V48SK05040

200W DC/DC Power Modules

Photo is for reference only

FEATURES

Electrical

- High efficiency: 94.5% @ 5V/40A
- Industry standard footprint and pinout
- Fixed frequency operation
- Input UVLO
- OTP
- Output OCP hiccup mode
- Monotonic startup into normal and pre-biased loads
- 2250V isolation and basic insulation
- No minimum load required

Mechanical

- Size (open frame): 33 x 22.8 x 10.8mm (1.30"x0.90"x0.43")
- Size (with baseplate): 33 x 22.8 x 12.7mm (1.30"x0.90"x0.50")

Safety & Reliability

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

OPTIONS

- Negative Or Positive remote On/Off
- Open frame or with heat spreader

SOLDERING METHOD

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

APPLICATIONS

- Networking
- Telecom
- Data center

MODEL LIST

MODEL NAME	INPUT		OUTPUT		EFF @ 100% LOAD
V48SK05040NRFH	36V~72V	6.3A	5V	40A	94.5% @ 48Vin

PART NUMBERING SYSTEM

V	48	S	K	050	40	N	R	F	H	F
Form Factor	Input Voltage	Number of Outputs	Product Series	Output Voltage	Output Current	ON/OFF Logic	Pin Length	Pin assignment	Option Code	Customer Specific
V - 1/16 Brick	48 - Vin=48V	S - Single	K - Series Number	050 - Vout=5V	40 - 40A	N - Negative P - Positive	N - 0.145" R - 0.170" M - SMD pin	F - RoHS 6/6 (Lead Free) Space - RoHS5/6	A - Open frame H - With Baseplate	F - Halogen Free R - Reflow (PIH)

TECHNICAL SPECIFICATIONS

(T_A=25°C, airflow rate=200 LFM, V_{in}=48Vdc, nominal Vout unless otherwise noted.)

PARAMETER	NOTES and CONDITIONS	V48SK05040 (Standard)			
		Min.	Typ.	Max.	Units
ABSOLUTE MAXIMUM RATINGS					
Input Voltage					Vdc
Continuous		0		72	Vdc
Transient (100ms)	100ms			75	Vdc
Vin step				10	V/ms
Operating Ambient Temperature		-40		85	°C
Storage Temperature		-55		125	°C
Input/Output Isolation Voltage				2250	Vdc
INPUT CHARACTERISTICS					
Operating Input Voltage		36	48	72	Vdc
Input Under-Voltage Lockout					
Turn-On Voltage Threshold		33		36	Vdc
Turn-Off Voltage Threshold		32		35	Vdc
Lockout Hysteresis Voltage		0.5	1	4	Vdc
Maximum Input Current	Full Load, 36Vin	4.5		6.5	A
No-Load Input Current	Vin=48V, Io=0A	60		180	mA
Off Converter Input Current	Vin=48V, Io=0A			10	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		40		dB
OUTPUT CHARACTERISTICS					
Output Voltage Set Point		4.925	5	5.075	Vdc
Output Regulation					
Over Load	Vin=48V,Io=Io, min to Io, max		±10		mV
Over Line			±10		mV
Over Temperature	Tc= -40°C to 85°C		±20		mV
Total Output Voltage Range	Over load, line and temperature	4.85		5.15	V
Output Voltage Ripple and Noise	20MHz bandwidth				
Peak-to-Peak	110µF ceramic, 100µF oscon,10µF tantalum	0		150	mV
RMS	110µF ceramic, 100µF oscon ,10µF tantalum	0		50	mV
Operating Output Current Range		0		40	A
Output Over Current Protection(hiccup mode)	Output Voltage 10% Low	44	52	58	A
DYNAMIC CHARACTERISTICS					
Output Voltage Current Transient	48Vin, 1mF OSCON, 10uF Tan & 1µF Ceramic load cap, 1A/µs				
Positive Step Change in Output Current	75% Io.max to 25% Io.max		200	360	mV
Negative Step Change in Output Current	25% Io.max to 75% Io.max		200	360	mV
Settling Time (within 1% Vout nominal)			200		µs
Turn-On Transient					
Start-Up Time, From On/Off Control		17	55	85	mS
Start-Up Time, From Input		17	55	85	mS
Output Capacitance	110µF ceramic;others cap:oscon cap	210		20000	µF
EFFICIENCY					
100% Load	Vin=48V		94		%
50% Load	Vin=48V		94		%
ISOLATION CHARACTERISTICS					
Input to Output				2250	Vdc
Isolation Resistance		100			MΩ
Isolation Capacitance			4700		pF
FEATURE CHARACTERISTICS					
Switching Frequency			300		KHz
ON/OFF Control, Negative Remote On/Off logic					
Logic Low (Module On)	Von/off			0.8	V
Logic High (Module Off)	Von/off	3.0		5	V
ON/OFF Control, Positive Remote On/Off logic					
Logic Low (Module Off)	Von/off			0.8	V
Logic High (Module On)	Von/off	3.0		5	V
ON/OFF Current (for both remote on/off logic)	Ion/off at Von/off=0.0V			1.5	mA
Leakage Current (for both remote on/off logic)	Logic High, Von/off=5V		5		uA
Output Voltage Trim Range	Pout ≦ max rated power,Io ≦ Io.max	80		110	%
Output Voltage Remote Sense Range				10	%
GENERAL SPECIFICATIONS					
MTBF	Io=80% of Io, max; Ta=25°C, airflow rate=300LFM		13.4		Mhours
Weight	Open frame		18.0		grams
Weight	With heat-spreader		24.0		grams
Over-Temperature Shutdown (Open frame)	Refer to Figure 18 for Hot spot 1's location (48Vin,80% Io, 200LFM,Airflow from Vin- to Vin+)		133		°C
Over-Temperature Shutdown (With heat spreader)	Refer to Figure 20 for Hot spot 2's location (48Vin,80% Io, 200LFM,Airflow from Vin- to Vin+)		133		°C
Over-Temperature Shutdown (NTC resistor)			130		°C

Note1: In the Glitch test,the minimum delay time between first turn off and second turn on is 200 ms.
Note2: Please attach thermocouple on NTC resistor to test OTP function, the hot spots' temperature is just for reference.

