E36SR3R320

1/8 Brick DC/DC Power Module

18~75Vin, 3.3V/20A out

E36SR, Eighth Brick, 18~75V input, single output, isolated DC/DC converter is being offered from a world leader in power systems technology and manufacturing — Delta Electronics, Inc. This product family provides up to 66 watts of power or 20A of output current in an industry standard footprint. With creative design technology and optimization of component placement, these converters possess outstanding electrical and thermal performances, as well as extremely high reliability under highly stressful operating conditions. All models are fully protected from abnormal input/output voltage, current, and temperature conditions. E36SR series meet all safety requirements with basic insulation.

FEATURES

Electrical

- High efficiency: 88% @ 3.3V/ 20A
- Industry standard pin out
- Fixed frequency operation
- Input UVLO, Output OCP, OVP, and OTP
- 2250V isolation
- Basic insulation
- No minimum load required

Mechanical

Size: 58.4 x 22.8 x 9.2mm (2.30"x0.90"x0.36")
(without Heat-Spreader)
Size: 58.4 x 22.8 x 12.7mm (2.30"x0.90"x0.50")
(with Heat-Spreader)

Safety & Certificate

- IEC/EN/UL/CSA 62368-1, 2nd edition
- IEC/EN/UL/CSA 60950-1, 2nd edition+A2
- ISO 9001, TL 9000, ISO 14001, QS 9000, OHSAS18001 certified manufacturing facility

OPTIONS

- SMT or through-hole versions
- Positive on/off logic
- Short pin lengths available
- Heat spreader option

APPLICATIONS

- Telecom / Datacom
- Wireless Networks
- Optical Network Equipment
- Server and Data Storage
- Industrial / Testing Equipment

SOLDERING METHOD

- Wave soldering
- Hand soldering

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(TA=25°C, airflow rate=300 LFM, Vin=48Vdc, nominal Vout unless otherwise noted.)

PARAMETER	NOTES and CONDITIONS	E36SR3R320 (Standard)			
		Min.	Typ.	Max.	Units
ABSOLUTE MAXIMUM RATINGS					
Input Voltage					
Continuous		18	24/48	75	Vdc
Transient (100ms)	100ms			100	Vdc
Operating Temperature	Refer to Figure 21 for measuring point	-40		122	°C
Storage Temperature		-55		125	°C
Input/Output Isolation Voltage				2250	Vdc
INPUT CHARACTERISTICS					
Operating Input Voltage		18	24/48	75	Vdc
Input Under-Voltage Lockout					
Turn-On Voltage Threshold		16.5	17	17.5	Vdc
Turn-Off Voltage Threshold		15.5	16	16.5	Vdc
Lockout Hysteresis Voltage			1	2	Vdc
Maximum Input Current	100% Load, 18Vin			4.3	A
No-Load Input Current	No load, 48Vin		80		mA
Off Converter Input Current			10	15	mA
Inrush Current(I2t)				1	A2s
Input Reflected-Ripple Current	P-P thru 12μH inductor, 5Hz to 20MHz		20		mA
Input Voltage Ripple Rejection	120 Hz		60		dB
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	Vin=48V, Io=Io.max, Tc=25°C	3.267	3.300	3.333	Vdc
Output Voltage Regulation					
Over Load	Io=Io,min to Io,max		±3.3	±6.6	mV
Over Line	Vin=18V to 75V				
Over Temperature	Tc=-40°C to 85°C				
Total Output Voltage Range	over sample load, line and temperature	3.234		3.366	V
Output Voltage Ripple and Noise	5Hz to 20MHz bandwidth				
Peak-to-Peak	Full Load, 1μF ceramic, 10μF tantalum		80		mV
RMS	Full Load, 1μF ceramic, 10μF tantalum		10		mV
Operating Output Current Range		0		20	A
Output DC Current-Limit Inception	Output Voltage 10% Low	110		140	%Io
DYNAMIC CHARACTERISTICS					
Output Voltage Current Transient	48V, 10μF Tan & 1μF Ceramic load cap, 0.1A/μs				
Positive Step Change in Output Current	25% Io.max to 50% Io.max		150		mV
Negative Step Change in Output Current	50% Io.max to 25% Io.max		150		mV
Settling Time (within 1% Vout nominal)			200		us
Turn-On Transient					
Start-Up Time, From On/Off Control			10	20	ms
Start-Up Time, From Input			10	20	ms
Maximum Output Capacitance	Full load; 5% overshoot of Vout at startup			5000	μF
EFFICIENCY					
100% Load	Vin=48V; Tc=25°C		88		%
60% Load			89		%
ISOLATION CHARACTERISTICS					
Input to Output				2250	Vdc
Isolation Resistance		10			MΩ
Isolation Capacitance			1500		pF
FEATURE CHARACTERISTICS					
Switching Frequency			300		kHz
ON/OFF Control, Negative Remote On/Off logic					
Logic Low (Module On)	Von/off at Ion/off=1.0mA	0		1.8	V
Logic High (Module Off)	Von/off at Ion/off=0.0 μA	2.4		18	V
ON/OFF Control, Positive Remote On/Off logic					
Logic Low (Module Off)	Von/off at Ion/off=1.0mA	0		1.8	V
Logic High (Module On)	Von/off at Ion/off=0.0 μA	2.4		18	V
ON/OFF Current (for both remote on/off logic)	Ion/off at Von/off=0.0V			1	mA
Leakage Current (for both remote on/off logic)	Logic High, Von/off=15V			50	uA
Output Voltage Trim Range	Across Pins 9 & 5, Pout ≦ max rated power	-10		10	%
Output Voltage Remote Sense Range	Pout ≦ max rated power			10	%
Output Over-Voltage Protection	Over full temp range; % of nominal Vout	115		140	%Vo
GENERAL SPECIFICATIONS					
MTBF	Io=80% of Io, max; 300LFM @25℃		3.2		M hours
Weight	Bare module without heat-sink		25		grams
Over-Temperature Shutdown	Refer to Figure 21 for measuring point		127		°C

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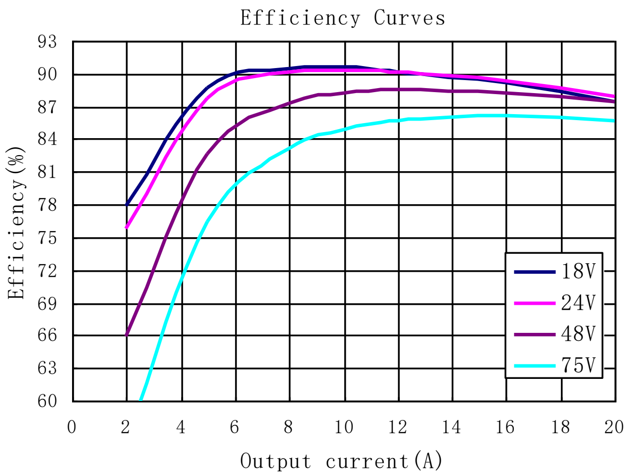

Figure 1: *Efficiency vs. load current for minimum, nominal, and maximum input voltage at 25°C.*

