VRNE-60E1A0

Non-Isolated DC-DC Converter

The VRNE-60E1A0 has single non-isolated step-down DC/DC converters providing up to 60 A of output current and designed to be compatible with the Intel VRM12.5 CPU requirements. Standard features include remote on/off, over current protection, remote sense, VR_Hot# signal and a power good signal. This product also makes use of adaptive positioning to improve transient response performance. These products may be used almost anywhere low-voltage silicon is being employed and a nominal 12 Vdc source is available. Typical applications include file servers, workstations and other computing applications.

RoHS Compliant

Key Features & Benefits

- Single Output
- High Efficiency
- High Power Density
- Output Current Monitor
- Input Under-Voltage Lockout
- Input Over Current Protection
- Output Over Voltage Protection
- Thermal Warning
- Two-Wire Remote Sense
- SVID
- VR12.5 Compliant
- Wide Input Range (7.5 - 13.5 V)
- Remote On/Off
- OCP/SCP
- Power Management Bus
- 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
VRNE-60E1A0G	0 - 2.3 VDC	7.5 - 13.5 VDC	60 A	138 W	88.5%

PART NUMBER EXPLANATION

V	R	NE	-	60	E	1A	0	G
Mounting Type	RoHS Status	Series Name		Output Current	Input Range	Output Voltage	Active Logic	Package Type
Vertical Mount	RoHS	VRM		60 A	7.5 - 13.5 V	0 - 2.3 V	Active High	Tray Package

2. ABSOLUTE MAXIMUM RATINGS

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNITS
Continuous non-operating Input Voltage		-0.3	-	13.5	V
Input Transient Voltage	100 ms maximum	-	-	15	V
Remote On/Off		-0.3	-	5.25	V
Ambient temperature		-40	-	85	°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		7.5	12	13.5	V
Input Current (full load)	Vin = 12 V, Vout = 1.7 V	-	-	9.3	A
Input Current (no load)	Vin = 12 V, PS = 00h, Vo = 1.7 V	-	350	480	mA
	Vin = 12 V, PS = 01h, Vo = 1.7 V	-	240	330	mA
	Vin = 12 V, PS = 10h or 11h, Vo = 1.7 V	-	150	220	mA
Remote Off Input Current		-	80	120	mA
Input Reflected Ripple Current (rms)	0.33 uH inductor×1, 22 µF/25 V Ceramic caps×3, 180 µF /16V Os-Con caps, 22 mΩ, Vishay #94SVP187X0016E12×2, 680 µF / 16 V Aluminum Cap, 80 mΩ, Panasonic # EEEFK1C681GP×1.	-	15	20	mA
Input Reflected Ripple Current (pk-pk)		-	70	100	mA
Turn-on Voltage Threshold		6.9	7.2	7.45	V
Turn-off Voltage Threshold		6.1	6.6	6.8	V

NOTE: 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 Range	Io = 0 A	0	-	2.3	V
Output Voltage Set Point (without SVID)	Io = 0 A, Start-up boot voltage without SVID command.	-	1.70	-	V
Load Regulation		-	1.055	-	mΩ
Line Regulation		-	5	10	mV
Regulation Over Temperature	Working ambient temperature range is from 0°C to 60°C	-	6	10	mV
Output Current Range	Thermal design	0	-	60	A
	Peak current rating	0	-	100	A
Output DC Current Limit		105	120	135	A
Output Ripple and Noise (pk-pk)	Vin = 12 V, PS = 00h, Vout_set = 1.7 V, 0-20MHz BW, with 22 µF/4 V, X6S, 0805 GRM21BC80G226M×8, 22 µF/4 V, X6S, 0805 GRM21BC80G226M×54, 470 µF /2.5 V, 4.5 mΩ, 7343 EEFSX0E471E4×6	-	15	30	mV
Output Ripple and Noise (rms)		-	2	6	mV
Turn On Time		-	4.4	6	ms
	This time is tested when the boot voltage is set 1.7 V.	-	3.8	6	ms
Rise Time		-	220	260	µs
Output Capacitance	Recommended: 22 µF/4 V, X6S, 0805 GRM21BC80G226M×8, 22 µF/4 V, X6S, 0805 GRM21BC80G226M×54, 470 µF/2.5 V, 4.5 mΩ, 7343 EEFSX0E471E4×6	-	4184	-	µF

