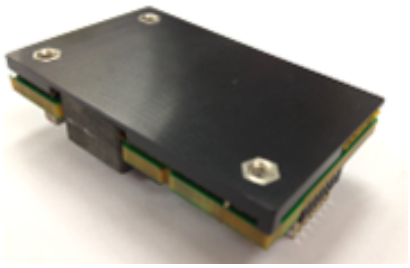
DELPHI SERIES



## FEATURES

- High efficiency: 96% @12V/34A
- Size:
  Without Heat spreader:
  58.4 x 36.8 x 11.2mm (2.30”x1.45”x0.44”)
  With heat spreader:
  58.4 x 36.8 x 12.7mm (2.30”x1.45”x0.50”)
- PMBus Rev.1.2 compliance
- Industry standard, DOSA compliant pin out
- Can be connected in parallel directly
- Parallel and Droop current sharing
- Fixed frequency operation
- Input UVLO, Output OCP & OVP, OTP
- Monotonic startup into normal and Pre-biased loads
- 2250V Isolation and basic insulation
- No minimum load required
- ISO 9001, TL 9000, ISO 14001, QS 9000, OHSAS 18001 certified manufacturing facility
- UL/cUL 60950-1 (US & Canada) to be recognized

# Delphi Series Q48SD Quarter Brick Family Full Digital Control DC/DC Power Modules: 48V In, 12V/34A Out

The Delphi Series Q48SD, 36~75V input, isolated single output, Quarter Brick, are full digital control DC/DC converters, and are the latest offering from a world leader in power systems technology and manufacturing — Delta Electronics, Inc. The Q48SD series provide up to 400 watts of power in an industry standard, DOSA compliant footprint and pin out; the typical efficiency is 96% at 48V input, 12V output and 34A load. There is a built-in digital PWM controller in the Q48SD series, which is used to complete the Vo feedback, PWM signal generation, droop current sharing, fault protection, and PWBUS communications, and so on. With the digital control, many design and application flexibility, advanced performance, and reliability are obtained; and the Q48SD series can be connected in parallel directly for higher power without add external oring-fet.

## OPTIONS

- Digital PMBus interface
- Parallel and Droop Current sharing
- Trim
- Positive On/Off logic
- With heatspreader
- Short pin lengths available

## APPLICATIONS

- Telecom / DataCom
- Wireless Networks
- Optical Network Equipment
- Server and Data Storage
- Industrial/Test Equipment

**DATASHEET**
**DS_Q48SD12034_09142012**

Delta Electronics, Inc.

# TECHNICAL SPECIFICATIONS

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

| PARAMETER | NOTES and CONDITIONS | Q48SD12034 (Standard) | | | |
|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | Units |
| **ABSOLUTE MAXIMUM RATINGS** | | | | | |
| Input Voltage | | | | | |
| Continuous | | | | 80 | Vdc |
| Transient (100ms) | 100ms | | | 100 | Vdc |
| On/off Pin Voltage | | -50 | | 50 | V |
| Other Pin Voltage | Trim/Current Sharing, C2, Data, SMBAlert, Clock, Addr1, Addr0 | -0.3 | | 3.6 | V |
| Operating Ambient Temperature | | -40 | | 85 | °C |
| Storage Temperature | | -55 | | 125 | °C |
| Input/Output Isolation Voltage | | | | 2250 | Vdc |
| **INPUT CHARACTERISTICS** | | | | | |
| Operating Input Voltage | | 36 | | 75 | Vdc |
| Input Under-Voltage Lockout | | | | | |
| Turn-On Voltage Threshold | | 32.5 | 34 | 35.5 | Vdc |
| Turn-Off Voltage Threshold | | 30.5 | 32 | 33.5 | Vdc |
| Maximum Input Current | Vin=36V, 100% Load, | | 11.33 | 11.5 | A |
| No-Load Input Current | | | 75 | 110 | mA |
| Off Converter Input Current | | | 18 | 23 | mA |
| Inrush Current($I^2t$) | With 100uF external input capacitor | | | 1 | $A^2s$ |
| Input Terminal Ripple Current | RMS, With 100uF input cap. | | 0.32 | 0.48 | A |
| Input Reflected-Ripple Current | P-P thru 12μH inductor, 5Hz to 20MHz | | 20 | | mA |
| Input Voltage Ripple Rejection | 120 Hz | | 50 | | dB |
| **OUTPUT CHARACTERISTICS** | | | | | |
| **The module without droop current sharing option code** | | | | | |
| Output Voltage Set Point | Vin=48V, Io=Io.max, Tc=25°C | 11.95 | 12 | 12.05 | Vdc |
| Output Voltage Regulation | | | | | |
| Over Load | Io=Io,min to Io,max | | 20 | 50 | mV |
| Over Line | Vin=38.5V to 75V | | 20 | 50 | mV |
| Over Temperature | Tc=-40°C to 125°C | | ±120 | | mV |
| Total Output Voltage Range | over sample load, and temperature, from 38.5~75V Vin | 11.75 | 12 | 12.25 | V |
| | over sample load, and temperature, from 36~75V Vin | 11.2 | 12 | 12.25 | V |
| **The module with droop current sharing option code** | | | | | |
| Output Voltage Set Point | Vin=48V, Io=0A, Tc=25°C | 12.4 | 12.45 | 12.5 | Vdc |
| Output Voltage Regulation | | | | | |
| Over Load | Io=Io,min to Io,max | | 500 | 600 | mV |
| Over Line | Vin=40V to 75V | | 20 | 50 | mV |
| Over Temperature | Tc=-40°C to 125°C | | ±120 | | mV |
| Total Output Voltage Range | over sample load, and temperature, from 40~75V Vin | 11.7 | 12.45 | 12.65 | V |
| | over sample load, and temperature, from 36~75V Vin | 11.2 | 12.45 | 12.65 | V |
| **Both With and without droop current sharing option code** | | | | | |
| Output Voltage Ripple and Noise | 5Hz to 20MHz bandwidth | | | | |
| Peak-to-Peak | Full Load, 1μF ceramic, 10μF tantalum | | 100 | 200 | mV |
| RMS | Full Load, 1μF ceramic, 10μF tantalum | | 40 | 80 | mV |
| Operating Output Current Range | Full input voltage range | 0 | | 34 | A |
| Output DC Current-Limit Inception | Output Voltage 10% Low | 110 | | 150 | % |
| Output Voltage Trim Range | Vin=48V, Pout ≦ max rated power; For droop parallel module, such function is disabled. | -20 | | 10 | % |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| Output Voltage Current Transient | 48V, 10μF Tan & 1μF Ceramic load cap, 0.1A/μs | | | | |
| Output voltage overshoot and undershoot | 0.1A/μs, 50% to 75% Io.max, 10μF Tan load cap | | 200 | 400 | mV |
| Setting Time (within 1% Vout nominal) | | | | 300 | μs |
| Output voltage overshoot and undershoot | 2.5A/μs, 25% to 75% Io.max, 4000μF Tan load cap | | 300 | 450 | mV |
| Setting Time (within 1% Vout nominal) | | | | 1000 | μs |
| Turn-On Transient | | | | | |
| Start-Up Time, From On/Off Control | | | 40 | 50 | ms |
| Start-Up Time, From Input | | | 50 | 60 | ms |
| Output Capacitance | | 220 | | 16000 | μF |
| **EFFICIENCY** | | | | | |
| 100% Load | Vin=48V | 94.7 | 95.5 | | % |
| 60% Load | Vin=48V | 95.2 | 96.0 | | % |
| **ISOLATION CHARACTERISTICS** | | | | | |
| Input to Output | | | | 2250 | Vdc |
| Isolation Resistance | | 10 | | | MΩ |
| Isolation Capacitance | | | 1500 | | pF |
| **FEATURE CHARACTERISTICS** | | | | | |
| Current sharing accuracy | | | | 10 | % |
| Switching Frequency | | | 130 | | kHz |
| ON/OFF Control | | | | | |
| Logic Low | Von/off | -0.7 | | 0.8 | V |
| Logic High | Von/off | 2.4 | | 50 | V |
| ON/OFF Current (for both remote on/off logic) | Ion/off at Von/off=0.0V | | | 0.5 | mA |
| ON/OFF Current (for both remote on/off logic) | Ion/off at Von/off=2.4V | 10 | | | μA |
| Leakage Current (for both remote on/off logic) | Logic High, Von/off=15V | | | 50 | μA |
| Output Voltage Trim Range | Vin=48V, Pout ≦ max rated power | -20 | | 10 | % |
| Output Over-Voltage Protection | Over full temp range; % of nominal Vout | 14 | | 17 | V |

