# Contraction Series



### Delphi Series Q48SK, Quarter Brick Family DC/DC Power Modules: 36~75V in, 12V/33A out, 400W

The Delphi series Q48SK12033, 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 provides up to 400 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 Q48SK12033 offers more than 95.5% high efficiency at 33A full load. The Q48SK12033 is fully protected from abnormal input/output voltage, current, and temperature conditions and meets all safety requirements with basic insulation.

#### **FEATURES**

- High efficiency : 95.5% @ 12V/33A
  Size:
- 57.9x36.8x11.2mm (2.28"x1.45"x0.44") (w/o heat spreader) 57.9\*36.8\*12.7mm(2.28"\*1.45"0.50") (with heat spreader)
- Standard footprint
- Industry standard pin out
- Fixed frequency operation
- Input UVLO, Output OCP, OVP, OTP
- Hiccup output over current protection (OCP)
- Hiccup output over voltage protection (OVP)
- Auto recovery OTP and input UVLO
- 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)
   recognized

### **OPTIONS**

- Latched over current protection
- Positive On/Off logic
- Heat spreader available for extended operation.

#### **APPLICATIONS**

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



DATASHEET DS\_Q48SK12033\_01062011



# **TECHNICAL SPECIFICATIONS**

(T<sub>A</sub>=25°C, airflow rate=300 LFM, V<sub>in</sub>=48Vdc, nominal Vout unless otherwise noted;