5. GENERAL SPECIFICATIONS

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
Efficiency	The efficiency is measured at Vin = 12 V, Iout = 60 A, Ta=25°C. Vout_set = 1.7 V.	84	88.5	-	%
Over Temperature Warning	Only the VR_HOT# is asserted, the power stage is not protected by the VRM controller.	-	115	-	°C
Switching Frequency	Single phase frequency	-	450	-	kHz
MTBF	Calculated Per Telcordia SR-332, Issue2 (Vin = 12 V, Vout_set = 1.7 V, Iout = 60 A, Ta = 25°C, FIT = 10^9/MTBF)	2	-	-	Mhrs
Weight		-	43	-	g
Dimensions (L × W × H)		2.60 x 0.75 x 1.10			inch
		66.04 x 19.05 x 27.94			mm

6. REMOTE ON/OFF

PARAMETER		DESCRIPTION	MIN	TYP	MAX	UNIT
Signal Low (Unit Off)	Active High	Remote on/off pin is open, the module Unit off	-0.3	-	0.65	V
Signal High (Unit On)			1.15	-	5	V
Current Sink			0	-	1	mA

7. Vc5

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNITS
Output Voltage Setpoint		4.96	4.98	5	V
Output Current		-	-	5	mA
Output Voltage Regulation (Total output voltage range)		4.78	-	5.13	V
Vout Temperature Coefficient		-	50	150	ppm/C
Line Regulation		-0.02	-	0.02	V
Load Regulation		-0.13	-	0.13	V
Ouput Noise	pk-pk, 20 MHz bandwidth	-	15	25	mV

8. EFFICIENCY DATA

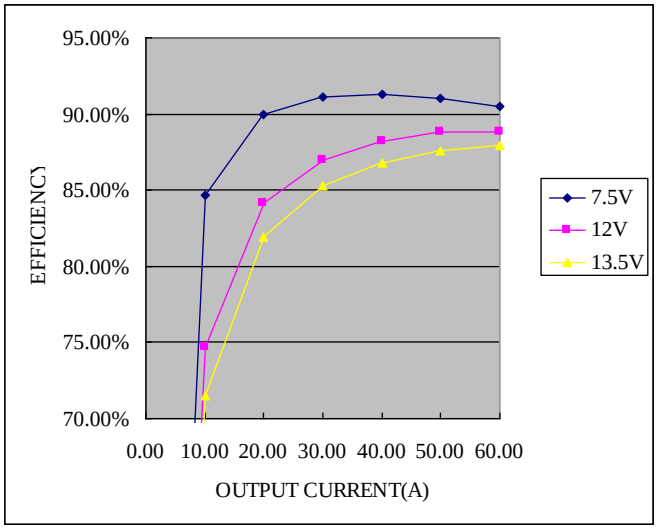


Figure 1. Efficiency data

9. THERMAL DERATING CURVE

Maximum junction temperature of semiconductors derated to 118°C.