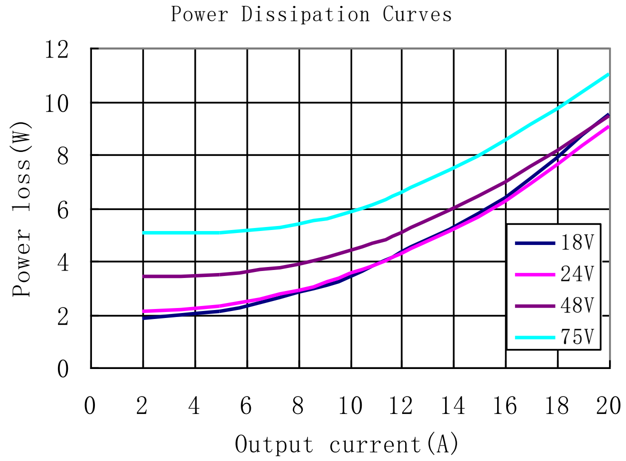

Figure 2: *Power dissipation vs. load current for minimum, nominal, and maximum input voltage at 25°C.*

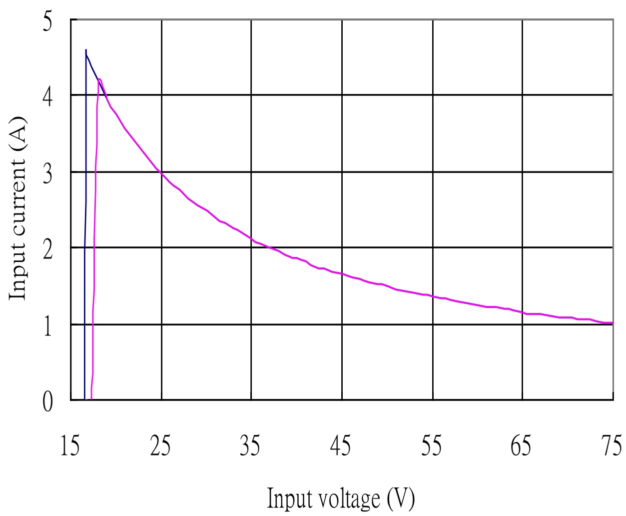

Figure 3: *Typical full load input characteristics at room temperature.*

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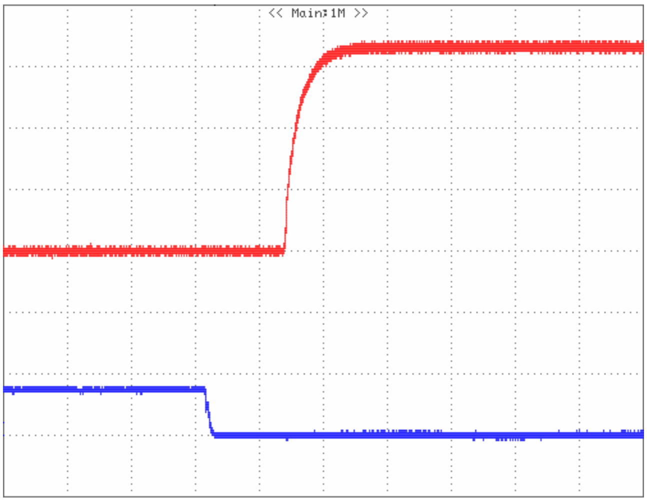


Figure 4: *Turn-on transient at full rated load current (CC mode) (5ms/div). Vin=48V.Top Trace: Vout, 1V/div; Bottom Trace: ON/OFF input, 5V/div.*

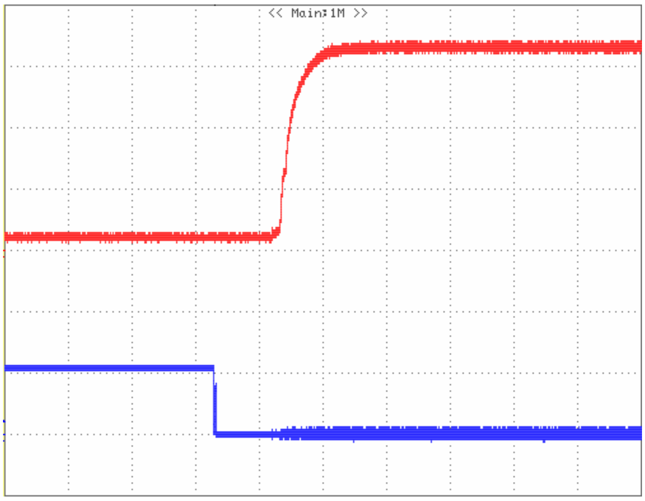


Figure 5: *Turn-on transient at zero load current (5ms/div). Vin=48V.Top Trace: Vout, 2V/div; Bottom Trace: ON/OFF input, 5V/div.*

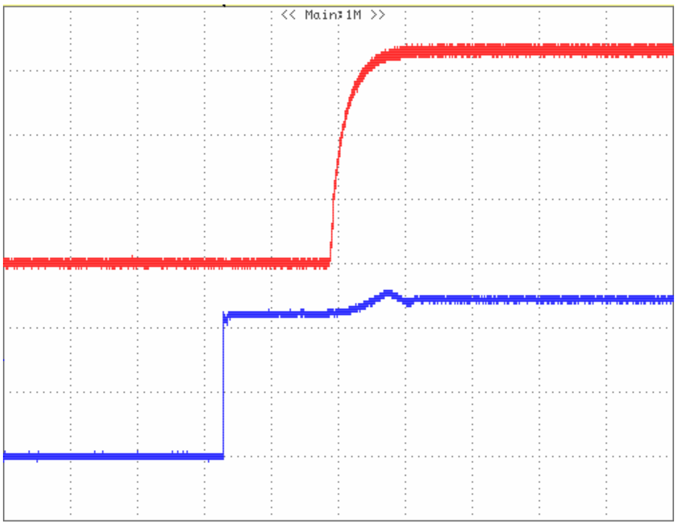


Figure 6: *Turn-on transient at full rated load current (CC mode) (5ms/div). Vin=48V.Top Trace: Vout, 2V/div; Bottom Trace: input voltage, 20V/div.*

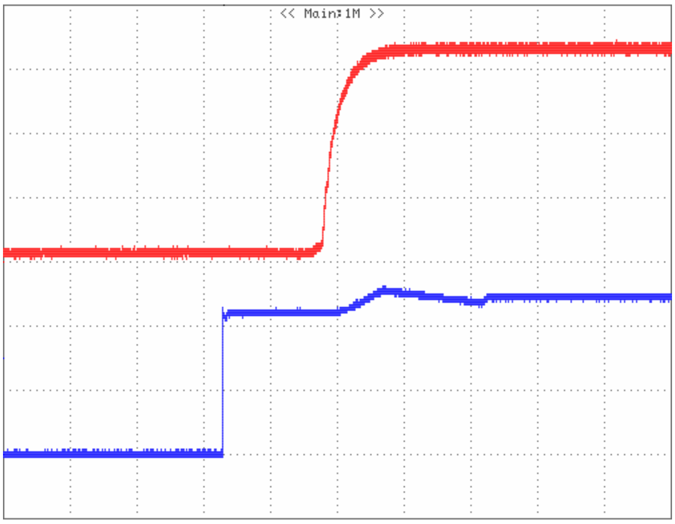


Figure 7: *Turn-on transient at zero load current (5ms/div). Vin=48V.Top Trace: Vout, 2V/div; Bottom Trace: input voltage, 20V/div.*

