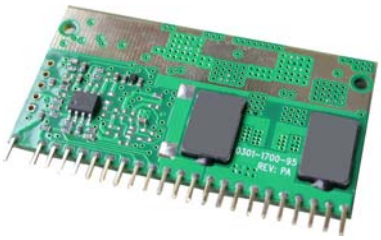
NON-ISOLATED DC/DC CONVERTERS

10.8 Vdc - 13.2 Vdc Input 1.23 Vdc - 3.3 Vdc/21.5 A Output

VRPG-22A1AE RoHS Compliant Rev.A

- Non-Isolated
- High Efficiency
- Fixed Frequency
- Low Cost
- UL60950-1 Recognized (UL/cUL)
- Under-Voltage Lockout (UVLO)
- OCP/SCP
- Output Voltage Trim
- Power Good
- Remote On/Off



Description

The Bel VRPG-22A1AE is part of the low cost non-isolated dc/dc converter power module series. The module use a SIP package for ease of layout and space savings. The output is closely regulated and can be trimmed from 1.23 Vdc to 3.3 Vdc over a wide range of input voltage (Vin=10.8 Vdc-13.2 Vdc). The efficiency is typically 79% at 1.23 Vdc output at full load. Typical features include remote on/off, under-voltage lockout, over-current protection and short circuit protection.

Part Selection

Output Voltage	Input Voltage	Max. Output Current	Max. Output Power	Typical Efficiency at 1.23 V	Model Number
1.23 V - 3.3 V	10.8 V - 13.2 V	21.5 A	26 W	79%	VRPG-22A1AE

Notes: 1. All part numbers above indicate RoHS 6. Change the second letter "R" to "7" for RoHS 5 part numbers.
2. Add “G” suffix at the end of the model numbers listed above to indicate “Tray Packaging”.

Absolute Maximum Ratings

Parameter	Min	Typ	Max	Notes
Input Voltage (continuous)	-0.3 V	-	15 V	
Output Enable Terminal Voltage	-0.3 V	-	15 V	
Ambient Temperature	0 °C	-	65 °C	
Storage Temperature	-45 °C	-	85 °C	

Input Specifications

Parameter	Min	Typ	Max	Notes
Input Voltage	10.8 V	12 V	13.2 V	
Input Current (Full load)				This power module is not internally fused and an external fuse in the input line is recommended.
Vo=3.3 V	-	-	8 A	
Vo=2.5 V	-	-	6 A	
Vo=1.8 V	-	-	5 A	
Vo=1.5 V	-	-	4 A	
Vo=1.23 V	-	-	3.3 A	
Input Current (No load)				
Vo=3.3 V	-	340 mA	-	
Vo=2.5 V	-	280 mA	-	
Vo=1.8 V	-	220 mA	-	
Vo=1.5 V	-	190 mA	-	
Vo=1.23 V	-	165 mA	-	
Remote Off Input Current	-	10 mA	30 mA	
External Input Capacitance	480 uF	-	-	With a combination of 470 uF/16 V AL capacitor with 10 uF/25 V Y5V ceramic capacitor at the input

Input Specifications (Continued)

Parameter	Min	Typ	Max	Notes
Input Reflected Ripple Current (pk-pk)				Tested with simulated source impedance of 1.5 uH, 5 Hz to 20 MHz, and a combination of 470 uF/ 16 V AL capacitor with 10 uF/25 V Y5V ceramic capacitor at the input
Vo=3.3 V	-	350 mA	-	
Vo=2.5 V	-	300 mA	-	
Vo=1.8 V	-	250 mA	-	
Vo=1.5 V	-	200 mA	-	
Vo=1.23 V	-	150 mA	-	
Input Reflected Ripple Current (rms)				
Vo=3.3 V	-	55 mA	80 mA	
Vo=2.5 V	-	50 mA	75 mA	
Vo=1.8 V	-	45 mA	70 mA	
Vo=1.5 V	-	40 mA	60 mA	
Vo=1.23 V	-	30 mA	50 mA	
I^2t Inrush Current Transient	-	0.2 A^2s	0.4 A^2s	
Turn-on Voltage Threshold	-	9.8 V	10.4 V	
Turn-off Voltage Threshold	-	9.4 V	10.0 V	

