DELPHI SERIES

FEATURES

- High efficiency: 91.1% @ 12V/10A
- Size:
- Without heat spreader:
- 33.0x22.8x9.5mm (1.30"x0.90"x0.37")
- With heat spreader
- 33.0x22.8x12.7mm (1.30"x0.90"x0.50")
- Industry standard footprint and pinout
- Fixed frequency operation
- SMD or through-hole versions
- Input UVLO
- OTP and output OCP, OVP
- Output voltage trim: -20%, +10%
- 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
- ISO 9001, TL 9000, ISO 14001, QS 9000, OHSAS18001 certified manufacturing facility(pending)

Delphi Series V48SC, 1/16th Brick 120W DC/DC Power Modules: 48V in, 12V, 10A out

The Delphi Series V48SC, 1/16th Brick, 48V 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 120 watts of power or 30A of output current in the 1/16th brick form factor (1.3"x0.90") and pinout. 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 12V/10A module is greater than 91.1%. All modules are protected from abnormal input/output voltage, current, and temperature conditions. For lower power needs, but in a similar small form factor, please check out Delta V36SE (50W), S48SP (36W or 10A) and S36SE (17W or 5A) series standard DC/DC modules.

OPTIONS

- SMD pins
- Short pin lengths available
- Positive remote On/Off
- Open frame with heat-spreader

APPLICATIONS

- Optical Transport
- Data Networking
- Communications
- Servers

Delta Electronics, Inc.

TECHNICAL SPECIFICATIONS

(T_A=25°C, airflow rate=300 LFM, V_{in}=48Vdc, nominal Vout unless otherwise noted.)

PARAMETER	NOTES and CONDITIONS	V48SC12010 (Standard)			
		Min.	Typ.	Max.	Units
ABSOLUTE MAXIMUM RATINGS					
Input Voltage					
Continuous				80	Vdc
Transient (100ms)	100ms			100	Vdc
Operating Ambient Temperature		-40		85	°C
Storage Temperature		-55		125	°C
Input/Output Isolation Voltage				1500	Vdc
INPUT CHARACTERISTICS					
Operating Input Voltage		42	48	60	Vdc
Input Under-Voltage Lockout					
Turn-On Voltage Threshold		38.5		41.5	Vdc
Turn-Off Voltage Threshold		35.5		38.5	Vdc
Lockout Hysteresis Voltage		1.5		4.5	Vdc
Maximum Input Current	100% Load, 42Vin			3.6	A
No-Load Input Current	open load,48Vin		70	90	mA
Off Converter Input Current	open load,48Vin		8	12	mA
Inrush Current (I^2t)	With 100uF external input capacitor			1	A^2s
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	11.82	12	12.18	Vdc
Output Voltage Regulation					
Load Regulation	Io=Io, min to Io, max		±9	±18	mV
Line Regulation	Vin=36V to 75V		±9	±18	mV
Temperature Regulation	Tc=-40°C to125°C		±180		mV
Total Output Voltage Range	Over sample load, line and temperature	11.64		12.36	V
Output Voltage Ripple and Noise	5Hz to 20MHz bandwidth				
Peak-to-Peak	max load on output, 20MHz bandwidth 10uF tantalum + 1uF ceramic capacitor		150	250	mV
RMS	max load on output, 20MHz bandwidth 10uF tantalum + 1uF ceramic capacitor		50	80	mV
Operating Output Current Range		0		10	A
Output Over Current Protection	Output Voltage 10% Low	110		150	%
DYNAMIC CHARACTERISTICS					
Output Voltage Current Transient	load capacitor10uF tantalum + 1u ceramic 1A/uS Frequency= 250Hz				
Positive Step Change in Output Current	50% Io.max to 75% Io.max		600	800	mV
Negative Step Change in Output Current	75% Io.max to 50% Io.max		600	800	mV
Settling Time (within 1% Vout nominal)			200		us
Turn-On Transient					
Start-Up Delay Time, From On/Off Control or Input	From On/Off Control or Input to 10%Vo	10		50	ms
Start-Up Rise Time, From On/Off Control or Input	From 10%Vo to 90% Vo	15		50	ms
Maximum Output Capacitance	Full load; 5% overshoot of Vout at startup;	0		3300	µF
EFFICIENCY					
100% Load	Vin=48V		91.1		%
60% Load	Vin=48V		91.6		%
ISOLATION CHARACTERISTICS					
Input to Output				1500	Vdc
Isolation Resistance		10			MΩ
Isolation Capacitance			1000		pF
FEATURE CHARACTERISTICS					
Switching Frequency			420		kHz
ON/OFF Control, Negative Remote On/Off logic					
Logic Low (Module On)	Von/off	0		0.7	V
Logic High (Module Off)	Von/off	2.4		5	V
ON/OFF Control, Positive Remote On/Off logic					
Logic Low (Module Off)	Von/off	0		0.7	V
Logic High (Module On)	Von/off	2.4		5	V
ON/OFF Current (for both remote on/off logic)	Ion/off at Von/off=0.0V			1	mA
ON/OFF Current (for both remote on/off logic)	Ion/off at Von/off=2.4V		500		uA
Leakage Current (for both remote on/off logic)	Logic High, Von/off=5V		0		uA
Output Voltage Trim Range	Max rated current guaranteed at full trim range	-20		10	%
Output Voltage Remote Sense Range	Max rated current guaranteed at full remote sense range			10	%
Output Over-Voltage Protection	Over full temp range; % of nominal Vout	110		140	%
GENERAL SPECIFICATIONS					
MTBF	Per Telecordia SR-332, 80% load, 25°C, 48Vin, 300LFM		4.9		M hours
Weight	Open frame		15		grams
weight	With heat-spreader		24		grams
Over-Temperature Shutdown (Without heat spreader)	Refer to Figure 22 for Hot Spot 1's location (48Vin,80%Io, 200LFM,Airflow from Vout+ to Vin+)		132		°C
Over-Temperature Shutdown (With heat spreader)	Refer to Figure 24 for Hot Spot 2's location (48Vin,80%Io, 200LFM,Airflow from Vout+ to Vin+)		120		°C
Over-Temperature Shutdown (NTC resistor)	Refer to Figure 22 for NTC resistor location		125		°C
Note: Please attach thermocouple on NTC resistor to test OTP function, the hot spot's temperature is just for reference.					

