VRP1-30E1A0

Non-Isolated DC-DC Converter

The Bel VRP1-30E1A0 is part of the non-isolated DC-DC converter Power Module series. The module uses a SIP package. This converter is available in a range of output voltages from 0.591 VDC to 5.1 VDC over a wide range of input voltage (Vin = 4.5 - 13.8 VDC). The efficiency is typically 94% @ 12 Vin and 5.0 Vout at full load.

RoHS Compliant

Key Features & Benefits

- Non-Isolated
- High Efficiency
- Fixed Frequency
- High Power Density
- Wide Input
- Low Cost
- Under Voltage Lockout
- OCP/SCP
- Remote On/Off
- Remote Sense
- Wide Trim
- Power Good Signal
- Class II, Category 2, Isolated DC-DC Converter (refer to IPC-9592B)

Applications

- Networking
- Computers and Peripherals
- Telecommunications

1. MODEL SELECTION

MODEL NUMBER	OUTPUT VOLTAGE	INPUT VOLTAGE	MAX. OUTPUT CURRENT	MAX. OUTPUT POWER	TYPICAL EFFICIENCY
VRP1-30E1A0G	0.591 - 5.1 VDC	4.5 - 13.8 VDC	30 A	150 W	94%

PART NUMBER EXPLANATION

V	R	P1	-	30	E	1A	0	G
Mounting Type	RoHS Status	Series Name		Output Current	Input Range	Output Voltage	Active Logic	Package Type
Vertical Mount	RoHS	SIP		30 A	4.5 - 13.8 V	0.591 - 5.1 V	Active High	Tray Package

2. ABSOLUTE MAXIMUM RATINGS

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNITS
Continuous non-operating Input Voltage		-0.3	-	15	V
Remote On/Off		-0.3	-	5.5	V
Ambient Temperature		0	-	70	°C
Storage Temperature		-40	-	125	°C
Altitude		-	-	2000	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	Vo < 3.45 V	4.5	12	13.8	V
	Vo ≥ 3.45 V	1.3*Vo	12	13.8	V
Input Current (full load)		-	-	30	A
Input Current (no load)		-	150	300	mA
Remote Off Input Current		-	20	-	mA
Input Reflected Ripple Current (rms)	With simulated source impedance of 1 µH, 5 Hz to 20 MHz. Use a 1000 µF/16 V electrolytic capacitor with ESR = 1 ohm max, at 200 kHz @25°C.	-	20	40	mA
Input Reflected Ripple Current (pk-pk)		-	50	100	mA
I^2t Inrush Current Transient		-	-	1	A^2s
Turn-on Voltage Threshold		-	4.4	-	V
Turn-off Voltage Threshold		-	3.9	-	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 45 A on system board. Refer to the fuse manufacture's datasheet for further information.

NOTE:

1. This converter has internal C (60 µF) filter.
2. A 30.1 K resistor is connected from Enable to Vin.
3. All specifications are typical at 25°C unless otherwise stated.

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 = 12 V, Iout = half load		-1.5	-	1.5	%Vo,set
Load Regulation				-	-	1	%Vo,set
Line Regulation				-	-	0.5	%Vo,set
Regulation Over Temperature (0°C to 70°C)				-	-	1	%Vo,set
Output Current Range				0	-	30	A
Output DC Current Limit				-	45	-	A
Output Ripple and Noise (pk-pk)		0-20 MHz BW, 10 µF tantalum cap and 1 µF ceramic on output.		-	50	80	mV
Output Ripple and Noise (rms)				-	20	40	mV
Ripple and Noise (pk-pk) under worst case		Over entire operating input voltage range, load and ambient temperature condition.		-	-	100	mV
Short Circuit Surge Transient				-	1	3	A^2s
Turn on Time				-	4	10	ms
Rise Time				-	3.3	-	ms
Overshoot at Turn on				-	0	3	%
Output Capacitance		Unit can work at Vo = 1.1 V with 2700 µF output Cap		0	-	1000	µF
Transient Response							
△V 50%~75% of Max Load	Overshoot	Vo = 1.1 V	di/dt = 2.5 A/µs, Vin = 12.0 VDC, Ta = 25°C, 10 µF tantalum cap and 1 µF ceramic on output.	-	50	70	mV
	Settling Time			-	30	50	µs
△V 75%~50% of Max Load	Overshoot			-	50	70	mV
	Settling Time			-	30	50	µs
△V 50%~75% of Max Load	Overshoot	Vo = 2.5 V		-	120	150	mV
	Settling Time			-	30	50	µs
△V 75%~50% of Max Load	Overshoot			-	120	150	mV
	Settling Time			-	30	50	µs
△V 50%~75% of Max Load	Overshoot	Vo = 5.1 V		-	220	300	mV
	Settling Time			-	30	50	µs
△V 75%~50% of Max Load	Overshoot			-	220	300	mV
	Settling Time			-	30	50	µs

5. GENERAL SPECIFICATIONS

PARAMETER		DESCRIPTION	MIN	TYP	MAX	UNIT
Efficiency	Vo = 0.591 V	Vin = 12.0 V, full load	-	72	-	%
	Vo = 1.1 V		-	83	-	%
	Vo = 2.5 V		-	91	-	%
	Vo = 3.3 V		-	92	-	%
	Vo = 5.1 V		-	94	-	%
Switching Frequency			-	500	-	kHz
Output Voltage Trim Range (Wide Trim)			0.591	-	5.1	V
Remote Sense Compensation			-	-	0.2	V
FIT		Calculated Per Bell Core SR-332 (Io = 80% load, Ta = 25°C, FIT = 10^9/MTBF)	-	183	-	-
Weight			-	10.7	-	g
Dimensions (L × W × H)			1.20 x 0.71 x 0.61			inch
			30.48 x 18.03 x 15.49			mm

