Photo is for reference only

Input voltage: 36~60V
Output: 5.0Vdc,12Vdc
Output power: 60W

FEATURES

Electrical

- High efficiency: 93.5%@ full load
- Fixed frequency operation
- Input UVLO, OTP and output OCP, OVP
- Output voltage trim: max 20%
- Pre-biased startup
- 2250V isolation and basic insulation
- Applied to altitude up to 5000m

Mechanical

- Open-frame:
  Size: 33.0mm(L)x22.8mm(W)x8.8mm(H)
- With heat spreader:
  Size: 33.0mm(L)x22.8mm(W)x11.8mm(H)

Soldering Methods

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

Safety & Reliability

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

Recommended Part Number

Model Name	Input	Output		Eff. @ 60% Load	Others
V48SD05012NNFA	36V~60V	5V	12A	93.2%	Negative on/off
V48SD05012NNFH		5V	12A	93.2%	Negative on/off with heat spreader
V48SD12005NNFA	36V~60V	12V	5A	92.2%	Negative on/off
V48SD12005NNFH		12V	5A	92.2%	Negative on/off with heat spreader

Part Numbering System

V	48	S	D	05	012	N	N	F	A	R
Type of Product	Input Voltage	Number Of Outputs	Product series	Output Voltage	Output Current	ON/OFF Logic	Pin Length	Option Code	Option Code	Option Code
V - 1/16 Brick	48 - 36V~60V	S - Single	D - Serial number	05 - 5V 12 - 12V	012 - 12A 005 - 5A	N - Negative P – Positive	R - 0.170" N - 0.145" M - SMD	F - RoHS 6/6 (Lead Free)	A - Standard Functions H – With heat spreader	R – Reflow version Omit- Non-reflow version

			V48SD05012	V48SD12005
INPUT	Voltage	continuous	36~60Vdc	36~60Vdc
		absolute max input voltage	80Vdc	80Vdc
		transient	100V/100ms	100V/100ms
	Current	@36Vin, full load	2.1A	2.1A
		@48Vin,No load	20mA	35mA
		@Enable off & 48Vin	10mA	10mA
	Efficiency	48Vin, 100% load	93.5%	93.0 %
		48Vin, 60% load	93.2%	92.2%
OUTPUT	Voltage Setting(48Vin,full load,25℃)		5V±3%	12V±3%
	Current Rating		0~12A	0~5A
	Voltage trim range Note1		-20~20%	-20%~20%
	Ripple & Noise Vpp Note2		120mV	240mV
	Output Regulation	Line	0.3% Max	0.3% Max
		Load	0.3% Max	0.3% Max
		Temperature	0.004%/℃	0.004%/℃
	Start-up Time Note3	Delay from input	30ms	30ms
		Delay from on/off	30ms	30ms
		Rise time	25ms	25ms
	Transient response Note4	Voltage deviation	5% Vo,nom	5% Vo,nom
		Response time	100us	100us
	Output capacitance		0~ 5000uF	0~ 3000uF
PROTECTION	Output Over Current (hiccup)		110%~180% Iomax	110%~180% Iomax
	Output Over Voltage (hiccup)		6.2~8V	14.8~21.6V
	Input UVLO	On threshold	33~36V	33~36V
		Off threshold	30~33V	30~33V
		Hysteresis	2V	2V
	OTP shutdown	NTC temperature	130 ℃	130 ℃
		Restart Hysteresis	30 ℃	30 ℃
ISOLATION	Input to Output		2250Vdc	2250Vdc
	Isolation Resistance (Input to Output at 500Vdc)		10 MΩ min	10 MΩ min
	Isolation Capacitance(Input to Output)		1000 pF	1000 pF
ENVIRONMENT	Operating ambient temperature		-40~85℃	-40~85℃
	Storage temperature		-40~125℃	-40~125℃
	Operating Humidity		Max 95%	Max 95%
	Shock & Vibration		IPC 9592B	IPC 9592B
ENABLE CONTROL	Logic low		-0.7~0.8V	-0.7~0.8V
	Logic high		3.5-10V	3.5-10V
	Current ($V_{on/off}$=0V)		1mA max	1mA max
	Voltage when floating		<10V	<10V
OTHERS	Switching Frequency		420kHz	420kHz
	MTBF(48Vin,80% load,25℃)		2.4M hours	2.3 M hours
	Weight（open frame）		12.3±2g	12.3±2g
	Weight（with Heat spreader）		20±3g	20±3g
	Altitude		5000m	5000m

Notes (All specifications valid at 48Vin, 100% Rated load and 25℃ ambient, unless otherwise indicated.)

***1** Maximum output power & current of the module should not over rated output power & current; Maximum trim range is 10% if input voltage below 44V.

***2** Ripple & Noise measurement bandwidth is 0-20MHz, Vin=48V, full load, Cout=10uF Tantalum +1uF ceramic + 33uF electrolytic capacitor.

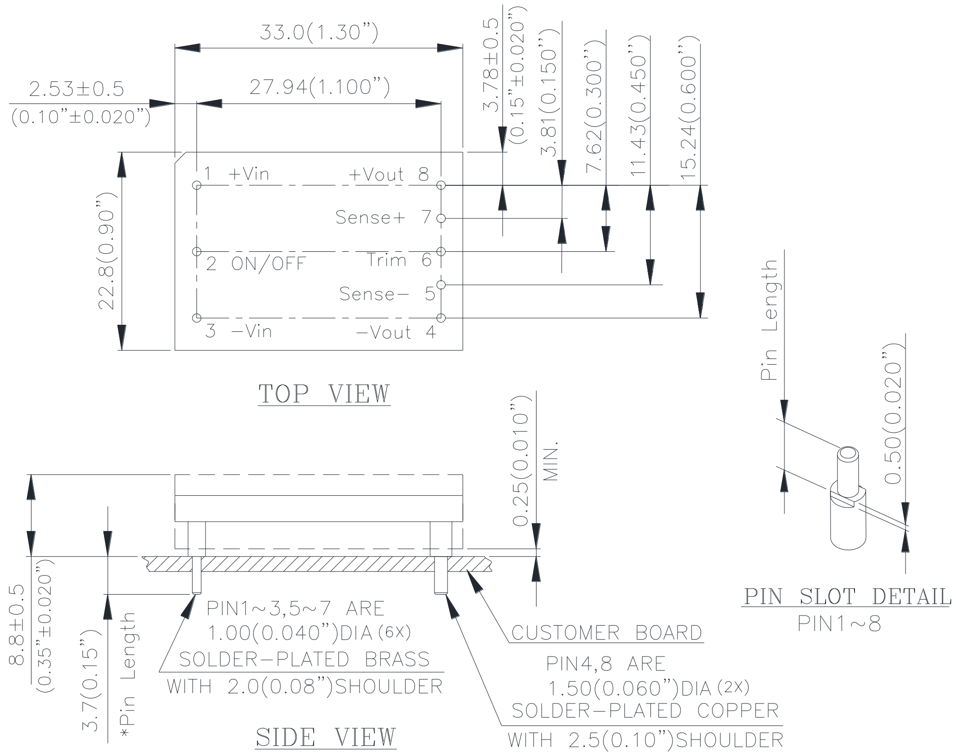
***3 "Delay from input":** from Vin reaching turn-on threshold to 10% V_{out} (pre-applied enable); **"Delay from on/off":** From enable to 10% V_{out} (pre-applied V_{in}); **"Rise time"** From 10% to 90% Vout.