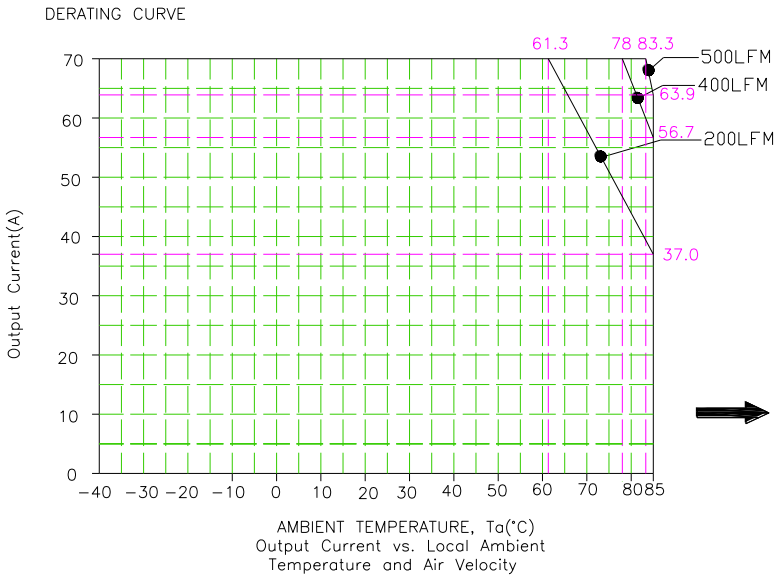


Figure 2. Thermal derating curve under normal input

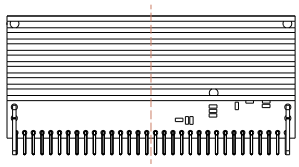


Figure 3. Airflow direction

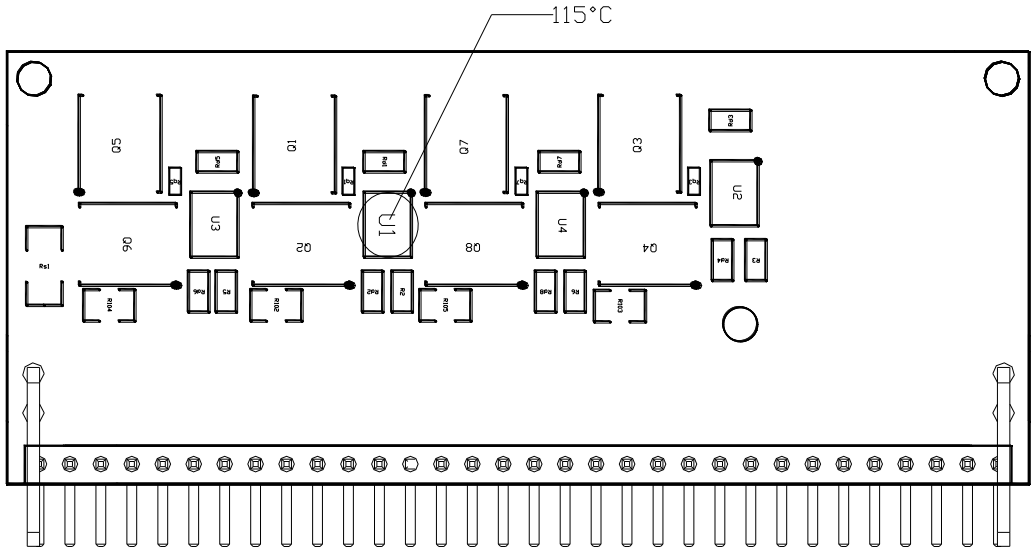


Figure 4. Hot spot

The over temperature warning is sensed by NTC and the VR_HOT# signal will be pulled down when the component U1 reaches its temperature upper limit 115°C, Then VR_HOT# signal informs the system should reduce its power consumption. It will recover automatically when the temperature of U1 falls to 105°C. The Warning point will be varied a little under different conditions (air flow, ambient temperature, input voltage, load and so on).

10. RIPPLE AND NOISE

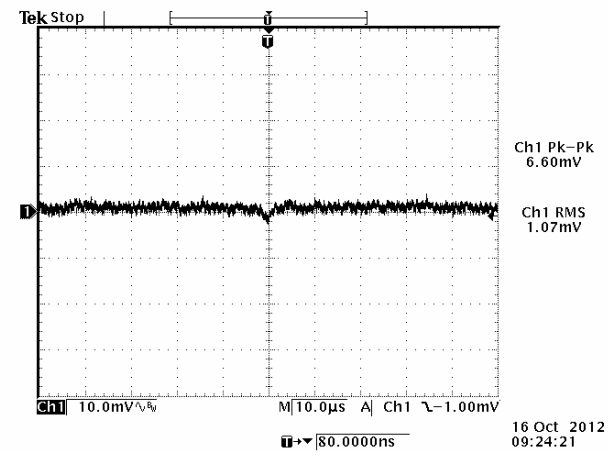


Figure 5.

