DELPHI SERIES

FEATURES

- High efficiency: 91.5% @ 28V/25A
- Industry standard size and pinout: 61.0 x 116.8 x 12.7mm (2.40”x 4.60”x 0.50”)
- Fixed frequency operation
- Remote sense
- Input UVLO, Output OCP, OVP & OTP
- Auxiliary bias power
- Basic insulation
- 2250V isolation
- 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 directive

Delphi Series F48SA, 700W Full Brick Family DC/DC Power Module: 48Vin, 28Vout

The Delphi Series F48SA, 48V input, single output, full brick sized isolated DC/DC converter is the latest offering from a world leader in power systems technology and manufacturing — Delta Electronics, Inc. The Delphi F48SA series provides up to 700 watts of power or up to 25A of output current. This product family operates from a wide input range of 36V to 75V. With creative design technology and optimization of component placement, these 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, and feature 2250V input/output isolation and basic insulation. An optional heatsink is available for extended operation.

OPTIONS

- Negtive On/Off logic
- Heatsink for extended operation
- Output current monitoring
- Delayed overcurrent shutdown
- Parallel operation using forced current sharing

APPLICATIONS

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

Delta Electronics, Inc.

TECHNICAL SPECIFICATIONS

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

PARAMETER	NOTES and CONDITIONS	F48SA28025 (Standard)			
		Min.	Typ.	Max.	Units
ABSOLUTE MAXIMUM RATINGS					
Input Voltage					
Continuous				80	Vdc
Transient (100ms)	100ms			100	Vdc
Operating Temperature	Please refer to Fig 20 for measuring point	-40		95	°C
Storage Temperature		-55		125	°C
Input/Output Isolation Voltage				2250	Vdc
INPUT CHARACTERISTICS					
Operating Input Voltage		36	48	75	Vdc
Input Under-Voltage Lockout					
Turn-On Voltage Threshold		33	34.5	36	Vdc
Turn-Off Voltage Threshold		31	32.5	34	Vdc
Lockout Hysteresis Voltage			2		Vdc
Input Over-Voltage Lockout					
Turn-On Voltage Threshold		76	78	80	Vdc
Turn-Off Voltage Threshold		78	80	82	Vdc
Lockout Hysteresis Voltage			2		Vdc
Maximum Input Current	100% Load, 36Vin			23	A
Inrush Current(I^2t)				1	A^2s
Input Reflected-Ripple Current	P-P thru 15μH inductor, 5Hz to 20MHz		20		mA
Input Voltage Ripple Rejection	120 Hz		50		dB
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	Vin=48V, Io=Io.max, Tc=25°C	27.72	28.00	28.28	Vdc
Output Voltage Regulation					
Over Load	Io=Io,min to Io,max		28	56	mV
Over Line	Vin=36V to 75V		28	56	mV
Over Temperature	Tc=-40°C to 100°C		100	300	mV
Total Output Voltage Range	over all load, line and temperature	27.25	28.00	28.75	V
Output Voltage Ripple and Noise	5Hz to 20MHz bandwidth				
Peak-to-Peak	Full Load, 1μF ceramic, 10μF Low ESR cap		200		mV
RMS	Full Load, 1μF ceramic, 10μF Low ESR cap		65		mV
Operating Output Current Range		2		25	A
Output DC Current-Limit Inception	Output Voltage 10% Low		120	150	%
DYNAMIC CHARACTERISTICS					
Output Voltage Current Transient	48V, Tested with a 10μF, a 1μF Ceramic cap and 470uF low ESR aluminum load cap, $\triangle$Io/$\triangle$t=1A/μs				
Positive Step Change in Output Current	50% Io.max to 75% Io.max		450		mV
Negative Step Change in Output Current	75% Io.max to 50% Io.max		450		mV
Settling Time (within 1% Vout nominal)			500		us
Turn-On Transient					
Start-Up Time, From On/Off Control			20	35	ms
Start-Up Time, From Input			20	35	ms
Output Capacitive Load		470		6000	μF
EFFICIENCY					
100% Load			91.5		%
60% Load			91.5		%
ISOLATION CHARACTERISTICS					
Input to Output				2250	Vdc
Input to Case				2250	Vdc
Output to Case				500	Vdc
Isolation Resistance		10			MΩ
Isolation Capacitance			1800		pF
FEATURE CHARACTERISTICS					
Switching Frequency			300		kHz
Output overshoot Voltage during start up			0		
Power good pin max applied voltage	Max sink current 5mA			35	V
Auxiliary output voltage	Aux pin source current <=20mA Referenced to Sense(-) pin	7	10	13	V
Output Voltage Trim Range	Pout ≦ max rated power	-15		+10	%
Output Voltage Remote Sense Range	Pout ≦ max rated power			0.5	V
Output Over-Voltage Protection	Over full temp range; % of nominal Vout	115		140	%
GENERAL SPECIFICATIONS					
MTBF	Io=80% of Io, max; Ta=25°C		1.14		M hours
Weight			168		grams
Over-Temperature Shutdown	Please refer to Fig.20 for measuring point		100		°C