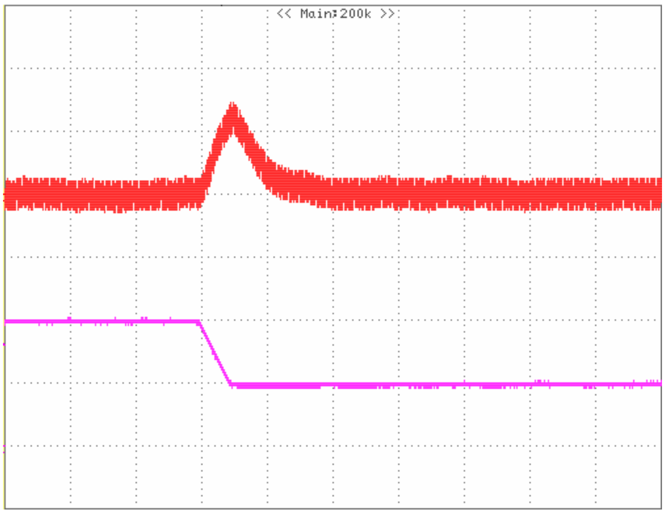


Figure 8: *Output voltage response to step-change in load current (50%-25% of Io, max; di/dt = 0.1A/µs). Load cap: 10µF, tantalum capacitor and 1µF ceramic capacitor. Top Trace: Vout (100mV/div, 100us/div), Bottom Trace: I out (5A/div).*

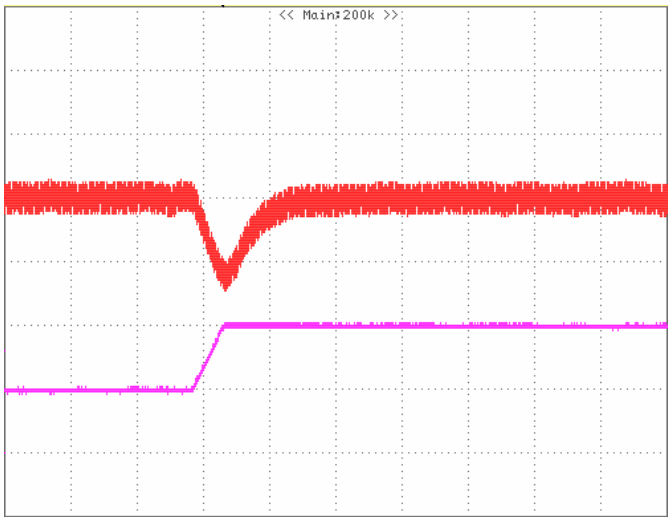


Figure 9: *Output voltage response to step-change in load current (25%-50% of Io, max; di/dt = 0.1A/µs). Load cap: 10µF, tantalum capacitor and 1µF ceramic capacitor. Top Trace: Vout (100mV/div, 10us/div), Bottom Trace: I out (5A/div).*

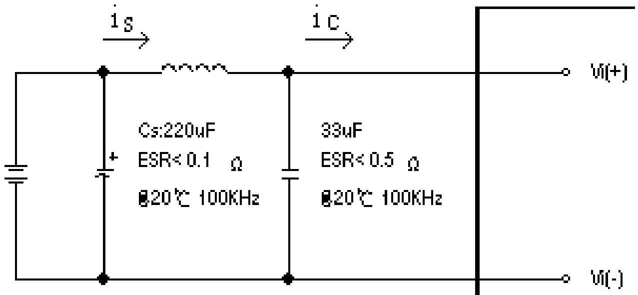


Figure 10: *Test set-up diagram showing measurement points for Input Terminal Ripple Current and Input Reflected Ripple Current.*

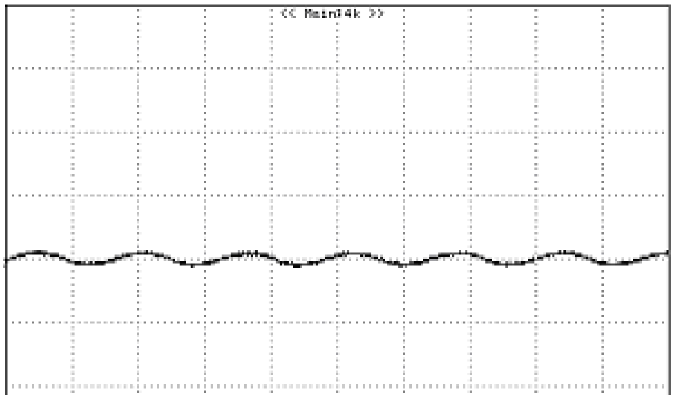


Figure 11: *Input Terminal Ripple Current, i_c, at 48Vin and 20 output current with 12µH source impedance and 33µF electrolytic capacitor (500 mA/div, 2us/div).*

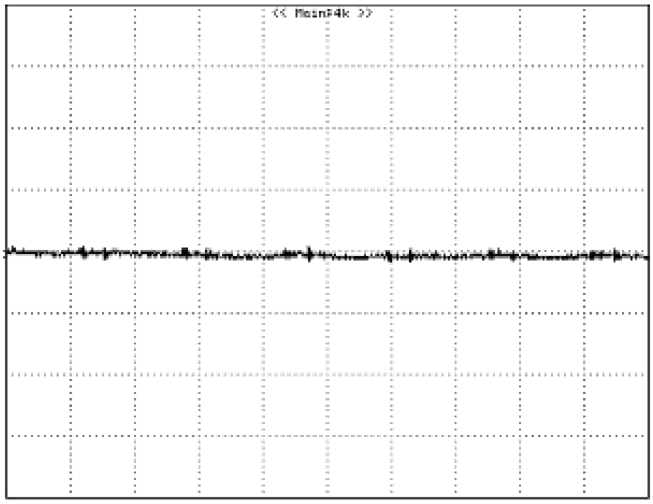


Figure 12: *Input reflected ripple current, i_s, through a 12µH source inductor at 48Vin and 20 output current (20 mA/div, 2us/div).*

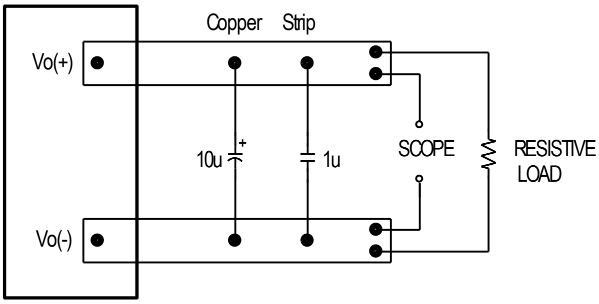


Figure 13: *Output voltage noise and ripple measurement test setup.*

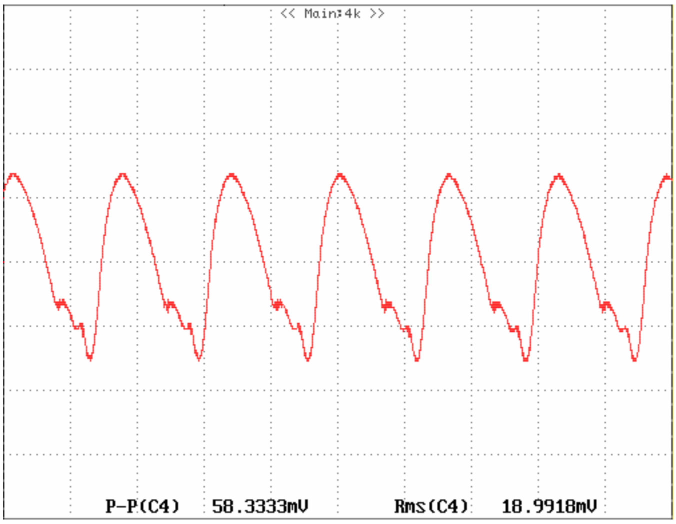


Figure 14: *Output voltage ripple at 48Vin and rated load current (Io=20A)(20 mV/div, 2us/div)*
Load capacitance: 1µF ceramic capacitor and 10µF tantalum capacitor. Bandwidth: 20 MHz.

