DELPHI SERIES

Delphi Series S36SA, 25W Family
DC/DC Power Modules: 18Vin to 60Vin, 3.3V/8A out

The Delphi Series S36SA, surface mountable, 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 25 watts of power or up to 8A of output current 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.

OPTIONS

- Positive On/Off logic

APPLICATIONS

- Telecom/DataCom
- Wireless Networks
- Optical Network Equipment
- Server and Data Storage
- Industrial/Test 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	S36SA3R308NRFA			
		Min.	Typ.	Max.	Units
ABSOLUTE MAXIMUM RATINGS					
Input Voltage					
Continuous				65	Vdc
Transient (100ms)	100ms			100	Vdc
Operating Temperature	Refer to Figure 13 for measuring point	-40		100	°C
Storage Temperature		-55		125	°C
Input/Output Isolation Voltage	1 minute	1500			Vdc
INPUT CHARACTERISTICS					
Operating Input Voltage		18		60	Vdc
Input Under-Voltage Lockout					
Turn-On Voltage Threshold		16	17	18	Vdc
Turn-Off Voltage Threshold		15	16	17	Vdc
Lockout Hysteresis Voltage		0.7	1.5	2	Vdc
Maximum Input Current	100% Load, 18Vin			2.1	A
No-Load Input Current			45	100	mA
Off Converter Input Current			4	10	mA
Inrush Current(I^{2}t)			0.003	1	A^{2}s
Input Reflected-Ripple Current	P-P thru 12µH inductor, 5Hz to 20MHz			15	mA
Input Voltage Ripple Rejection	120 Hz		50		dB
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	Vin=48V, Io=Io.max, Tc=25C	3.25	3.30	3.35	Vdc
Output Voltage Regulation					
Over Load	Io=Io,min to Io,max		±3	±12	mV
Over Line	Vin=18V to60V		±3	±10	mV
Over Temperature	Tp=-40°C to 100°C		±15		mV
Total Output Voltage Range	over sample load, line and temperature	3.16		3.44	mV
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		10	30	mV
Operating Output Current Range		0		8	A
Output DC Current-Limit Inception	Output Voltage 10% Low	110		150	%
DYNAMIC CHARACTERISTICS					
Output Voltage Current Transient	48V, 10µF Tan & 1µF Ceramic load cap, 1A/µs				
Positive Step Change in Output Current	50% Io,max to 100% Io,max		80	200	mV
Negative Step Change in Output Current	100 % Io,max to 50% Io,max		80	200	mV
Settling Time (within 1% Vout nominal)			200		us
Turn-On Transient					
Start-Up Time, From On/Off Control			6	15	ms
Start-Up Time, From Input			7	15	ms
Maximum Output Capacitance	Full load; 5% overshoot of Vout at startup			3000	µF
EFFICIENCY					
100% Load	Vin=48V	86.5	88.5		%
100% Load	Vin=24V	87.5	89.5		%
ISOLATION CHARACTERISTICS					
Input to Output		1500			Vdc
Isolation Resistance		100			MΩ
Isolation Capacitance			1500		PF
FEATURE CHARACTERISTICS					
Switching Frequency			350		kHz
ON/OFF Control, (Logic Low-Module ON)					
Logic Low	Von/off at Ion/off=1.0mA			0.7	V
Logic High	Von/off at Ion/off=0.0 µA	2		18	V
ON/OFF Current	Ion/off at Von/off=0.0V			1	mA
Leakage Current	Logic High, Von/off=15V			50	uA
Output Voltage Trim Range	Across Pins 9 & 5, Pout ≤ max rated power	-10		10	%
Output Voltage Remote Sense Range	Pout ≤ max rated power			10	%
Output Over-Voltage Protection	Over full temp range; % of nominal Vout	115	122	135	%
GENERAL SPECIFICATIONS					
MTBF	Io=80% of Io, max; Tc=40°C		5.8		Mhour
Weight			16.9		grams
Over-Temperature Shutdown	Refer to Figure 13 for measuring point		105		°C