## TECHNICAL SPECIFICATIONS

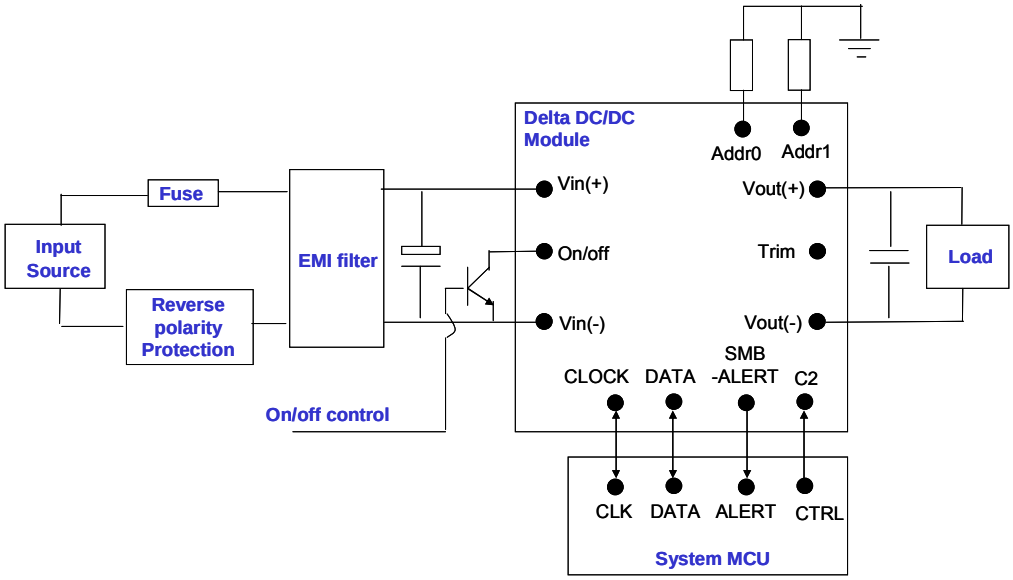
**($T_A$=25°C, airflow rate=300 LFM, $V_{in}$=48Vdc, nominal Vout unless otherwise noted.)**

| PARAMETER | NOTES and CONDITIONS | Q48SD12034 (Standard) | | | |
|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | Units |
| **PMBus Signal Interface Characteristics** | | | | | |
| Logic Input Low ($V_{IL}$) | C2, Data, SMBAlert, Clock pin | 0 | | 0.8 | V |
| Logic Input High ($V_{IH}$) | C2, Data, SMBAlert, Clock pin | 2.1 | | 3.3 | V |
| Logic Onput Low ($V_{OL}$) | C2, Data, SMBAlert, Clock pin; $I_{OL}$=6mA | | | 0.4 | V |
| Logic Onput High ($V_{OH}$) | C2, Data, SMBAlert, Clock pin; $I_{OH}$=-6mA | 2.6 | | | V |
| PMBus Operating Frequency Range | | 100 | | 400 | KHz |
| **PMBus Monitoring CHARACTERISTICS** | | | | | |
| Output Current Reading Accuracy | Io=50% ~ 100% of Io, max; | -5 | | +5 | % |
| | Io=5% ~ 50% of Io, max; | -2 | | +2 | A |
| Output Voltage Reading Accuracy | | -2 | | +2 | % |
| Input Voltage Reading Accuracy | | -4 | | +4 | % |
| Temperature Reading Accuracy | | -5 | | +5 | ℃ |
| **GENERAL SPECIFICATIONS** | | | | | |
| MTBF | Io=100% of Io, max; 300LFM; Ta=25℃ | | 1 | | M hours |
| Weight | Without heat spreader | | 52.5 | | grams |
| Weight | With heat spreader | | 66.5 | | grams |
| Over-Temperature Shutdown ( Without heat spreader) | Refer to Figure 22 for Hot spot 1 location (48Vin,80% Io, 200LFM,Airflow from Vin+ to Vin-) | | 128 | | °C |
| Over-Temperature Shutdown (With heat spreader) | Refer to Figure 24 for Hot spot 2 location (48Vin,80% Io, 200LFM,Airflow from Vin+ to Vin-) | | 120 | | °C |
| Over-Temperature Shutdown ( NTC resistor ) | Refer to Figure 22 for NTC resistor location | | 125 | | °C |
| Note: Please attach thermocouple on NTC resistor to test OTP function, the hot spots' temperature is just for reference. | | | | | |