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

Output Specifications

Parameter	Min	Typ	Max	Notes
Output Voltage Set Point				Test condition: Vin=12 V, Iout= full load
Vo=3.3 V	3.234 V	3.3 V	3.366 V	
Vo=2.5 V	2.450 V	2.5 V	2.550 V	
Vo=1.8 V	1.764 V	1.8 V	1.836 V	
Vo=1.5 V	1.470 V	1.5 V	1.530 V	
Vo=1.23 V	1.215 V	1.23 V	1.265 V	
Load Regulation				Tested at 50% load step at 25 °C.
Vo=3.3 V	-	±7 mV	±14 mV	
Vo=2.5 V	-	±5 mV	±10 mV	
Vo=1.8 V	-	±4 mV	±8 mV	
Vo=1.5 V	-	±3 mV	±6 mV	
Vo=1.23 V	-	±3 mV	±6 mV	
Line Regulation				
Vo=3.3 V	-	±4 mV	±6 mV	
Vo=2.5 V	-	±3 mV	±6 mV	
Vo=1.8 V	-	±2 mV	±5 mV	
Vo=1.5 V	-	±2 mV	±5 mV	
Vo=1.23 V	-	±2 mV	±5 mV	
Regulation Over Temperature (0 °C to +65 °C)				
Vo=3.3 V	-	±16 mV	±33 mV	
Vo=2.5 V	-	±12 mV	±25 mV	
Vo=1.8 V	-	±9 mV	±18 mV	
Vo=1.5 V	-	±8 mV	±15 mV	
Vo=1.23 V	-	±6 mV	±13 mV	
Output Ripple and Noise (pk-pk)				Tested at 0-20 MHz BW, with 10 uF Tantalum capacitor and 1 uF ceramic capacitor at the test point.
Vo=3.3 V	-	50 mV	80 mV	
Vo=2.5 V	-	50 mV	80 mV	
Vo=1.8 V	-	40 mV	60 mV	
Vo=1.5 V	-	30 mV	50 mV	
Vo=1.23 V	-	30 mV	50 mV	

Output Specifications (continued)

Parameter		Min	Typ	Max	Notes
Output Ripple and Noise (rms)					
Vo=3.3 V		-	13 mV	20 mV	Tested at 0-20 MHz BW, with 10 uF Tantalum capacitor and 1 uF ceramic capacitor at the test point.
Vo=2.5 V		-	13 mV	20 mV	
Vo=1.8 V		-	10 mV	15 mV	
Vo=1.5 V		-	10 mV	15 mV	
Vo=1.23 V		-	10 mV	15 mV	
Output Current		0 A	-	21.5 A	
Current Limit Threshold		25 A	32 A	45 A	
Short Circuit Surge Transient		-	0.75 A^2s	1.5 A^2s	
Turn on Time		-	7 mS	15 mS	
Overshoot at Turn on		-	-	5%	
Output Capacitance [1]		-	-	10000 uF	
Transient Response					
50% ~ 75% Max Load	Vo=3.3 V	-	80 mV	160 mV	Test conditions: di/dt = 1 A/uS; Vin = 12 V
Settling Time		-	30 uS	60 uS	
75% ~ 50% Max Load		-	80 mV	160 mV	
Settling Time		-	30 uS	60 uS	
50% ~ 75% Max Load	Vo=2.5 V	-	80 mV	160 mV	
Settling Time		-	30 uS	60 uS	
75% ~ 50% Max Load		-	80 mV	160 mV	
Settling Time		-	30 uS	60 uS	
50% ~ 75% Max Load	Vo=1.8 V	-	60 mV	120 mV	
Settling Time		-	30 uS	60 uS	
75% ~ 50% Max Load		-	60 mV	120 mV	
Settling Time		-	30 uS	60 uS	
50% ~ 75% Max Load	Vo=1.5 V	-	50 mV	100 mV	
Settling Time		-	30 uS	60 uS	
75% ~ 50% Max Load		-	50 mV	100 mV	
Settling Time		-	30 uS	60 uS	
50% ~ 75% Max Load	Vo=1.23 V	-	40 mV	100 mV	
Settling Time		-	30 uS	60 uS	
75% ~ 50% Max Load		-	40 mV	100 mV	
Settling Time		-	30 uS	60 uS	

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

1. This module does not have output capacitors on the converter. Therefore, external capacitors are required. The recommended combination of external output capacitors is: 2 × 150 uF/4 V Aluminum-Organic capacitor + 2 × 470 uF/16 V Aluminum capacitor + 10 uF/25 V ceramic Y5V capacitor.