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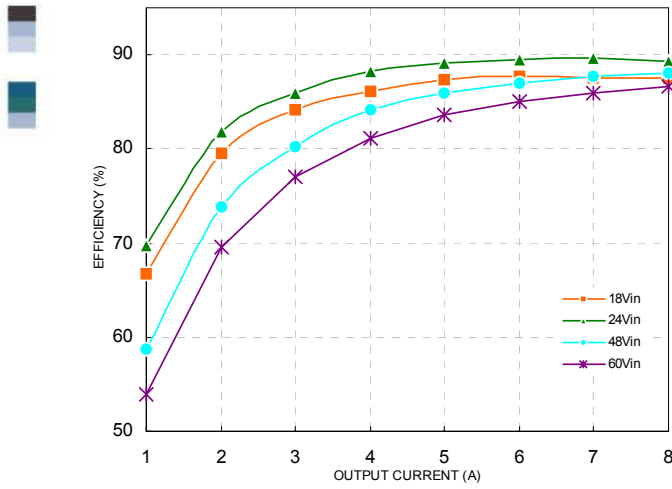
Figure 1: *Efficiency vs. load current for minimum, nominal, and maximum input voltage at 25°C.*
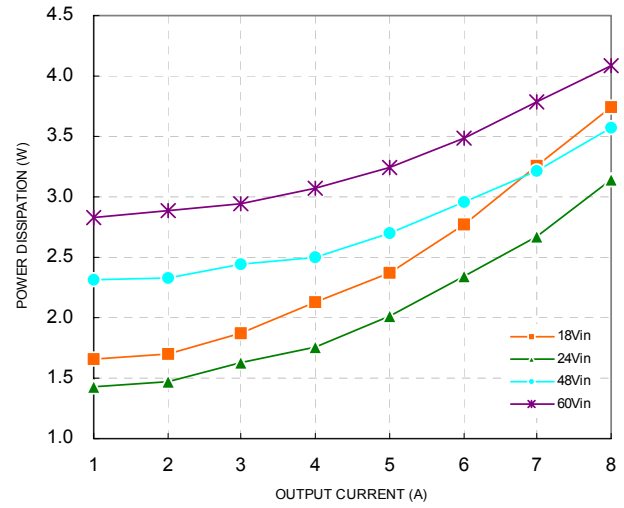

Figure 2: *Power dissipation vs. load current for minimum, nominal, and maximum input voltage at 25°C.*
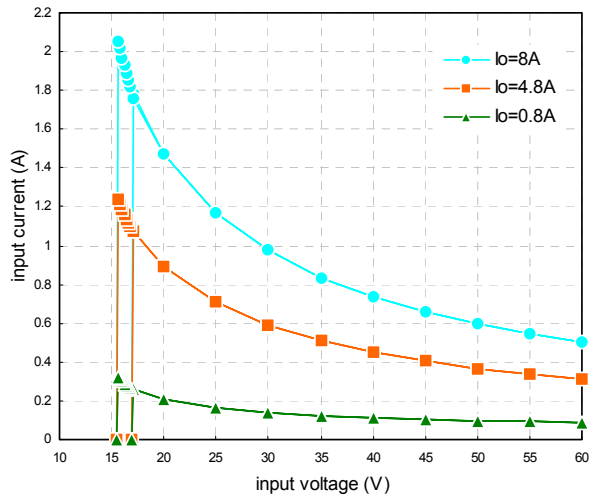

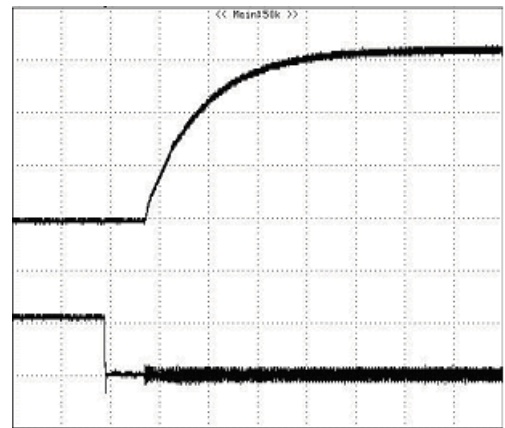**Figure 3:** *Typical input characteristics at 25°C.*