*__4__ Load transient test condition: 48Vin, 50% to 75% full load, 10uF Tantalum & 1uF ceramic & 33uF electrolytic capacitor, 0.1A/us.

*__5__ Define that the maximum Vin rising rate is 30V/ms and the recommend output capacitance is 100uF.

*__6__ The recommended external input capacitance is 100uF.

Through-hole-open-frame-module



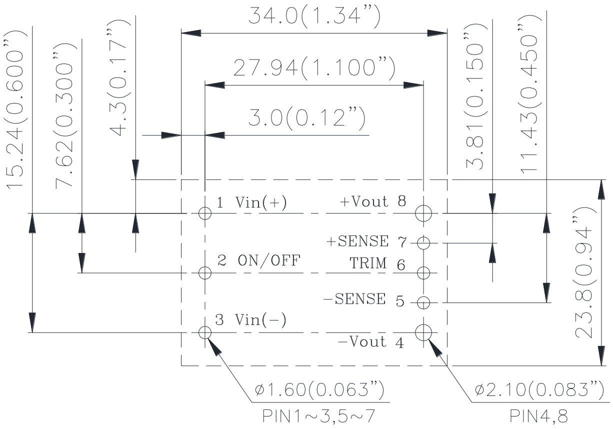
*Standard pin tail length. Optional pin tail lengths shown in PART NUMBERING SYSTEM

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 Specification:

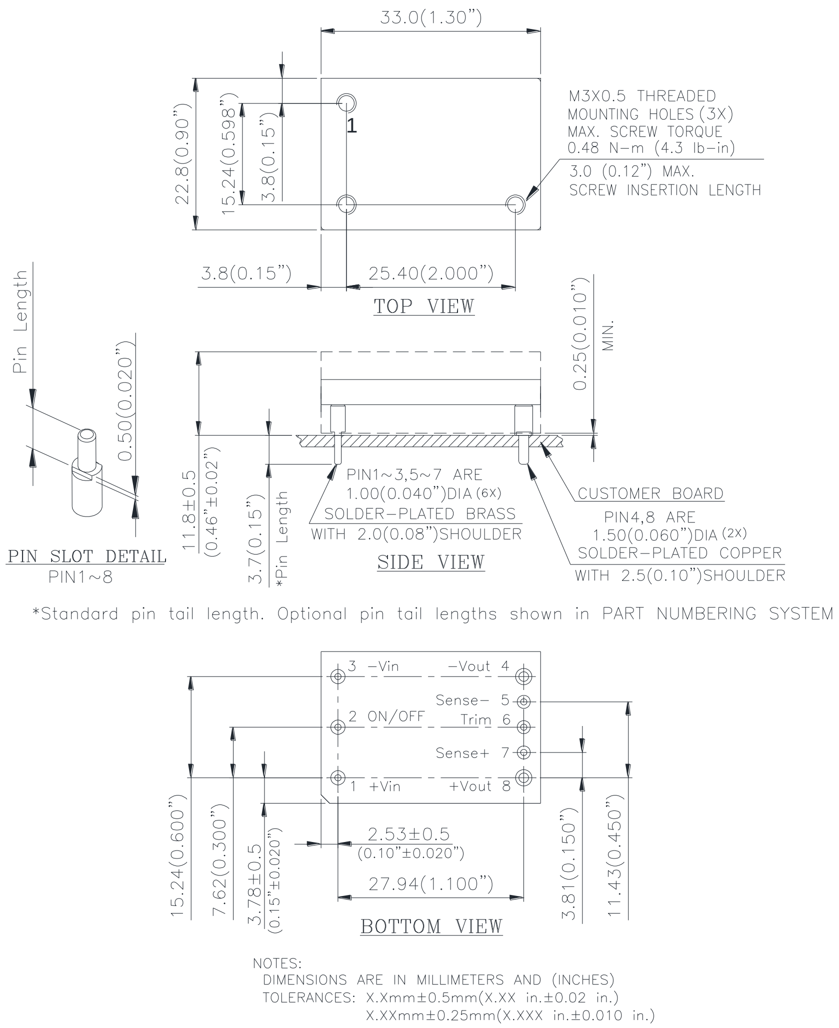
Pins 1,2,3,5,6,7	1.00mm (0.040") diameter; copper alloy with matte Tin plating over Nickel under plating
Pins 4,8	1.50mm (0.060") diameter; copper alloy with matte Tin plating over Nickel under plating

SUGGESTED P.W.B. PAD LAYOUT



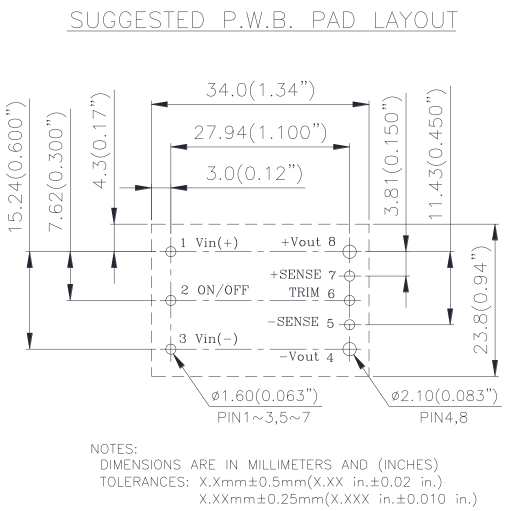
NOTES:
DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
X.XXmm±0.25mm(X.XXX in.±0.010 in.)

Through-hole-with-heat-spreader-module



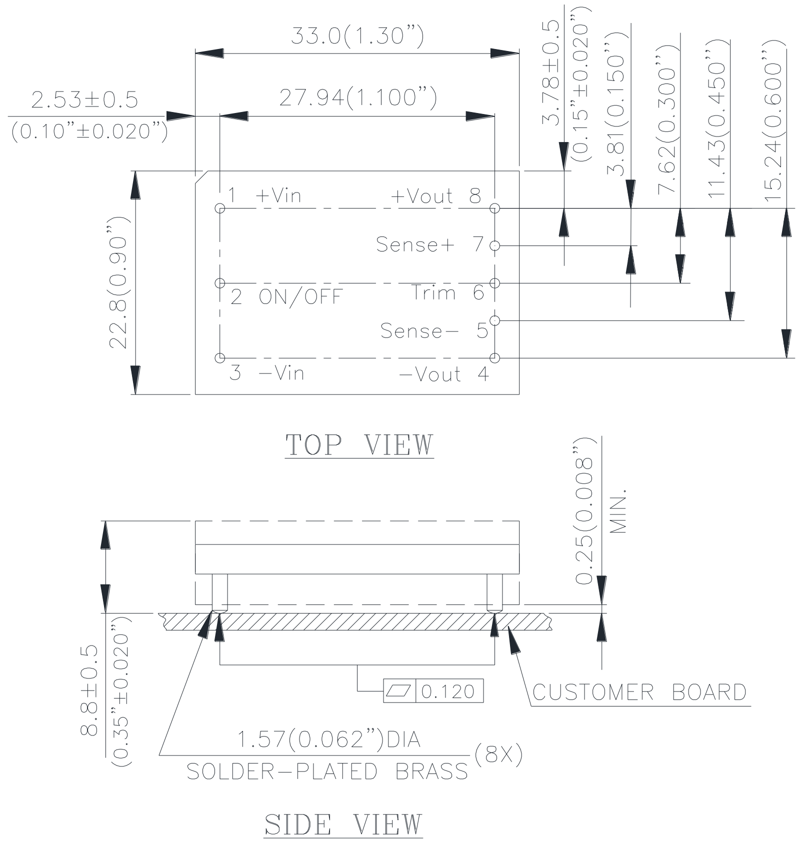
Pin Specification:

Pins 1,2,3,5,6,7	1.00mm (0.040") diameter; copper alloy with matte Tin plating over Nickel under plating
Pins 4,8	1.50mm (0.060") diameter; copper alloy with matte Tin plating over Nickel under plating



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

Surface-mount module

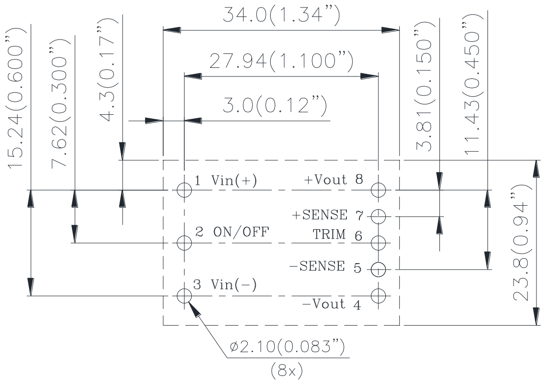


NOTES:
DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
X.XXmm±0.25mm(X.XXX in.±0.010 in.)

Pin Specification:

Pins 1,2,3,4,5,6,7,8	1.57mm (0.062") diameter; copper alloy with matte Tin plating over Nickel under plating

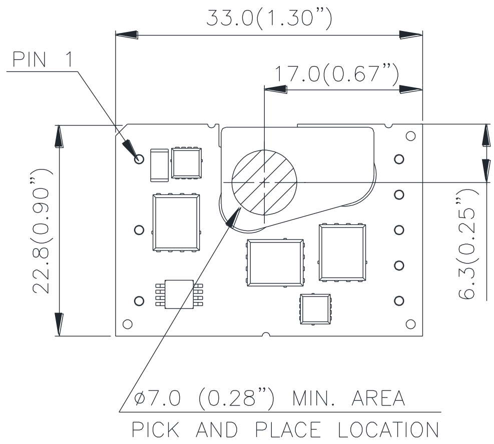
SUGGESTED P.W.B. PAD LAYOUT



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.)

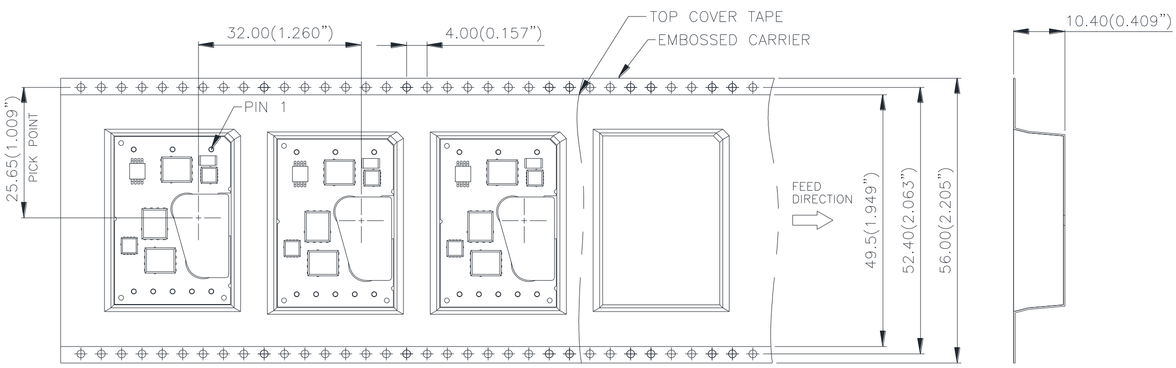
Surface-mount module

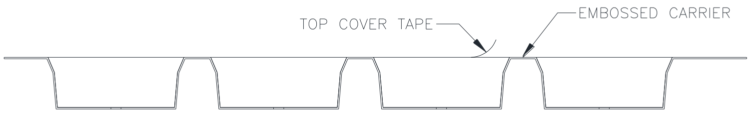
PICK AND PLACE LOCATION

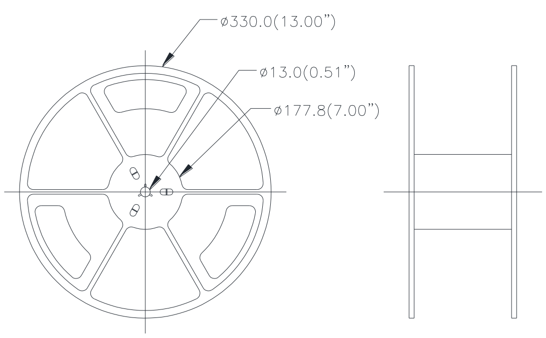


NOTES:
ALL DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
X.XXmm±0.25mm(X.XXX in.±0.010 in.)

SURFACE-MOUNT TAPE & REEL

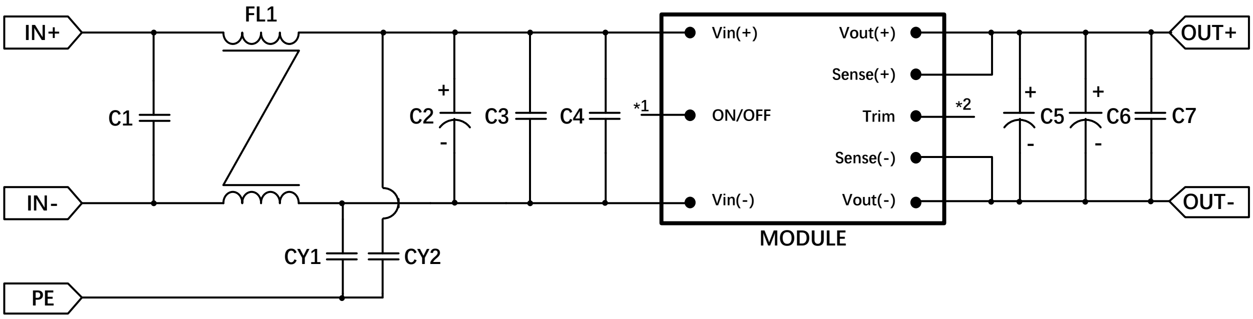






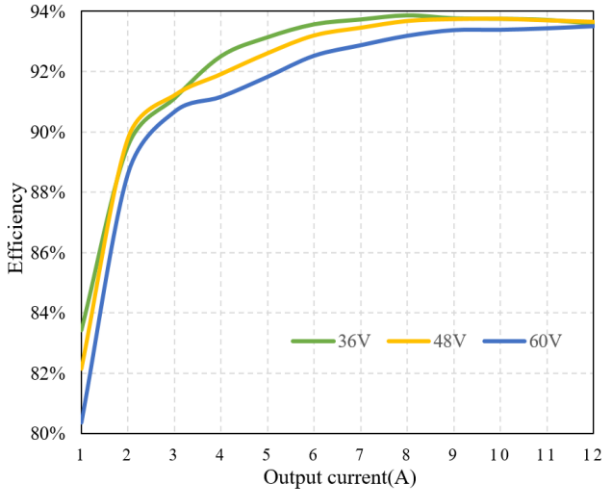
NOTES:
CONFORMS TO EIA-481 SATNDARD
MODULES ARE SHIPPED IN QUANTITIES OF 100 PER REEL.
ALL DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
X.XXmm±0.25mm(X.XXX in.±0.010 in.)

