DELPHI SERIES

FEATURES

- High efficiency: 85% @ 5V/2A
- Standard footprint: 2.0” ×1.0”
- Industry standard pin out
- Low profile
  - Open Frame: 9.1mm (0.36”)
  - Encapsulated: 10.7mm (0.42”)
- Fixed frequency operation
- Input UVLO, Output OCP, OVP
- No minimum load required
- 2:1 input voltage range
- ISO 9001, TL 9000, ISO 14001, QS9000, OHSAS18001 certified manufacturing facility
- UL/cUL 60950 (US & Canada) Recognized, and TUV (EN60950) Certified
- CE mark meets 73/23/EEC and 93/68/EEC directives

Delphi Series S48SR, 15W 2”x1” Family DC/DC Power Modules: 48V in, 5V/2A out

The Delphi Series S48SR printed circuit board mounted, 48V input, single output, isolated DC/DC converters are the latest offering from a world leader in power system and technology and manufacturing — Delta Electronics, Inc. This product family provides up to 15 watts of power or up to 4.5A of output current (for 3.3V and below) in an industry standard footprint. With creative design technology and optimization of component placement, the Delphi Series Small Power converters possess outstanding electrical and thermal performance, as well as extremely high reliability under highly stressful operating conditions. All models are protected from abnormal input/output voltage and current conditions. An encapsulated version is available for the most robust performance in harsh environments.

OPTIONS

- Short pin length

APPLICATIONS

- Telecom/DataCom
- Wireless Networks
- Optical Network Equipment
- Server and Data Storage
- Industrial/Test Equipment

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

PARAMETER	NOTES and CONDITIONS	S48SR05002ER A/B/C/D			
		Min.	Typ.	Max.	Units
ABSOLUTE MAXIMUM RATINGS					
Input Voltage					
Continuous				80	Vdc
Transient (100ms)	100ms			100	Vdc
Operating Case Temperature		-40		100	°C
Storage Temperature		-55		125	°C
Input/Output Isolation Voltage	1 minute	1500			Vdc
INPUT CHARACTERISTICS					
Operating Input Voltage		36	48	75	V
Input Under-Voltage Lockout					
Turn-On Voltage Threshold		33.8	34.5	35.8	V
Turn-Off Voltage Threshold		32.0	33.5	34.5	V
Lockout Hysteresis Voltage		1	2	3	V
Maximum Input Current	100% Load, 36Vin			0.5	A
No-Load Input Current			25		mA
Inrush Current(I^2t)			0.01		A^2s
Input Reflected-Ripple Current	P-P thru 12µH inductor, 5Hz to 20MHz		5		mA
Input Voltage Ripple Rejection	120 Hz		50		dB
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	Vin=48V, Io=50%Io.max, Tc=25C	4.90	5.00	5.10	V
Output Voltage Regulation					
Over Load	Io=Io,min to Io,max		±10	±25	mV
Over Line	Vin=36V to 75V		±5	±15	mV
Over Temperature	Tc=-40C to 100C		100	300	ppm/℃
Total Output Voltage Range	Over sample load, line and temperature	TBD		TBD	V
Output Voltage Ripple and Noise	5Hz to 20MHz bandwidth				
Peak-to-Peak	Full Load, 1µF ceramic, 10µF tantalum		50	100	mV
RMS	Full Load, 1µF ceramic, 10µF tantalum		15	25	mV
Operating Output Current Range		0		2	A
Output DC Current-Limit Inception	Output Voltage 10% Low	2.4	3.4	4.4	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% Io.max		75	100	mV
Negative Step Change in Output Current	75% Io.max to 50% Io.max		75	100	mV
Settling Time to 1% of Final value			600		µs
Turn-On Transient					
Start-Up Time, From Input			35	50	ms
Maximum Output Capacitance	Full load; 5% overshoot of Vout at startup			470	µF
EFFICIENCY					
100% Load		83	85		%
ISOLATION CHARACTERISTICS					
Isolation Voltage		1500			V
Isolation Resistance		100			MΩ
Isolation Capacitance			500		pF
FEATURE CHARACTERISTICS					
Switching Frequency			290		kHz
Output Voltage Trim Range	Across Trim Pin & +Vo or –Vo, Pout≦max rated	-10		+10	%
Output Over-Voltage Protection	Over full temp range; % of nominal Vout	115	125	140	%
GENERAL SPECIFICATIONS					
Calculated MTBF	Io=80% of Io, max; Tc=40°C		3		M hours
Weight (Encapsulated)			25.5		grams
Weight (Open Frame)			12.5		grams