Figure 4: *Turn-on transient at full load current (Constant resistance mode) (1 ms/div). Vin: 48V; Top Trace: Vout (1V/div); Bottom Trace: ON/OFF Control (5V/div).*
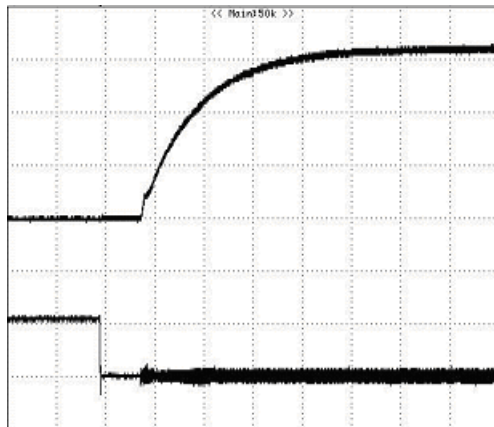
ELECTRICAL CHARACTERISTICS CURVES

Figure5: Turn-on transient at zero load current (Constant resistance mode) (1 ms/div). **Vin: 48V;** Top Trace: Vout (1V/div); Bottom Trace: ON/OFF Control (5V/div).
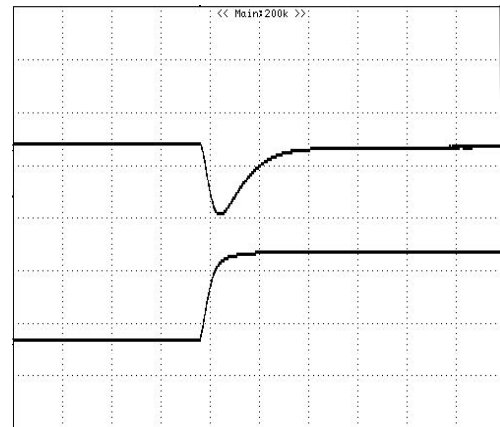

Figure 6: Output voltage response to step-change in load current (50%-100% of Io, max; di/dt = 1A/µs). Load cap: 10µF, 100 mΩ ESR tantalum capacitor and 1µF ceramic capacitor. Top Trace: Vout (50mV/div, 100 us/div), Bottom Trace: Iout (2.42A/div).

Figure 7: Output voltage response to step-change in load current (100%-50% of Io, max; di/dt = 1A/µs). Load cap: 10µF, 100 mΩESR tantalum capacitor and 1µF ceramic capacitor. Top Trace: Vout (50mV/div, 100 us/div), Bottom Trace: Iout (2.42A/div).
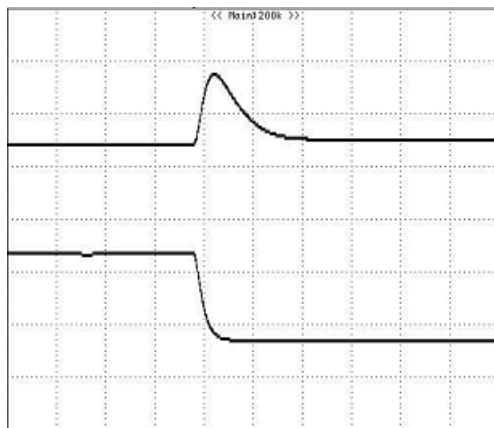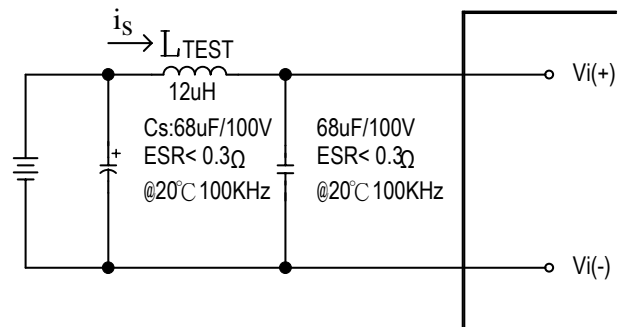

