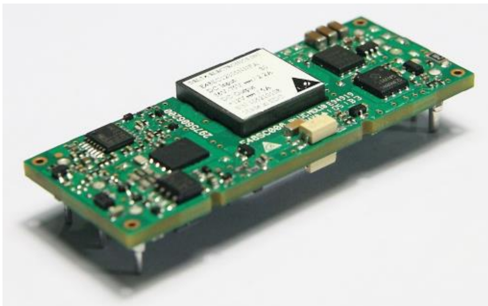
DELPHI SERIES



FEATURES

- High efficiency: 92% @ 12V/5A
- Size: 58.4mmx22.8mmx8.4mm (2.30"x0.90"x0.33")
- Standard footprint
- Industry standard pin out
- Fixed frequency operation
- Input UVLO, Output OCP, OVP, OTP
- 2250V isolation
- Basic insulation
- No minimum load required
- ISO 9001, TL 9000, ISO 14001, QS 9000, OHSAS 18001 certified manufacturing facility
- IEC/EN/UL/CSA62368-1, 2nd edition

Delphi Series E48SC12005, Eighth Brick Family DC/DC Power Modules: 48V in, 12V/5A out

The Delphi Series E48SC12005, Eighth Brick, 48V input, single output, isolated DC/DC converter is the latest offering from a world leader in power systems technology and manufacturing -- Delta Electronics, Inc. This product family provides up to 60 watts, improved and very cost effective power solution of industry standard footprint and pinout. 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. All models are fully protected from abnormal input/output voltage, current, and temperature conditions. The Delphi Series converters meet all safety requirements with basic insulation.

OPTIONS

- Positive on/off logic
- SMT or through-hole version

Soldering Method

- Wave soldering
- Hand soldering
- Reflow soldering (MSL3)

APPLICATIONS

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

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	E48SC12005 (Standard)			
		Min.	Typ.	Max.	Units
ABSOLUTE MAXIMUM RATINGS					
Input Voltage					
Continuous				80	Vdc
Transient	100ms			100	Vdc
Operating Hot Spot Temperature	Refer to Figure 19 for measuring point	-40		117	°C
Storage Temperature		-55		125	°C
Input/Output Isolation Voltage				2250	Vdc
INPUT CHARACTERISTICS					
Operating Input Voltage		36		75	Vdc
Input Under-Voltage Lockout					
Turn-On Voltage Threshold		33	34	35	Vdc
Turn-Off Voltage Threshold		31	32	33	Vdc
Lockout Hysteresis Voltage		1	2	3	Vdc
Maximum Input Current	100% Load, 36Vin			2.2	A
No-Load Input Current			70		mA
Off Converter Input Current			5		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		60		dB
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	Vin=48V, Io=Io.max, Tc=25°C	11.88	12.00	12.12	Vdc
Output Voltage Regulation					
Over Load	Io=Io,min to Io,max		±3	±15	mV
Over Line	Vin= 36V to 75V		±3	±15	mV
Over Temperature	Tc= -40°C to 85°C			±100	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	Full Load, 1µF ceramic, 10µF tantalum		40	120	mV
RMS	Full Load, 1µF ceramic, 10µF tantalum		15	25	mV
Operating Output Current Range		0		5	A
Output DC Current-Limit Inception	Output Voltage 10% Low	110		140	%
DYNAMIC CHARACTERISTICS					
Output Voltage Current Transient	48V, 10µF Tan & 1µF Ceramic load cap, 0.1A/µs				
Positive Step Change in Output Current	25% Io.max to 50% Io.max		200		mV
Negative Step Change in Output Current	50% Io.max to 25% Io.max		200		mV
Settling Time (within 1% Vout nominal)			200		µs
Turn-On Transient					
Start-Up Time, From On/Off Control			30		ms
Start-Up Time, From Input			40		ms
Maximum Output Capacitance	Full load; 5% overshoot of Vout at startup			2000	µF
EFFICIENCY					
100% Load	48Vin		92.0		%
60% Load	48Vin		90.5		%
ISOLATION CHARACTERISTICS					
Input to Output				2250	Vdc
Isolation Resistance		10			MΩ
Isolation Capacitance			3000		pF
FEATURE CHARACTERISTICS					
Switching Frequency			350		kHz
ON/OFF Control, Negative Remote On/Off logic					
Logic Low (Module On)	Von/off at Ion/off=1.0mA	-0.7		0.8	V
Logic High (Module Off)	Von/off at Ion/off=0.0 µA	3.5		12	V
ON/OFF Control, Positive Remote On/Off logic					
Logic Low (Module Off)	Von/off at Ion/off=1.0mA	-0.7		0.8	V
Logic High (Module On)	Von/off at Ion/off=0.0 µA	3.5		12	V
ON/OFF Current (for both remote on/off logic)	Ion/off at Von/off=0.0V			1	mA
Leakage Current (for both remote on/off logic)	Logic High, Von/off=12V			50	µA
Output Voltage Trim Range	Pout ≦ max rated power	-20%		10%	%
Output Voltage Remote Sense Range	Pout ≦ max rated power			10	%
Output Over-Voltage Protection	Over full temperature range	13.8	15.3	18	V
GENERAL SPECIFICATIONS					
MTBF	48V,Io=Io, max; 300LFM @25C		4.5		M hours
Weight			21		grams
Over-Temperature Shutdown	Refer to Figure 19 for measuring point		131		°C