Note: Ripple and noise at full load, 12 Vdc input, 1.7 Vdc/60 A output, 0-20 MHz BW and Ta=25°C and with 22 µF/4 V, X6S, 0805 GRM21BC80G226M×8, 22 µF/4 V, X6S, 0805 GRM21BC80G226M×54, 470 µF/2.5 V, 4.5 mΩ, 7343 EEFSX0E471E4×6.

The first Trace is Vout.

11. STARTUP

Rise Time

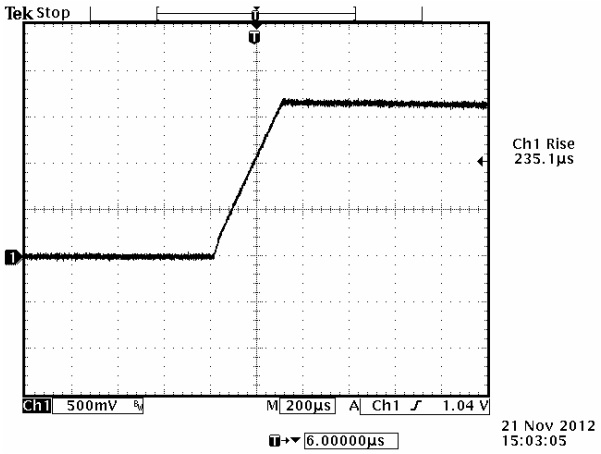


Figure 6. Vin = 12 V, Vo = 1.7 V, Io = 60 A

Startup Time

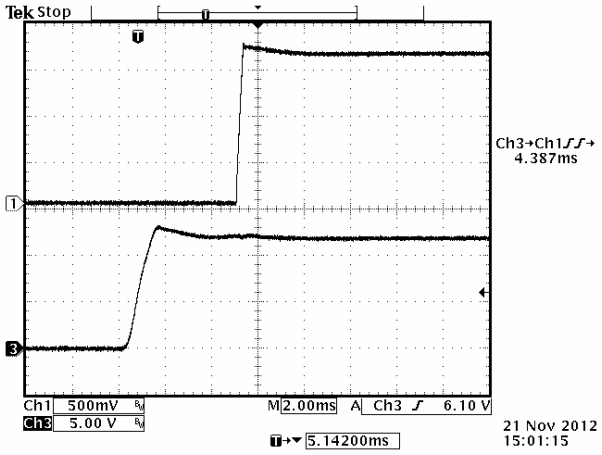


Figure 7. Startup from Vin
Ch1: Vo
Ch3: Vin
Vin = 12 V, Vo = 1.7 V, Io = 60 A

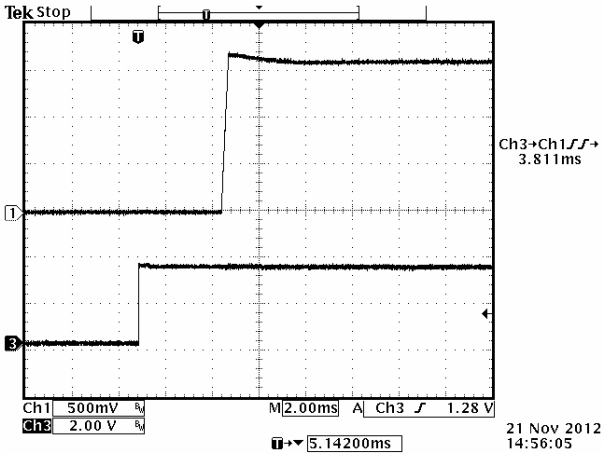


Figure 8. Startup from on/off
Ch1: Vo
Ch3: on/off
Vin = 12 V, Vo = 1.7 V, Io = 60 A

12. 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 8 ms. The module operates normally when the output current goes into specified range. The typical average output current is 10.9 A during hiccup.

