

### Q48SK12448NNFB, For 600W Quarter Brick DC/DC Power Modules: 46~60V in, 12V/ 50A out

The Delphi Module Q48SK12448NNFB, Quarter Brick, 46~60V 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 600 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 Q48SK12448NNFB offers more than 96.2% high efficiency at 50A load. The Q48SK12448NNFB is fully protected from abnormal input/output voltage, current, and temperature conditions and meets all safety requirements with basic insulation.

### FEATURES

- High efficiency:
- 96.2% @ 12V/50A out
- Max output power is up to 800 watts (4 ms)
- size(with heat spreader):  
58.4 x 36.8 x 12.9mm (2.30"x1.45"x0.51")
- Standard footprint
- Pre-bias startup
- No minimum load required
- External with 450uF minimum capacitance
- Fixed frequency operation
- Input UVLO, output OCP, OVP, OTP
- Hiccup output over current protection (OCP)
- Latch output over voltage protection (OVP)
- Auto recovery OTP and input UVLO
- 1500V isolation and function insulation
- ISO 9001, TL 9000, ISO 14001, QS 9000, OHSAS 18001 certified manufacturing facility
- UL/cUL 60950 (US & Canada) certification

### OPTIONS

- OVP hiccup or latch mode

### APPLICATIONS

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



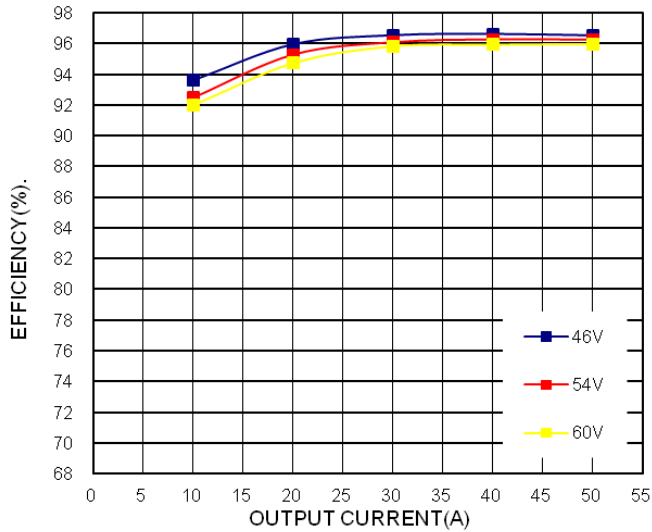
## TECHNICAL SPECIFICATIONS

(T<sub>A</sub>=25°C, airflow rate=300 LFM, V<sub>in</sub>=54Vdc, nominal V<sub>out</sub> unless otherwise noted;

