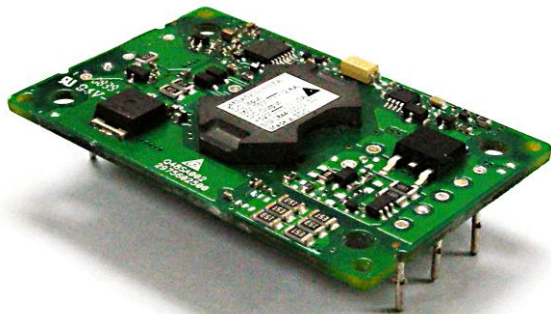


DELPHI SERIES



Delphi Series Q48SA, 80W Quarter Brick Family DC/DC Power Modules: 36~75V in, 54V/1.5A out

The Delphi Q48SA series quarter Brick, 36~75V input, single output, isolated DC/DC converter is the latest offering from a world leader in power system and technology and manufacturing — Delta Electronics, Inc. This product family operates from a wide 36~75V input voltage range and provides up to 80 watts of power in an 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.

FEATURES

- ◆ High efficiency 92% @54V/1.5A
- ◆ Size:
 - 57.9x36.8x9.8mm (2.28"x1.45"x0.39") (w/o Heat Spreader)
 - 57.9x36.8x12.7mm (2.28"x1.45"x0.50") (with Heat Spreader)
- ◆ Standard footprint
- ◆ Industry standard pin out
- ◆ Fixed frequency operation
- ◆ Input UVLO, Output OCP, OVP, OTP
- ◆ 2250V isolation and basic insulation
- ◆ No minimum load required
- ◆ ISO 9001, TL 9000, ISO 14001, QS9000, OHSAS18001 certified manufacturing facility
- ◆ UL/cUL 60950-1 (US & Canada), and TUV (EN60950-1) - pending

OPTIONS

- ◆ Positive, negative, or no On/Off
- ◆ OTP and Output OVP, OCP mode, Auto-restart (default) or latch-up

APPLICATIONS

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

TECHNICAL SPECIFICATIONS

(T_A=25°C, airflow rate=300 LFM, V_{in}=48Vdc, nominal V_{out} unless otherwise noted;

PARAMETER	NOTES and CONDITIONS	Q48SA54001 (Standard)			
		Min.	Typ.	Max.	Units
ABSOLUTE MAXIMUM RATINGS					
Input Voltage					
Continuous				80	Vdc
Transient (100ms)	100ms			100	Vdc
Operating Case Temperature (Open-frame Version)	Please refer to Figure 20	-40		115	°C
Operating Case Temperature (Heat spreader Version)	Please refer to Figure 22	-40		114	°C
Storage Temperature		-55		125	°C
Input/Output Isolation Voltage	1 minute			2250	Vdc
INPUT CHARACTERISTICS					
Operating Input Voltage		36	48	75	Vdc
Input Under-Voltage Lockout					
Turn-On Voltage Threshold		32		35	Vdc
Turn-Off Voltage Threshold		29		32	Vdc
Lockout Hysteresis Voltage		2		4	Vdc
Maximum Input Current	100% Load, 36V _{in}			3.5	A
No-Load Input Current			50		mA
Off Converter Input Current	V _{in} =48V		8		mA
Inrush Current(I ² t)				1	A ² s
Input Reflected-Ripple Current	P-P thru 12μH inductor, 5Hz to 20MHz		10		mA
Input Voltage Ripple Rejection	120 Hz		50		dB
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	V _{in} =48V, I _o =I _{o,max} , T _c =25°C	52.7	53.5	54.2	Vdc
Output Voltage Regulation					
Over Load	I _o =I _{o,min} to I _{o,max}		±20	+802.5	mV
Over Line	V _{in} =36V to 75V		±20	+267.5	mV
Over Temperature	T _c =-40°C to 100°C			0.02	%V _o /°C
Total Output Voltage Range	over sample load, line and temperature	51.9		55.1	V
Output Voltage Ripple and Noise					
Peak-to-Peak	(high frequency low ESR external capacitor required)		100	200	mV
RMS	(high frequency low ESR external capacitor required)		30	50	mV
Operating Output Current Range		0		1.5	A
Output over current protection	Hiccup mode	1.65		2.25	A
DYNAMIC CHARACTERISTICS					
Output Voltage Current Transient	48V, 220μF electrolytic& 1μF Ceramic load cap, 0.1A/μs				
Positive Step Change in Output Current	25% I _{o,max} to 50% I _{o,max}		750		mV
Negative Step Change in Output Current	50% I _{o,max} to 25% I _{o,max}		750		mV
Settling Time (within 1% V _{out} nominal)			TBD		μs
Turn-On Transient					
Start-Up Time, From On/Off Control			100	200	ms
Start-Up Time, From Input			100	200	ms
External Output Capacitance	Full load; 5% overshoot of V _{out} at startup	100	220	2200	μF
EFFICIENCY					
100% Load	V _{in} =48V		92.0		%
60% Load	V _{in} =48V		91.5		%
ISOLATION CHARACTERISTICS					
Input to Output				2250	Vdc
Isolation Resistance		10			MΩ
Isolation Capacitance			1000		pF
FEATURE CHARACTERISTICS					
Switching Frequency			350		kHz
ON/OFF Control, Negative Remote On/Off logic					
Logic Low (Module On)	V _{on/off} at I _{on/off} =1.0mA	-0.7		1.2	V
Logic High (Module Off)	V _{on/off} at I _{on/off} =0.0 μA	3.5		15	V
ON/OFF Control, Positive Remote On/Off logic					
Logic Low (Module Off)	V _{on/off} at I _{on/off} =1.0mA	0		1.2	V
Logic High (Module On)	V _{on/off} at I _{on/off} =0.0 μA	3.5		15	V
ON/OFF Current (for both remote on/off logic)	I _{on/off} at V _{on/off} =0.0V			1.5	mA
Leakage Current (for both remote on/off logic)	Logic High, V _{on/off} =15V				μA
Output Voltage Trim Range	P _{out} ≤max rated power	85		100	%V _o
Output Over-Voltage Protection (Hiccup Mode)	Over full temp range; % of nominal V _{out}	57		65	V
GENERAL SPECIFICATIONS					
MTBF	I _o =80% of I _{o,max} ; T _c =40°C		TBD		M hours
Weight			43		grams
Over-Temperature Shutdown (Openframe Version)	Please refer to Figure 20		125		°C
Over-Temperature Shutdown (Heat spreader Version)	Please refer to Figure 22		126		°C