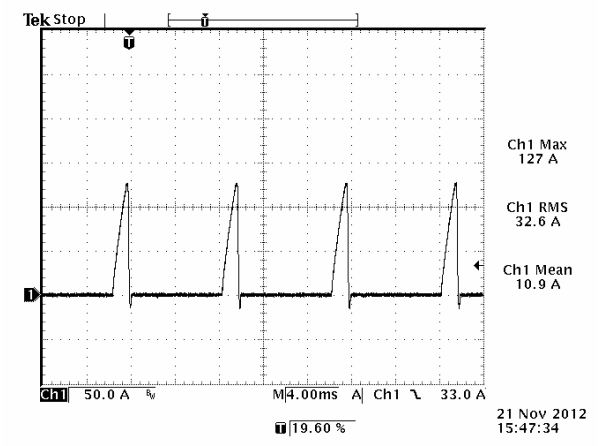


Figure 9. CH1: Output current waveform
Test condition: Vin = 12 V, Vout = 1.7 V, Ta = 25°C

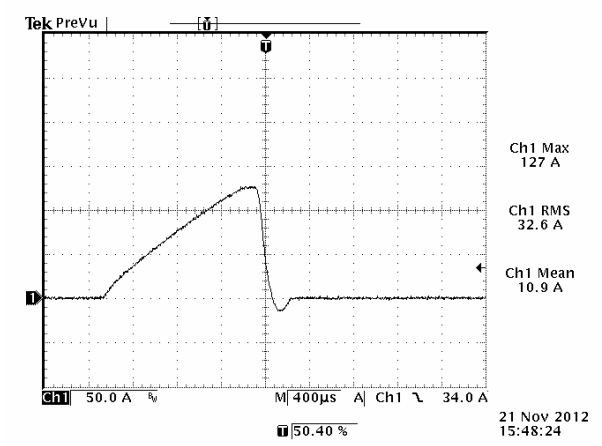


Figure 10. CH1: Output current waveform
Expansion of on time portion of above figure

13. POWER GOOD

1.This module has one power good indicator output. Power good pin used positive logic and is open collector.
2. The maximum voltage pulled up externally on Power Good pin should not exceed 5 V.
3. When the output reaches 100% of the nominal set-point, the power good pin will be pulled high.

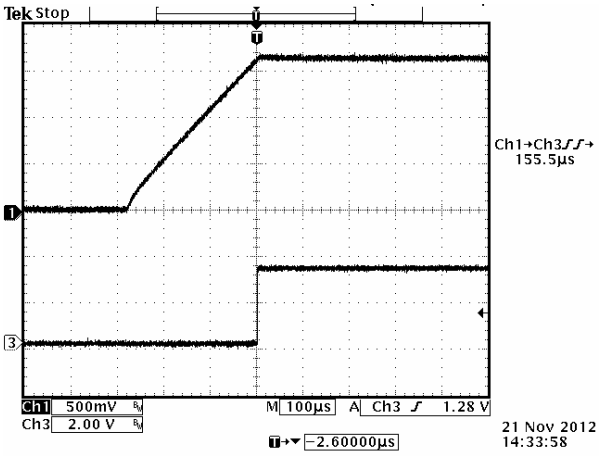


Figure 11. CH1: Output Voltage CH3: PG
Typical Start-up Using Remote ON/OFF
(Vin = 12.0 V, Vo = 1.7 V, Io = 0 A)

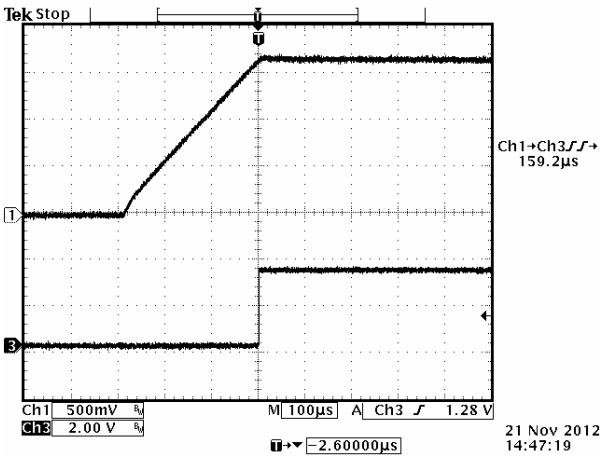


Figure 12. CH1: Output Voltage CH3: PG
Typical Start-up Using Remote ON/OFF
(Vin = 12.0 V, Vo = 1.7 V, Io = 60 A)

