V48SC06511

70W DC/DC Power Modules

FEATURES

- High efficiency : 91.0% @ 6.5V/11A
- Size:
  33.0mm(L)*22.8mm(W)
- Standard footprint
- Industry standard pin out
- Fixed frequency operation
- Input UVLO
- Hiccup output over current protection (OCP)
- Hiccup output over voltage protection (OVP)
- Auto recovery OTP
- Monotonic startup into normal and pre-biased loads
- 1500V isolation and basic insulation
- No minimum load required
- ISO 9001, TL 9000, ISO 14001, QS9000, OHSAS18001 certified manufacturing facility
- IEC/EN/UL/CSA 62368-1, 2nd edition
- IEC/EN/UL/CSA 60950-1, 2nd edition+A2

V48SC06511
Sixteenth Brick DC/DC Power Module
36~75V in, 6.5V/11A out, 70W

V48SC06511, sixteenth brick, 36~75V input, single output, isolated DC/DC converter is the latest offering from a world leader in power system and technology and manufacturing — Delta Electronics, Inc. This product provides up to 70 watts of power in an industry standard footprint and pin out. 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. The V48SC06511 offers more than 91.0% high efficiency at 11A load.

OPTIONS

- Positive or negative ON/OFF logic

APPLICATIONS

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

Soldering method

- Hand soldering
- Wave soldering
- Reflow soldering (MSL rating of 3)

TECHNICAL SPECIFICATIONS

PARAMETER	NOTES and CONDITIONS	V48SC06511			
		Min.	Typ.	Max.	Units
ABSOLUTE MAXIMUM RATINGS					
Input Voltage					
Continuous		36		75	Vdc
Transient	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		36	48	75	Vdc
Input Under-Voltage Lockout					
Turn-On Voltage Threshold		32.0	34.0	36.0	Vdc
Turn-Off Voltage Threshold		30.0	32.0	34.0	Vdc
Lockout Hysteresis Voltage			2		Vdc
Maximum Input Current	Full Load, 36Vin			2.3	A
No-Load Input Current	Vin=48V, Io=0A		50		mA
Off Converter Input Current	Vin=48V, Io=0A		10		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		-50		dB
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	Vin=48V, Io=0, Tc=25°C	6.4	6.5	6.6	Vdc
Output Voltage Regulation					
Over Load	Vin=48V, Io=Io min to Io max			±13	mV
Over Line	Vin=36V to 75V, Io=Io min			±13	mV
Over Temperature	Vin=48V, Tc= min to max case temperatrue		±33		mV
Total Output Voltage Range	over sample load, line and temperature	6.305		6.695	Vdc
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		30		mV
Operating Output Current Range		0		11	A
Output DC Current-Limit Inception	Output Voltage 10% Low	12.1		15.4	A
DYNAMIC CHARACTERISTICS					
Output Voltage Current Transient	48V, 10µF Tan & 1µF Ceramic load cap, 0.1A/µs				
Positive Step Change in Output Current	50% Io.max to 75%		150		mV
Negative Step Change in Output Current	75% Io.max to 50%		150		mV
Settling Time (within 1% Vout nominal)			300		µs
Turn-On Transient					
Start-Up Time, From On/Off Control			30		ms
Start-Up Time, From Input			30		ms
Maximum Output Capacitance		0		5000	µF
EFFICIENCY					
100% Load	Vin=48V		91.0		%
60% Load	Vin=48V		90.0		%
ISOLATION CHARACTERISTICS					
Input to Output				1500	Vdc
Isolation Resistance		10			MΩ
Isolation Capacitance			1000		pF
FEATURE CHARACTERISTICS					
Switching Frequency		560	630	700	kHz
ON/OFF Control, Negative Remote On/Off logic					
Logic Low (Module On)	Von/off at Ion/off=1.0mA	0		0.8	V
Logic High (Module Off)	Von/off at Ion/off=0.0 µA	3.5		10	V
ON/OFF Current (for both remote on/off logic)	Ion/off at Von/off=0.0V				mA
Leakage Current (for both remote on/off logic)	Logic High, Von/off=10V				uA
Output Voltage Trim Range		-20		10	%
Output Voltage Remote Sense Range				10	%
Output Over-Voltage Protection	48Vin, % of nominal Vout	115		150	%
GENERAL SPECIFICATIONS					
MTBF	Io=80% of Io max; Tc=25°C;Airflow=300LFM, Issue 3		10.53		M hours
Weight (open frame)			18.0		Grams
Weight (with heatspead)			25.0		Grams
Over-Temperature Shutdown (Without heat spreader)	Refer to Figure 21 for Hot spot 1 location (48Vin,80% Io, 200LFM,Airflow from Vo+ to Vin+)		134		°C
Over-Temperature Shutdown (With heat spreader)	Refer to Figure 23 for Hot spot 2 location (48Vin,80% Io, 200LFM,Airflow from Vo+ to Vin+)		123		°C
Over-Temperature Shutdown (NTC resistor)	Refer to Figure 21 for NTC resistor location		130		°C
Note: Please attach thermocouple on NTC resistor to test OTP function, the hot spots' temperature is just for reference.					

T_A=25°C, Natural convection, Vin=48Vdc, nominal Vout unless otherwise noted;

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ELECTRICAL CHARACTERISTICS CURVES

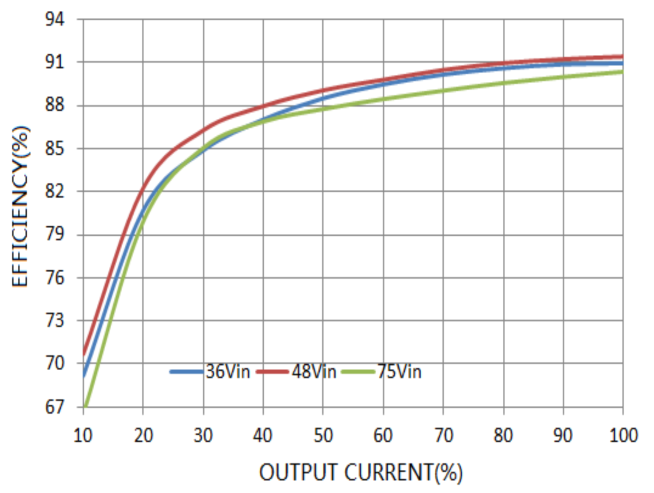

Figure 1: *Efficiency vs. load current for 6.5Vout, 36V, 48V, and 75V input voltage at 25°C.*