ELECTRICAL CHARACTERISTICS CURVES

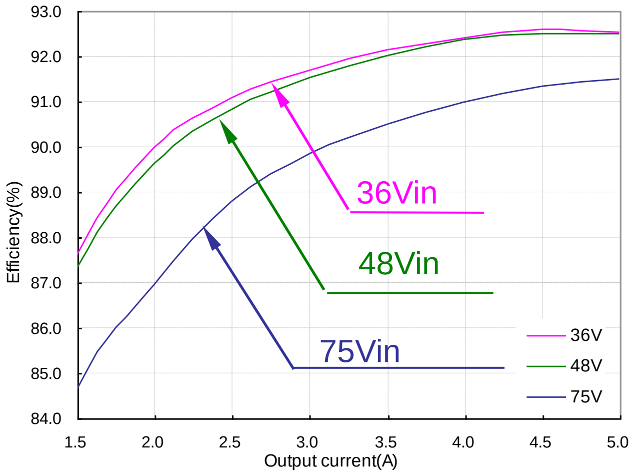


Figure 1: *Efficiency vs. load current for 5A, minimum, nominal, and maximum input voltage at 25°C*

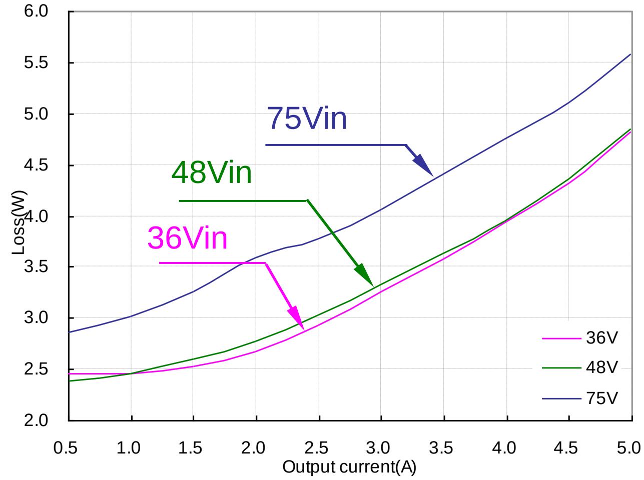


Figure 2: *Power dissipation vs. load current for 5A, minimum, nominal, and maximum input voltage at 25°C.*

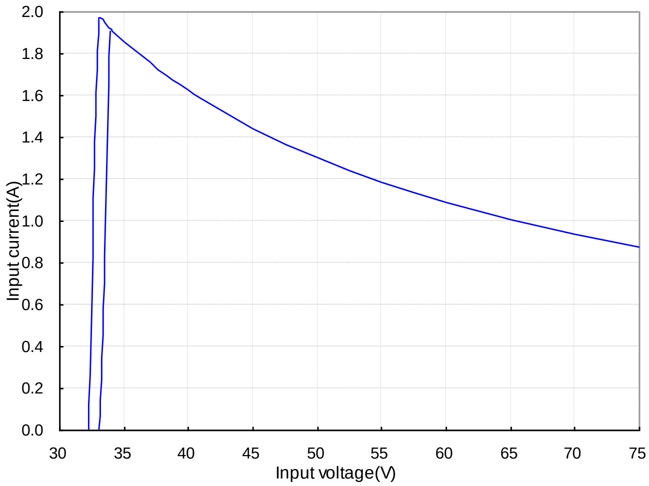


Figure 3: *Typical full load input characteristics at room temperature*

ELECTRICAL CHARACTERISTICS CURVES

For Negative Remote On/Off Logic

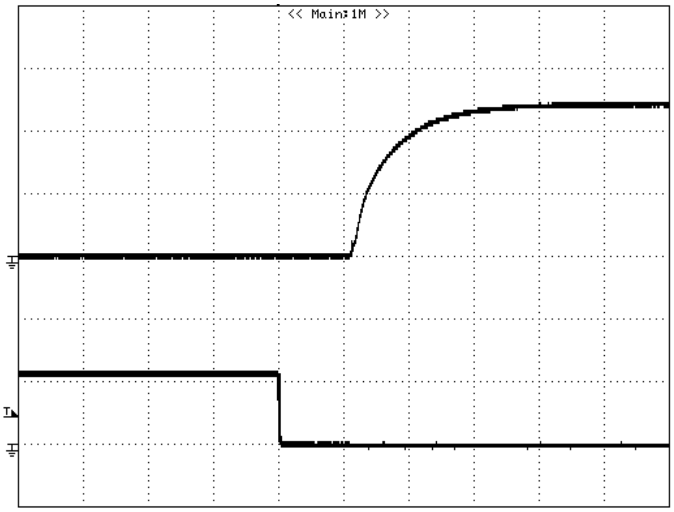


Figure 4: *Turn-on transient at full rated load current (CC Mode load) (10ms/div). Vin=48V.Top Trace: Vout, 5V/div; Bottom Trace: ON/OFF input, 5V/div*

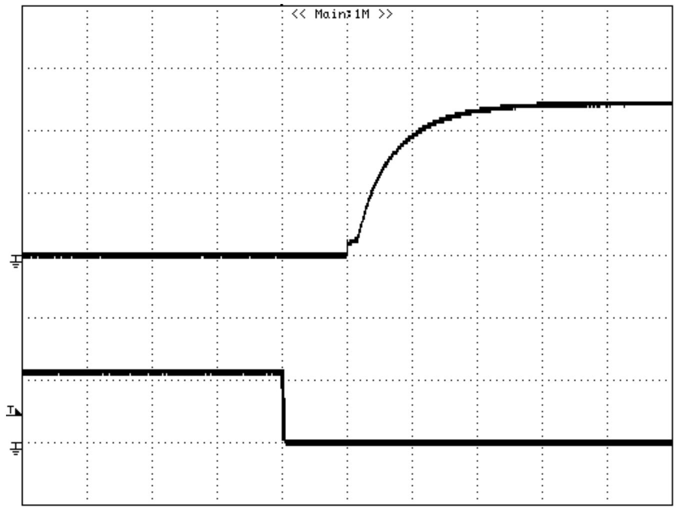


Figure 5: *Turn-on transient at zero load current (10ms/div). Vin=48V.Top Trace: Vout, 5V/div; Bottom Trace: ON/OFF input, 5V/div*