ELECTRICAL CHARACTERISTICS CURVES

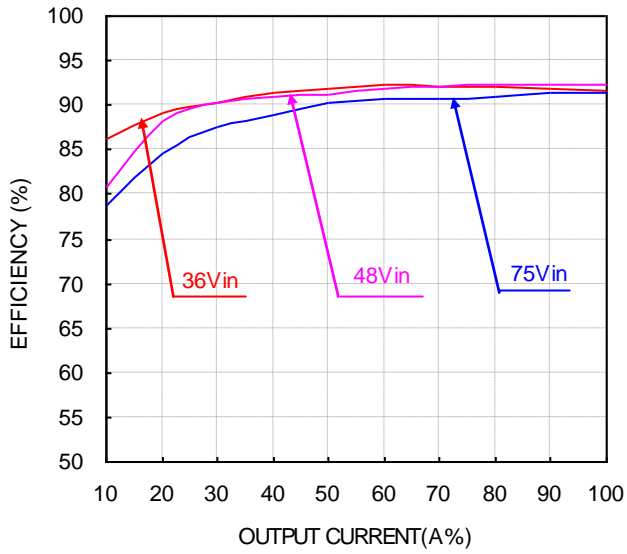


Figure 1: Efficiency vs. load current for minimum, nominal, and maximum input voltage at 25°C.

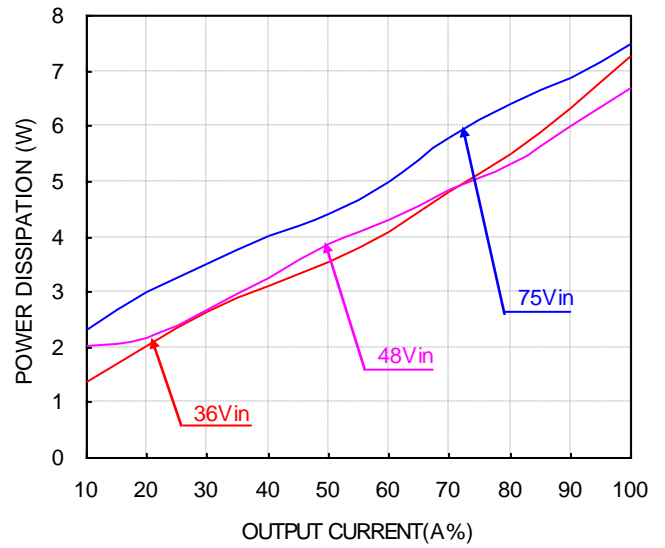


Figure 2: Power dissipation vs. load current for minimum, nominal, and maximum input voltage at 25°C.

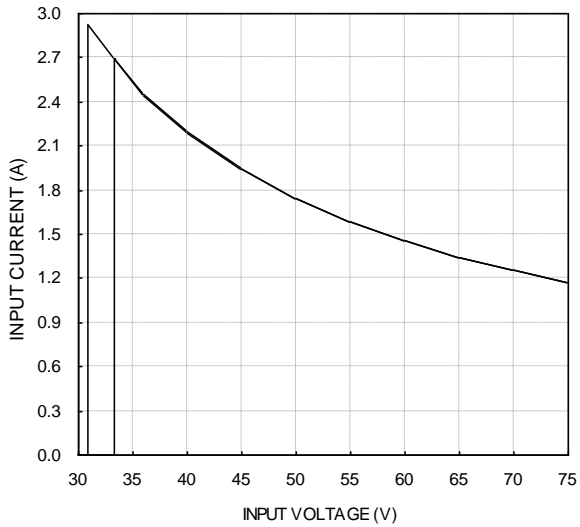


Figure 3: Typical full load input characteristics at room temperature.



ELECTRICAL CHARACTERISTICS CURVES

For Negative Remote On/Off Logic

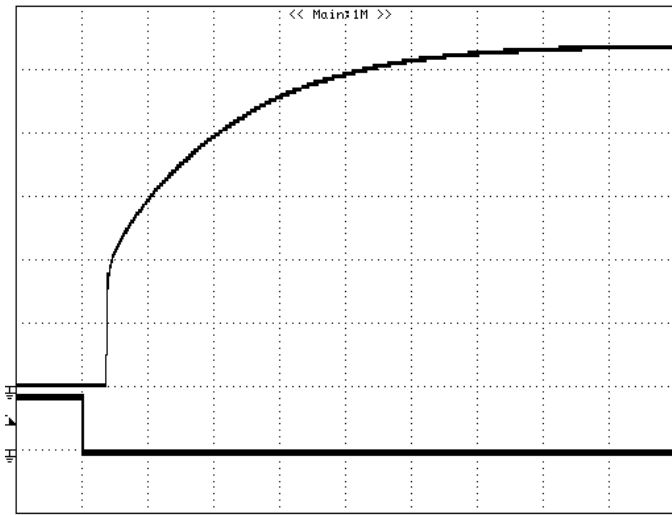


Figure 4: Turn-on transient at full rated load current (20ms/div).
Top Trace: Vout; 10V/div; Bottom Trace: ON/OFF input: 5V/div.