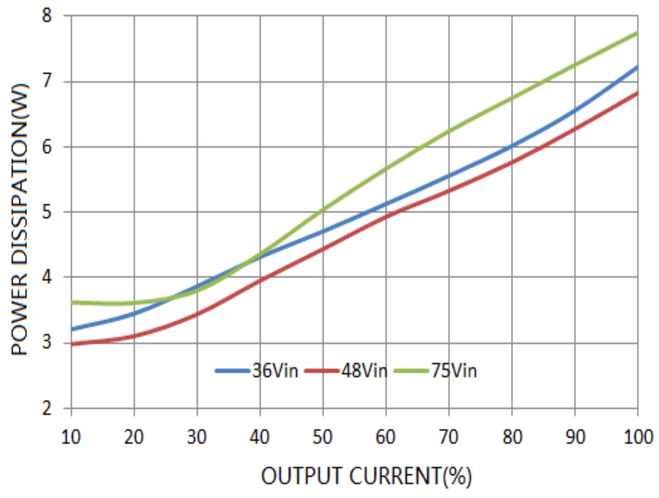

***Figure 2**: Power dissipation vs. load current for 6.5Vou, 36V, 48V, and 75V input voltage at 25°C.*

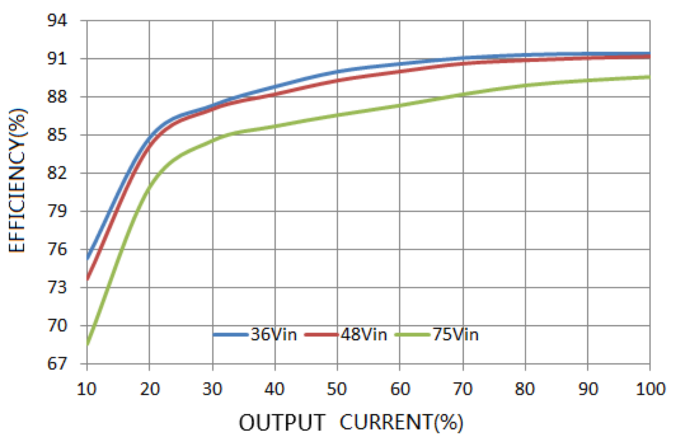

Figure 3: *Efficiency vs. load current for 5.2Vout, 36V, 48V, and 75V input voltage at 25°C.*

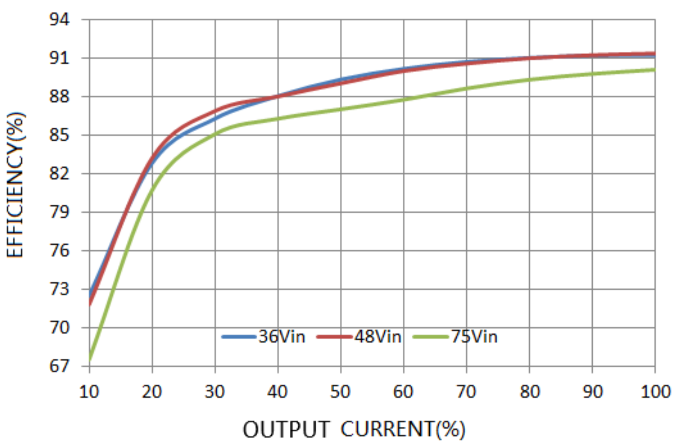

Figure 4: *Efficiency vs. load current for 6Vout, 36V, 48V, and 75V input voltage at 25°C.*

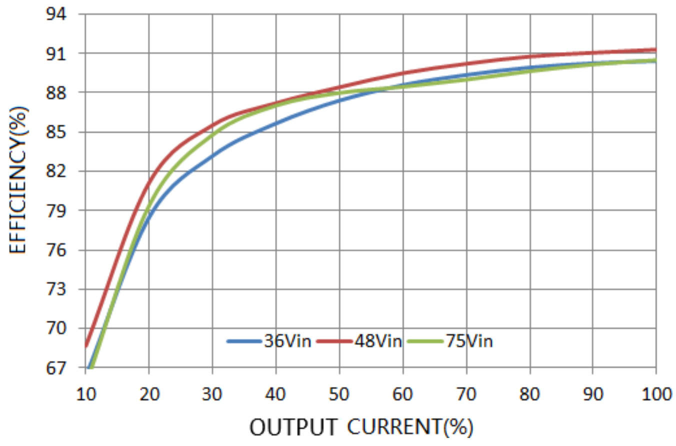

Figure 5: *Efficiency vs. load current for 7.15Vout, 36V, 48V, and 75V input voltage at 25°C.*

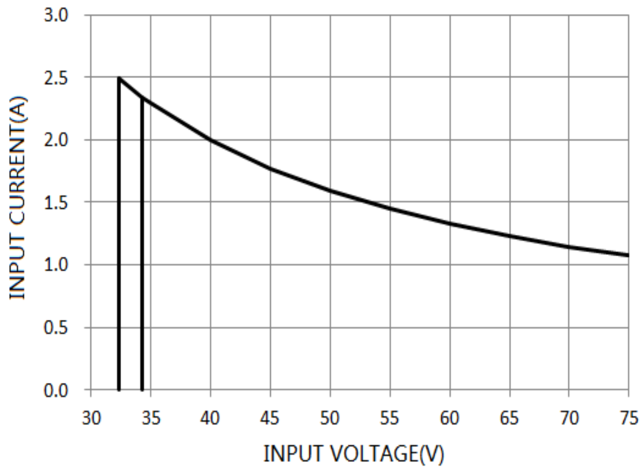

Figure 6: *Full load input characteristics at room temperature for 6.5Vout.*

ELECTRICAL CHARACTERISTICS CURVES

For Negative Remote On/Off Logic

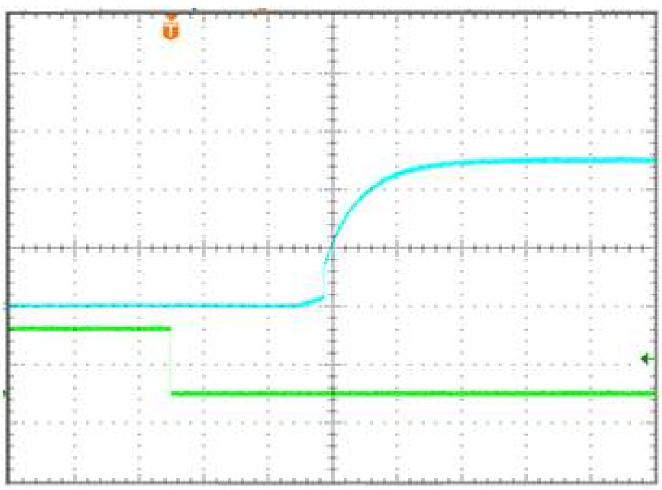

Figure 7: *Turn-on transient at zero load current) (10ms/div). Top Trace: Vout; 2V/div; Bottom Trace: ON/OFF input: 5V/div.*