14. FUNDAMENTAL CIRCUIT DIAGRAM

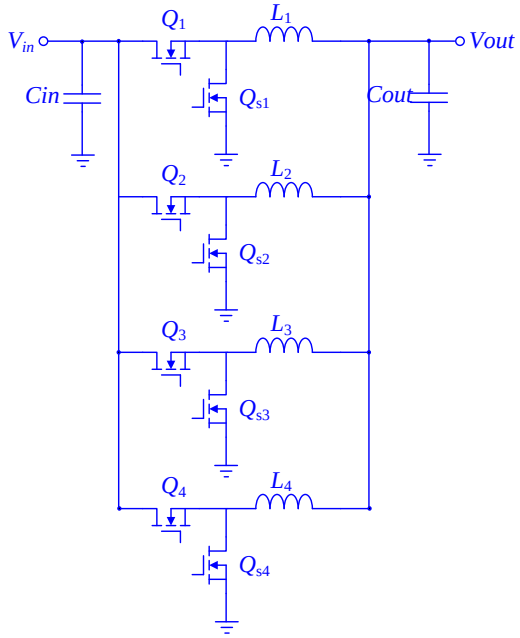
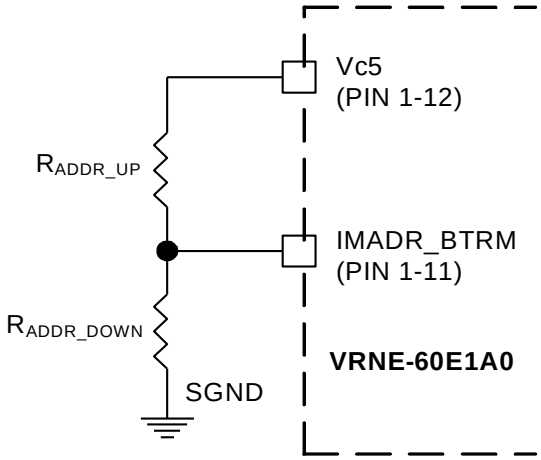


Figure 13. Fundamental circuit diagram

15. ADDRESS SELECTION

A voltage divider sets the SVID and Power Management Bus addresses for this module. The resistors for the divider are external to the module and need to be placed on the customer board. Below are the available addresses for the module and their associated resistor values, along with a diagram showing how the voltage divider should be connected to the module.



SVID Address / Power Management Bus Address (Hex)	$R_{ADDR-UP}$ (kΩ)	$R_{ADDR-DOWN}$ (kΩ)
00 / 80	158	44.2
00 / 82	93.1	56.2
00 / 84	64.9	73.2
00 / 86	49.9	110

Figure 14. Voltage divider on IMADR_BTRM pin to select SVID address

Note:
1. For the external divider, it's recommended to use 1%, 100 ppm/k or better resistors, and same type are preferred for all resistors. Do not use any RC decoupling network on the resistor divider.
2. The resistor value in above table is only for the specific boot voltage and output current which are presented in the output specification. If a different output voltage / current setting is used, please contact Bel Power Application Support for SVID / Power Management Bus address setting.