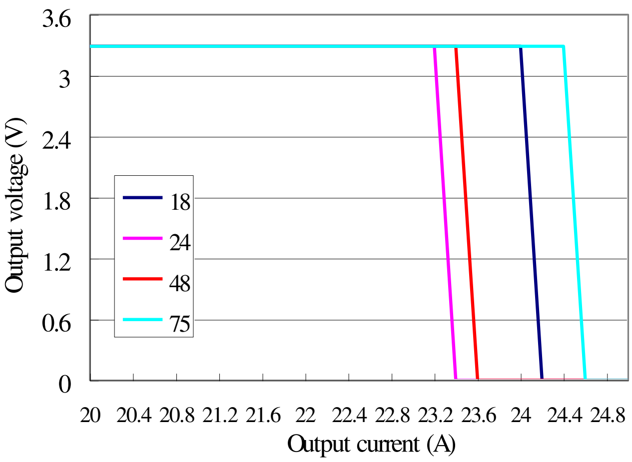


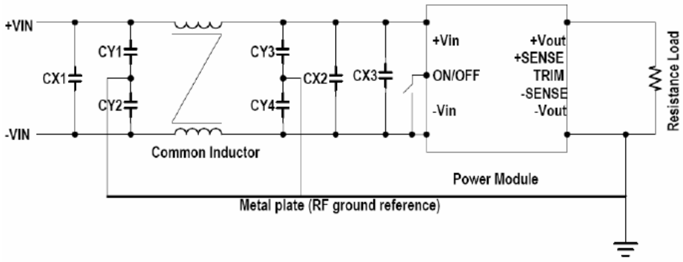
Figure 15: *Output voltage vs. load current showing typical current limit curves and converter shutdown points.*

Input Source Impedance

The impedance of the input source connecting to the DC/DC power modules will interact with the modules and affect the stability. A low ac-impedance input source is recommended. If the source inductance is more than a few μH, we advise adding a 10 to 100 μF electrolytic capacitor (ESR < 0.7 Ω at 100 kHz) mounted close to the input of the module to improve the stability.

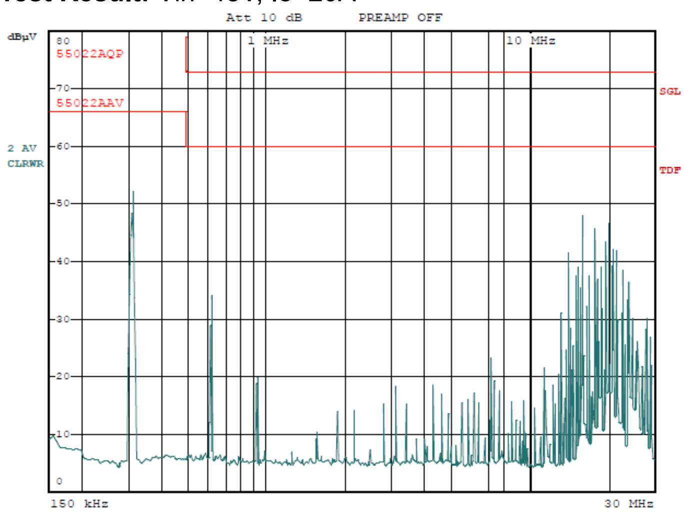
Layout and EMC Considerations

Delta's DC/DC power modules are designed to operate in a wide variety of systems and applications. Below is a reference design for an input filter tested with E36SR3R320XXXX to meet EN55022 class A.

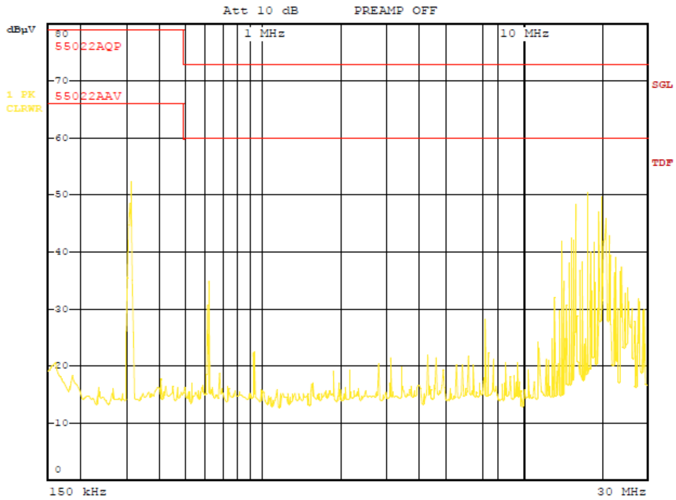


CX1=CX2=4*0.47uF/100V; Ceramic cap
CY1=CY2=CY3=CY4=22nF/250V; Y cap
CX3=100uF/100V; Aluminum Electronic cap
Common inductor is PULSE P0527; 0.53mH

Test Result: Vin=48V, Io=20A



Average Mode



Peak Mode

Safety Considerations

The power module must be installed in compliance with the spacing and separation requirements of the end-user's safety agency standard, i.e. IEC 62368-1: 2014 (2nd edition), EN 62368-1: 2014 (2nd edition), UL 62368-1, 2nd Edition, 2014-12-01 and CSA C22.2 No. 62368-1-14, 2nd Edition, 2014-12. IEC 60950-1: 2005, 2nd Edition + A1: 2009 + A2: 2013, UL60950-1, CAN/CSA-C22.2, No. 60950-1 and EN60950-1+A11 and IEC60950-1, if the system in which the power module is to be used must meet safety agency requirements.

Basic insulation based on 75 Vdc input is provided between the input and output of the module for the purpose of applying insulation requirements when the input to this DC-to-DC converter is identified as TNV-2 or SELV. An additional evaluation is needed if the source is other than TNV-2 or SELV.

When the input source is SELV circuit, the power module meets SELV (safety extra-low voltage) requirements. If the input source is a hazardous voltage which is greater than 60 Vdc and less than or equal to 75 Vdc, for the module's output to meet SELV requirements, all of the following must be met:

- The input source must be insulated from the ac mains by reinforced or double insulation.
- The input terminals of the module are not operator accessible.
- If the metal baseplate / heatspreader is grounded the output must be also grounded.

A SELV reliability test is conducted on the system where the module is used, in combination with the module, to ensure that under a single fault, hazardous voltage does not appear at the module's output.

When installed into a Class II equipment (without grounding), spacing consideration should be given to the end-use installation, as the spacing between the module and mounting surface have not been evaluated.

The power module has extra-low voltage (ELV) outputs when all inputs are ELV.