ELECTRICAL CHARACTERISTICS CURVES

Figure 6: *Output voltage response to step-change in load current (50%-25%-50% of Io, max; di/dt = 0.1A/µs). Load cap: 10µF, tantalum capacitor and 1µF ceramic capacitor. Top Trace: Vout (200mV/div, 500us/div), Bottom Trace: I out (2A/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 7: *Output voltage response to step-change in load current (50%-25%-50% of Io, max; di/dt = 2.5A/µs). Load cap: 10µF, tantalum capacitor and 1µF ceramic capacitor. Top Trace: Vout (200mV/div, 500us/div), Bottom Trace: I out (2A/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*

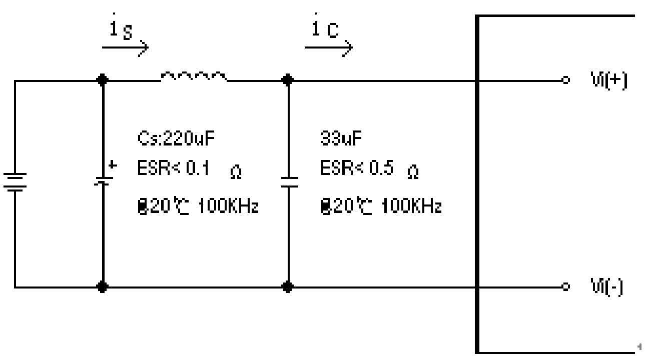


Figure 8: *Test set-up diagram showing measurement points for Input Terminal Ripple Current and Input Reflected Ripple Current.*
Note: Measured input reflected-ripple current with a simulated source Inductance (L_{TEST}) of 12µH. Capacitor Cs offset possible battery impedance. Measure current as shown above

ELECTRICAL CHARACTERISTICS CURVES

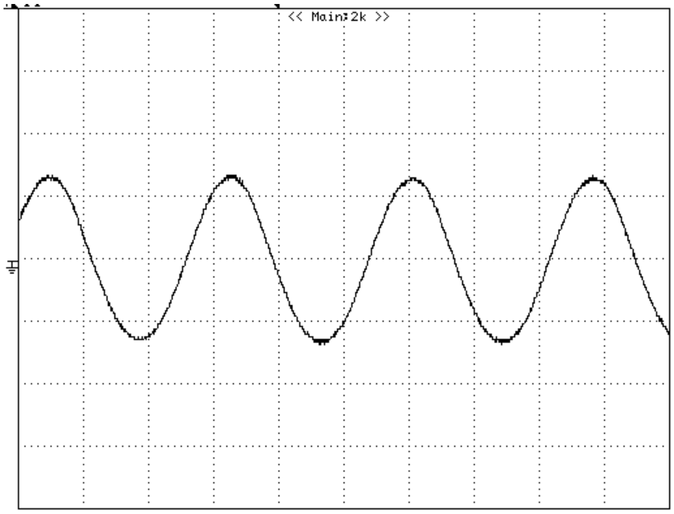


Figure 9: *Input Terminal Ripple Current, i_c, at full rated output current and nominal input voltage with 12µH source impedance and 33µF electrolytic capacitor (100mA/div,1us/div)*

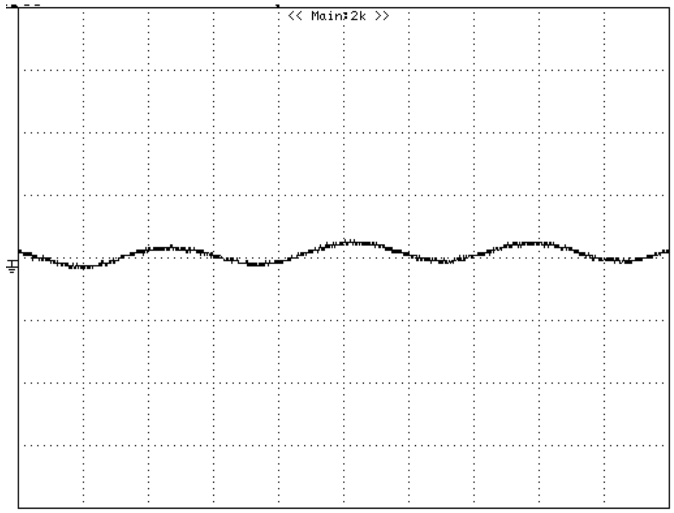


Figure 10: *Input reflected ripple current, i_s, through a 12µH source inductor at nominal input voltage and rated load current (20mA/div,1us/div)*