General Specifications

Parameter	Min	Typ	Max	Notes
Efficiency				
Vo=3.3 V	86%	89%	-	Measured at Vin=12 V, full load.
Vo=2.5 V	84%	87%	-	
Vo=1.8 V	82%	85%	-	
Vo=1.5 V	80%	83%	-	
Vo=1.23 V	77%	80%	-	
Switching Frequency	195 kHz	230 kHz	265 kHz	
Remote Sense Compensation (±)	-	-	10%	
MTBF	602,093 hours			Calculated Per 217F (Io =17.2 A, Vo=1.23 V; Vin=12 V; Ta = 25 ℃)
Dimensions				
Inches (L × W × H)	2.4 x 1.25 x 0.22			
Millimeters (L × W × H)	60.96 x 31.75 x 5.59			
Weight	-	16 g	-	

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

Control Specifications

Parameter	Min	Typ	Max	Notes
Remote On/Off				
Signal Low (Unit Off)	0 V	-	1 V	Remote On/Off pin open, the module is ON.
Signal High (Unit On)	2.4 V	-	13.2 V	
Power Good				
Power Good Delay [1]	-	-	10 mS	
Signal Low	0 V	-	1 V	
Signal High	2.4 V	-	5 V	

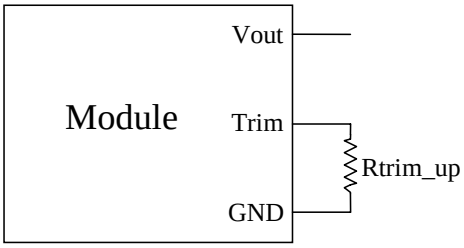
Notes: All specifications are typical at 25 °C unless otherwise stated.

1. Power good delay time is the time from output voltage reaches its final regulation value to Power Good Signal is set.

Output Trim Equation

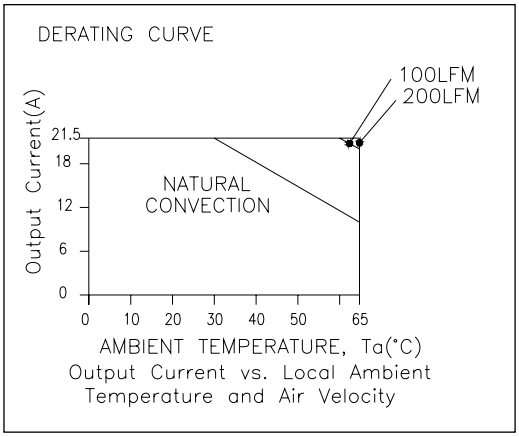
Equation for calculating the trim resistor (in Kohm) given the desired adjusted voltage at no load (V_{adj_up}) is shown below. The R_{trim_up} resistor should be connected between the Trim pin and Ground.

$$R_{trim\_up} = \frac{0.2537}{V_{adj\_up} - 1.2375} - 0.075$$

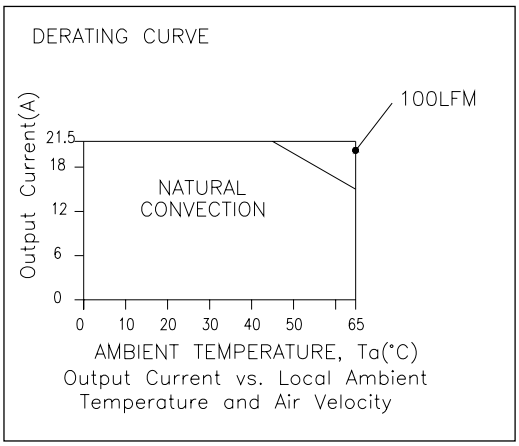


Note: Vadj_up is the desired adjusted Vo.