6. EFFICIENCY DATA

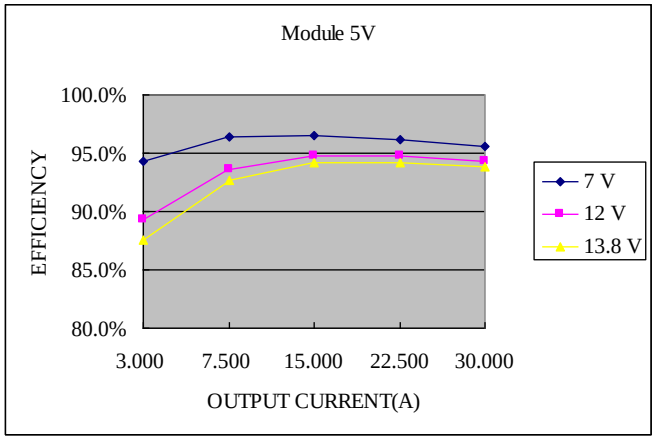

Figure 1. Efficiency data at Vo = 5 V

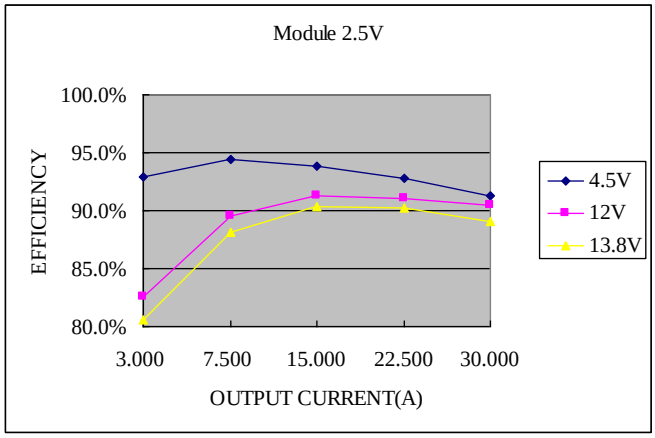

Figure 2. Efficiency data at Vo = 2.5 V

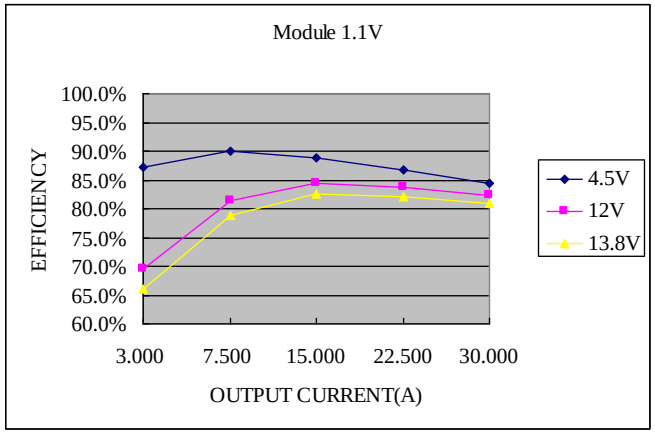

Figure 3. Efficiency data at Vo = 1.1 V

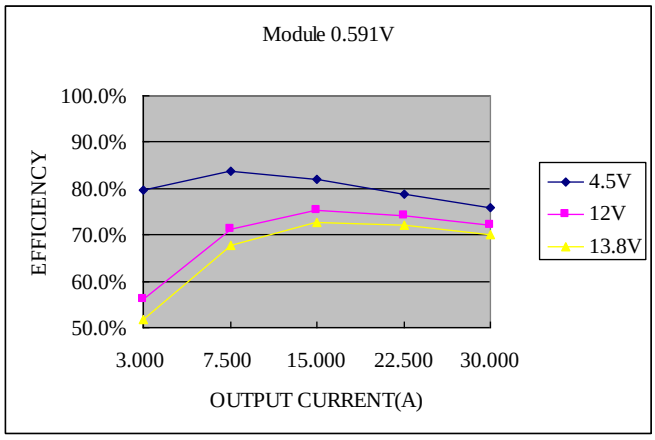

Figure 4. Efficiency data at Vo = 0.591 V

7. REMOTE ON/OFF

PARAMETER		DESCRIPTION	MIN	TYP	MAX	UNIT
Signal Low (Unit Off)	Active High	Remote On/Off pin is open, the module is off. If a 30.1 k resistor is connected from Enable to Vin and Remote On/Off pin is open, the module is on.	-0.3	-	0.4	V
Signal High (Unit On)			2	-	5.5	V
Current Sink			0	-	1	mA

Recommended remote on/off circuit for active high

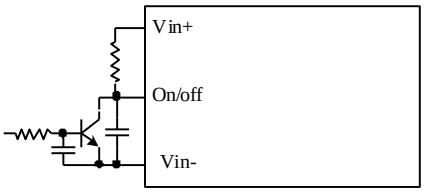

Figure 5. Control with open collector/drain circuit

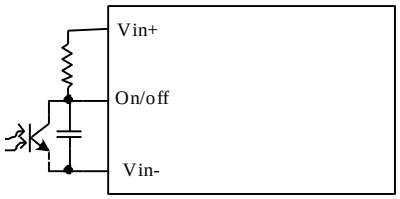

Figure 6. Control with photocoupler circuit

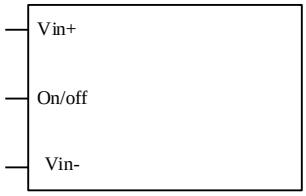

Figure 7. Permanently off

8. OUTPUT TRIM EQUATIONS

Equations for calculating the trim resistor are shown below.

Minimum trim down voltage is 0.591 V.

Maximum trim up voltage is 5.1 V.