SEGUTPE Invariant	PARAMETER	NOTES and CONDITIONS	Q48SK12033 (Standard)				
Input Websage         Input We			Min.	Тур.	Max.	Units	
Continuous         methods							
Transient         100m         100         Vice           Operating HoS Soft Emperature (With that spreader)         Refer to figure 20 for measuing point         40         117         1C           Operating HoS Soft Emperature (With heat spreader)         Refer to figure 20 for measuing point         40         118         1C           Storage Emperature (With heat spreader)         Refer to figure 20 for measuing point         40         125         125         C           Input Over Voltage         38         48         75         Voltage         2250         Voltage           Operating fing Voltage         38         48         75         Voltage         22         Voltage           Input Overting Emperature (With heat spreader)         Sector Hystepress Voltage         38         48         75         Voltage           Num-Ov Voltage Threshold         32.0         34.0         36.0         48         75         Voltage           Nuccode Hystepress Voltage Content         100% Load, 38Vin         22.0         Voltage         76         76         76           Nuclead input Corrent         Num-48V, LoeOA         170         76         76         76         76         76         76         76         76         76         76         76					80	Vdc	
Operating Loss Temperature (Without heat spreader)         Refer to figure 20 for measuring point         40         117         °C           Storage Temperature (Without heat spreader)         Refer to figure 20 for measuring point         40         108         °C           Storage Temperature (Without heat spreader)         Refer to figure 20 for measuring point         40         108         °C           Diput Ording Temporature         755         Vital Storage Temperature         2250         Vital Storage Temperature           Diput Ording Temperature         755         Vital Storage Temperature         300         32.0         34.0         38.0         Vital Storage Temperature           Turn-Of Voltage Treshold         100°L Load, 32Vin         1         70         70         70           Net Coal Ingat Current         100°L Load, 32Vin         70         1         A53           Ingut Veltage Repet Repet Corrent         P-P thru 12µH Inductor, 5Hz to 20Hit 2         10         1         A53           Ingut Veltage Repet R		100ms					
Operating Case Temperature (With heat spreader)         Refer to figure 20 for measuring point         4-0         108         °C           Ingui/Dapit isolation Voltage         -55         -125         °C         °C           Ingui/Dapit isolation Voltage         -55         -125         °C         °C           Ingui/Dapit isolation Voltage         -55         -125         °C         °C           Ingui/Dapit isolation Voltage         -56         -125         °C         °C           Ingui/Dapit isolation Voltage         -56         -125         °C         °C           Ingui/Dapit isolation Voltage         -56         -125         °Vde         °Vde           Ingui/Dapit isolation Voltage Threshold         -20         34.0         36.0         Vde           Not-Sad Ingui Current         -10% Load, 36Vin         -11         -13         AA           Not-Sad Ingui Current         -10% Load, 36Vin         -10         -1         AA           Not-Sad Ingui Current         -10% Load, 36Vin         -10         -1         AA           Not-Sad Ingui Current         -10% Load, 10% Cond, 76         -30         -00         -00           Output Voltage Repie Rolition         Vin-48V, 10=0, 7, 72,87         11.4         11.7         -12.0 </td <td></td> <td></td> <td>-40</td> <td></td> <td></td> <td></td>			-40				
Input Output Isolation Voltage         2280         Vice           Operating Input Voltage         36         48         75         Vice           Operating Input Voltage         320         34.0         36.0         Vice           Turn-On Voltage Threshold         32.0         34.0         36.0         Vice           Nomman Input Order-Voltage Threshold         32.0         32.0         34.0         36.0         Vice           Nomman Input Order-Voltage Threshold         30.0         32.0         34.0         36.0         Vice           Nomman Input Output Onteret         100% Load, 36.Vin         70         3.0         36.0         Vice           Nombar Current (IT)         Pr-Ptitru 12,Hinductor, 5Hz to 20MHz         10         1         A.8           Niput Orditage Step Ront         Vin=46V, Io=0, Ter2S'C         11.4         11.7         12.0         Vice           Output Voltage Regulation         Vin=46V, Io=0, Ter2S'C         11.4         11.7         12.0         Vice           Over Load         Vin=46V, Io=0, Ter2S'C         11.4         11.7         12.0         Vice           Output Voltage Regulation         Vin=46V, Io=0, Ter2S'C         11.4         10.0         mv           Over Load         Vin=46V			-40				
NPUT CHARACTERISTICS         36         48         76         Vide           input Under-Votage Lockout         36         36         48         76         Vide           input Under-Votage Lockout         30.0         32.0         34.0         96.0         Vide           Turn-ON Votage Treshold         30.0         32.0         34.0         Vide         Vide           Maximum Input Current         100% Load, 36Vin         1         1         A           On Concerter Input Current         Win+48V, lo=0A         10         1         mA           Input Vistage Ringle Current         P-P Ihru 12/H inducts, RF to 20MHz         30         60         Minute Vistage Ringle Ringle Current         10         1         mA           Input Vistage Ringle Ringle Current         P-P Ihru 12/H inducts, RF to 20MHz         30         60         mV           Over Load         Vin=48V, lo=0, Tc=25'C         11.4         11.7         12.0         Vide           Over Load         Vin=48V, lo=0, Tc=25'C         11.4         11.7         12.0         Vide           Over Load         Vin=48V, lo=0, Tc=25'C         11.4         11.7         12.0         Vide           Over Load         Vin=48V, To=40'C to 85'C, lo= In Rin         ± 100	Storage Temperature	· · · · ·	-55		125	°C	
Operating hout Voltage         model         36         48         75         Vide           Turn-On Voltage Threshold         32.0         34.0         36.0         Vide           Turn-On Voltage Threshold         30.0         32.0         34.0         Vide           Maximum Input Under Voltage Threshold         30.0         32.0         34.0         Vide           Maximum Input Outrent         100% Load, 36Vin         13         A           NeaLoad Input Connent         Win-48V, Ge/GA         170         mA           NeaLoad Input Connent         Win-48V, Ge/GA         170         mA           Input Reflected-Ripple Current         P-P thru 12,111 inductor, SHz to 20MHz         10         1         mA           Unput Voltage Ripple Rejection         12.0 Hz         .0         1         mA           Output Voltage Ripple Rejection         12.0 Hz         .0         1         mA           Output Voltage Ripple Rejection         Vin-48V, Io-0, Tic-28°C         11.4         17.7         12.0         Vide           Output Voltage Ripple and Noise         SHz to 20MHz break         1         100         mV         mV           Over Loc         Vin-48V, Io-0, Tic-28°C         11.2         12.0         Vide <tr< td=""><td></td><td></td><td></td><td></td><td>2250</td><td>Vdc</td></tr<>					2250	Vdc	
Input Under-Voltage Threshold         B2.0         34.0         36.0         Vdc           Turn-On Voltage Threshold         30.0         32.0         34.0         Vdc           Lockout Hystersis Voltage Threshold         2         Vdc         Vdc           Maximum Input Current         100% Load, 38Vin         13         A           Not-Load Input Current         Win-48V, Io-0A         10         mA           Not-Load Input Current         Win-48V, Io-0A         10         1         A/S           Not-Load Input Current         Win-48V, Io-0A         10         1         A/S           Notade Step Christics         120 Hz         -30         0         mA           Output Voltage Step Cont         Vin-48V, Io-0A         11         A/S         0         0         mA           Output Voltage Reputation         Vin-48V, Io-0A         11         4/S         0 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>							
Turn-On Voltage Threshold         S2:0         34:0         36:0         Vdc           Turn-Of Voltage Threshold         30:0         32:0         34:0         Vdc           Maximum Input Current         100% Load, 38Vin         2         Vdc           Mochaed Input Current         Win-48V, Io-0A         10         mA           Inrush Current         Win-48V, Io-0A         10         mA           Ingut Reflect-Ripple Current         P-P thru 12µH Inductor, SHz to 20MHz         10         mA           Ingut Reflect-Ripple Current         P-P thru 12µH Inductor, SHz to 20MHz         10         mA           Ingut Reflect-Ripple Carent         P-P thru 12µH Inductor, SHz to 20MHz         10         mA           UpUIDICIALATCHENTICS         Vin-48V, Io-0A         11         41:7         12.0         Vdc           Output Voltage Regulation         Vin-48V, Io-0A (TS/) Clon mint to Iomax         ± 3:0         ± 00         mV           Over Line         Vin-48V, Io-0A (TS/) Clon mint to Iomax         ± 100         mV         mV           Over Line         Vin-48V, Io-0A (TS/) Clon BS/C         ± 100         mV         mV           Over Line         Vin-48V, Io-0A (TS/) Clon mint to Iomax         ± 3:0         ± 00         mV           Over Line			36	48	75	Vdc	
Turn-Off Voltage Threshold         90.0         32.0         34.0         Vdc           Lockot Hysteress Voltage         10% Load, 35Vin         13         A           No-Load input Current         Vin-48V, lo-0A         100         mA           Off Converter Input Current         Vin-48V, lo-0A         100         mA           Input Reflected-Ripple Rejection         P-P thru 12µH inductor, 5Hz to 20MHz         100         mA           Input Reflected-Ripple Rejection         10.1         AS         300         dB           Output Voltage Replet Rejection         10.1         MA         MA         100         MA           Output Voltage Replet Rejection         Vin-48V, lo=0, fc=25°C         11.4         11.7         12.0         Vdc           Output Voltage Repletion         Vin-48V, lo=0, fc=25°C         11.4         11.7         12.0         Vdc           Over Line         Vin-48V, lo=0, fc=25°C         11.4         11.2         10.0         mV           Over Line         Vin-48V, lo=0, fc=25°C         11.2         10.0         mV           Over Line         Vin-48V, lo=0, fc=25°C         11.2         10.0         mV           Over Line         Vin-48V, lo=0, fc=25°C         11.2         10.0         mV			22.0	24.0	26.0	Vdo	