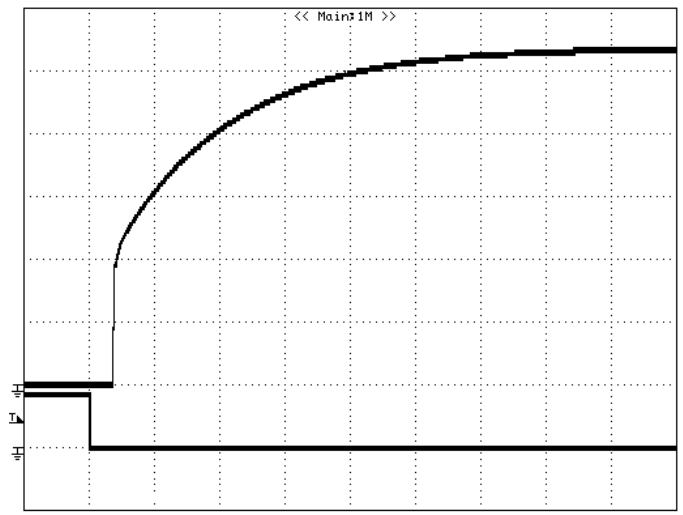


Figure 5: Turn-on transient at zero load current (20ms/div).
Top Trace: Vout; 10V/div; Bottom Trace: ON/OFF input:5V/div.

For Input Voltage Start up

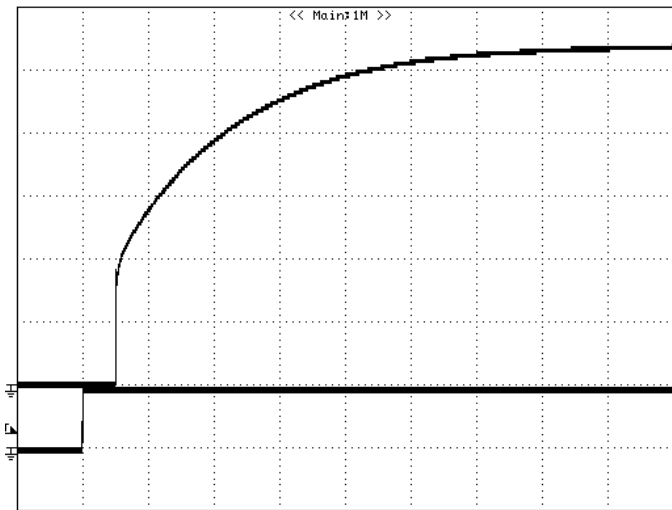


Figure 6: Turn-on transient at full rated load current (20ms/div).
Top Trace: Vout; 10V/div; Bottom Trace: input voltage: 50V/div.

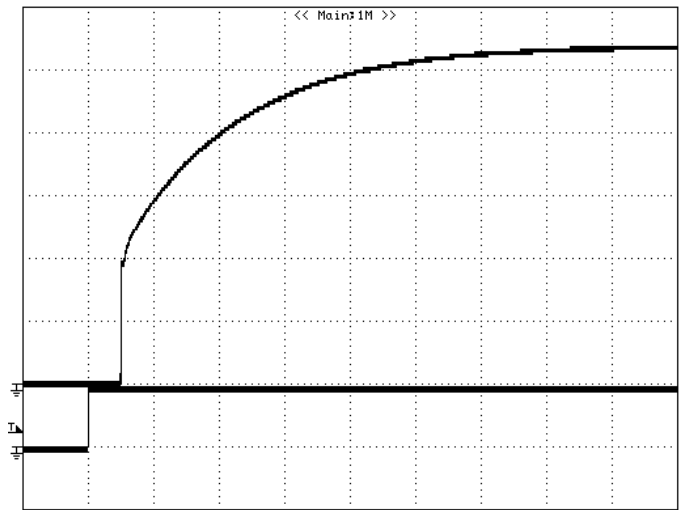


Figure 7: Turn-on transient at zero load current (20ms/div).
Top Trace: Vout; 10V/div; Bottom Trace: input voltage: 50V/div.

ELECTRICAL CHARACTERISTICS CURVES

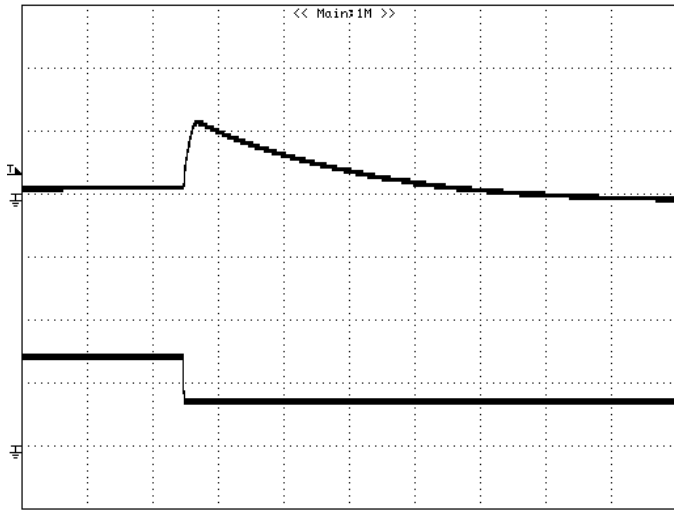


Figure 8: Output voltage response to step-change in load current (50%-25% of I_o , max; $di/dt = 0.1A/\mu s$). Load cap: 220 μF aluminum capacitor and 1 μF ceramic capacitor. TOP Trace: V_{out} (200mV/div), Bottom Trace: I_{out} (500mA/div), Scope measurement should be made using a BNC cable (length shorter than 20 inches). Position the load between 51 mm to 76 mm (2 inches to 3 inches) from the module.