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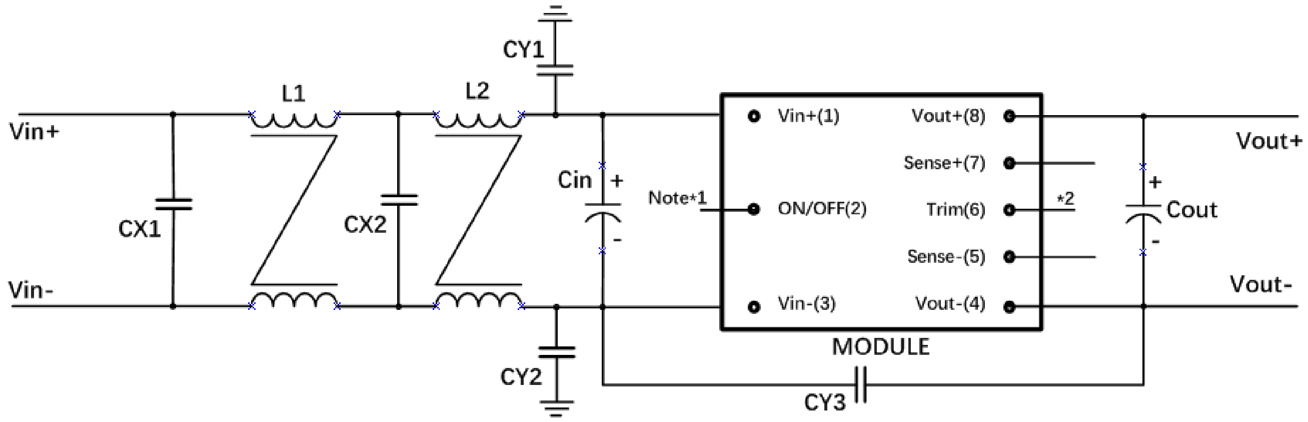
TYPICAL APPLICATION SCHEMATIC



***Note:**

1.Refer to page9 for On/off(pin2) implementation.

2.Refer to page9 for Trim(pin6) implementation.

Location	Vendor P/N	Description	Qty	Vendor	Purpose
Cin	EKZE101EC3221MK25S	CAP AL LD 100V 220uF M 12.5*25 P5	1	NCC	For stable operation
Cout	PLS1C101MDL4TD	CAP AL SP 16V 100uF M 6.3*10.5 TP P2.5	1	NICHICON	
	CL32B226KOJNFNE	CAP MC SMD 16V 22uF K X7R 1210	5	SAMSUNG	
CX1	B32923C3225M003	CAP X2 MP PC 305VAC 2.2uF M S22.5 THB4 26.5*14.5*29.5	1	TDK	For EMC
CX2	B32923C3225M003	CAP X2 MP PC 305VAC 2.2uF M S22.5 THB4 26.5*14.5*29.5	1	TDK	
CY1	YU1AH472M130D3EA0B	CAP Y1/X1 CD 400VAC 4700pF M E VI10	3	WALSIN	
CY2	YU1AH472M130D3EA0B	CAP Y1/X1 CD 400VAC 4700pF M E VI10	3	WALSIN	
CY3	B32021A3103M289	CAP Y2 MP 300VAC 0.01uF M TP P10	2	TDK	
L1	P0429NL	LINE FILTER 0.63mH +/-35% SMD	1	Pulse	
L2	PH9455.155NL	LINE FILTER 1.62mH +50%/-35% SMD	1	Pulse	

*The components for EMC purpose can be deleted if don't need the function.

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ELECTRICAL CHARACTERISTICS CURVES

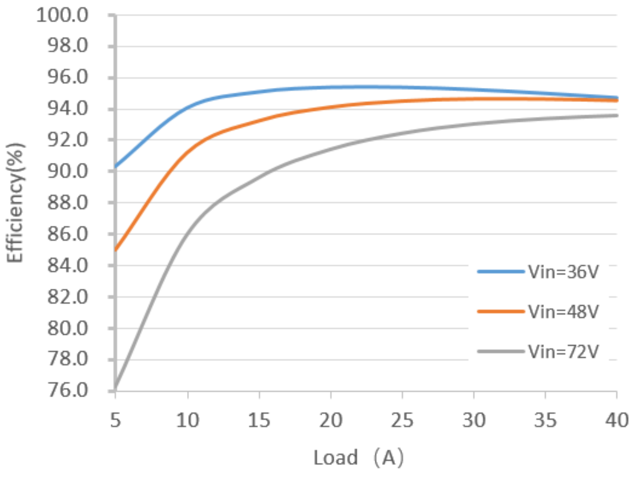

Figure 1: *Efficiency vs. load current for 36V, 48V, 53V and 72V input voltage at 25°C.*

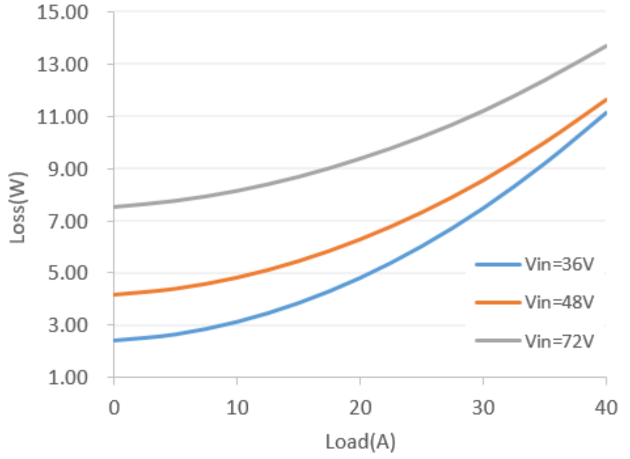

Figure 2: *Power dissipation vs. load current for 36V, 48V, 53V and 72V input voltage at 25°C.*