ELECTRICAL CHARACTERISTICS CURVES

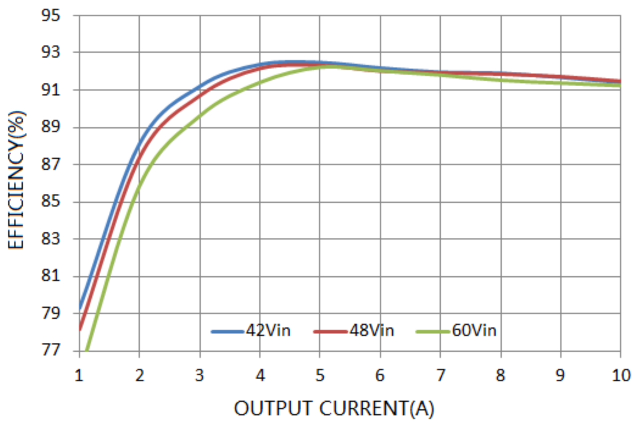


Figure 1: *Efficiency vs. load current for minimum, nominal, and maximum input voltage at 25°C*

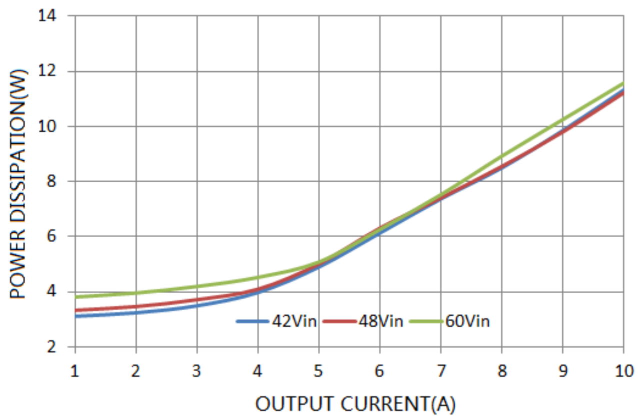


Figure 2: *Power dissipation vs. load current for minimum, nominal, and maximum input voltage at 25°C.*

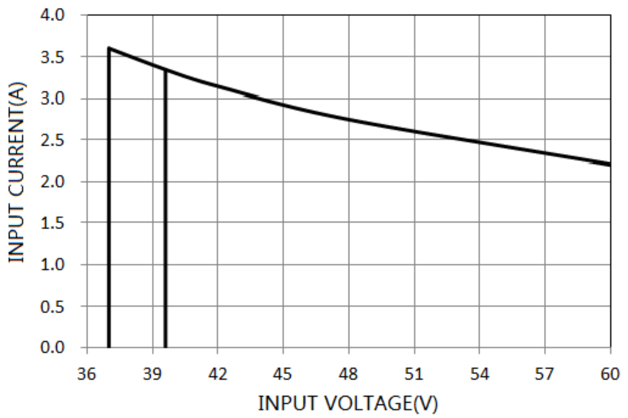


Figure 3: *Typical full load input characteristics at room temperature*

ELECTRICAL CHARACTERISTICS CURVES

For Negative Remote On/Off Start up

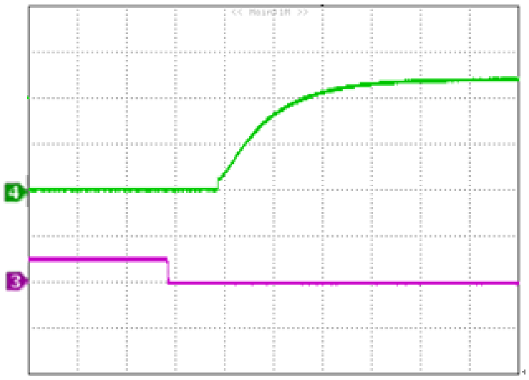


Figure 4: *Turn-on transient at full rated load current (10 ms/div). Vin=48V. Top Trace: Vout, 5.0V/div; Bottom Trace: ON/OFF input, 5V/div*

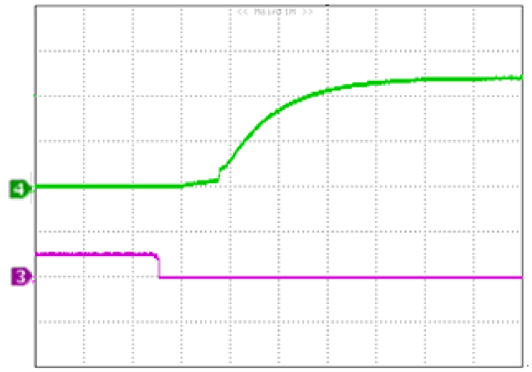


Figure 5: *Turn-on transient at zero load current (10 ms/div). Vin=48V. Top Trace: Vout: 5.0V/div, Bottom Trace: ON/OFF input, 5V/div*

For Input Voltage Start up

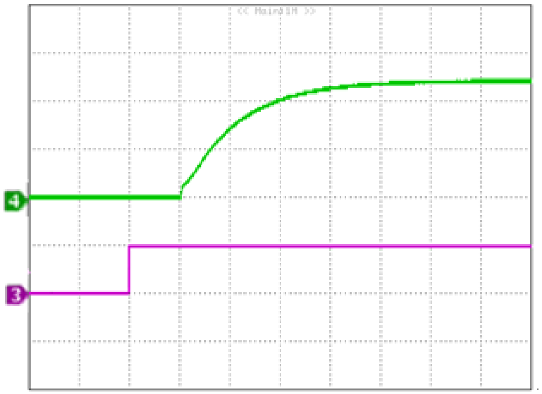


Figure 6: *Turn-on transient at full rated load current (10 ms/div). Vin=48V. Top Trace: Vout, 5.0V/div; Bottom Trace: Vin, 50V/div*

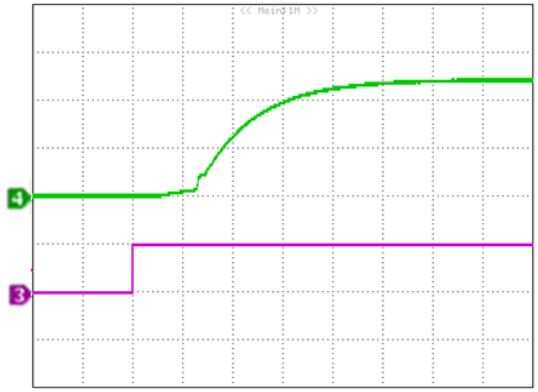


Figure 7: *Turn-on transient at zero load current (10 ms/div). Vin=48V. Top Trace: Vout, 5.0V/div; Bottom Trace: Vin, 50V/div*