Typical EMI filter circuit for EN55032 Class A Conducted Emission

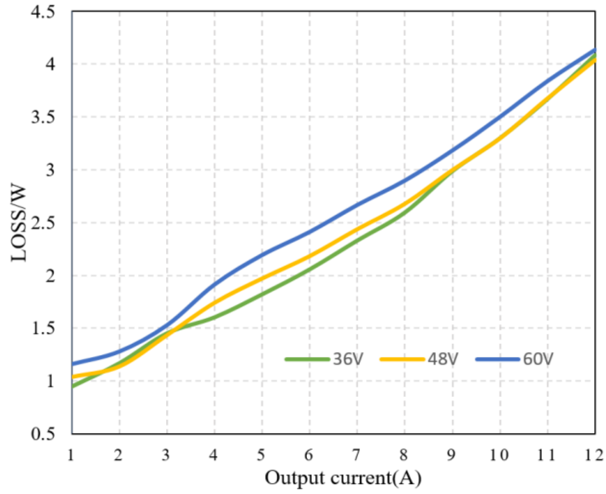


*1,2: Please refer to page12 for the On/Off (pin2) and Trim (pin6) implementation.

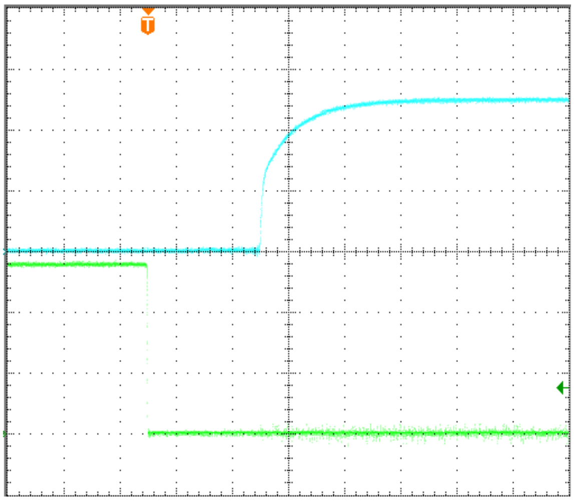
Location	Vendor P/N	Description	Qty	Vendor	Purpose
C1	D3D2H505KB00352	500V 5uF K S27.5 32*11*20	2	FARATRONIC	EMC
FL1	PH9455.155NL	19A 1.62mH NPB SRF 10MHz	1	Pulse	EMC
CY1	CS12-F2GA472MYNSAC	250VAC 4700pF M F VI7.5	5	TDK	EMC
CY2	CS12-F2GA472MYNSAC	250VAC 4700pF M F VI7.5	5	TDK	EMC
C2	ECLA251EC3331MM351	250V 220uF M 18*35 P7.5	1	NCC	EMC
C3	C1210X475K101TX	100V 4.7uF K X7R 1210	2	HOLY STONE	EMC
C4	GRJ319R72A104KE11L	100V 0.1uF K X7R 1206	2	MURATA	EMC
C5	63PZE33MTA8*9	CAP AL HB 63V 33uF M 8*9 TP KI5	1	RUBYCON	RIPPLE
C6	25TQC10M	25V 10uF M SMD TP 6.0*3.2*2.84.8	1	MATSUSHITA	RIPPLE
C7	GRM31MR71H105KA88L	50V 1uF K X7R 1206	1	MURATA	RIPPLE



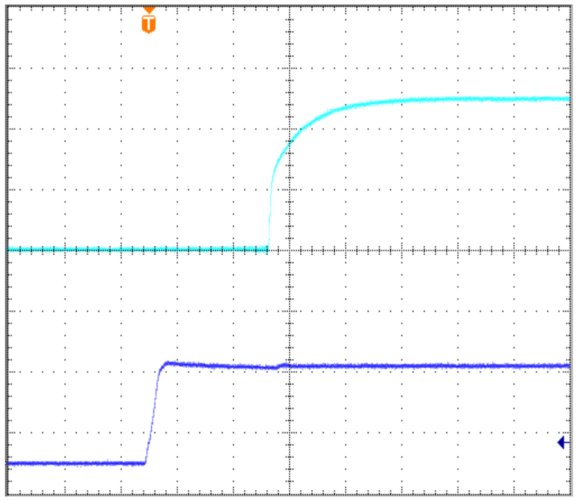
Efficiency vs. load current for various input voltage.



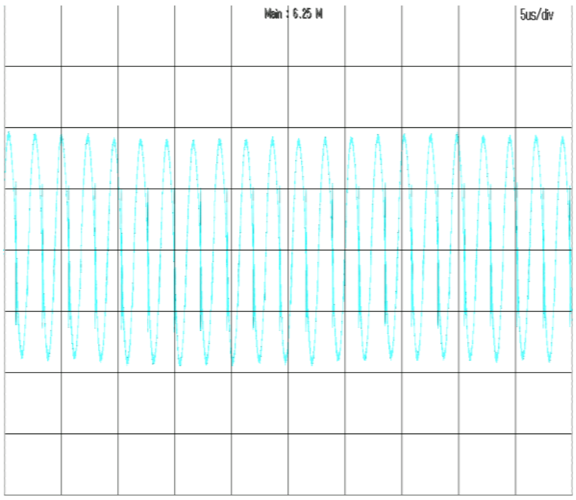
Power dissipation vs. load current.



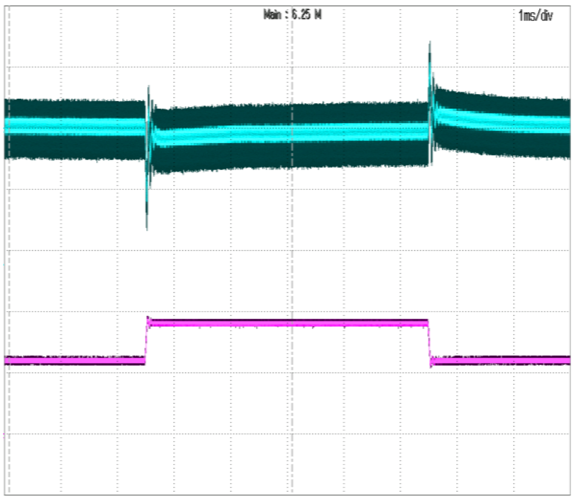
Turn-on transient at full load current (20ms/div).
Top Trace: Vout; 2V/div; Bottom Trace: ON/OFF input: 2V/div.



Turn-on transient at full load current (20ms/div).
Top Trace: Vout; 2V/div; Bottom Trace: input voltage: 30V/div.