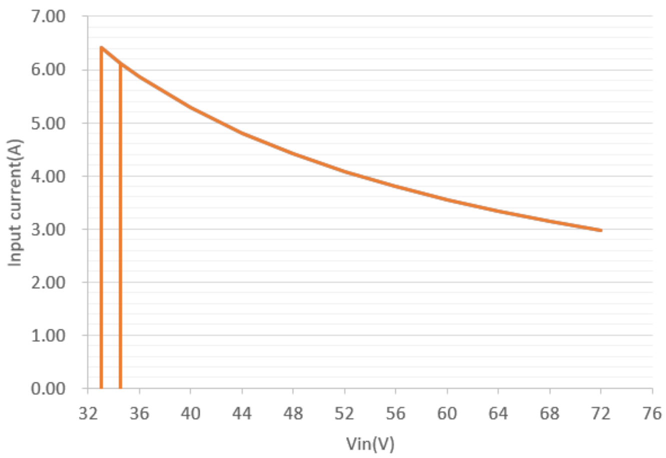

Figure 3: *Full load input characteristics at room temperature.*

ELECTRICAL CHARACTERISTICS CURVES

For Negative Remote On/Off Logic

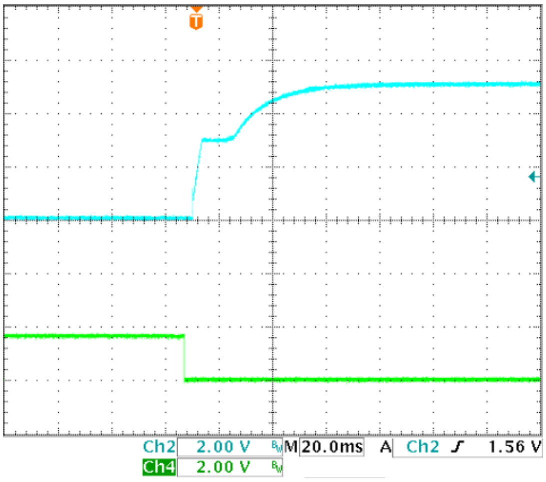

Figure 4: *Turn-on transient at zero load current (20ms/div). Vin=48V. Top Trace: Vout; 2V/div; Bottom Trace: ON/OFF input: 2V/div.*

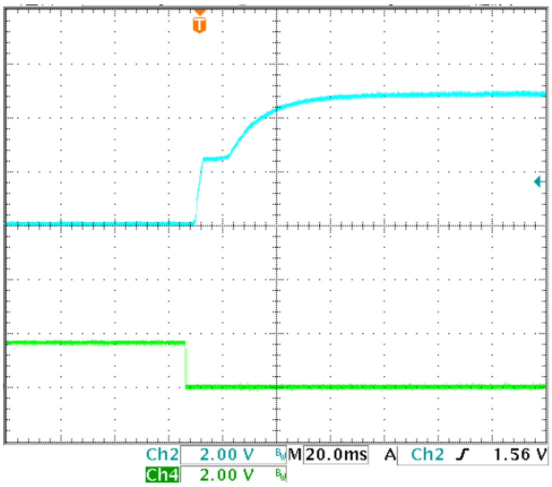

Figure 5: *Turn-on transient at full load current (20ms/div). Vin=48V. Top Trace: Vout: 2V/div; Bottom Trace: ON/OFF input: 2V/div.*

For Input Voltage Start up

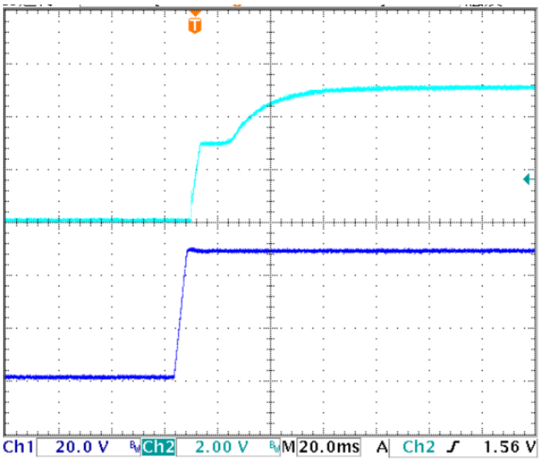

Figure 6: *Turn-on transient at zero load current (20 ms/div). Top Trace: Vout; 2V/div; Bottom Trace: input voltage: 20V/div*

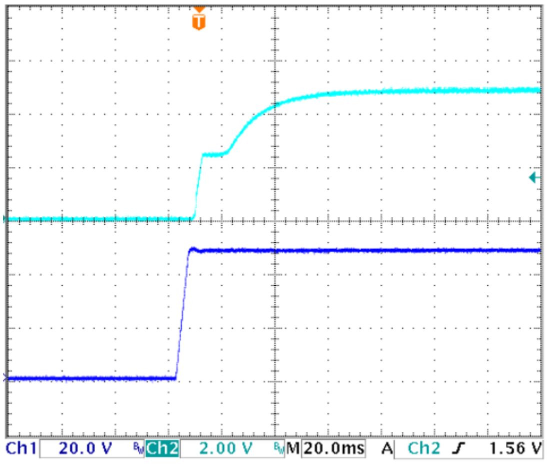

Figure 7: *Turn-on transient at full load current (20 ms/div). Top Trace: Vout; 2V/div; Bottom Trace: input voltage:20V/div.*

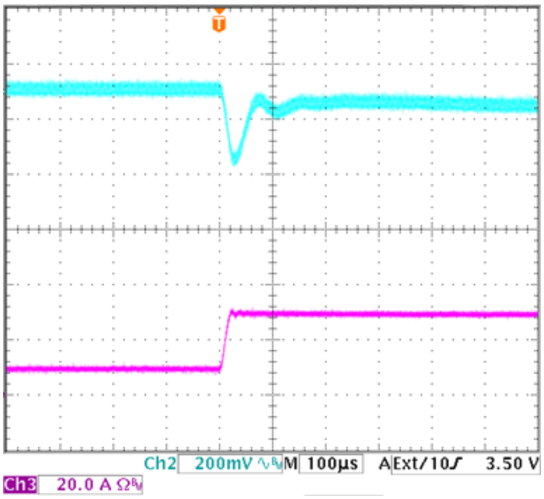

Figure 8: *Output voltage response to step-change in load current (25%-75% of Io, max; di/dt = 1A/µs; Vin=48V). Load cap: 1mF tantalum capacitor and 1µF ceramic capacitor. Top Trace: Vout (0.2V/div, 100us/div), Bottom Trace: Iout (20A/div). Scope measurement should be made using a BNC cable (length shorter than 20 inches). Position the load between 51 mm to 76 mm (2 inches to 3 inches) from the module*