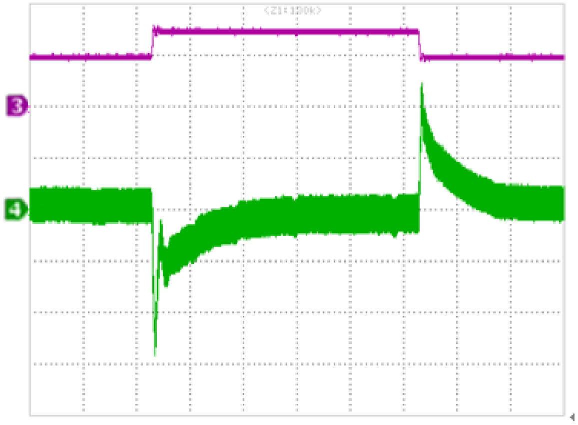


Figure 8: *Output voltage response to step-change in load current (75%-50%-75% of Io, max; di/dt = 1A/µs). Load cap: 10µF tantalum capacitor and 1µF ceramic capacitor. Top Trace: Iout (5A/div), Bottom Trace: Vout (0.2V/div, 200us/div). Scope measurement should be made using a BNC cable (length shorter than 20 inches). Position the load between 51 mm to 76 mm (2 inches to 3 inches) from the module*

ELECTRICAL CHARACTERISTICS CURVES

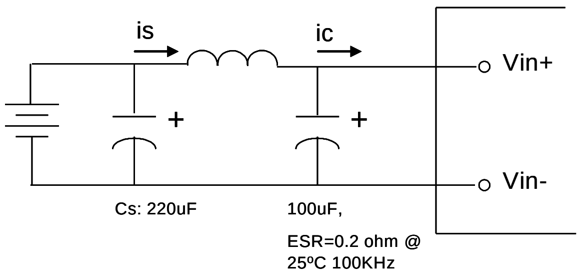


Figure 9: *Test set-up diagram showing measurement points for Input Terminal Ripple Current and Input Reflected Ripple Current.*
Note: Measured input reflected-ripple current with a simulated source Inductance (L_{TEST}) of 12 µH. Capacitor Cs offset possible battery impedance. Measure current as shown above

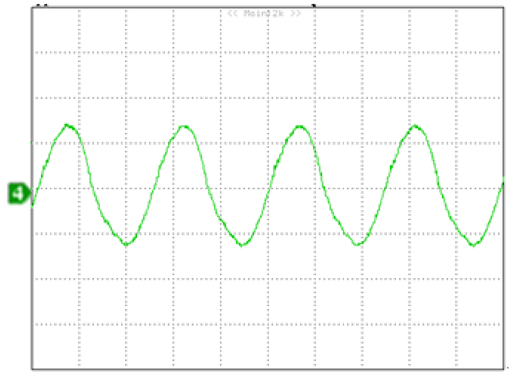


Figure 10: *Input Terminal Ripple Current, i_c, at full rated output current and nominal input voltage with 12µH source impedance and 33µF electrolytic capacitor (200 mA/div, 1us/div)*

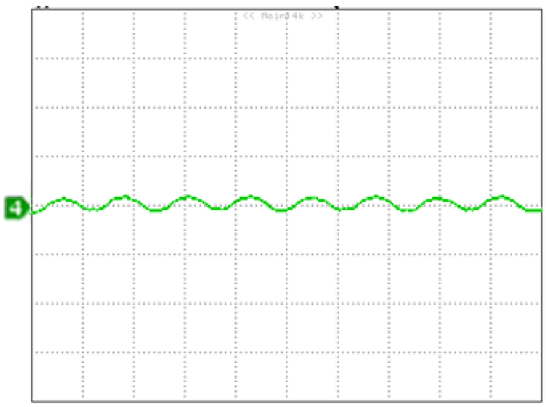


Figure 11: *Input reflected ripple current, i_s, through a 12µH source inductor at nominal input voltage and rated load current (20 mA/div, 2us/div)*

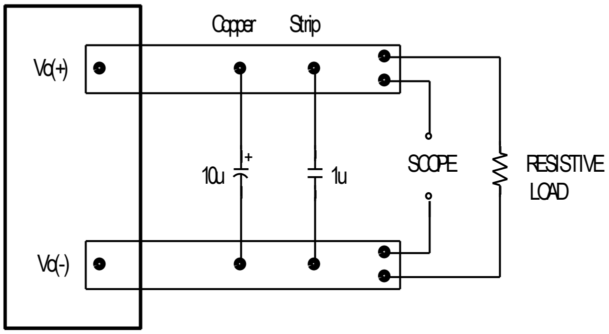


Figure 12: *Output voltage noise and ripple measurement test setup*

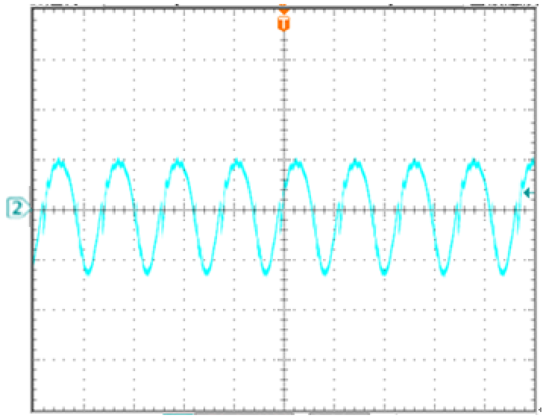


Figure 13: *Output voltage ripple at nominal input voltage and rated load current (Io=10A)(50 mV/div, 2us/div)*
Load capacitance: 1µF ceramic capacitor and 10µF tantalum capacitor. Bandwidth: 20 MHz. Scope measurements should be made using a BNC cable (length shorter than 20 inches). Position the load between 51 mm to 76 mm (2 inches to 3 inches) from the module.