Lockott Hysteress Voltage         Vdc         2         Vdc         Vdc           No-Load Input Current         10% Load, 35Vn         10         mA           No-Load Input Current         Vin-48V, Io-0A         10         mA           Inrush Current (ft)         Vin-48V, Io-0A         10         mA           Inrush Current (ft)         P-P thru 12µH inductor, SHz to 20MHz         0         mA           Input Reflected-Ripple Carent         P-P thru 12µH inductor, SHz to 20MHz         30         dB           Untrust Vindage Ripple Rejection         112.4         11.7         12.0         Vdc           Odeput Voltage Reputation         Vin-48V, Io-0, Te-25°C         11.4         11.7         12.0         Vdc           Over Load         Vin-48V, Io-49°C to 85°C         11.4         11.7         12.0         Vdc           Over Load         Vin-48V, Io-49°C to 85°C         11.4         11.7         12.0         Vdc           Over Load         Vin-48V, Io-49°C to 85°C         11.4         11.7         12.0         Vdc           Over Load         Vin-48V, Io-49°C to 85°C         11.2         12.0         Vdc           Over Load         Vin-48V, Io-49°C to 85°C         11.0         12.0         Vdc           Over							
Maximum Input Current         10% Load, 36Vin         13         A           Off Converter Input Current         Vin=48V, Io=0A         10         mA           Off Converter Input Current         Vin=48V, Io=0A         10         mA           Input Reflected-Ripple Current         P-P thru 12µH Inductor, 5Hz to 20MHz         10         mA           Input Reflected-Ripple Rejection         120 Hz         -30         dB           Output Votage Regulation         Vin=48V, Io=0, min to Io, max         ± 30         ± 60         mV           Over Lad         Vin=48V, Io=0, min to Io, max         ± 30         ± 60         mV           Over Line         Vin=48V, Io=0, min to Io, max         ± 50         mV         VV           Over Line         Vin=48V, Io=0, min to Io, max         ± 50         mV         VV           Over Line         Vin=48V, Io=0, fin and temperature         11.2         12.0         Vdc           Output Votage Range         over sample load, Iine caramic, 10pf tantalum         160         mV           Peak-to-Peak         Full Load, 1ipF ceramic, 10pf tantalum         160         mV           VinaMUC CHARADTERISTICS         0         300         mV         MV           VinaMUC CHARADTERISTICS         0         300 <t< td=""><td></td><td></td><td>30.0</td><td></td><td>34.0</td><td></td></t<>			30.0		34.0		
NoL-Gad Input Current         Vin=48V, Io=0A         170         mA           Inrush Current (1)         Vin=48V, Io=0A         10         mA           Inrush Current (1)         Vin=48V, Io=0A         10         mA           Inrush Current (1)         P-P thru 12µH Inductor, 5Hz to 20MHz         10         mA           Input Voltage Ripple Rejection         120 Hz         10         mA           Ordput Voltage Replat Rejutation         120 Hz         11.4         11.7         12.0         Vid           Output Voltage Replat Rejutation         10         mA         MA         Ma         Ma           Over Laad         Vin=48V, Io=0, Train (1)         ± 50         10         mV         Ma           Over Temperature         Vin=48V, Io=0, Troin (1)         ± 50         mV         Ma         Ma           Over Temperature         Vin=48V, Io=0, Top! Eantalum         11.2         12.0         Vid         Ma         <	Maximum Input Current	100% Load. 36Vin		_	13		
Off Converter Input Current         Vn=48V, Io=0A         10         mn         mn           Input Reflected-Ripple Current         P-P thru 12µH inductor, 5Hz to 20MHz         10         mA           Input Reflected-Ripple Current         P-P thru 12µH inductor, 5Hz to 20MHz         30         dB           OUTPUT CHARACTERISTICS         11.4         11.7         12.0         VdC           Output Voltage Regulation         Vm=48V, Io=0, To=25°C         11.4         11.7         12.0         VdC           Over Line         Vm=48V, Io=0, To=25°C         11.4         11.7         12.0         VdC           Over Line         Vm=48V, Io=0, To=25°C         11.4         11.7         12.0         VdC           Over Line         Vm=48V, Io=0, To=5°C         11.0         mV         mV         mV           Over Line         Vm=48V, Io=0, To=5°C         11.0         11.0         mV         mV           Over Line Range         Over sample bad, line and temperature         11.2         12.0         VdC           Output Voltage Range         Fuil Load, 1µF ceramic, 10µF lantalum         10         13.3         mV           Output Voltage Current Tams Incepton         Output Voltage 10% Low         110         13.0         VmV           Output Volt				170			
Input Reflected-Rippie Current         P-P thru 12µH inductor, 5Hz to 20MHz         10         mm           DUTPUT CHARACTERISTICS	Off Converter Input Current	Vin=48V, Io=0A		10		mA	
Input Voltage Ripple Rejection         120 Hz         -30         dB           Output Voltage Replation         Vin=48V, [b=0, Tc=25°C         11.4         11.7         12.0         Vd           Over Load         Vin=48V, [b=0, Tic=25°C         11.4         11.7         12.0         Vd           Over Load         Vin=48V, [b=0, Tic=25°C         11.4         11.7         12.0         Vd           Over Load         Vin=48V, [b=0, Tic=25°C         ± 30         ± 80         mV           Over Load         Vin=48V, [b=0, Tic=25°C         ± 100         mV           Over Temperature         Vin=48V, [b=0, Tic=25°C         ± 100         mV           Output Voltage Ripple and Noise         SH2 to 20MHz bankwidth         11.2         Vd           Peak-to-Peak         Full Load, 1µF ceramic, 10µF banklum         80         mV           Output Voltage Ripple and Noise         Full Load, 1µF ceramic, 10µF banklum         80         mV           Output Voltage Ripple and Noise         Full Load, 1µF ceramic, 10µF banklum         80         mV           Output Voltage Ripple and Noise         Full Load, 1µF ceramic load cap, 0.1Aµis         10         40         %           Vine48U Centern Transent         0         0.0         33         A         M					1		
DUTPUT CHARACTERISTICS         Vin=48V, lo=0, To=25°C         11.4         11.7         12.0         Vde           Output Voltage Regulation         Vin=48V, lo=0, To=25°C         11.4         1         7         2.0         Vde           Over Line         Vin=48V, lo=0, min         ± 30         ± 80         mV           Over Line         Vin=48V, lo=0, min         ± 30         ± 80         mV           Over Line         Vin=48V, lo=0, min         ± 50         mV         mV           Over Temperature         Vin=48V, lo=2, mon         ± 100         mV         mV           Output Voltage Rape         Over sample load, line and temperature         11.2         12.0         Vdc           Output Voltage Rapie and Noise         5Hz to 20MHz bandwidth         150         mV           RNS         Full Load, Lip E ceramic, 10µF tantalum         150         mV           RNS         Full Load, Lip E ceramic load cap, 0.1Ayus         0         33         A           Output Voltage Current Transient         48V, 10µF Tan 8.1µF Ceramic load cap, 0.1Ayus         00         mV           Neative D range in Output Current         50% to max to 50% to max         300         mV         MV           Neative D range in Output Current         50% to max to 50% to max <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>							
Output Voltage Set Point         Vin=48V, Io=0, To=25°C         11.4         11.7         12.0         Vdc           Ovput Voltage Regulation         Vin=48V, Io=0, mint         b         2.00         ± 30         ± 80         mV           Over Load         Vin=48V, Io=0, mint         b         ± 30         ± 80         mV           Over Temperature         Vin=48V, Tc=-40°C to 85°C         ± 100         mV         Vdc           Total Output Voltage Range         over sample toad, line and temperature         11.2         12.0         Vdc           Output Voltage Rapie and Noise         Full Load, UF ceramic, ToUF tantalum         160         mV           Peak-to-Peak         Full Load, UF ceramic, ToUF tantalum         160         mV           Output Voltage ToW, Current Range         0         33         A           Output Voltage Current Transient         48V, 10µF Tan & 1µF Ceramic load cap, 0.1Aµs         140         %           Voltage Change in Output Current         50% to.max to 75% to.max         300         mV         MV           Positive Step Change in Output Current         75% to.max to 50% to.max         300         mV         Me           Start-Up Time, From On/Off Control         70         ms         ms         Start-Up Time, From On/Off Control         70<		120 Hz		-30		dB	
Output Voltage Regulation         Vin-48V, lo=lo,min to lo,max         ± 30         ± 80         mVV           Over Line         Vin-48V, lo=lo,min         ± 30         ± 80         mV           Over Temperature         Vin-48V, lo=lo,min         ± 50         mV         mV           Over Temperature         Vin-48V, lo=lo,min         ± 100         mV         mV           Output Voltage Rape         Set to 20MHz bandwidth         11.2         12.0         V/dc           Output Voltage Rape         Bet to 20MHz bandwidth         11.0         mV         mV           Peak-to-Peak         Full Load, tyP Ceramic, 10PF tantalum         0         33         A           Output Voltage Current Transient         48V, 10PF Tan & 1pF Ceramic load cap, 0.1Aus         0         33         A           Over Setting Transient         48V, 10PF Tan & 1pF Ceramic load cap, 0.1Aus         0         33         A           VNMAIC CHARCT ERISTICS         0         100         140         %         MV           Neative Set Change in Output Current         50% Io.max to 50% Io.max         300         mV         Neative Set Change in Output Current         70         ms           Start-Up Time, From Input         Maximum Output Capacitance         Low ESR CAP (OSCON), 100% load;         80 <td></td> <td></td> <td>44.4</td> <td>44.7</td> <td>40.0</td> <td></td>			44.4	44.7	40.0		