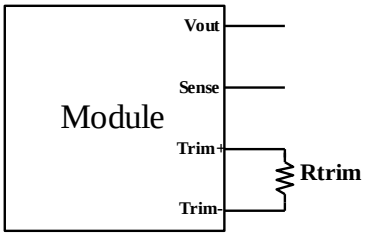

Figure 8. Trim up test circuit

$$Rtrim = \left[\frac{1.182}{Vo - 0.591} \right]$$

Vo is the desired output voltage.
Rtrim is the required resistance between Trim+ and Trim-.

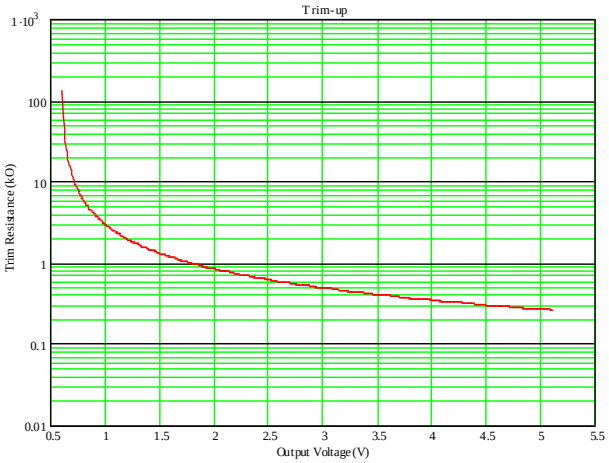

Figure 9. Trim up derating curve

9. 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 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. It can make an effect on the module's compensation, affecting the stability and dynamic response. A 0.1 μF 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+ (10 ohm) from Vo+ to Sense+ and a resistor RS- (10 ohm)) from Vo- to Sense- inside of this module.

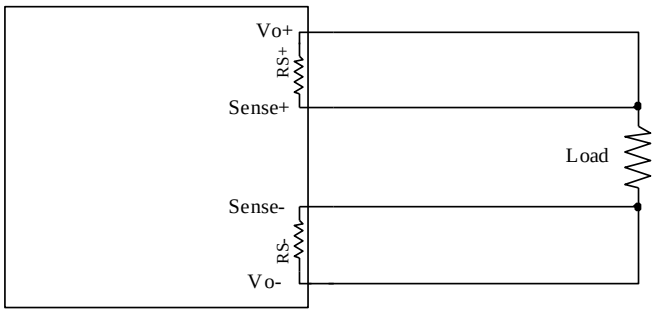

Figure 10.

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.

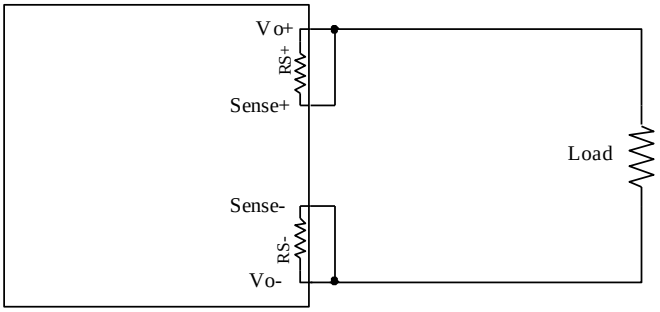

Figure 11.

10. INPUT UNDER-VOLTAGE LOCKOUT

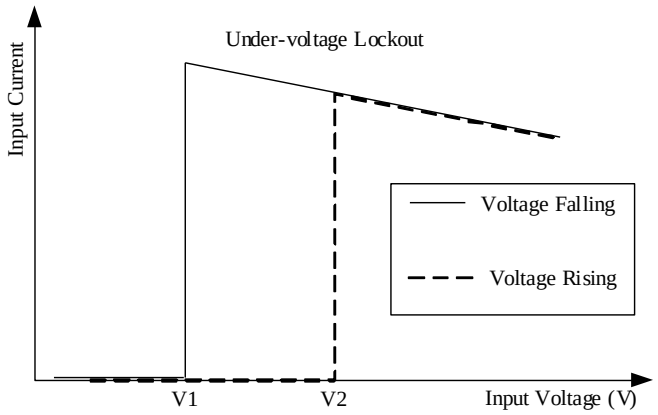

Figure 12. Input under-voltage lockout
V1 = 3.9 V
V2 = 4.4 V
A 30.1k resistor is connected from Enable to Vin

11. THERMAL DERATING CURVE

The thermal reference point is shown above. For reliable operation this temperature should not exceed 110°C. The output power of the module should not exceed the rated power for the module.