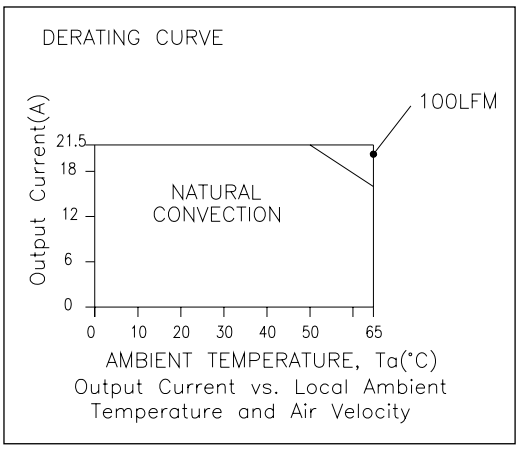
Thermal Derating Curves



Vo=3.3 V

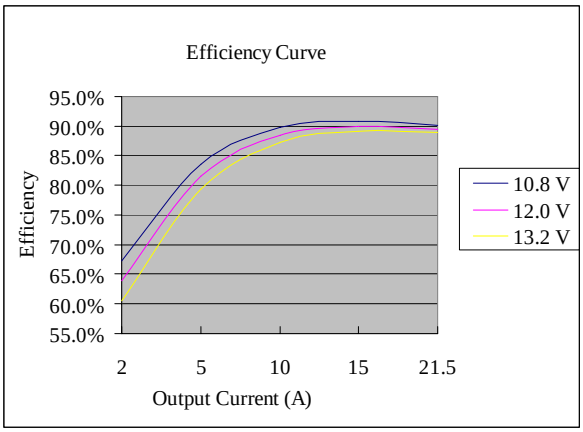


Vo=1.8 V

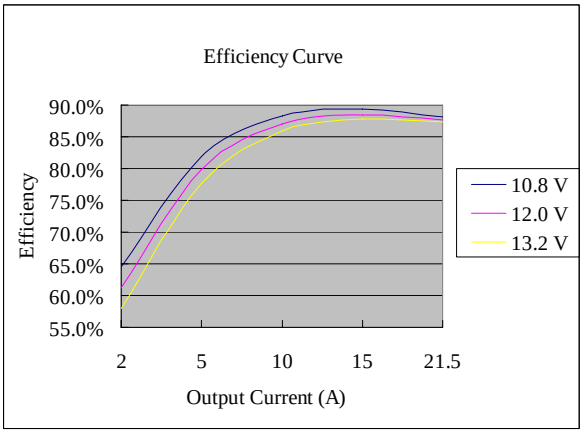


Vo=1.23 V

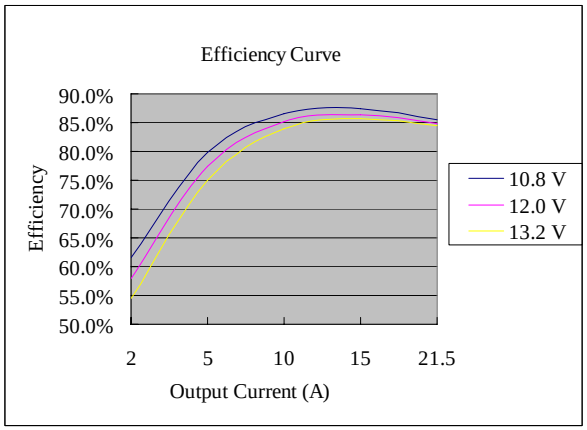
Efficiency Data



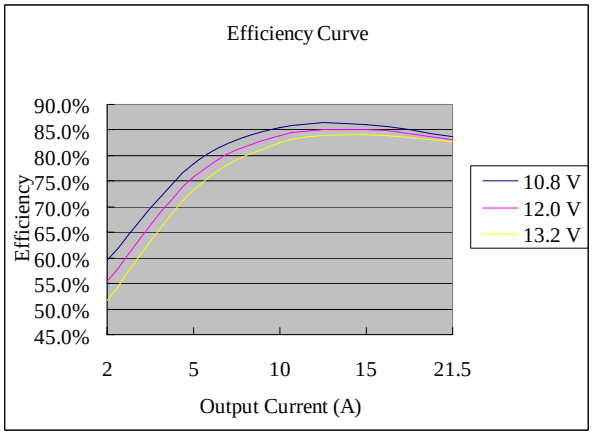
Vo=3.3 V



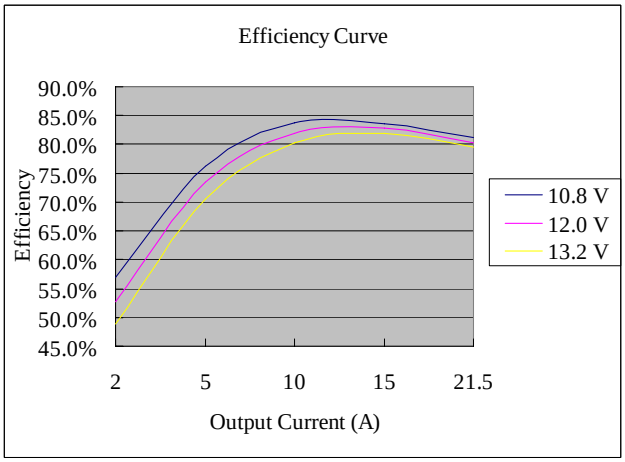