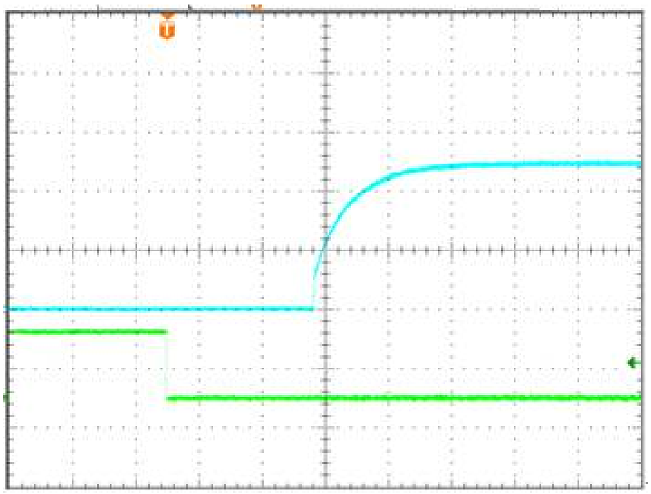

Figure 8: *Turn-on transient at full load current (10 ms/div). Top Trace: Vout: 2V/div; Bottom Trace: ON/OFF input: 5V/div.*

For Input Voltage Start up

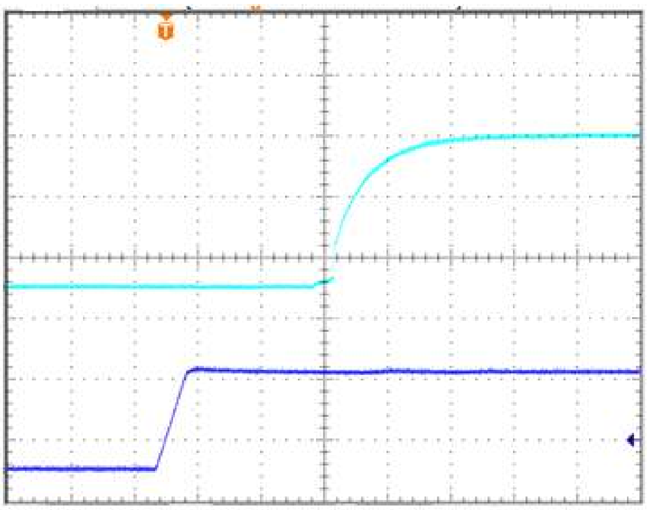

Figure 9: *Turn-on transient at zero load current (10 ms/div). Top Trace: Vout; 2V/div; Bottom Trace: input voltage: 30V/div.*

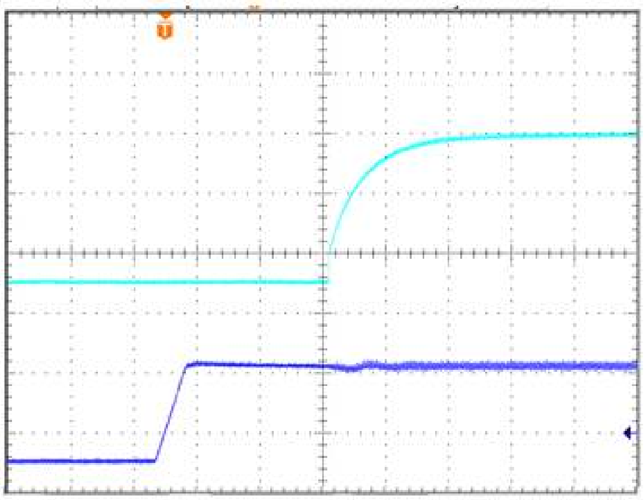

Figure 10*: Turn-on transient at full load current (10 ms/div). Top Trace: Vout; 2V/div; Bottom Trace: input voltage: 30V/div.*

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ELECTRICAL CHARACTERISTICS CURVES

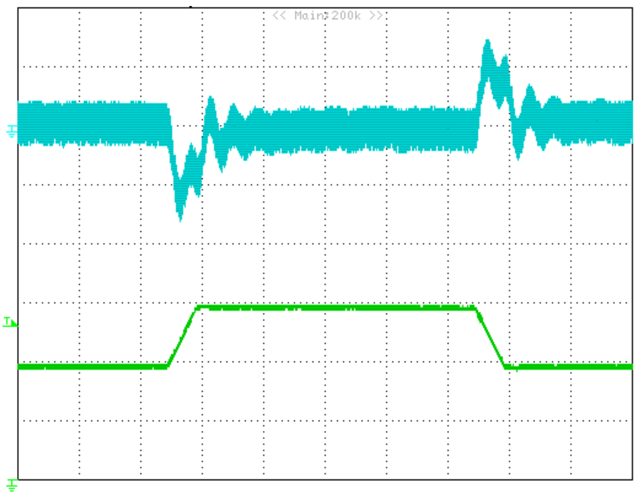

Figure 11: *Output voltage response to step-change in load current (50%-75%-50% of full load; di/dt = 0.1A/µs). Load cap: 10µF, tantalum capacitor and 1µF ceramic capacitor. Top Trace: Vout; 100mV/div; Bottom Trace: output current: 5A/div, Time: 100us/div*

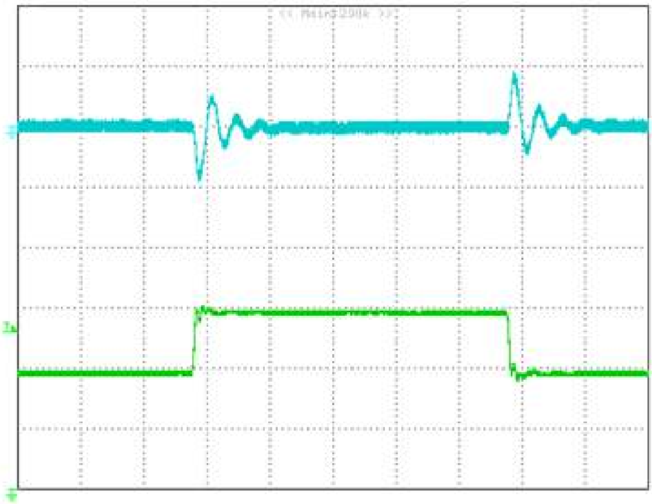

Figure 12: *Output voltage response to step-change in load current (50%-75%-50% of full load; di/dt = 2.5A/µs). Load cap: 10µF, tantalum capacitor and 1µF ceramic capacitor. Top Trace: Vout; 500mV/div; Bottom Trace: output current: 5A/div, Time: 100us/div*

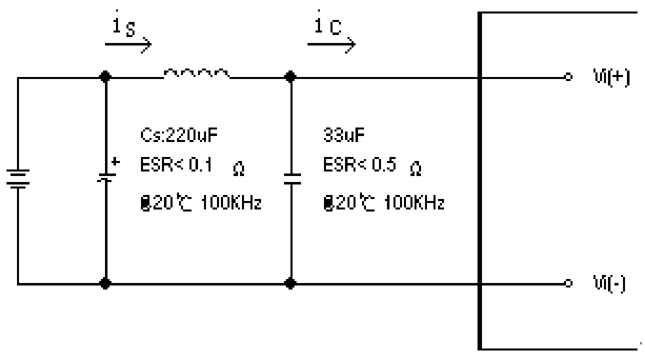

Figure 13: *Test set-up diagram showing measurement points for Input Terminal Ripple Current and Input Reflected Ripple Current.*
Note: Measured input reflected-ripple current with a simulated source Inductance (L_{TEST}) of 12 µH. Capacitor Cs offset possible battery impedance. Measure current as shown above.