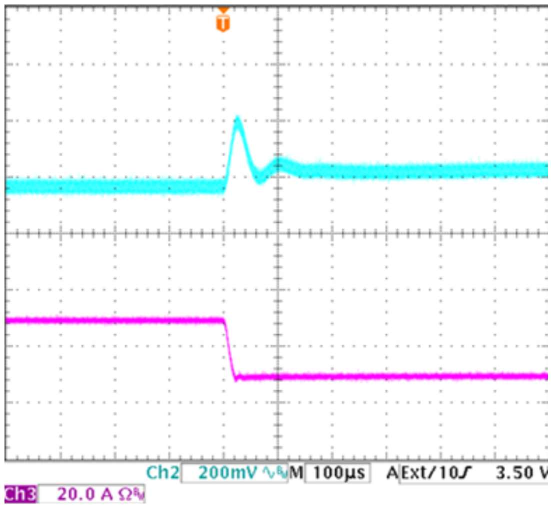

Figure 9: *Output voltage response to step-change in load current (75%-25% of Io, max; di/dt = 1A/µs; Vin=48V). Load cap: 1mF tantalum capacitor and 1µF ceramic capacitor. Top Trace: Vout (0.2V/div, 200us/div), Bottom Trace: Iout (20A/div). Scope measurement should be made using a BNC cable (length shorter than 20 inches). Position the load between 51 mm to 76 mm (2 inches to 3 inches) from the module*

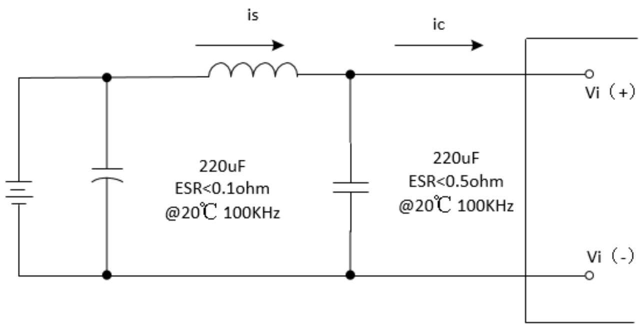

Figure 10: *Test set-up diagram showing measurement points for Input Terminal Ripple Current and Input Reflected Ripple Current.*
Note: Measured input reflected-ripple current with a simulated source Inductance (L_{TEST}) of 12 µH. Capacitor Cs offset possible battery impedance. Measure current as shown above.

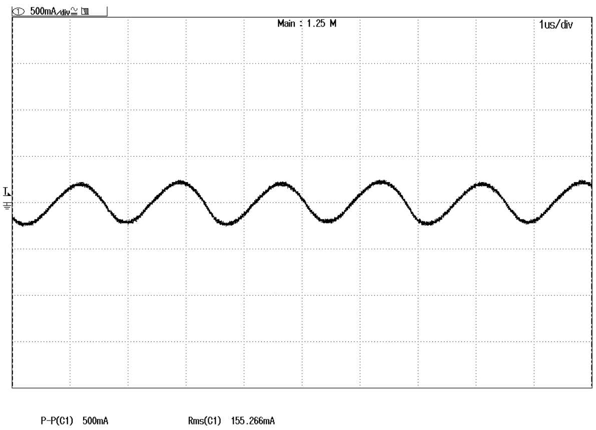

Figure 11: *Input Terminal Ripple Current, i_c, at max output current and nominal input voltage with 12µH source impedance and 220µF electrolytic capacitor (500 mA/div，1us/div).*

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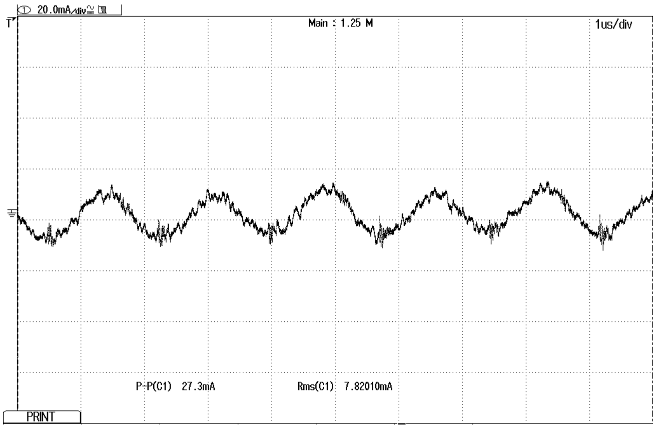


Figure 12: *Input reflected ripple current, i_s, through a 12µH source inductor at nominal input voltage and max load current (20mA/div，1us/div).*

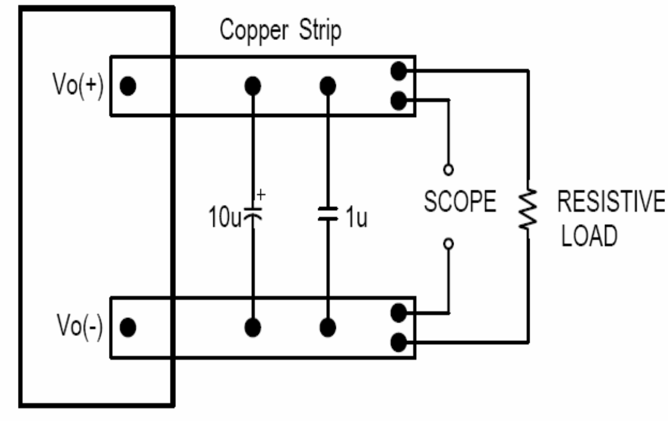


Figure 13: *Output voltage noise and ripple measurement test setup.*

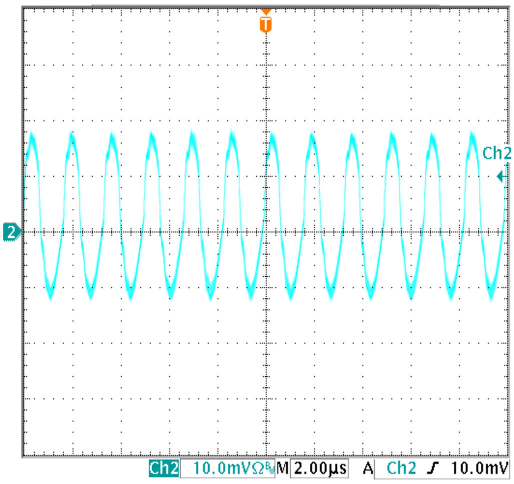


Figure 14: *Output voltage ripple at nominal input voltage and max load current (10 mV/div, 2us/div)*
Load capacitance: 100µF ceramic capacitor 100uF oscon capacitor and 10µF tantalum capacitor. Bandwidth: 20 MHz.