## PIN DEFINATION

| Pin# | Name | Function | Pin# | Name | Function |
|---|---|---|---|---|---|
| 1 | VIN(+) | | 7 | C2 | Secondary on/off control pin; The default configuration is set to ignore this input. And such pin can be reconfigured by the PMBus Interface. |
| 2 | ON/OFF | Primary on/off control pin | 8 | Sig_Gnd | Signal ground |
| 3 | VIN(-) | | 9 | Data | PMBus data line |
| 4 | VOUT(-) | | 10 | SMBAlert | PMBus SMBAlert line |
| 5 | Trim | Trim pin | 11 | Clock | PMBus clock line |
| 6 | VOUT(+) | | 12 | Addr1 | ADDR1 pin sets the high order digit of the address. |
| | | | 13 | Addr0 | ADDR0 pin sets the low order digit of the address. |

## SIMPLIFIED APPLICATION CIRCUIT



## ELECTRICAL CHARACTERISTICS CURVES

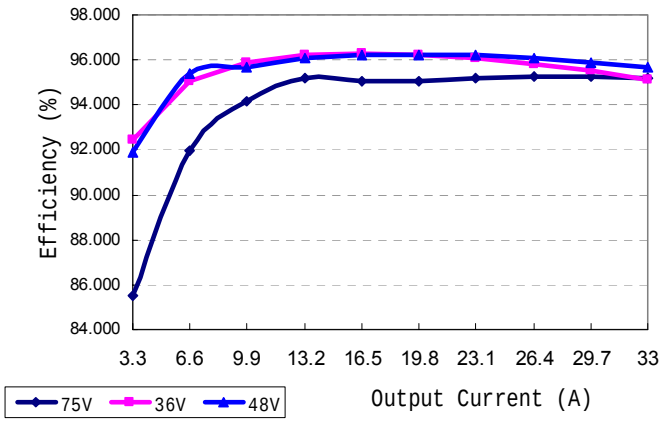



***Figure 1:*** *Efficiency vs. load current for minimum, nominal, and maximum input voltage at 25°C*

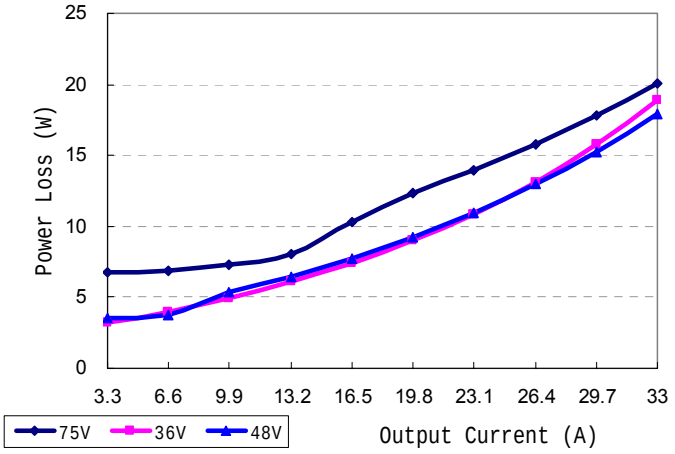



***Figure 2:*** *Power dissipation vs. load current for minimum, nominal, and maximum input voltage at 25°C*

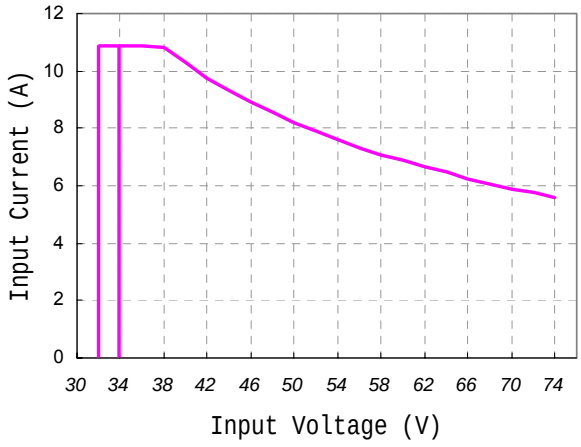



***Figure 3:*** *Typical full load input characteristics at room temperature*

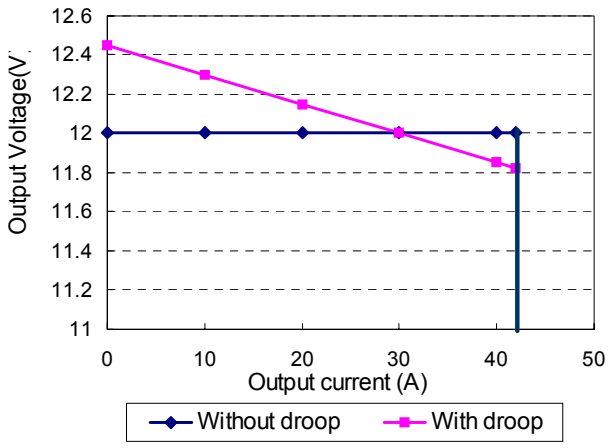



***Figure 4:*** *Output voltage regulation vs load current showing typical current limit curves and converter shutdown points for nominal input voltage at room temperature*

## ELECTRICAL CHARACTERISTICS CURVES

### For Negative Remote On/Off Logic

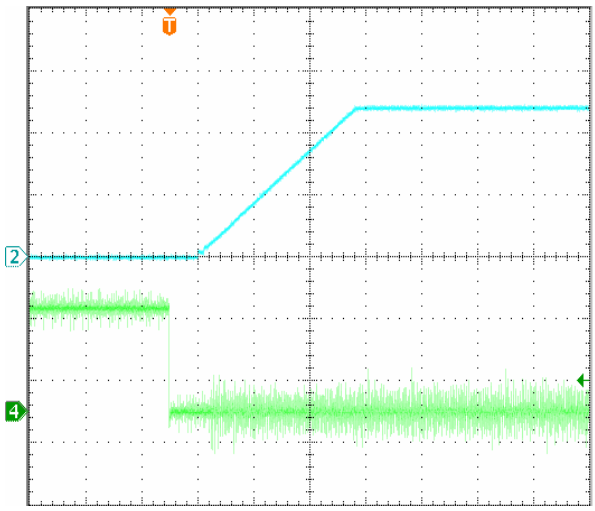


***Figure 5:*** *Turn-on transient at zero load current (10ms/div). Vin=48V. Top Trace: Vout, 5V/div; Bottom Trace: ON/OFF input, 2V/div*