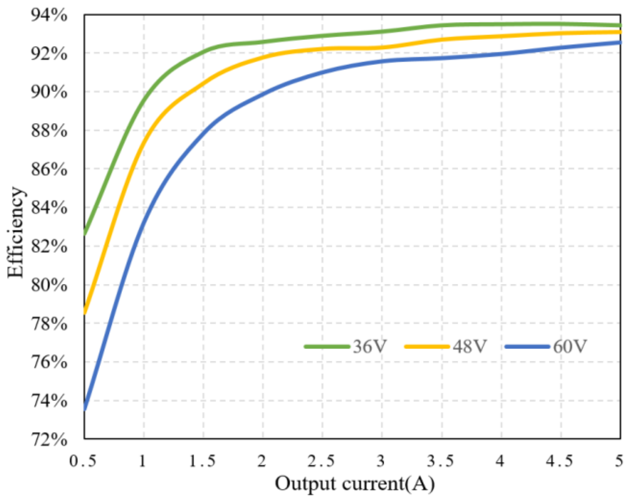


Output voltage ripple at nominal input voltage and max load current (20mV/div, 5us/div)
Load cap: 10µF Tantalum, 1uF ceramic capacitor, 33uF electrolytic capacitor
Bandwidth: 20MHz

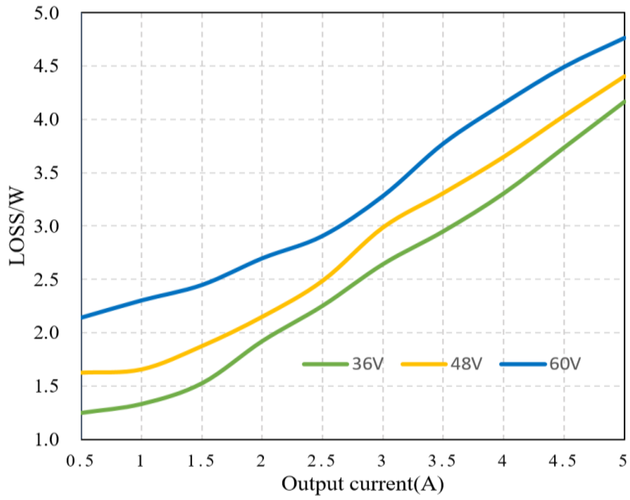


Top trace Vout dynamic AC Value,200mV/div,1ms/div
Load cap: 10µF Tantalum, 1uF ceramic capacitor 33uF electrolytic capacitor
Bottom Trace :load 50% to 75% of rated Iout 5A/div,
Bandwidth:20MHz

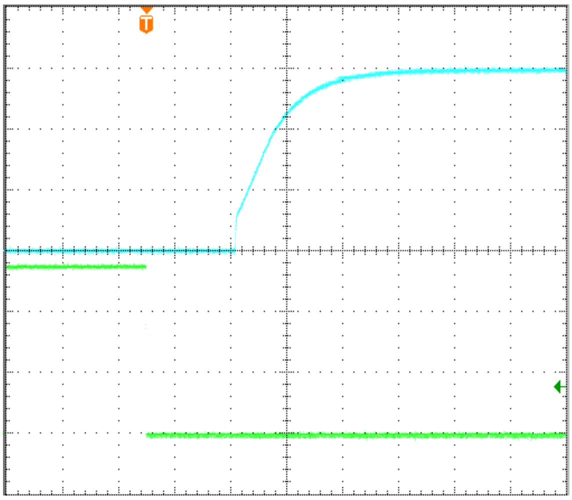
ELECTRICAL CURVES-V48SD12005(12V/5A)



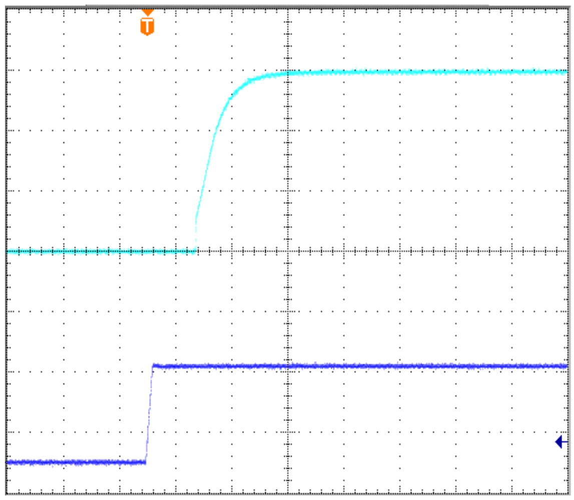
Efficiency vs. load current for various input voltage.



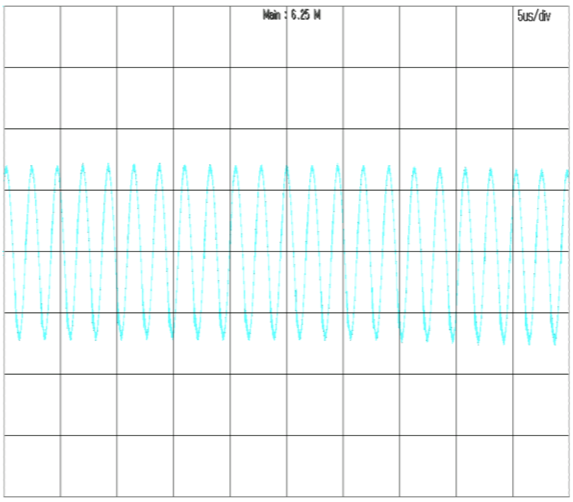
Power dissipation vs. load current.



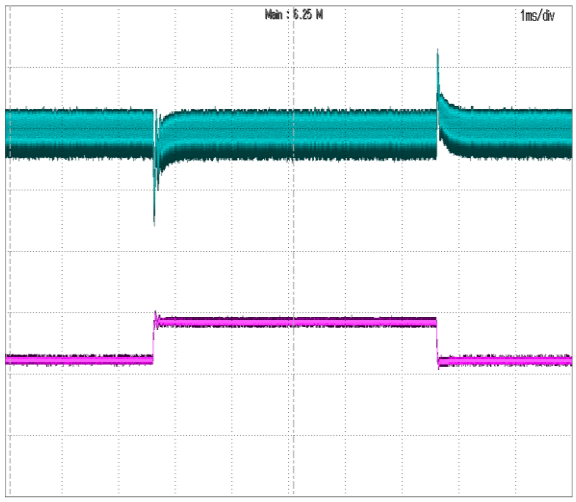
Turn-on transient at full load current (20ms/div).
Top Trace: Vout; 4V/div; Bottom Trace: ON/OFF input: 2V/div.



Turn-on transient at full load current (20ms/div).
Top Trace: Vout; 4V/div; Bottom Trace: input voltage: 30V/div.