Figure 8: Test set-up diagram showing measurement points for Input Reflected Ripple Current (Figure 9).
Note: Measured input reflected-ripple current with a simulated source Inductance (L_{TEST}) of 12 µH. Capacitor Cs offset possible battery impedance.
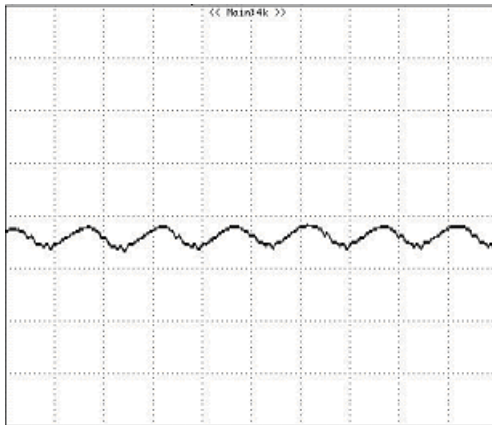
ELECTRICAL CHARACTERISTICS CURVES

Figure 9: *Input reflected ripple current, i_S, at full rated output current and nominal input voltage with 12µH source impedance and 68µF electrolytic capacitor (20 mA/div).*

Figure 10: *Output voltage noise and ripple measurement test setup. 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.*

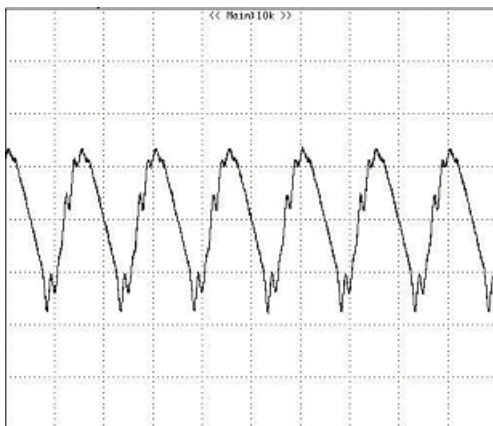**Figure 11:** *Output voltage ripple at nominal input voltage and rated load current (20 mV/div). Load capacitance: 1µF ceramic capacitor and 10µF tantalum capacitor. Bandwidth: 20 MHz.*

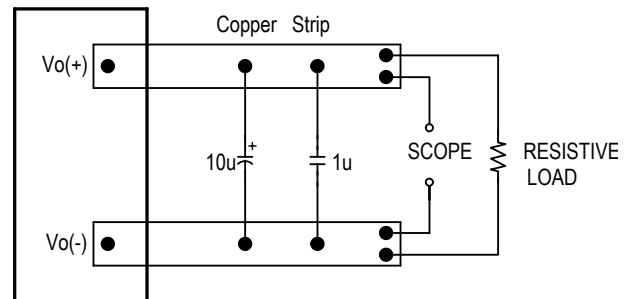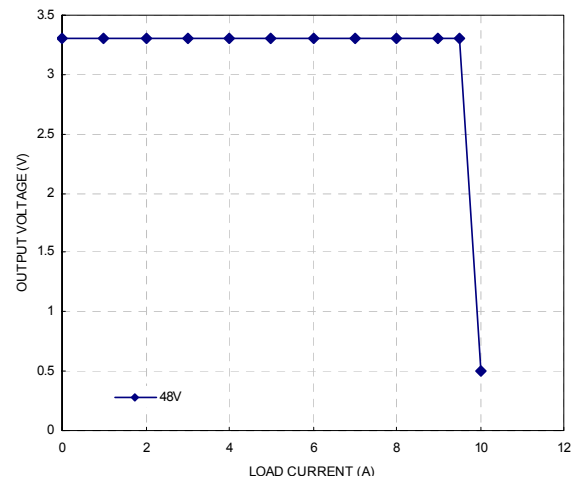**Figure 12:** *Output voltage vs. load current showing typical current limit curves and converter shutdown points.*

