E54SJ3R350
Eighth Brick DC/DC Power Module
40~60V in, 3.3V/50A out, 165W

E54SJ3R350, Eighth Brick, 40~60V input, single output, isolated DC/DC converters, are the latest offering from a world leader in power systems technology and manufacturing — Delta Electronics, Inc. This product family provides up to 165 watts of power with very high efficiency. With creative design technology and optimization of component placement, these converters possess outstanding electrical and thermal performance, as well as extremely high reliability under highly stressful operating conditions. Typical efficiency of the 3.3V/50A module is greater than 94%.

FEATURES

Electrical

- High efficiency:
  94% @ 3.3V/50A
  94% @ 3.3V/20A
- Industry standard footprint and pin-out
- Fixed frequency operation
- OTP, Input UVLO, Output OVP
- Output OCP Hiccup mode
- Monotonic startup into normal and pre-biased loads
- 1500V isolation and basic insulation
- No minimum load required
- No negative current during power or enable On/Off

Mechanical

Size:
- Without heat-spreader
  58.4x22.8x10.9mm (2.30"x0.90"x0.43")
- With heat-spreader
  58.4x22.8x12.7mm (2.30"x0.90"x0.50")

Safety & Reliability

- UL 60950-1 & CSA C22.2 No.60950-1-07
- IPC9592B
- ISO 9001, TL 9000, ISO 14001, QS 9000,
- OHSAS18001 certified manufacturing facility

OPTIONS

- Negative or Positive remote On/Off
- Open frame/Heat-spreader

APPLICATIONS

- Optical Transport
- Data Networking
- Communications
- Servers

E-mail: dcdc@deltaww.com
http://www.deltaww.com/dcdc

(T_A=25°C, airflow rate=100 LFM, V_{in}=48Vdc, nominal V_{out} unless otherwise noted.)

PARAMETER	NOTES and CONDITIONS	E54SJ3R350			
		Min.	Typ.	Max.	Units
ABSOLUTE MAXIMUM RATINGS					
Input Voltage					Vdc
Continuous		0		60	Vdc
Transient (100ms)	100ms			80	Vdc
Operating Ambient Temperature		-40		85	°C
Storage Temperature		-55		125	°C
Input/Output Isolation Voltage				1500	Vdc
INPUT CHARACTERISTICS					
Operating Input Voltage		40	48/54	60	Vdc
Input Under-Voltage Lockout					
Turn-On Voltage Threshold		32.5	34.0	35.5	Vdc
Turn-Off Voltage Threshold		30.5	32.0	33.5	Vdc
Lockout Hysteresis Voltage		1	2	3	Vdc
Maximum Input Current	Full Load, 40V_{in}			4.8	A
No-Load Input Current	V_{in}=48V, I_o=0A		80	120	mA
Off Converter Input Current	V_{in}=48V, I_o=0A		8	12	mA
Inrush Current (I^2t)				1	A^2s
Input Reflected-Ripple Current	P-P thru 12µH inductor, 5Hz to 20MHz		20		mA
Input Voltage Ripple Rejection	120 Hz		45		dB
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	V_{in}=48V, I_o=$I_{o.max}$, T_c=25°C	3.25	3.3	3.35	Vdc
Output Regulation					
Load Regulation	I_o=$I_{o,\ min}$ to $I_{o,\ max}$			0.3	%$V_{o,set}$
Line Regulation	V_{in}=40V to 60V			0.3	%$V_{o,set}$
Temperature Regulation	T_c=-40°C to 85°C		1		%$V_{o,set}$
Total Output Voltage Range	Over sample load, line and temperature	3.2		3.4	V
Output Voltage Ripple and Noise	5Hz to 20MHz bandwidth				
Peak-to-Peak	V_{in}=48V, Full Load, 1µF ceramic, 10µF tantalum		100	150	mV
RMS	V_{in}=48V, Full Load, 1µF ceramic, 10µF tantalum		40	60	mV
Operating Output Current Range	V_{in}=40V to 60V	0		50	A
Output Over Current Protection(hiccup mode)	Output Voltage 10% Low	55		75	A
DYNAMIC CHARACTERISTICS					
Output Voltage Current Transient	48V_{in}, 10µF Tan & 1µF Ceramic load cap, 0.1A/µs				
Positive Step Change in Output Current	75% $I_{o.max}$ to 50% $I_{o.max}$		70	120	mV
Negative Step Change in Output Current	50% $I_{o.max}$ to 75% $I_{o.max}$		70	120	mV
Settling Time (within 1% nominal V_{out})			100	200	µs
Turn-On Delay and Rise Time					
Start-Up Delay Time From Input Voltage	On/Off=On, from V_{in}=Turn-On Threshold to V_o=10% $V_{o,nom}$	10	15	20	mS
Start-Up Delay Time From On/Off Control	V_{in}=$V_{in,nom}$, from On/Off=On to V_o=10% $V_{o,nom}$	10	15	20	mS
Output Voltage Rise Time	V_o=10% to 90% $V_{o,nom}$	10	15	20	mS
Output Capacitance (note1)	Full load; 5% overshoot of V_{out} at startup			10000	µF
EFFICIENCY					
100% Load	V_{in}=48V		94.0		%
50% Load	V_{in}=48V		94.0		%
ISOLATION CHARACTERISTICS					
Input to Output				1500	Vdc
Isolation Resistance		10			MΩ
Isolation Capacitance			1100		pF
FEATURE CHARACTERISTICS					
Switching Frequency			200		KHz
On/Off Control, Negative Remote On/Off logic					
Logic Low (Module On)	$V_{on/off}$			0.8	V
Logic High (Module Off)	$V_{on/off}$	2		15	V
On/Off Control, Positive Remote On/Off logic					
Logic Low (Module Off)	$V_{on/off}$			0.8	V
Logic High (Module On)	$V_{on/off}$	2		15	V
On/Off Current (for both remote On/Off logic)	$I_{on/off}$ at $V_{on/off}$=0.0V				mA
Leakage Current (for both remote On/Off logic)	Logic High, $V_{on/off}$=5V				
Output Voltage Trim Range	P_{out} ≦ max rated power, I_o ≦ $I_{o.max}$	-20		10	%$V_{o,nom}$
Output Voltage Remote Sense Range	P_{out} ≦ max rated power, I_o ≦ $I_{o.max}$	-10		0	%$V_{o,nom}$
Output Over-Voltage Protection	% of nominal V_{out}	120		140	%$V_{o,nom}$
GENERAL SPECIFICATIONS					
MTBF	I_o=80% of $I_{o,\ max}$; T_a=25°C, airflow rate=300LFM		5		Mhours
Weight	Without heat-spreader		29		grams
Weight	With heat-spreader		38		grams
Over-Temperature Shutdown (without heat-spreader)	Refer to Figure 18 for Hot spot 1 location (48V_{in}, 80% I_o, 200LFM,Airflow from V_{in+} to V_{in-})		125		°C
Over-Temperature Shutdown (with heat-spreader)	Refer to Figure 20 for Hot spot 2 location (48V_{in}, 80% I_o, 200LFM,Airflow from V_{in+} to V_{in-})		115		°C
Over-Temperature Shutdown (NTC resistor)	Refer to Figure 18 for NTC resistor location		125		°C
Note: Please attach thermocouple on NTC resistor to test OTP function, the hot spots' temperature is just for reference.					