ELECTRICAL CHARACTERISTICS CURVES

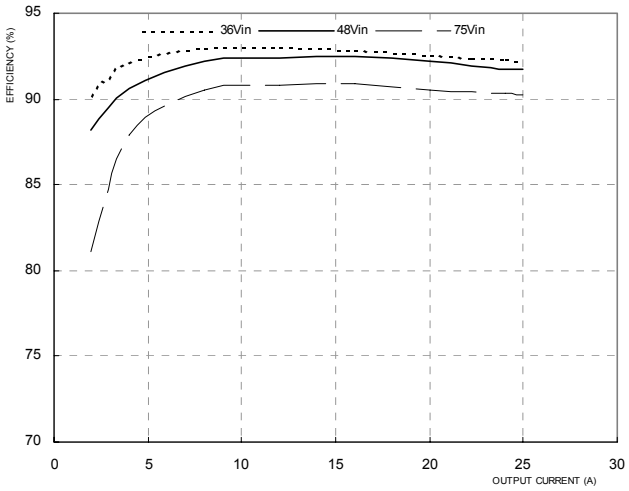


Figure 1: *Efficiency vs. load current for minimum, nominal, and maximum input voltage at 25°C.*

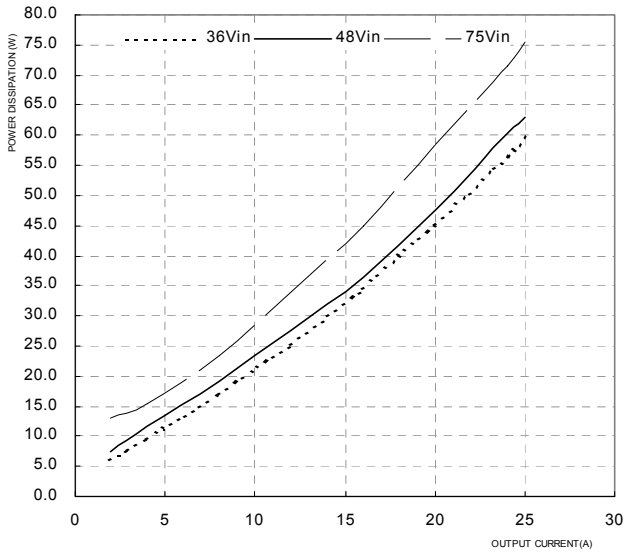


Figure 2: *Power dissipation vs. load current for minimum, nominal, and maximum input voltage at 25°C.*

ELECTRICAL CHARACTERISTICS CURVES

For Negative Remote On/Off Logic

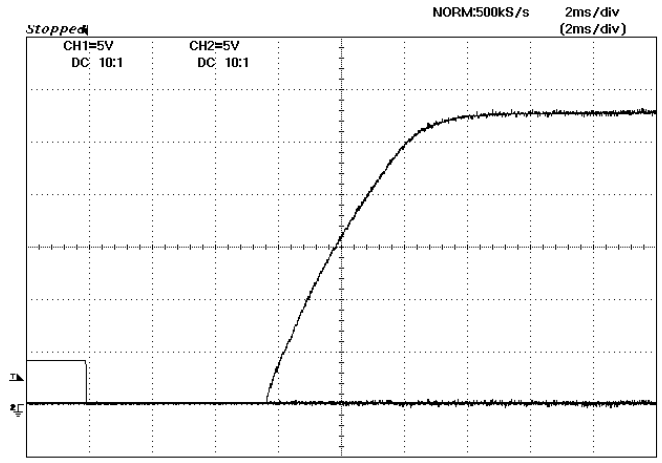


Figure 3: *Turn-on transient at full rated load current (resistive load). CH3: Vout;5V/div; CH1: ON/OFF input: 5V/div*

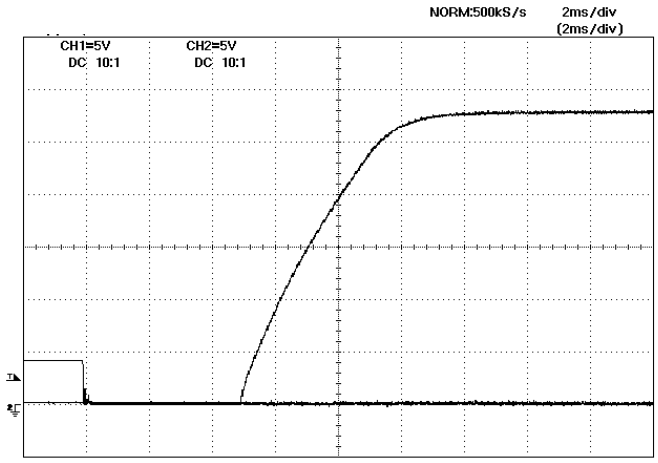


Figure 4: *Turn-on transient at minimum load current . CH3: Vout: 5V/div; CH1: ON/OFF input:5V/div*