THERMAL DERATING CURVE

Hot spot

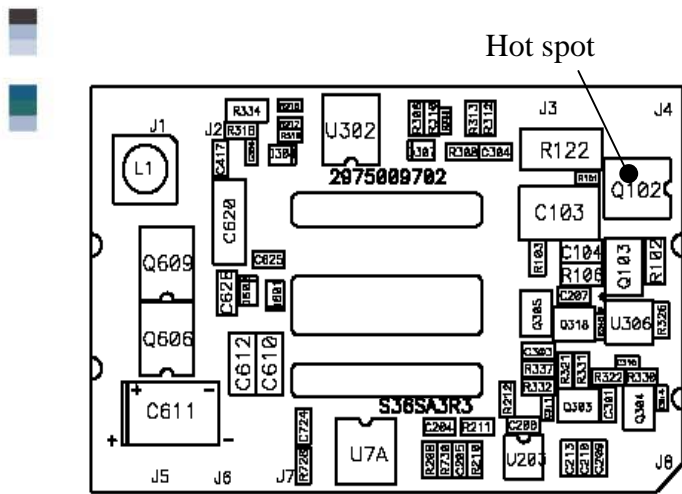**Figure 13:** *Hot spot location*

S36SA3R308NR A Output Load vs. Ambient Temperature and Air Velocity
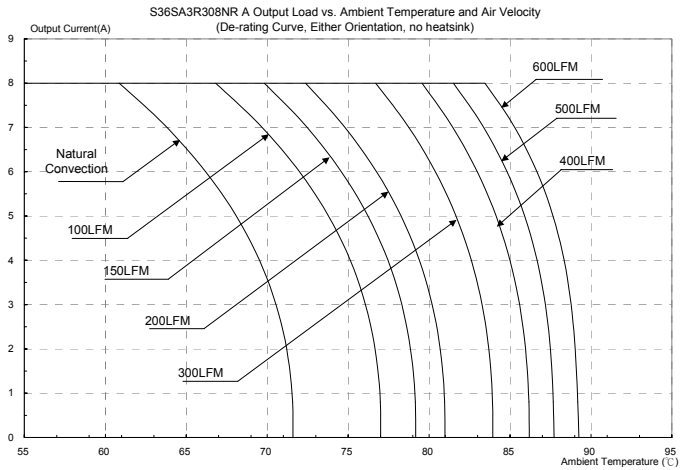(De-rating Curve, Either Orientation, no heatsink)

Figure 14: *Output current vs. ambient temperature and air velocity (Either Orientation)*

DESIGN CONSIDERATION

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 5A 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 (Hiccup mode). The modules will try to restart after shutdown. If the fault condition still exists, the module will shut down again. This restart trial will continue until the fault 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 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.

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.
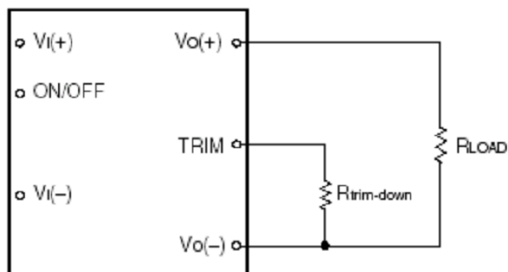

Figure 15: Circuit configuration for trim-down (decrease output voltage)

