DELPHI SERIES



FEATURES

- High efficiency : 86% @ 3.3V/7.5A
- Size: 19.1mmx23.4mmx8.9mm (0.92”x0.75”x0.35”)
- Standard footprint
- Fixed frequency operation
- Hiccup output over current protection (OCP)
- Hiccup output over voltage protection (OVP)
- Auto recovery OTP
- Input UVLO
- Output voltage trim:-20%,+10%
- Pre-biased loads
- 1500V 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) recognized

Delphi Series T48SR, 1/32 Brick Family DC/DC Power Modules: 36~75V in, 3.3V/7.5A out, 24.75W

The Delphi series T48SR3R307, 1/32 brick, 36V~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 provides up to 24.75 watts of power in an industry standard footprint and pin out. 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. The T48SR3R307 offers more than 86% high efficiency at 7.5A full load.

OPTIONS

- Latched over voltage protection
- Positive On/Off logic

APPLICATIONS

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

Delta Electronics, Inc.

TECHNICAL SPECIFICATIONS

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

PARAMETER	NOTES and CONDITIONS	T48SR3R307 (Standard)			
		Min.	Typ.	Max.	Units
ABSOLUTE MAXIMUM RATINGS					
Input Voltage					
Continuous				80	Vdc
Transient	100ms			100	Vdc
Operating Temperature		-40		85	°C
Storage Temperature		-55		125	°C
Input/Output Isolation Voltage				1500	Vdc
INPUT CHARACTERISTICS					
Operating Input Voltage		36	48	75	Vdc
Input Under-Voltage Lockout					
Turn-On Voltage Threshold		32.5	34	35.5	Vdc
Turn-Off Voltage Threshold		30.5	32	33.5	Vdc
Lockout Hysteresis Voltage		1	2	5	Vdc
Maximum Input Current	100% Load, 36Vin			1	A
No-Load Input Current	Vin=48V, Io=0A		40		mA
Off Converter Input Current	Vin=48V, Io=0A		9		mA
Inrush Current (I^2t)				1	A^2s
Input Reflected-Ripple Current	P-P thru 12μH inductor, 5Hz to 20MHz			40	mA
Input Voltage Ripple Rejection	120 Hz		-50		dB
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	Vin=48V, Io=0, Tc=25°C	3.25	3.3	3.35	Vdc
Output Voltage Regulation					
Over Load	Vin=48V, Io=Io,min to Io,max		±5	±10	mV
Over Line	Vin=36V to 75V, Io=Io max		±5	±10	mV
Over Temperature	Vin=48V, Tc=-40°C to 85°C		±10		mV
Total Output Voltage Range	over sample load, line and temperature	3.2		3.4	Vdc
Output Voltage Ripple and Noise	5Hz to 20MHz bandwidth				
Peak-to-Peak	Full Load, 400μF ceramic		25		mV
RMS	Full Load, 400μF ceramic		5		mV
Operating Output Current Range		0		7.5	A
Output DC Current-Limit Inception	Output Voltage 10% Low	110		160	%
DYNAMIC CHARACTERISTICS					
Output Voltage Current Transient	48V, 400μF Ceramic load cap, 1A/μs				
Positive Step Change in Output Current	50% Io.max to 75% Io.max		115		mV
Negative Step Change in Output Current	75% Io.max to 50% Io.max		115		mV
Settling Time (within 1% Vout nominal)			130		μs
Turn-On Transient					
Start-Up Time, From On/Off Control			10	30	ms
Start-Up Time, From Input			15	30	ms
Maximum Output Capacitance	Full load;	0	400	5000	μF
EFFICIENCY					
100% Load	Vin=48V		86		%
60% Load	Vin=48V		85		%
ISOLATION CHARACTERISTICS					
Input to Output				1500	Vdc
Isolation Resistance		10			MΩ
Isolation Capacitance			1300		pF
FEATURE CHARACTERISTICS					
Switching Frequency			480		KHz
ON/OFF Control, Negative Remote On/Off logic					
Logic Low (Module On)	Von/off at Ion/off=1.0mA	0		0.8	V
Logic High (Module Off)	Von/off at Ion/off=0.0 μA	2.4		5	V
ON/OFF Control, Positive Remote On/Off logic					
Logic Low (Module Off)	Von/off at Ion/off=1.0mA	0		0.8	V
Logic High (Module On)	Von/off at Ion/off=0.0 μA	2.4		5	V
ON/OFF Current (for both remote on/off logic)	Ion/off at Von/off=0.0V			1	mA
Leakage Current (for both remote on/off logic)	Logic High, Von/off=5V				uA
Output Over-Voltage Protection		120		140	%
GENERAL SPECIFICATIONS					
MTBF	Vin=48V; Io=80% of Io, max; Ta=25°C; 100LFM		5.3		M hours
Weight(open frame)			8.2		grams
Over-Temperature Shutdown (Hot Spot)	Refer to Figure 24 for Hot spot location (48Vin,80%Io, 200LFM,Airflow from Vin+ to Vin-)		128		°C
Over-Temperature Shutdown (NTC Resistor)	Refer to Figure 24 for NTC resistor location		125		°C
Note: Please attach thermocouple on NTC resistor to test OTP function, the hot spot's temperature is just for reference.					