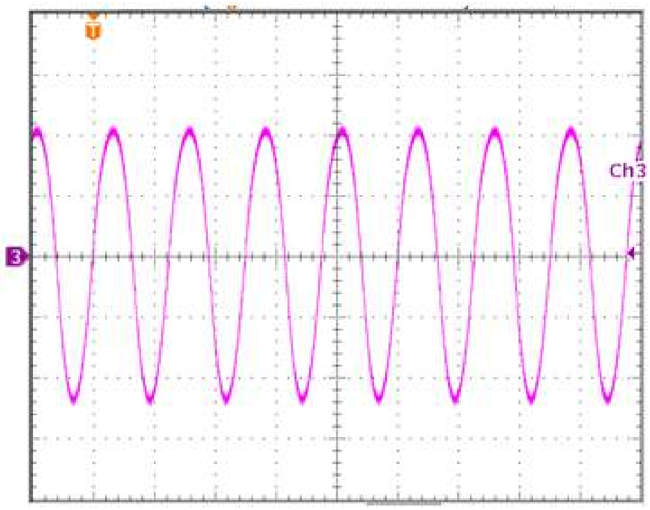

Figure 14: *Input Terminal Ripple Current, i_c, at max output current and nominal input voltage with 12µH source impedance and 33µF electrolytic capacitor (250 mA/div，2us/div).*

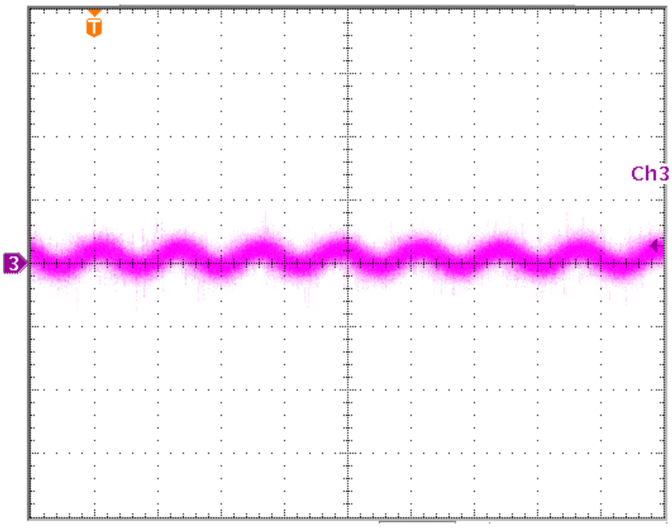

Figure 15: *Input reflected ripple current, i_s, through a 12µH source inductor at nominal input voltage and max load current (10 mA/div，2us/div).*

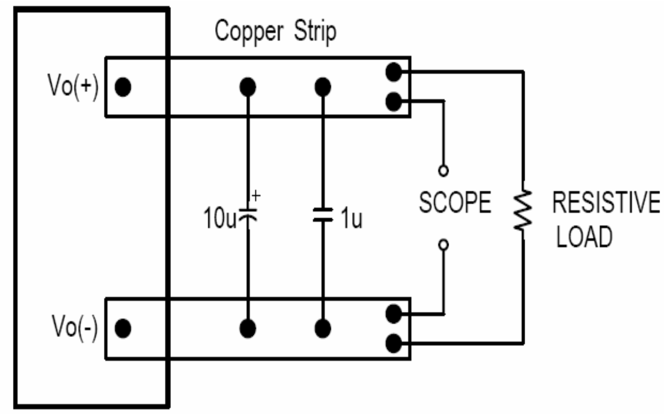

Figure 16: *Output voltage noise and ripple measurement test setup.*

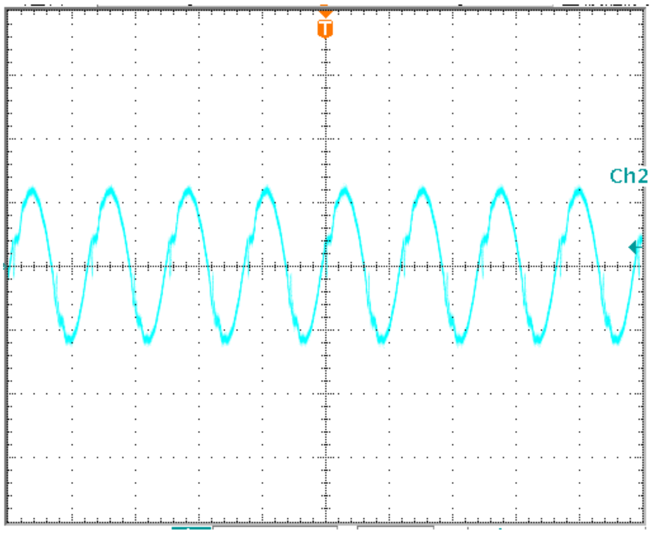

Figure 17: *Output voltage ripple at nominal input voltage and max load current (20 mV/div, 2us/div)*
Load capacitance: 1µF ceramic capacitor and 10µF tantalum capacitor. Bandwidth: 20 MHz.

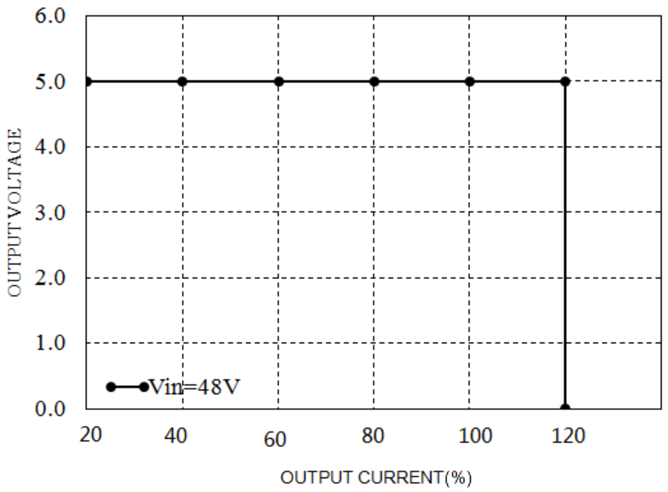

Figure 18: *Output voltage vs. load current showing typical current limit curves and converter shutdown points.*

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DESIGN CONSIDERATIONS

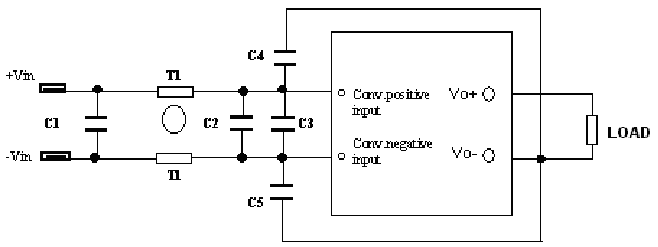
Input Source Impedance

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 100µF 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 V48SC06511 to meet class A in CISSPR 22.