Note: For applications with higher output capacitive load, please contact Delta.

T_A=25°C

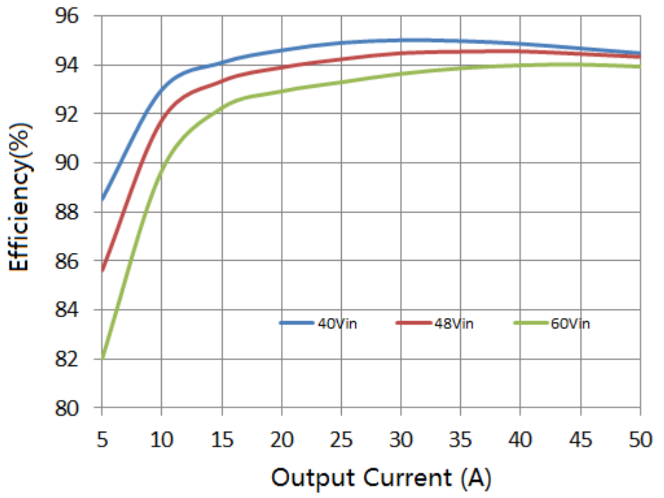


Figure 1: Efficiency vs. Output Current

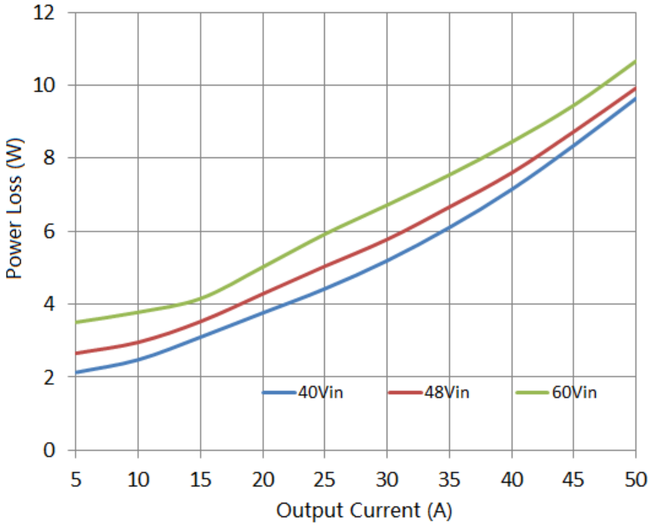


Figure 2: Power Dissipation vs. Output Current

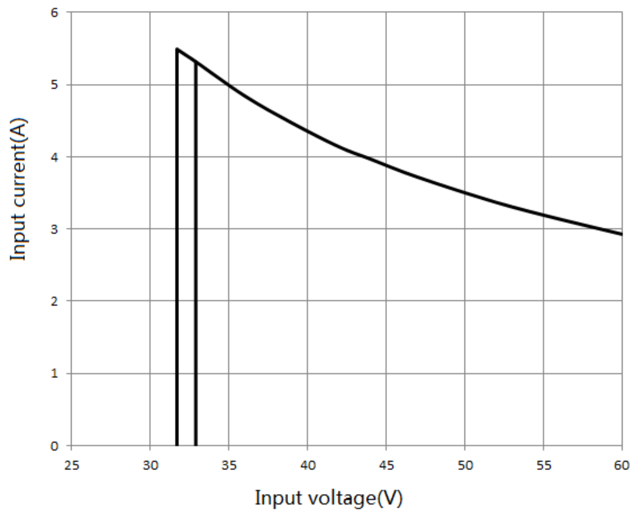


Figure 3: Full Load Input Characteristics

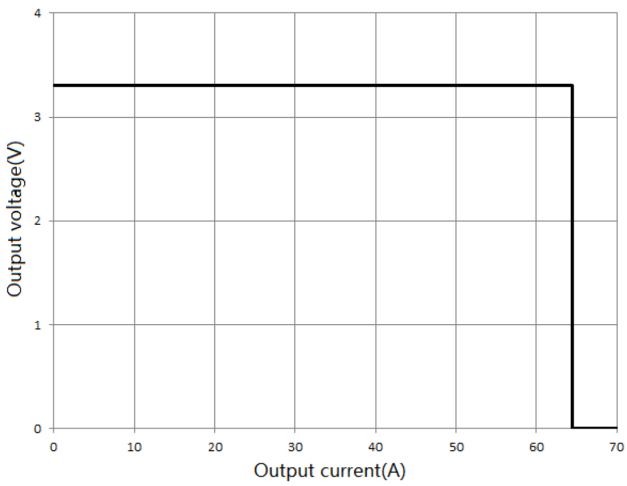


Figure 4: Output Voltage vs. Output Current showing typical current limit curves and converter shutdown points.

T_A=25°C, V_{in}=48Vdc

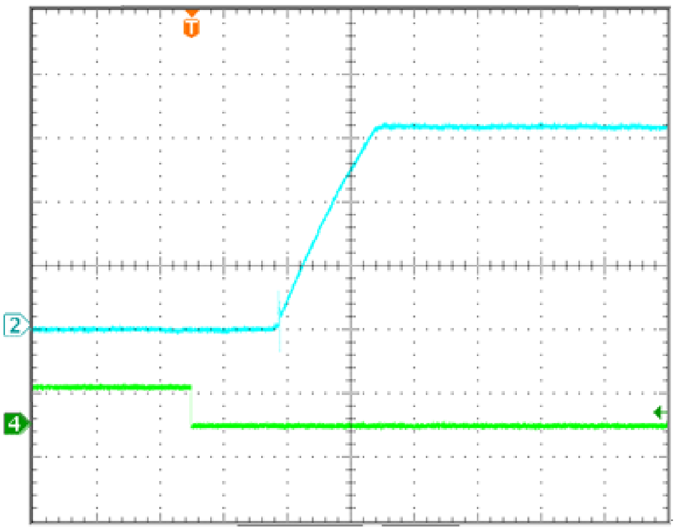


Figure 5: Remote On/Off (negative logic) at full load
Time: 10ms/div.
V_{out} (top trace): 1V/div;
$V_{remote\ On/Off\ signal}$ (bottom trace): 5V/div.