ELECTRICAL CHARACTERISTICS CURVES

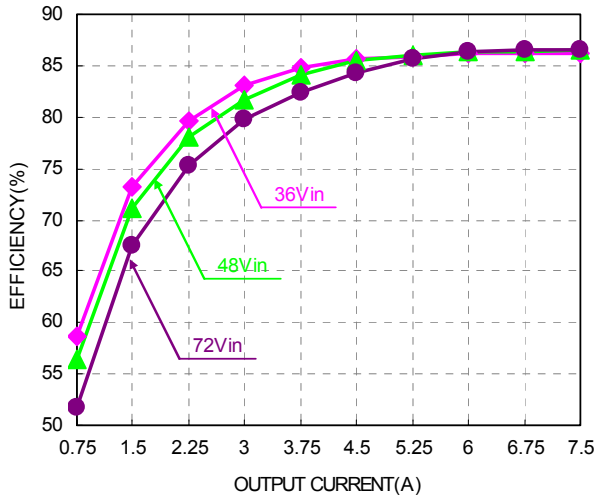


Figure 1: *Efficiency vs. load current for minimum, nominal, and maximum input voltage.*

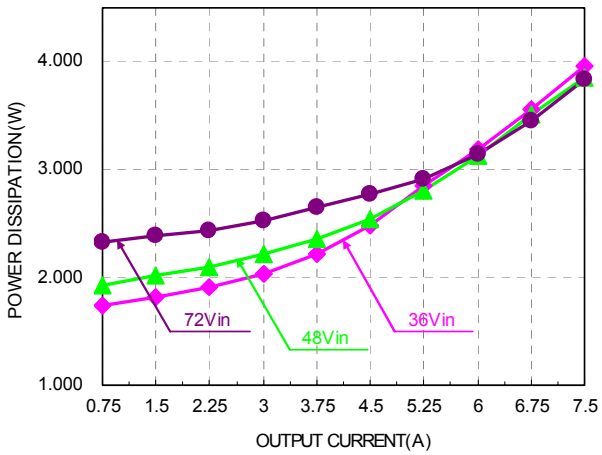


Figure 2: *Power dissipation vs. load current for minimum, nominal, and maximum input voltage.*

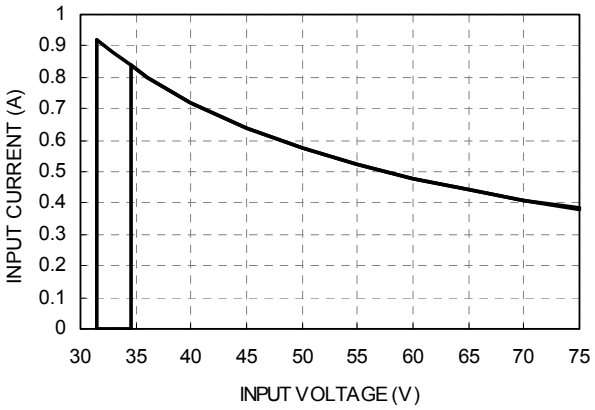


Figure 3: *Typical full load input characteristics.*

ELECTRICAL CHARACTERISTICS CURVES

For Negative Remote On/Off Logic

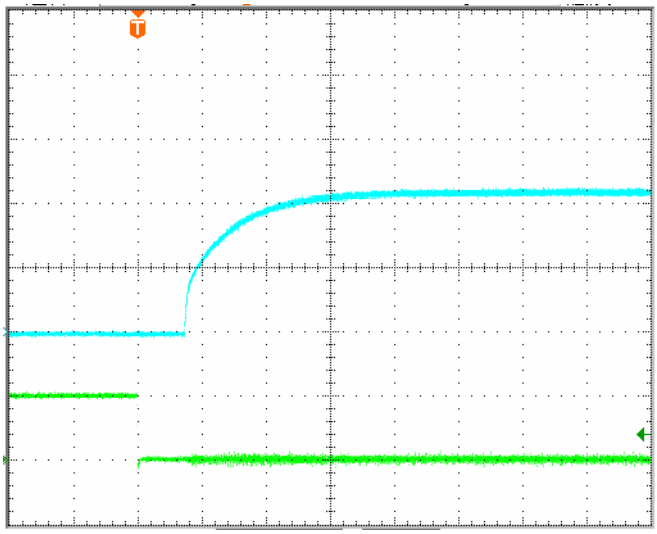


Figure 4: *Turn-on transient at zero load current) (4ms/div). Top Trace: Vout; 1.5V/div; Bottom Trace: ON/OFF input: 5V/div.*