ELECTRICAL CHARACTERISTICS CURVES

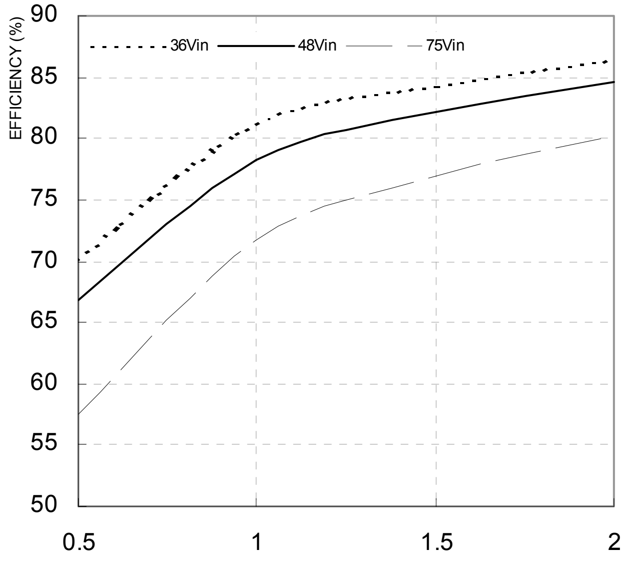


Figure 1: *Efficiency vs. load current for minimum, nominal, and maximum input voltage at 25°C.*

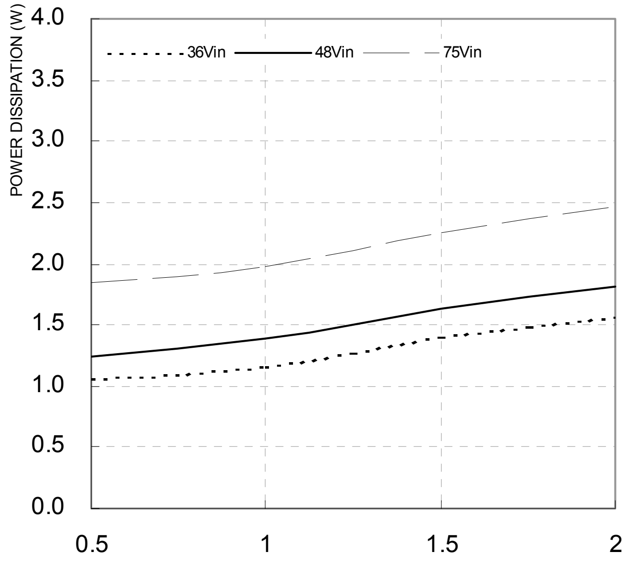


Figure 2: *Power dissipation vs. load current for minimum, nominal, and maximum input voltage at 25°C.*

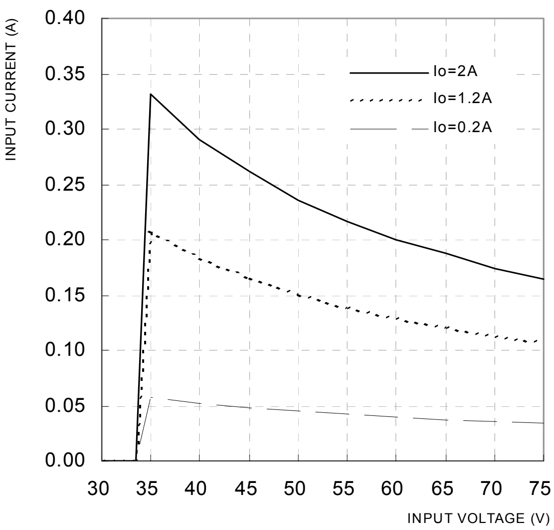


Figure 3: *Typical S48SR05002ER input characteristics at room temperature*

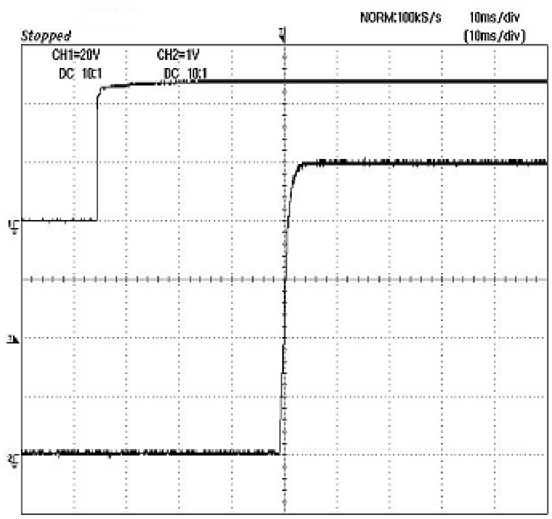


Figure 4: *Turn-on transient at full rated load current (resistive load) (10 ms/div). Top Trace: Vin (20V/div); Bottom Trace: Vout (1V/div)*