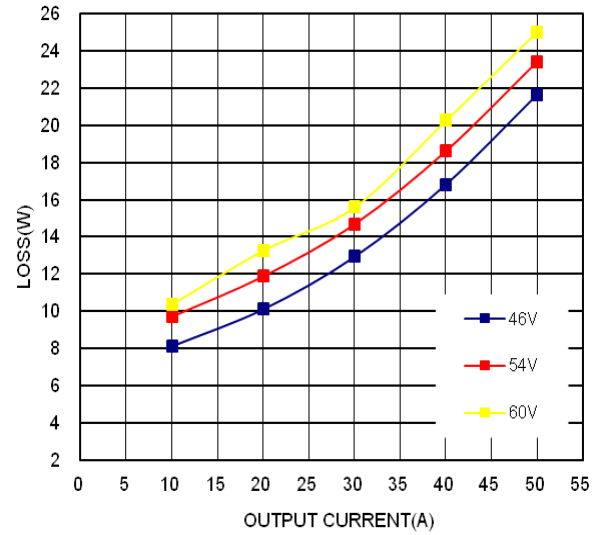
PARAMETER	NOTES and CONDITIONS	Q48SK12448NNFB			
		Min.	Typ.	Max.	Units
ABSOLUTE MAXIMUM RATINGS					
Input Voltage					
Continuous				60	Vdc
Operating Ambient temperature		-40		85	°C
Storage Temperature		-55		125	°C
Input/Output Isolation Voltage				1500	Vdc
Min time interval between trun off to next turn on		20			ms
INPUT CHARACTERISTICS					
Operating Input Voltage		46	54	60	Vdc
Input Under-Voltage Lockout					
Turn-On Voltage Threshold		42	44	46	Vdc
Turn-Off Voltage Threshold		40	42	44	Vdc
Lockout Hysteresis Voltage			2		Vdc
Maximum Input Current	50A Load, 46Vin			15	A
Maximum Input Current	800 watts Load for 4ms, 46Vin			19.5	A
No-Load Input Current	Vin=54V, Io=0A	80	160	210	mA
Off Converter Input Current	Vin=54V, Io=0A	7	15	20	mA
Inrush Current (I <sub>r</sub> t)				1	A <sup>2</sup> s
Input Reflected-Ripple Current	P-P thru 12μH inductor, 5Hz to 20MHz		250		mA
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	Vin=54V, Io=0, Tc=25°C	11.9	12	12.1	Vdc
Output Voltage Regulation					
Over Load	Vin=54V, Io=Io min to Io max		30		mV
Over Line	Vin=46V to 60V, Io=Io min		20		mV
Over Temperature	Vin=54V, Tc= min to max case temperatrue			130	mV
Total Output Voltage Range	over sample load, line and temperature	11.4		12.6	Vdc
Output Voltage Ripple and Noise	20MHz bandwidth				
Peak-to-Peak	Full Load, 1μF ceramic,10μF tantalum,450uF Oscon		250	350	mV
RMS	Full Load, 1μF ceramic,10μF tantalum,450uF Oscon		20	60	mV
Operating Output Current Range		0		50	A
Operating Output Current Range	800 watts Load for 4ms	0		67	A
Output DC Current-Limit Inception	Output Voltage 10% Low	73	80	87	A
Start afford load time, From On/Off Control		2			s
DYNAMIC CHARACTERISTICS					
Output Voltage Current Transient	, 1μF ceramic,10μF tantalum,450uF Oscon 0.1A/μs				
Positive Step Change in Output Current	50% to 75% of full load		200	350	mV
Negative Step Change in Output Current	75% to 50% of full load		200	350	mV
Settling Time (within 1% Vout nominal)				450	μs
Turn-On Transient	Vin slew rate: 10V/mS				
Start-Up Time, From On/Off Control		60	90	120	ms
Start-Up Time, From Input		60	90	120	ms
Maximum Output Capacitance	Low ESR CAP (OSCON), 100% load;			8900	μF
EFFICIENCY					
100% Load	Vin=54V		96.2	96.7	%
60% Load	Vin=54V		96.0	96.5	%
ISOLATION CHARACTERISTICS					
Input to Output				1500	Vdc
Isolation Resistance		10			MΩ
Isolation Capacitance			1000		pF
FEATURE CHARACTERISTICS					
Switching Frequency			180		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		50	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=15V			50	uA
Output Over-Voltage Protection	Over full temp range	14		16	Vdc
GENERAL SPECIFICATIONS					
MTBF	Io=80% of Io, max; Ta=25°C	2.1			M hours
Weight(with heat spreader)			74.5		grams
Over-Temperature Shutdown (Hot Spot)	Refer to Figure18 for Hot spot location (54Vin,80%Io, 200LFM,Airflow from Vin+ to Vin-)		125		°C
Over-Temperature Shutdown (NTC Resistor)			130		°C
Note: Please attach thermocouple on NTC resistor to test OTP function. the hot spot's temperature is just for reference.					

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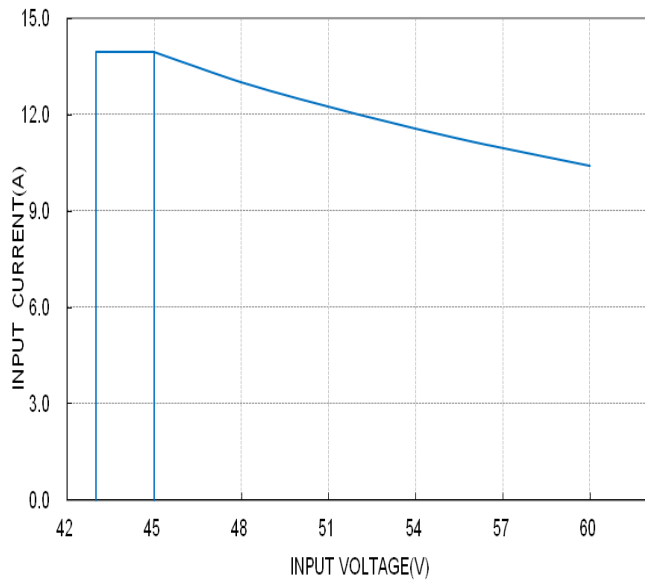
## ELECTRICAL CHARACTERISTICS CURVES