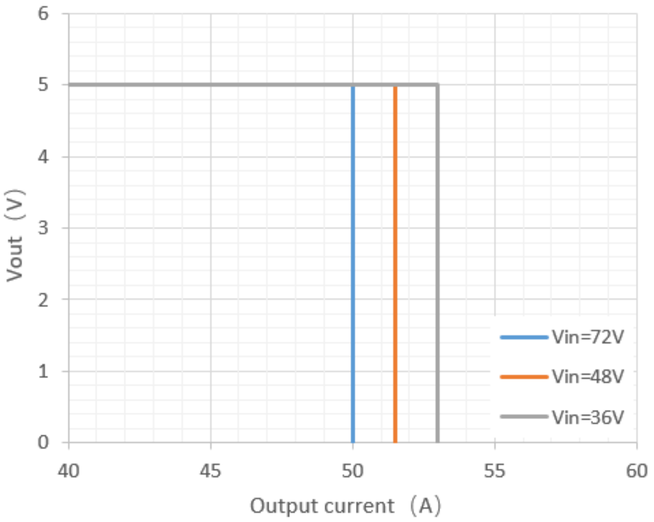


Figure 15: *Output voltage vs. load current showing typical current limit curves and converter shutdown points.*

DESIGN CONSIDERATIONS

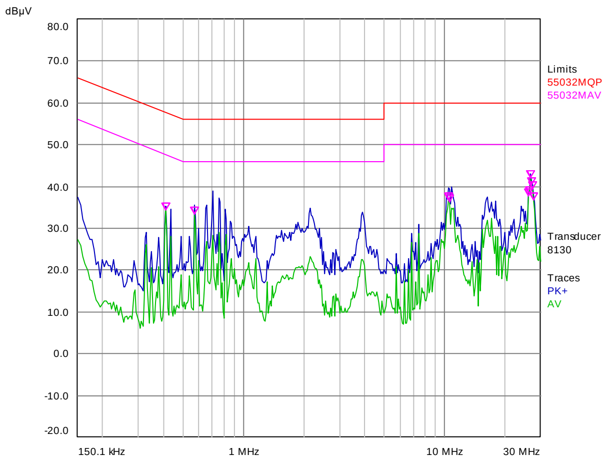
Input Source Impedance

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 V48SK05040 to meet class B in CISSPR 22. Refer to page 3 Typical Application schematic .

Test Result: Vin=48V,Io=40A.



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, if the system in which the power module is to be used must meet safety agency requirements.

The power module has basic insulation between DC input to DC output with 2250Vdc isolation and is not designed for the ordinary person accessible.
DC input is considered as ES2, basic safeguard shall be provided between ES2 and MAINS.

Heat spreader is considered as floating, the additional consideration is required during end-use application where the higher grade of isolation is required.

The power module has been evaluated and tested in the combination with external fuse, rated 20A/100Vdc from Littelfuse type 456 series during the safety abnormal test. The need for repeating these tests in the end-use application shall be considered if installed with a higher rated protective device.

The output is classified as ES1, the need for evaluate end-use application shall be considered if on the system where the module is used, in combination with the module, to ensure that under a single fault, the output voltage does not exceed ES1 limit.

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.

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 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 (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-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.

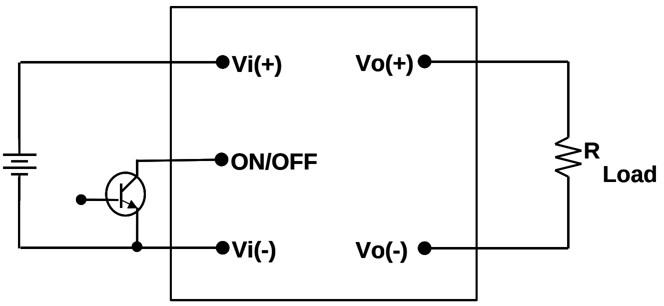


Figure 16: *Remote on/off implementation*

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:

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

Ex. When Trim-down -20% (5.0V×0.8=4.0V)

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

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

$$R_{\text{trim-up}} = \left[\frac{5.11Vo*(100+\Delta)}{1.225*\Delta} - \frac{511}{\Delta} - 10.22\right](K\Omega)$$

Ex. When Trim-up +10% (5.0V×1.1=5.5V)

$$R_{\text{trim-up}} = \left[\frac{5.11Vo*(100+10)}{1.225*10} - \frac{511}{10} - 10.22\right](K\Omega) = 168(K\Omega)$$

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

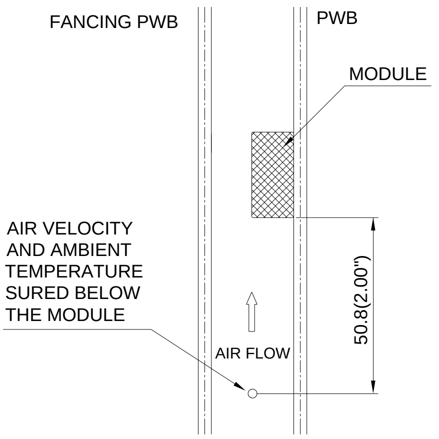
Thermal management is an important part of the system design. To ensure proper, reliable operation, sufficient cooling of the power module is needed over the entire temperature range of the module. Convection cooling is usually the dominant mode of heat transfer.

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 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 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 (OPEN FRAME)

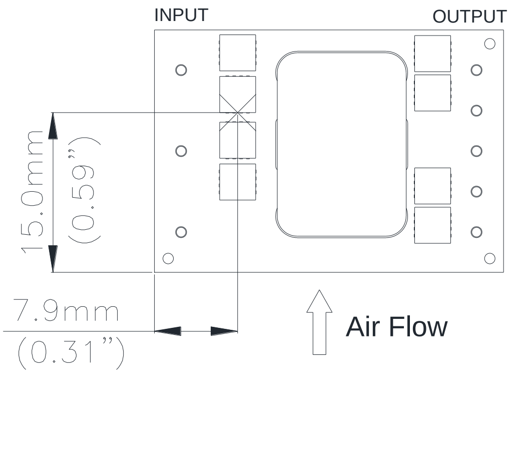


Figure 18: ** Hot spot 1's temperature measured point.*
The allowed maximum hot spot's temperature is defined at 120℃.