Over Lead         Vin=48V, lo=lo.min to lo.max         ± 30         ± 80         mV           Over Line         Vin=48V, lo=lo.min         ± 50         mV           Over Sample load, line and temperature         11.2         12.0         Vid           Total Output Voltage Range         over sample load, line and temperature         11.2         12.0         Vid           Output Voltage Rapple and Noise         5Hz to 20MHz bandwidth         150         mV           Peak-to-Peak         Full Load, 1µF ceramic, 10µF tantalum         800         mV           Output Voltage Rupple and Noise         0         33         A           Output Current Range         Output Voltage 10% Low         110         1400         %           Output Current-Linni Inception         Output Voltage 10% Low         110         1400         %           VoltadU Concent-Linkin Roeption         Output Voltage 10% Low         110         1400         %           VoltadU Voltage Current Transient         48V, 10µF Tan & 1µF Ceramic load cap, 0.14µs         00         mV           Positive Step Change in Output Current         75% lo.max to 55% lo.max         300         mV           Start-Up Time, From On/Off Control         70         ms         800         ms           Start-Up Time, From		VIN=48V, 10=0, 1C=25°C	11.4	11.7	12.0	Vdc	
Over Line         Vin=36V to 75V, to=1omin         ± 50         mV           Over Temperature         Vin=48V, Tc=-40°C to 85°C         ± 100         mV           Output Voltage Rappe         over sample load, line and temperature         11.2         12.0         Vdc           Output Voltage Rappe         and temperature         11.2         12.0         Vdc           Output Voltage Rappe         and temperature, 10.0         150         mV           RMS         Full Load, 1.0F ceramic, 10.0F tantalum         80         mV           Output DC current Range         Output Voltage 10% Low         110         140         %           Output Voltage Current Transient         48V, 10.0F Tan & 1.0F Ceramic load cap, 0.1A/ps         300         mV           Positive Step Change in Output Current         75% to.max to 75% to.max         300         mV           Negative Step Change in Output Current         75% to.max to 55% to.max         300         mV           Start-Up Time, From On/Off Control         70         ms         80         ms           Start-Up Time, From On/Off Control         200         Vin=48V         95.5         %           Soldtoin Capacitance         Low ESR CAP (OSCON), 100% load;         505.5         %           Soldtoin Capacitance		$\frac{1}{10}$		1.20			
Over Temperature         Vin+48V, TC=+40°C to 85°C         ± 100         mV           Total Output Voltage Range         over sample tota, line and temperature         11.2         12.0         Vic           Output Voltage Range         over sample tota, line and temperature         11.2         12.0         Vic           Output Voltage Range         SH±to 20MHz bandwidth         150         mV           Peak-to-Peak         Full Load, tµF ceramic, 10µF tantalum         80         mV           Output Voltage Rappie and Noise         Full Load, tµF ceramic, 10µF tantalum         0         33         A           Output Voltage Current Transient         48V, 10µF Tan & 1µF Ceramic load cap, 0.1Aµs         0         33         A           Voltage Step Change in Output Current         50% lo.max to 75% lo.max         300         mV           Negative Step Change in Output Current         75% lo.max to 55% lo.max         300         mV           Start-Up Time, From On/Off Control         70         ms         start-Up Time, From Input         80         ms           Start-Up Time, From Input         Eve Change in Output Current         76% lo.max         95.5         %           Start-Up Time, From Input         80         ms         80         ms           Start-Up Time, From Input <td< td=""><td></td><td></td><td></td><td></td><td>± 80</td><td></td></td<>					± 80		
Total Output Voltage Range         over sample load, line and temperature         11.2         12.0         Vdc           Output Voltage Ripple and Noise         SH± to 20MHz bandwidth         150         mV           Peak-to-Peak         Full Load, 1µF ceramic, 10µF tantalum         0         33         A           Output Voltage Ripple and Noise         0         33         A         00         mV           RMS         Output Voltage Tantalum         0         33         A         00         mV           Voltage Ripple and Noise         Output Voltage 10% Low         110         140         %           Voltage Ripple and Noise         0         33         A         00         mV           Voltage Ripple and Noise         0         110         140         %           Voltage Ripple and Noise         00         110         140         %           Voltage Ripple and Noise         00         110         140         %           Voltage Ripple and Noise         00         110         140         %           VinAIIC CHARACTERISTICS         00         mV         mV         Megative Step Change in Output Current         70         ms           Start-Up Time, From Input         Low ESR CAP (OSCON), 100% load;		,					
Output Voltage Ripple and Noise         5Hz to 20MHz bandwith         Image Noise         Model           Peak-to-Peak         Full Load, 1µF caramic, 10µF tantalum         150         mV           RMS         Output Qurrent Range         0         33         A           Operating Output Current Integtion         Output Voltage 10% Low         110         140         %           Voluput Current Limit Inception         Output Voltage 10% Low         110         140         %           Voluput Current Limit Inception         Output Voltage 10% Low         110         140         %           Voluput Voltage Current Transient         48V, 10µF Tan & 1µF Ceramic load cap, 0.1A/µs         0         mV         Model			44.0	± 100	10.0		
Peak-to-Peak         Full Load, 1µF ceramic, 10µF tantalum         150         mV           RMS         Full Load, 1µF ceramic, 10µF tantalum         80         mV           Operating Output Current Range         0         33         A           Output DC Current Itansient         0Utput Voltage 10% Low         110         140         %           VNAMIC CHARACT ERISTICS         48V, 10µF Tan & 1µF Ceramic load cap, 0.1Aµs         100         mV           Positive Step Change in Output Current         50% Lomax to 75% Lomax         300         mV           Statit Vp Time, From Input         50% Lomax to 55% Lomax         300         µF           Start-Up Time, From Input         Low ESR CAP (OSCON), 100% load;         6000         µF           EFFICIENCY         100         100         mrs         6000         µF           100% Load         Vin=48V         95.5         %         %           Solari-Up Time, From Input         Low ESR CAP (OSCON), 100% load;         100         µF           100% Load         Vin=48V         95.5         %         %           Solari-Up tub         Vin=48V         95.2         %           Solari Congeschance         100         µF         MO         MO         MO           <			11.2		12.0	Vac	
RMS         Full Load, 1µF ceramic, 10µF tantalum         80         mV           Output DC Current Range         0         110         140         %           Output DC Current-Limit Inception         Output Voltage 10% Low         110         140         %           VNAMIC CHARACT ERISTICS         140         %         110         140         %           Voltput Voltage Current Transient         48V, 10µF Tan & 1µF Ceramic load cap, 0.1A/µs         300         mV           Positive Step Change in Output Current         50% Io.max to 75% Io.max         300         mV           Negative Step Change in Output Current         75% Io.max to 50% Io.max         300         mV           Start-Up Time, From On/Off Control         70         ms         ms         Maximum Output Capacitance         Low ESR CAP (OSCON), 100% load;         6000         µF           EFFICIENCY         100% Load         Vin=48V         95.5         %         60%         600         µF           Solation Capacitance         10         100         ms         Maximum Output         2250         Vdc           Solation Capacitance         10         100         p5.2         %         50         100         FE           Solation Capacitance         10         1000 <td></td> <td></td> <td></td> <td></td> <td>150</td> <td>m\/</td>					150	m\/	
Operating Output Current Range       0       33       A         Output DC Current-Limit Inception       Output Voltage 10% Low       110       140       %         VNAMIC CHARACTERISTICS       48V, 10µF Tan 8, 1µF Ceramic load cap, 0, 1A/µs       140       %         Positive Step Change in Output Current       50% Io.max to 75% Io.max       300       mV         Negative Step Change in Output Current       50% Io.max to 55% Io.max       300       mV         Start-Up Time, From On/Off Control       70       ms       ms         Start-Up Time, From On/Off Control       70       ms       ms         100% Load       Vin=48V       95.5       %         60Va Load       Vin=48V       95.5       %         60Va Load       Vin=48V       95.2       %         60Valton Chapacitance       100       MQ       MQ         Isolation Capacitance       100       MQ       MQ         Isolation Capacitance       100       Vin       %         0N/OFF Control, Negative Remote On/Off logic       Von/off at lon/of							
Output DC Current-Limit Inception         Output Voltage 10% Low         110         140         %           VNAMIC CHARACTERISTICS         ************************************			0				
DynAmic CHARACTERISTICS         48V, 10µF Tan & 1µF Ceramic load cap, 0.1A/µs           Output Voltage Current Transient         48V, 10µF Tan & 1µF Ceramic load cap, 0.1A/µs           Positive Step Change in Output Current         50% lo.max to 75% lo.max         300         mV           Negative Step Change in Output Current         75% lo.max to 55% lo.max         300         mV           Start-Up Time, Krom Input         70         ms         300         mV           Start-Up Time, From On/Off Control         70         ms         start-Up Time, From Input         600         µr           100% Load         Vin=48V         95.5         %         6000         µF           100% Load         Vin=48V         95.5         %         600         µr           Solation Capacitance         10         1000         pF         F           Solation Capacitance         10         1000         pF           Solation Capacitance         10         1000         pF           Start-Up Circle (Module Off)         Von/off at lon/off=1.0mA         0         0.8         V           Solation Resistance         10         1000         pF         F         F         F         F         F         F         F         F         F		Output Voltage 10% Low	110				