For Positive Remote On/Off Logic

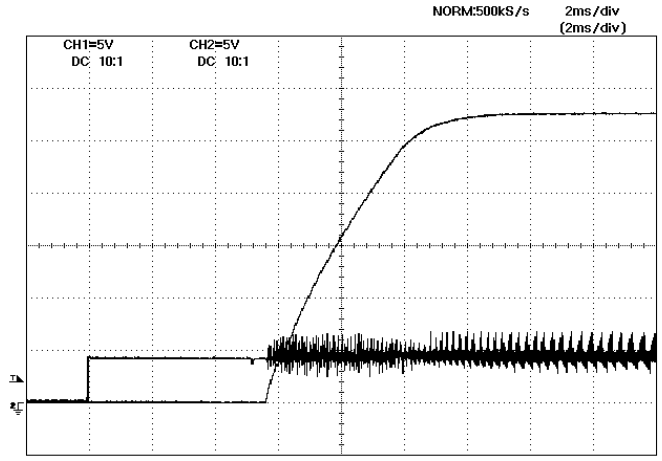


Figure 5: *Turn-on transient at full rated load current (resistive load) (10ms/div). Top Trace: Vout; 5V/div; Bottom Trace: ON/OFF input: 2V/div*

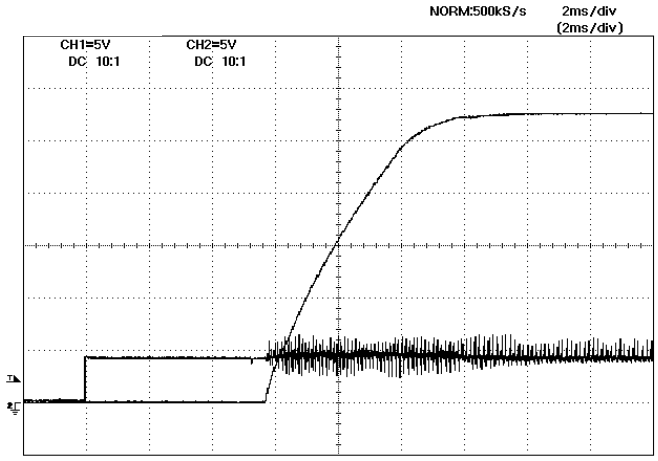
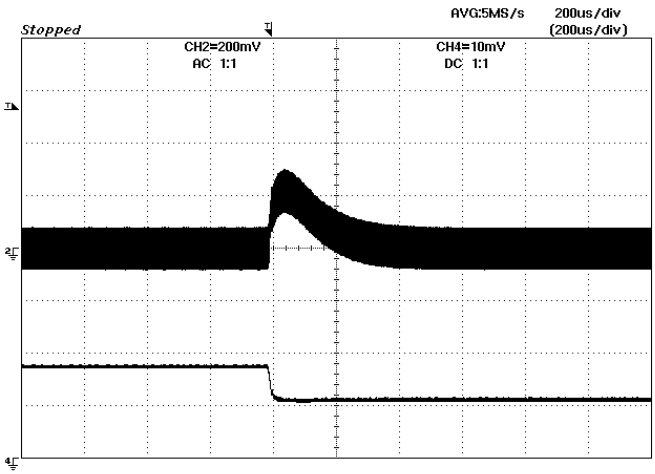


Figure 6: *Turn-on transient at minimum load current (10ms/div). Top Trace: Vout: 5V/div; Bottom Trace: ON/OFF input: 2V/div*

ELECTRICAL CHARACTERISTICS CURVES



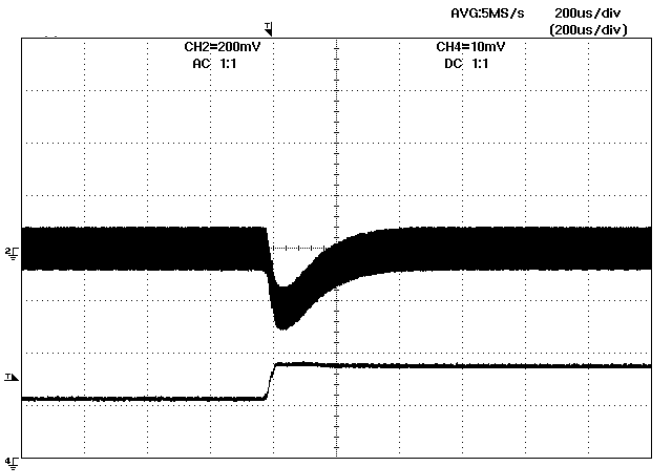


Figure 7: *Output voltage response to step-change in load current (75%-50% of Io, max; di/dt = 1A/µs). Load cap: 470µF aluminum ,10uF Low ESR capacitor and 1µF ceramic capacitor. Top Trace: Vout (200mV/div), Bottom Trace: Iout (10A/div). Scope measurement should be made using a BNC cable (length shorter than 20 inches). Position the load between 51 mm to 76 mm (2 inches to 3 inches) from the module.*