This power module is not internally fused. To achieve optimum safety and system protection, an input line fuse is highly recommended. The safety agencies require a normal-blow fuse with 10A maximum rating to be installed in the ungrounded lead. A lower rated fuse can be used based on the maximum inrush transient energy and maximum input current.

Soldering and Cleaning Considerations

Post solder cleaning is usually the final board assembly process before the board or system undergoes electrical testing. Inadequate cleaning and/or drying may lower the reliability of a power module and severely affect the finished circuit board assembly test. Adequate cleaning and/or drying is especially important for un-encapsulated and/or open frame type power modules. For assistance on appropriate soldering and cleaning procedures, please contact Delta's technical support team.

Over-Current Protection

The modules include an internal output over-current protection circuit, which will endure current limiting for an unlimited duration during output overload. If the output current exceeds the OCP set point, the modules will automatically shut down (hiccup mode).

The modules will try to restart after shutdown. If the overload condition still exists, the module will shut down again. This restart trial will continue until the overload condition is corrected.

Over-Voltage Protection

The modules include an internal output over-voltage protection circuit, which monitors the voltage on the output terminals. If this voltage exceeds the over-voltage set point, the module will shut down and latch off. The over-voltage latch is reset by either cycling the input power or by toggling the on/off signal for one second.

Over-Temperature Protection

The over-temperature protection consists of circuitry that provides protection from thermal damage. If the temperature exceeds the over-temperature threshold the module will shut down.

The module will try to restart after shutdown. If the over-temperature condition still exists during restart, the module will shut down again. This restart trial will continue until the temperature is within specification.

Remote On/Off

The remote on/off feature on the module can be either negative or positive logic. Negative logic turns the module on during a logic low and off during a logic high. Positive logic turns the modules on during a logic high and off during a logic low.

Remote on/off can be controlled by an external switch between the on/off terminal and the Vi(-) terminal. The switch can be an open collector or open drain.

For negative logic if the remote on/off feature is not used, please short the on/off pin to Vi(-). For positive logic if the remote on/off feature is not used, please leave the on/off pin to floating.

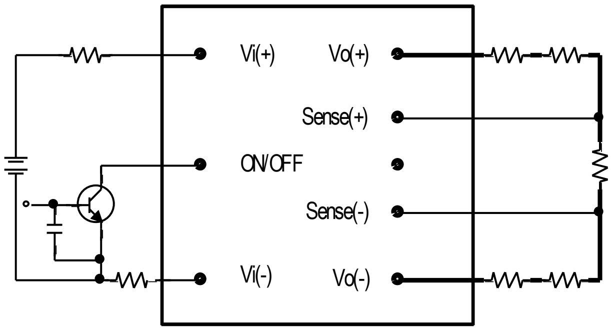


Figure 16: *Remote on/off implementation*

Remote Sense

Remote sense compensates for voltage drops on the output by sensing the actual output voltage at the point of load. The voltage between the remote sense pins and the output terminals must not exceed the output voltage sense range given here:

[Vo(+) – Vo(–)] – [SENSE(+) – SENSE(–)] ≤ 10% × Vout

This limit includes any increase in voltage due to remote sense compensation and output voltage set point adjustment (trim).

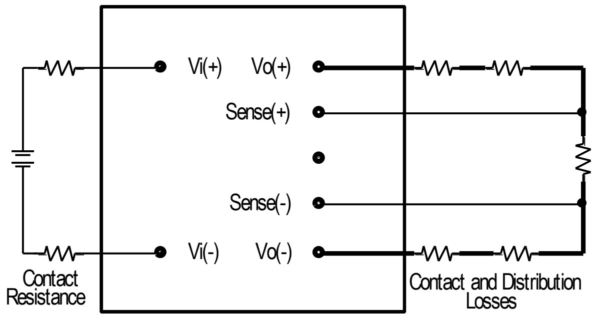


Figure 17: *Effective circuit configuration for remote sense operation*

If the remote sense feature is not used to regulate the output at the point of load, please connect SENSE(+) to Vo(+) and SENSE(–) to Vo(–) at the module.

The output voltage can be increased by both the remote sense and the trim; however, the maximum increase is the larger of either the remote sense or the trim, not the sum of both.

When using remote sense and trim, the output voltage of the module is usually increased, which increases the power output of the module with the same output current.

Care should be taken to ensure that the maximum output power does not exceed the maximum rated power.

Output Voltage Adjustment (TRIM)

To increase or decrease the output voltage set point, the modules may be connected with an external resistor between the TRIM pin and either the SENSE(+) or SENSE(-). The TRIM pin should be left open if this feature is not used.

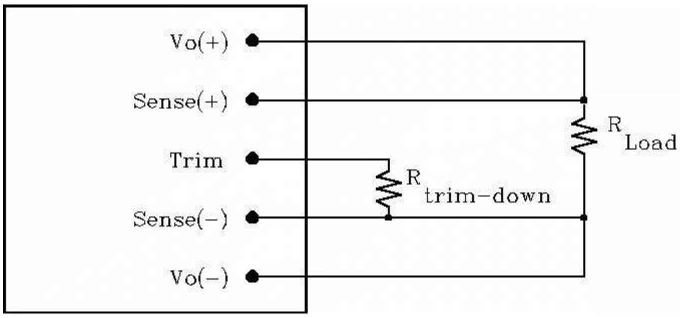


Figure 18: *Circuit configuration for trim-down (decrease output voltage)*

If the external resistor is connected between the TRIM and SENSE (-) pins, the output voltage set point decreases (Fig. 18). The external resistor value required to obtain a percentage of output voltage change △% is defined as:

$$Rtrim-down = \frac{511}{\Delta} - 10.21(K\Omega)$$

Ex. When Trim-down -10%(3.3V×0.9=2.97V)

$$Rtrim-down = \frac{511}{10} - 10.21 = 40.89(K\Omega)$$

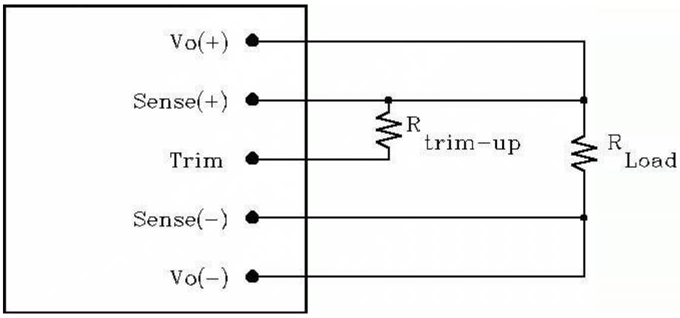


Figure 19: *Circuit configuration for trim-up (increase output voltage)*

If the external resistor is connected between the TRIM and SENSE (+) the output voltage set point increases (Fig. 19). The external resistor value required to obtain a percentage output voltage change △% is defined as:

$$Rtrim-up = \frac{5.11Vo(100+\Delta)}{1.225\Delta} - \frac{511}{\Delta} - 10.21(K\Omega)$$

Ex. When Trim-up +10%(5V×1.1=5.5V)

$$Rtrim-up = \frac{5.11\times 3.3\times(100+10)}{1.225\times 10} - \frac{511}{10} - 10.21 = 90.11(K\Omega)$$

The output voltage can be increased by both the remote sense and the trim, however the maximum increase is the larger of either the remote sense or the trim, not the sum of both.