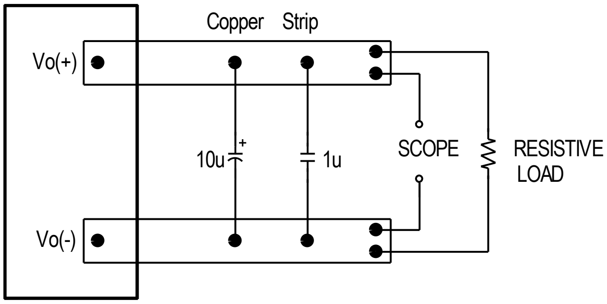
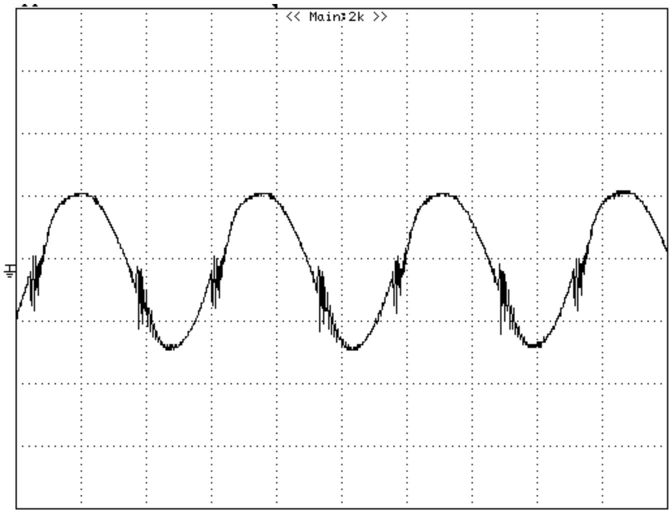


Figure 11: *Output voltage noise and ripple measurement test setup*

ELECTRICAL CHARACTERISTICS CURVES



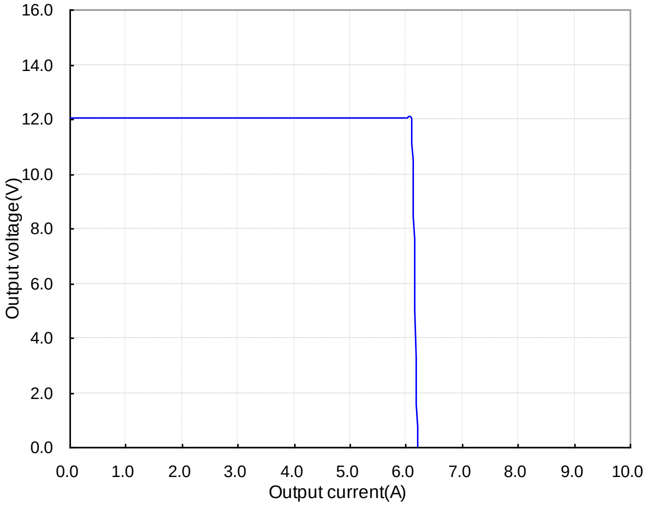


Figure 12: *Output voltage ripple at nominal input voltage and rated load current (Io=5A)(20mV/div,1us/div)*
Load capacitance: 1µF ceramic capacitor and 10µF tantalum capacitor. Bandwidth: 20 MHz. Scope measurements should be made using a BNC cable (length shorter than 20 inches). Position the load between 51 mm to 76 mm (2 inches to 3 inches) from the module

Figure 13: *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 adding a 10 to 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. Application notes to assist designers in addressing these issues are pending release.

Safety Considerations

The power module must be installed in compliance with the spacing and separation requirements of the 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.

This product is provided with basic insulation between DC input and DC output with 2250Vdc isolation.

DC input is considered as ES2, basic safeguard shall be provided between ES2 and MAINS.

This product is not designed for the ordinary person accessible.

The DC 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.

This product has been evaluated and tested in the combination with a supplementary external fast-acting fuse in parallel, rated 10A/100Vdc from littlefuse 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 or difference type of protective device.
When installed into a Class II equipment (without grounding), spacing consideration should be given to the end-use application, as the spacing between this product 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 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 (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 module will shut down (hiccup mode)。

The modules 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.

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 if 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.

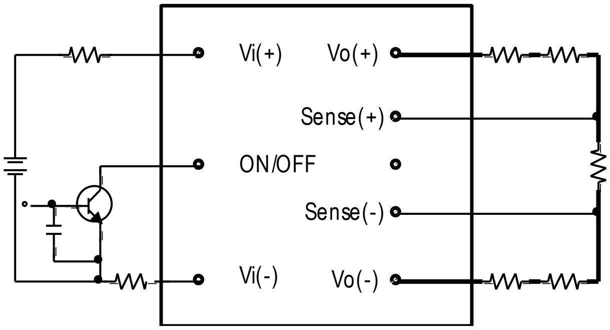


Figure 14: *Remote on/off implementation*

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).

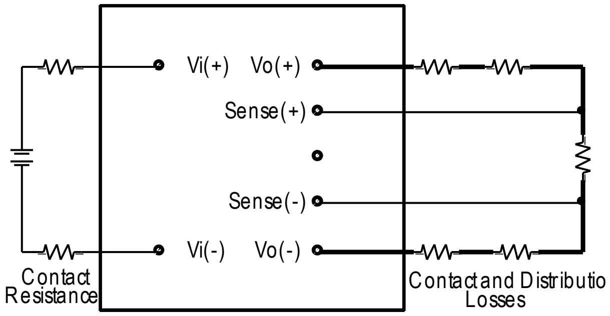


Figure 15: *Effective circuit configuration for remote sense operation*

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.

Care should be taken to ensure that the maximum output power does not exceed the maximum rated power.

FEATURES DESCRIPTIONS (CON.)