Figure 8: *Output voltage response to step-change in load current (50%-75% of Io, max; di/dt = 1A/µs). Load cap: 470µF aluminum,10uF Low ESR capacitor and 1µF ceramic capacitor. Top Trace: Vout (200mV/div), Bottom Trace: Iout (10A/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.*

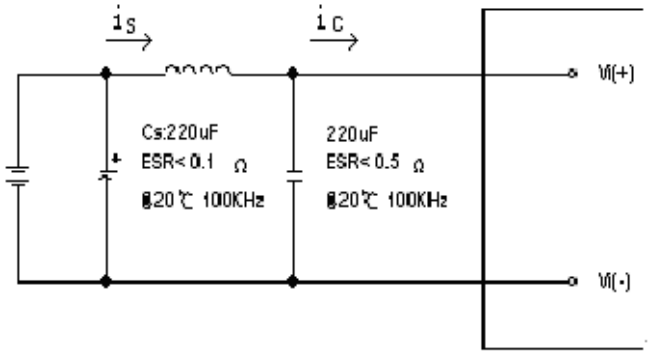


Figure 9: *Test set-up diagram showing measurement points for Input Terminal Ripple Current and Input Reflected Ripple Current.*
Note: Measured input reflected-ripple current with a simulated source Inductance (L_{TEST}) of 15 µH. Capacitor Cs offset possible battery impedance. Measure current as shown above.

ELECTRICAL CHARACTERISTICS CURVES

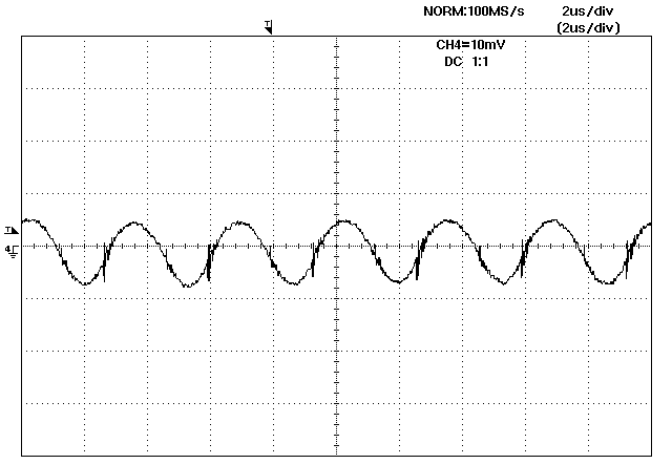


Figure 10: *Input Terminal Ripple Current, i_c, at full rated output current and nominal input voltage with 15µH source impedance and 220µF electrolytic capacitor (1A/div).*

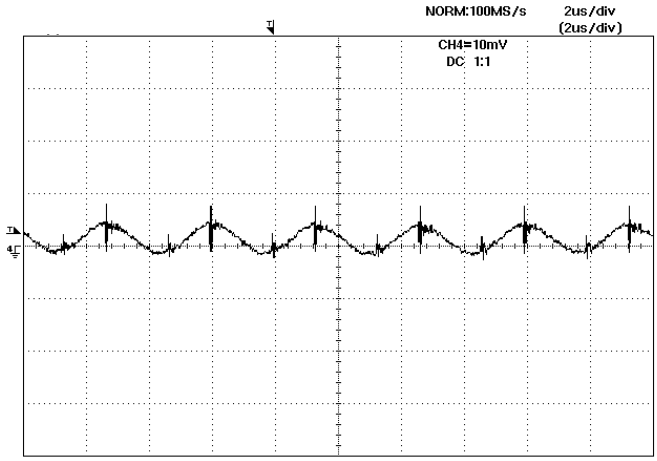


Figure 11: *Input reflected ripple current, i_s, through a 15µH source inductor at nominal input voltage and rated load current (10 mA/div)*