DESIGN CONSIDERATIONS

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 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. For design assistance with EMC compliance and related PWB layout issues, please contact Delta's technical support team. An external input filter module is available for easier EMC compliance design. Below is the reference design for an input filter tested with V48SC120XXX to meet EN55032 (VDE0878) class A(both q. peak and average)

Schematic and Components List

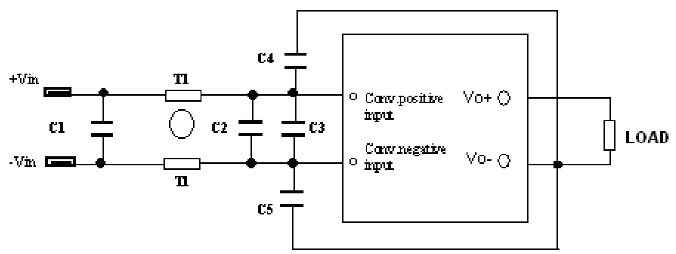


Figure 14: *EMI test schematic*

C1= 3.3uF/100 V

C2= 47uF/100 V

C3= 47uF/100 V

C4=C5=1nF/250Volt

T1=1mH, type P53910(Pulse)

Test Result:

At T = +25°C , Vin = 48 V and full load.

Yellow line is quasi peak mode; Blue line is average mode.

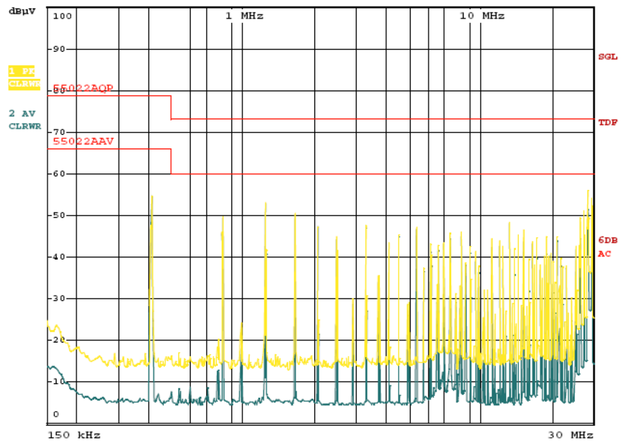


Figure 15: *EMI test negative line*

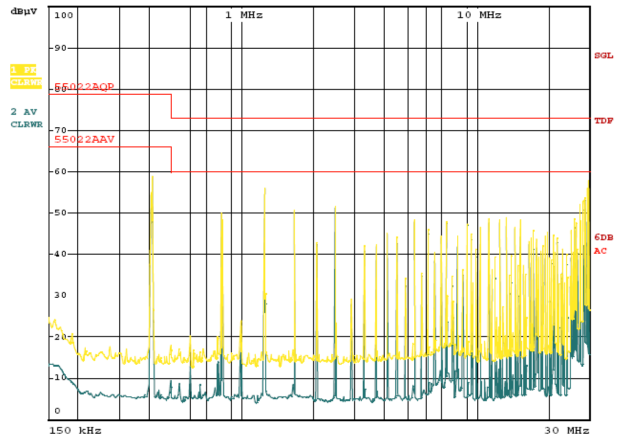


Figure 16: *EMI test positive line*

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 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.
- 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 20A 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, and enter hiccup mode or latch mode, which is optional, the default is hiccup mode.

For hiccup mode, the module will try to restart after shutdown. If the over current condition still exists, the module will shut down again. This restart trial will continue until the over-current 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 enter in hiccup mode or latch mode, which is optional, the default is hiccup mode.

For hiccup mode, the module will try to restart after shutdown. If the over voltage condition still exists, the module will shut down again. This restart trial will continue until the over-voltage condition is corrected.

For 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, and enter in auto-restart mode or latch mode, which is optional, the default is auto-restart mode.

For auto-restart mode, the module will monitor the module temperature after shutdown. Once the temperature is dropped and within the specification, the module will be auto-restart.

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 floating.

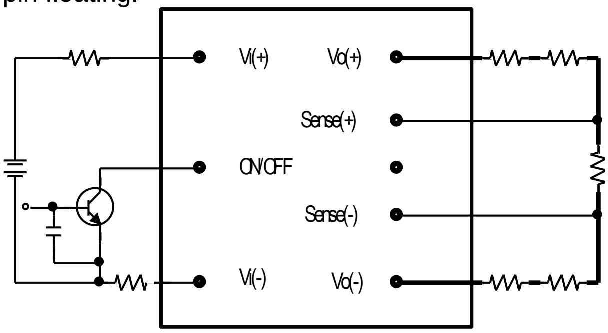


Figure 17: *Remote on/off implementation*

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).

FEATURES DESCRIPTIONS (CON.)

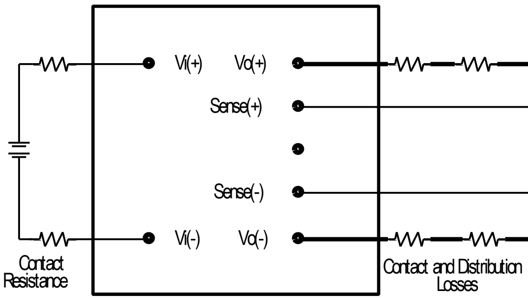


Figure 18: *Effective circuit configuration for remote sense operation*

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.

Max rated current is guaranteed at full output voltage remote sense range.

Output Voltage Adjustment (TRIM)

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

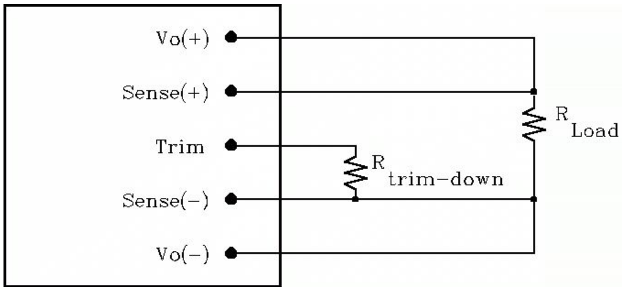


Figure 19: *Circuit configuration for trim-down (decrease output voltage)*

If the external resistor is connected between the TRIM and SENSE (-) pins, the output voltage set point decreases (Fig. 19). 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 -10% (12V×0.9=10.8V)