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 $\triangle$Vo% is defined as:

$$Rtrim-down = \frac{511}{\Delta\%} - 6.11 [K\Omega]$$

Ex. When trim-down –10% (3.3V X 0.9 = 2.97V)

$$Rtrim-down = \frac{511}{10} - 6.11 = 44.99 [K\Omega]$$
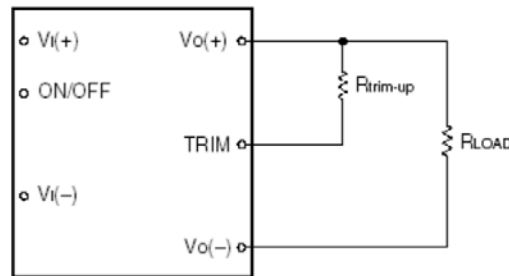
Figure 16: Circuit configuration for trim-up (increase output voltage)

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 $\triangle$Vo% is defined as:

$$Rtrim-up = \frac{5.11*Vo*(100+\Delta\%)}{1.225*\Delta\%} - \frac{511}{\Delta\%} - 6.11[K\Omega]$$

Ex. When trim-up +10% (3.3V X 1.1 = 3.63V)

$$Rtrim-up = \frac{5.11*3.3*(100+10)}{1.225*10} - \frac{511}{10} - 6.11 = 94.21[K\Omega]$$

Care should be taken to ensure that the maximum output power of the module remains at or below the maximum rated power.

FEATURES DESCRIPTIONS (CONTINUED)

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. If the remote on/off feature is not used, please short the on/off pin to Vi(-) for negative logic and let the pin open for positive logic.
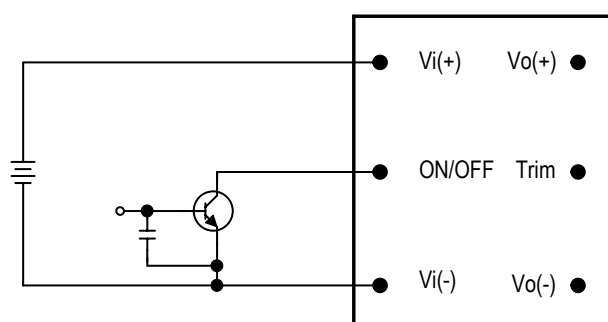

Figure 17: Circuit configuration for remote ON/OFF

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 and 14 show maximum output is a function of ambient temperature and airflow rate. The module's highest hot spot temperature is +120°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.
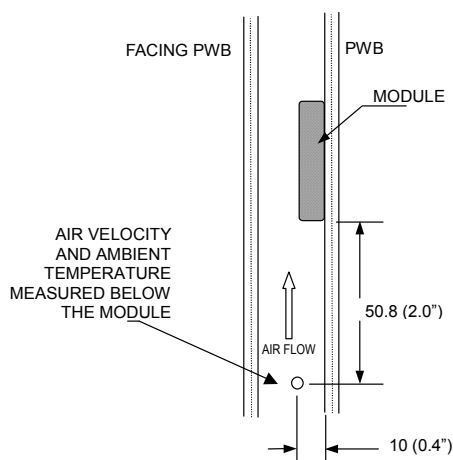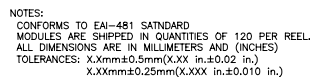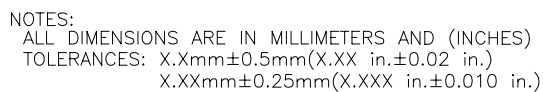

Note: Wind Tunnel Test Setup Figure Dimensions are in millimeters and (Inches)

Figure 18: Wind tunnel test setup

PICK AND PLACE LOCATION

47.2 (1.86")

23.40 (0.921")

14.10 (0.555")

29.5 (1.16")

PIN 1

Ø6.0 (0.24") MIN. AREA
PICK AND PLACE LOCATION

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

SURFACE-MOUNT TAPE & REEL

36.00 (1.417")   4.00 (0.157")

TOP COVER TAPE
EMBOSSED CARRIER

9.40 (0.370")