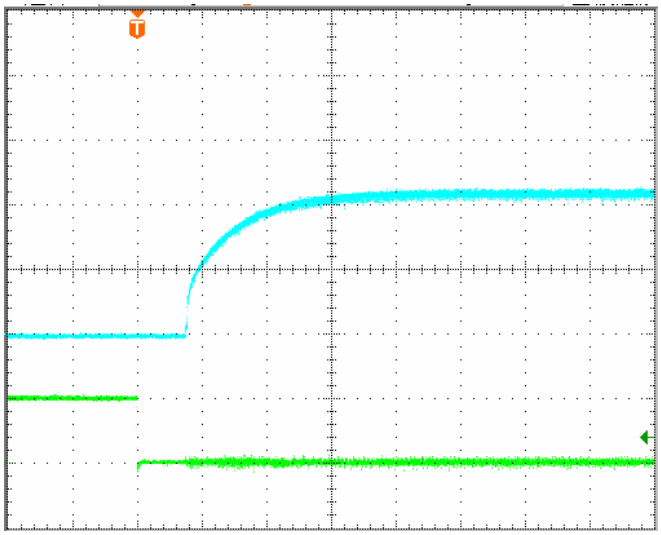


Figure 5: *Turn-on transient at full rated load current (4 ms/div). Top Trace: Vout: 1.5V/div; Bottom Trace: ON/OFF input: 5V/div.*

For Input Voltage Start up

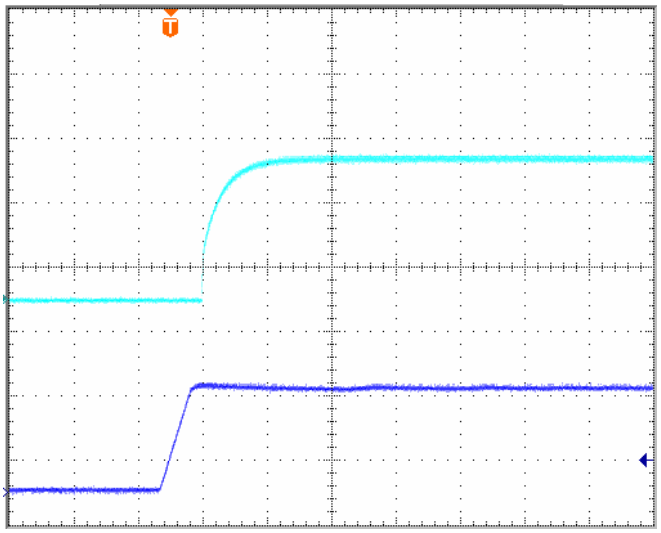


Figure 6: *Turn-on transient at zero load current (10 ms/div). Top Trace: Vout; 1.5V/div; Bottom Trace: input voltage: 30V/div.*

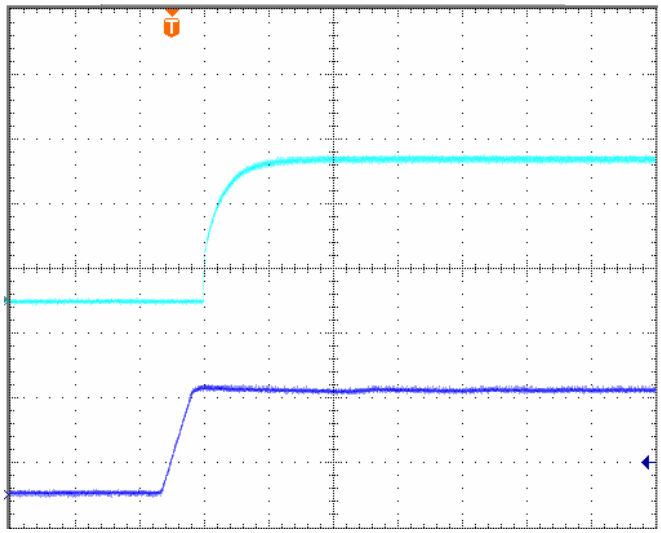


Figure 7*: Turn-on transient at full rated load current (10 ms/div). Top Trace: Vout; 1.5V/div; Bottom Trace: input voltage: 30V/div.*

ELECTRICAL CHARACTERISTICS CURVES

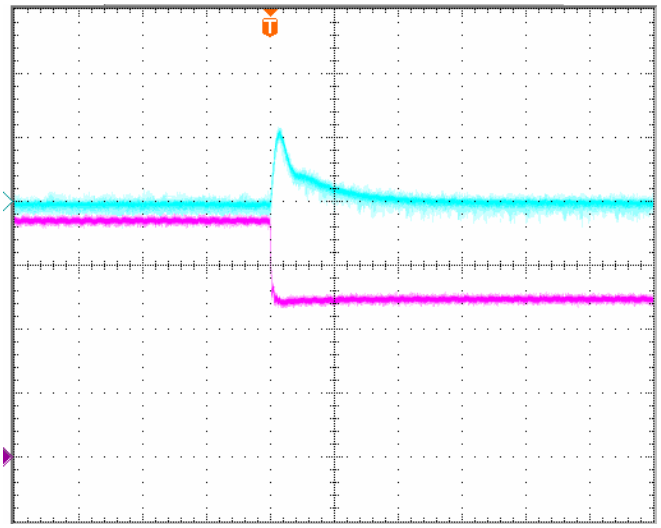


Figure 8: *Output voltage response to step-change in load current (75%-50% of Io, max; di/dt =1A/μs). Load cap: 400μF, ceramic capacitor. Top Trace: Vout (100mV/div,200us/div); Bottom Trace: output current(1.5A/div, 200us/div)*