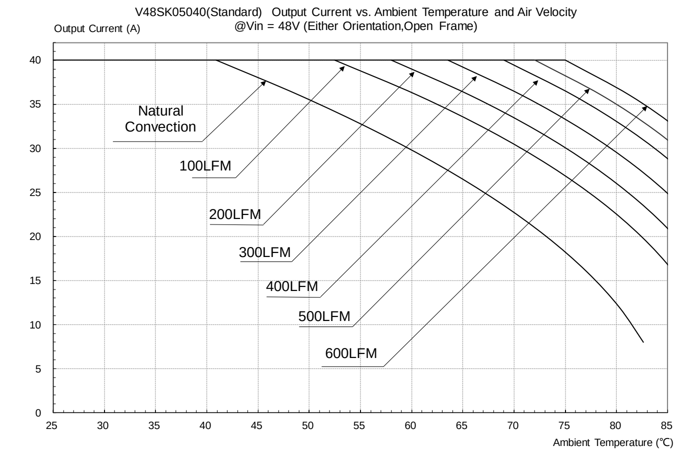


Figure 19: *Output current vs. ambient temperature and air velocity @Vin=48V(Either orientation, open frame)*

THERMAL CURVES (WITH HEAT SPREADER)

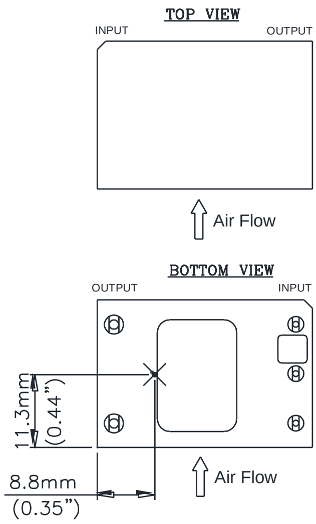


Figure 20: ** Hot spot 2's temperature measured point.*
The allowed maximum hot spot's temperature is defined at 120℃.

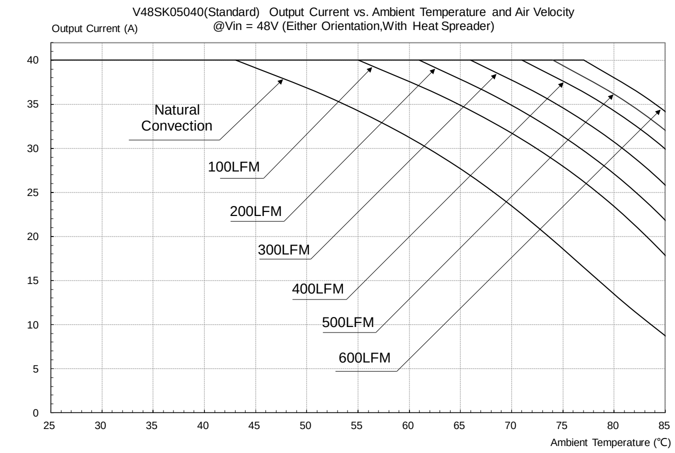


Figure 21: *Output current vs. ambient temperature and air velocity @Vin=48V(Either orientation, with heat spreader)*

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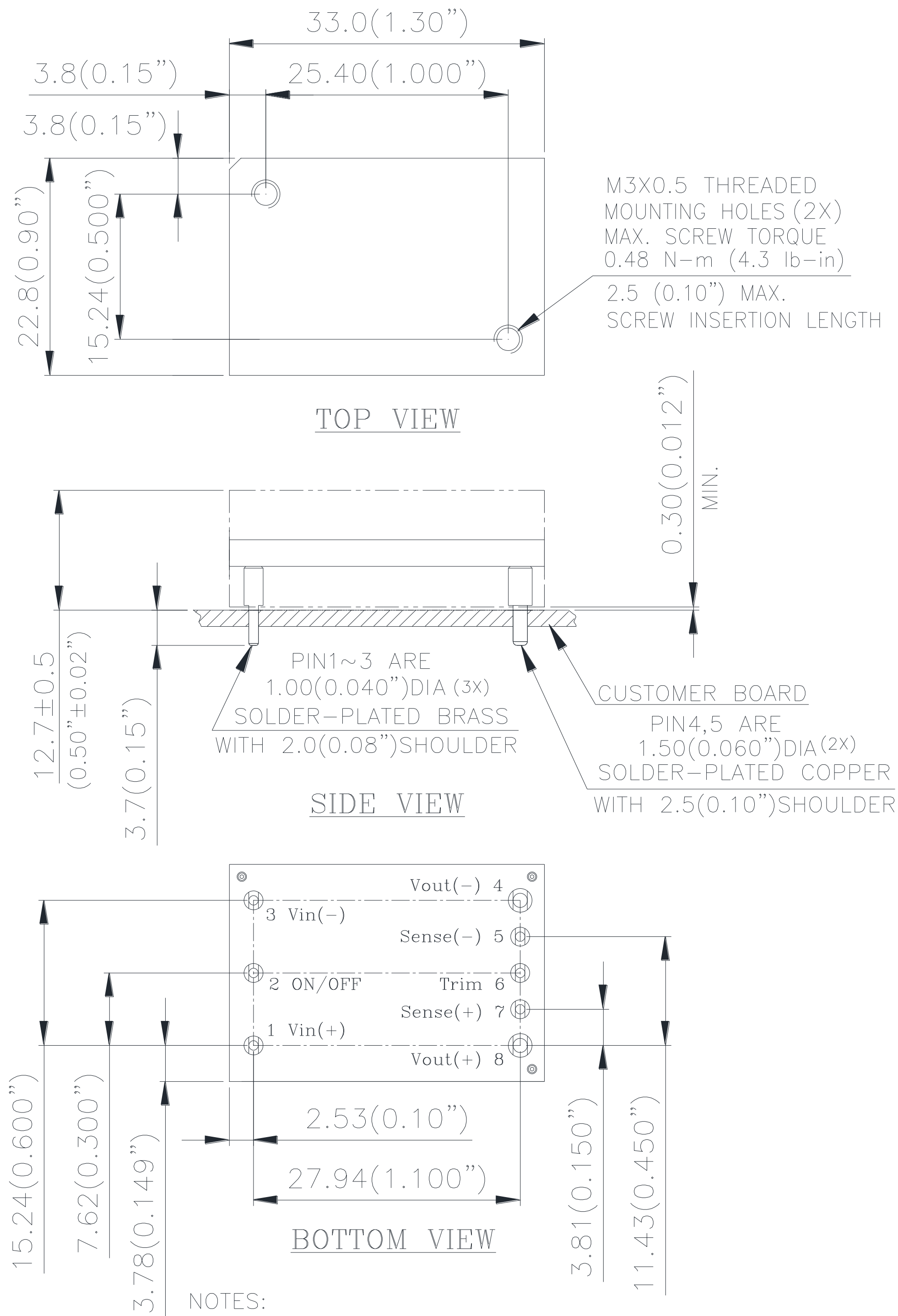
MECHANICAL DRAWING (WITH HEAT-SPREADER)