ELECTRICAL CHARACTERISTICS CURVES

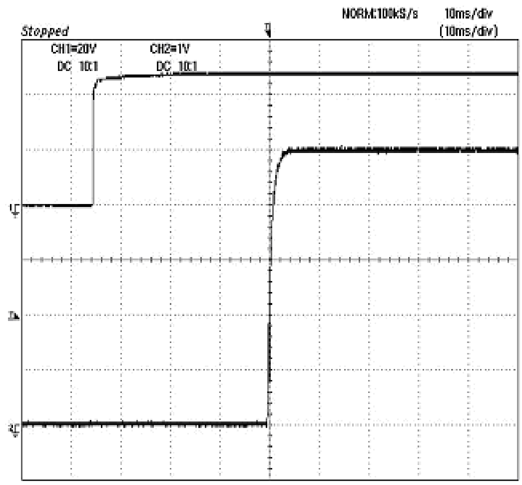


Figure 5: *Turn-on transient at zero load current (10 ms/div). Top Trace: Vin (20V/div); Bottom Trace Vout (1V/div)*

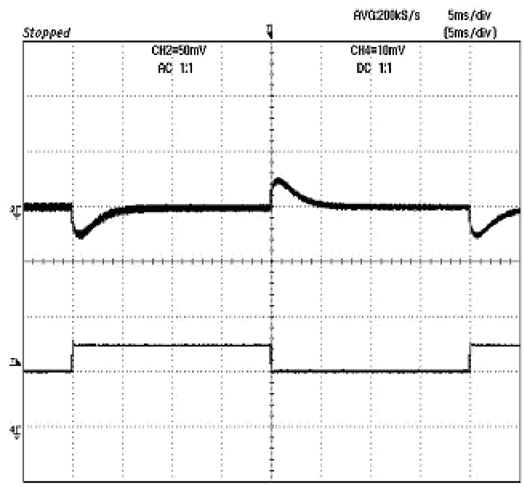


Figure 6: *Output voltage response to step-change in load current (50%-75%-50% of Imax; dI/dt = 0.1A/µs). Load cap: 10µF, 100mΩ ESR tantalum capacitor and 1µF ceramic capacitor.*
Top trace: Vout (50mV/div), Bottom trace:I out (1A/div).

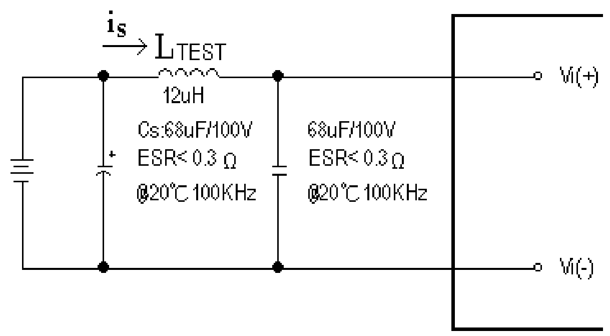


Figure 7: *Test set-up diagram showing measurement points for Input Reflected Ripple Current (Figure 8).*
Note: Measured input reflected-ripple current with a simulated source Inductance (L_{TEST}) of 12 µH. Capacitor Cs offset possible battery impedance.

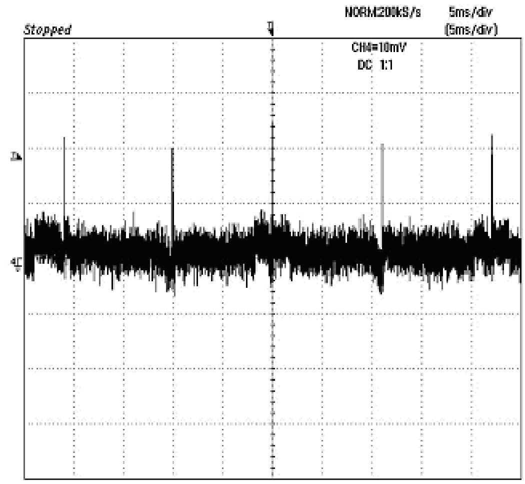


Figure 8: *. Input Reflected Ripple Current, i_C, at full rated output current and nominal input voltage with 12µH source impedance and 68µF electrolytic capacitor (2 mA/div).*