**Figure 1:** Efficiency vs. load current for 46V, 54V, and 60V input voltage at 25°C.



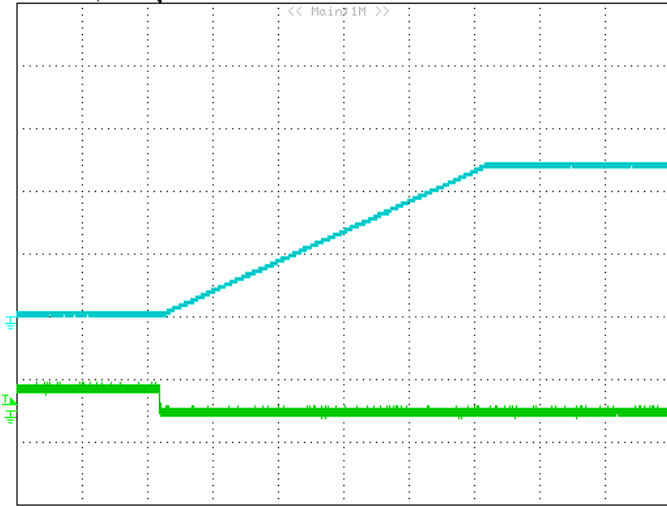
**Figure 2:** Power dissipation vs. load current for 46V, 54V, and 60V input voltage at 25°C.



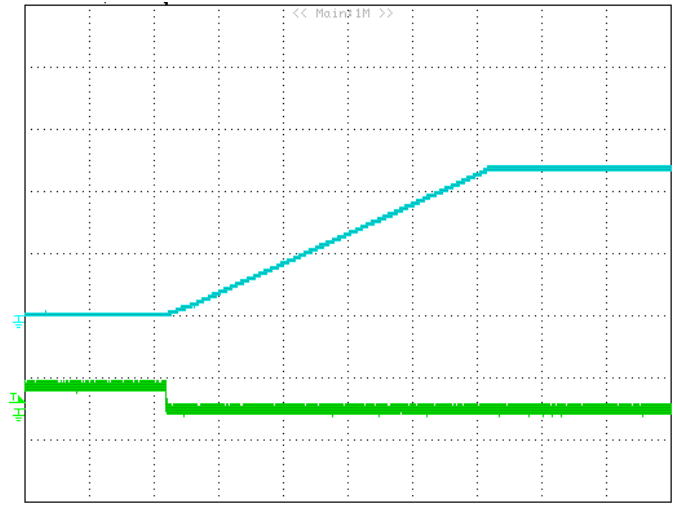
**Figure 3:** full load input characteristics at room temperature.

## ELECTRICAL CHARACTERISTICS CURVES

### For Negative Remote On/Off Logic

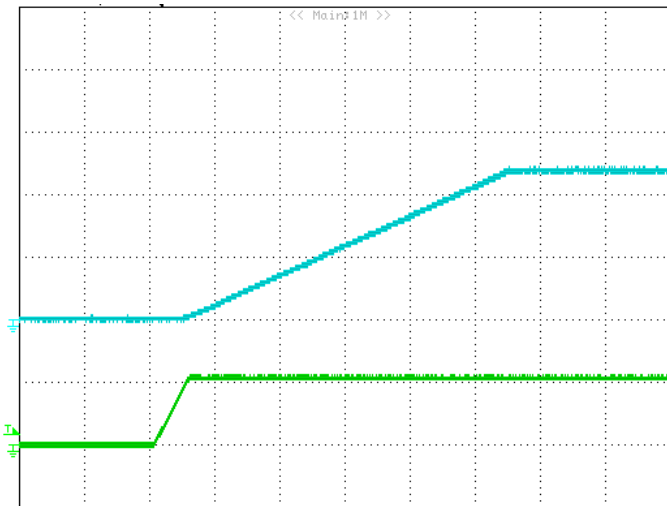


**Figure 4:** Turn-on transient at zero load current (20ms/div). Top Trace: Vout; 5V/div; Bottom Trace: ON/OFF input: 10V/div.