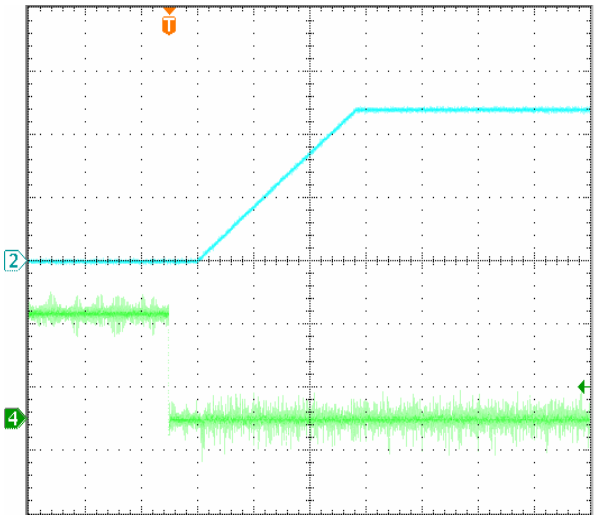


***Figure 6:*** *Turn-on transient at full rated load current (constant current load) (10 ms/div). Vin=48V. Top Trace: Vout, 5V/div; Bottom Trace: ON/OFF input, 2V/div*

### For Input Voltage Start up

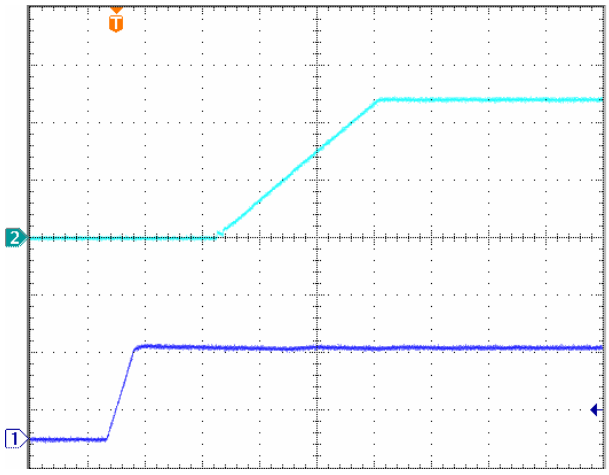


***Figure 7:*** *Turn-on transient at zero load current (10 ms/div). Vin=48V. Top Trace: Vout, 5V/div, Bottom Trace: input voltage, 30V/div*

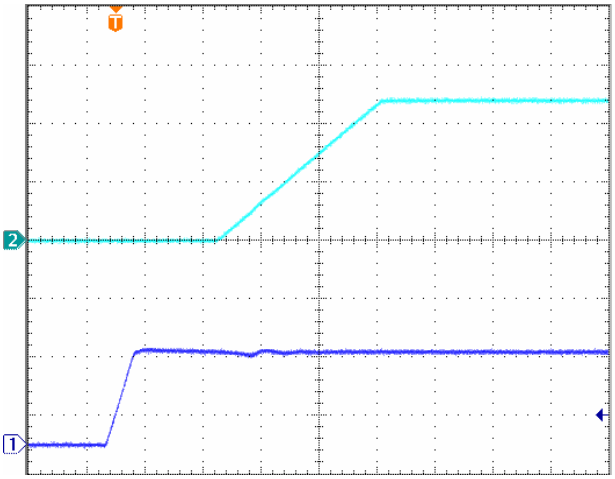


***Figure 8:*** *Turn-on transient at full rated load current (constant current load) (10 ms/div). Vin=48V. Top Trace: Vout, 5V/div; Bottom Trace: input voltage, 30V/div*

## ELECTRICAL CHARACTERISTICS CURVES

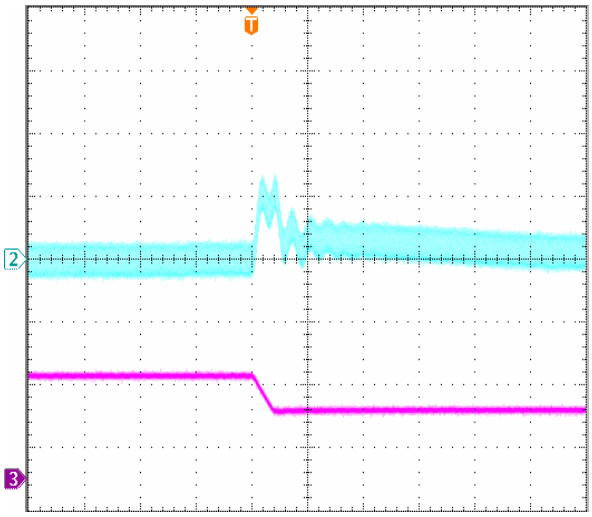


***Figure 9:*** *Output voltage response to step-change in load current (75%-50% of Io, max; di/dt = 0.1A/µs, Vin=48V). Load cap: 10µF, tantalum capacitor and 1µF ceramic capacitor. Top Trace: Vout (200mV/div, 200us/div); Bottom Trace: Io (15A/div, 200us/div). Scope measurement should be made using a BNC cable (length shorter than 20 inches). Position the load between 51 mm to 76 mm (2 inches to 3 inches) from the module..*

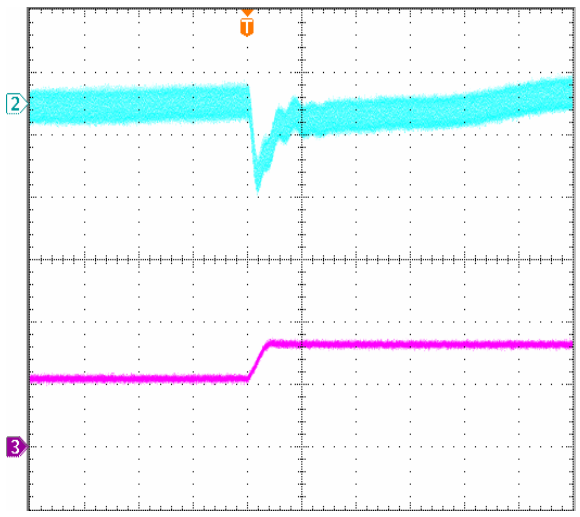


***Figure 10:*** *Output voltage response to step-change in load current (50%-75% of Io, max; di/dt = 0.1A/µs, Vin=48V). Load cap: 10µF, tantalum capacitor and 1µF ceramic capacitor. Top Trace: Vout (200mV/div, 200us/div); Bottom Trace: Io (15A/div, 200us/div). Scope measurement should be made using a BNC cable (length shorter than 20 inches). Position the load between 51 mm to 76 mm (2 inches to 3 inches) from the module..*