When using remote sense and trim, the output voltage of the module is usually increased, which increases the power output of the module with the same output current.

Care should be taken to ensure that the maximum output power of the module remains at or below the maximum rated power.

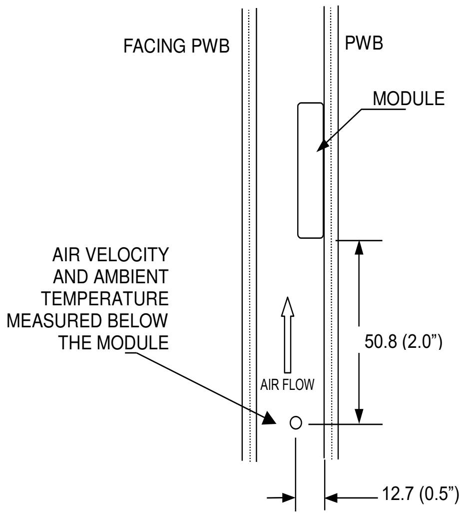
Thermal management is an important part of the system design. To ensure proper, reliable operation, sufficient cooling of the power module is needed over the entire temperature range of the module. Convection cooling is usually the dominant mode of heat transfer.

Hence, the choice of equipment to characterize the thermal performance of the power module is a wind tunnel.

Thermal Testing Setup

Delta's DC/DC power modules are characterized in heated vertical wind tunnels that simulate the thermal environments encountered in most electronics equipment. This type of equipment commonly uses vertically mounted circuit cards in cabinet racks in which the power modules are mounted.

The following figure shows the wind tunnel characterization setup. The power module is mounted on a test PWB and is vertically positioned within the wind tunnel. The space between the neighboring PWB and the top of the power module is constantly kept at 6.35mm (0.25'').



Note: Wind Tunnel Test Setup Figure Dimensions are in millimeters and (Inches)

Figure 20: *Wind tunnel test setup*

Thermal Derating

Heat can be removed by increasing airflow over the module. The hottest point temperature of the module is to be defined. To enhance system reliability; the power module should always be operated below the maximum operating temperature. If the temperature exceeds the maximum module temperature, reliability of the unit may be affected.

Thermal Curves

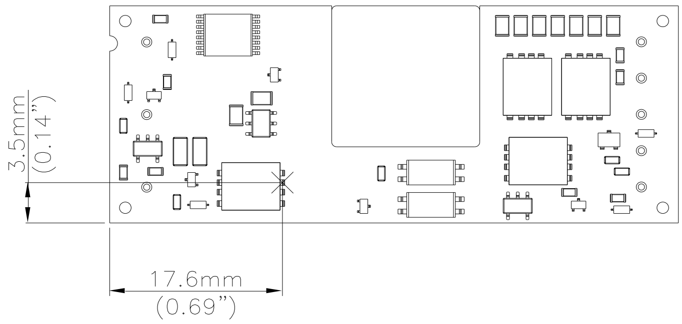


Figure 21: *Hot spot temperature measured point.*

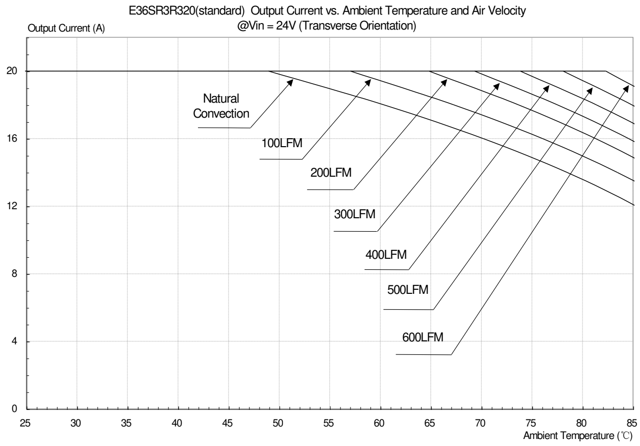


Figure 22: *Output load vs. ambient temperature and air velocity @ V_{in}=24V(Transverse Orientation)*

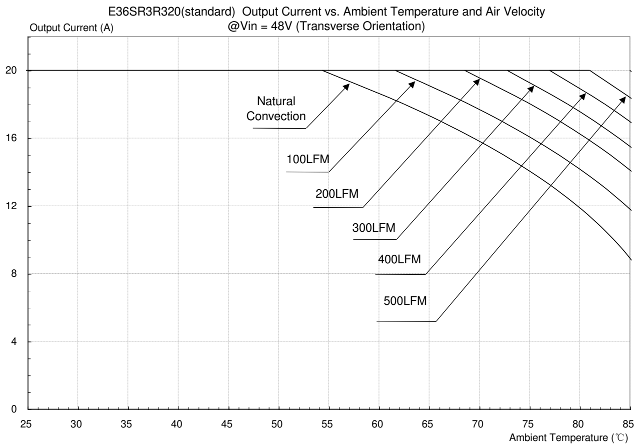
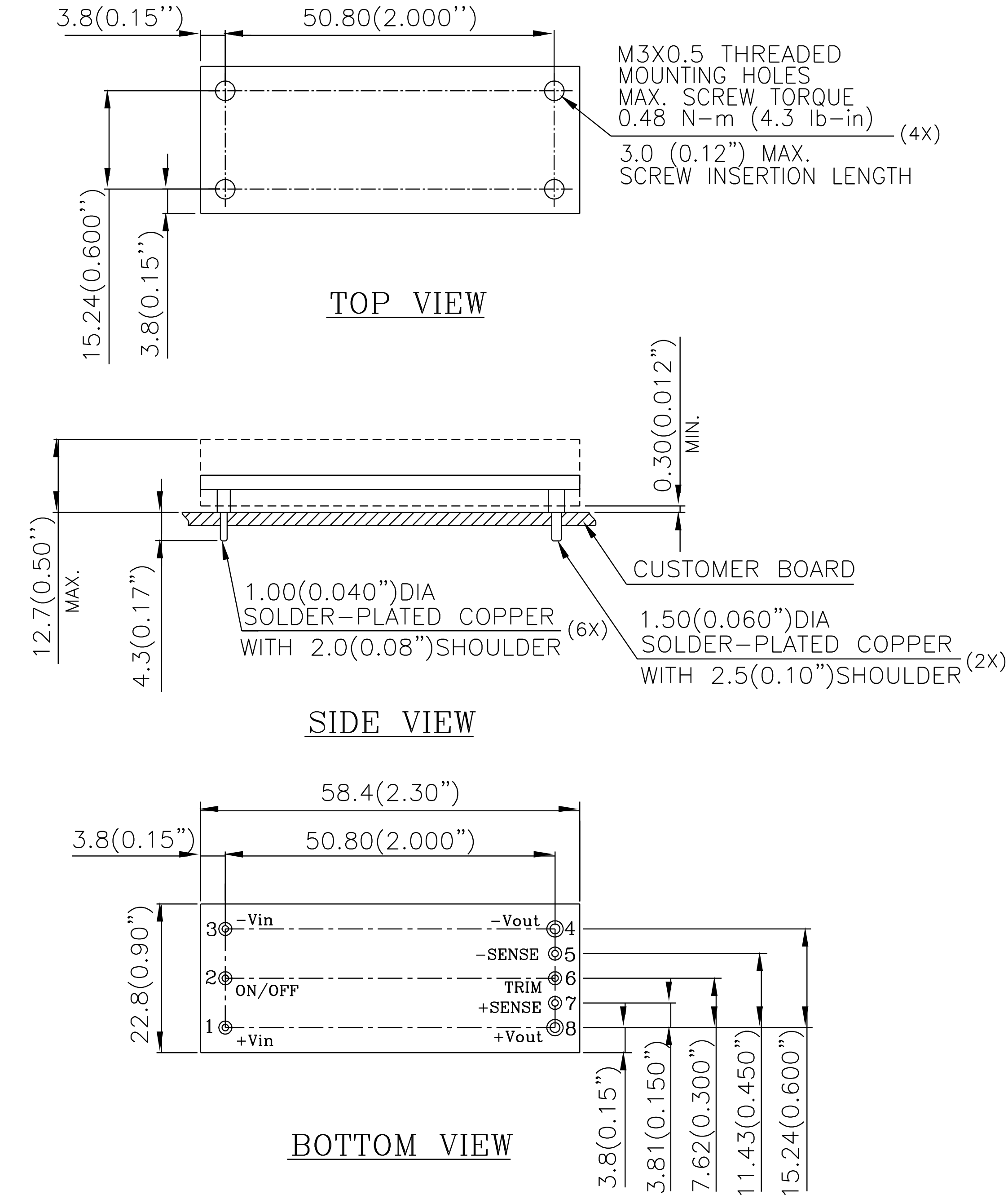