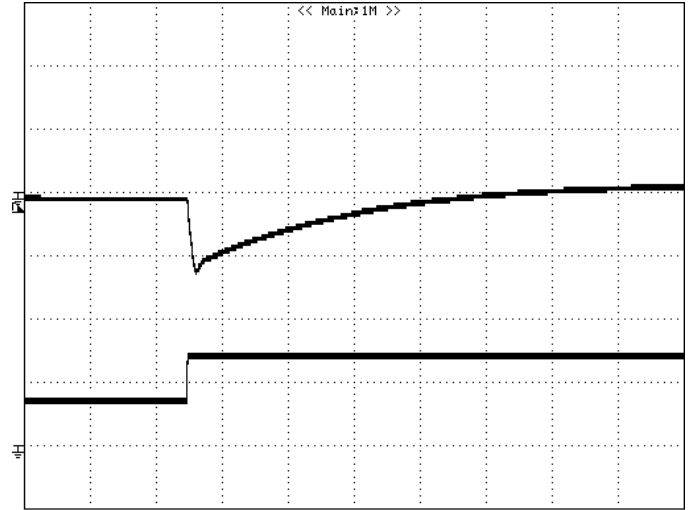


Figure 9: Output voltage response to step-change in load current (25%-50% of I_o , max; $di/dt = 0.1A/\mu s$). Load cap: 220 μF aluminum capacitor and 1 μF ceramic capacitor. TOP Trace: V_{out} (200mV/div), Bottom Trace: I_{out} (500mA/div), Scope measurement should be made using a BNC cable (length shorter than 20 inches). Position the load between 51 mm to 76 mm (2 inches to 3 inches) from the module.

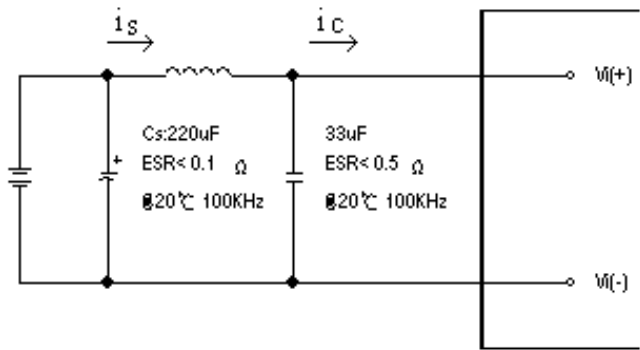


Figure 10: Test set-up diagram showing measurement points for Input Terminal Ripple Current and Input Reflected Ripple Current.
 Note: Measured input reflected-ripple current with a simulated source Inductance (L_{TEST}) of 12 μH . Capacitor C_s offset possible battery impedance. Measure current as shown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

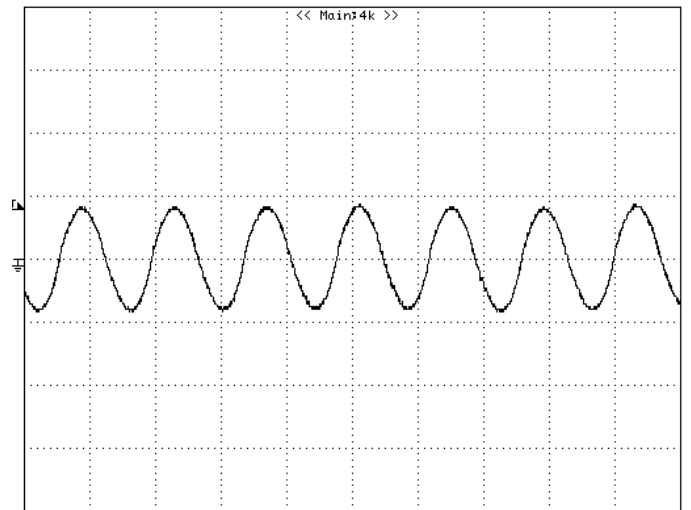


Figure 11: Input Terminal Ripple Current, i_c , at full rated output current and nominal input voltage with 12 μH source impedance and 33 μF electrolytic capacitor (200mA/div, 2 μs /div).

ELECTRICAL CHARACTERISTICS CURVES

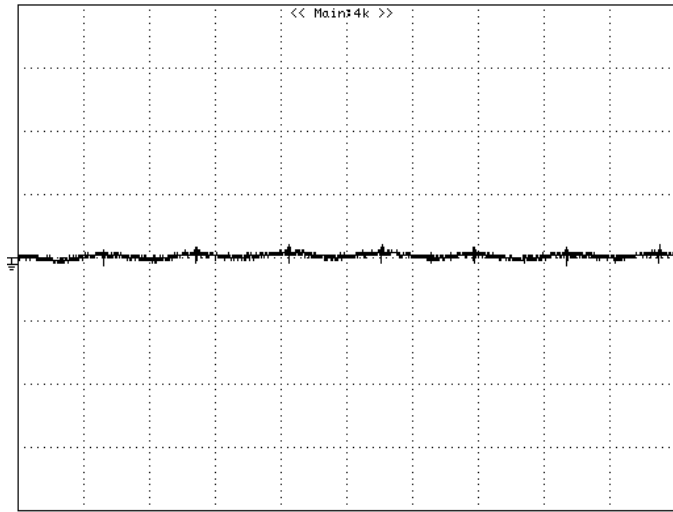


Figure 12: Input reflected ripple current, i_s , through a $12\mu H$ source inductor at nominal input voltage and rated load current ($20mA/div$, $2\mu s/div$).