Schematic and Components List



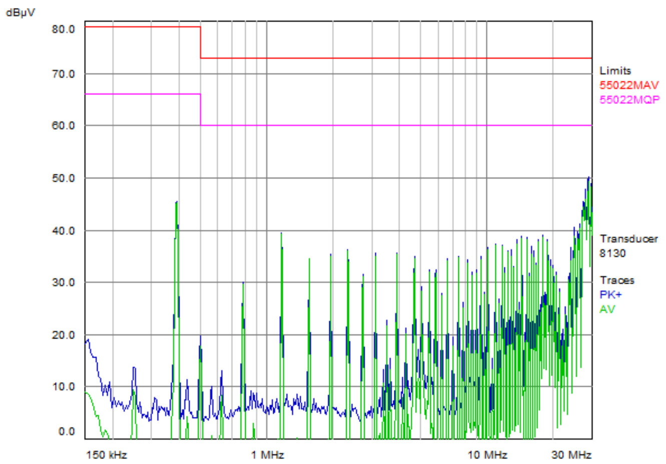
C1= 3.3uF/100 V

C2= 47uF/100 V

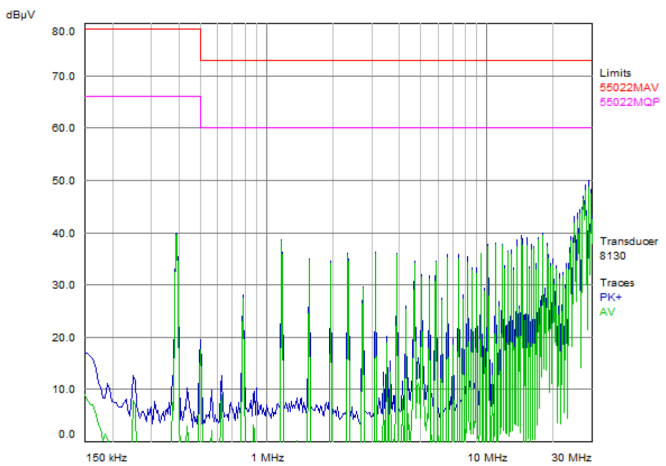
C3= 47uF/100 V

C4=C5=1nF/250Volt
T1=1mH, common choke, type P53910(Pulse)

Test Result:
At T = +25°C , Vin = 48 V and full load
Green line is quasi peak mode;
Blue line is average mode.



EMI test positive line



EMI test negative 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. 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, EN 60950-1: 2006 + A11: 2009 + A1: 2010 + A12: 2011 + A2: 2013, UL 60950-1, 2nd Edition, 2011-10-14 and CSA C22.2 No. 60950-1-07, 2nd Edition, 2010-14, 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.

FEATURES DESCRIPTIONS

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, and will try to restart after shutdown(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.

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).

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. 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.

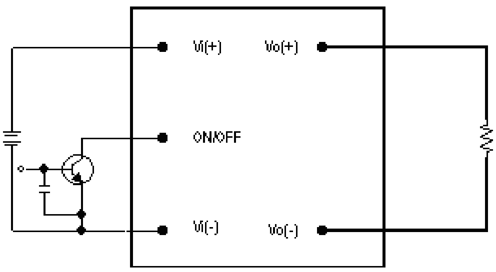


Figure 19: *Remote on/off implementation*

Output Voltage Adjustment (TRIM)

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

For trim down, 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% (6.5V×0.8=5.2V)

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

For trim up, 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% (6.5V×1.1=7.15V)

$$Rtrim-up=\frac{5.11\times6.5\times(100+10)}{1.225\times10}-\frac{511}{10}-10.22=236.9(K\Omega)$$

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 CONSIDERATIONS

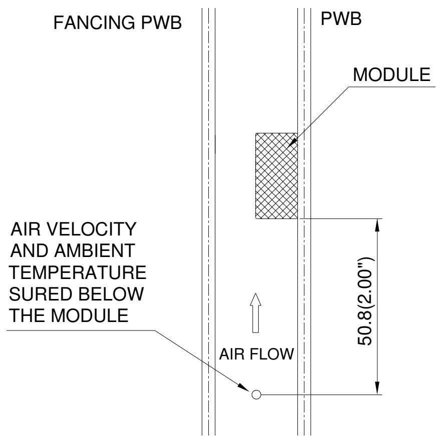
Thermal management is an important part of the system design. To ensure proper, reliable operation, sufficient cooling of the power module is needed over the entire temperature range of the module. Convection cooling is usually the dominant mode of heat transfer.

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 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. 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)

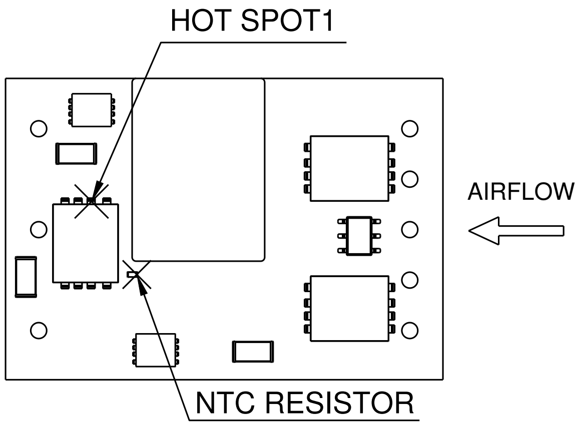


Figure 21: ** Hot spot 1& NTC resistor temperature measured points, the allowed maximum hot spot 1 temperature is defined at 122℃*

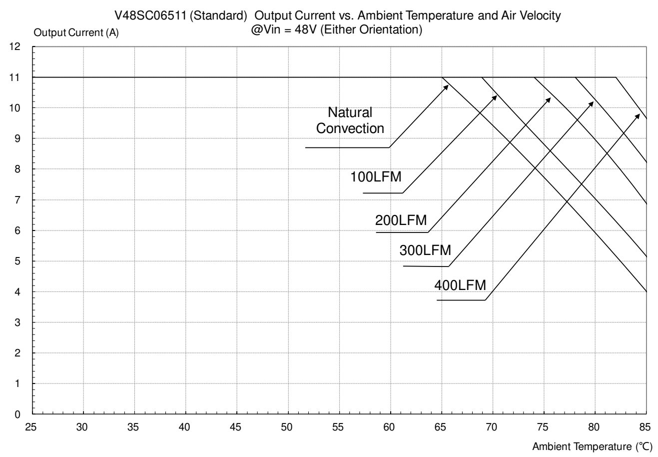


Figure 22: *Output current vs. ambient temperature and air velocity @Vin=48V(Either Orientation, without heat spreader)*

THERMAL CURVES (WITH HEAT SPREADER)