$$Rtrim-down=\left[\frac{511}{10}-10.22\right](K\Omega)=40.88(K\Omega)$$

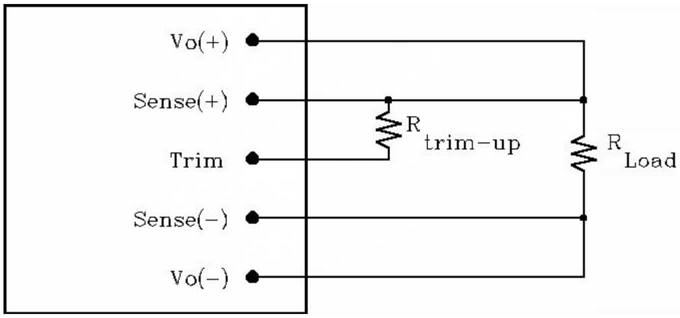


Figure 20: *Circuit configuration for trim-up (increase output voltage)*

If the external resistor is connected between the TRIM and SENSE (+) the output voltage set point increases (Fig. 20). The external resistor value required to obtain a percentage output voltage change △% is defined as:

$$Rtrim-up=\frac{5.11Vo\ (100+\Delta)}{1.225\,\Delta}-\frac{511}{\Delta}-10.22(K\Omega)$$

Ex. When Trim-up +10% (12V×1.1=13.2V)

$$Rtrim-up=\frac{5.11\times 12\times(100+10)}{1.225\times 10}-\frac{511}{10}-10.22=489.31(K\Omega)$$

Trim resistor can also be connected to Vo+ or Vo- but it would introduce a small error voltage than the desired value.

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.

THERMAL CONSIDERATIONS

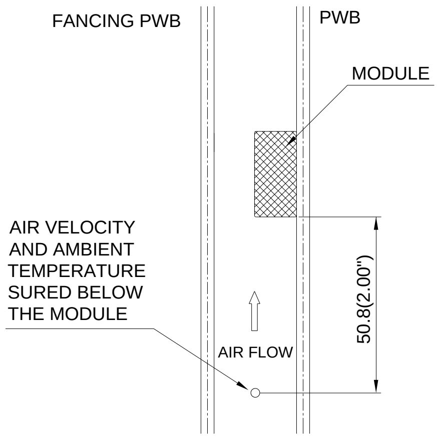
Thermal management is an important part of the system design. To ensure proper, reliable operation, sufficient cooling of the power module is needed over the entire temperature range of the module. Convection cooling is usually the dominant mode of heat transfer.

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 185mmX185mm,70μm (2Oz),6 layers 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 21: *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)

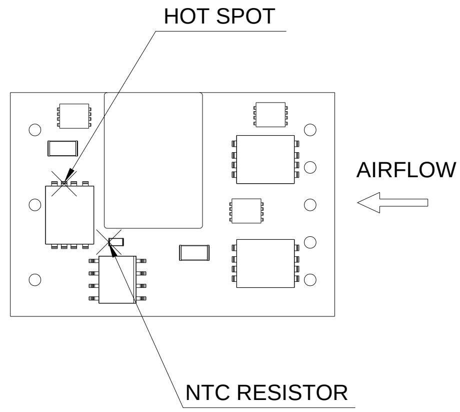


***Figure 22:* *** *Hot spot 1& NTC resistor temperature measurement location. The allowed maximum hot spot temperature is defined at 120℃*

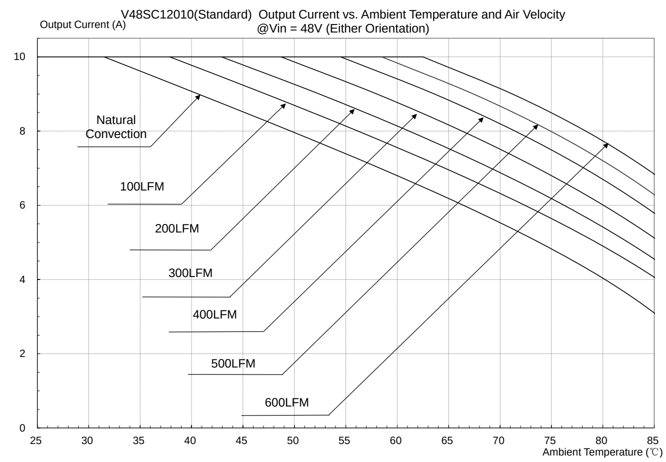


Figure 23: *Output Current vs. Ambient Temperature and Air Velocity @ Vin=48V (Either Orientation, Without Heat Spreader)*

THERMAL CURVES
(WITH HEAT SPREADER)

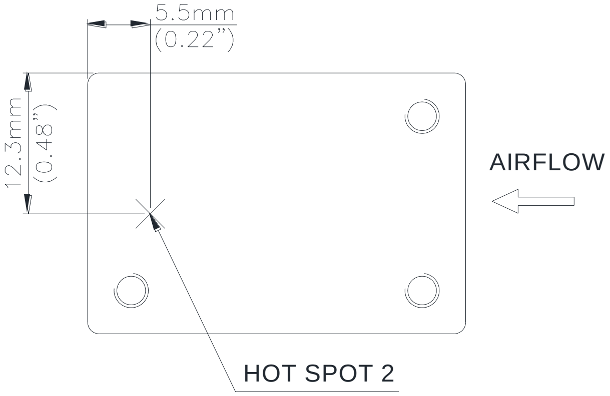


Figure 24: * *Hot spot 2 temperature measurement location.*
The allowed maximum hot spot 2 temperature is defined at 110℃

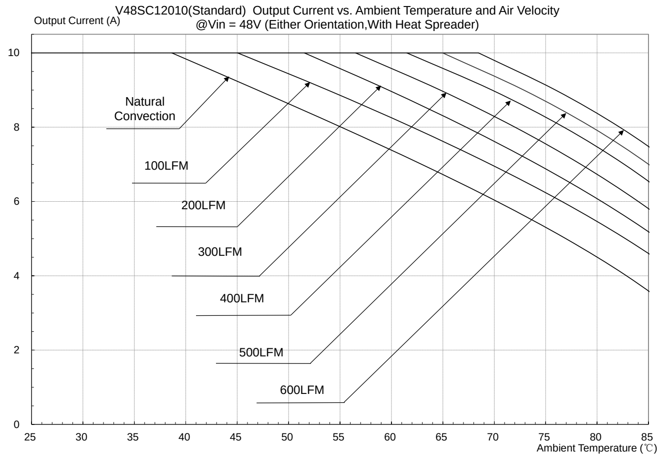
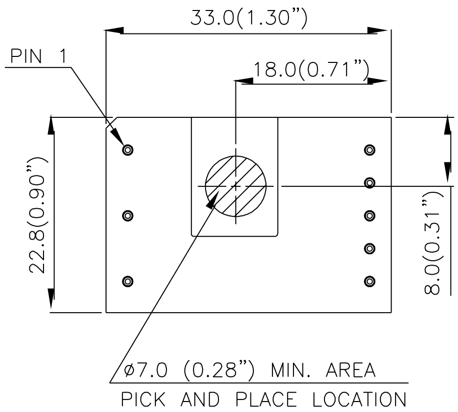