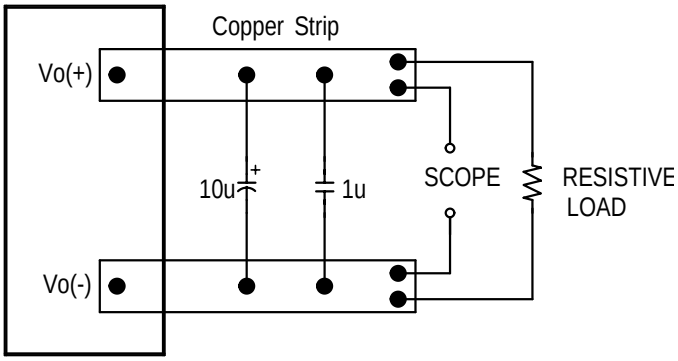


Figure 12: *Output voltage noise and ripple measurement test setup*

ELECTRICAL CHARACTERISTICS CURVES

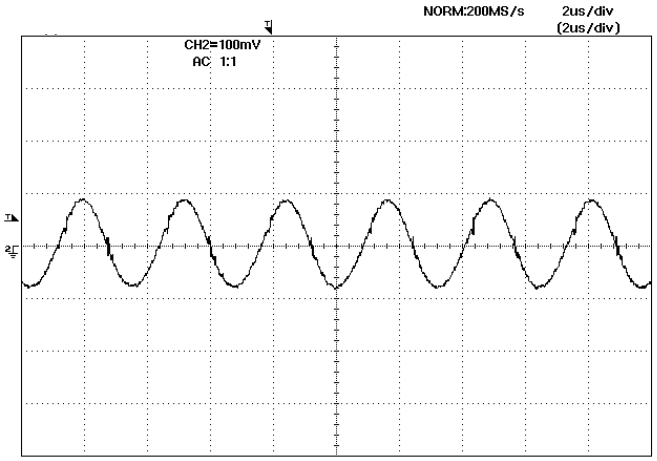


Figure 13: *Output voltage ripple at nominal input voltage and rated load current (100 mV/div). Load capacitance:470uF aluminum, 1µF ceramic capacitor and 10µFlow ESR capacitor. Bandwidth: 20 MHz. Scope measurement should be made using a BNC cable (length shorter than 20 inches). Position the load between 51 mm to 76 mm (2 inches to 3 inches) from the module.*

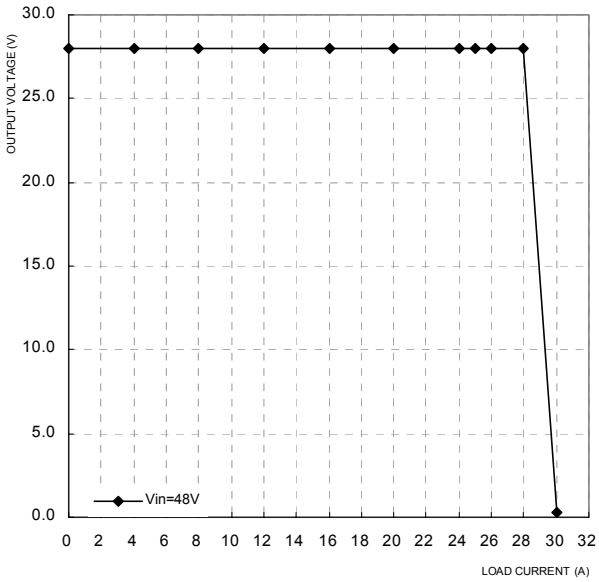


Figure 14: *Output voltage vs. load current showing typical current limit curves and converter shutdown points.*

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 220 to 470 µF electrolytic capacitor (ESR < 0.1 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, i.e., UL60950, CAN/CSA-C22.2 No. 60950-00 and EN60950:2000 and IEC60950-1999, if the system in which the power module is to be used must meet safety agency requirements.

Basic insulation based on 75 Vdc input is provided between the input and output of the module for the purpose of applying insulation requirements when the input to this DC-to-DC converter is identified as TNV-2 or SELV. An additional evaluation is needed if the source is other than TNV-2 or SELV.

When the input source is SELV, the power module meets SELV (safety extra-low voltage) requirements. If the input source is a hazardous voltage which is greater than 60 Vdc and less than or equal to 75 Vdc, for the module's output to meet SELV requirements, all of the following must be met:

- The input source must be insulated from the ac mains by reinforced or double insulation.
- The input terminals of the module are not operator accessible.
- If the metal baseplate is grounded, one Vi pin and one Vo pin shall also be grounded.
- A SELV reliability test is conducted on the system where the module is used, in combination with the module, to ensure that under a single fault, hazardous voltage does not appear at the module's output.

When installed into a Class II equipment (without grounding), spacing consideration should be given to the end-use installation, as the spacing between the module and mounting surface have not been evaluated.

The power module has extra-low voltage (ELV) outputs when all inputs are ELV.

This power module is not internally fused. To achieve optimum safety and system protection, an input line fuse is highly recommended. The safety agencies require a normal-blow fuse with 20A maximum rating to be installed in the ungrounded lead. A lower rated fuse can be used based on the maximum inrush transient energy and maximum input current.