Output Voltage Adjustment (TRIM)

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

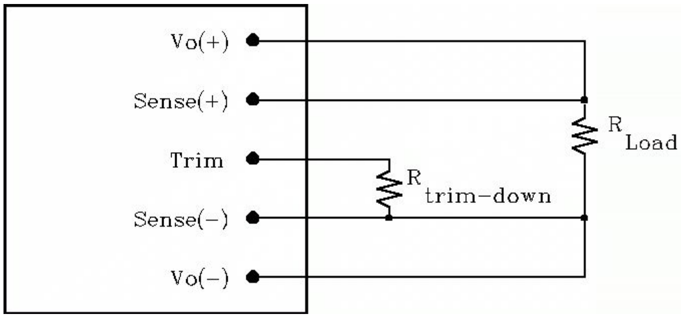


Figure 16: *Circuit configuration for trim-down (decrease output voltage)*

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

$$Rtrim-down=\frac{511}{\Delta}-10.2(K\Omega)$$

Ex. When Trim-down -20%(12V×0.8=9.6V)

$$Rtrim-down=\frac{511}{20}-10.2=15.4(K\Omega)$$

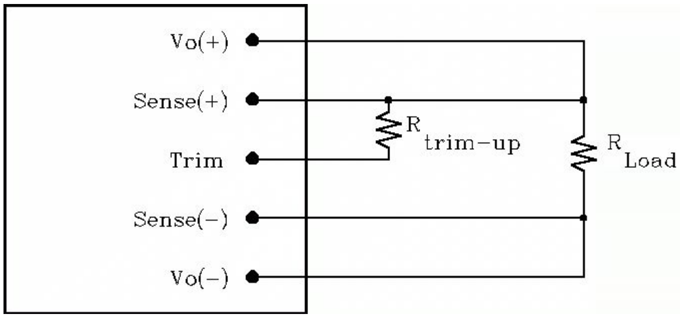


Figure 17: *Circuit configuration for trim-up (increase output voltage)*

If the external resistor is connected between the TRIM and SENSE (+) the output voltage set point increases (Fig. 17). The external resistor value required to obtain a percentage output voltage change △% is defined as:

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

Ex. When Trim-up +10%(12V×1.1=13.2V)

$$Rtrim-up=\frac{5.11\times12\times(100+10)}{1.225\times10}-\frac{511}{10}-10.2=489.329(K\Omega)$$

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

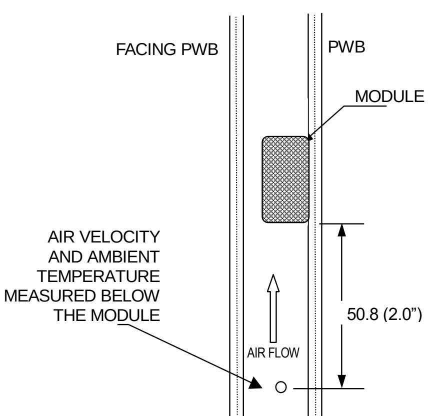
Thermal management is an important part of the system design. To ensure proper, reliable operation, sufficient cooling of the power module is needed over the entire temperature range of the module. Convection cooling is usually the dominant mode of heat transfer.

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 18: *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

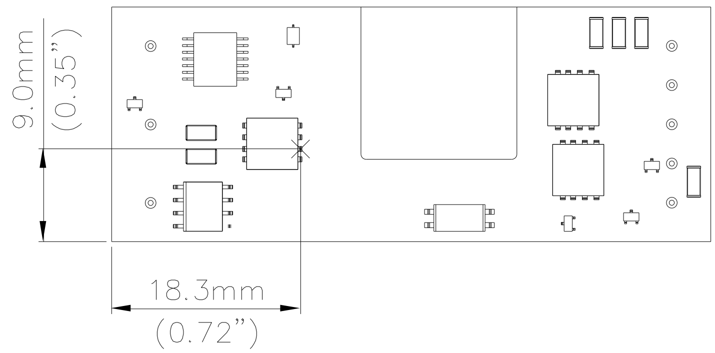


Figure 19: *Hot spot temperature measured point.*
∗The allowed maximum hot spot temperature is defined at 117℃

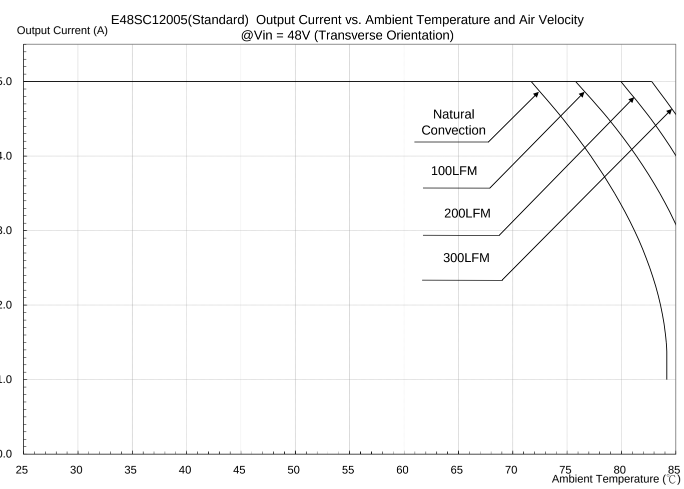
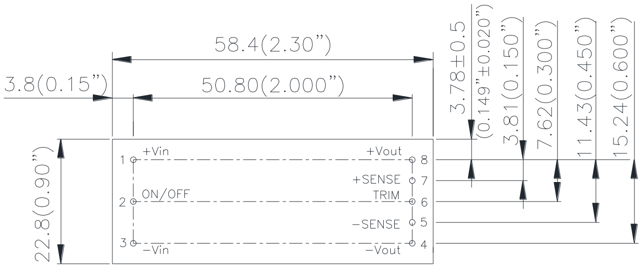