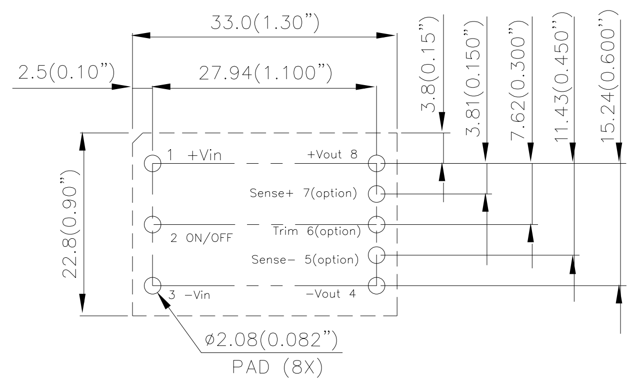
Figure 25: *Output Current vs. Ambient Temperature and Air Velocity @ Vin=48V (Either Orientation, With Heat Spreader)*

PICK AND PLACE LOCATION (SMD)



NOTES:
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.)

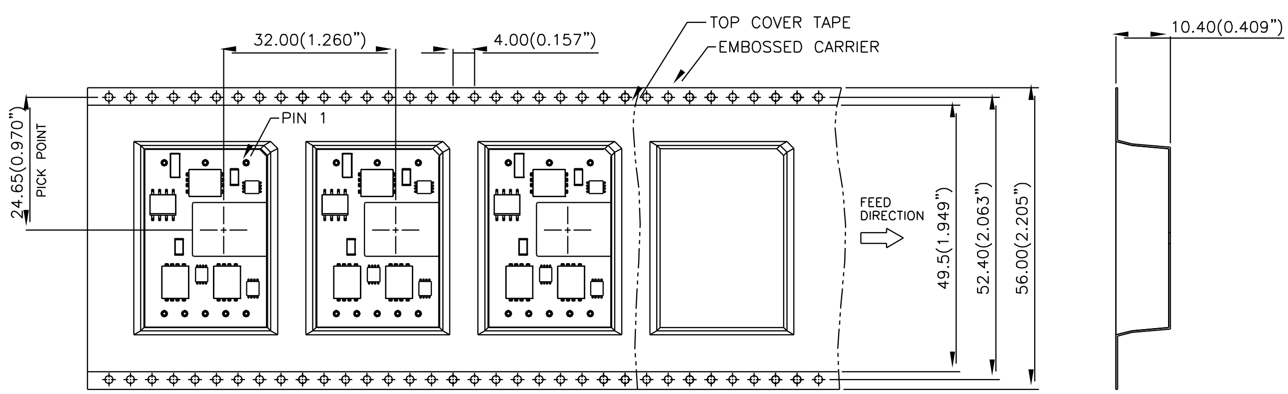
RECOMMENDED PAD LAYOUT (SMD)

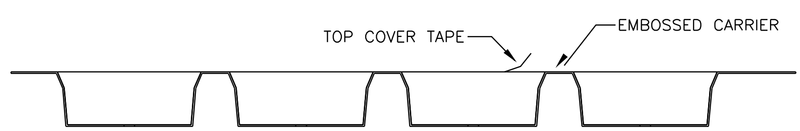


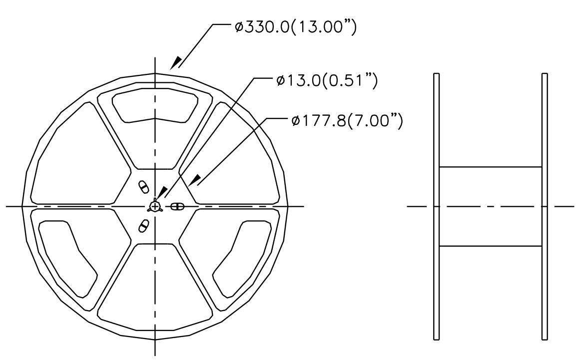
RECOMENDED P.W.B. PAD LAYOUT

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.)

SURFACE-MOUNT TAPE & REEL (FOR SMD ONLY)