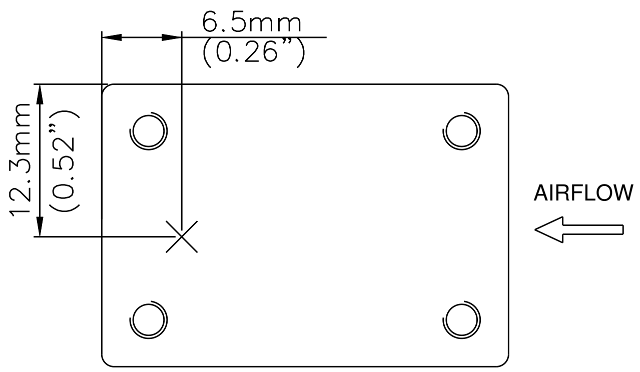


Figure 23: ** Hot spot 2 temperature measured point, the allowed maximum hot spot 2 temperature is defined at 111℃*

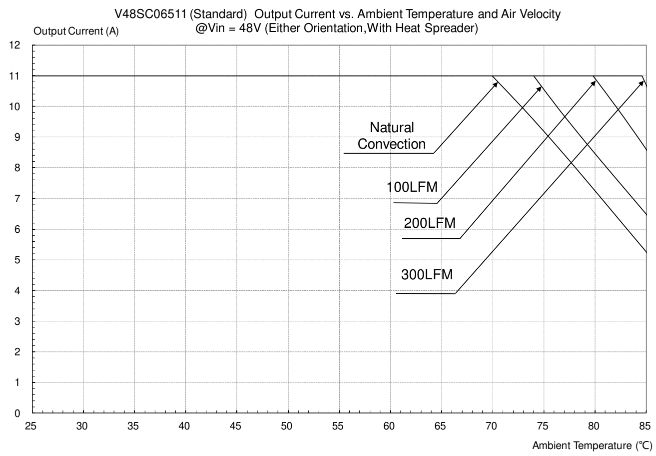
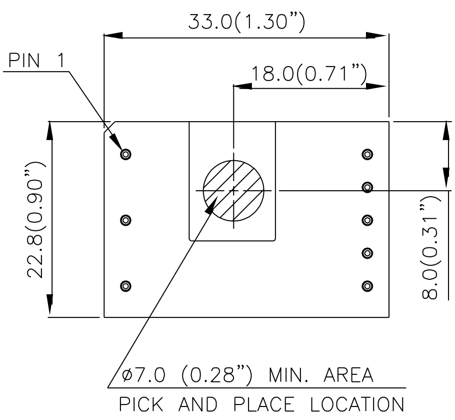


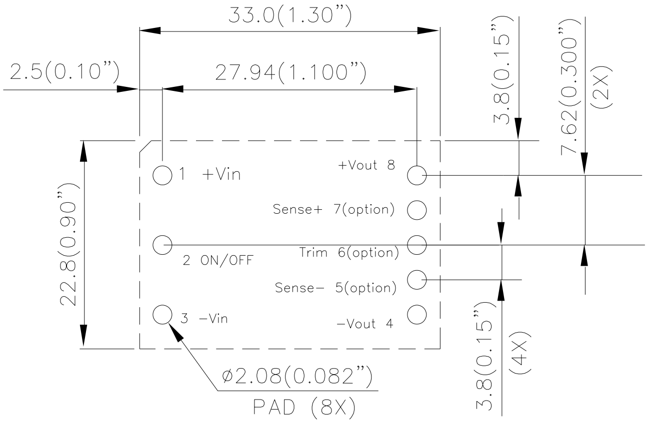
Figure 24: *Output current vs. ambient temperature and air velocity @Vin=48V(Either Orientation, with heat spreader)*

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.)

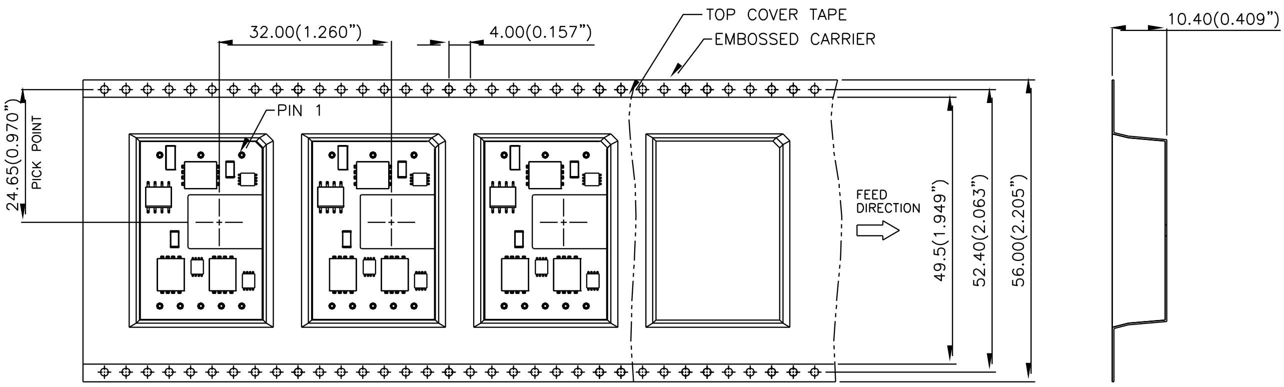
RECOMMENDED PAD LAYOUT (SMD)

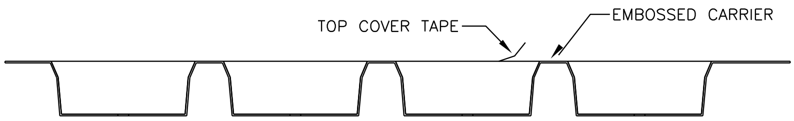


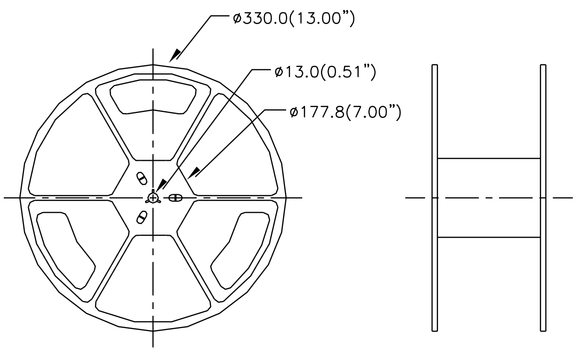
RECOMENDED P.W.B. PAD LAYOUT

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(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.)