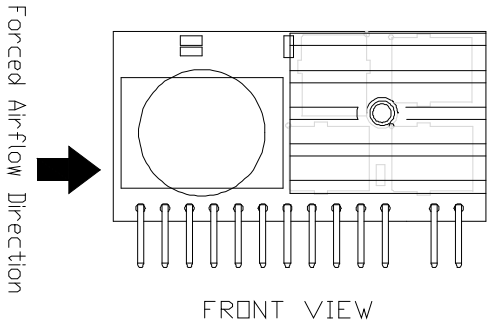

Figure 13. Airflow direction

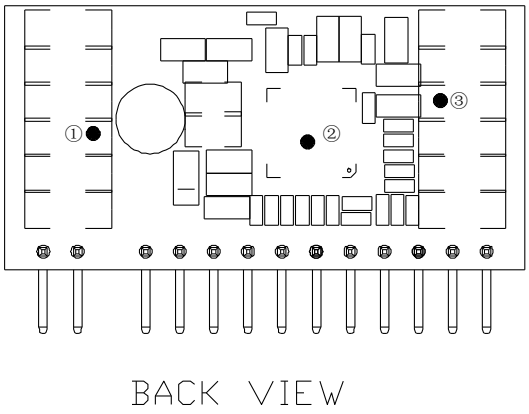

Figure 14. Hot spot in the back view

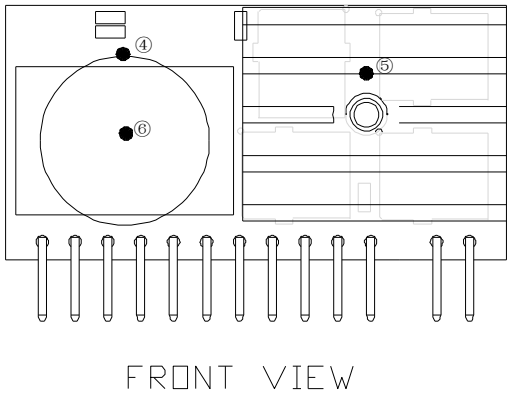

Figure 15. Hot spot in the front View

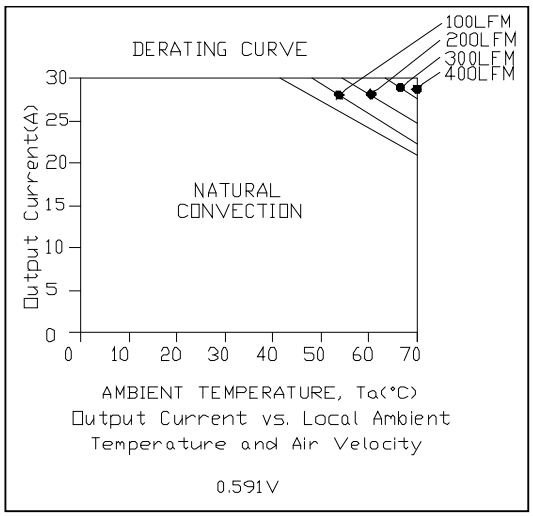

Figure 16. Vo = 0.591 V

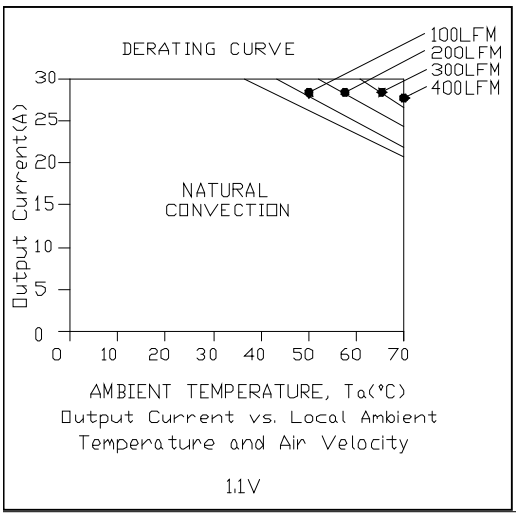

Figure 17. Vo = 1.1 V

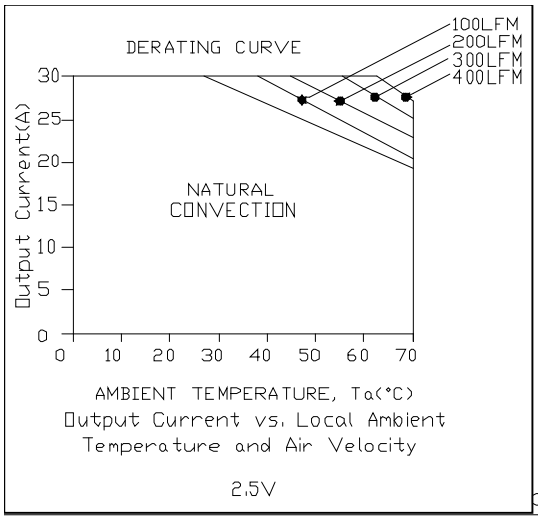

Figure 18. Vo = 2.5 V

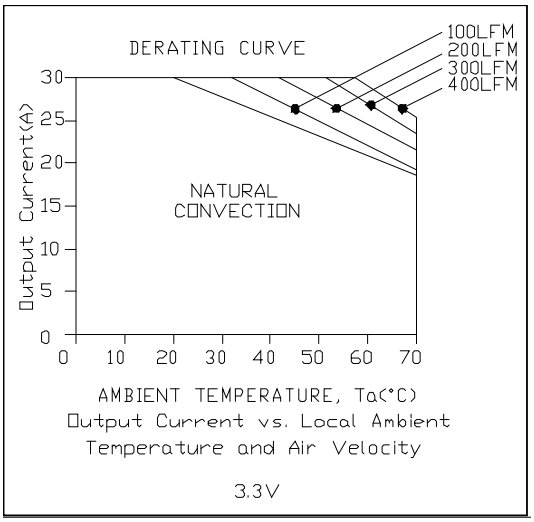

Figure 19. Vo = 3.3 V

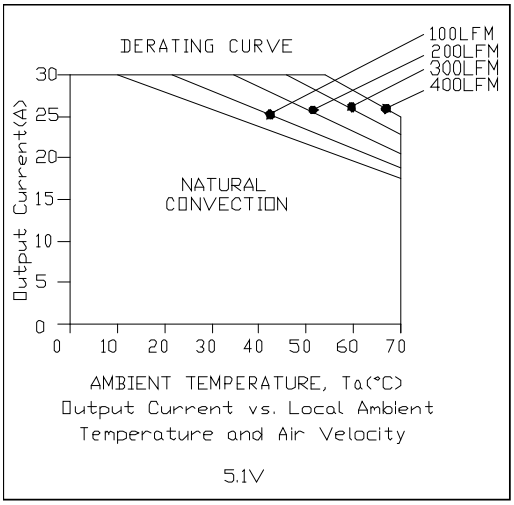