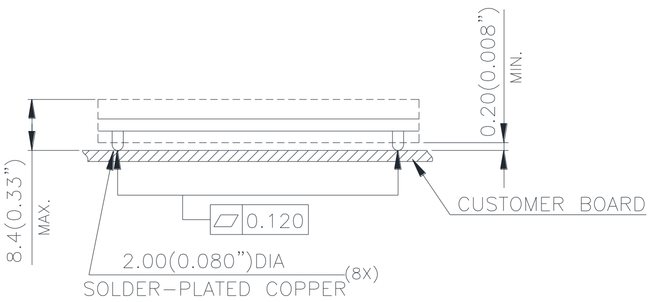
Figure 20: *Output current vs. ambient temperature and air velocity @ V_{in}=48V(Transverse Orientation)*

MECHANICAL DRAWING

Surface-mount module

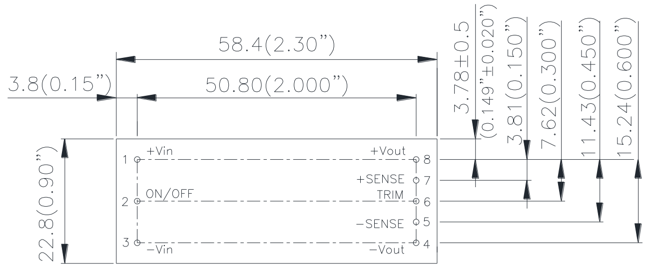


TOP VIEW

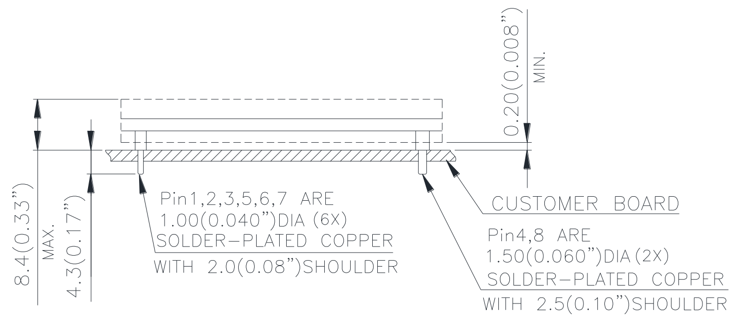


SIDE VIEW

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.)

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

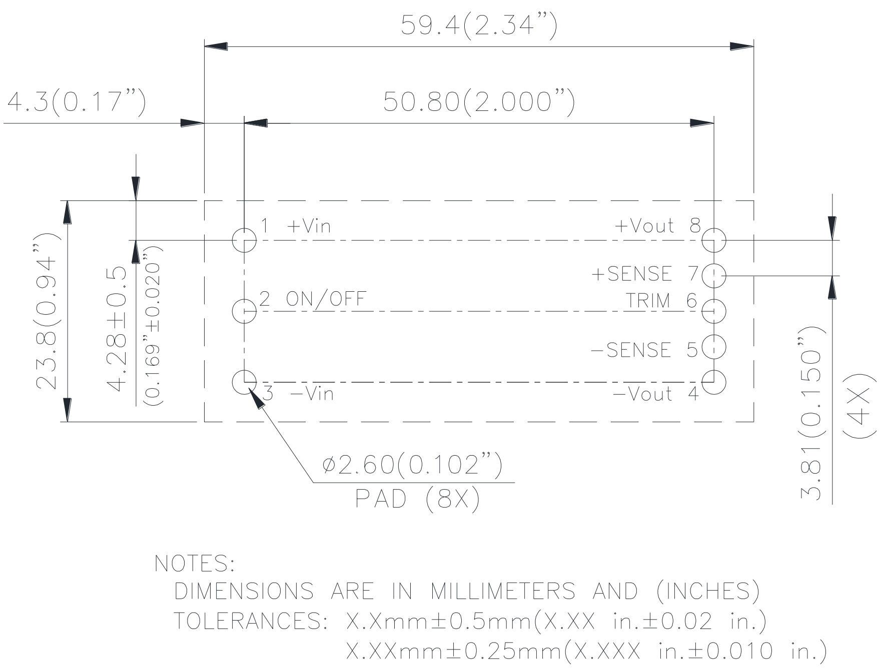
Pin Specification:

Pins 1-3,5-7	1.00mm (0.040") diameter
Pins 4 & 8	1.50mm (0.059") diameter

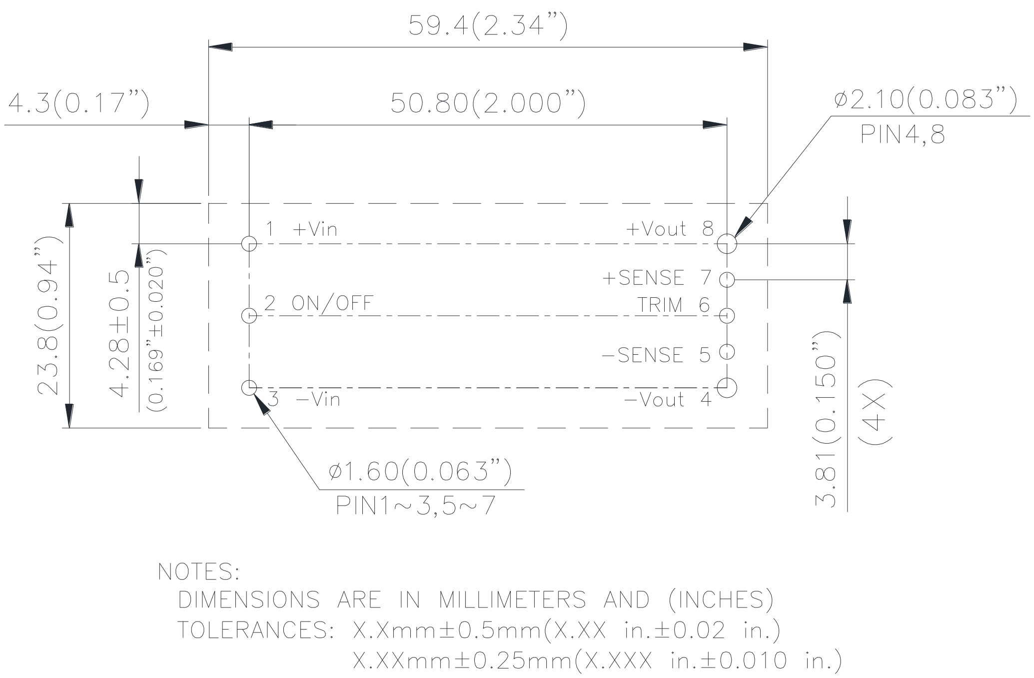
All pins are copper with tin plated

RECOMMENDED PAD LAYOUT

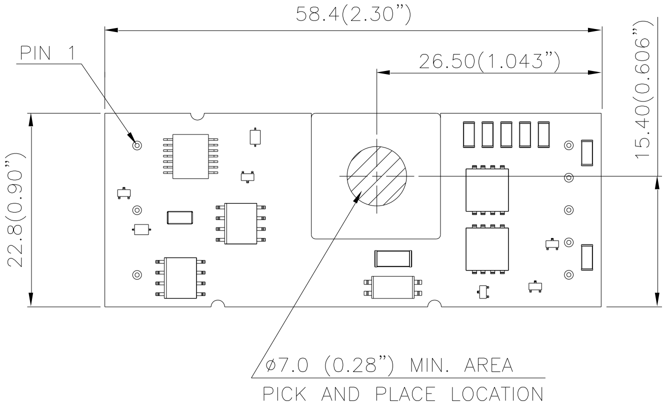
Surface-mount module



Through-hole module

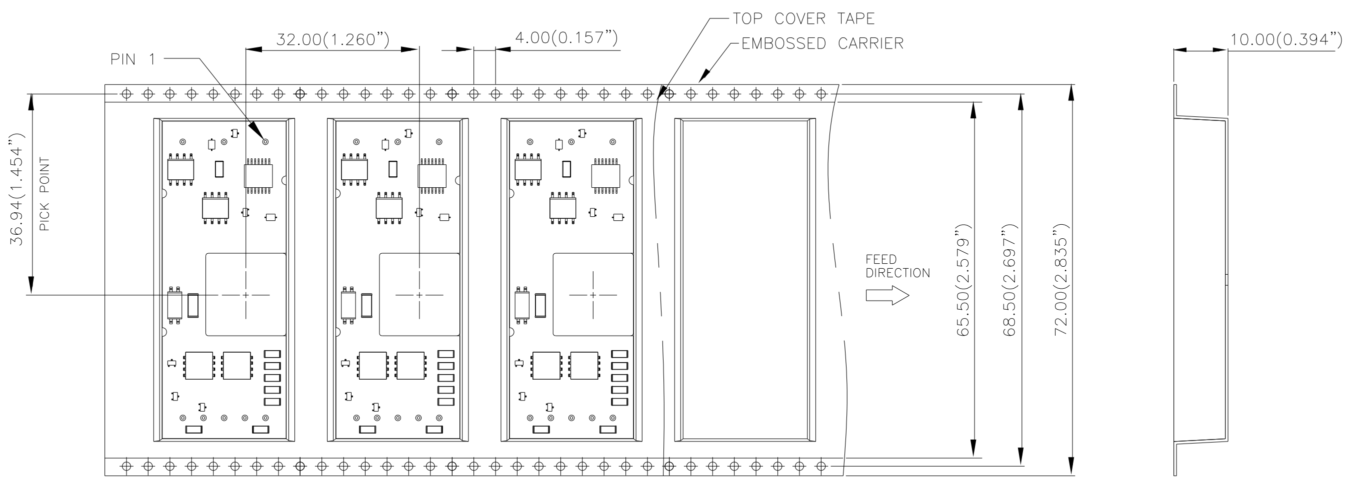


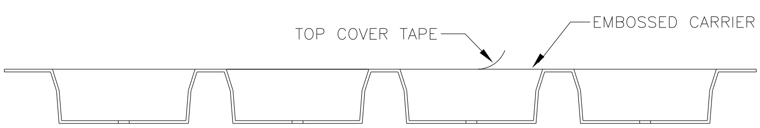
PICK AND PLACE LOCATION(SMD)

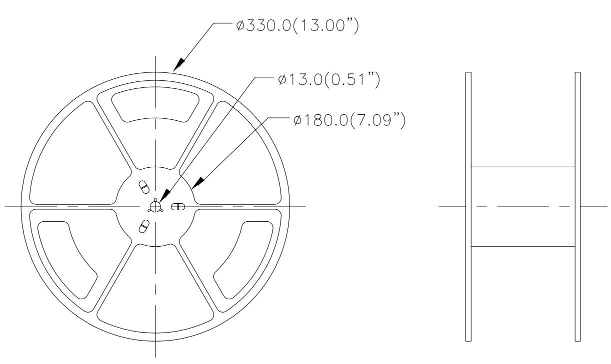


NOTES:
DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
X.XXmm±0.25mm(X.XXX in.±0.010 in.)