ELECTRICAL CHARACTERISTICS CURVES

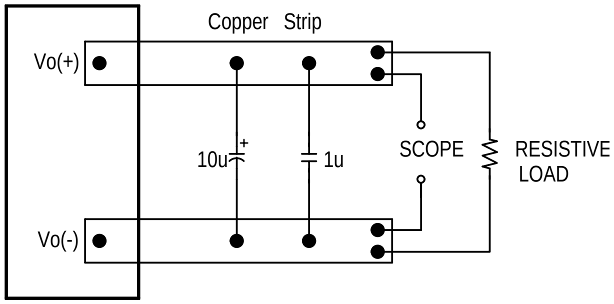


Figure 9: Output voltage noise and ripple measurement test setup. Scope measurement should be made using a BNC cable (length short than 20 inches). Position the load between 51 mm and 76 mm (2 inches to 3 inches) from the module.

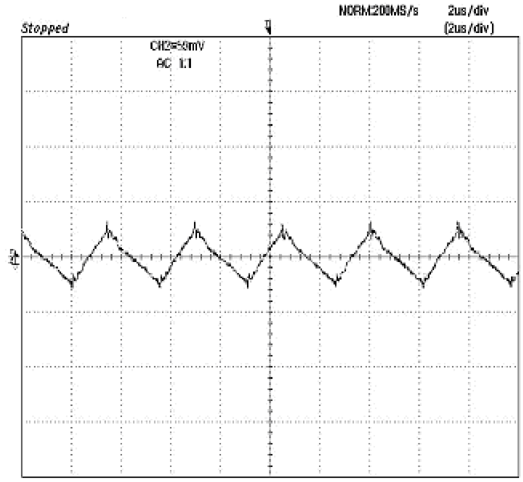


***Figure 10:** Output voltage ripple at nominal input voltage and rated load current (50 mV/div). Load capacitance: 1μF ceramic capacitor and 10μF tantalum capacitor. Bandwidth: 20 MHz.*

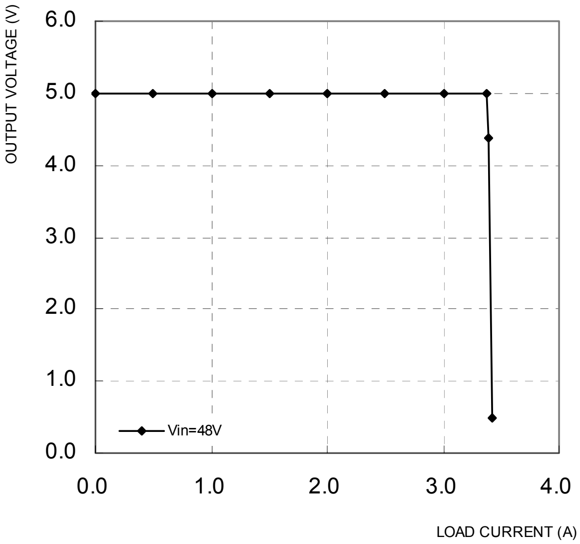


***Figure 11:** Output voltage vs. load current showing typical current limit curves and converter shutdown points.*

THERMAL CURVES: ENCAPSULATED VERSION

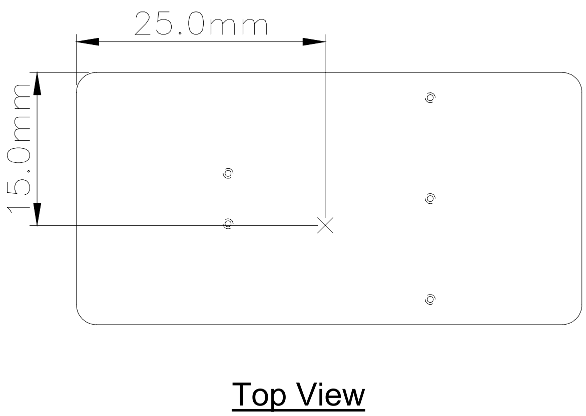


Figure 12: *Case Temperature measurement location. Pin locations are for reference only.*