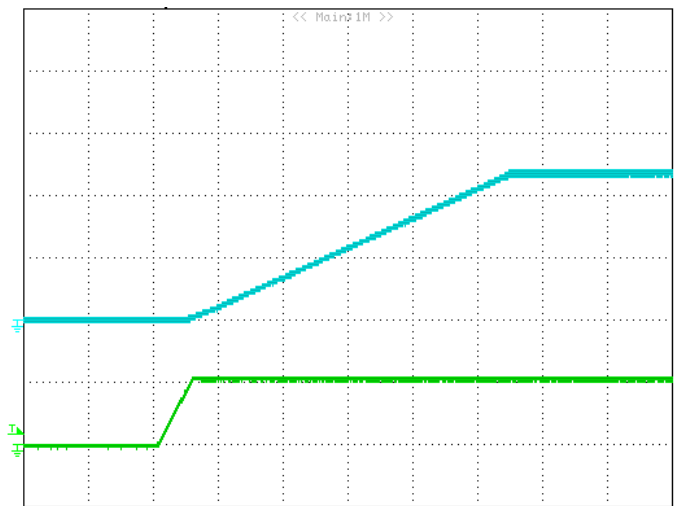


**Figure 5:** Turn-on transient at full load current (20 ms/div). Top Trace: Vout; 5V/div; Bottom Trace: ON/OFF input: 10V/div.

### For Input Voltage Start up

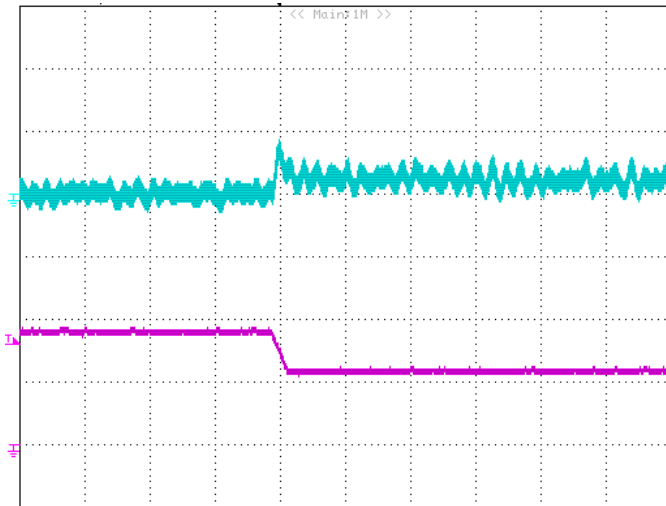


**Figure 6:** Turn-on transient at zero load current (20 ms/div). Top Trace: Vout; 5V/div; Bottom Trace: input voltage: 50V/div.

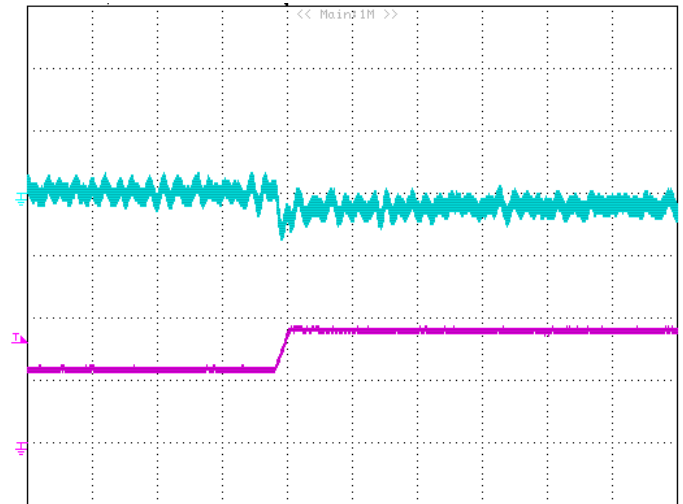


**Figure 7:** Turn-on transient at full load current (20 ms/div). Top Trace: Vout; 5V/div; Bottom Trace: input voltage: 50V/div.