16. MECHANICAL DIMENSIONS

OUTLINE

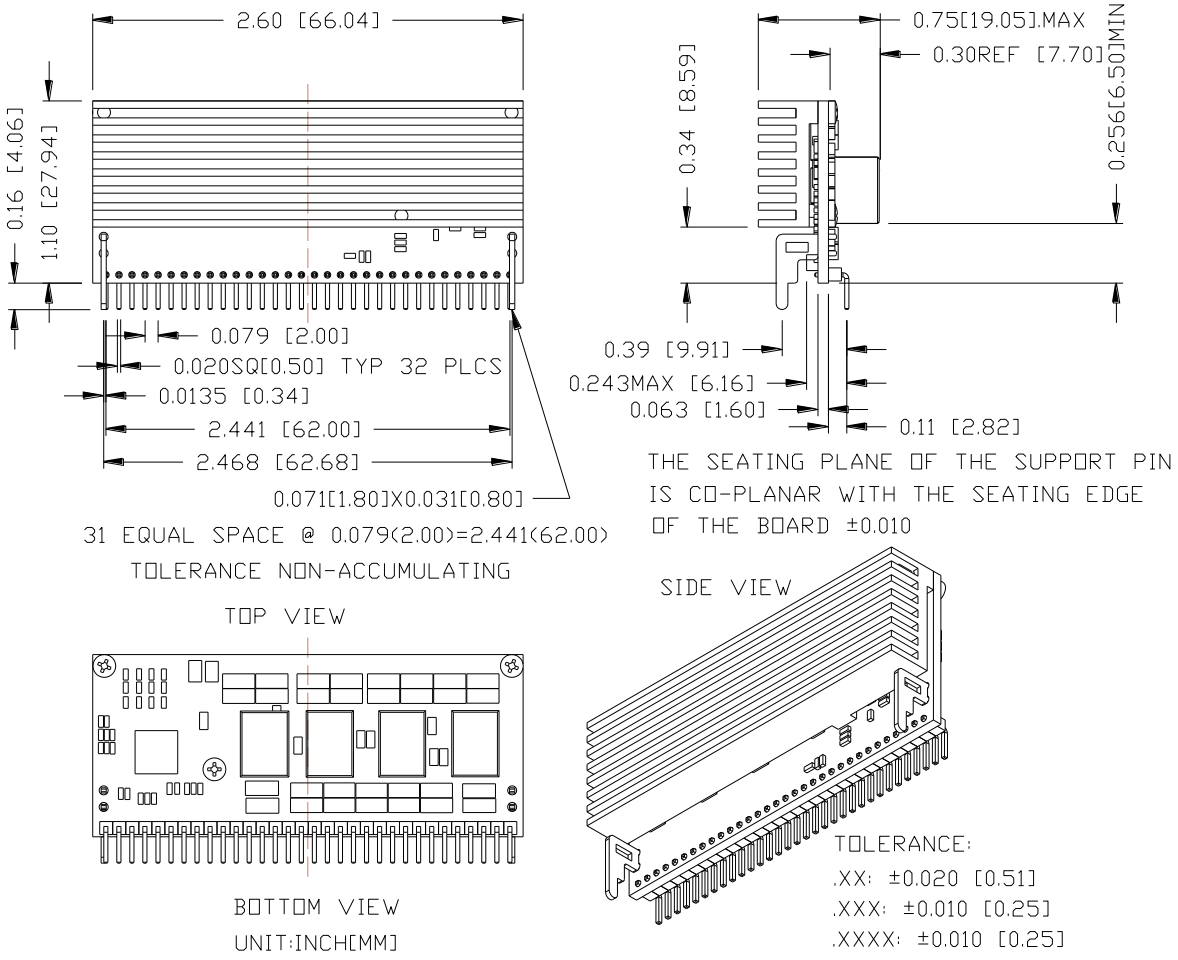


Figure 15. Outline

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].