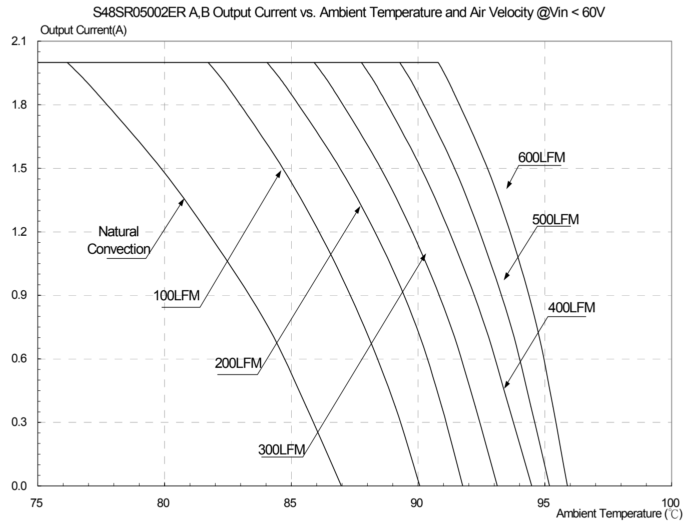


Figure 13: *Output Current vs. Ambient Temperature and Air Velocity @ V<60V*

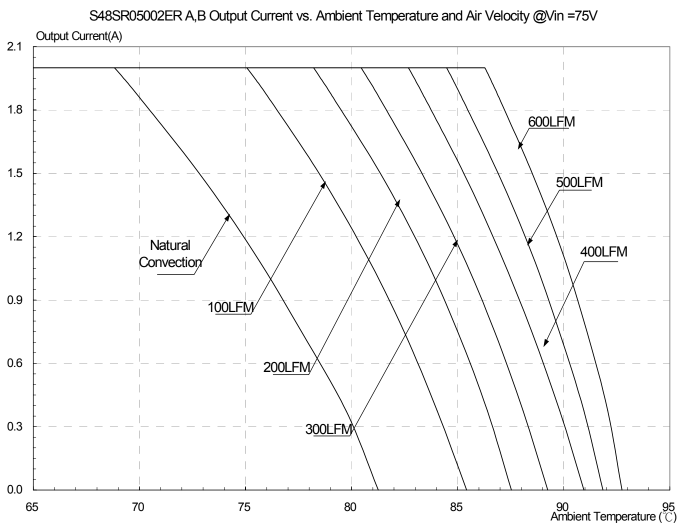


Figure 14: *Output Current vs. Ambient Temperature and Air Velocity@ V =75V*

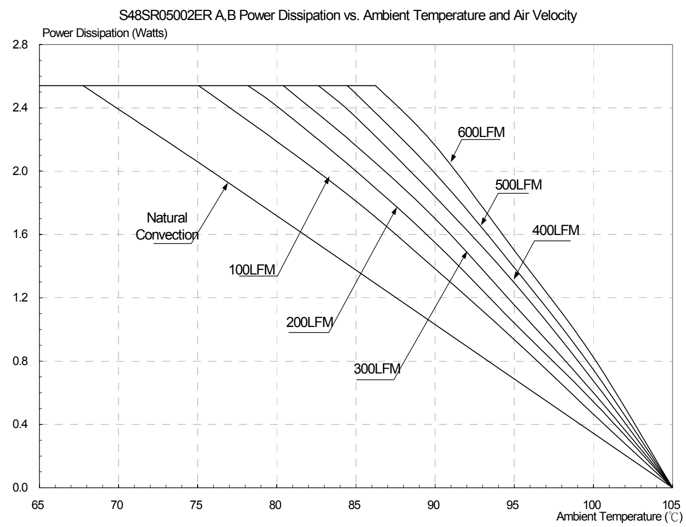


Figure 15: *Power Dissipation vs. Ambient Temperature and Air Velocity*

THERMAL CURVES: OPEN FRAME VERSION

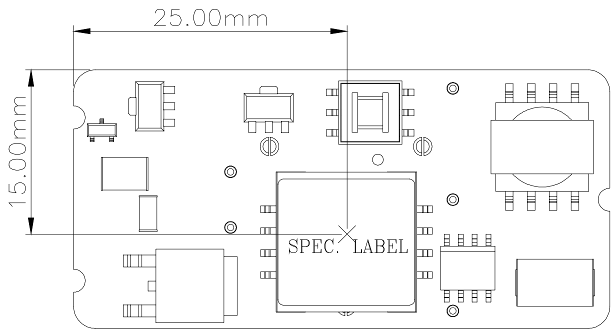


Figure 16: *Hot spot location.*
Pin locations are for reference only.