Output voltage ripple at nominal input voltage and max load current (50mV/div, 5us/div)
Load cap: 10μF Tantalum, 1uF ceramic capacitor, 33uF electrolytic capacitor
Bandwidth: 20MHz

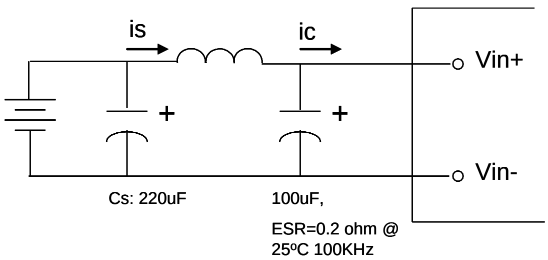


Top trace Vout dynamic AC Value,200mV/div,1ms/div
Load cap: 10μF Tantalum, 1uF ceramic capacitor, 33uF electrolytic capacitor
Bottom Trace :load 50% to 75% of rated Iout 2A/div,
Bandwidth:20MHz

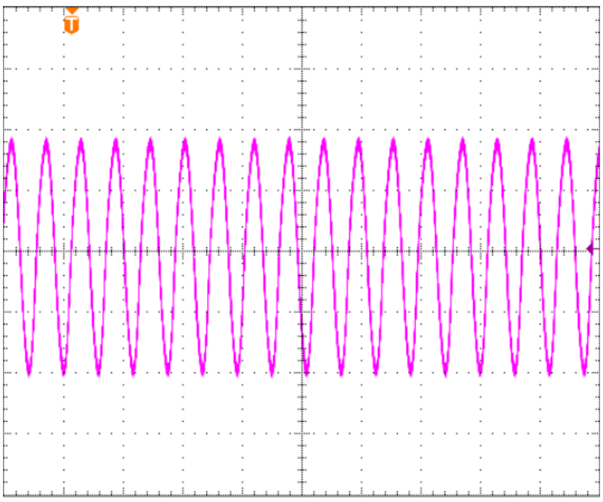
Input Source and Impedance

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 a 100μF electrolytic capacitor mounted close to the input of the module to improve the stability. The delay time between turn off and next turn on should be >100 ms.

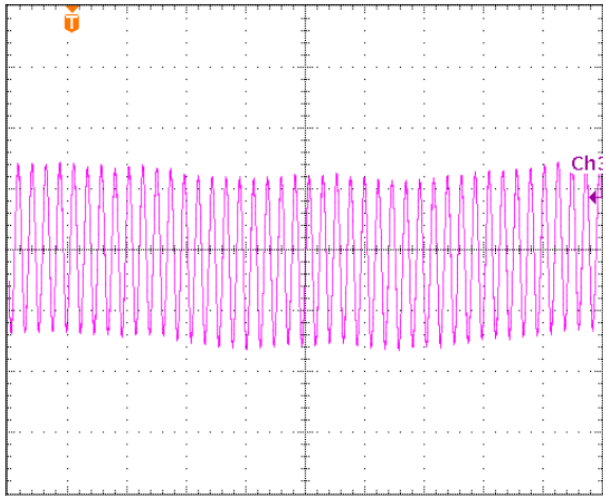
Input Reflected Ripple Current



Test set-up diagram showing measurement points for Input Terminal Ripple Current and Input Reflected Ripple Current.
Measured input reflected-ripple current with a simulated source Inductance (LTEST) of 12 μH. Capacitor Cs offset possible battery impedance.

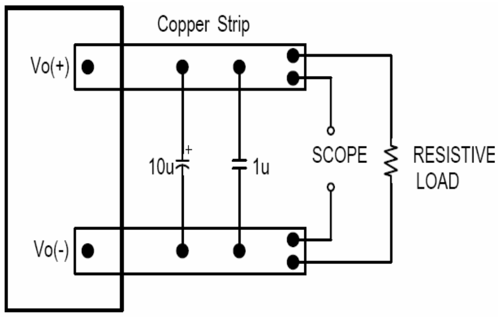


Input Terminal Ripple Current, ic, at full rated output current and nominal input voltage with 12μH source impedance and 100μF electrolytic capacitor (500 mA/div, 4us/div).



Input reflected ripple current, Is, through a 12μH source inductor at nominal input voltage and rated load current (25 mA/div, 10us/div)

Output Ripple Noise

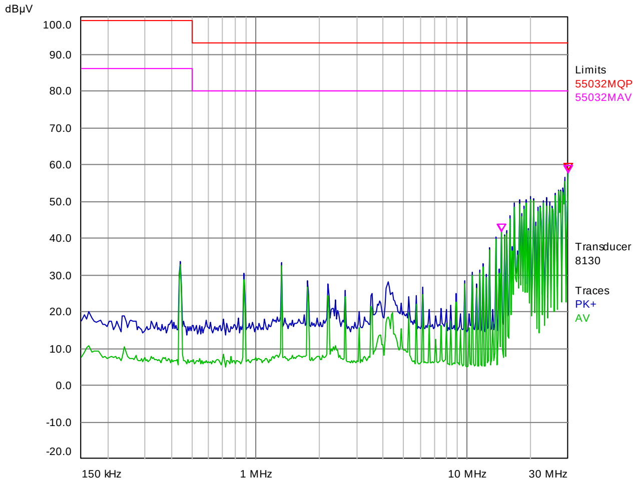


Output voltage ripple test setup.
Load capacitance: 1μF ceramic capacitor and 10μF tantalum capacitor and some extra electrolytic capacitor may be needed. Bandwidth: 20 MHz. Scope measurements should be made using a BNC cable (length shorter than 20 inches). Position the load between 51 mm to 76 mm (2 inches to 3 inches) from the module.

Layout and EMI considerations

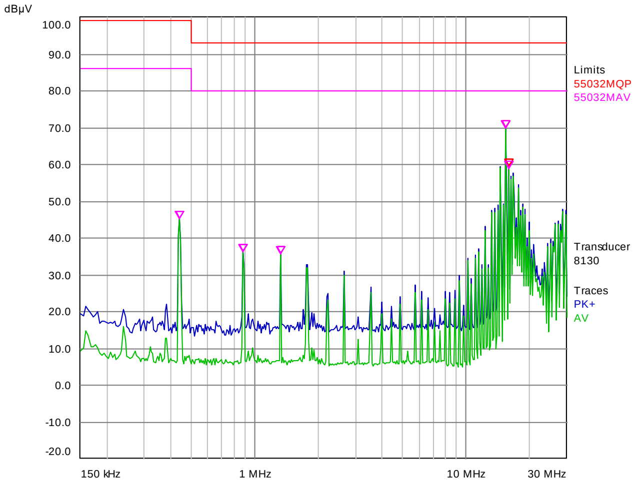
Delta's DC/DC power modules are designed to operate in a wide variety of systems and applications. For design assistance with EMC compliance and related PWB layout issues, please contact Delta's technical support team.

Below is the EN55032 Class A Conducted Emission test result using typical EMI filter circuit.
At T = +25°C, Typical input voltage and full load.



V48SD05012

EN55032 Class A Conducted Emission Test Result



V48SD12005

EN55032 Class A Conducted Emission Test Result

Recommended PCB Layout

It is suggested to use multiple layers PCB and large size copper on system board which connects to pins of module, that can achieve better thermal performance.

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 (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 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 over-temperature is detected the module will shut down, and restart after the temperature is within specification.

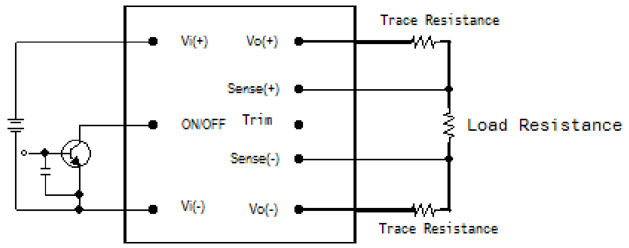
Enable On/Off

The Enable 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 an external logic low and off during a logic high. If the Enable on/off feature is not used, please short the on/off pin to Vi (-).
- For Positive logic version, turns the modules on

during an external logic high and off during a logic low. If the Enable on/off feature is not used, please leave the on/off pin to floating.