Figure 23: *Output load vs. ambient temperature and air velocity @ V_{in}=48V(Transverse Orientation)*

Mechanical Drawing (with Heat-spreader)

For modules with through-hole pins and the optional heats-preader, they are intended for wave soldering assembly onto system boards, please do not subject such modules through reflow temperature profile.

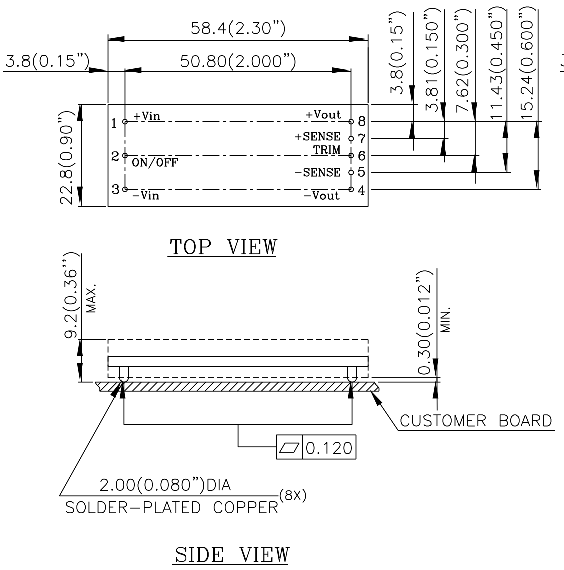
THROUGH-HOLE MODULE

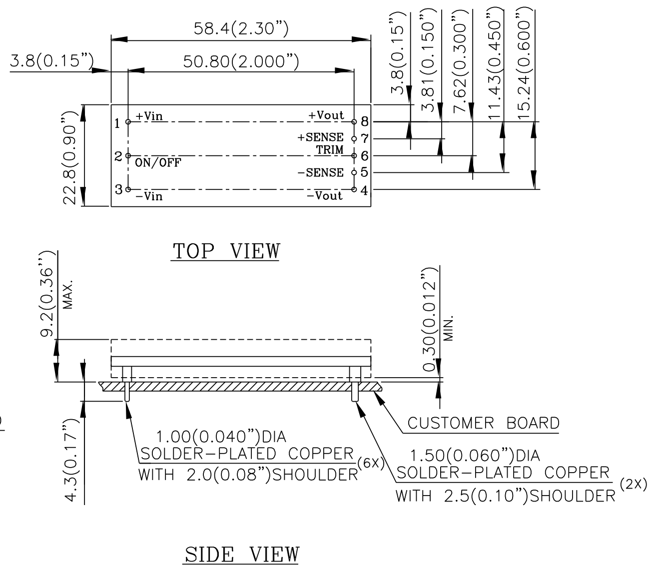


NOTES:
DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
X.XXmm±0.25mm(X.XXX in.±0.010 in.)

Mechanical Drawing (without Heat-spreader)

Surface-mount module | **Through-hole module**





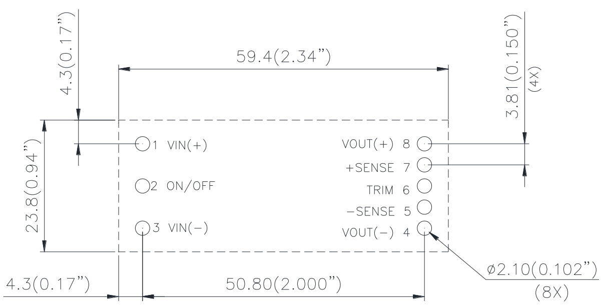
NOTES:
DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
X.XXmm±0.25mm(X.XXX in.±0.010 in.)

Pin No.	Name	Function
1	+Vin	Positive input voltage
2	ON/OFF	Remote ON/OFF
3	-Vin	Negative input voltage
4	-Vout	Negative output voltage
5	-SENSE	Negative remote sense
6	TRIM	Output voltage trim
7	+SENSE	Positive remote sense
8	+Vout	Positive output voltage

Suggested Pad Layout

Surface-mount module

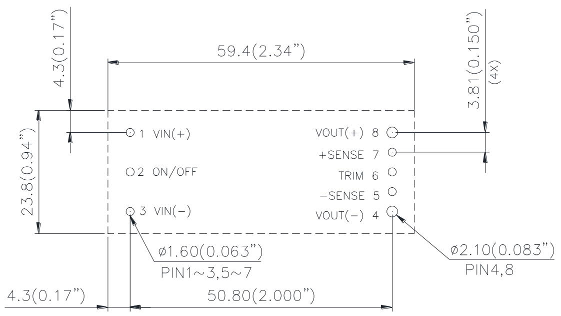
SUGGESTED PAD LAYOUT



NOTES:
DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
X.XXmm±0.25mm(X.XXX in.±0.010 in.)