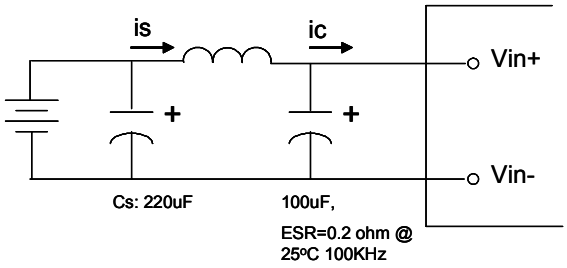



***Figure 11:*** *Test set-up diagram showing measurement points for Input Terminal Ripple Current and Input Reflected Ripple Current.*
*Note: Measured input reflected-ripple current with a simulated source Inductance ($L_{TEST}$) of 12 µH. Capacitor Cs offset possible battery impedance. Measure current as shown below*

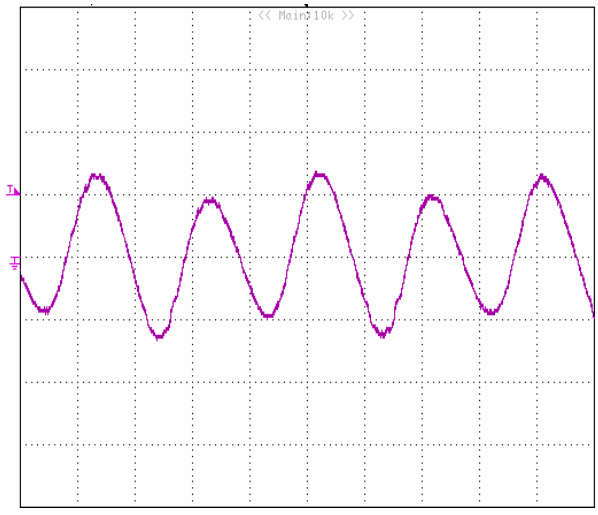


***Figure 12:*** *Input Terminal Ripple Current, $i_c$, at full rated output current and nominal input voltage with 12µH source impedance and 100µF electrolytic capacitor (100 mA/div, 2us/div).*

## ELECTRICAL CHARACTERISTICS CURVES

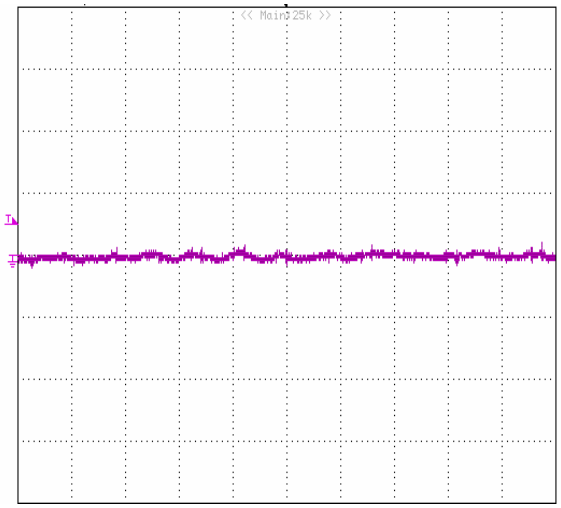


***Figure 13:*** *Input reflected ripple current, $i_s$, through a 12µH source inductor at nominal input voltage and rated load current (20 mA/div, 5us/div).*

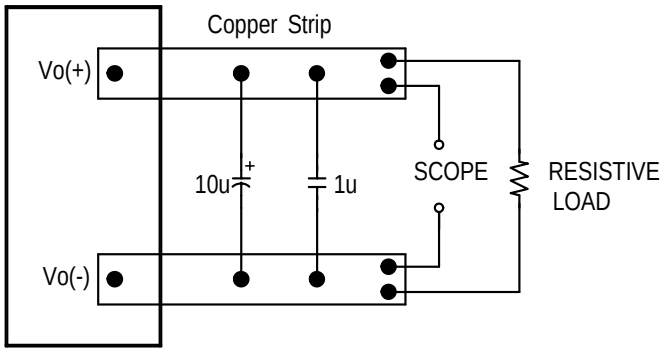



***Figure 14:*** *Output voltage noise and ripple measurement test setup*

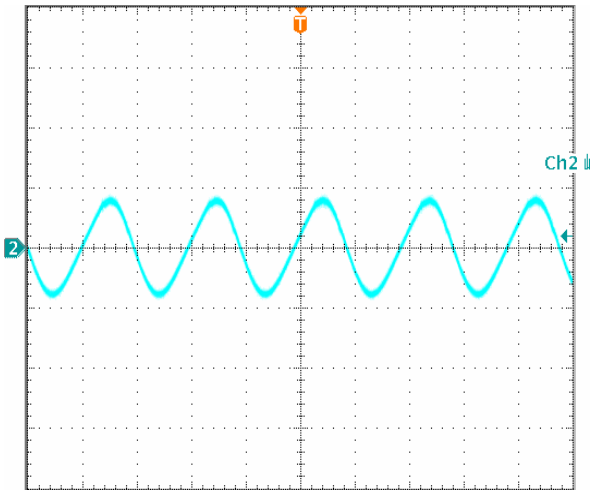



***Figure 15:*** *Output voltage ripple at nominal input voltage and rated load current (50 mV/div, 2us/div)*
*Load capacitance: 1µF ceramic capacitor and 10µF tantalum capacitor. Bandwidth: 20 MHz. Scope measurements should be made using a BNC cable (length shorter than 20 inches). Position the load between 51 mm to 76 mm (2 inches to 3 inches) from the module.*

# DESIGN CONSIDERATIONS

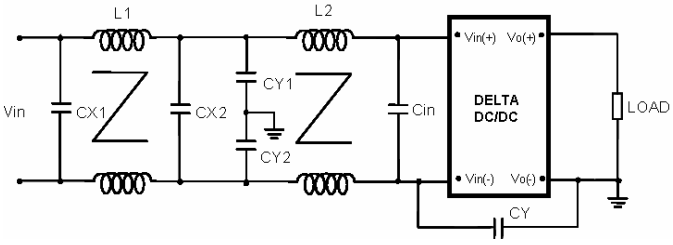
## Input Source Impedance

The impedance of the input source connecting to the DC/DC power modules will interact with the modules and affect the stability. A low ac-impedance input source is recommended. If the source inductance is more than a few μH, we advise adding a 100 to 200 μF electrolytic capacitor (ESR < 0.7 Ω at 100 kHz) mounted close to the input of the module to improve the stability.