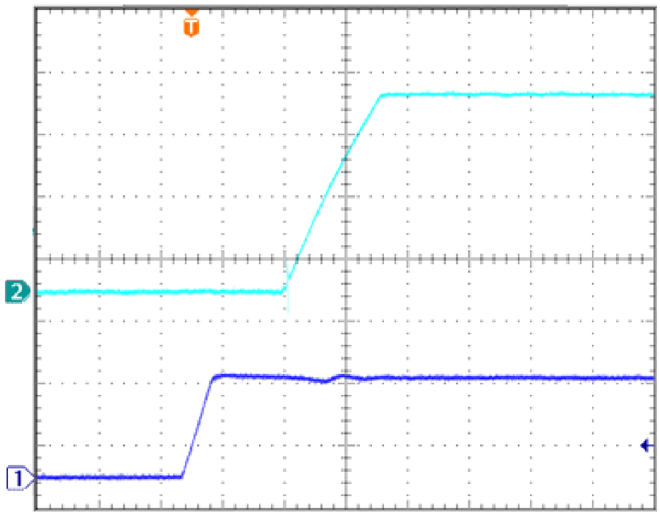


Figure 6: Input Voltage Start-up at full load
Time: 10ms/div.
V_{out} (top trace): 1V/div;
V_{in} (bottom trace): 30V/div.

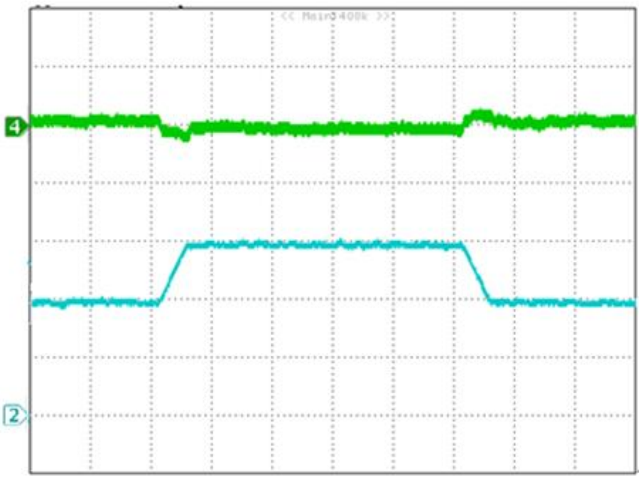


Figure 7: Transient Response
(0.1A/µs step change in load from 50% to 75% to 50% of $I_{o,\ max}$)
V_{out} (top trace): 0.1V/div, 200us/div;
I_{out} (bottom trace): 12.5A/div.
Load cap: 10µF tantalum capacitor and 1µF ceramic capacitor.
Scope measurement should be made using a BNC cable (length shorter than 20 inches). Position the load between 51 mm to 76 mm (2 inches to 3 inches) from the module

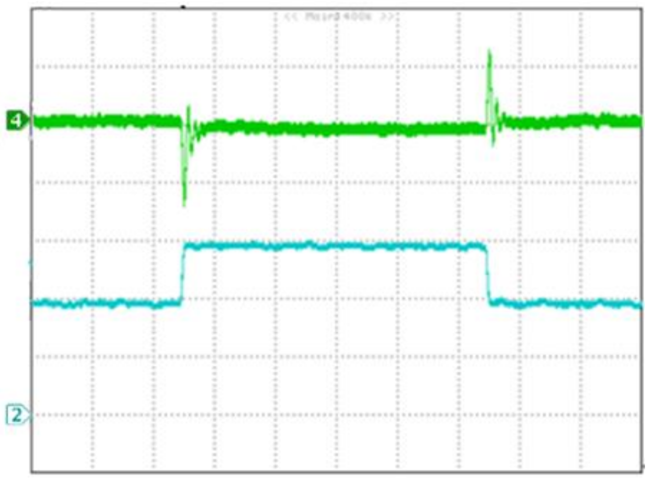


Figure 8: Transient Response
(1A/µs step change in load from 50% to 75% to 50%of $I_{o,\ max}$)
V_{out} (top trace):0.1V/div, 200us/div;
I_{out} (bottom trace): 12.5A/div.
Load cap: 10µF tantalum capacitor and 1µF ceramic capacitor.
Scope measurement should be made using a BNC cable (length shorter than 20 inches). Position the load between 51 mm to 76 mm (2 inches to 3 inches) from the module

T_A=25°C, V_{in}=48Vdc

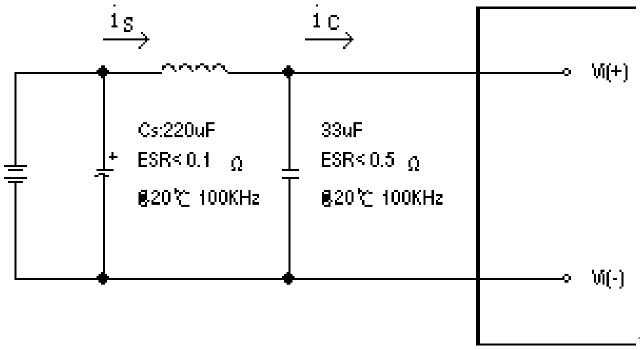


Figure 9: Test Setup Diagram for Input Ripple Current
Note: Measured input reflected-ripple current with a simulated source Inductance (L_{TEST}) of 12µH. Capacitor Cs offset possible battery impedance. Measure current as shown above.