SURFACE-MOUNT TAPE & REEL







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.)

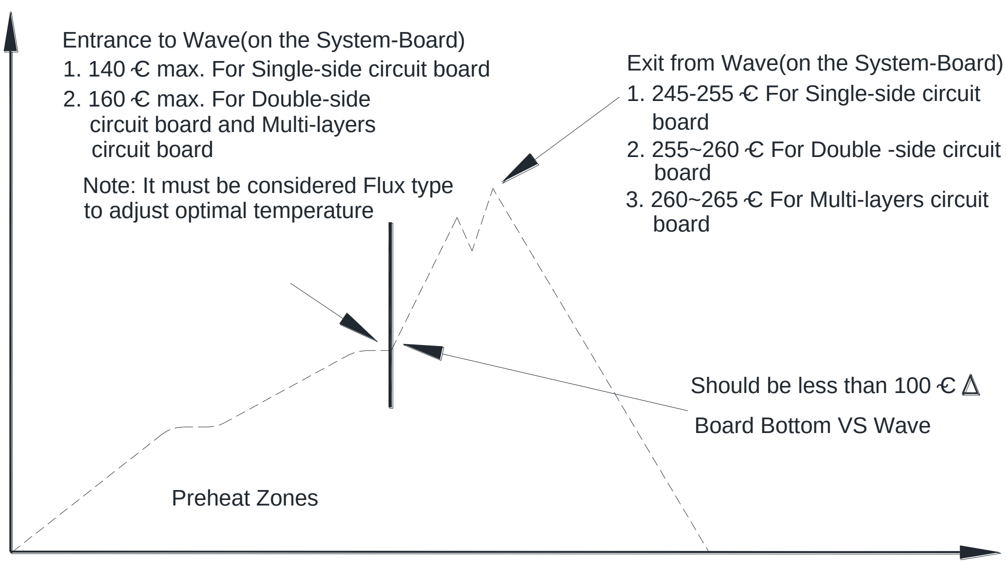
Soldering Method

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)

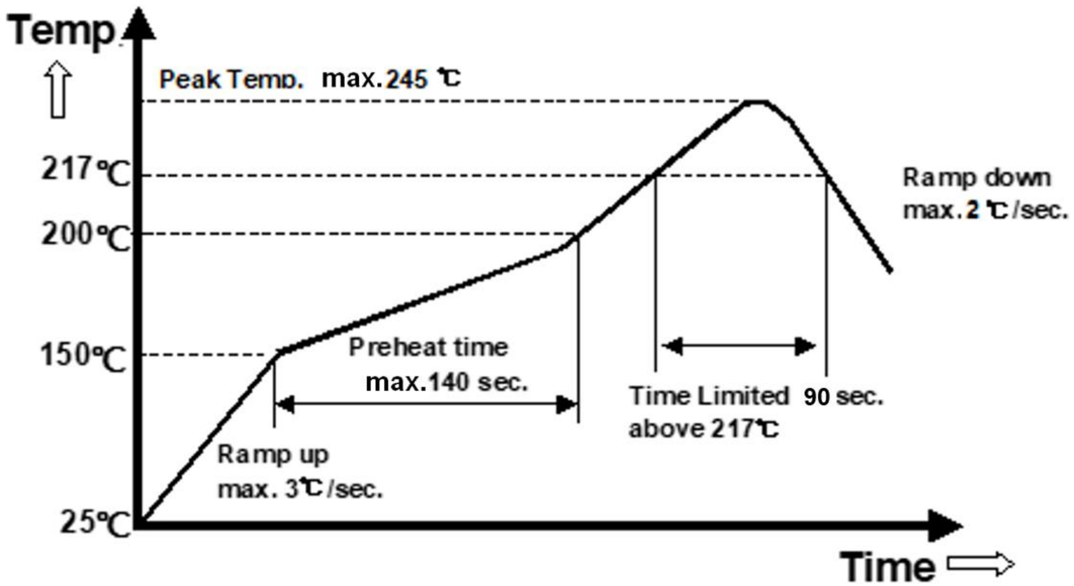
Hand soldering is the least preferred method because the amount of solder applied, the time the soldering iron is held on the joint, the temperature of the iron, and the temperature of the solder joint are variable. The recommended hand soldering guideline is listed in following table. The suggested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

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 below figure for recommended temperature profile parameters.

Shielding cap is requested to mount on DCDC module if with heat-spreader/heat-sink, to prevent the customer side high temperature of reflow to re-melt the DCDC module's internal component's soldering joint.



Recommended Temperature Profile for Lead-free Reflow Soldering

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

PART NUMBERING SYSTEM

E	48	S	C	120	05	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
E- Eighth Brick	48 - 36~75V	S- Single	C- Improved E48SR series	120 - 12V	05 -5A	N - Negative P - Positive	R - 0.170" N - 0.145" M - SMD pin	F- RoHS 6/6 (Lead Free) Space - RoHS 5/6	A- Standard Functions H- Heat spreader

MODEL LIST

MODEL NAME	INPUT		OUTPUT		EFF @ 100% LOAD
E48SC12005NNFA	36V -75V	2.2A	12V	5A	92%
E48SC12005NRFA	36V -75V	2.2A	12V	5A	92%

Default remote on/off logic is negative and pin length is 0.145"

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.

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