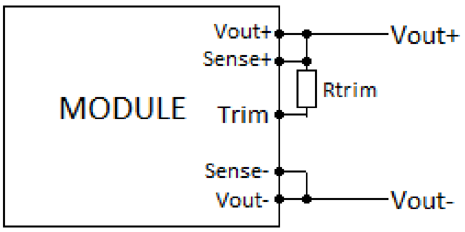
Enable on/off can be controlled by an external switch between the on/off terminal and the Vi (-) terminal. The switch can be an open collector or open drain.



Enable on/off implementation

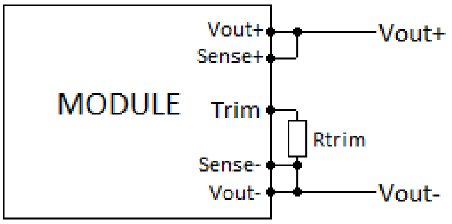
Output Voltage Adjustment (TRIM)

To increase the output voltage set point, connect an external resistor between the TRIM pin and the Sense(+).



Circuit for trim-up (increase output voltage)

To decrease the output voltage set point, connect an external resistor between the TRIM pin and the Sense(-).



Circuit for trim-down (decrease output voltage)

The maximum adjust range is ±20%, the TRIM pin should be left open if this feature is not used.

Take V48SD12005 as example, for trim down, the external resistor value required to obtain a percentage of output voltage change △ is defined as:

$$R_{trim-down} = \left[\frac{5.11}{\Delta} - 10.22\right](K\Omega)$$

Ex. When Trim-down -10% (12V×0.9=10.8V)

$$R_{trim-down} = \left[\frac{5.11}{10\%} - 10.22\right](K\Omega) = 40.88(K\Omega)$$

For trim up, the external resistor value required to obtain a percentage output voltage change △ is defined as:

$$R_{trim-up} = \left[\frac{44.4}{\Delta} + 39.3\right]K\Omega$$

Ex. When Trim-up +10% (12V×110%=13.2V)

$$R_{trim-up} = \left[\frac{44.4}{10\%} + 39.3\right] = 483.3\,(K\Omega)$$

Modules	Rtrim-up kohm	Rtrim-down kohm
V48SD05012	15.8/Δ+10.6	5.11/Δ-10.22
V48SD12005	44.4/Δ+39.3	5.11/Δ-10.22

Where
Δ=|Vnom-Vadj|/Vnom
Vnom=Typical Output Voltage
Vadj=Disired Output Voltage

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., EN 62368-1: 2014, IEC 62368-1: 2014, CSA C22.2 No. 62368-1-14, 2nd Edition and UL 62368-1, 2nd Edition, if the system in which the power module is to be used must meet safety agency requirements.

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-blow fuse with 6A 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

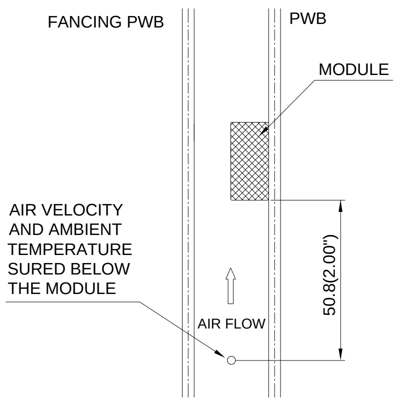
Thermal Testing Setup

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.

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 203.2mmX203.2mm,105μm (3Oz),8 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 1: 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.

Hot Spot's Location (Open Frame)

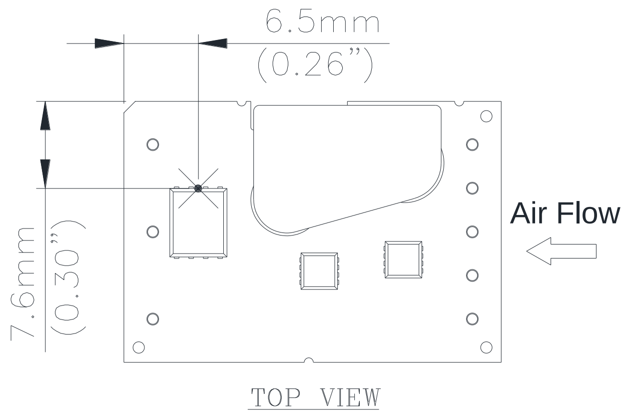


Figure 2: * Hot spot1 temperature measured point.
The allowed maximum hot spot1 temperature is defined at 117℃.

Hot Spot's Location (With Heat Spreader)

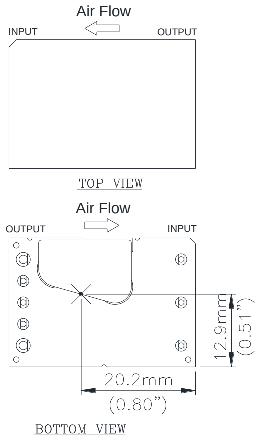


Figure 5: * Hot spot2 temperature measured point.
The allowed maximum hot spot2 temperature is defined at 113℃.

Thermal Curves (V48SD05012, Open Frame)

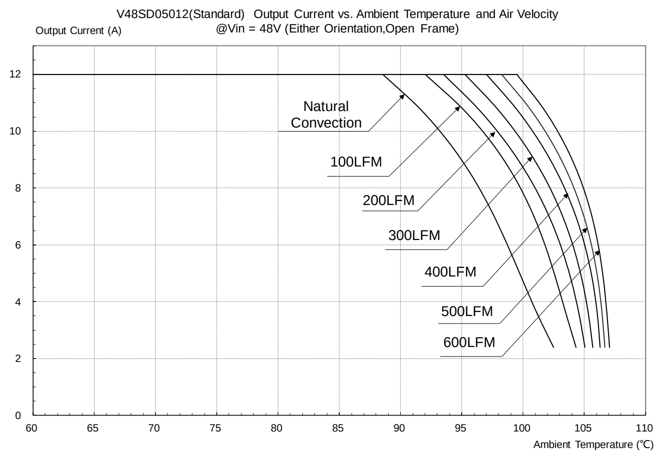


Figure 3: V48SD05012 Output current vs. ambient temperature and air velocity @V_{in}=48V (Either Orientation, Open Frame)

Thermal Curves (V48SD05012, With Heat Spreader)

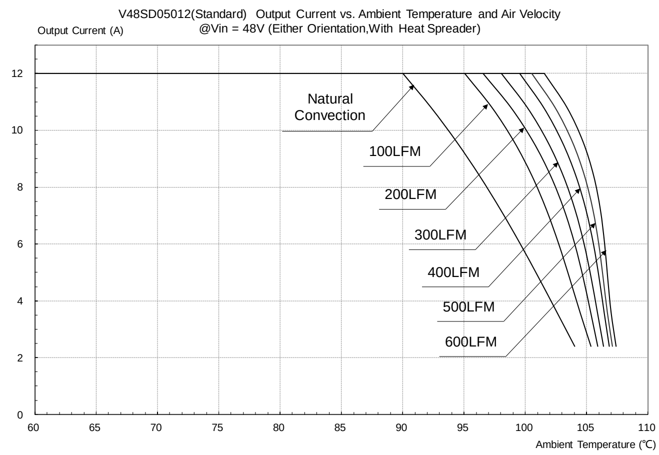


Figure 6: V48SD05012 Output current vs. ambient temperature and air velocity @V_{in}=48V (Either Orientation, With Heat Spreader)