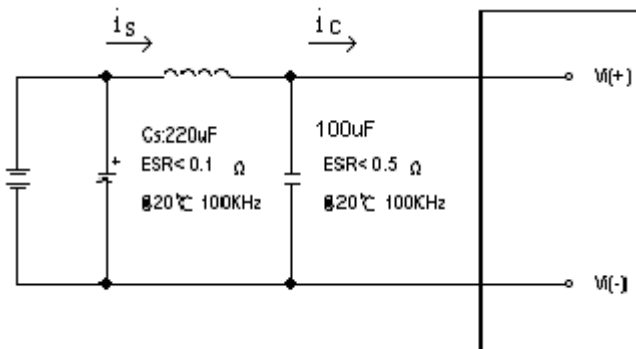
## ELECTRICAL CHARACTERISTICS CURVES



**Figure 8:** Output voltage response to step-change in load current (75%-50% of full load;  $di/dt = 0.1A/\mu s$ ). Load cap:  $10\mu F$ , tantalum capacitor,  $1\mu F$  ceramic capacitor and  $450\mu F$  Oscon capacitor. Top Trace:  $V_{out}$ ;  $200mV/div$ ; Bottom Trace: output current:  $20A/div$ , Time:  $500\mu s/div$

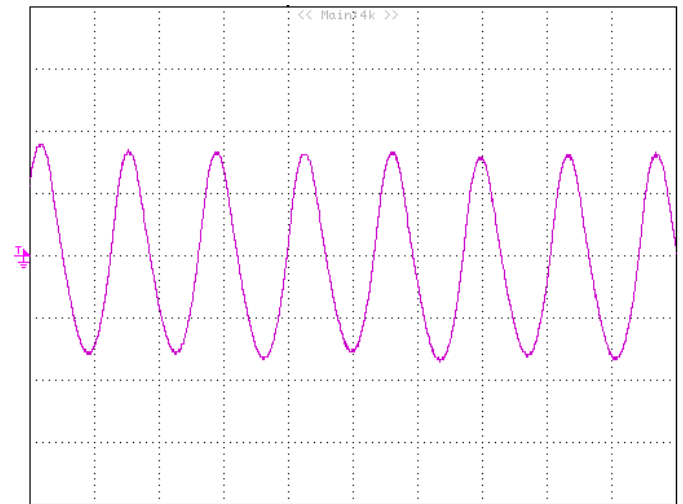


**Figure 9:** Output voltage response to step-change in load current (50%-75% of full load;  $di/dt = 0.1A/\mu s$ ). Load cap:  $10\mu F$ , tantalum capacitor,  $1\mu F$  ceramic capacitor and  $450\mu F$  Oscon capacitor. Top Trace:  $V_{out}$ ;  $200mV/div$ ; Bottom Trace: output current:  $20A/div$ , Time:  $500\mu s/div$



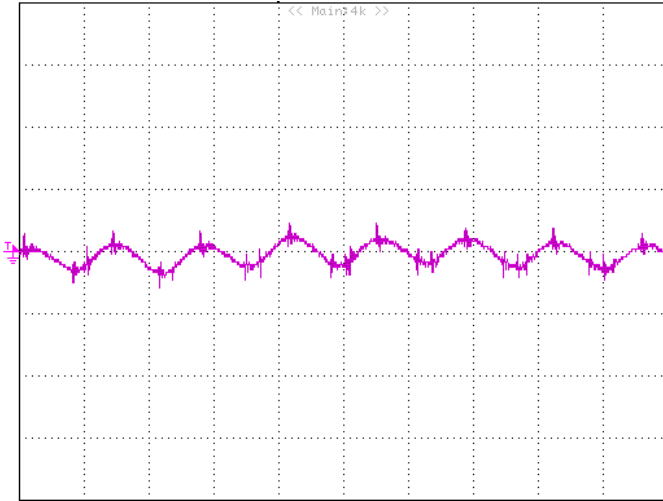
**Figure 10:** Test set-up diagram showing measurement points for Input Terminal Ripple Current and Input Reflected Ripple Current.

Note: Measured input reflected-ripple current with a simulated source Inductance ( $L_{TEST}$ ) of  $12\mu H$ . Capacitor  $C_s$  offset possible battery impedance. Measure current as shown above.