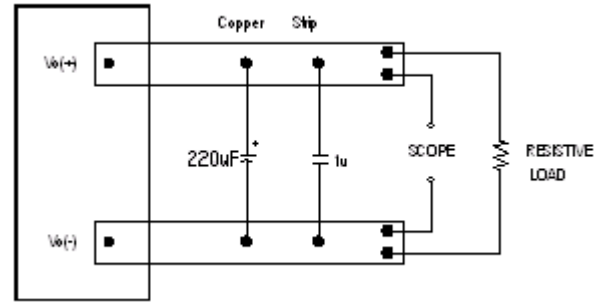


Figure 13: Output voltage noise and ripple measurement test setup.

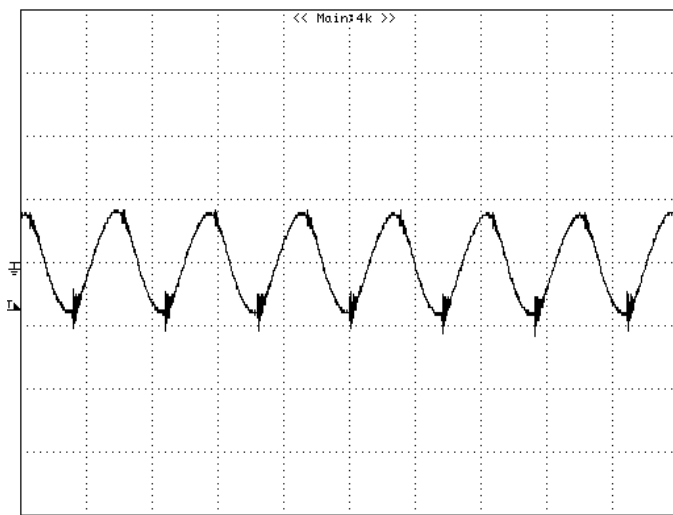


Figure 14: Output voltage ripple at nominal input voltage and rated load current ($I_o=1.5A$) ($50mV/div$, $2\mu s/div$)
Load capacitance: $1\mu F$ ceramic capacitor and $220\mu F$ electrolytic capacitor. Bandwidth: $20MHz$. Scope measurements should be made using a BNC cable (length shorter than 20 inches). Position the load between 51 mm to 76 mm (2 inches to 3 inches) from the module.

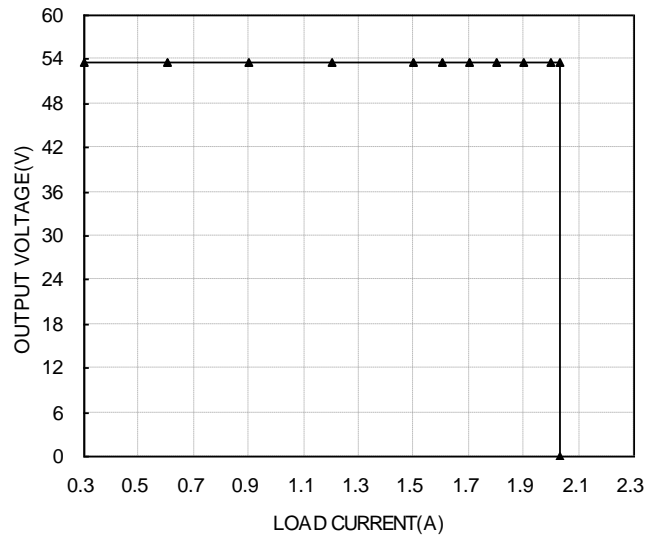


Figure 15: Output voltage vs. load current showing typical current limit curves and converter shutdown points.

DESIGN CONSIDERATIONS

Input Source Impedance

The impedance of the input source connecting to the DC/DC power modules will interact with the modules and affect the stability. A low ac-impedance input source is recommended. If the source inductance is more than a few μH , we advise adding a $10\mu\text{F}$ to $100\mu\text{F}$ electrolytic capacitor ($\text{ESR} < 0.7 \Omega$ 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., UL60950-1, CAN/CSA-C22.2, No. 60950-1 and EN60950-1+A11 and IEC60950-1, 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 circuit, 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 / heatspreader is grounded the output must be also 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. The default OVP operation is hiccup mode. Under 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.

Also, an optional latch-off mode for OVP is available. 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

The remote on/off feature on the module can be either negative or positive logic. Negative logic turns the module on during a logic low and off during a logic high. Positive logic turns the modules on during a logic high and off during a logic low.

Remote on/off can be controlled by an external switch between the on/off terminal and the Vi(-) terminal. The switch can be an open collector or open drain.

For negative logic, if the remote on/off feature is not used, please short the on/off pin to Vi (-). For positive logic, if the remote on/off feature is not used, please leave the on/off pin to floating.