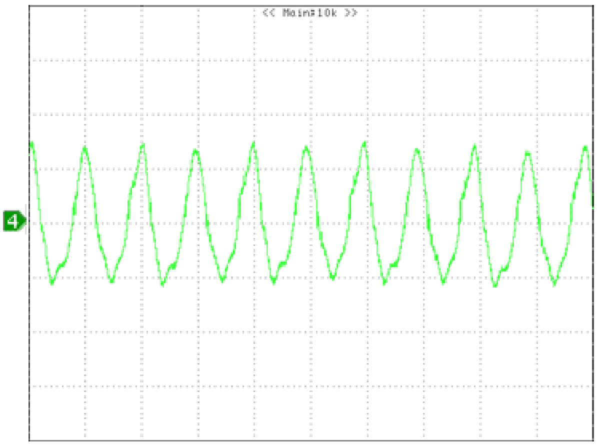


Figure 10: Input Terminal Ripple Current, i_c, at max output current and nominal input voltage with 12µH source impedance and 33µF electrolytic capacitor (100 mA/div, 2us/div).

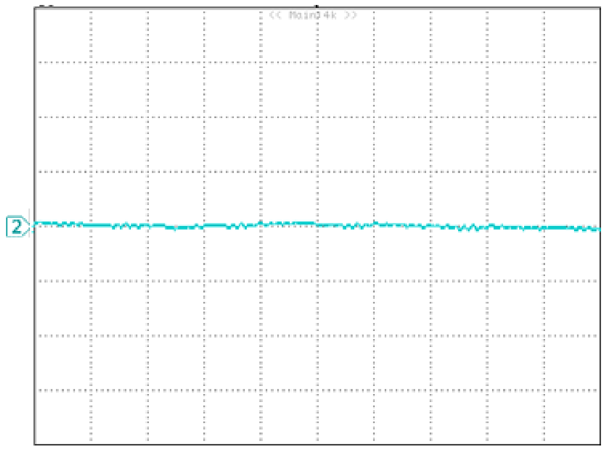


Figure 11: Input Reflected Ripple Current, i_s, through a 12µH source inductor at nominal input voltage and max load current (20mA/div, 2us/div).

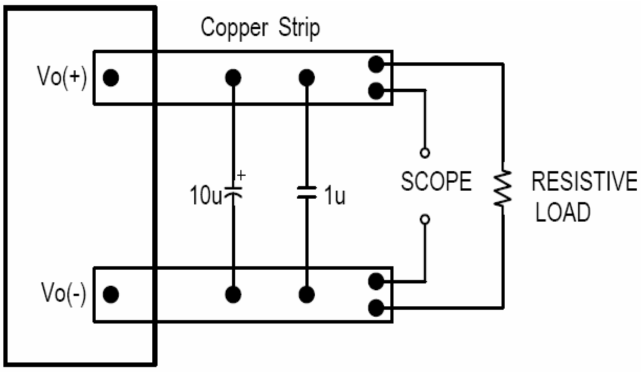


Figure 12: Test Setup for Output Voltage Noise and Ripple

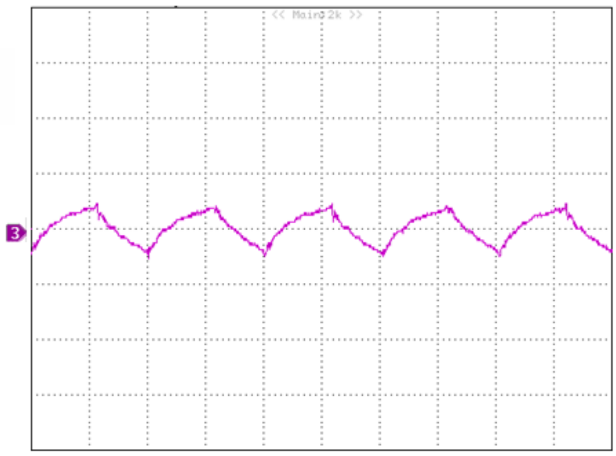


Figure 13: Output Voltage Ripple and Noise at nominal input voltage and max load current (100 mV/div, 2us/div)
Load cap: 1µF ceramic capacitor and 10µF tantalum capacitor.
Bandwidth: 20MHz.

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 100μF electrolytic capacitor (ESR < 0.7Ω at 100kHz) 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. For design assistance with EMC compliance and related PWB layout issues, please contact Delta's technical support team. Below is the reference design for an input filter tested with same family product to meet class B in CISSPR 22.

Schematic and Components List

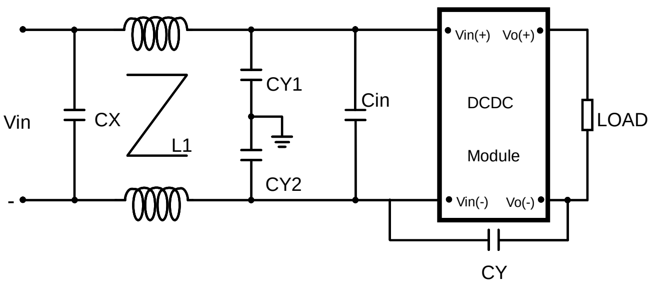


Figure 14-1: Recommended Input Filter
Cin is 100uF*2 low ESR Aluminum cap;
CX is 2.2uF ceramic cap;
CY1 are 10nF ceramic caps;
CY2 are 10nF ceramic caps;
CY is 1nF ceramic cap;
L1 is common-mode inductor, L1=0.88mH;

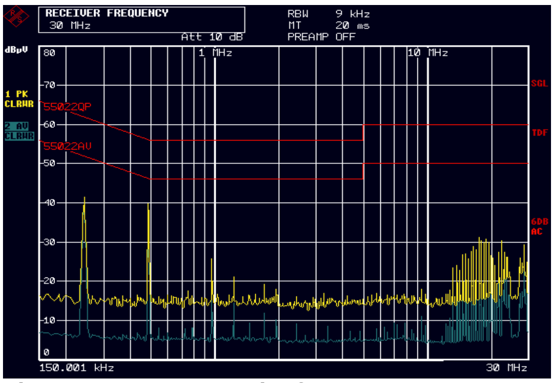


Figure 14-2: Test Result of EMC
V_{in}=48V, I_o=25A.
Yellow line is quasi peak mode;
Blue line is average mode.

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., UL60950-1, CSA C22.2 NO. 60950-1 2nd and IEC 60950-1 2nd: 2005 and EN 60950-1 2nd: 2006+A11+A1: 2010, if the system in which the power module is to be used must meet safety agency requirements.

Basic insulation based on 75Vdc 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 60Vdc and less than or equal to 75Vdc, 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.
- 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 fast acting fuse with 30A 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.

The input of E54SJ3R350 meets SELV requirement, but the design still meets basic insulation.

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 shut down.

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

E54SJ3R350 provides an option for a latch OCP mode, customer need contact to Delta for this option. Under latch mode, the module will latch off once it shutdown. The latch is reset by either cycling the input power or by toggling the on/off signal for one second.