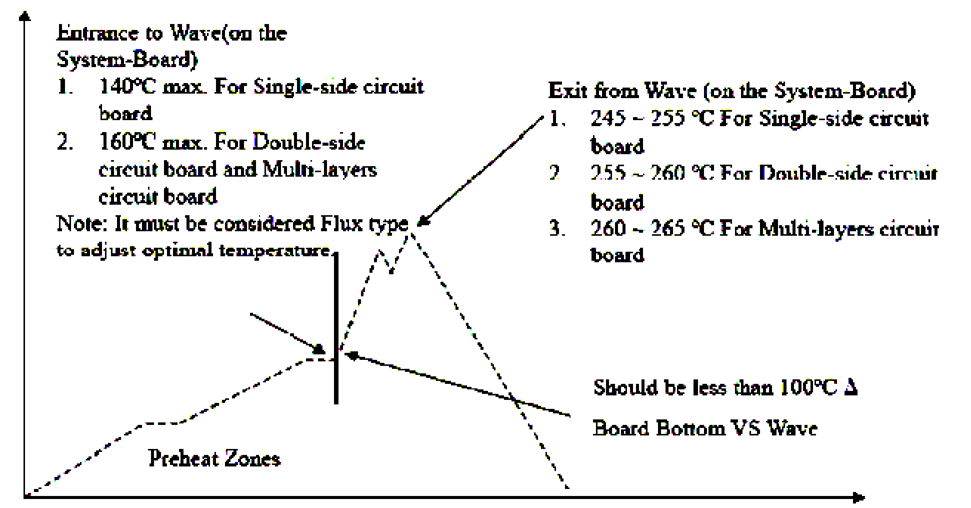
Soldering Method

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)

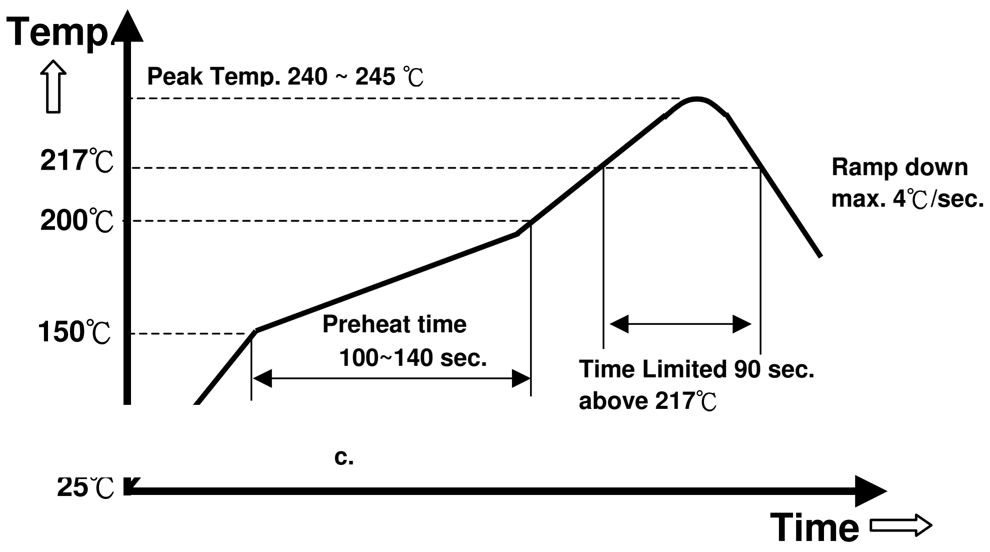
Hand soldering is the least preferred method because the amount of solder applied, the time the soldering iron is held on the joint, the temperature of the iron, and the temperature of the solder joint are variable. The recommended hand soldering guideline is listed in following table. The suggested 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

Reflow Soldering (Lead-free)

High temperature and long soldering time will result in IMC layer increasing in thickness and thereby shorten the solder joint lifetime. Therefore the peak temperature over 245℃ is not suggested due to the potential reliability risk of components under continuous high-temperature. In the meanwhile, the soldering time of temperature above 217℃ should be less than 90 seconds. Please refer to following fig for recommended temperature profile parameters.



Note: The temperature is measured on solder joint of pins of power module

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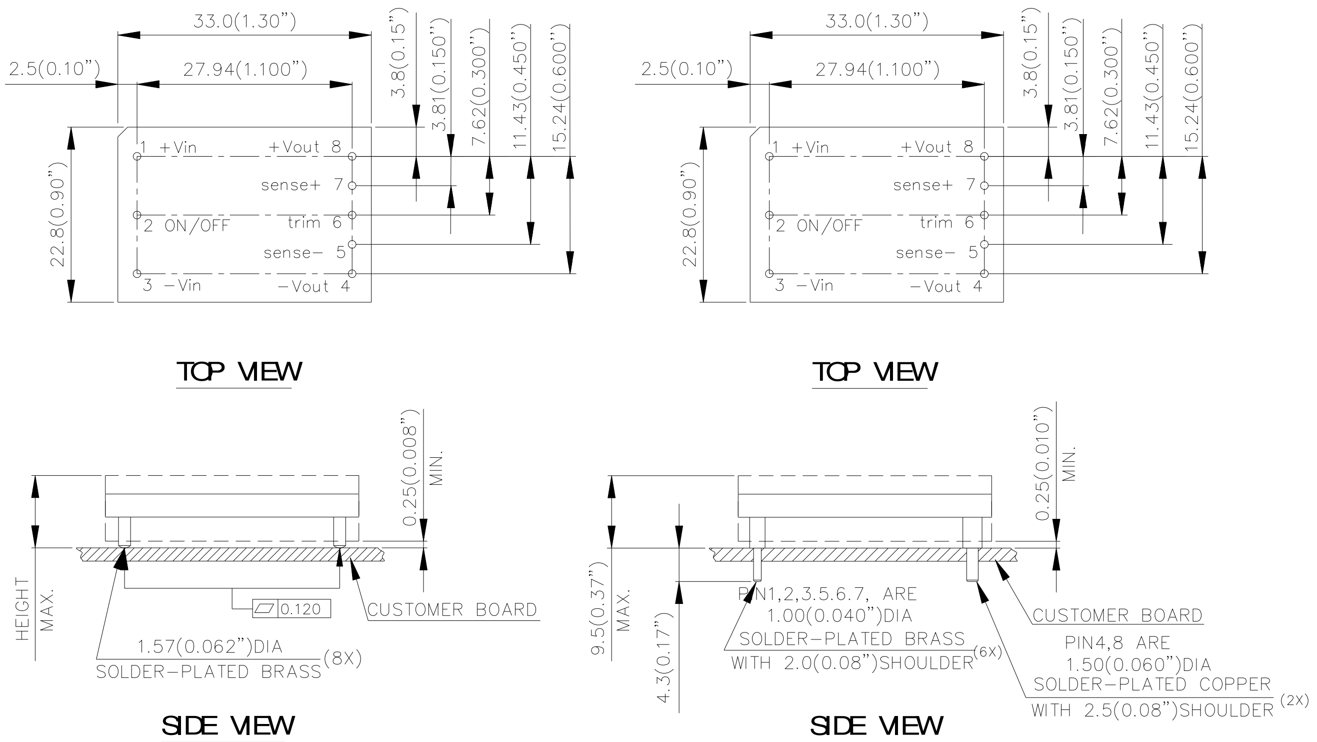
MECHANICAL DRAWING(OPEN FRAME)