PIN DEFINITIONS

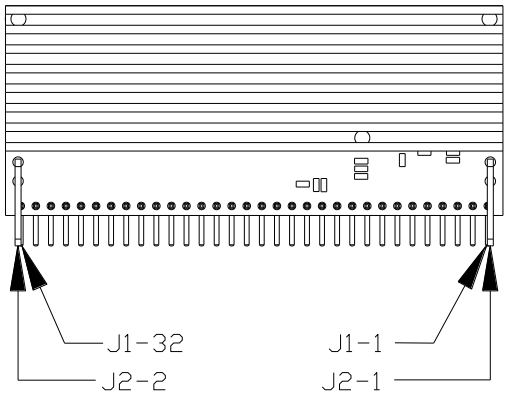


Figure 16. Pins

PIN	FUNCTION	PIN	FUNCTION	PIN	FUNCTION
2-1	SGND	1-12	Vc5	1-24	VOUT+
1-1	SVID_DATA	1-13	Vsense+	1-25	GND
1-2	SVID_ALERT#	1-14	Vsense-	1-26	GND
1-3	SVID_CLK	1-15	VOUT+	1-27	VOUT+
1-4	VR_HOT#	1-16	VOUT+	1-28	VOUT+
1-5	VR_FAULT#	1-17	GND	1-29	GND
1-6	VR_READY	1-18	GND	1-30	GND
1-7	ENABLE	1-19	VOUT+	1-31	Vin+
1-8	Power Management Bus_DATA	1-20	VOUT+	1-32	Vin+
1-9	Power Management Bus_ALERT#	1-21	GND	2-2	Vin+
1-10	Power Management Bus_CLK	1-22	GND		
1-11	IMADR_BTRM	1-23	VOUT+		

RECOMMENDED PAD LAYOUT

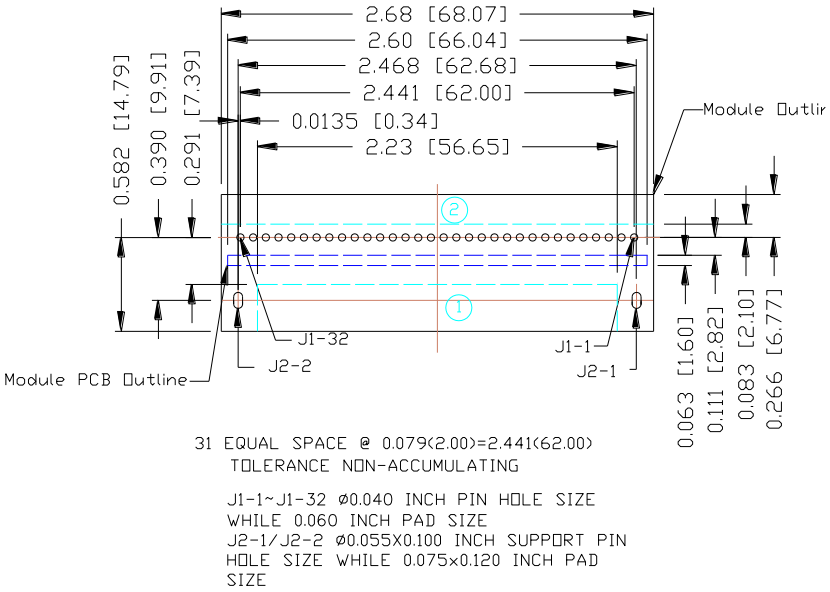


Figure 17. Recommended pad layout

Notes:

Components may be placed in the areas marked as ① and ②.

Components in these areas may be shadowed by the module.

The height of the components in area ① is limited to 0.295 [7.50] max.

The height of the components in area ② is limited to 0.217 [5.50] max.

The remaining keep out area should not contain any components..

17. REVISION HISTORY

DATE	REVISION	CHANGES DETAIL	APPROVAL
2012-08-30	PA	First release.	J.Yan
2012-11-22	PB	Update Input Specs, Output Specs, General, Efficiency Data, TD, NR, Startup, Remote on/off, OCP, PG and MD.	J.Yan
2013-04-24	PC	Update MD.	J.Yan
2013-07-15	D	Update Abs Max# and TD.	J.Yan
2014-03-25	E	Update All TBD, Remote on/off.	J.Yan
2014-07-29	F	Update TD.	J.Yan
2015-03-27	G	Update description, MD, SVID/Power Management Bus address setting.	J.Yan
2015-06-18	H	Add Vc5 specification	J.Yan
2021-08-03	I	Add object ID and module photo. Update to new form.	XF.Jiang

For more information on these products consult: tech.support@psbel.com

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