## Layout and EMC Considerations

Delta's DC/DC power modules are designed to operate in a wide variety of systems and applications. For design assistance with EMC compliance and related PWB layout issues, please contact Delta's technical support team. An external input filter module is available for easier EMC compliance design. Below is the reference design for an input filter tested with Q48SD120XXXXXX to meet class B in CISSPR 22.

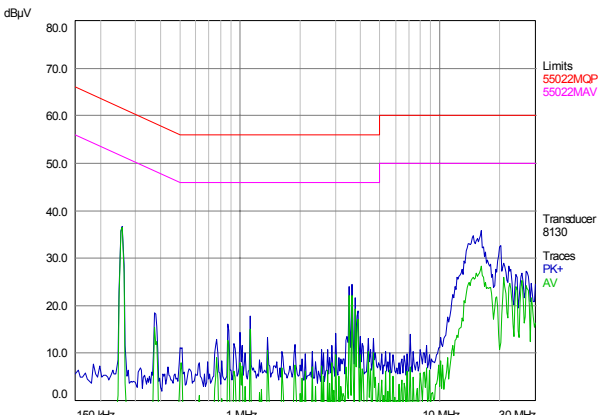
**Schematic and Components List**




**For Single Module Application**

Cin is 100uF low ESR Aluminum cap;
CX1 is 2.2uF ceramic cap×2pcs in parallel;
CX2 is 2.2uF ceramic cap;
CY1 and CY2 are 47nF ceramic cap;
CY is 3.3nF ceramic cap;
L1 and L2 are common-mode inductors, L1=L2=0.47mH;

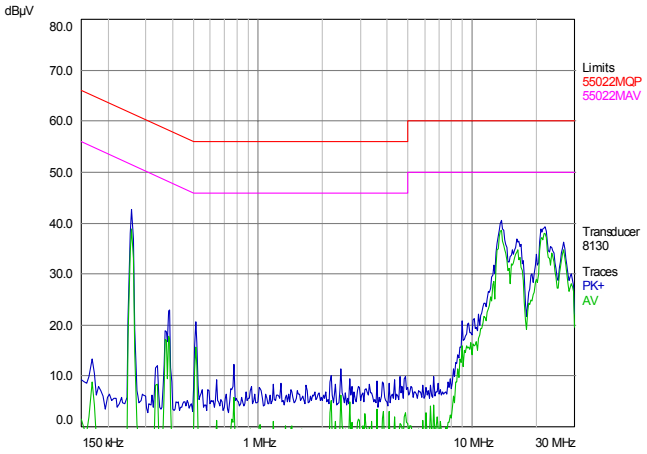
**Test Result:** Vin=48V, Io=34A




**For parallel application**

Cin is 100uF low ESR Aluminum cap x 2pcs in parallel;
CX1 is 2.2uF ceramic cap×2pcs in parallel;
CX2 is 2.2uF ceramic cap;
CY1 is 47nF ceramic cap x 2pcs in parallel;
CY2 is 47nF ceramic cap x 2pcs in parallel;
CY is 3.3nF ceramic cap;
L1 is Pulse P0469NL (0.63mH/11.6A) x 2pcs in parallel;
L2 is Pulse P0469NL (0.63mH/11.6A) x 2pcs in parallel;

**Test Result:** Vin=48V, Io=68A




The blue line is quasi peak mode and the green one is average mode.

## Safety Considerations

The power module must be installed in compliance with the spacing and separation requirements of the end-user's safety agency standard, i.e., UL60950-1, CSA C22.2 NO. 60950-1 2nd, IEC 60950-1 2nd : 2005, EN 60950-1 2nd: 2006+A11+A1: 2010, if the system in which the power module is to be used must meet safety agency requirements.

Basic insulation based on 75 Vdc input is provided between the input and output of the module for the purpose of applying insulation requirements when the input to this DC-to-DC converter is identified as TNV-2 or SELV. An additional evaluation is needed if the source is other than TNV-2 or SELV.

When the input source is SELV circuit, the power module meets SELV (safety extra-low voltage) requirements. If the input source is a hazardous voltage which is greater than 60 Vdc and less than or equal to 75 Vdc, for the module's output to meet SELV requirements, all of the following must be met:

- The input source must be insulated from the ac mains by reinforced or double insulation.
- The input terminals of the module are not operator accessible.
- A SELV reliability test is conducted on the system where the module is used, in combination with the module, to ensure that under a single fault, hazardous voltage does not appear at the module's output.

When installed into a Class II equipment (without grounding), spacing consideration should be given to the end-use installation, as the spacing between the module and mounting surface have not been evaluated.

The power module has extra-low voltage (ELV) outputs when all inputs are ELV.

This power module is not internally fused. To achieve optimum safety and system protection, an input line fuse is highly recommended. The safety agencies require a Fast-acting fuse with 30A 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, and enter hiccup mode or latch mode. For hiccup mode, the module 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. For latch mode, the module will shut down and not attempt to restart. The latch is reset by either cycling the input power or by toggling the primary on/off signal for one second. The OCP threshold and protection mode can be reconfigured by the PMBus Interface; the default configuration is hiccup mode.

### Over-Voltage Protection

The modules include an internal output over-voltage protection circuit. If output voltage exceeds the over-voltage set point, the module will shut down, and enter in hiccup mode or latch mode. For hiccup mode, the module will try to restart after shutdown. If the output overvoltage condition still exists, the module will shut down again. This restart trial will continue until the over-voltage condition is corrected. For latch mode, the module will shut down and not attempt to restart. The latch is reset by either cycling the input power or by toggling the primary on/off signal for one second. The Vo OVP threshold and protection mode can be reconfigured by the PMBus Interface; The default configuration is hiccup mode.

### Over-Temperature Protection

The modules include an internal over-temperature protection circuit. If the module temperature exceeds the over-temperature threshold the module will shut down, and enter in auto-recovery mode or latch mode. For auto-recovery mode, the module will monitor the module temperature after shutdown. Once the temperature is dropped and within the specification, the module will be auto-recovery. For latch mode, the module will shut down and not attempt to restart. The latch is reset by either cycling the input power or by toggling the primary on/off signal for one second. The OTP threshold and protection mode can be reconfigured by the PMBus Interface; The default configuration is hiccup mode.

### Primary Remote On/Off

The primary 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.