Positive Step Change in Output Current       50% Io.max to 75% Io.max       300       mV         Negative Step Change in Output Current       75% Io.max to 50% Io.max       300       mV         Stetting Time (within 1% Vout nominal)       300       mV       300       mV         Start-Up Time, From On/Off Control       70       ms       ms       start-Up Time, From Input       80       ms         Maximum Output Capacitance       Low ESR CAP (OSCON), 100% load;       95.5       %       6000       µF         FFICIENCY       Low ESR CAP (OSCON), 100% load;       95.2       %       %         SOLATION CHARACTERISTICS       10       MQ       MQ       MQ       95.2       %         Solation Resistance       10       100       PF       MQ       95.2       %       %         Solation Resistance       10       100       PF       MQ       PF       MQ       PF	DYNAMIC CHARACTERISTICS						
Negative Step Change in Output Current         75% io.max to 50% io.max         300         mV           Setting Time (within 1% Vout nominal)         300         µs           Turn-On Transient         300         µs           Start-Up Time, From On/Off Control         70         ms           Start-Up Time, From Input         80         ms           Maximum Output Capacitance         Low ESR CAP (OSCON), 100% load;         6000         µF           EFFICIENCY         95.5         %         60%         %           00% Load         Vin=48V         95.5         %           SOLATION CHARACTERISTICS         10         MΩ           Isolation Resistance         10         MΩ         MΩ           Isolation Resistance         1000         PF         EATURE CHARACTERISTICS         F           Suffing Frequency         Von/off at Ion/off=1.0mA         0         0.8         V           Logic Low (Module On)         Von/off at Ion/off=0.0 µA         2         50         V           ON/OFF							
Settling Time (within 1% Vout nominal)       300       μs         Turn-On Transient       70       mss         Start-Up Time, From On/Off Control       70       mss         Maximum Output Capacitance       Low ESR CAP (OSCON), 100% load;       6000       μf         EFFICIENCY       100% Load       Vin=48V       95.5       %         100% Load       Vin=48V       95.2       %         SOLATION CHARACTERISTICS       10       2250       Vdc         Input to Output       10       100       pf       PF         Isolation Capacitance       10       1000       pf         EFATURE CHARACTERISTICS       1000       pf       PF         Solation Capacitance       10       0       MΩ         Isolation Capacitance       100       0       PF         EATURE CHARACTERISTICS       1000       pf         Switching Frequency       160       KHz         ON/OFF Control, Negative Remote On/Off logic       Von/off at Ion/off=1.0mA       0       0.8         Logic Low (Module Off)       Von/off at Ion/off=0.0 µA       2       50       V         Logic Ligh (Module Off)       Von/off at Ion/off=0.0 µA       2       50       V         ON/							
Turn-On Transient70msStart-Up Time, From On/Off Control70msStart-Up Time, From Input80msMaximum Output CapacitanceLow ESR CAP (OSCON), 100% load;6000μFEFFICIENCY95.5%100% LoadVin=48V95.5%60% LoadVin=48V95.2%SOLATION CHARACTERISTICS10MΩInput to Output10MΩIsolation Resistance10MΩIsolation Capacitance10MΩSwitching Frequency160kHzON/OFF Control, Negative Remote On/Off logicVon/off at Ion/off=1.0mA00.8Logic Ligh (Module Off)Von/off at Ion/off=0.0 µA250VLogic Ligh (Module Off)Von/off at Ion/off=0.0 µA250VOutput Over-Voltage ProtectionOver full temp range; % of nominal Vout115140%ENTRACE PERIONIo=80% of Io, max; Tc=25°C; Airflow=300LFM1.15M houWeight(with heat spreader)Io=80% of Io, max; Tc=25°C; Airflow=300LFM1.15M houWeight(with heat spre		75% lo.max to 50% lo.max					
Start-Up Time, From On/Off Control       70       ms         Maximum Output Capacitance       Low ESR CAP (OSCON), 100% load;       80       ms         100% Load       Vin=48V       95.5       %         60% Load       Vin=48V       95.5       %         SOLATION CHARACTERISTICS       100       2250       Vdc         Input to Output       10       Maximum Output Capacitance       2250       Vdc         Isolation Resistance       10       MMD       MDD       MpD         Switching Frequency       100       MDD       MC       PF         Logic Low (Module Off)       Von/off at lon/off=1.0mA       0       0.8       V         Logic Low (Module Off)       Von/off at lon/off=0.0 µA       2       50       V         Logic Low (Module Off)       Von/off at lon/off=0.0 µA       2       50       V         Logic Low (Module Off)       Von/off at lon/off=0.0 µA       2       50       V         ON/OFF Current (for both remote on/off logic)       Von/off at lon/off=0.0 µA       2       50       V         Output Cyce-Voltage Protection       Over full temp range; % of nominal Vout       115       140       %         Output Over-Voltage Protection       Over full temp range; % of nominal Vout </td <td></td> <td></td> <td></td> <td>300</td> <td></td> <td>μs</td>				300		μs	
Start-Up Time, From Input80msMaximum Output CapacitanceLow ESR CAP (OSCON), 100% load;6000μF100% LoadVin=48V95.5%60% LoadVin=48V95.2%SQLATION CHARACTERISTICS102250VdcInput to Output10MΩMΩIsolation Resistance101000MΩIsolation Resistance101000MΩIsolation Capacitance1000VmFFEATURE CHARACTERISTICS1000KHzSwitching Frequency1600KHzON/OFF Control, Negative Remote On/Off logicVon/off at lon/off=1.0mA00.8Logic Low (Module Off)Von/off at lon/off=1.0mA00.8VLogic Low (Module Off)Von/off at lon/off=0.0 µA250VON/OFF Control, Positive Remote On/Off logic100.8.VVLogic Low (Module Off)Von/off at lon/off=1.0mA00.8.VLogic Low (Module Off)Von/off at lon/off=1.0mA00.8.VLogic Low (Module Off)Von/off at lon/off=0.0 µA250.VON/OFF Current (for both remote on/off logic)Lon/off at lon/off=0.0 µA250.VON/OFF Current (for both remote on/off logic)Logic High, Won/off=15V1MA0Output Over-Voltage ProtectionOver full temp range; % of nominal Vout115140%ENTRAL SPECIFICATIONS1M hou%1.15M hou <t< td=""><td></td><td></td><td></td><td>70</td><td></td><td>ma</td></t<>				70		ma	
Maximum Output Capacitance       Low ESR CAP (OSCON), 100% load;       6000       μF         EFFICIENCY       Vin=48V       95.5       60%         100% Load       Vin=48V       95.2       %         60% Load       Vin=48V       95.2       %         SOLATION CHARACTERISTICS       2250       Vdc         Input to Output       10       MΩ         Isolation Resistance       10       MΩ         Isolation Capacitance       1000       pF         EATURE CHARACTERISTICS       1000       KHz         Switching Frequency       160       KHz         ON/OFF Control, Negative Remote On/Off logic       0       0.8       V         Logic Low (Module Off)       Von/off at lon/off=1.0mA       0       0.8       V         Logic Low (Module Off)       Von/off at lon/off=0.0 µA       2       50       V         Logic Low (Module Off)       Von/off at lon/off=0.0 µA       2       50       V         ON/OFF Current (for both remote on/off logic)       Ion/off at lon/off=0.0 µA       2       50       V         Logic Low (Module Off)       Von/off at lon/off=1.0mA       0       0.8.8       V         Logic Low (Module Off)       Von/off at lon/off=0.0 µA       2							
EFFICIENCY       Vin=48V       95.5       %         100% Load       Vin=48V       95.5       %         SOLATION CHARACTERISTICS       95.2       %         Input to Output       2250       Vdc         Isolation Resistance       10       MΩ         Isolation Capacitance       10       MΩ         Switching Frequency       10       1000         ON/OFF Control, Negative Remote On/Off logic       160       kHz         Logic Low (Module On)       Von/off at lon/off=1.0mA       0       0.8         ON/OFF Control, Negative Remote On/Off logic       10       10       10         Logic Low (Module Of)       Von/off at lon/off=1.0mA       0       0.8       V         Logic Low (Module Off)       Von/off at lon/off=0.0 µA       2       50       V         Logic Low (Module Off)       Von/off at lon/off=1.0mA       0       0.8       V         Logic Low (Module Off)       Von/off at lon/off=1.0mA       0       0.8       V         Logic Low (Module Off)       Von/off at lon/off=0.0 µA       2       50       V         ON/OFF Current (for both remote on/off logic)       Lon/off at lon/off=0.0V       1       mA         Leakage Current (for both remote on/off logic) <t< td=""><td></td><td>Low ESR CAP (OSCON) 100% load:</td><td></td><td>00</td><td>6000</td><td></td></t<>		Low ESR CAP (OSCON) 100% load:		00	6000		
100% LoadVin=48V95.5%60% LoadVin=48V95.2%SOLATION CHARACTERISTICS95.2%Input to Output102250Isolation Resistance10MΩIsolation Resistance10MΩSwitching Frequency160KHzON/OFF Control, Negative Remote On/Off logic160Logic Low (Module Off)Von/off at lon/off=1.0mA0Logic Low (Module Off)Von/off at lon/off=0.0 µA250Logic Low (Module Off)Von/off at lon/off=0.0 µA250Logic Low (Module Off)Von/off at lon/off=0.0 µA250Using High (Module Off)Von/off at lon/off=0.0 µA250Using High (Module Off)Over full temp range; % of nominal Vout115140Setterer (for both remote on/off logic)					0000	μι	
SOLATION CHARACTERISTICS       Input to Output       2250       Vdc         Isolation Capacitance       10       MΩ         Isolation Capacitance       10       MΩ         Switching Frequency       160       KHz         ON/OFF Control, Negative Remote On/Off logic       160       KHz         Logic Low (Module On)       Von/off at lon/off=1.0mA       0       0.88       V         Logic Low (Module Off)       Von/off at lon/off=1.0mA       0       0.88       V         Logic Low (Module Off)       Von/off at lon/off=1.0mA       0       0.8       V         Logic Low (Module Off)       Von/off at lon/off=0.0 µA       2       50       V         ON/OFF Control, Positive Remote On/Off logic       0       0.8       V         Logic Low (Module Off)       Von/off at lon/off=0.0 µA       2       50       V         ON/OFF Current (for both remote on/off logic)       Ion/off at Von/off=150.0V       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; % of nominal Vout       115       140       %         SHERAL SPECIFICATIONS       1       MTBF(with heat spreader)       50.5       gram <td></td> <td>Vin=48V</td> <td></td> <td>95.5</td> <td></td> <td>%</td>		Vin=48V		95.5		%	
Input to Output2250VdcIsolation Resistance10MΩIsolation Capacitance100pFEATURE CHARACTERISTICS1000pFSwitching Frequency160kHzON/OFF Control, Negative Remote On/Off logic1600.8Logic Low (Module Off)Von/off at Ion/off=1.0mA00.8ON/OFF Control, Positive Remote On/Off logicVon/off at Ion/off=1.0mA00.8Logic Low (Module Off)Von/off at Ion/off=0.0 µA250Logic Low (Module On)Von/off at Ion/off=0.0 µA250Logic High (Module On)Von/off at Ion/off=0.0 µA250Uory OVFF Current (for both remote on/off logic)Ion/off at Von/off at Ion/off=0.0 µA250Output Over-Voltage ProtectionOver full temp range; % of nominal Vout1151140SENERAL SPECIFICATIONSVor1.15M houWeight(with heat spreader)Ion-80% of Io, max; Tc=25°C;Airflow=300LFM1.15M houWeight(with heat spreader)S0.5gramWeight(with heat spreader)S0.5gramWeight(with heat spreader)Refer to figure 18 for measuring point122°C	60% Load	Vin=48V		95.2		%	