Figure 20. Vo = 5.1 V

12. RIPPLE AND NOISE WAVEFORMS

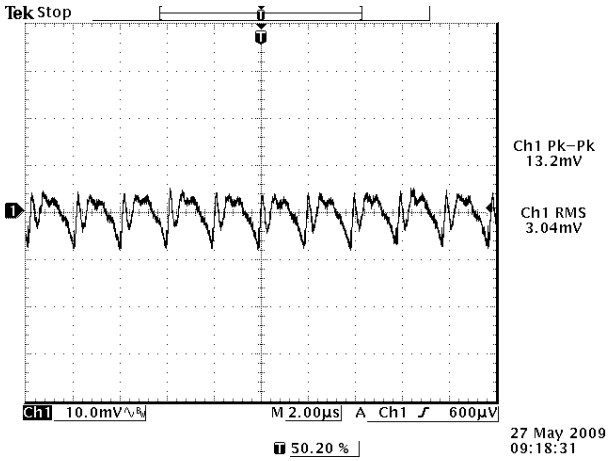

Figure 21. 12 VDC input, 0.591 VDC output

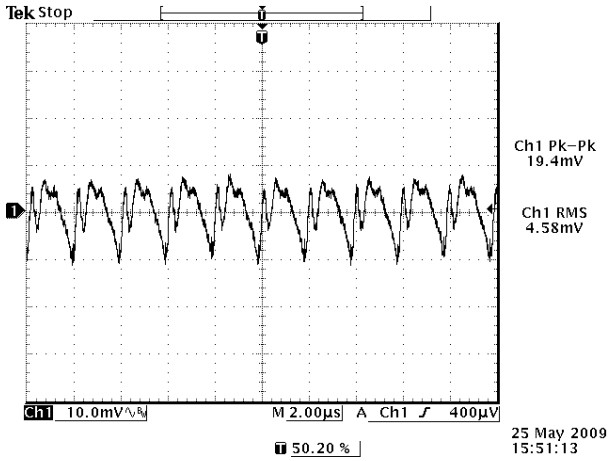

Figure 22. 12VDC input, 1.1 VDC output

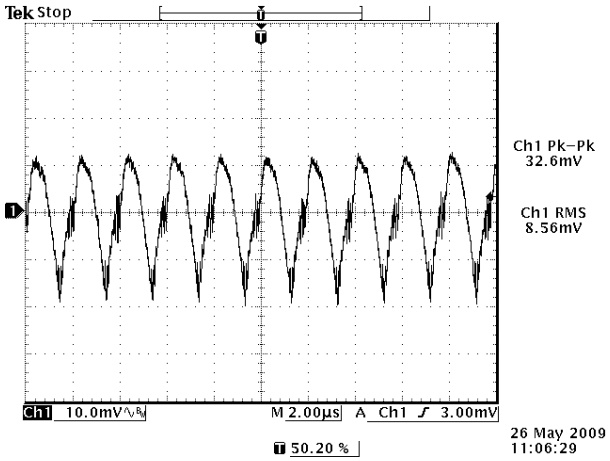

Figure 23. 12 VDC input, 2.5 VDC output

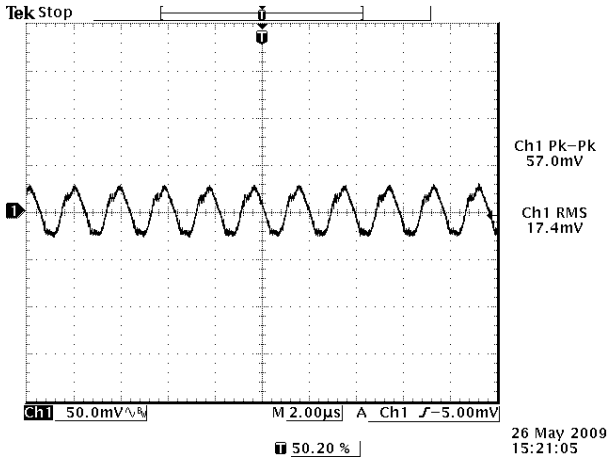

Figure 24. 12 VDC input, 5.0 VDC output

Note: Ripple and noise at full load, 0-20 MHz BW, with a 10 µF tantalum cap and 1 µF ceramic on output, and Ta=25°C.