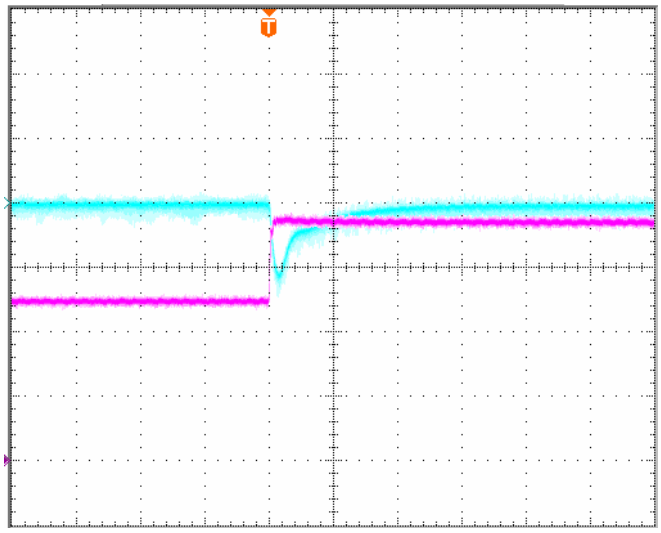


Figure 9: *Output voltage response to step-change in load current (50%-75% of Io, max; di/dt =1A/μs). Load cap: 400μF ceramic capacitor. Top Trace: Vout (100mV/div,200us/div); Bottom Trace: output current(1.5A/div, 200us/div)*

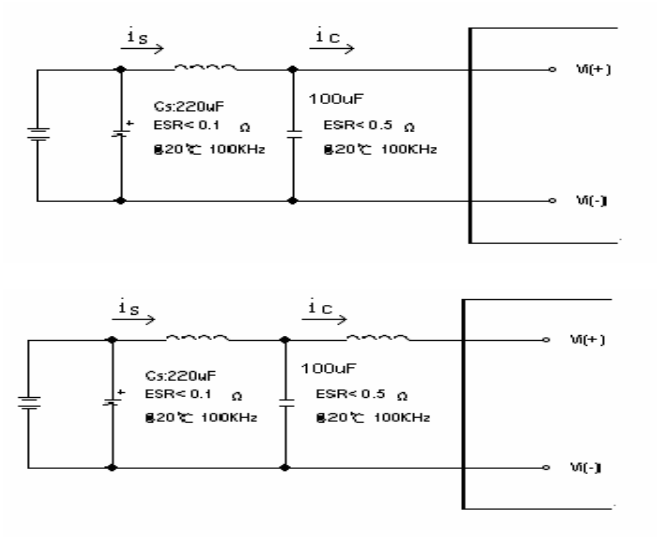


Figure 10: *Test set-up diagram showing measurement points for Input Terminal Ripple Current and Input Reflected Ripple Current.*
Note: Measured input reflected-ripple current with a simulated source Inductance (L_{TEST}) of 12 μH. Capacitor Cs offset possible battery impedance. Measure current as shown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

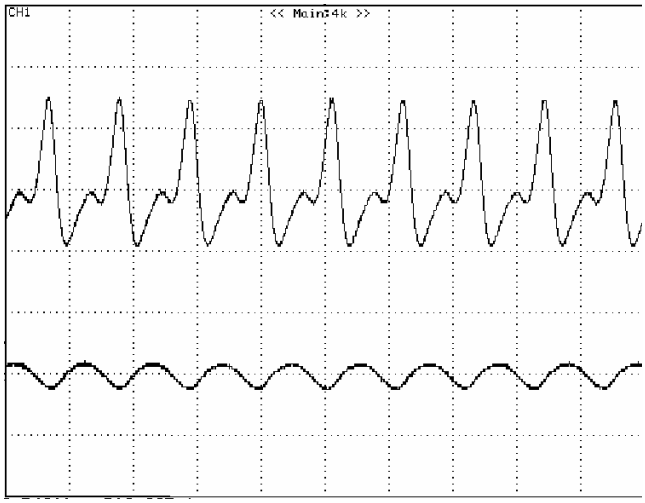


Figure 11: *Top trace: Input Terminal Ripple Current, i_c, at full rated output current and nominal input voltage with 12μH source impedance and 100μF electrolytic capacitor (2A/div，2us/div), Setup is shown in Figure 10 top picture.*
Bottom trace: Input Terminal Ripple Current, i_c, at full rated output current and nominal input voltage with 12μH source impedance and 100μF electrolytic capacitor (2A/div，2us/div), Setup is shown in Figure 10 bottom picture, there is one 1uH inductor in front of module input side.