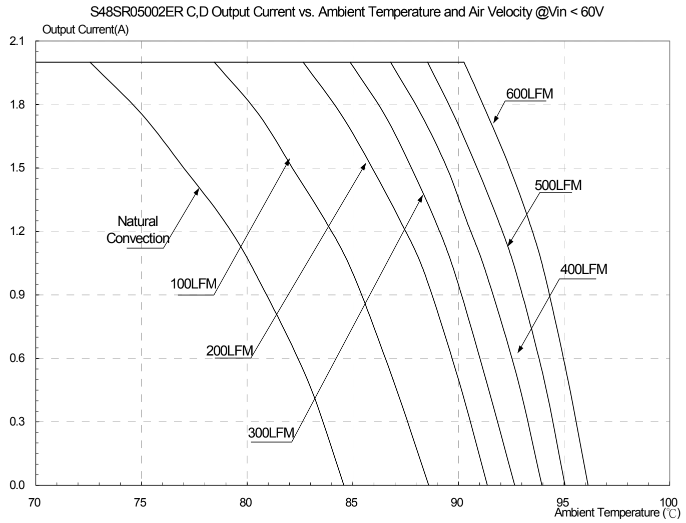


Figure 17: *Output Current vs. Ambient Temperature and Air Velocity @ V<60V*

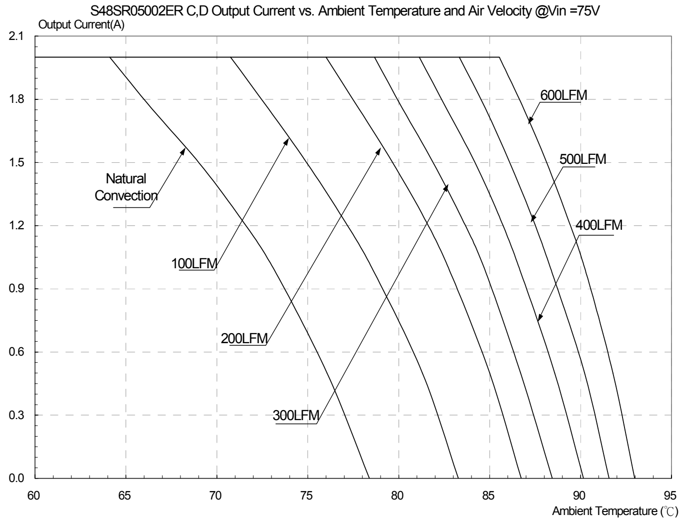


Figure 18: *Output Current vs. Ambient Temperature and Air Velocity @ V=75V*

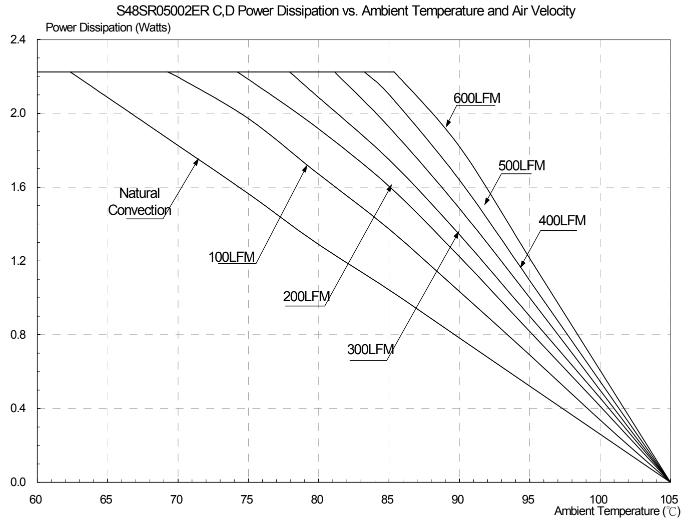


Figure 19: *Power Dissipation vs. Ambient Temperature and Air Velocity*

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 end-user's safety agency standard if the system in which the power module is to be used must meet safety agency requirements.

When the input source is 60Vdc or below, 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 any hazardous voltages, including the ac mains, with reinforced insulation.
- One Vi pin and one Vo pin are grounded, or all the input and output pins are kept floating.
- The input terminals of the module are not operator accessible.
- A SELV reliability test is conducted on the system where the module is used to ensure that under a single fault, hazardous voltage does not appear at the module's output.