Surface mount　　　　　　　　　　Through hole



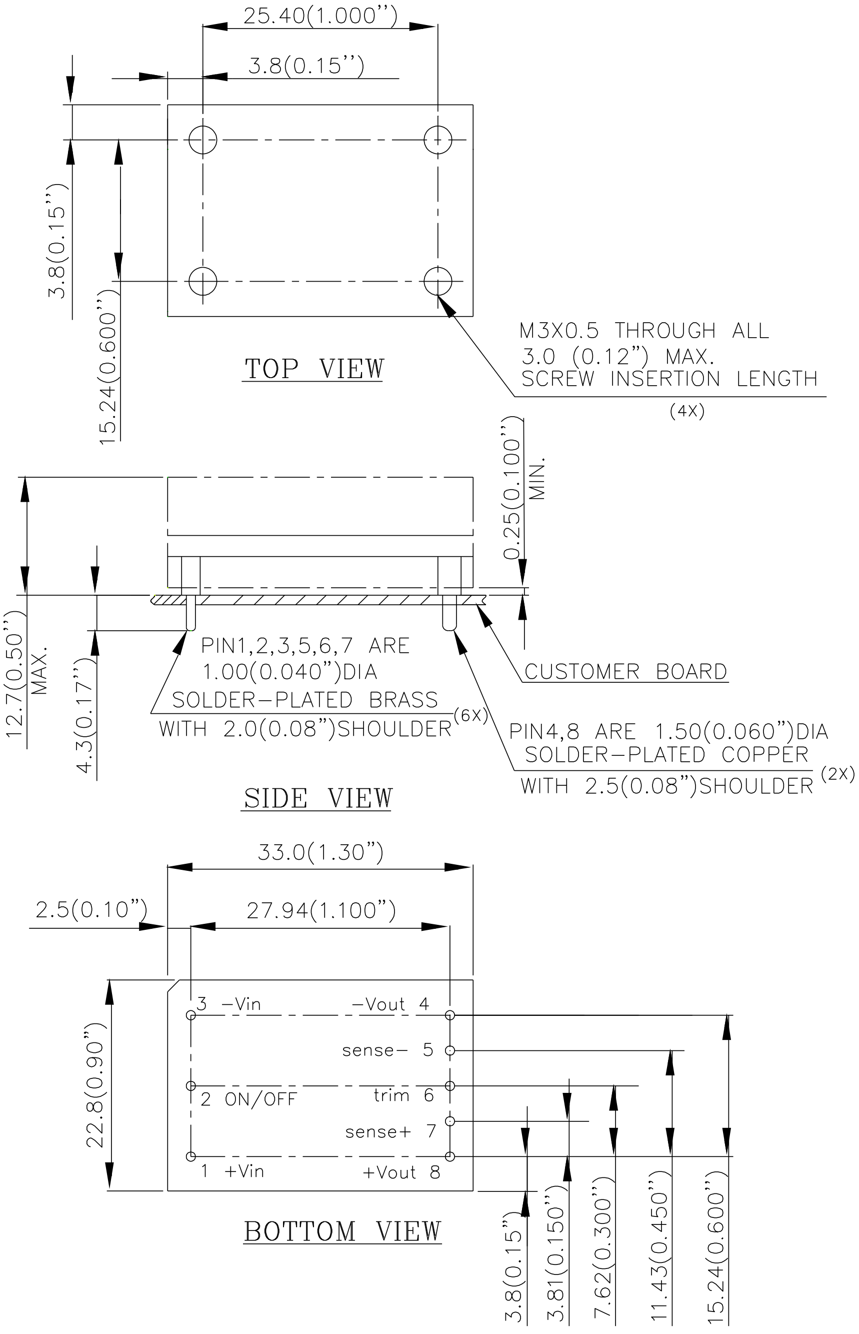
MODEL	HEIGHT
V48SC06511NMFA	8.5±0.5(0.33"±0.020")
V48SC06511NMFS	9.5±0.5(0.37"±0.020")

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.)

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

MECHANICAL DRAWING(WITH HEAT-SPREADER)

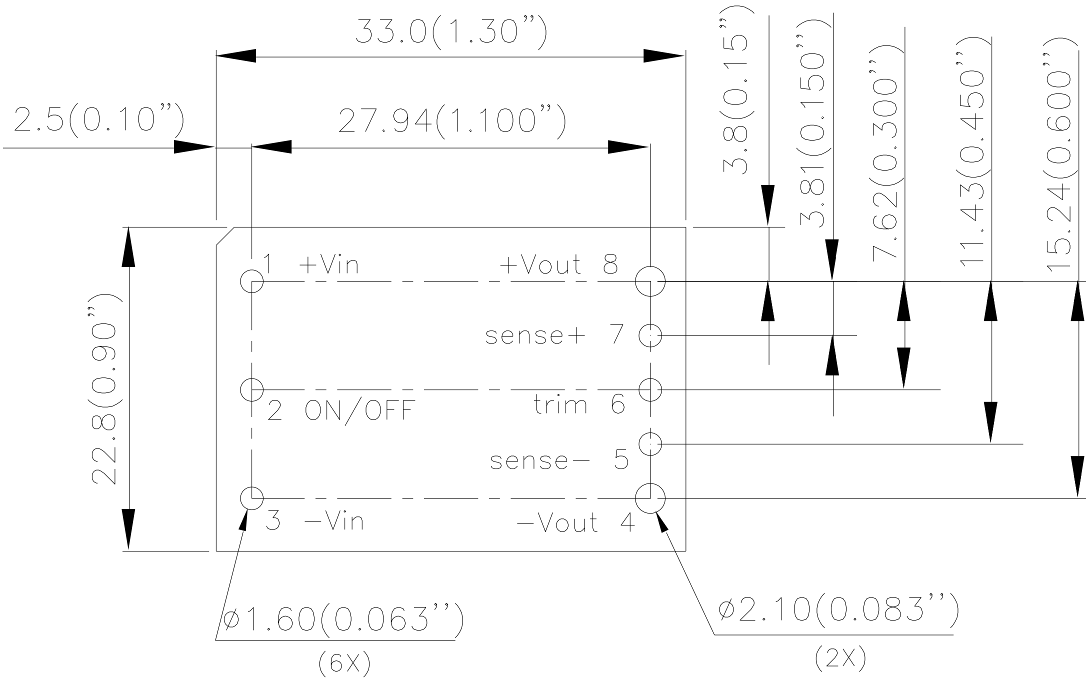
For modules with through-hole pins and the optional heatspreader, they are intended for wave soldering assembly onto system boards; please do not subject such modules through reflow temperature profile.



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.)

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

SUGGSETED PAD LAYOUT (THROUGH HOLE)



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.)

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PART NUMBERING SYSTEM

V	48	S	C	065	11	N	R	F	A
Form Factor	Input Voltage	Number of Outputs	Product Series	Output Voltage	Output Current	ON/OFF Logic	Pin Length		Option Code
V - Sixteenth Brick	48 - 36V~75V	S - Single	C - Series Number	065 - 6.5V	11 - 11A	N - Negative	M - SMD pin R – 0.170"	F - RoHS 6/6 (Lead Free) Space - RoHS 5/6	A - Standard Function (height=8.5±0.5) H - With heatspreader

RECOMMENDED PART NUMBER

MODEL NAME	INPUT		OUTPUT		EFF @ 100% LOAD
V48SC06511NRFA	36V~75V	2.3A	6.5V	11A	91.0%

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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.

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