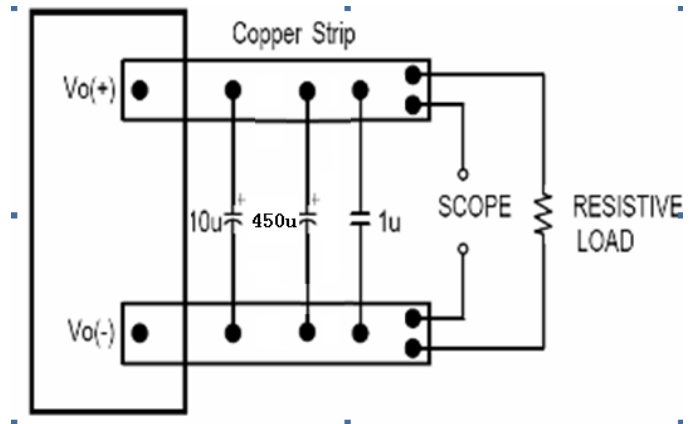


**Figure 11:** Input Terminal Ripple Current,  $i_c$ , at max output current and nominal input voltage with  $12\mu H$  source impedance and  $100\mu F$  electrolytic capacitor ( $0.5A/div$ ,  $2\mu s/div$ ).

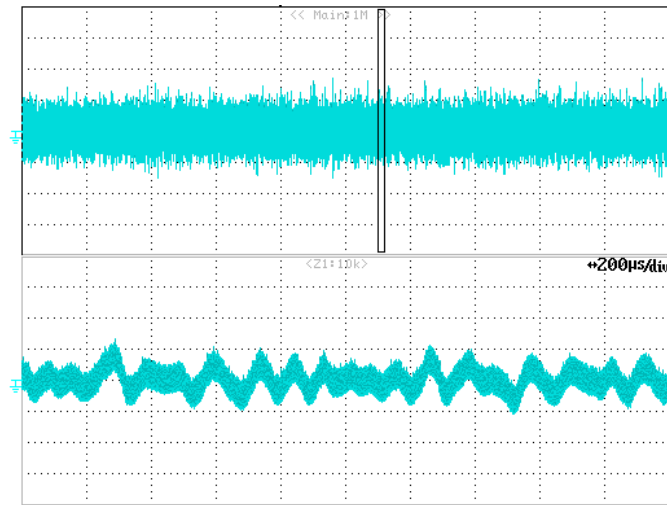
## ELECTRICAL CHARACTERISTICS CURVES



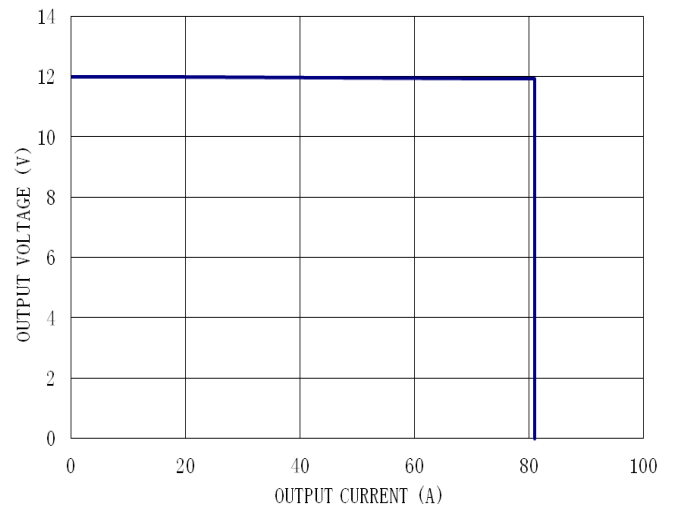
**Figure 12:** Input reflected ripple current,  $i_s$ , through a  $12\mu\text{H}$  source inductor at nominal input voltage and max load current ( $20\text{mA/div}$  ·  $2\mu\text{s/div}$ ).



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



**Figure 14:** Output voltage ripple at nominal input voltage and max load current ( $50\text{ mV/div}$ ,  $20\text{ms/div}$ )  
Load capacitance:  $10\mu\text{F}$  tantalum capacitor,  $1\mu\text{F}$  ceramic capacitor and  $450\mu\text{F}$  Oscon capacitor. Bandwidth:  $20\text{ MHz}$ .



**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  $\mu\text{H}$ , we advise 100 $\mu\text{F}$  electrolytic capacitor (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

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 60A 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. If the output current exceeds the OCP set point, the modules will shut down (hiccup mode). The hiccup time will last 2s. 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 (latch mode) and keep not restart again until module restart up by input voltage.