Isolation Resistance       10       MΩ         Isolation Capacitance       1000       pF         EATURE CHARACTERISTICS       160       kHz         Switching Frequency       160       kHz         ON/OFF Control, Negative Remote On/Off logic       0       0.88         Logic Low (Module On)       Von/off at lon/off=1.0mA       0       0.88         Logic High (Module Off)       Von/off at lon/off=0.0 µA       2       50       V         ON/OFF Control, Positive Remote On/Off logic              Logic Low (Module Off)       Von/off at lon/off=0.0 µA       2       50       V         ON/OFF Control, Positive Remote On/Off logic              Logic Low (Module Off)       Von/off at lon/off=0.0 µA       2       50       V          Logic High (Module On)       Von/off at lon/off=0.0 µA       2       50       V          ON/OFF Current (for both remote on/off logic)       Logic High, Von/off=15V       50       uA         Output Over-Voltage Protection       Over full temp range; % of nominal Vout       115       140       %         MTBF(with heat spreader)       Io=80% of lo, max; Tc=25°C;Airlflow=300LFM       1.15							
Isolation Capacitance1000pFEATURE CHARACTERISTICS160kHzSwitching Frequency160kHzON/OFF Control, Negative Remote On/Off logic00.8VLogic Low (Module On)Von/off at lon/off=1.0mA00.8VLogic Low (Module Off)Von/off at lon/off=0.0 µA250VON/OFF Control, Positive Remote On/Off logicVon/off at lon/off=1.0mA00.8VLogic Low (Module Off)Von/off at lon/off=0.0 µA250VON/OFF Control, Positive Remote On/Off logicVon/off at lon/off=0.0 µA250VLogic High (Module Off)Von/off at lon/off=0.0 µA250VON/OFF Current (for both remote on/off logic)Ion/off at Von/off at Von/off=0.0 µA250VON/OFF Current (for both remote on/off logic)Ion/off at Von/off=0.0V1mALeakage Current (for both remote on/off logic)Logic High, Von/off=15V50uAOutput Over-Voltage ProtectionOver full temp range; % of nominal Vout115140%ENERAL SPECIFICATIONS10=80% of lo, max; Tc=25°C;Airflow=300LFM1.15M houWeight(with heat spreader)50.5gramWeight(with heat spreader)65.5gramWeight(with heat spreader)Refer to fique 18 for measuring point122°C					2250	Vdc	
EATURE CHARACTERISTICS       160       kHz         Switching Frequency       160       kHz         ON/OFF Control, Negative Remote On/Off logic       0       0.8       V         Logic Low (Module On)       Von/off at lon/off=0.0 µA       2       50       V         ON/OFF Control, Positive Remote On/Off logic       0       0.8       V         Logic Low (Module Off)       Von/off at lon/off=0.0 µA       2       50       V         ON/OFF Control, Positive Remote On/Off logic       0       0.8       V         Logic Low (Module Off)       Von/off at lon/off=0.0 µA       2       50       V         ON/OFF Current (for both remote on/off logic)       Ion/off at lon/off=0.0 µA       2       50       V         ON/OFF Current (for both remote on/off logic)       Ion/off at lon/off=0.0 V       1       mA         Quiput Over-Voltage Protection       Over full temp range; % of nominal Vout       115       140       %         EENERAL SPECIFICATIONS       10=80% of lo, max; Tc=25°C;Airflow=300LFM       1.15       M hou         Weight(with heat spreader)       50.5       gram         Over -Temperature Shutdown (Without heat spreader)       65.5       gram			10				
Switching Frequency       160       kHz         ON/OFF Control, Negative Remote On/Off logic       0       0.8       V         Logic Low (Module On)       Von/off at lon/off=1.0mA       0       0.8       V         Logic Low (Module Off)       Von/off at lon/off=0.0 µA       2       50       V         ON/OFF Control, Positive Remote On/Off logic       10       0       0.8       V         Logic Low (Module Off)       Von/off at lon/off=0.0 µA       0       0.8       V         Logic Low (Module Off)       Von/off at lon/off=0.0 µA       0       0.8       V         Logic High (Module On)       Von/off at lon/off=0.0 µA       2       50       V         ON/OFF Current (for both remote on/off logic)       Ion/off at Von/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; % of nominal Vout       115       140       %         SENERAL SPECIFICATIONS       1       1.15       M hou         Weight(without heat spreader)       50.5       gram         Weight(with heat spreader)       65.5       gram         Over -Temperature Shutdown (Without heat spreader)       65.5 <td></td> <td></td> <td></td> <td>1000</td> <td></td> <td>pF</td>				1000		pF	
ON/OFF Control, Negative Remote On/Off logic       Von/off at lon/off=1.0mA       0       0.8       V         Logic Low (Module On)       Von/off at lon/off=0.0 µA       2       50       V         ON/OFF Control, Positive Remote On/Off logic       Von/off at lon/off=0.0 µA       2       50       V         ON/OFF Control, Positive Remote On/Off logic       Von/off at lon/off=1.0mA       0       0.8       V         Logic Low (Module Off)       Von/off at lon/off=1.0mA       0       0.8       V         Logic Low (Module On)       Von/off at lon/off=0.0 µA       2       50       V         ON/OFF Current (for both remote on/off logic)       Ion/off at Von/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; % of nominal Vout       115       140       %         ENERAL SPECIFICATIONS       Io=80% of lo, max; Tc=25°C;Airflow=300LFM       1.15       M hou         Weight(with heat spreader)       50.5       gram         Weight(with heat spreader)       65.5       gram         Over -Temperature Shutdown (Without heat spreader)       Refer to figure 18 for measuring point       122       °C				100			
Logic Low (Module On)Von/off at lon/off=1.0mA00.8VLogic High (Module Off)Von/off at lon/off=0.0 μA250VON/OFF Control, Positive Remote On/Off logicVon/off at lon/off=1.0mA00.8VLogic Low (Module Off)Von/off at lon/off=1.0mA00.8VLogic High (Module Off)Von/off at lon/off=0.0 μA250VON/OFF Current (for both remote on/off logic)Ion/off at Von/off at Von/off=0.0 μA250VON/OFF Current (for both remote on/off logic)Logic High, Von/off=15V50uAOutput Over-Voltage ProtectionOver full temp range; % of nominal Vout115140%BTNEFAL SPECIFICATIONSIo=80% of lo, max; Tc=25°C;Airflow=300LFM1.15M houWeight(with heat spreader)50.5gramWeight(with heat spreader)Refer to figure 18 for measuring point122°C				160		KHZ	
Logic High (Module Off)Von/off at lon/off=0.0 μA250VON/OFF Control, Positive Remote On/Off logicVon/off at lon/off=0.0 μA00.8VLogic Low (Module Off)Von/off at lon/off=1.0mA00.8VLogic High (Module On)Von/off at lon/off=0.0 μA250VON/OFF Current (for both remote on/off logic)Ion/off at Von/off at Von/off=0.0V1mALeakage Current (for both remote on/off logic)Logic High, Von/off=15V50uAOutput Over-Voltage ProtectionOver full temp range; % of nominal Vout115140%SENERAL SPECIFICATIONSIo=80% of lo, max; Tc=25°C;Airflow=300LFM1.15M houWeight(without heat spreader)50.5gramWeight(with heat spreader)Refer to figure 18 for measuring point122°C		Von/off at Ion/off=1 0mA	0		0.8	V	
ON/OFF Control, Positive Remote On/Off logic       Image: Control, Positive Remote On/						V	
Logic Low (Module Off)Von/off at lon/off=1.0mA00.8VLogic High (Module On)Von/off at lon/off=0.0 µA250VON/OFF Current (for both remote on/off logic)Ion/off at Von/off at Von/off=0.0 V1mALeakage Current (for both remote on/off logic)Logic High, Von/off=15V50uAOutput Over-Voltage ProtectionOver full temp range; % of nominal Vout115140%ENERAL SPECIFICATIONSIo=80% of lo, max; Tc=25°C;Airflow=300LFM1.15M houWeight(with heat spreader)50.5gramWeight(with heat spreader)65.5gramOver-Temperature Shutdown (Without heat spreader)Refer to figure 18 for measuring point122°C			-			v	
Logic High (Module On)       Von/off at lon/off=0.0 μA       2       50       V         ON/OFF Current (for both remote on/off logic)       lon/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; % of nominal Vout       115       140       %         ENERAL SPECIFICATIONS       Io=80% of lo, max; Tc=25°C;Airflow=300LFM       1.15       M hou         Weight(with heat spreader)       50.5       gram         Weight(with heat spreader)       65.5       gram         Over - Voltage Protection       Refer to figure 18 for measuring point       122       °C		Von/off at Ion/off=1.0mA	0		0.8	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; % of nominal Vout       115       140       %         SENERAL SPECIFICATIONS       Io=80% of lo, max; Tc=25°C;Airflow=300LFM       1.15       M hou         Weight(without heat spreader)       50.5       gram         Over-Temperature Shutdown (Without heat spreader)       Refer to figure 18 for measuring point       122       °C							
Leakage Current (for both remote on/off logic)       Logic High, Von/off=15V       50       uA         Output Over-Voltage Protection       Over full temp range; % of nominal Vout       115       140       %         ETNETAL SPECIFICATIONS       Image: Speader)       Speader       Image: Speader)       Image: Speader)       Image: Speader)       Image: Speader)       Speader       Speader       Image: Speader)       Image: Speader)       Image: Speader)       Speader		Ion/off at Von/off=0.0V				mA	
ALENERAL SPECIFICATIONS       Io=80% of Io, max; Tc=25°C;Airflow=300LFM       1.15       M hou         Weight(without heat spreader)       50.5       gram         Weight(with heat spreader)       65.5       gram         Over-Temperature Shutdown (Without heat spreader)       Refer to figure 18 for measuring point       122       °C	Leakage Current (for both remote on/off logic)	Logic High, Von/off=15V				uA	
MTBF(with heat spreader)       Io=80% of lo, max; Tc=25°C;Airflow=300LFM       1.15       M hou         Weight(without heat spreader)       50.5       gram         Weight(with heat spreader)       65.5       gram         Over-Temperature Shutdown (Without heat spreader)       Refer to figure 18 for measuring point       122       °C		Over full temp range; % of nominal Vout	115		140	%	
Weight(without heat spreader)       50.5       gram         Weight(with heat spreader)       65.5       gram         Over-Temperature Shutdown (Without heat spreader)       Refer to figure 18 for measuring point       122       °C							
Weight(with heat spreader)         65.5         gram           Over-Temperature Shutdown (Without heat spreader)         Refer to figure 18 for measuring point         122         °C		Io=80% of Io, max; Tc=25°C;Airflow=300LFM				M hou	
Over-Temperature Shutdown (Without heat spreader) Refer to figure 18 for measuring point 122 °C							
Over-temperature Studiouvil (Without near spreader) Refer to righter 18 for measuring point 122 °C		Defecto figuro 19 for managuring paint					
	Over-Temperature Shutdown (Without heat spreader) Over-Temperature Shutdown (With heat spreader)	Refer to figure 18 for measuring point Refer to figure 20 for measuring point		122		ۍ ۲	