Do not ground one of the input pins without grounding one of the output pins. This connection may allow a non-SELV voltage to appear between the output pin and ground.

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 normal-blow fuse with 1A 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 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 and latch off. The over-voltage latch is reset by cycling the input power.

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 Vo+ or Vo -. The TRIM pin should be left open if this feature is not used.

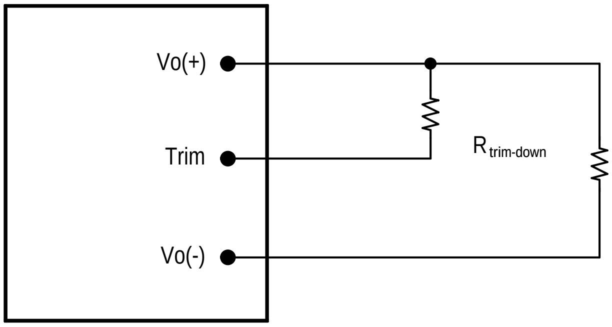


Figure 20: *Circuit configuration for trim-down (decrease output voltage*)

If the external resistor is connected between the TRIM and Vo+ pins, the output voltage set point decreases. The external resistor value required to obtain a percentage of output voltage change △Vo% is defined as:

$$Rtrim-down=\frac{35.381-47.05\Delta Vo}{5\Delta Vo+0.016}-6.49[\mathrm{K\Omega}]$$

EX. When Trim-down –10%(5V×0.9=4.5V)

$$Rtrim\text{ - }down=\frac{35.381-47.05\times 0.1}{5\times 0.1+0.016}-6.49=52.96[\mathrm{K\Omega}]$$

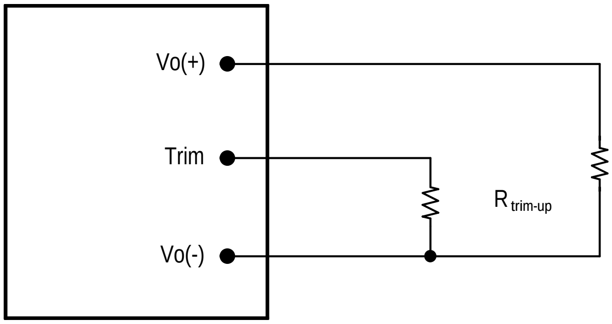


Figure 21: *Circuit configuration for trim-up (increase output voltage)*

If the external resistor is connected between the TRIM and Vo- the output voltage set point increases. The external resistor value required to obtain a percentage output voltage change △Vo% is defined as:

$$\mathrm{Rtrim\text{ - }up}=\frac{11.668}{5\Delta Vo-0.016}-6.49[\mathrm{K\Omega}]$$

Ex. When Trim-up +10%(5V×1.1=5.5V)

$$\mathrm{Rtrim\text{ - }up}=\frac{11.668}{5\times 0.1\text{-}0.016}-6.49=17.62[\mathrm{K}\Omega]$$

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.

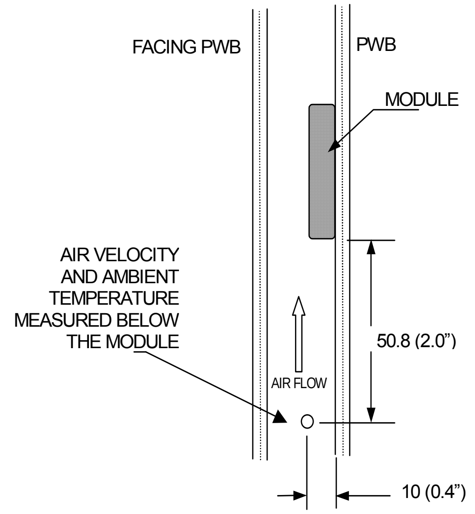
Thermal Testing Setup

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 or a heat sink is 6.35mm (0.25").

Thermal Derating

Heat can be removed by increasing airflow over the module. Figure 13, 14, 17, and 18 show maximum output is a function of ambient temperature and airflow rate. The module's maximum case temperature is +100°C. 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.

