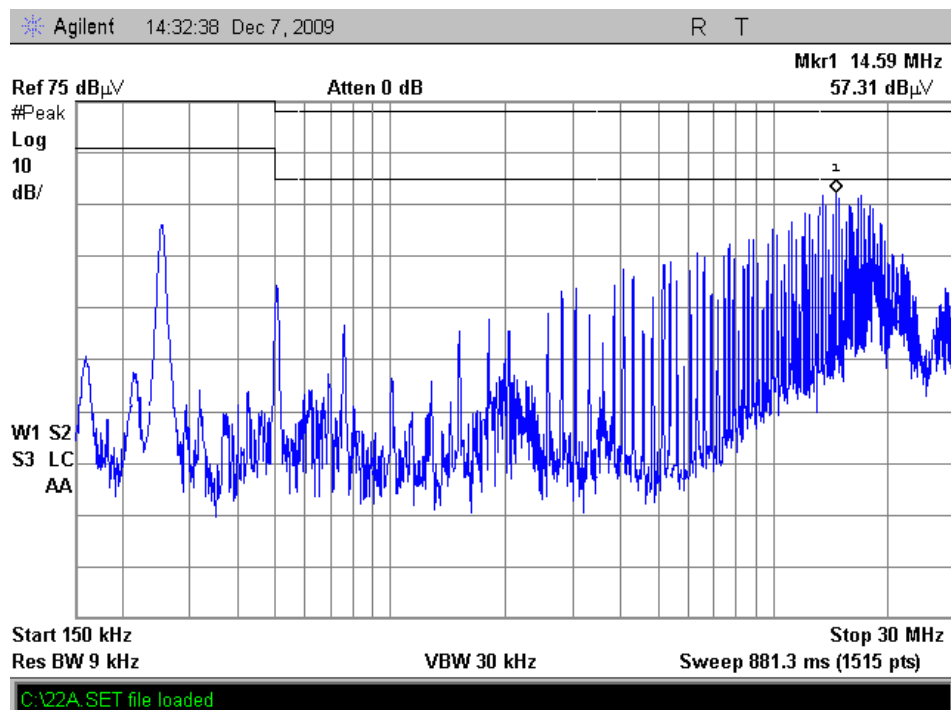
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## Safety & EMC (continued)

Positive:



Negative:





# ISOLATED DC/DC CONVERTERS

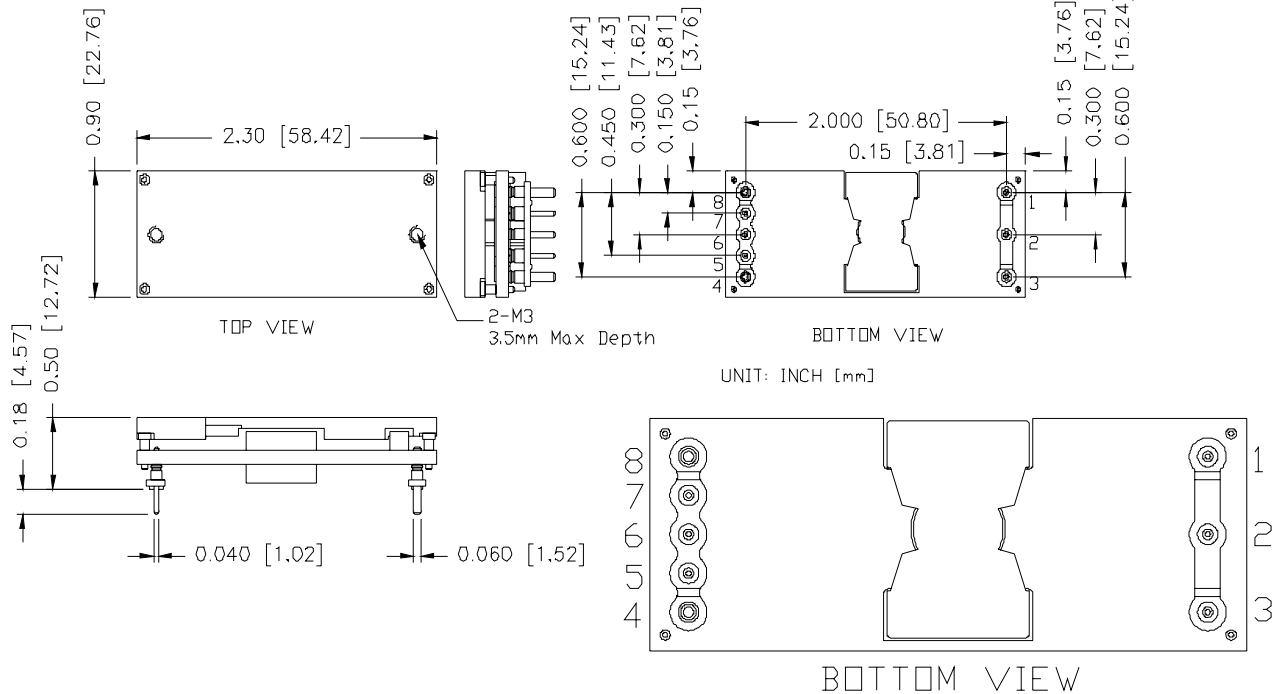
18 Vdc - 75 Vdc Input 3.3 Vdc /20 A Output, 1/8 Brick



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## Mechanical Outline



## Pin Connections

Pin	Name	Function	Pin Dia
1	Vin+	Positive input voltage	0.040"
2	On/Off	Input to turn converter on and off, referenced to Vin-	0.040"
3	Vin-	Negative input voltage	0.040"
4	Vout-	Negative output voltage	0.060"
5	Sense-	Negative remote sense	0.040"
6	Trim	Output voltage trim	0.040"
7	Sense+	Positive output voltage	0.040"
8	Vout+	Positive output voltage	0.060"

- Note:** 1. Pin 5 must be connected to Vout(-).  
 2. Leave Pin 6 open for nominal voltage.  
 3. Pin 7 must be connected to Vout(+).

**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.

### Note:

- All Pins: Material - Copper Alloy;  
Finish – 3 micro inches minimum Gold over 50 micro inches minimum Nickel plate.
- Undimensioned components are shown for visual reference only.
- All dimensions in inches (mm); Tolerances: x.xx +/-0.02 in. (x.x +/-0.5mm) x.xxx +/-0.010 in. (x.xx +/-0.25mm).

# ISOLATED DC/DC CONVERTERS

18 Vdc - 75 Vdc Input 3.3 Vdc /20 A Output, 1/8 Brick



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## Revision History

Date	Revision	Changes Detail	Approval
2008-10-29	A	First release.	Han
2009-12-07	B	Change to new datasheet format, add OCP, OVP, OTP...etc.	XF Jiang
2010-1-12	C	Update outline.	XF Jiang
2010-3-10	D	Update thermal derating curves.	XF Jiang
2010-3-24	E	Add thermal derating curves under 18V input and 75V input	XF Jiang

### 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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