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 protection circuit will constrain the max duty cycle to limit the output voltage; if the output voltage continuously increases the modules will shut down, and then restart after a hiccup-time (hiccup mode).

E54SJ3R350 provides an option for a latch OVP mode, customer need contact to Delta for this option. Under latch mode, the module will latch off once it shutdown. The 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 restart after the temperature is within specification.

Remote On/Off

The remote On/Off feature on the module can be either negative or positive logic depend on the part number options on the last page.

- For Negative logic version, turns the module on during a external logic low and off during a logic high. If the remote on/off feature is not used, please short the On/Off pin to Vi(-).
- For Positive logic version, turns the modules on during a external logic high and off during a logic low. If the remote On/Off feature is not used, please leave the On/Off pin to floating.

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.

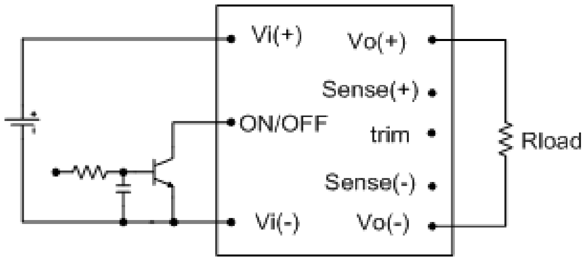


Figure 15: Remote On/Off Implementation

Output Voltage Adjustment (TRIM)

To decrease the output voltage set point, connect an external resistor between the TRIM pin and the SENSE(-) pin. The TRIM pin should be left open if this feature is not used.

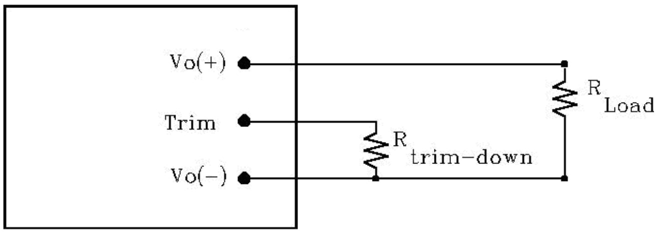


Figure 16-1: Circuit Configuration for Trim-Down (decrease output voltage)

If the external resistor is connected between the TRIM and Vo(-) pins, the output voltage set point decreases (Fig.16-1). The external resistor value required to obtain a percentage of output voltage change △% is defined as:

$$Rtrim-down=\left[\frac{511}{\Delta}-10.22\right](K\Omega)$$

Ex. When Trim-down -20% (3.3V×0.8=2.64V)

$$Rtrim-down=\left[\frac{511}{20}-10.22\right](K\Omega)=15.33(K\Omega)$$

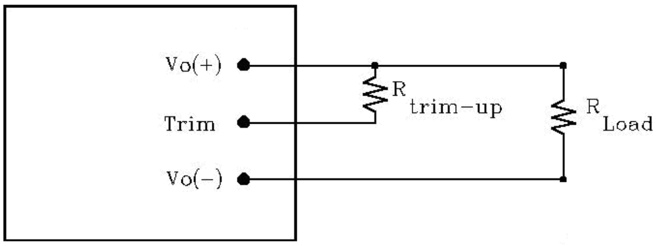


Figure 16-2: Circuit Configuration for Trim-Up (increase output voltage)

If the external resistor is connected between the TRIM and Vo(+) the output voltage set point increases (Fig.16-2) The external resistor value required to obtain a percentage output voltage change △% is defined as:

$$Rtrim-up=\frac{5.11Vo\,(100+\Delta)}{1.225\Delta}-\frac{511}{\Delta}-10.2(K\Omega)$$

Ex. When Trim-up +10% (3.3*1.1=3.63V)

$$Rtrim-up=\frac{5.11\times3.3\times(100+10)}{1.225\times10}-\frac{511}{10}-10.2=90.1(K\Omega)$$

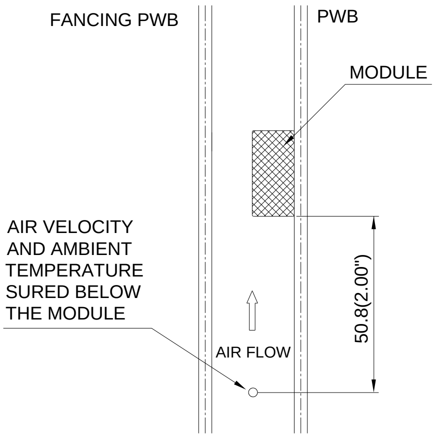
Thermal management is an important part of the system design. To ensure proper, reliable operation, sufficient cooling of the power module is needed over the entire temperature range of the module. Convection cooling is usually the dominant mode of heat transfer.

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 17: Wind Tunnel Test Setup

Thermal Derating

Heat can be removed by increasing airflow over the module. 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 (without heat-spreader)

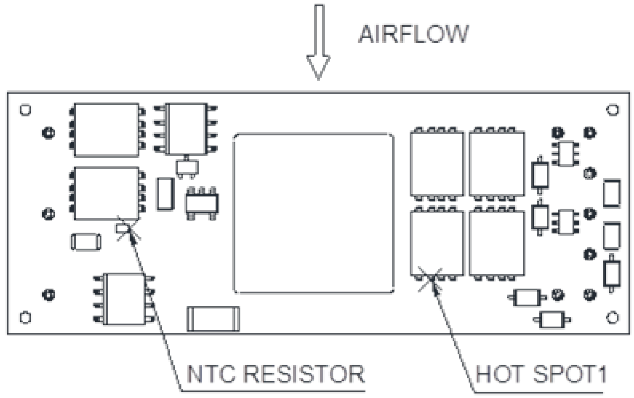


Figure 18: * Hot spot 1& NTC resistor temperature measured points. The allowed maximum hot spot temperature is defined at 120℃.