34.00 (1.338")
PICK POINT

FEED
DIRECTION

65.50 (2.578")
68.40 (2.692")
72.00 (2.834")

PIN 1   TOP COVER TAPE   EMBOSSED CARRIER

Ø330.0 (13.00")
Ø13.0 (0.51")
Ø177.8 (7.00")

NOTES:
 CONFORMS TO EAI-481 SATNDARD
 MODULES ARE SHIPPED IN QUANTITIES OF 120 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)

47.2 (1.86")

29.5 (1.16")

26.16 (1.030")

1.7 (0.07")

12 11
+Vin −Vin

9   8
N/C ON/OFF
(OPTION)

(OPTION) (OPTION)
+SENSE −SENSE TRIM

+Vout −Vout
1   2

4   5   6

3.6 (0.14")

5.00 (0.191")
(3X)

30.00 (1.181")

Ø2.80 (0.110")
PAD (9X)

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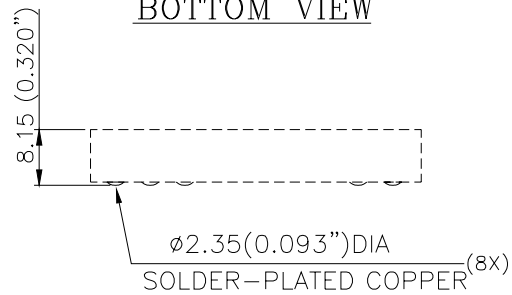
NOTES:
 DIMENSIONS ARE IN MILLIMETERS AND (INCHES)
 TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)
              X.XXmm±0.25mm(X.XXX in.±0.010 in.)

MECHANICAL DRAWING
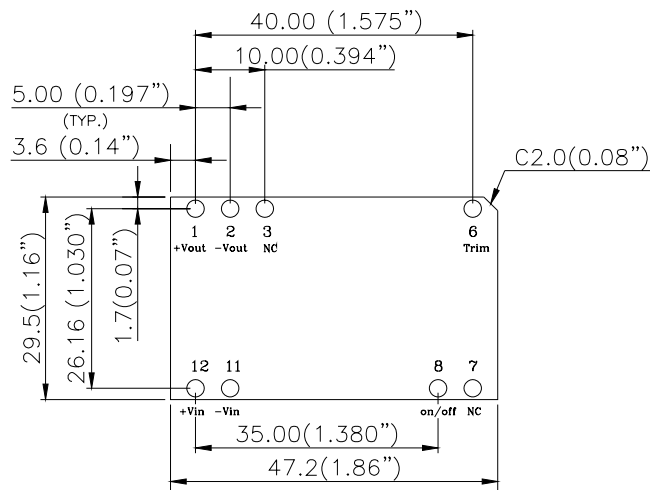
BOTTOM VIEW

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	+Vout	Positive output voltage
2	-Vout	Negative output voltage
3	NC	No Connection
6	Trim	Output voltage trim
7	NC	No Connection
8	ON/OFF	ON/OFF Logic
10	NC	No Connection
11	-Vin	Negative input voltage
12	+Vin	Positive input voltage

PART NUMBERING SYSTEM

S	36	S	A	3R3	08	N	R	F	A
Form Factor	Input Voltage	Number of Outputs	Product Series	Output Voltage	Output Current	ON/OFF Logic	Pin Type		Option Code
S- Small Power	18~60V	S- Single	A- Advanced	3R3- 3.3V	08- 8.0A	N- Negative P- Positive	R- SMD	Space-RoHS 5/6 F- RoHS 6/6 (Lead Free)	A- Standard

MODEL LIST

MODEL NAME	INPUT		OUTPUT		EFF @ 100% LOAD
S36SA3R308NRFA	18V~60V	2.1A	3.3V	8.0A	88.5%

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Email: DCDC@delta-es.com

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Telephone: +886 3 4526107 ext 6220
Fax: +886 3 4513485
Email: DCDC@delta.com.tw

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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