The primary remote on/off can be controlled by an external switch between the on/off terminal and the Vi(-) terminal. The switch can be an open collector or open drain. If the remote on/off feature is not used, for negative logic, please short the on/off pin to Vi(-); For positive logic, please leave the on/off pin floating. The module will not response to the remote on/off signal which is less than 120us. The primary remote on/off logic can be reconfigured by the PMBus Interface.

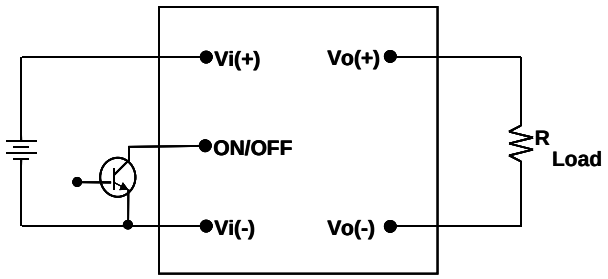



***Figure 17:*** *Remote on/off implementation*

### Secondary Remote On/Off

Reference to the Vo(-) terminal, there is a C2 pin. The default configuration is set to ignore this input. And such pin can be reconfigured as secondary remote on/off pin by the PMBus interface including 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. The secondary remote on/off can be controlled by an external switch between the on/off terminal and the Vo(-) terminal. The switch can be an open collector or open drain.

### Parallel and Droop Current Sharing

The modules are capable of operating in parallel, and realizing current sharing by droop current sharing method. There is about 500mV output voltage droop from 0A to full output Load, and there is no current sharing pin. By connectting the Vin pin and the Vo pin of the parallel module together, the current sharing can be realized automatically.

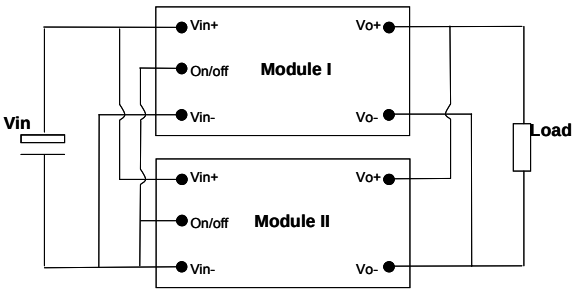



***Figure 18:*** *Parallel and droop current sharing configuration for no redundancy requirement system*

## FEATURES DESCRIPTIONS (CON.)

If system has no redundancy requirement, the module can be parallel directly for higher power without adding external oring-fet; whereas, If the redundancy function is required, the external oring-fet should be added.

For a normal parallel operation the following precautions must be observed:
1. The current sharing accuracy equation is:
X% = | Io – ( Itotal / N ) | / Irated, Where,
Io is the output current of per module;
Itotal is the total load current;
N is parallel module numbers;
Irated is the rated full load current of per module.

2. To ensure a better steady current sharing accuracy, below design guideline should be followed:
a) The inputs of the converters must be connected to the same voltage source; and the PCB trace resistance from Input voltage source to Vin+ and Vin- of each converter should be equalized as much as possible.
b) The PCB trace resistance from each converter's output to the load should be equalized as much as possible.
c) For accurate current sharing accuracy test, the module should be soldered in order to avoid the unbalance of the touch resistance between the modules to the test board.

3. To ensure the parallel module can start up monotonically without trigging the OCP circuit, below design guideline should be followed:
a) Before all the parallel module finished start up, the total load current should be lower than the rated current of 1 module.
b) The ON/OFF pin of the converters should be connected together to keep the parallel modules start up at the same time.
c) The under voltage lockout point will slightly vary from unit to unit. The dv/dt of the rising edge of the input source voltage must be greater than 1V/ms to ensure that the parallel module start up at the same time.

### PMBus Communication

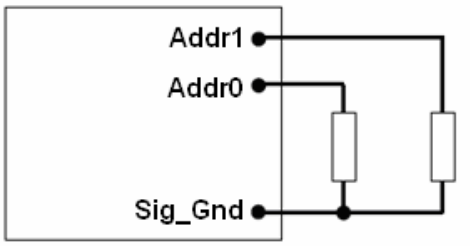
The module has a digital PMBus interface to allow the module to be monitored, controlled and configured by the system. The module supports 4 PMBus signal lines, Data, Clock, SMBALERT (optional), Control (C2 pin, optional), and 2 Address line Addr0 and Addr1. More detail PMBus information can be found in the PMB Power Management Protocol Specification, Part I and part II, revision 1.2; which is shown in http://pmbus.org . Both 100kHz and 400kHz bus speeds are supported by the module. Connection for the PMBus interface should be following the High Power DC specifications given in section 3.1.3 in the SMBus specification V2.0 or the Low Power DC specifications in section 3.1.2. The complete SMBus specification is shown in http://smbus.org.

The module supports the Packet Error Checking (PEC) protocol. It can check the PEC byte provided by the PMBus master, and include a PEC byte in all message responses to the master. And the module also can communicate with the master that does not implement the PEC mechanism.
SMBALERT protocol is also supported by the module. SMBALERT line is also a wired-AND signal; by which the module can alert the PMBUS master via pulling the SMBALERT pin to an active low. There are two ways that the master and the module response to the alert of SMBALERT line.
One way is for the module used in a system that does not support Alert Response Address (ARA). The module is to retain it's resistor programmed address, when it is in an ALERT active condition. The master will communicate with the slave module using the programmed address, and using the various READ_STATUS commands to find who cause for the SMBALERT. The CLEAR_FAULTS command will clear the SMBALERT.
The other way is for the module used in a system that does support Alert Response Address (ARA). In this case, the master simultaneously accesses all SMBALERT devices through the ARA. Only the device which pulled SMBALERT low will acknowledge the ARA. The master is expected to perform the modified received byte operation to get the address of the alert slave, and retire the SMBALERT active signal. And then, the alter slave will return to it's resistor programmed address, allowing normal master-slave communications to proceed.
If more than one slave pulls SMBALERT line low, the lowest address slave will win communication rights via standard arbitration during the slave address transfer. After acknowledging the ARA, the lowest address slave must disengage its SMBALERT pull down. If the master still sees SMBALERT line low, it knows to send another ARA and ask again "Now, who is holding the alert down". The second slave is now locked-up and can't responsive. But the solution is easy; the master should now initiate a "dummy command", for example read command on the bus and read any parameter from any slave. After this, the second slave (the one that lost arbitration in the first run) will be released. Now, if master sends the second ARA, the second slave will provide its address to the Master.
The module contains a data flash used to store configuration settings, which will not be programmed into the device data flash automatically. The STORE_DEFAULT_ALL command must be used to commit the current settings are transfer from RAM to data flash as device defaults.