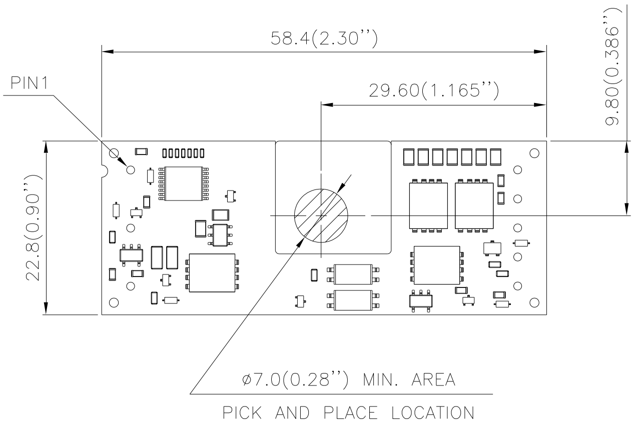
Through-hole module

SUGGESTED PAD LAYOUT



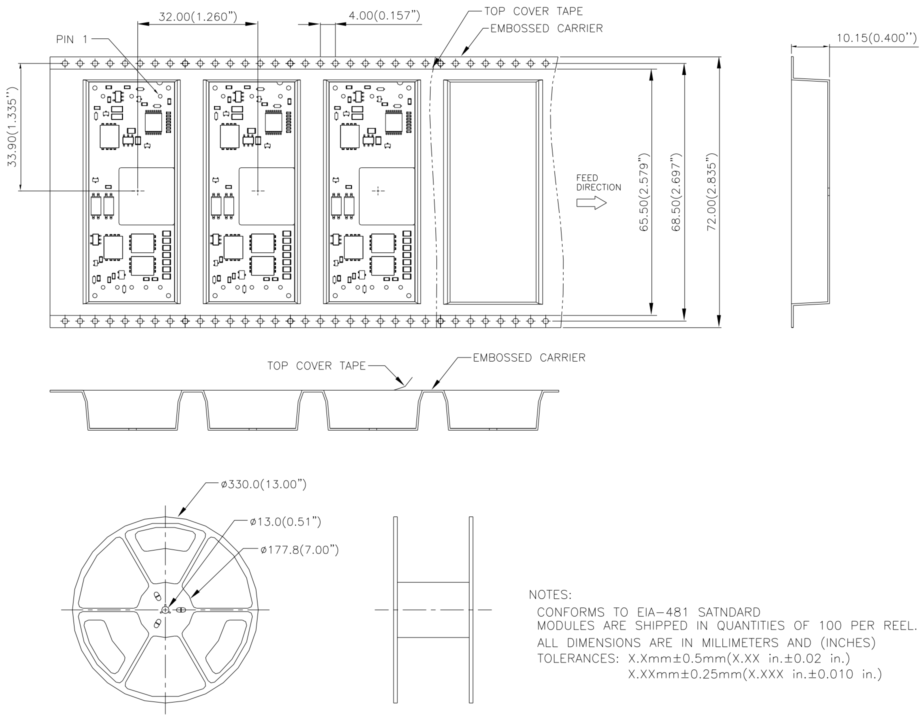
NOTES:
DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
X.XXmm±0.25mm(X.XXX in.±0.010 in.)

Pick and Place Location



NOTES:
DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
X.XXmm±0.25mm(X.XXX in.±0.010 in.)

Surface-Mount Tape & Reel



NOTES:
CONFORMS TO EIA-481 SATNDARD
MODULES ARE SHIPPED IN QUANTITIES OF 100 PER REEL.
ALL DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
X.XXmm±0.25mm(X.XXX in.±0.010 in.)

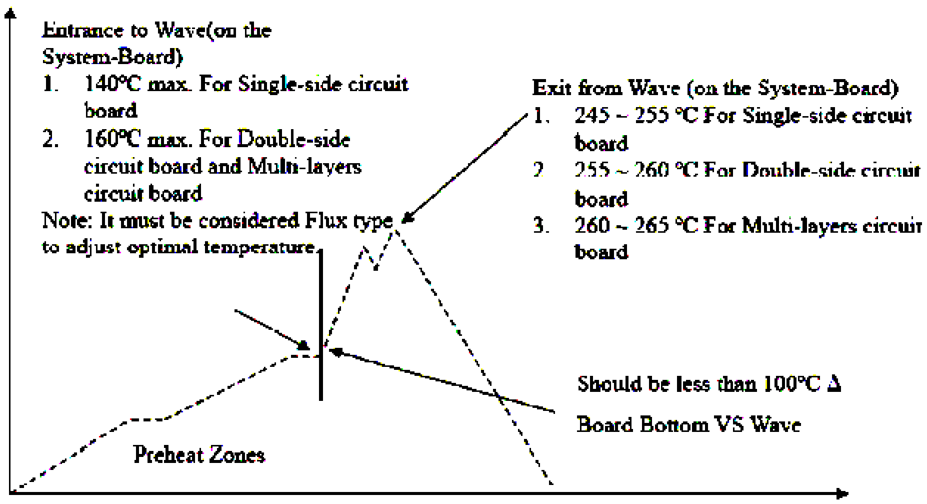
Soldering Method

Generally, as the most common mass soldering method for the solder attachment, wave soldering is used for through-hole power modules and reflow soldering is used for surface-mount ones. Delta recommended soldering methods and process parameters are provided in this document for solder attachment of power modules onto system board. SAC305 is the suggested lead-free solder alloy for all soldering methods.

Reflow soldering is not a suggested method for through-hole power modules due to many process and reliability concerns. If you have this kind of application requirement, please contact Delta sales or FAE for further confirmation.

Wave Soldering (Lead-free)

Delta's power modules are designed to be compatible with single-wave or dual wave soldering. The suggested soldering process must keep the power module's internal temperature below the critical temperature of 217℃ continuously. The recommended wave-soldering profile is shown in following figure.



Recommended Temperature Profile for Lead-free Wave Soldering
Note: The temperature is measured on solder joint of pins of power module.

The typical recommended (for double-side circuit board) preheat temperature is 115+/-10℃ on the top side (component side) of the circuit board. The circuit-board bottom-side preheat temperature is typically recommended to be greater than 135℃ and preferably within 100℃ of the solder-wave temperature. A maximum recommended preheat up rate is 3℃/s. A maximum recommended solder pot temperature is 255+/-5℃ with solder-wave dwell time of 3~6 seconds. The cooling down rate is typically recommended to be 6℃/s maximum.

Hand Soldering (Lead Free)

Hand soldering is the least preferred method because the amount of solder applied, the time the soldering iron is held on the joint, the temperature of the iron, and the temperature of the solder joint are variable. The recommended hand soldering guideline is listed in following table. The suggested soldering process must keep the power module's internal temperature below the critical temperature of 217℃ continuously.

Hand-Soldering Guideline

Parameter	Single-side Circuit Board	Double-side Circuit Board	Multi-layers Circuit Board
Soldering Iron Wattage Tip Temperature	90 385+/-10℃	90 420+/-10℃	90 420+/-10℃
Soldering Time	2 ~ 6 seconds	4 ~ 10 seconds	4 ~ 10 seconds

PART NUMBERING SYSTEM

E	36	S	R	3R3	20	N	R	F	H
Type of Product	Input Voltage	Number of Outputs	Product Series	Output Voltage	Output Current	ON/OFF Logic	Pin Length /Type		Mechanical Option
E- Eighth Brick	36-18~75V	S - Single	R - Regular	3R3 - 3.3V	20 -20A	N - Negative	R - 0.170"	F - RoHS 6/6 (Lead Free)	A- Standard Functions H- Standard Functions with heat-spreader N- 20000 uF capacitive load, 155%~190% OCP, and with heat-spreader

RECOMMENDED PART NUMBER.

Model Name	Input		Output		EFF @ 100% LOAD
E36SR3R320NRFA	18V~75V	4.3A	3.3V	20A	88%
E36SR3R320NRFN	18V~75V	4.3A	3.3V	20A	88%
E36SR3R320NRFH	18V~75V	4.3A	3.3V	20A	88%

Default remote on/off logic is negative and pin length is 0.170"
For different remote on/off logic and pin length, please refer to part numbering system above or contact your local sales office.

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WARRANTY

Delta offers a two (2) year limited warranty. Complete warranty information is listed on our web site or is available upon request from Delta.