If hiccup mode is needed for OVP, please contact with 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. The module will restart after 2s.

### Remote On/Off

The remote on/off feature on the module is negative logic. Negative logic turns the module on during a logic low and off during a logic high. If the remote on/off feature is not used, please short the on/off pin to  $V_i$  (-).

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

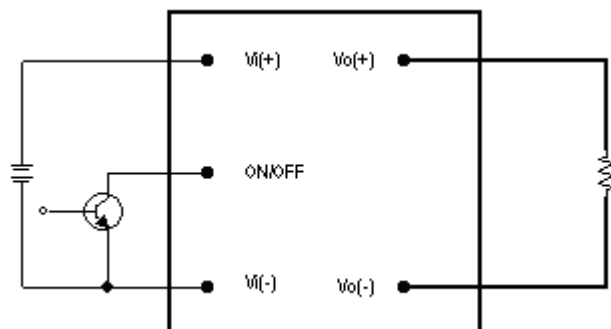


Figure 16: Remote on/off implementation

## THERMAL CONSIDERATIONS

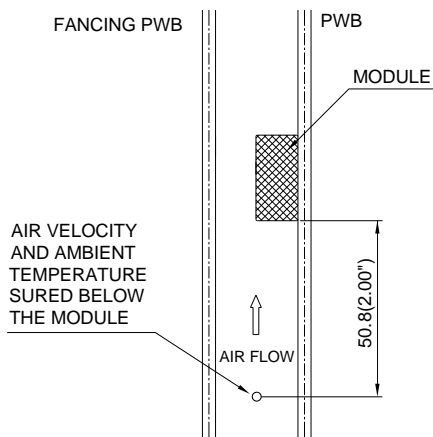
Thermal management is an important part of the system design. To ensure proper, reliable operation, sufficient cooling of the power module is needed over the entire temperature range of the module. Convection cooling is usually the dominant mode of heat transfer.

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 185mmX185mm, 70 $\mu$ m (20z), 6 layers test board 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").



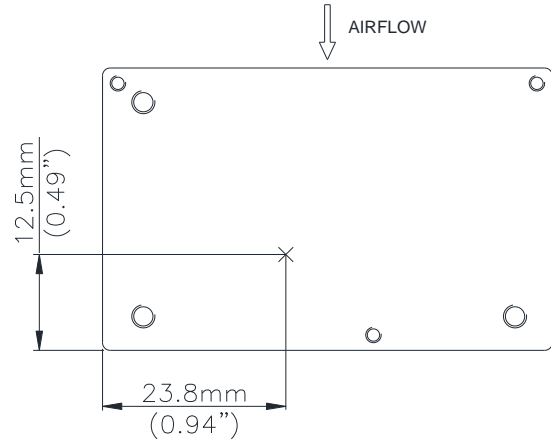
Note: Wind Tunnel Test Setup Figure Dimensions are in millimeters and (Inches)

**Figure 17:** Wind tunnel test setup

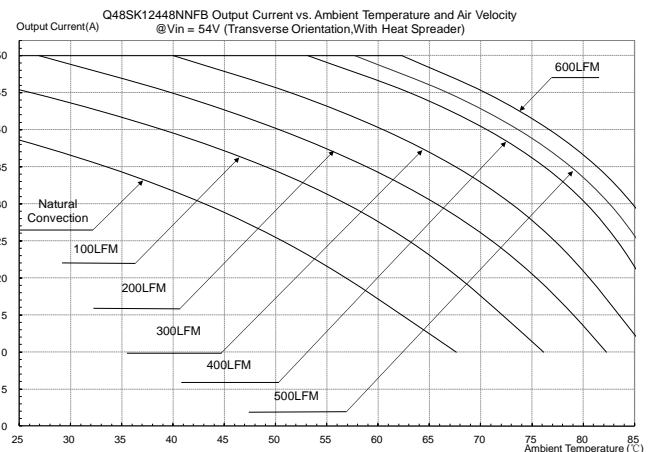
### Thermal Derating

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 (WITH HEAT SPREADER)