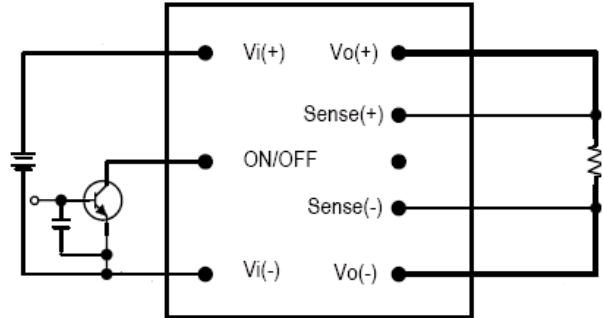


Figure 16: Remote on/off implementation

Output Voltage Adjustment (TRIM)

To increase or decrease the output voltage set point, the modules may be connected with an external resistor between the TRIM pin and either Vout1 (+) or Vout (-). The TRIM pin should be left open if this feature is not used.

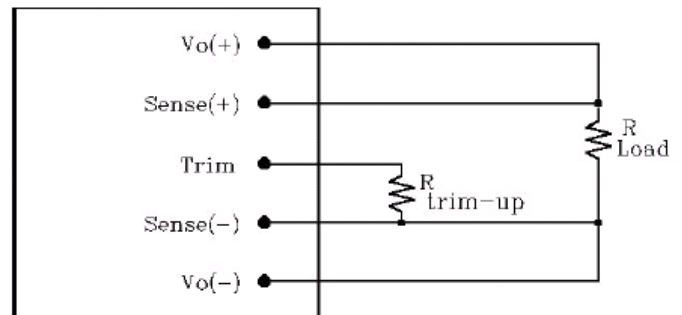


Figure 17: Circuit configuration for trim-up (increase output voltage)

If the external resistor is connected between the TRIM and sense (-) pin, the output voltage set point increases (Fig. 17). The external resistor value required to obtain output voltage change ΔU is defined as:

$$R_{trim-up} = \frac{127.5}{\Delta U} - 4.7(K\Omega)$$

Ex. When Trim-up 5%, ΔU is $5\% * V_{normal} = 0.05 * 53.5 = 2.675$

$$R_{trim-up} = \frac{127.5}{2.675} - 4.7 = 42.96K\Omega$$

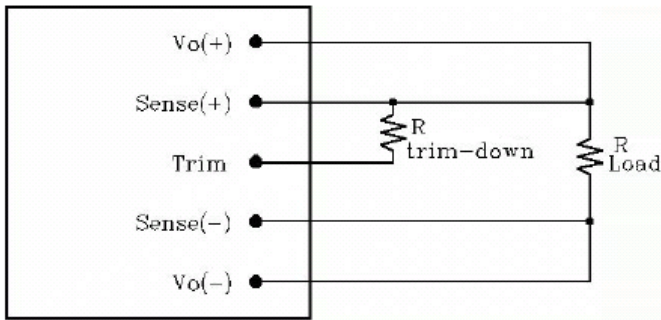


Figure 18: Circuit configuration for trim-down (decrease output voltage)

If the external resistor is connected between the TRIM and sense(+), V_{out} decreases (Fig. 18). The external resistor value required to obtain output voltage change ΔU is defined as:

$$R_{trim-down} = \frac{51 * 51}{\Delta U} - 55.7 (K\Omega)$$

Ex. When Trim-down 15%, ΔU is $15% * V_{normal} = 0.15 * 53.5 = 8.025$

$$R_{trim-down} = \frac{51 * 51}{8.025} - 55.7 = 268.4 (K\Omega)$$

When using trim-up, 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

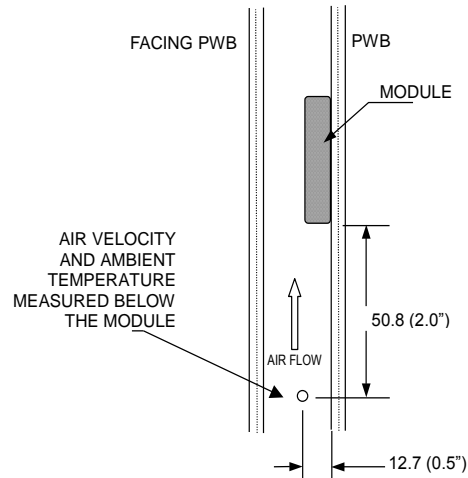
Thermal management is an important part of the system design. To ensure proper, reliable operation, sufficient cooling of the power module is needed over the entire temperature range of the module. Convection cooling is usually the dominant mode of heat transfer.

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. 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

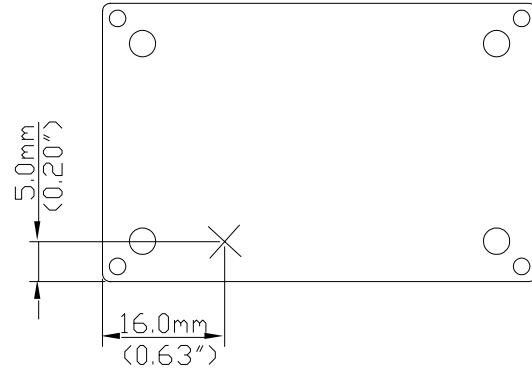
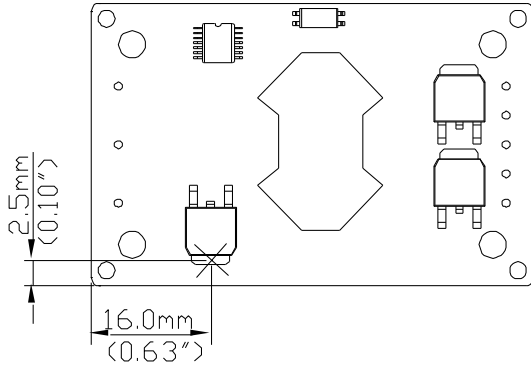