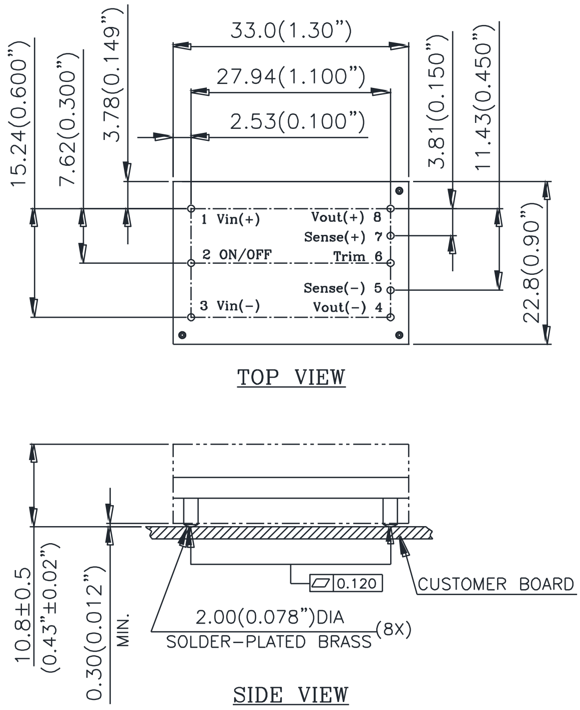
Through-hole module



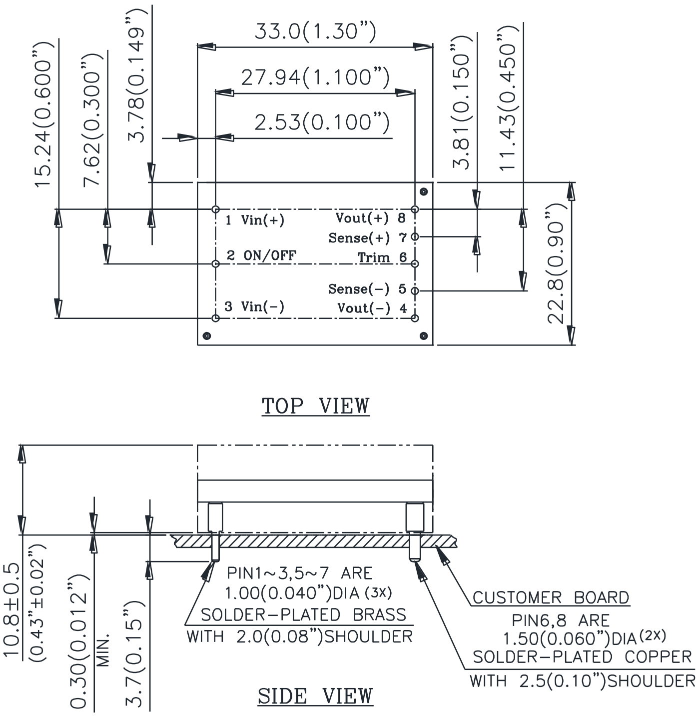
NOTES:
DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
X.XXmm±0.25mm(X.XXX in.±0.010 in.)

MECHANICAL DRAWING (OPEN FRAME)

Surface-mount module



Through-hole module

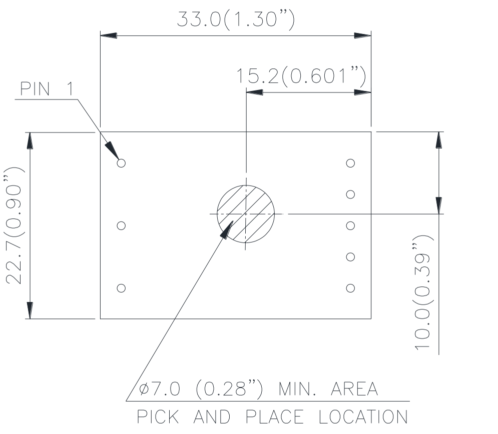


NOTES:
DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
X.XXmm±0.25mm(X.XXX in.±0.010 in.)

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

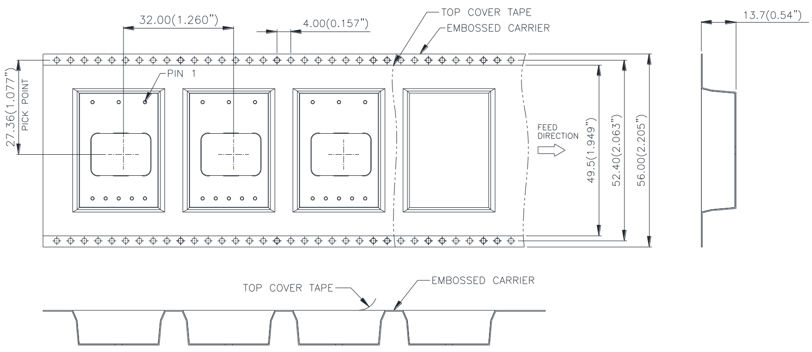
Note: All pins are copper alloy with matte Tin(Pb free) plated over Nickel under plating.

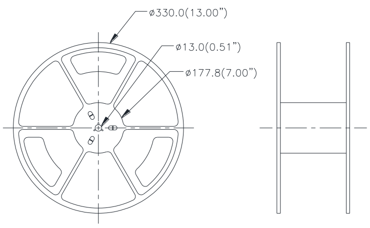
PICK AND PLACE LOCATION(SMD)



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.)