Vo=2.5 V



Vo=1.8 V

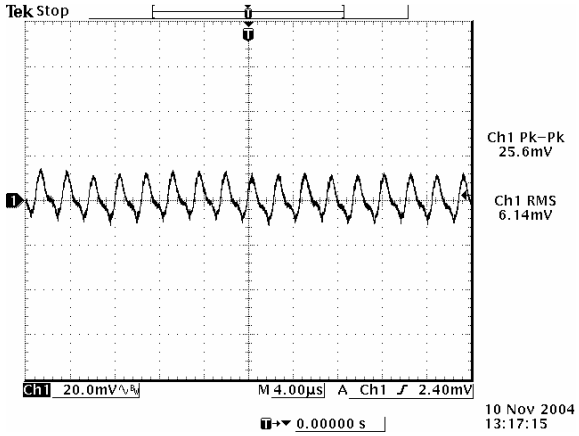


Vo=1.5 V

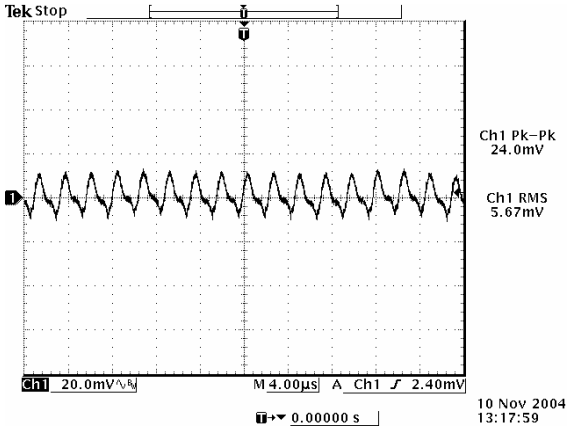


Vo=1.23 V

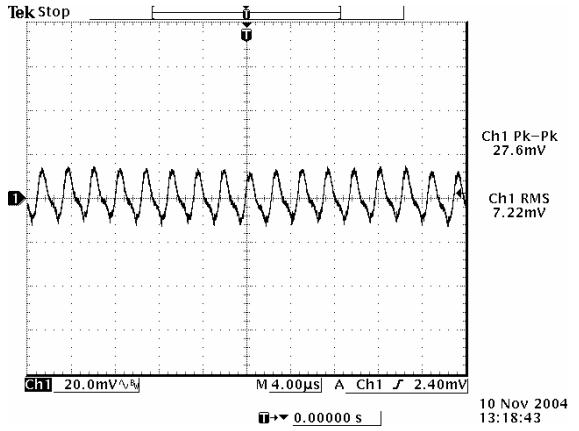
Ripple and Noise Waveforms



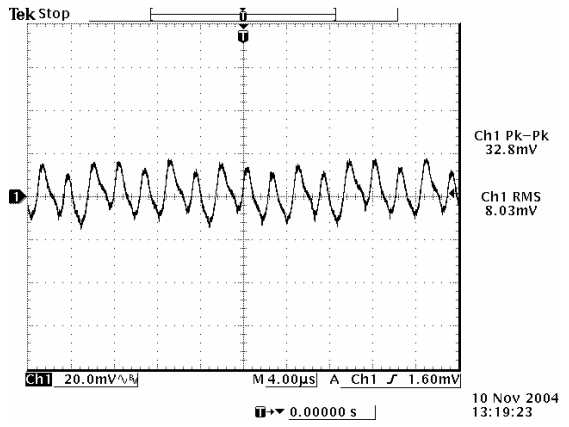
1.23 Vdc/0 A output



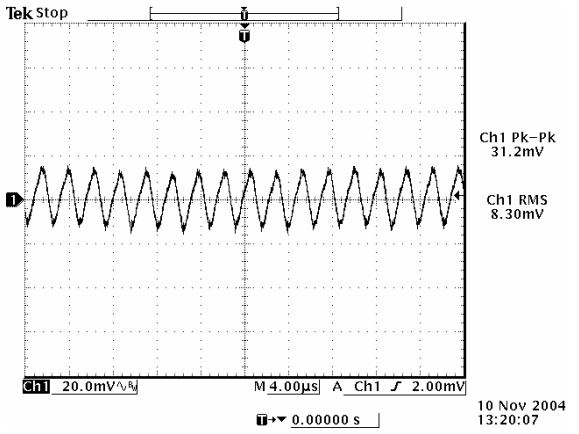
1.23 Vdc/21.5 A output