Soldering and Cleaning Considerations

Post solder cleaning is usually the final board assembly process before the board or system undergoes electrical testing. Inadequate cleaning and/or drying may lower the reliability of a power module and severely affect the finished circuit board assembly test. Adequate cleaning and/or drying is especially important for un-encapsulated and/or open frame type power modules. For assistance on appropriate soldering and cleaning procedures, please contact Delta's technical support team.

FEATURES DESCRIPTIONS

Over-Current Protection

The modules include an internal output over-current protection circuit, which will endure current limiting for an unlimited duration during output overload. If the output current exceeds the OCP set point, the modules will 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

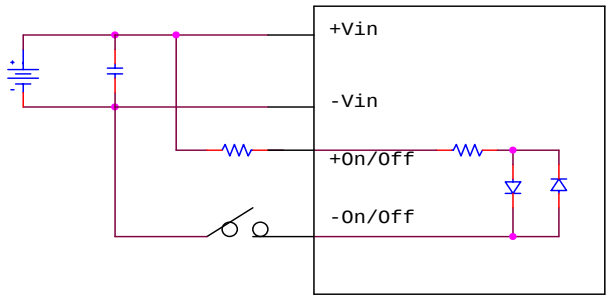
The modules include an internal output over-voltage protection circuit, which monitors the voltage on the output terminals. If this voltage exceeds the over-voltage set point, the module will shut down and latch off. The over-voltage latch is reset by either cycling the input power or by toggling the on/off signal for one second.

Over-Temperature Protection

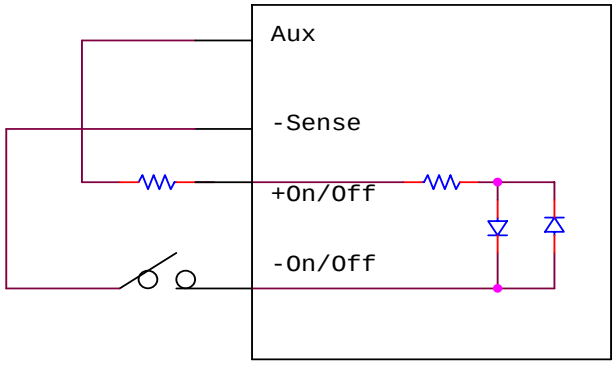
The over-temperature protection consists of circuitry that provides protection from thermal damage. If the temperature exceeds the over-temperature threshold the module will shut down.

The module will try to restart after shutdown. If the over-temperature condition still exists during restart, the module will shut down again. This restart trial will continue until the temperature is within specification.

Remote On/Off



Input side on off control



Output side on off control

Figure 15: *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:

$$[Vo(+) - Vo(-)] - [SENSE(+) - SENSE(-)] \leq 10\% \times Vout$$

This limit includes any increase in voltage due to remote sense compensation and output voltage set point adjustment (trim).

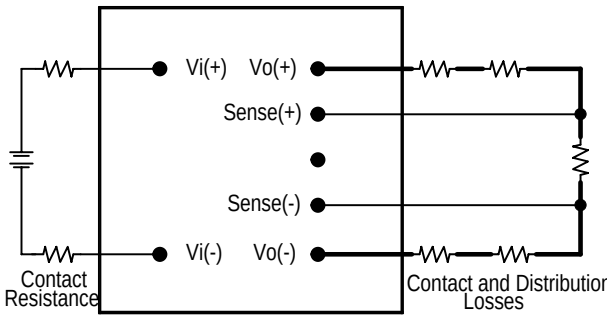


Figure 16: *Effective circuit configuration for remote sense operation*

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.

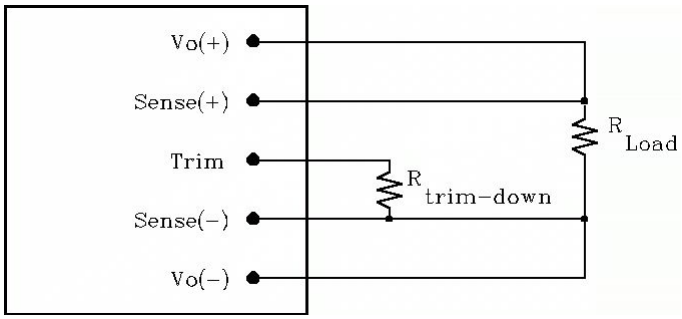


Figure 17: *Circuit configuration for trim-down (decrease output voltage)*

If the external resistor is connected between the TRIM and SENSE (-) pins, the output voltage set point decreases (Fig. 18). The external resistor value required to obtain a percentage of output voltage change △% is defined as:

$$Rt_dn := \left(\frac{1}{\Delta} - 2\right)\cdot k\Omega$$

Ex. When Trim-down -10% (28V * (1 – 10%) = 25.2V)