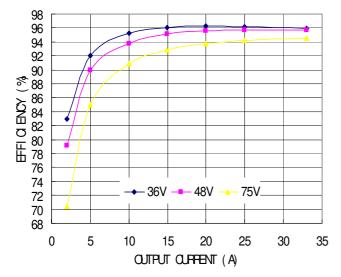


Figure 1: Efficiency vs. load current for minimum, nominal, and maximum input voltage at 85 °C.

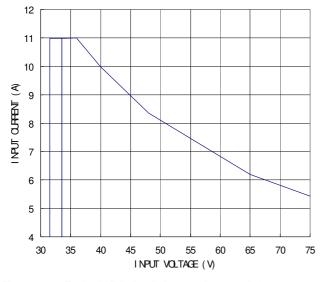


Figure 3: Typical full load input characteristics at room temperature.

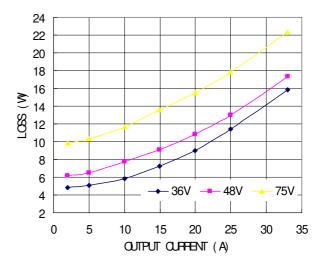
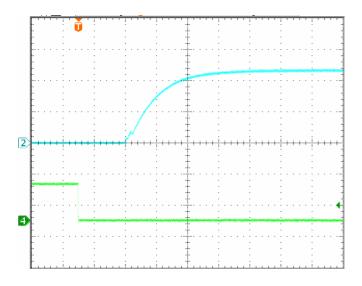


Figure 2: Power dissipation vs. load current for minimum, nominal, and maximum input voltage at 85°C.

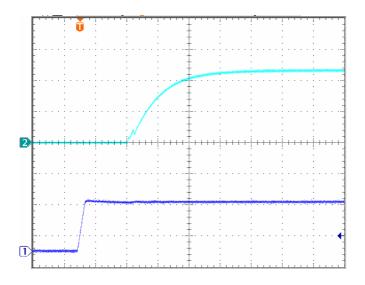


For Negative Remote On/Off Logic

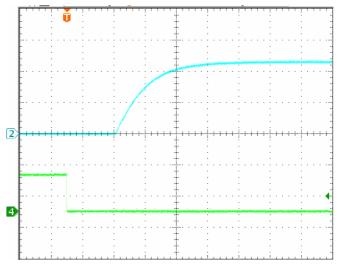


*Figure 4:* Turn-on transient at zero load current) (20ms/div). Top Trace: Vout; 5V/div; Bottom Trace: ON/OFF input: 2V/div.

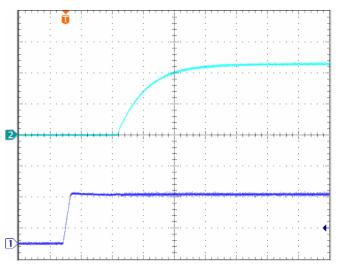
### For Input Voltage Start up



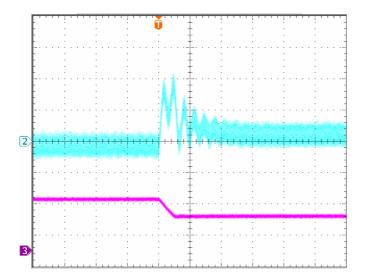
*Figure 6:* Turn-on transient at zero load current (20 ms/div). Top Trace: Vout; 5V/div; Bottom Trace: input voltage: 30V/div.



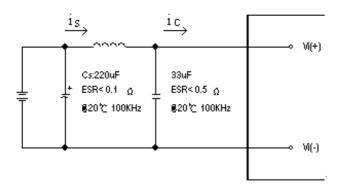
*Figure 5:* Turn-on transient at full rated load current (20 ms/div). Top Trace: Vout: 5V/div; Bottom Trace: ON/OFF input: 2V/div.



*Figure 7*: Turn-on transient at full rated load current (20 ms/div). Top Trace: Vout; 5V/div; Bottom Trace: input voltage: 30V/div.

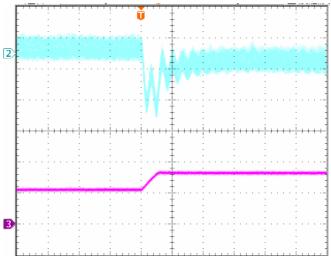


**Figure 8:** Output voltage response to step-change in load current (75%-50% of lo, max; di/dt =  $0.1A/\mu$ s). Load cap:  $10\mu$ F, tantalum capacitor and  $1\mu$ F ceramic capacitor. Top Trace: Vout; 100mV/div; Bottom Trace: output current: 15A/div, Time: 200us/div

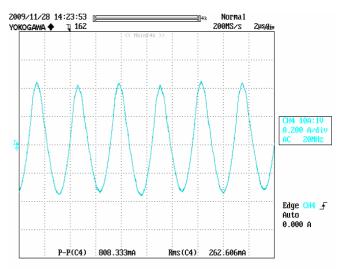


*Figure 10:* Test set-up diagram showing measurement points for Input Terminal Ripple Current and Input Reflected Ripple Current.