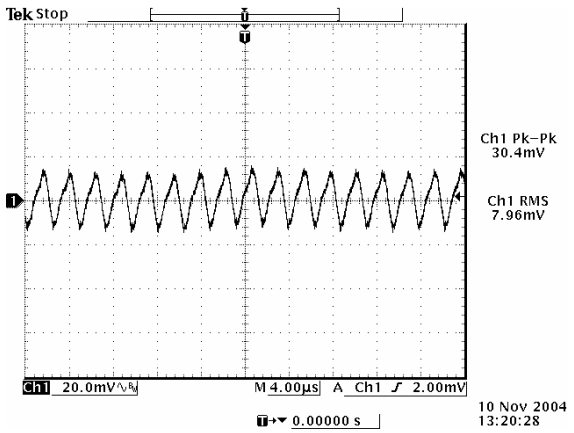
1.8 Vdc/0 A output



1.8 Vdc/21.5 A output



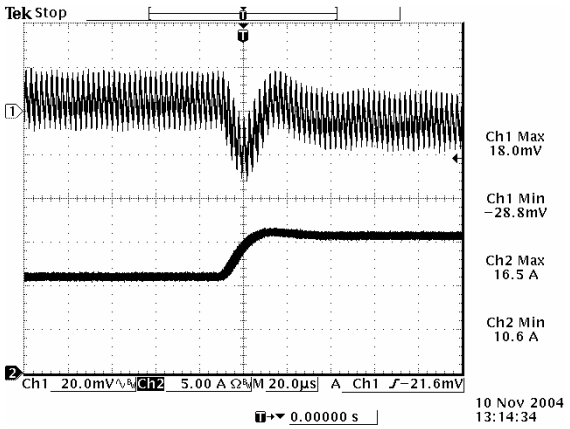
3.3 Vdc/0 A output



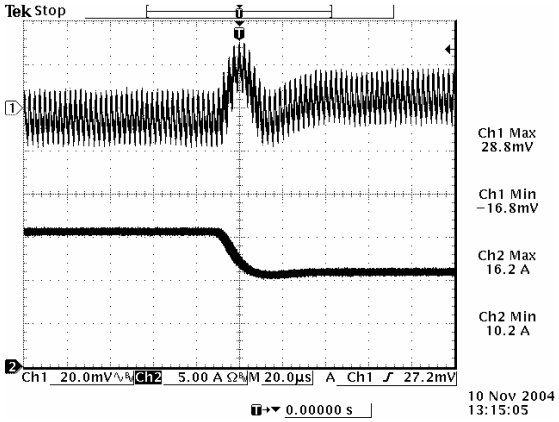
3.3 Vdc/21.5 A output

Note: Ripple and Noise at 12 V Input, with external 1uF ceramic cap at output ripple test point, Ta=25 deg C.