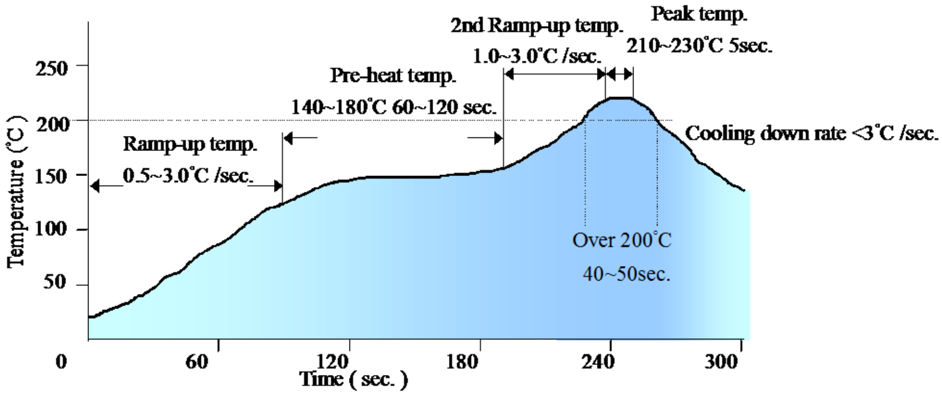






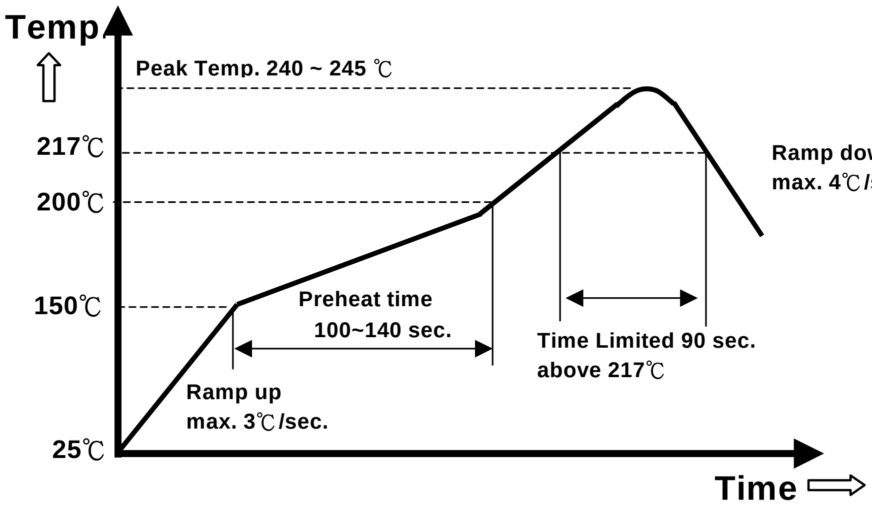
NOTES:
CONFORMS TO EIA-481 SATNDARD
MODULES ARE SHIPPED IN QUANTITIES OF 100 PER REEL.
ALL DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
X.XXmm±0.25mm(X.XXX in.±0.010 in.)

LEADED (Sn/Pb) PROCESS RECOMMEND TEMP. PROFILE (FOR SMD)



Note: The temperature refers to the pin of V48SC, measured on the pin +Vout joint.

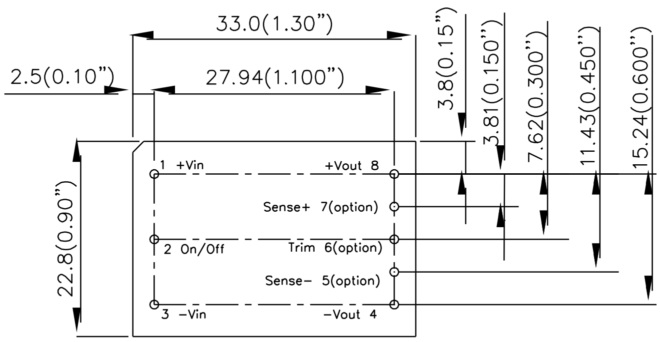
LEAD FREE (SAC) PROCESS RECOMMEND TEMP. PROFILE (FOR SMD ONLY)



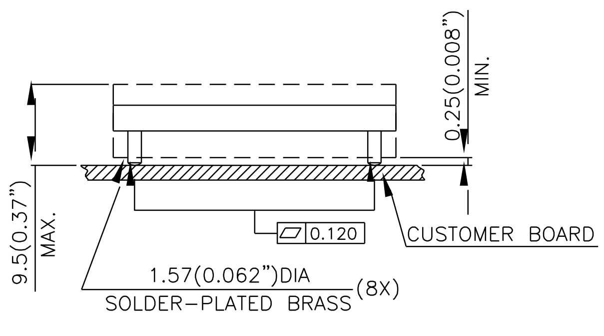
Note: The temperature refers to the pin of V48SC, measured on the pin +Vout joint.