ELECTRICAL CHARACTERISTICS CURVES

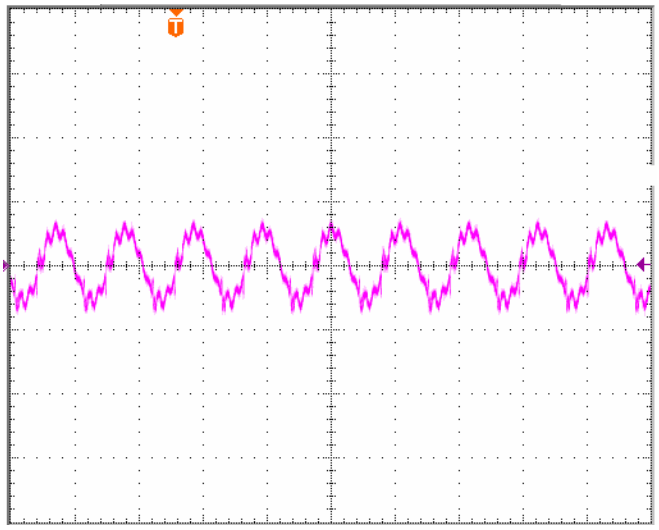


Figure 12: *Input reflected ripple current, i_s, through a 12µH source inductor at nominal input voltage and rated load current (25 mA/div，2us/div), Setup is shown in Figure 10 top picture.*

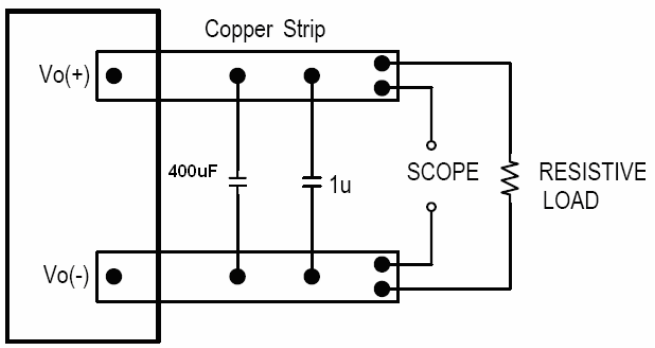


Figure 13: *Output voltage noise and ripple measurement test setup.*

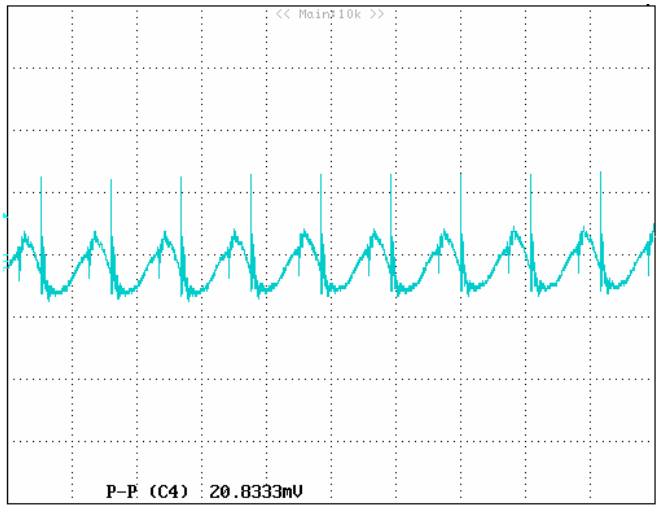


Figure 14: *Output voltage ripple at nominal input voltage and rated load current (Io=7.5A)(10 mV/div, 2us/div)*
Load capacitance: 400µF ceramic capacitor. Bandwidth: 20 MHz.

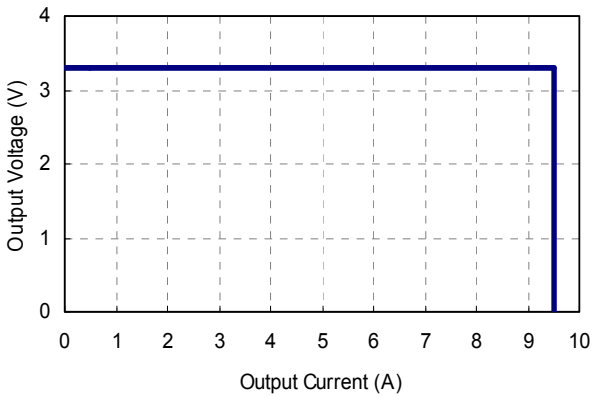


Figure 15: *Output voltage vs. load current showing typical current limit curves and converter shutdown points.*

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 100µF electrolytic capacitor mounted close to the input of the module to improve the stability.
Module internal input filter is only one 1uF ceramic cap, not L-C filter or Pi filter, so the external input cap ESR loss need be paid more attention. A external inductor (1uH) placed in front of module can decrease ESR loss of the external input cap.