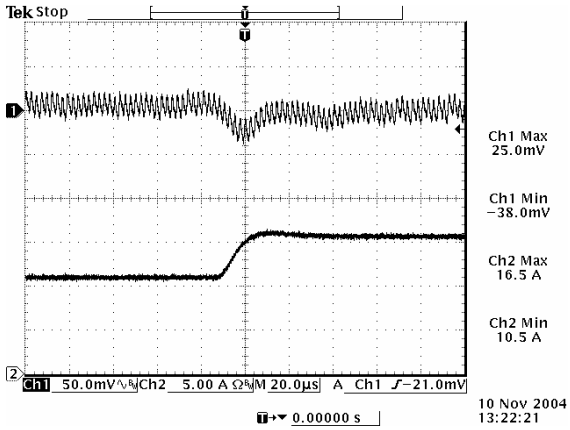
Transient Response Waveforms



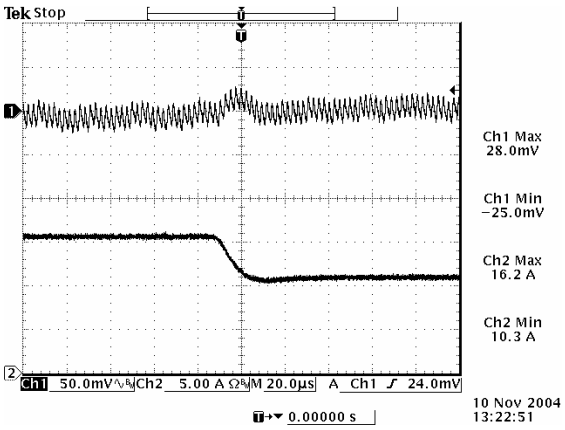
Transients 50% to 75% load, 1.23 Vdc Output



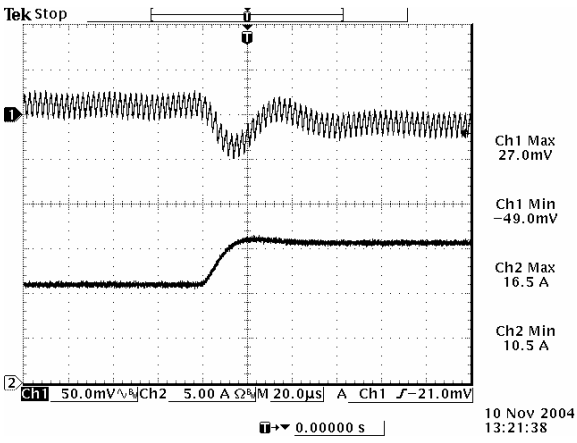
Transients 75% to 50% load, 1.23 Vdc Output



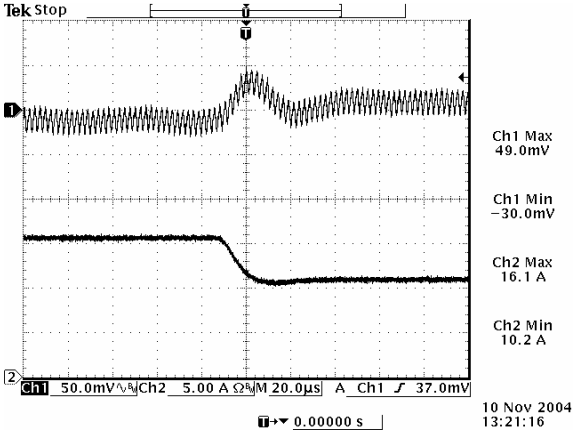
Transients 50% to 75% load, 1.8 Vdc Output