13. TRANSIENT RESPONSE WAVEFORMS

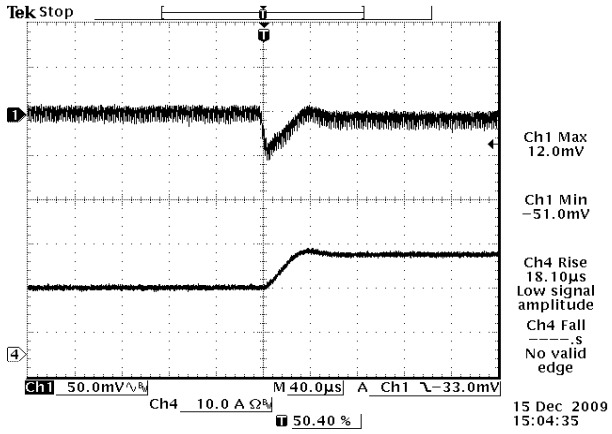

Figure 25. Vout = 1.1 V, 50%-75% Load Transients

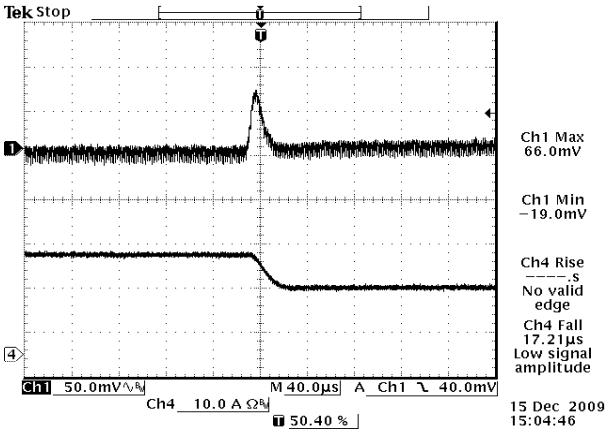

Figure 26. Vout = 1.1 V, 75%-50% Load Transients

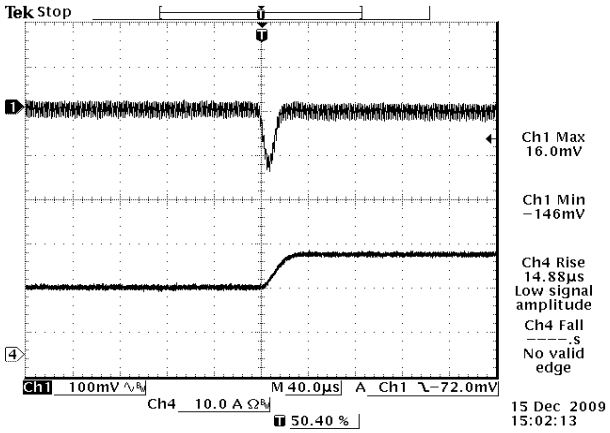

Figure 27. Vout = 2.5 V, 50%-75% Load Transients

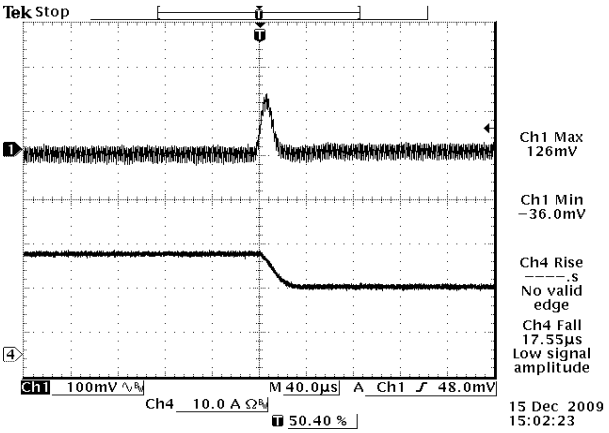

Figure 28. Vout = 2.5 V, 75%-50% Load Transients

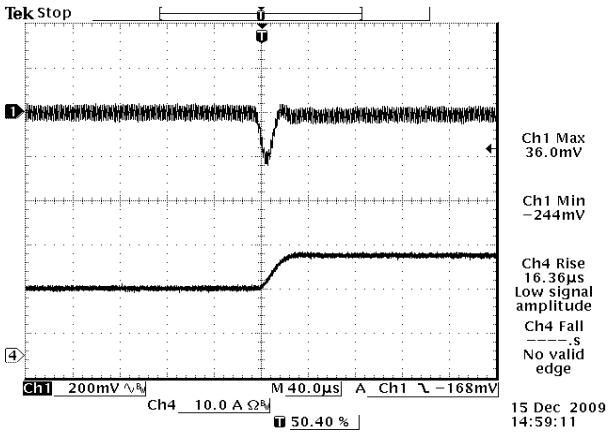

Figure 29. Vout = 5.0 V, 50%-75% Load Transients

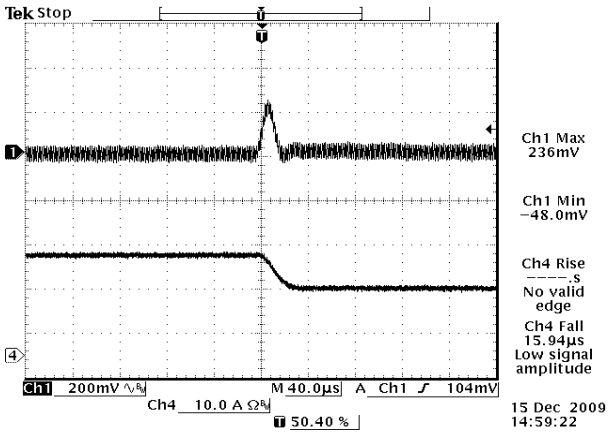

Figure 30. Vout = 5.0 V, 75%-50% Load Transients

Note: Vout = 1.0 V, Vin = 12 V@ Ta=25°C, Io = 45 A→90 A→45 A, 1 A/us, with 4 * 22 µF ceramic capacitors and 2 * 470 µF polymer caps at output.

14. STARTUP & SHUTDOWN

Rise Time

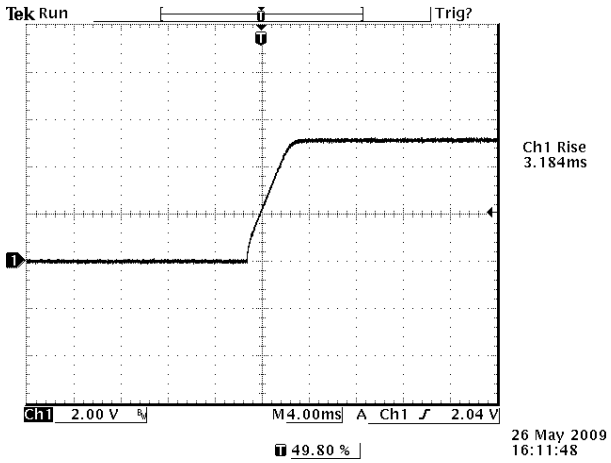

Figure 31.

Test Condition: Vin = 12 V, Vo = 5 V, full load with 1000 µF cap.