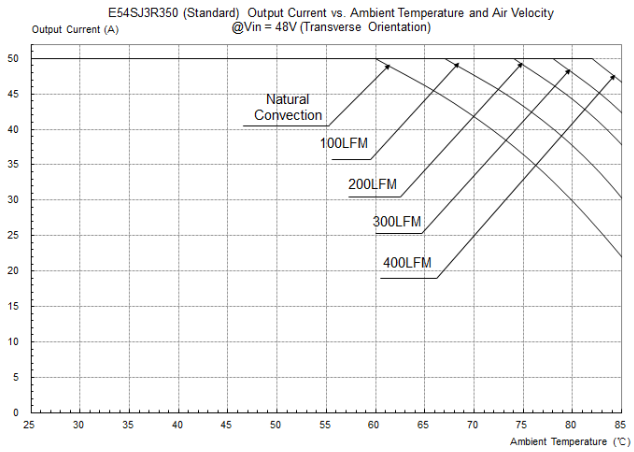


Figure 19: Output current vs. ambient temperature and air velocity @V_{in}=48V(Transverse Orientation, airflow from V_{in+} to V_{in-}, without heat-spreader)

Thermal Curves (with heat-spreader)

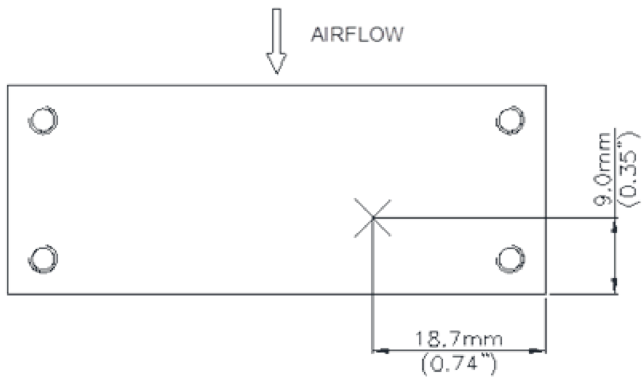


Figure 20: * Hot spot 2 temperature measured point. The allowed maximum hot spot temperature is defined at 110 ℃.

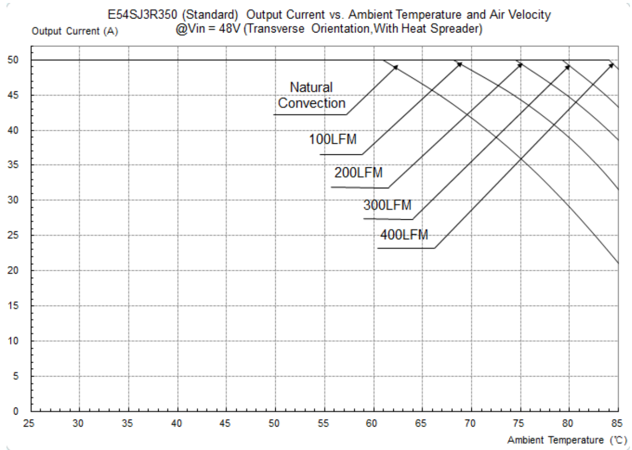
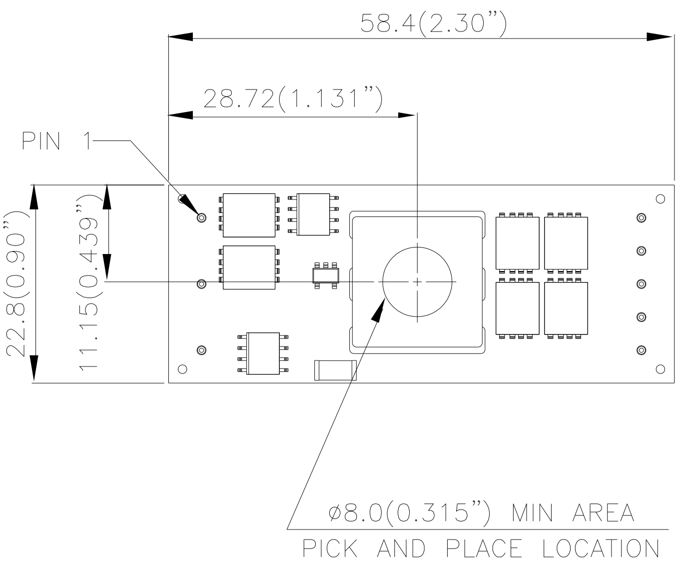


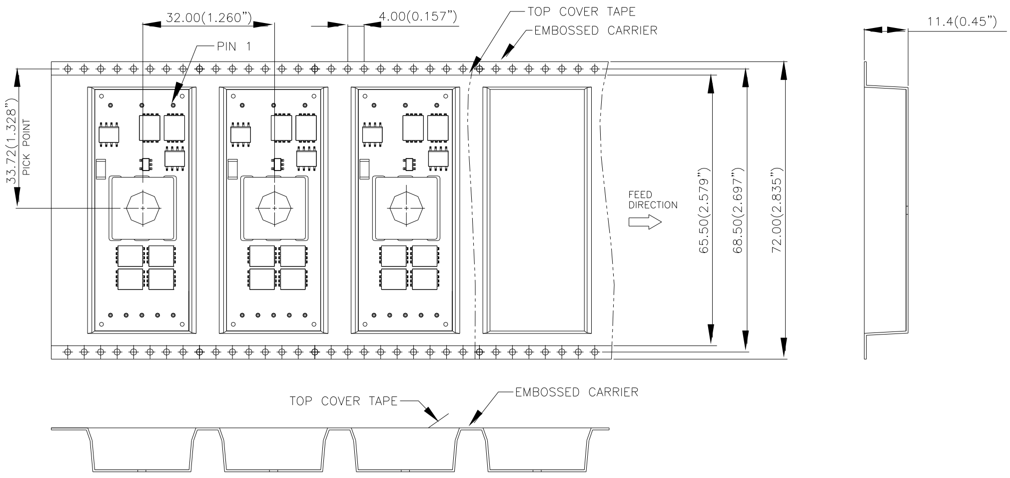
Figure 21: Output current vs. ambient temperature and air velocity @V_{in}=48V(Transverse Orientation, airflow from V_{in+} to V_{in-}, with heat-spreader)

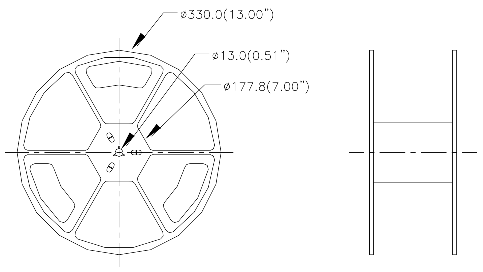
Pick and Place Location(for SMD only)



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.)