Transients 75% to 50% load, 1.8 Vdc Output



Transients 50% to 75% load, 3.3 Vdc Output



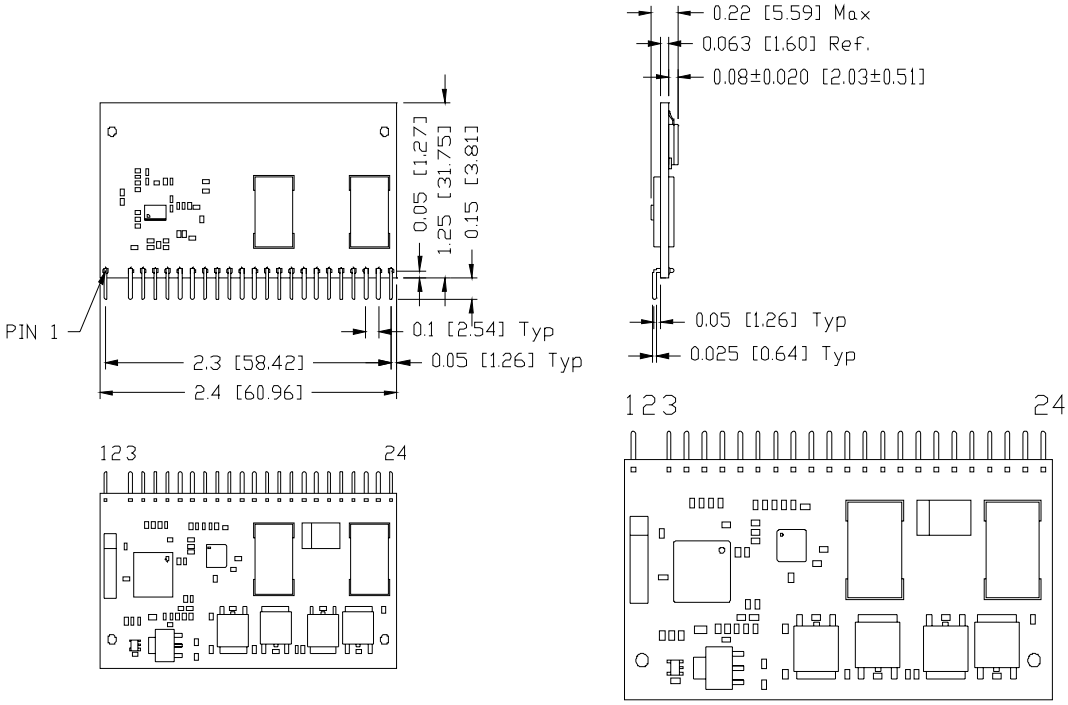
Transients 75% to 50% load, 3.3 Vdc Output

Note: Transient Response at Vin=12 Vdc, di/dt=1 A/uS, 2x150 uF/4 V Aluminum-Organic AO-CAP + 2x470 uF/16 V Aluminum Cap +10 uF/25 V Ceramic Y5V Cap at output, and Ta=25 deg C.

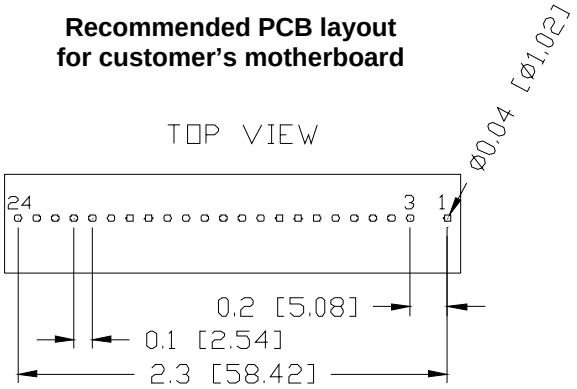
NON-ISOLATED DC/DC CONVERTERS

10.8 Vdc - 13.2 Vdc Input 1.23 Vdc - 3.3 Vdc/21.5 A Output

Mechanical Outline



Recommended PCB layout for customer's motherboard



Pin Connections

Pin	Function	Pin	Function
1	Trim	13	Vin
2	No Pin	14	Vin
3	Ground	15	Vout
4	PWRGOOD	16	Vout
5	No Connection	17	Ground
6	No Connection	18	Vout
7	Ground	19	Ground
8	Ground	20	Vout
9	Remote On/Off	21	Ground
10	Remote -Sense	22	Vout
11	Remote +Sense	23	Ground
12	Vin	24	Vout

RoHS Compliance

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

CORPORATE

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