Thermal Curves (V48SD12005, Open Frame)

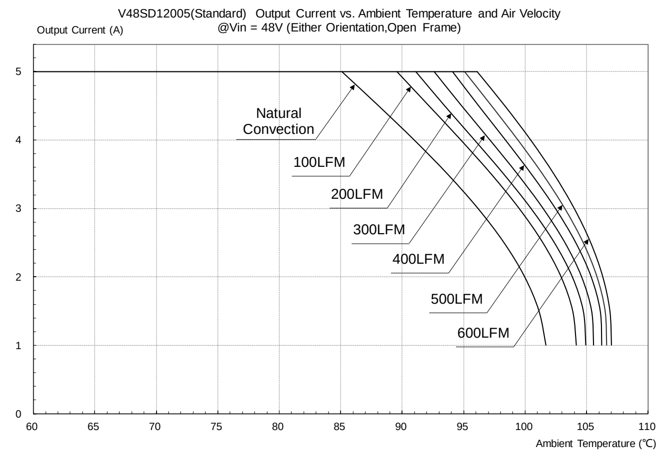


Figure 4: V48SD05012 Output current vs. ambient temperature and air velocity @V_{in}=48V (Either Orientation, Open Frame)

Thermal Curves (V48SD12005, With Heat Spreader)

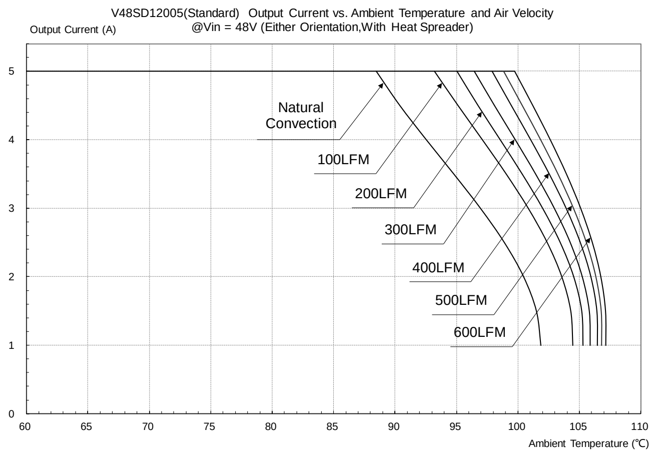


Figure 7: V48SD05012 Output current vs. ambient temperature and air velocity @V_{in}=48V (Either Orientation, With Heat Spreader)

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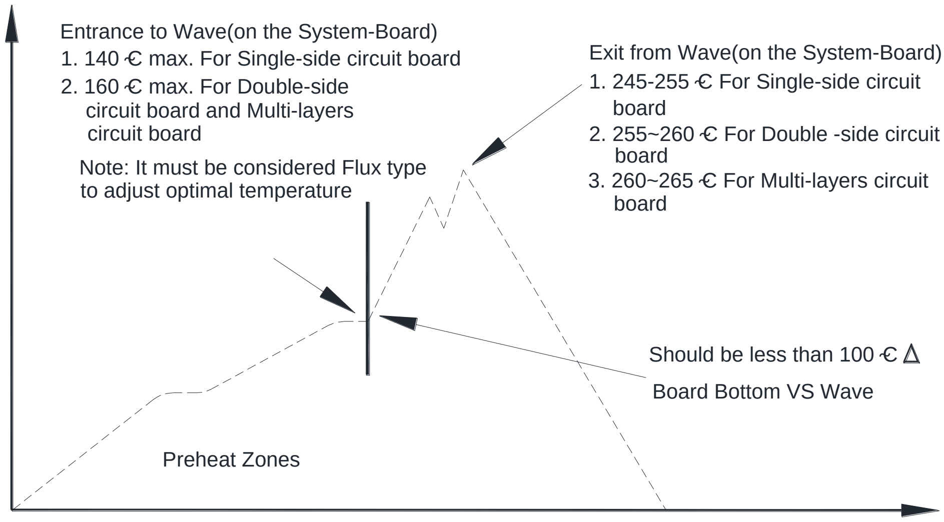
Soldering Method

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 the 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)

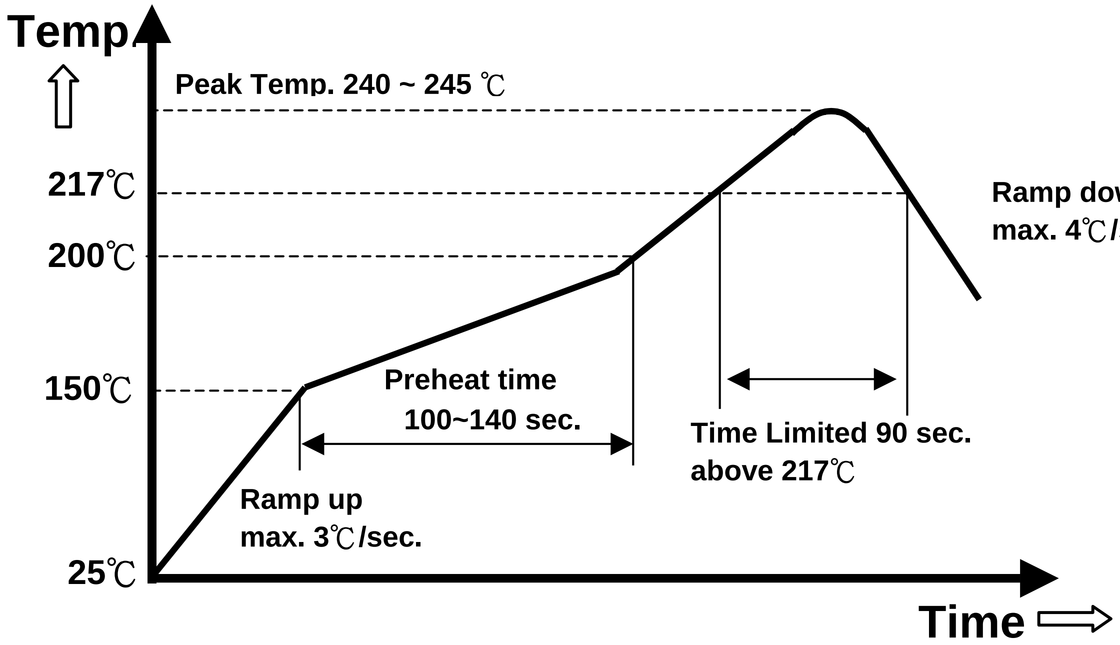
Hand soldering is the least preferred method because the amount of solder applied, the time the soldering iron is held on the joint, the temperature of the iron, and the temperature of the solder joint are variable. The recommended hand soldering guideline is listed in the below Table. The suggested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