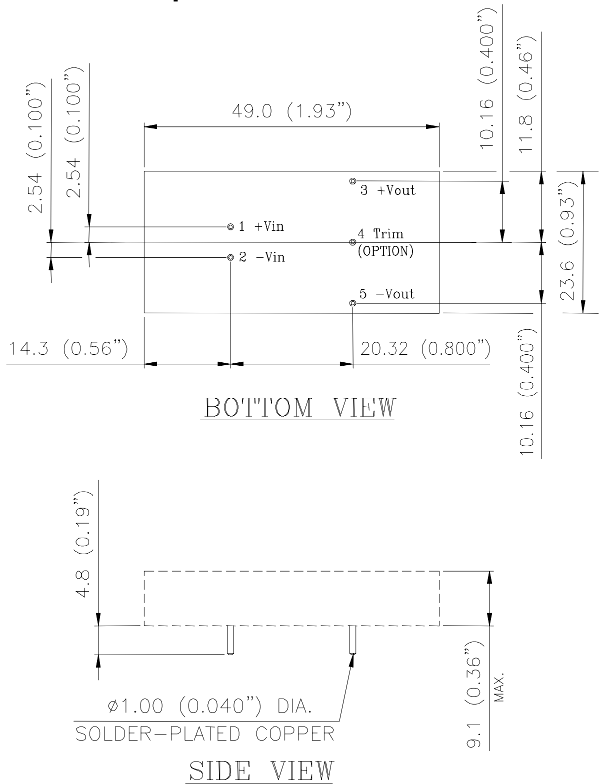


Note: Wind Tunnel Test Setup Figure Dimensions are in millimeters and (Inches)

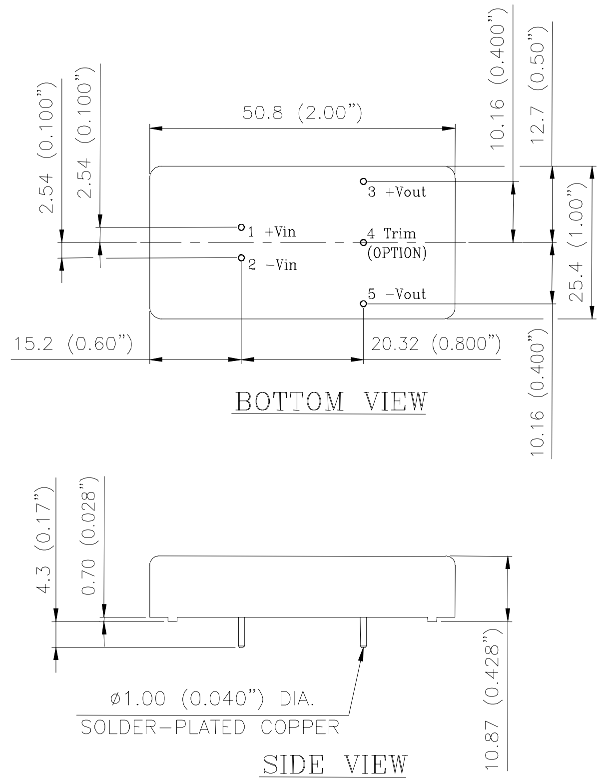
Figure 22: *Wind Tunnel Test Setup*

MECHANICAL DRAWING

Open Frame Version



Encapsulated Version



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	-Vin	Negative input voltage
3	+Vout	Positive output voltage
4	TRIM	Output voltage trim
5	-Vout	Negative output voltage

PART NUMBERING SYSTEM

S	48	S	R	050	02	E	R	F	A
Form Factor	**Input Voltage**	**Number of Outputs**	**Product Series**	**Output Voltage**	**Output Current**	**ON/OFF Logic**	**Pin Length**		**Option Code**
S- Small Power	48V	S- Single	R- Thru-hole	050-5.0V	02- 2A	E-No ON/OFF Control Function	R- 0.170" N- 0.145" K- 0.110"	Space-RoHS 5/6 F- RoHS 6/6 (Lead Free)	A- Encapsulated & Trim B- Encapsulated & No Trim C- Open Frame & Trim D- Open Frame & No Trim

MODEL LIST

MODEL NAME	INPUT		OUTPUT		EFF @ 100% LOAD
S48SR1R805ER A	36V~75V	0.5A	1.8V	5.0A	80.0%
S48SR2R504ER A	36V~75V	0.5A	2.5V	4.5A	83.0%
S48SR3R303ER A	36V~75V	0.5A	3.3V	3.0A	84.5%
S48SR3R304ER A	36V~75V	0.6A	3.3V	4.5A	86.0%
S48SR05002ER A	36V~75V	0.5A	5.0V	2.0A	85.0%
S48SR05003ER A	36V~75V	0.6A	5.0V	3.0A	86.5%
S48SR12001ER A	36V~75V	0.6A	12.0V	1.25A	86.5%

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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.