Startup Time

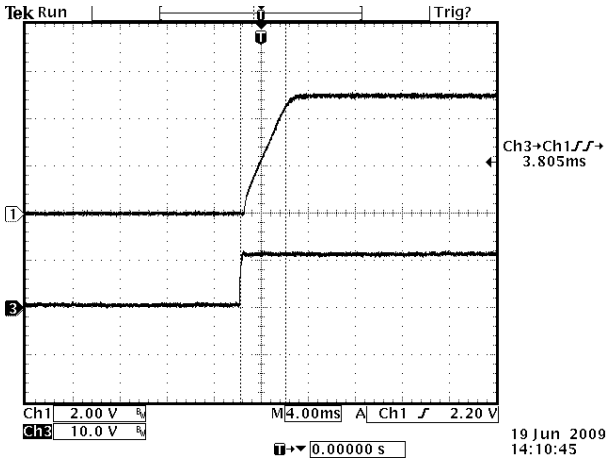

Figure 32. Startup from Vin
Ch1: Vo
Ch3: Vin
Vin = 12 V, Vo = 5 V, full load with 1000 µF cap

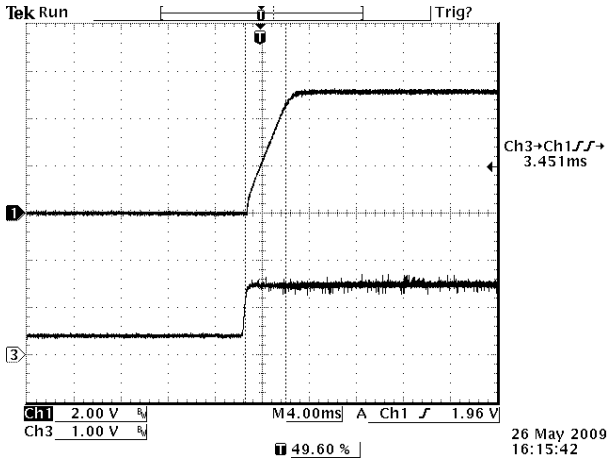

Figure 33. Startup from Remote on/off
Ch1: Vo
Ch3: Remote on/off
Vin = 12 V, Vo = 5 V, full load with 1000 µF cap

Shutdown

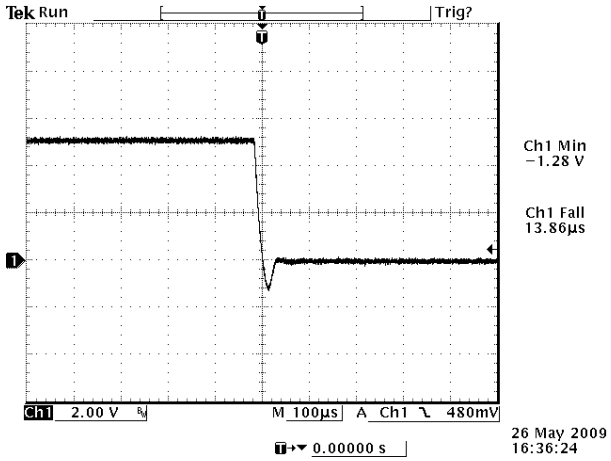

Figure 34.

Test Condition: Vin = 12 V, Vo = 5 V, full load.

15. 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 and restart once every 10 ms. The module operates normally when the output current goes into specified range. The typical average output current is 5 A during hiccup.

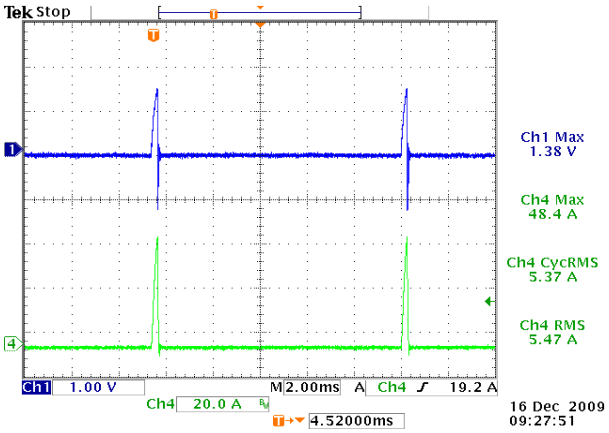

Figure 35. Vin = 12 V, Vout = 5 V, Rout = 0.06 Ω, Ta=25°C, with 10 µF tantalum cap and 1 µF ceramic on output

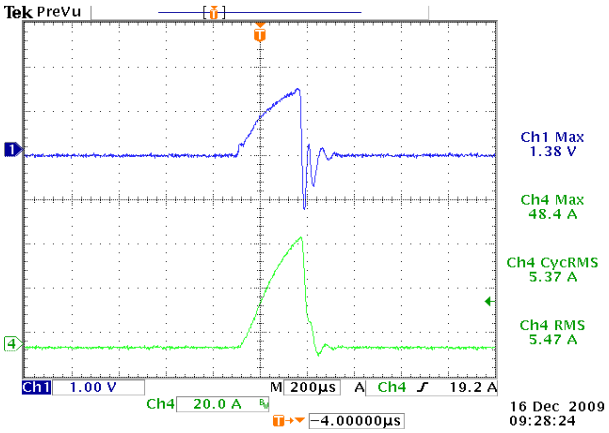

Figure 36. Expansion of on time portion of above figure

16. POWER GOOD

1. This module has a power good indicator output. Power good pin used positive logic and is open collector.
2. Power good pin can sink 10 mA.
3. The maximum voltage pulled up externally on Power Good pin should not exceed 6 V.
4. When a successful soft start is completed, the power good pin will be pulled high after 7 ms delay.

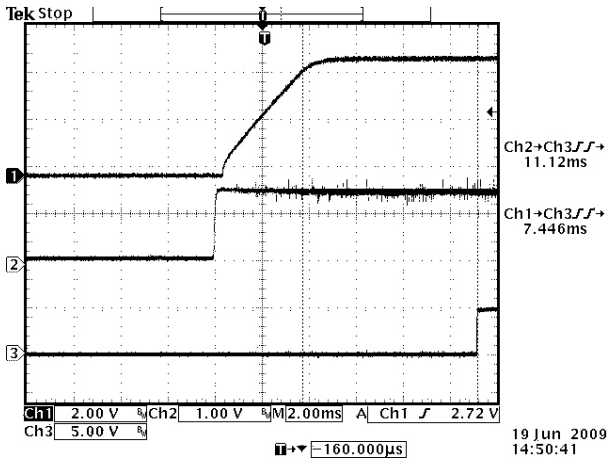

Figure 37. CH1: Output Voltage
CH3: PG
CH2: Remote ON/OFF
Typical Start-up Using Remote ON/OFF (Vin = 12 V, Vout = 5 V, Io = 30 A)

17. ASSEMBLY NOTE

Modules were designed for vertical insertion into host board. Experiments should be performed to make sure that the units meet the intended tilt specification. A fixture may be needed to make the module stand upright in assembly.