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. Below is the reference design for an input filter tested with T48SR3R307XXXX to meet EN55022 (VDE0878) class A(both q. peak and average)

Schematic and Components List

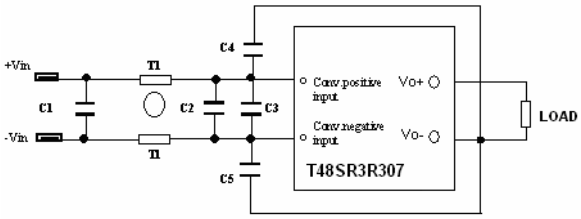


***Figure 16** : Capacitive and inductive EMI Filter*

C1=47uF /100 V(Low ESR)

C2=C3= 47 uF/100 V(Low ESR)

C4=C5=2200pF

T1=0.59mH type P0353 (Pulse)

Test Result:

At T = +25°C , Vin = 48 V and Io=7.5 A

Blue line is quasi peak mode; Green line is average mode.

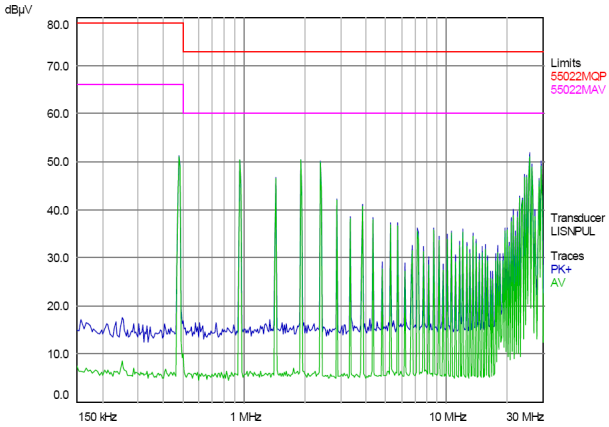


***Figure 17:** EMI test negative line @ T = +25℃ and Vin = 48 V*

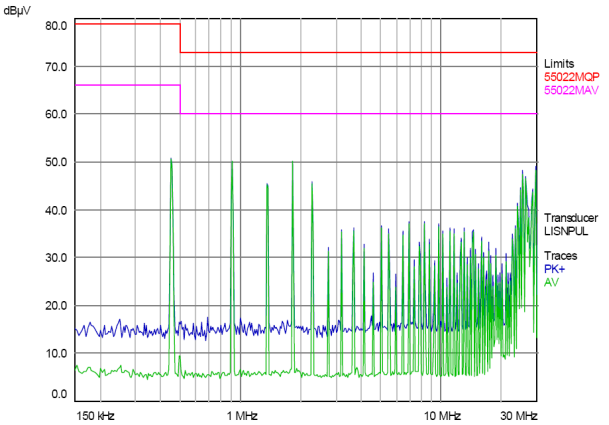


***Figure 18:** EMI test positive line @ T = +25℃ and Vin = 48 V*

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, CSA C22.2 NO. 60950-1 2nd and IEC 60950-1 2nd : 2005 and EN 60950-1 2nd: 2006+A11+A1: 2010, 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:

FEATURES DESCRIPTIONS

- 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.
- 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 Fast-acting 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.

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 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 modules will shut down, and then restart after a hiccup-time (hiccup mode). If customer needs a latch mode, please contact to Delta.

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, and enter in auto-restart mode.

For auto-restart mode, the module will detect temperature after shutdown. If the over temperature condition still exists, the module will remain shutdown. This restart trial will continue until the over-temperature condition is corrected.

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.

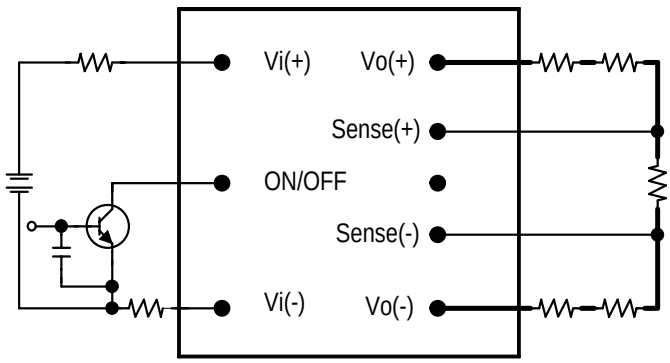


Figure 19: *Remote on/off implementation*

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:

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

FEATURES DESCRIPTIONS (CON.)

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

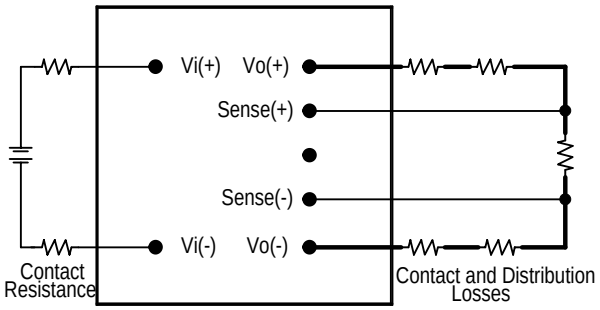


Figure 20: *Effective circuit configuration for remote sense operation*

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.