$$Rt_dn = \frac{1}{10\%} - 2 = 8k$$

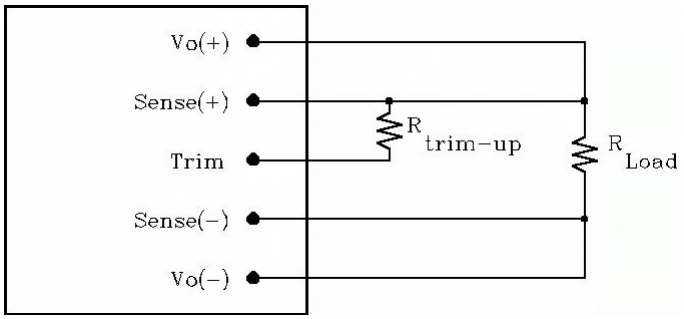


Figure 18: *Circuit configuration for trim-up (increase output voltage)*

If the external resistor is connected between the TRIM and SENSE (+) the output voltage set point increases (Fig. 19). The external resistor value required to obtain a percentage output voltage change △% is defined as:

$$Rt_up := \left[\frac{Vo\cdot(1+\Delta)}{1.24\cdot\Delta} - \frac{1}{\Delta} - 2\right]\cdot k\Omega$$

Ex. When Trim-up +10% (28.0V * (1+10%) = 30.8V)

$$Rt_up = \frac{28*(1+10\%)}{1.24*10\%} - \frac{1}{10\%} - 2 = 236.39k$$

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

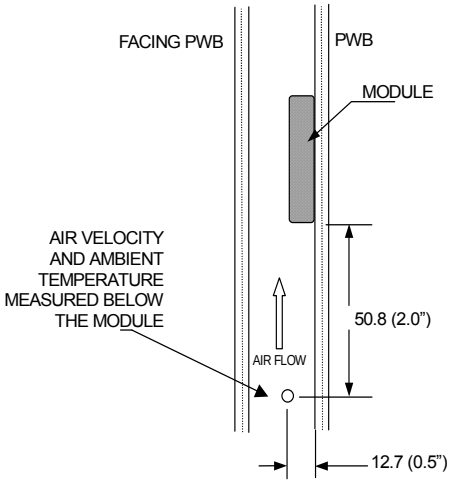
Thermal management is an important part of the system design. To ensure proper, reliable operation, sufficient cooling of the power module is needed over the entire temperature range of the module. Convection cooling is usually the dominant mode of heat transfer.

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 19: *Wind tunnel test setup*

Thermal Derating

Heat can be removed by increasing airflow over the module. The module's maximum case temperature is 95℃. 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

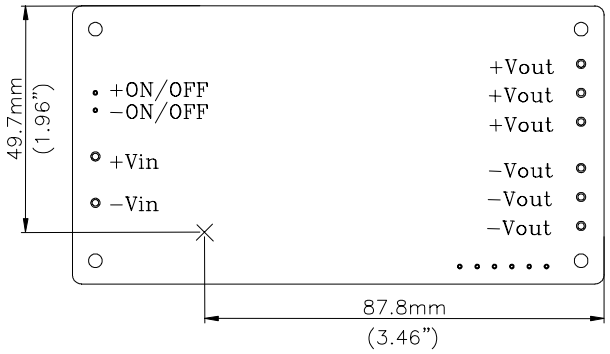


Figure 20: *Temperature measurement location viewed from the IMS side*
The allowed maximum hot spot temperature is defined at 95℃