MECHANICAL DRAWING

Surface-mount module

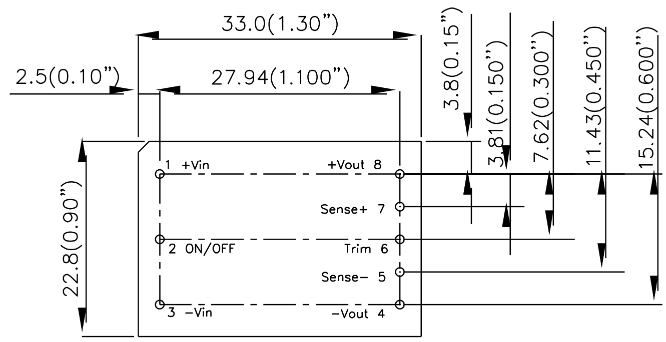


TOP VIEW

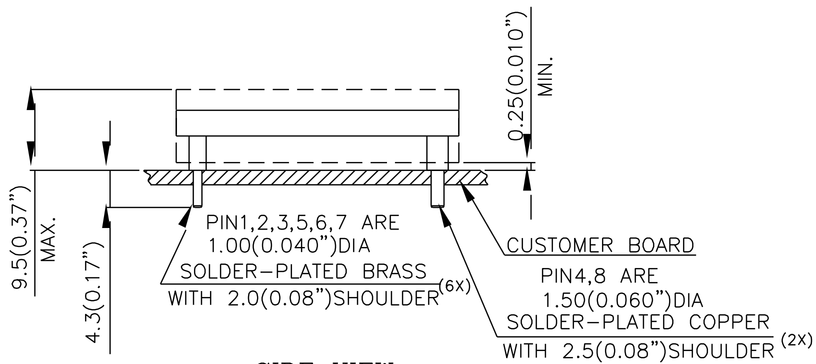


SIDE VIEW

Through-hole module



TOP VIEW

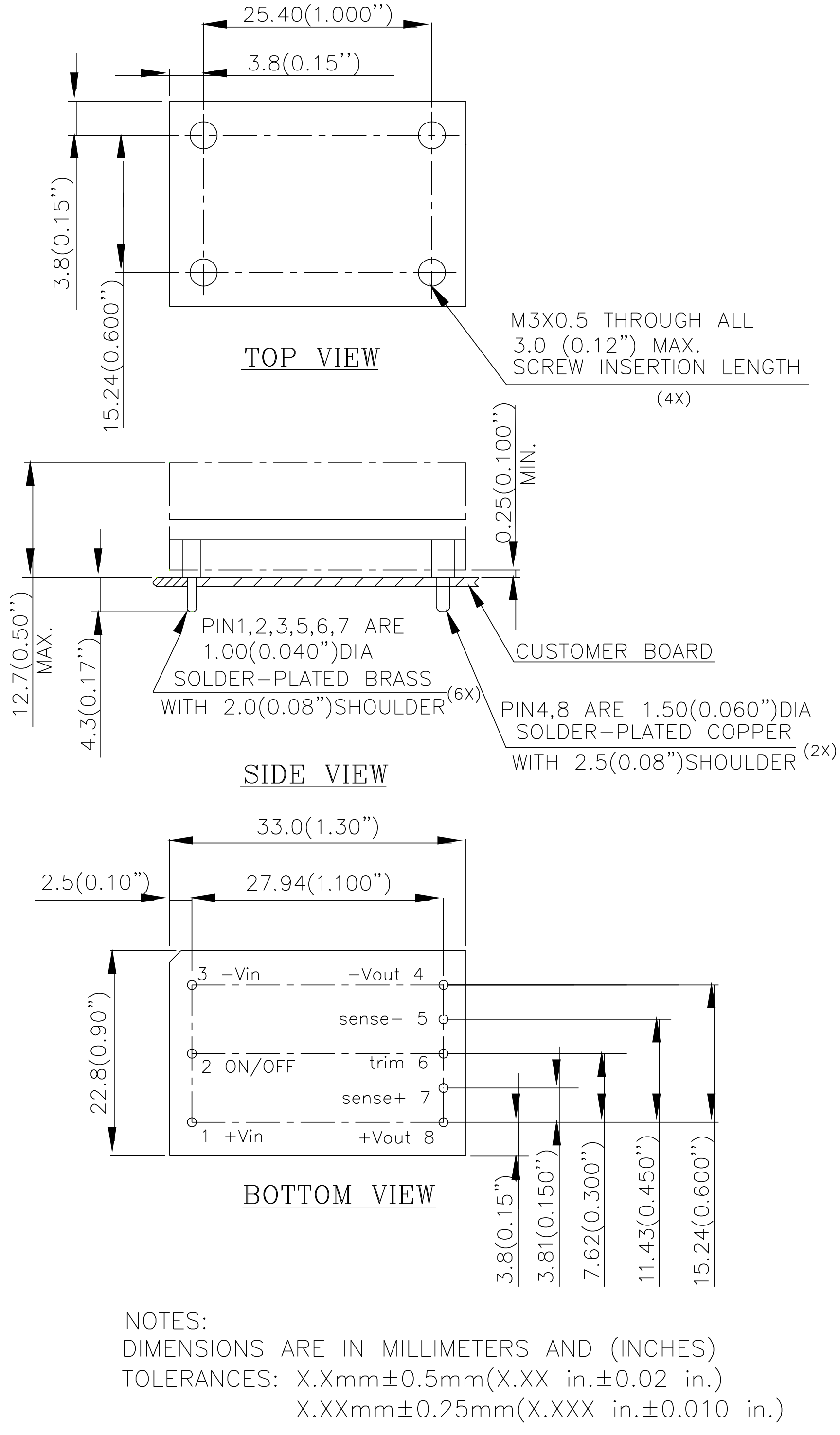


SIDE VIEW

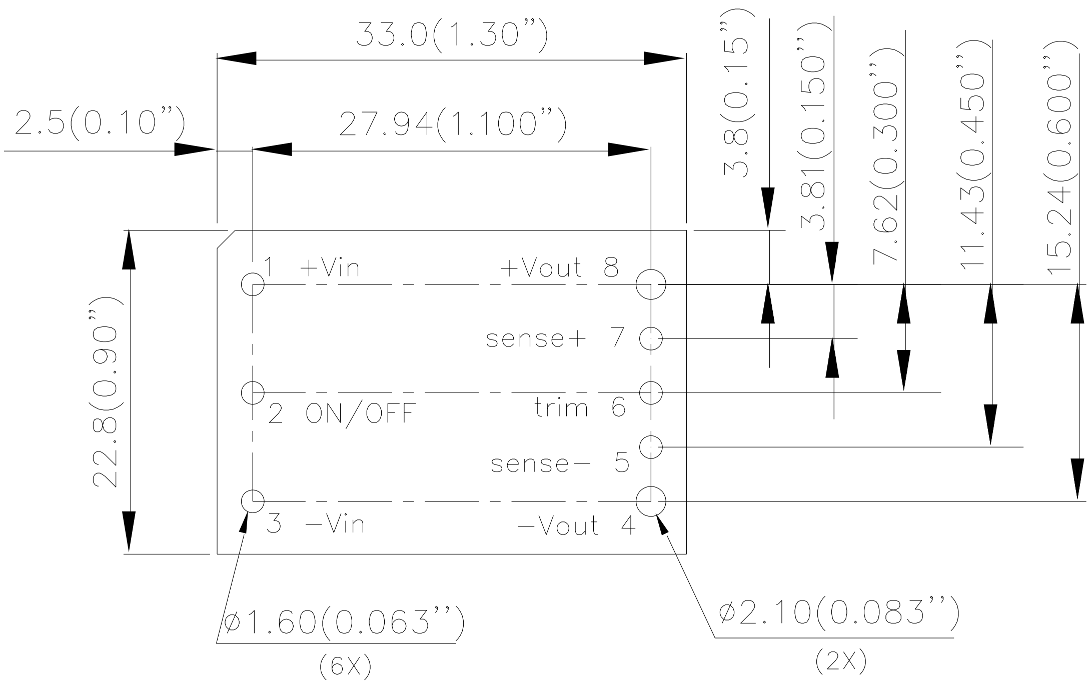
NOTES:
DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
X.XXmm±0.25mm(X.XXX in.±0.010 in.)

Through-hole module with heat spreader

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



All pins are copper alloy with Matte tin over Ni plated.



RECOMMENDED PCB HOLE 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.)

PART NUMBERING SYSTEM

V	48	S	C	120	10	N	R	F	A
Type of Product	Input Voltage	Number of Outputs	Product Series	Output Voltage	Output Current	ON/OFF Logic	Pin Length/Type		Option Code
V - 1/16 Brick	48 - 42V~60V	S - Single	C - Serial number	120 - 12V	10 - 10A	N - Negative P - Positive	R - 0.170" N - 0.145" K - 0.110" M - SMD	F - RoHS 6/6 (Lead Free) Space- RoHS5/6	A - Standard Functions H - With heat spreader

MODEL LIST

MODEL NAME	INPUT		OUTPUT		EFF @ 100% LOAD
V48SC12010NRFA	42~60V	3.6A	12V	10A	91.1%
V48SC12010NRFH	42~60V	3.6A	12V	10A	91.1%

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.