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.

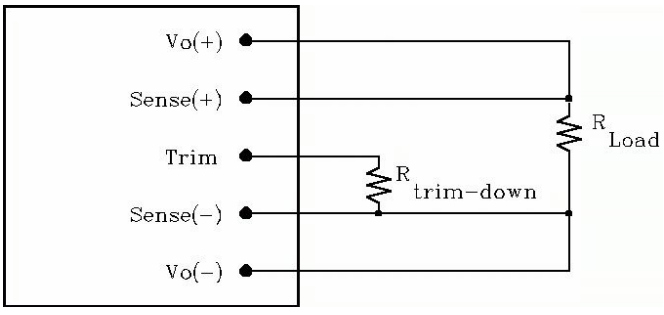


Figure 21: *Circuit configuration for trim-down (decrease output voltage)*

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:

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

Ex. When Trim-down -20 %(3.3V×0.8=2.64V)

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

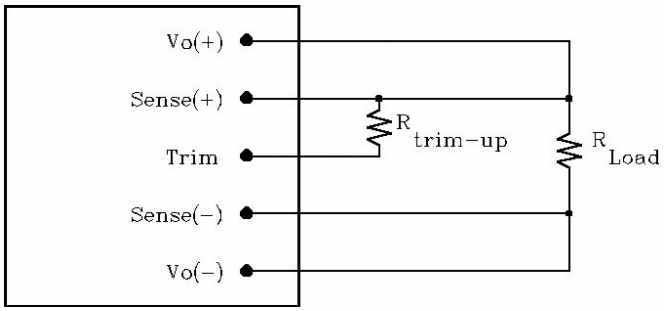


Figure 22: *Circuit configuration for trim-up (increase output voltage)*

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:

$$\text{Rtrim_up} = \left(\frac{865.7}{\Delta} + 3.547\right)\text{K}\Omega$$

Ex. When Trim-up +10%(3.3V×1.1=3.63V)

$$\text{Rtrim_up} = \frac{865.7}{10} + 3.547 = 90.117\text{K}\Omega$$

The output voltage can be increased by both the remote sense and the trim, however the maximum increase is the larger of either the remote sense or the trim, not the sum of both.

When using remote sense and trim, the output voltage of the module is usually increased, which increases the power output of the module with the same output current.

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

THERMAL CONSIDERATIONS

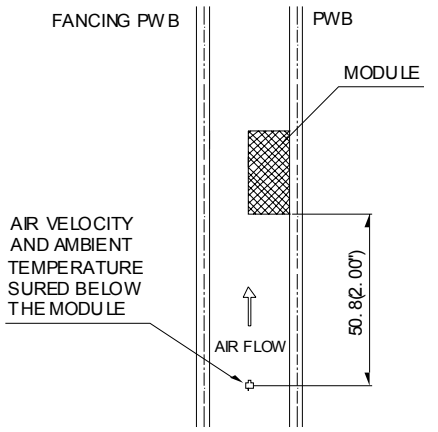
Thermal management is an important part of the system design. To ensure proper, reliable operation, sufficient cooling of the power module is needed over the entire temperature range of the module. Convection cooling is usually the dominant mode of heat transfer.

Hence, the choice of equipment to characterize the thermal performance of the power module is a wind tunnel.

Thermal Testing Setup

Delta's DC/DC power modules are characterized in heated vertical wind tunnels that simulate the thermal environments encountered in most electronics equipment. This type of equipment commonly uses vertically mounted circuit cards in cabinet racks in which the power modules are mounted.

The following figure shows the wind tunnel characterization setup. The power module is mounted on a test PWB and is vertically positioned within the wind tunnel. The space between the neighboring PWB and the top of the power module is constantly kept at 6.35mm (0.25").