Figure 20: Temperature measurement location

* The allowed maximum hot spot temperature is defined at 125°C

Figure 22: Temperature measurement location

* The allowed maximum hot spot temperature is defined at 126°C

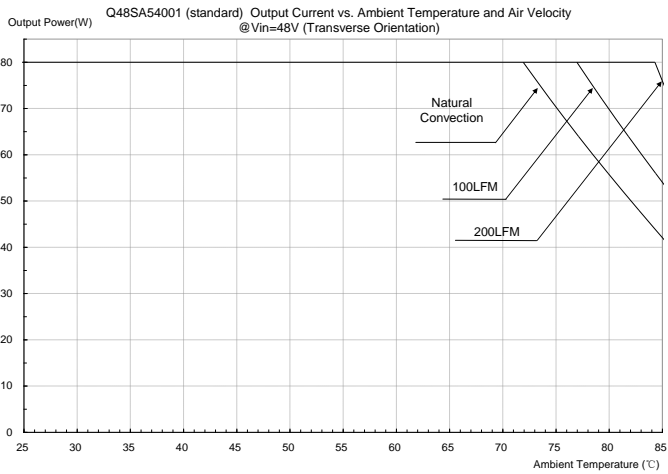


Figure 21: Output current vs. ambient temperature and air velocity @Vin=48V(Transverse Orientation, Openframe)

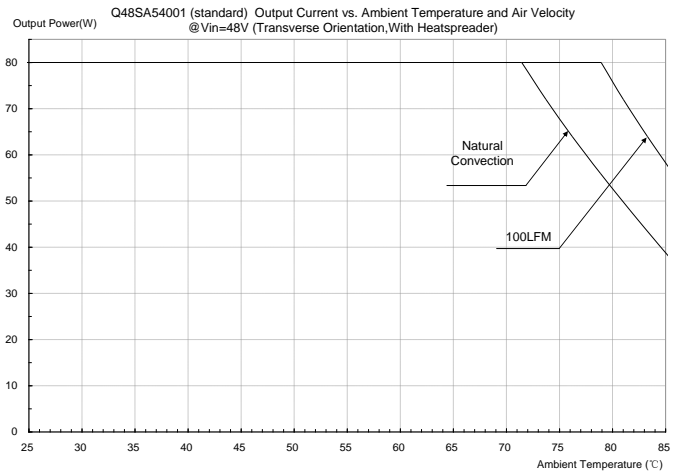
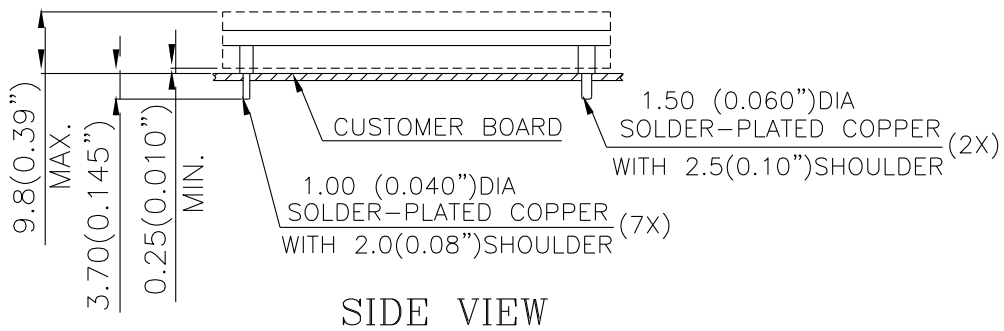
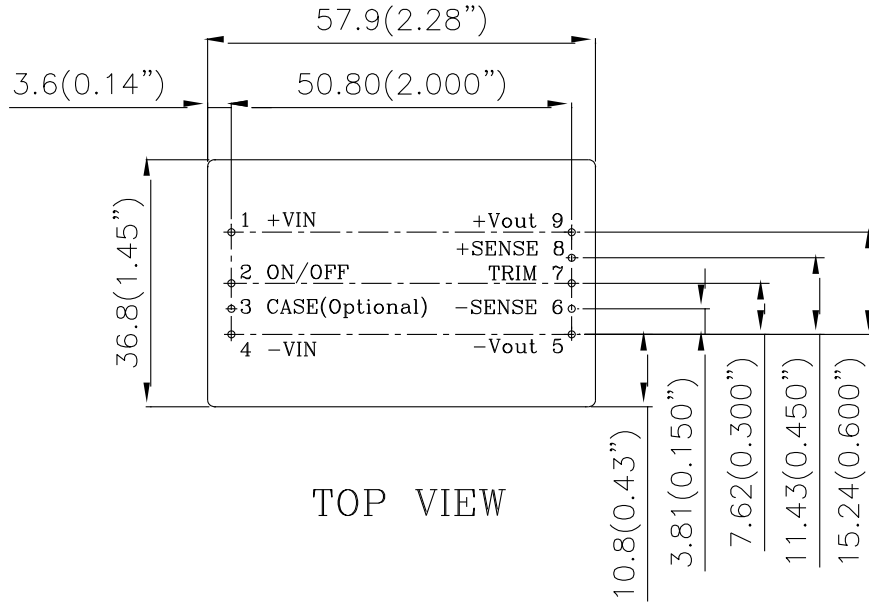


Figure 23: Output current vs. ambient temperature and air velocity @Vin=48V(Transverse Orientation, With Heat spreader)

MECHANICAL DRAWING (WITHOUT HEAT SPREADER)



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.)