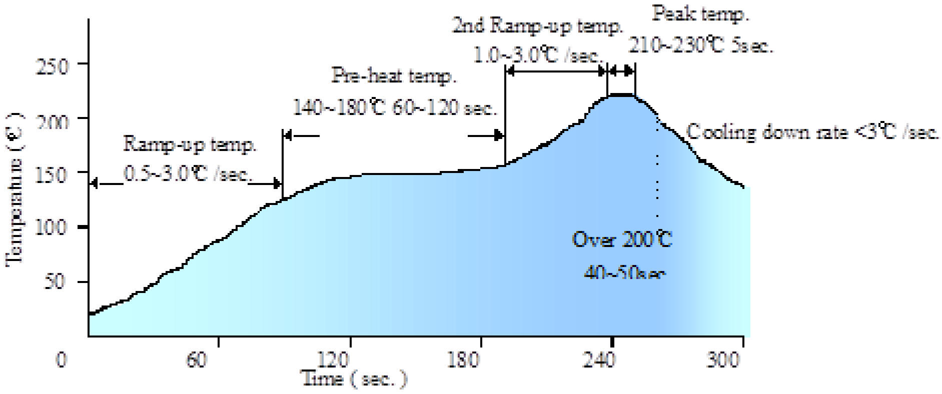
Tape & Reel Package for SMD Model





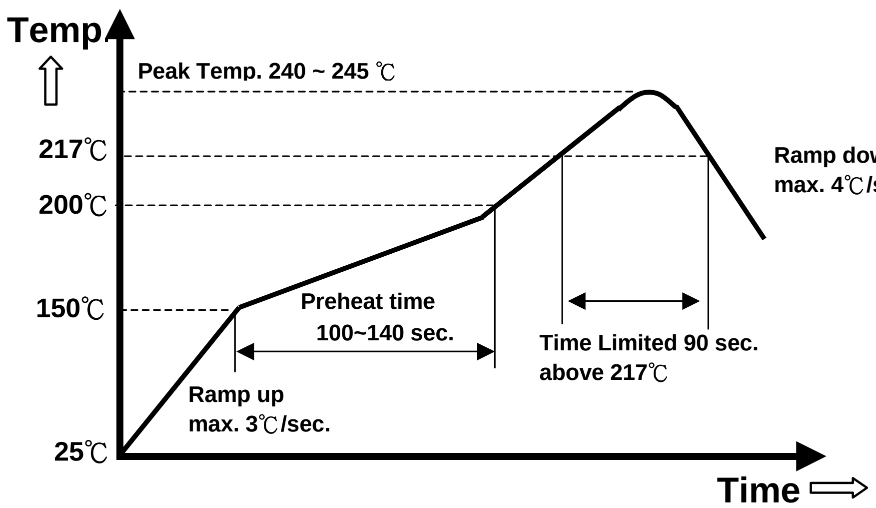
NOTES:
CONFORMS TO EIA-481 SATNDARD
MODULES ARE SHIPPED IN QUANTITIES OF 100 PER REEL.
ALL DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
X.XXmm±0.25mm(X.XXX in.±0.010 in.)

Leaded (Sn/Pb) Process Recommend Temp. Profile (for SMD model)



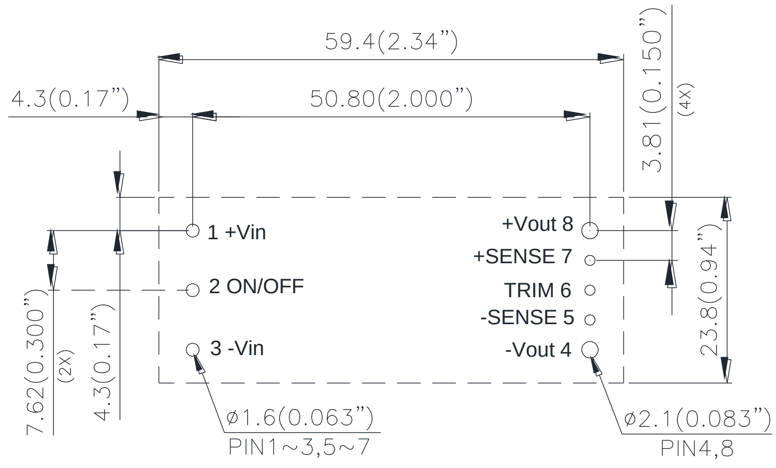
Note: The temperature refers to the pins, measured on the +V_{out} pin joint.

Lead Free (SAC) Process Recommend Temp. Profile (for SMD model)



Note: The temperature refers to the pins, measured on the +V_{out} pin joint.

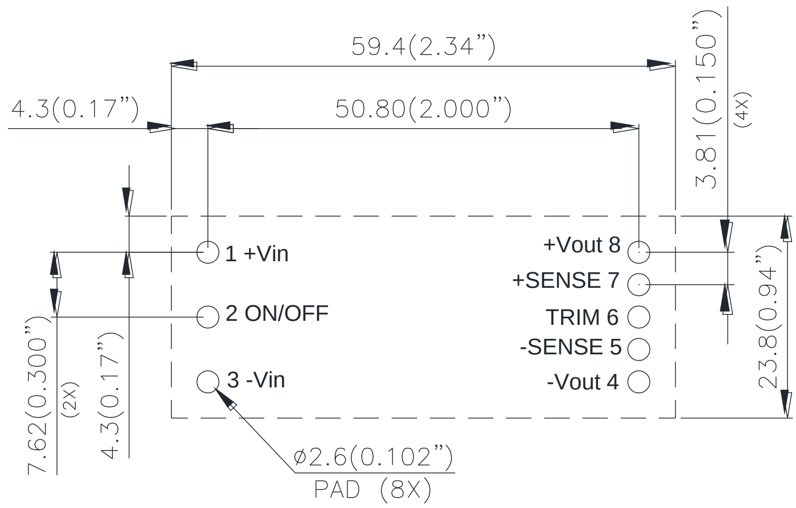
Recommended Pad Layout (Through-hole Module)



RECOMENDED P.W.B. 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.)