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

Figure 23: *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

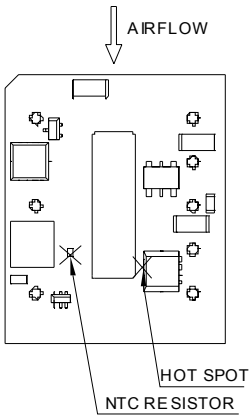


***Figure 24: *** *Hot spot& NTC resistor temperature measured points.*

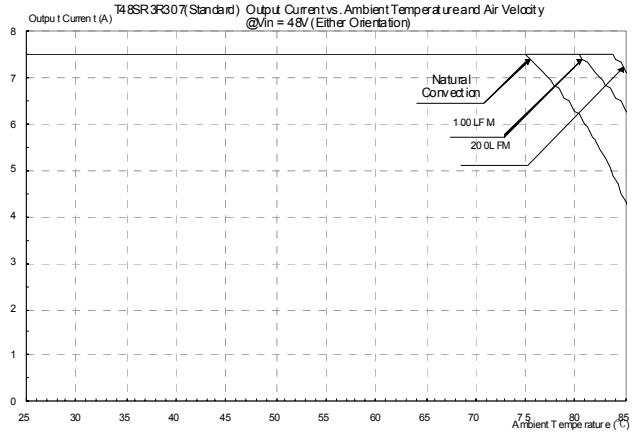
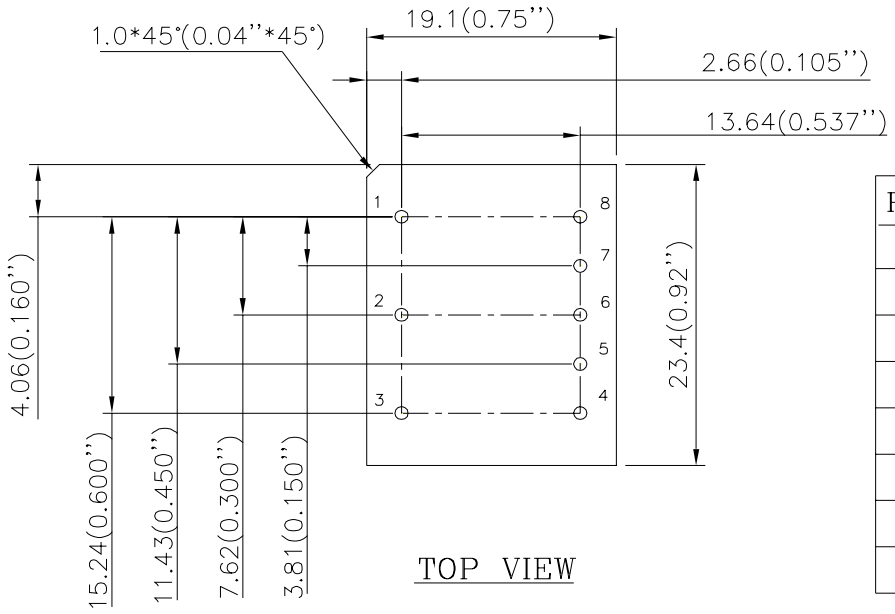
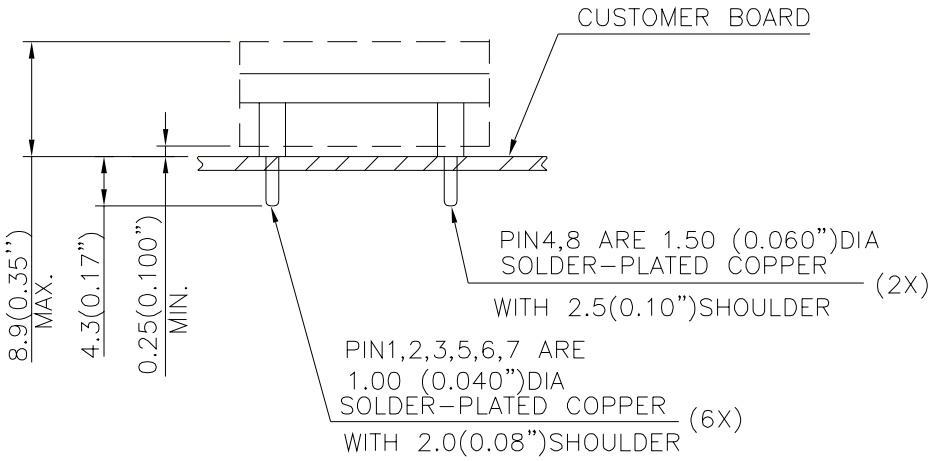


Figure 25: *Output current vs. ambient temperature and air velocity @Vin=48V(Either orientation, without heat spreader)*

MECHANICAL DRAWING



Pin#	Function
1	VIN(+)
2	ON/OFF
3	VIN(−)
4	VOUT(−)
5	SENSE (−)
6	Trim
7	SENSE(+)
8	VOUT(+)



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.)

Note: All pins are copper alloy with matte Tin over Ni plating .

PART NUMBERING SYSTEM

T	48	S	R	3R3	07	N	N	F	A
Form Factor	**Input Voltage**	**Number of Outputs**	**Product Series**	**Output Voltage**	**Output Current**	**ON/OFF Logic**	**Pin Length**		**Option Code**
T – 1/32 Brick	48-36V~75V	S - Single	R- Series Number	3R3 – 3.3V	07 – 7.5A	N - Negative P - Positive	N - 0.146” R - 0.170”	F - RoHS 6/6 (Lead Free) Space - RoHS5/6	A - Std. Functions

MODEL LIST

MODEL NAME	INPUT		OUTPUT		EFF @ 100% LOAD
T48SR3R307NNFA	36V~75V	1A	3.3V	7.5A	86%
T48SR05005NNFA	36V~75V	1A	5V	5A	86%

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

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