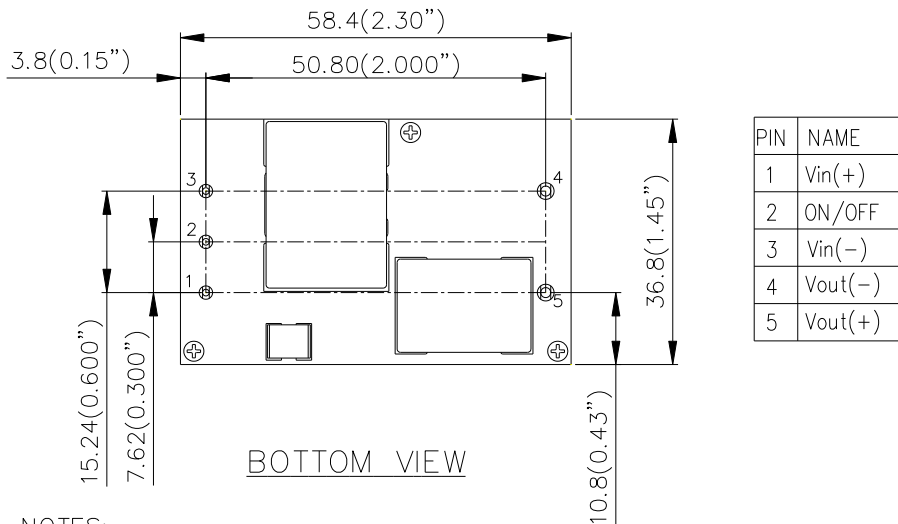
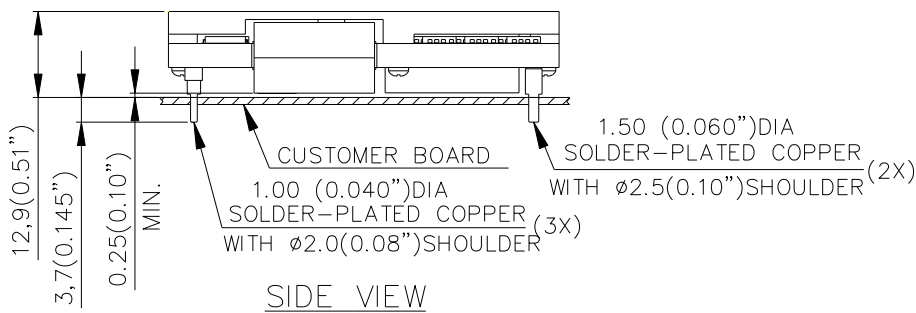
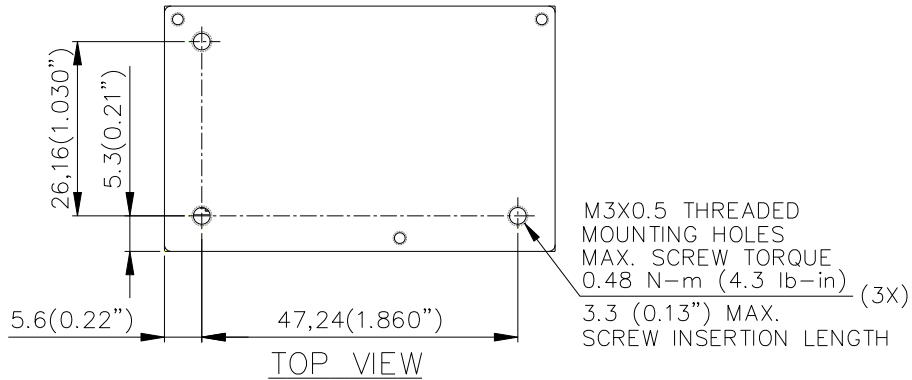
**Figure 18:** \* Hot spot temperature measured point.  
The allowed maximum hot spot temperature is defined at 110°C



**Figure 19:** Output Current vs. ambient temperature and air velocity @  $V_{in}=54V$  (Transverse Orientation, With Heat Spreader, Airflow from  $V_{in+}$  to  $V_{in-}$ )



## MECHANICAL DRAWING



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

Pin No.	Name	Function
1	+Vin	Positive input voltage
2	ON/OFF	Remote ON/OFF
3	-Vin	Negative input voltage
4	-Vout	Negative output voltage
5	+Vout	positive output voltage

### Pin Specification:

Pins 1,2,3 1.00mm (0.040") diameter  
Pins 4,5 1.50mm (0.060") diameter  
All pins are copper with matte Tin plating and Nickel under plating



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