18. MECHANICAL DIMENSIONS

OUTLINE

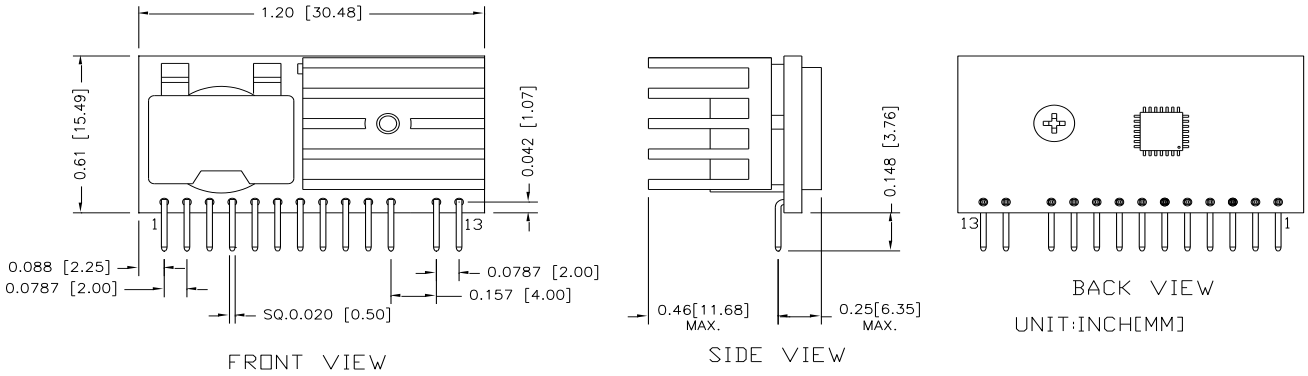

Figure 38. Outline

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 – Gold plated.
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

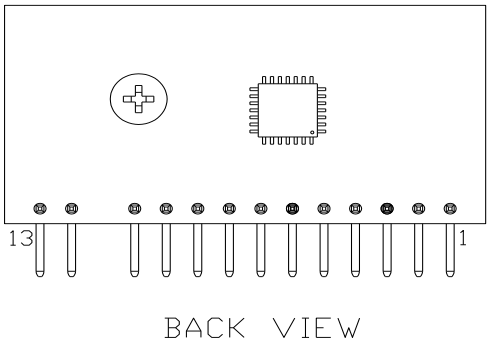

Figure 39. Pins

PIN	FUNCTION	PIN	FUNCTION
1	Vout	8	Trim+
2	Vout	9	PGRGD
3	Vout	10	Vsense-
4	GND	11	Vsense+
5	GND	12	Vin
6	Enable	13	Vin
7	Trim-		

RECOMMENDED PAD LAYOUT

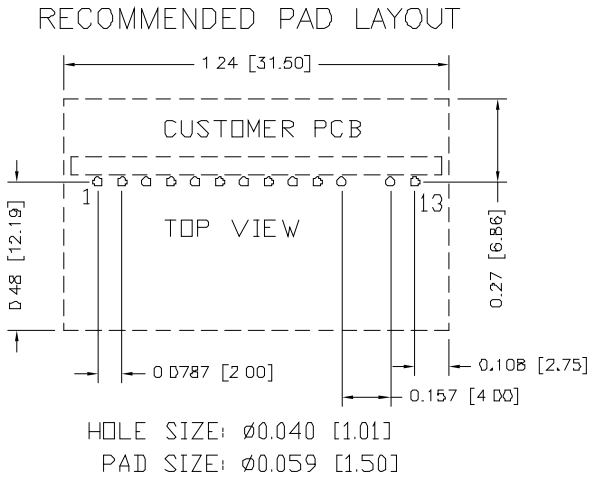

Figure 40. Recommended pad layout

19. REVISION HISTORY

DATE	REVISION	CHANGES DETAIL	APPROVAL
2009-03-30	A	First release.	HL.Lu
2009-04-28	B	1. Updated mechanical drawing; 2. Correct error in part number explanation; 3. Add NR, TR, PG and startup time waveforms; 4. Remove some “TBD” information.	HL.Lu
2009-05-05	C	1. Update OCP and Remote sense.	HL.Lu
2009-06-30	D	1. Input spec: Update no load input current, ripple and noise, turn on/off voltage, add note 1&2; 2. Output spec: Update ripple and noise, turn on time, transient response, add note of output capacitance; 3. General spec: Update efficiency data, add FIT and weight; 4. Add Efficiency curves, TD curves, NR, TR, Startup & shutdown, trim curve, OCP, Update PG and UVLO.	HL.Lu
2010-03-23	E	1. Absolute Maximum Ratings: Add remote on/off voltage; 2. Input spec: Update note for reflected ripple current and input C filter; 3. Output spec: Add ripple and noise under worst case and rise time; update current limit, overshoot at turn on and transient response; 4. Update efficiency data and efficiency curves, transient response waveforms, OCP figure; 5. Update MD (top and bottom view).	Jack.Fan
2010-03-30	F	1. Remove “Preliminary”.	Jack.Fan
2016-01-14	G	Add Assembly Note. Update mechanical drawing.	HL.Lu
2021-08-04	AH	Add object ID. Update to new form.	XF.Jiang