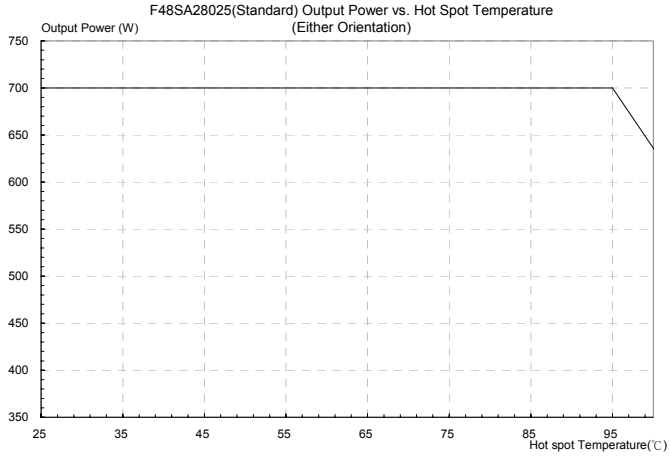
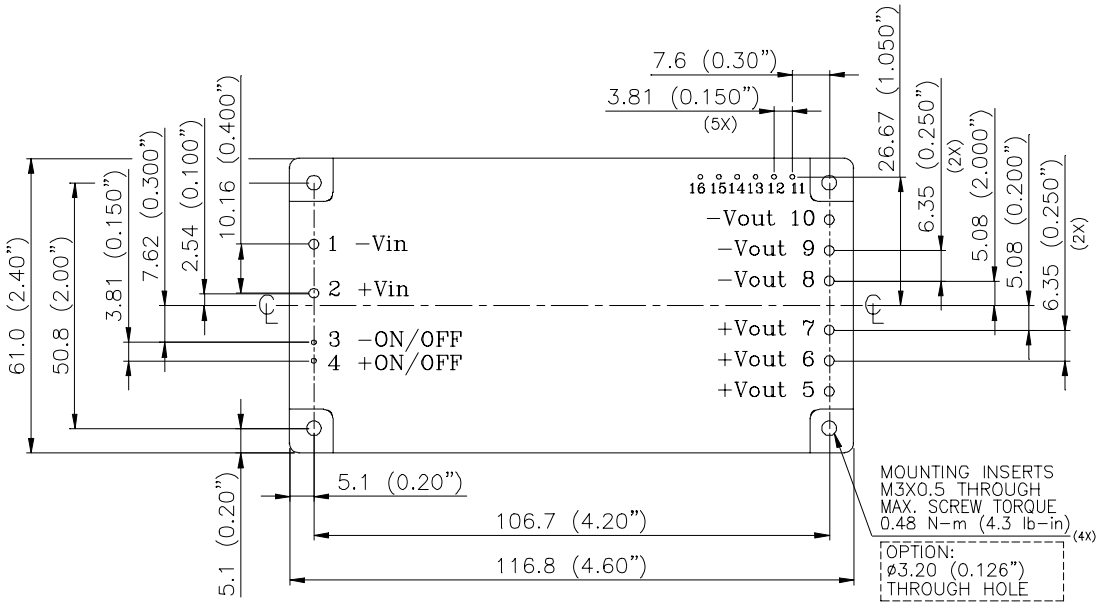
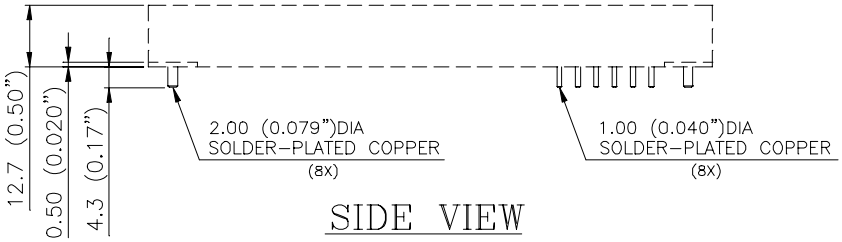


Figure 21: *Output power vs. hot spot temperature (Either Orientation)*

MECHANICAL DRAWING



BOTTOM VIEW



SIDE VIEW

PIN NO.	FUNCTION	PIN NO.	FUNCTION
11	SENSE(−)	14	PARALLEL
12	SENSE(+)	15	I.O.G. or CURRENT MONITOR
13	TRIM	16	Vaux

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	Negative input voltage
2	+Vin	Positive input voltage
3	-ON/OFF	Negative Remote ON/OFF
4	+ON/OFF	Positive Remote ON/OFF
5	+Vout	Positive output voltage
6	+Vout	Positive output voltage
7	+Vout	Positive output voltage
8	-Vout	Negative output voltage
9	-Vout	Negative output voltage
10	-Vout	Negative output voltage

Pin Specification:

Pins 3-4, 11-16	1.00mm (0.040") diameter
Pins 1-2, 6-10	2.00mm (0.079") diameter

All pins are copper with Tin plating.

PART NUMBERING SYSTEM

F	48	S	A	280	25	P	R	F	A
Form Factor	**Input Voltage**	**Number of Outputs**	**Product Series**	**Output Voltage**	**Output Current**	**ON/OFF Logic**	**Pin Length**		**Option Code**
F- Full Brick	48V	S- Single	A- Advanced	280- 28V	25- 25A	N- Negative P- Positive	R- 0.170” N- 0.145” K- 0.110”	F- RoHS 6/6 (Lead Free)	A - Standard Functions B - No thread heatsink mounting hole

MODEL LIST

MODEL NAME	INPUT		OUTPUT		EFF @ 100% LOAD
F48SA28025PRFA	36V~75V	21.4A	28V	25A	91.5 %

Default remote on/off logic is negative and pin length is 0.170”
For different remote on/off logic and pin length, please refer to part numbering system above or contact your local sales

CONTACT: www.delta.com.tw/dcdc

USA:
Telephone:
East Coast: (888) 335 8201
West Coast: (888) 335 8208
Fax: (978) 656 3964
Email: DCDC@delta-corp.com

Europe:
Phone: +41 31 998 53 11
Fax: +41 31 998 53 53
Email: DCDC@delta-es.com

Asia & the rest of world:
Telephone: +886 3 4526107 ext 6220
Fax: +886 3 4513485
Email: DCDC@delta.com.tw

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