Recommended Pad Layout (SMD Module)

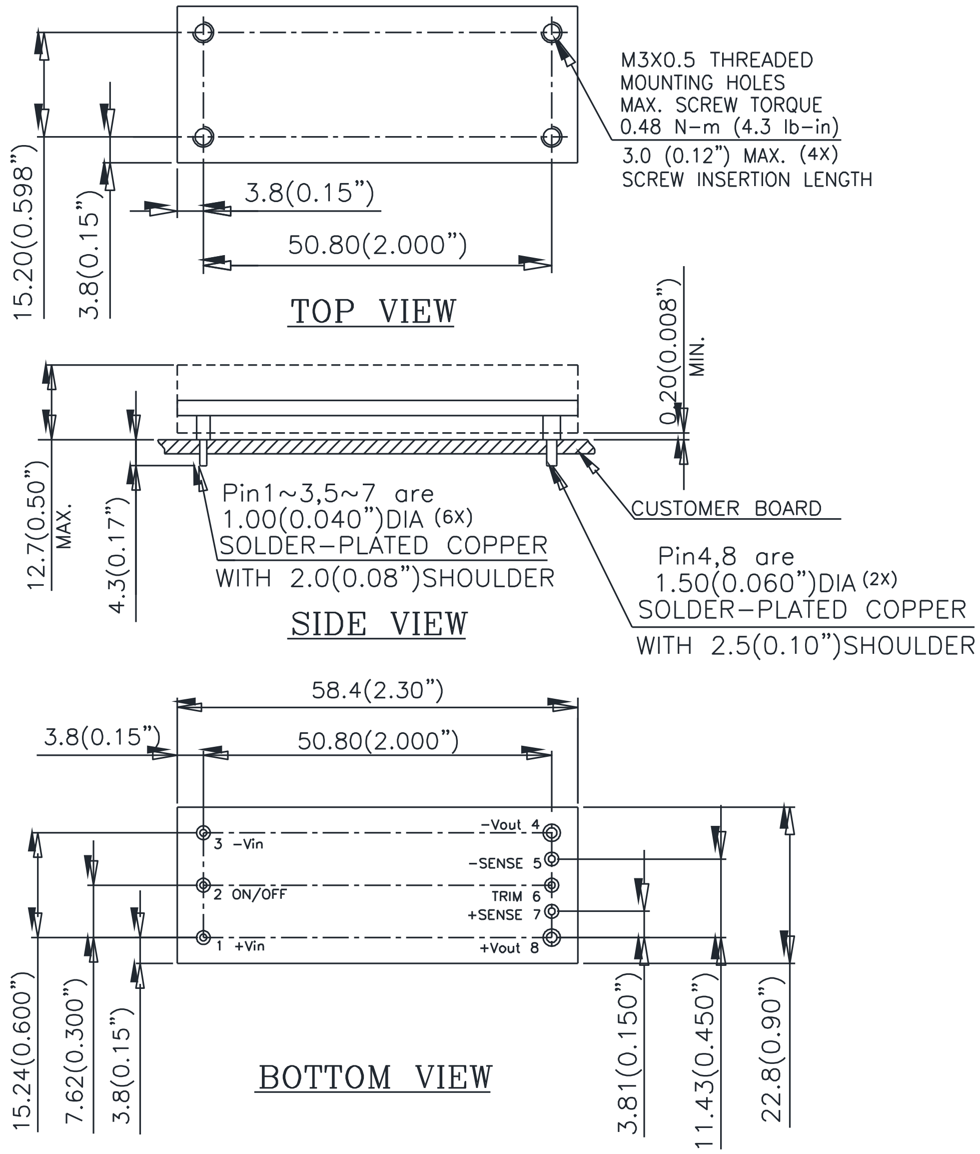


RECOMENDED P.W.B. PAD LAYOUT

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.)

Mechanical Drawing (with heat-spreader)

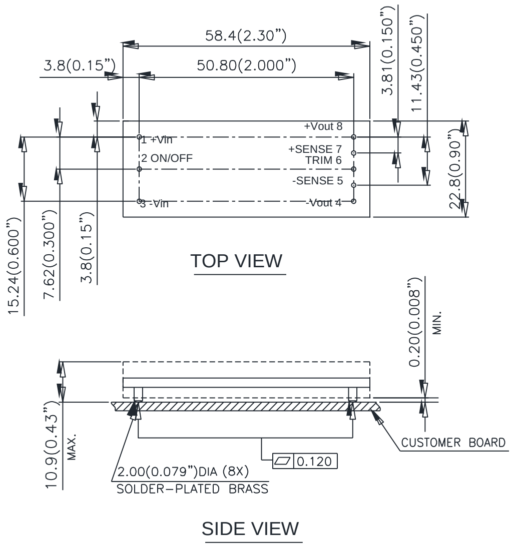
For modules with through-hole pins and the optional heat-spreader, they are intended for wave soldering assembly onto system boards; please do not subject such modules through reflow temperature profile.



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.)

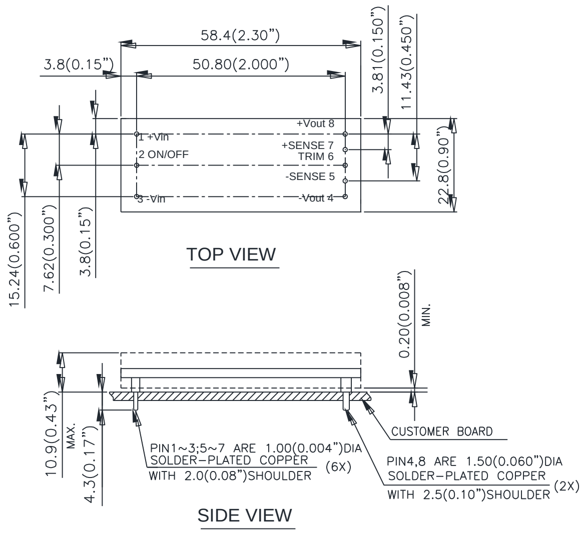
Mechanical Drawing (without heat-spreader)

SMD 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.)

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

Pin Specification:

Pins 1-3,5-7	1.00mm (0.040") diameter
Pins 4 & 8	1.50mm (0.060") diameter

Note: All pins are copper alloy with matte Tin (Pb free) plated over Nickel under plating.

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PART NUMBERING SYSTEM

E	54	S	J	3R3	50	N	R	F	H
Form Factor	Input Voltage	Number Of Outputs	Product Series	Output Voltage	Output Current	ON/OFF Logic	Pin Length	RoHS	Option Code
E - 1/8 Brick	54 - 40V~60V	S - Single	J - Series Number	3R3 – 3.3V	50 - 50A	N - Negative	K - 0.110" N - 0.145" R - 0.170" M - SMD pin	F - RoHS 6/6 (Lead Free) Space - RoHS5/6	A - Open Frame H - With heat-spreader

MODEL LIST

Model Name	Input		Output		Eff. @ 100% Load
E54SJ3R350NRFA	40V~60V	5A	3.3V	50A	94% @ $48V_{in}$

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

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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.