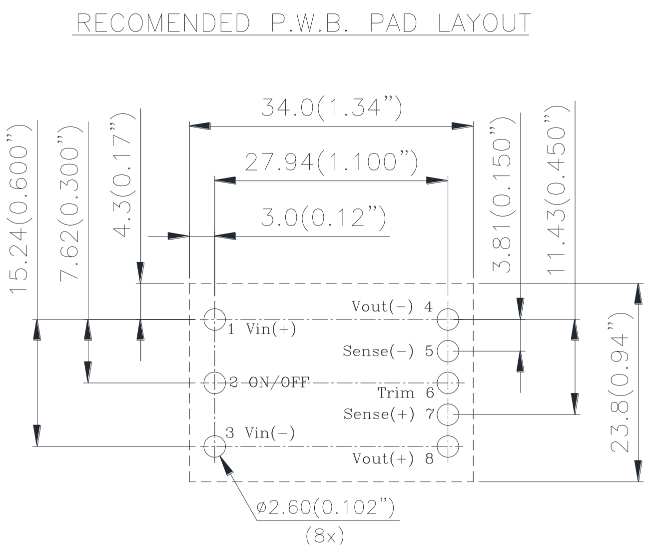
SURFACE-MOUNT TAPE & REEL (SMD)



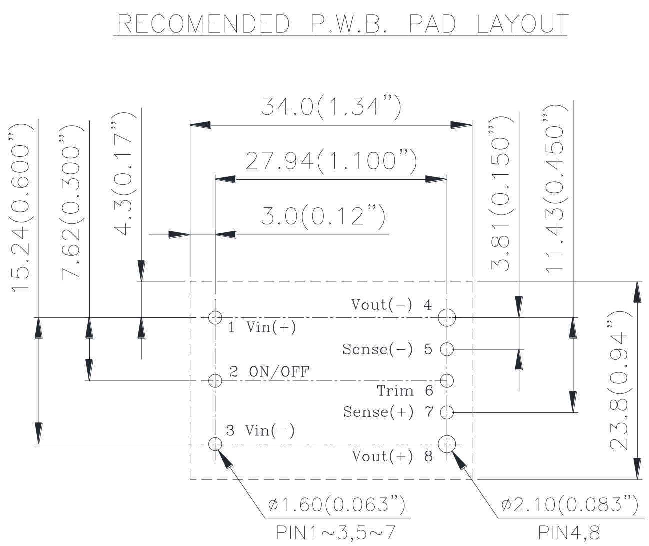


NOTES:
CONFORMS TO EIA-481 SATNDARD
MODULES ARE SHIPPED IN QUANTITIES OF 100 PER REEL.
ALL DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
X.XXmm±0.25mm(X.XXX in.±0.010 in.)

RECOMMENDED PAD LAYOUT(SMD)



RECOMMENDED PAD LAYOUT (THROUGH-HOLE MODULE)



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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.

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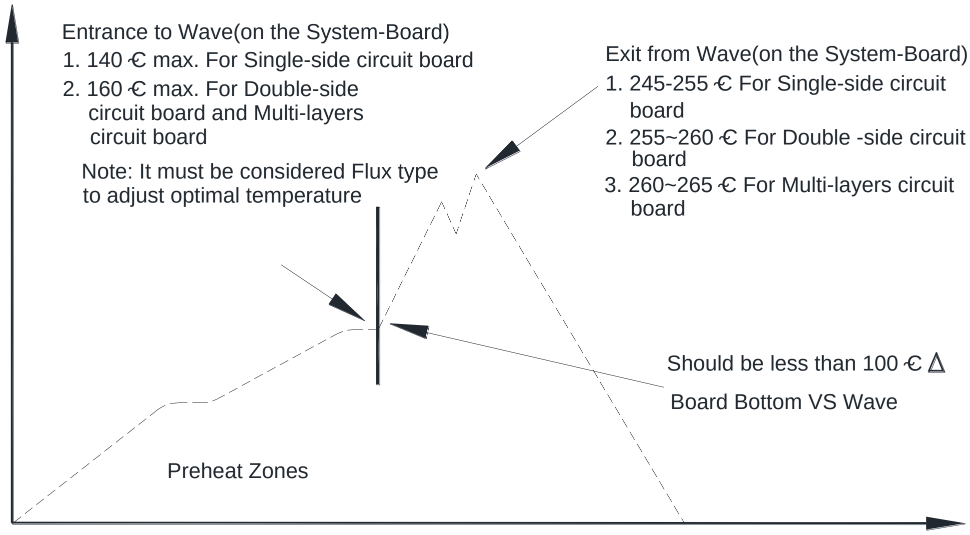
Wave Soldering (Lead-free)

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)

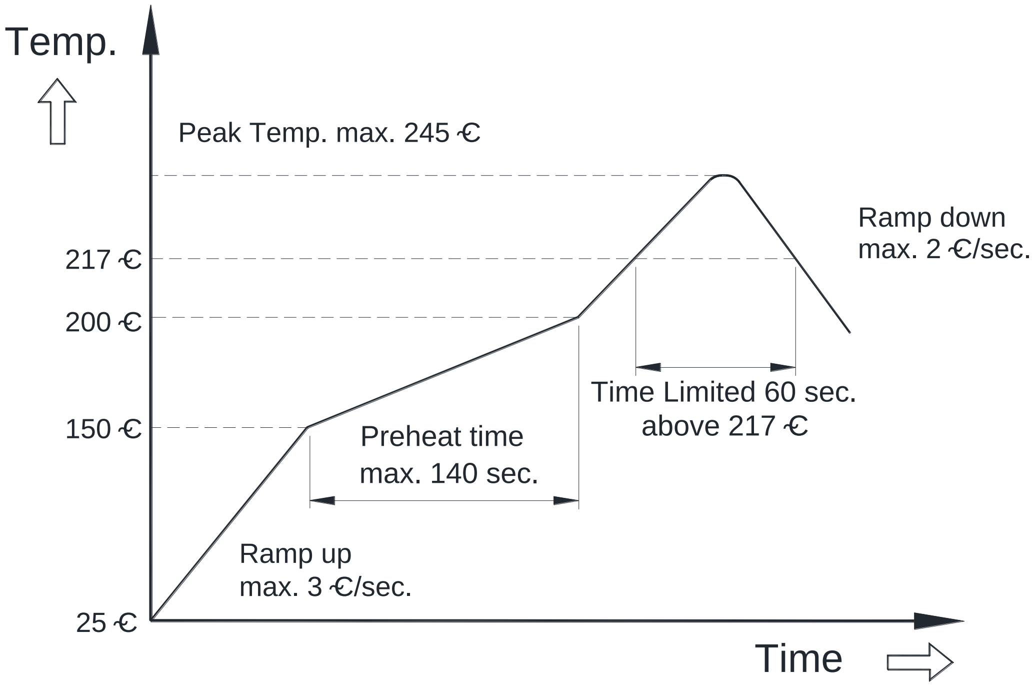
Hand soldering is the least preferred method because the amount of solder applied, the time the soldering iron is held on the joint, the temperature of the iron, and the temperature of the solder joint are variable. The recommended hand soldering guideline is listed in below Table. The suggested soldering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

Table 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 60seconds, and the cooling down rate should less than 2℃/minute. Please refer below for recommended temperature profile parameters.



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

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WARRANTY

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