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

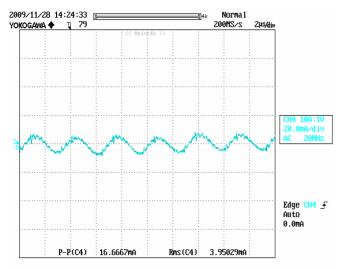


**Figure 9:** Output voltage response to step-change in load current (50%-75% of lo, max; di/dt =  $0.1A/\mu$ s). Load cap:  $10\mu$ F, tantalum capacitor and  $1\mu$ F ceramic capacitor. Top Trace: Vout; 100mV/div; Bottom Trace: output current: 15A/div, Time: 200us/div

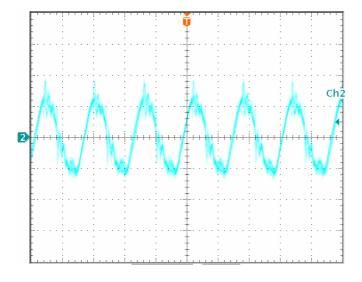


**Figure 11:** Input Terminal Ripple Current, *i*<sub>c</sub>, at full rated output current and nominal input voltage with 12µH source impedance and 33µF electrolytic capacitor (200 mA/div , 2us/div).





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



**Figure 14:** Output voltage ripple at nominal input voltage and rated load current (Io=33A)(20 mV/div, 2us/div)

Load capacitance:  $1\mu F$  ceramic capacitor and  $10\mu F$  tantalum capacitor. Bandwidth: 20 MHz.

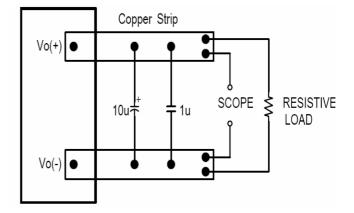
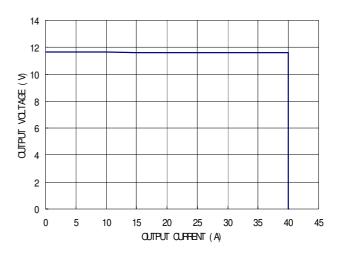


Figure 13: Output voltage noise and ripple measurement test setup.



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

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# **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  $\mu$ H, we advise adding a 10 $\mu$ F to 100 $\mu$ 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**

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 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 40A 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.

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# **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 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 protection circuit will constrain the max duty cycle to limit the output voltage, if the output voltage continuously increases the modules will shut down, and then restart after a hiccup-time (hiccup mode).

#### **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 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.

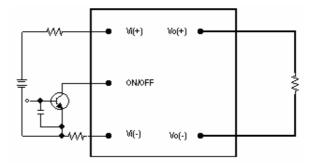


Figure 16: Remote on/off implementation



## THERMAL CONSIDERATIONS

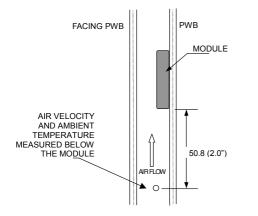
Thermal management is an important part of the system design. To ensure proper, reliable operation, sufficient cooling of the power module is needed over the entire temperature range of the module. Convection cooling is usually the dominant mode of heat transfer.

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").



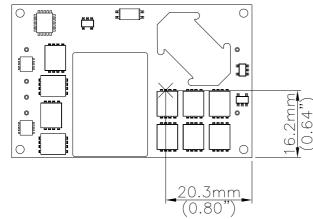
Note: Wind Tunnel Test Setup Figure Dimensions are in millimeters and (Inches)

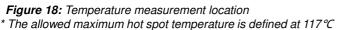
Figure 17: Wind tunnel test setup

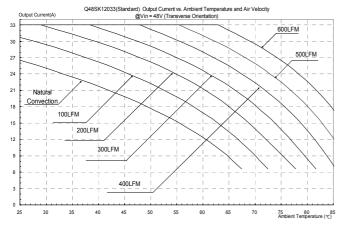
#### **Thermal Derating**

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 (WITHOUT HEAT SPREADER)







**Figure 19:** Output current vs. ambient temperature and air velocity @Vin=48V(Transverse Orientation, without heat spreader)

## THERMAL CURVES (WITH HEAT SPREADER)

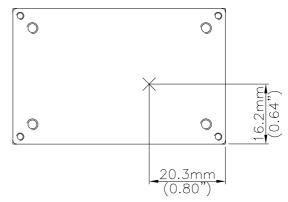
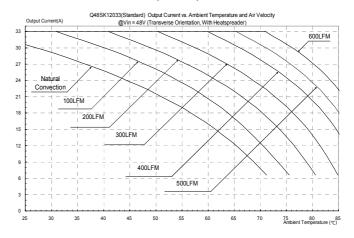


Figure 20: Temperature measurement location <sup>∗</sup> The allowed maximum hot spot temperature is defined at 108 ℃

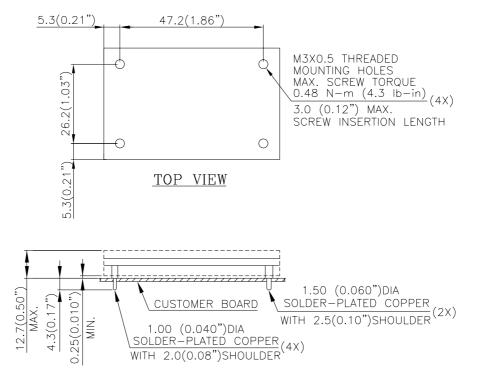


*Figure 21:* Output current vs. ambient temperature and air velocity @Vin=48V(Transverse Orientation, with heat spreader)

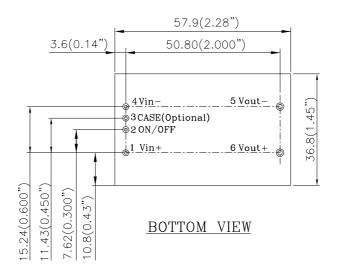


# **MECHANICAL DRAWING (WITH HEAT SPREADER)**

\* For modules with through-hole pins and the optional heatspreader, they are intended for wave soldering assembly onto system boards; please do not subject such modules through reflow temperature profile.

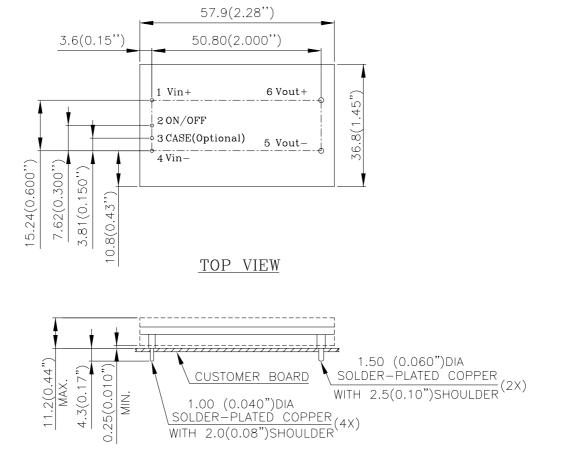


#### SIDE VIEW



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.)





#### 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.)

<u>Pin No. Name</u>		<b>Function</b>		
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	+Vout	Positive output voltage		

#### **Pin Specification:**

Pins 1-4	1.00mm (0.040") diameter
Pins 5 &6	1.50mm (0.059") diameter
All pins are copper with	Tin plating.

DS\_Q48SK12033\_01062011



### PART NUMBERING SYSTEM

Q	48	S	к	120	33	Ν	R	F	А
Form	Input	Number of	Product	Output	Output	ON/OFF	Pin		Option Code
Factor	Voltage	Outputs	Series	Voltage	Current	Logic	Length		
Q - Quarter	48-36V~75V	S - Single	K- QB high	120 - 12V	33 - 33A	N - Negative	K - 0.110"	F - RoHS 6/6	A - Std. Functions
Brick			power			P - Positive	N - 0.146"	(Lead Free)	without case pin
			series				R - 0.170"	Space - RoHS5/6	H - with heat spreader
									and case pin
									N - with heat spreader
									and without case pin

### **MODEL LIST**

MODEL NAME	INPUT		OUTPUT		EFF @ 100% LOAD	
Q48SK12033NRFA	36V~75V	13A	12V	33A	95.5%	
Q48SK12033NRFH	36V~75V	13A	12V	33A	95.5%	
Q48SK12033NNFH	36V~75V	13A	12V	33A	95.5%	

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

\* For modules with through-hole pins and the optional heatspreader, they are intended for wave soldering assembly onto system boards; please do not subject such modules through reflow temperature profile.

#### CONTACT: www.delta.com.tw/dcdc

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#### 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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