<u>Pin No.</u>	<u>Name</u>	<u>Function</u>
1	+Vin	Positive input voltage
2	ON/OFF	Remote ON/OFF
3	Case	Optional
4	-Vin	Negative input voltage
5	-Vout	Negative output voltage
6	-Sense	Negative remote sense
7	Trim	Output voltage trim
8	+Sense	Positive remote sense
9	+Vout	Positive output voltage

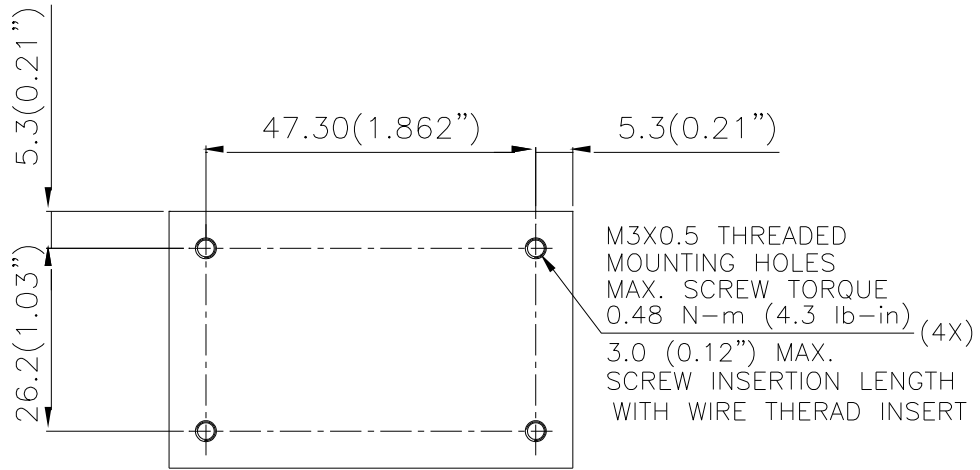
Pin Specification:

Pins 1-4,6-8 1.00mm (0.040") diameter

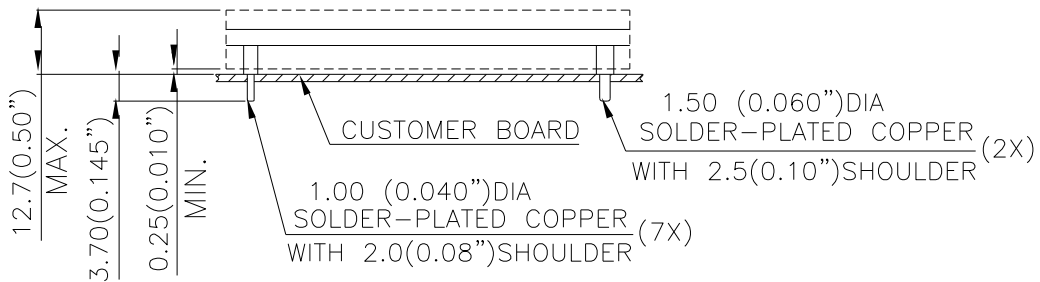
Pins 5 & 9 1.50mm (0.059") diameter

All pins are copper with Tin plating.

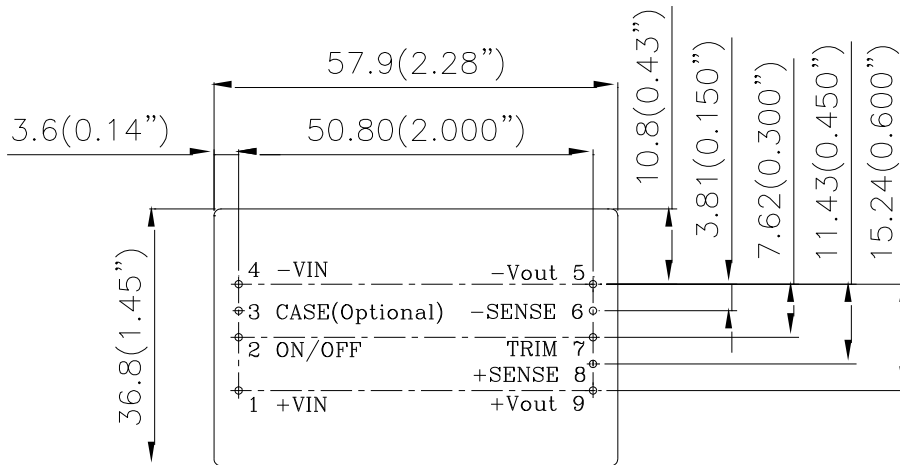
MECHANICAL DRAWING (WITH HEAT SPREADER)



TOP VIEW



SIDE VIEW



BOTTOM 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.)

PART NUMBERING SYSTEM

Q	48	S	A	540	01	N	N	F	H
Form Factor	Input Voltage	Number of Outputs	Product Series	Output Voltage	Output Current	ON/OFF Logic	Pin Length		Option Code
Q - Quarter Brick	48 - 36~75V	S - Single	A - Advanced	540 - 54V	01- 1.5A	N - Negative	R - 0.170" N - 0.145"	Space- RoHS 5/6 F- RoHS 6/6 (Lead Free)	H - with Heatspreader

MODEL LIST

MODEL NAME	INPUT		OUTPUT		EFF @ 100% LOAD
Q48SA54001NNFH	36V~75V	3.5 A	54V	1.5A	92%
Q48SA54001NN H	36V~75V	3.5 A	54V	1.5A	92%

* Standard OCP, OVP, OTP operations are auto-restart or hiccup.

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