#### PMBUS Addressing

The Module has flexible PMBUS addressing capability. When connect different resistor from Addr0 and Addr1 pin to GND pin, 64 possible addresses can be acquired. The address is in the form of octal digits; Each pin offer one octal digit, and then combine together to form the decimal address as shown in below.
Address = 8 * ADDR1 + ADDR0

## FEATURES DESCRIPTIONS (CON.)



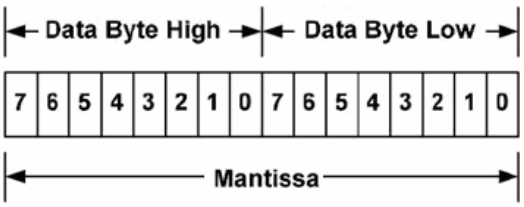

Corresponded to each octal digit, the requested resistor values are shown in below, and +/-5% resistors accuracy can be accepted. If there is any resistances exceeding the requested range, address 127 will be return. 0-12 and 40, 44, 45, and 55 in decimal address can't be used, since they are reserved according to the SMBus specifications, and which will also return address 127.

| Octal digit | Resistor(Kohm) |
|---|---|
| 0 | 10 |
| 1 | 15.4 |
| 2 | 23.7 |
| 3 | 36.5 |
| 4 | 54.9 |
| 5 | 84.5 |
| 6 | 130 |
| 7 | 200 |

**PMBus Data Format**

The module receives and report date in LINEAR format. The Exponent of the data words is fixed at a reasonable value for the command; altering the exponent is not supported. DIRECT format is not supported by the module.

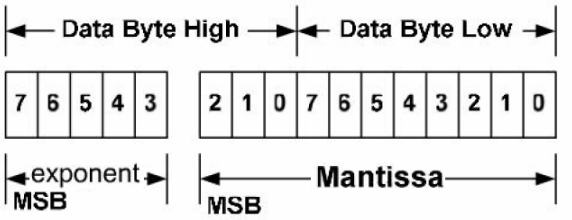
For commands that set or report any voltage thresholds related to the output voltage, the module supports the linear data format consisting of a two byte value with a 16-bit, unsigned mantissa, and a fixed exponent of -12. The format of the two data bytes is shown below:




The equation can be written as:
Vout = Mantissa x $2^{-12}$
For example, considering set Vout to 12V by VOUT_COMMAND, the read/write data can be calculated refer to below process:

1. Mantissa =Vout/$2^{-12}$= 12/$2^{-12}$=49152;
2. Converter the calculated Mantissa to hexadecimal 0xC000.

For commands that set or report all other thresholds, including input voltages, output current, temperature, time and frequency, the supported linear data format is a two byte value with: an 11 bit, two's complement mantissa , and a 5 bit, two's complement exponent (scaling factor).The format of the two data bytes is shown as in below.




The equation can be written as:
Value = Mantissa x $2^{exponent}$
For example, considering set the turn on threshold of input under voltage lockout to 34V by VIN_ON command; the read/write data can be calculated refer to below process:

1. Get the exponent of Vin, -3; whose binary is 11101
2. Mantissa =Vin/$2^{-3}$=34/$2^{-3}$=272;
3. Converter the calculated Mantissa to hexadecimal 110, then converter to binary 00100010000;
4. Combine the exponent and the mantissa, 11101 and 00100010000;
5. Converter binary 1110100100010000 to hexadecimal E910.

The detail exponent and resolution of main parameter is summarized as below:

| | Exponent | Resolution |
|---|---|---|
| Vin | -3 | 0.125V |
| Vo | -12 | 0.244mV |
| Io | -4 | 62.5mA |
| Temperature | -2 | / |
| Switching requency | -2 | 0.25Khz |
| Time | -1 | 0.5ms |

**Supported PMBus Commands**

The main PMBus commands described in the PMBus 1.2 specification are supported by the module. Partial PMBus commands are fully supported; Partial PMBus commands have difference with the definition in PMBus 1.2 specification. All the supported PMBus commands are detail summarized in below table.

## FEATURES DESCRIPTIONS (CON.)

| Command | Command Code | Command description | Transfer type | Compatible with standard PMBUS or not? | Data Format | Default value | Range limit | Data units | Exponent | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| OPERATION | 0x01 | Turn the module on or off by PMBUS command | R/W byte | Refer to below description; | Bit field | 0x80 | / | / | / | / |
| ON_OFF_CONFIG | 0x02 | Configures the combination of primary on/off pin and PMBUS command | R/W byte | Refer to below description; | Bit field | 0x1D (Neg Logic); 0x1F (Pos Logic); | / | / | / | / |
| CLEAR_FAULTS | 0x03 | Clear any fault bits that have been set | Send byte | Yes | / | / | / | / | / | / |
| STORE_DEFAULT_ALL | 0x11 | Stores operating parameters from RAM to data flash | Send byte | Yes | / | / | / | / | / | This command is effective to the parameter of all command in the table. |
| RESTORE_DEFAULT_ALL | 0x12 | Restores operating parameters from data flash to RAM | Send byte | Yes | / | / | / | / | / | This command can't be issued when the power unit is running. |
| VOUT_MODE | 0x20 | To read Vo data format | Read byte | Yes | mode+exp | 0x14 | / | / | / | / |
| VOUT_COMMAND | 0x21 | Set the output voltage | R/W word | Yes | Vout Linear | 12 | 9.6 ~13.2 | Volts | -12 | / |
| FREQUENCY_SWITCH | 0x33 | Set the switching frequency | R/W word | Yes | Frequency Linear | 130 | 120 ~140 | KHz | -2 | / |
| VIN_ON | 0x35 | Set the turn on voltage threshold of Vin under voltage lockout | R/W word | Yes | Vin Linear | 34 | 32~46 | V | -3 | VIN_ON should be higher than VIN_OFF, and keep 2V hystersis. |
| VIN_OFF | 0x36 | Set the turn off voltage threshold of Vin under voltage lockout | R/W word | Yes | Vin Linear | 32 | 32~46 | V | -3 | VIN_ON should be higher than VIN_OFF, and keep 2V hystersis. |
| VOUT_OV_FAULT_LIMIT | 0x40 | Set the output overvoltage fault threshold. | R/W word | Yes | Vout Linear | 15 | 11~16 | V | -12 | Must be higher than the value of VOUT_COMMAND and VOUT_OV_WARN_LIMIT; |

| Command | Command Code | Command description | Transf-er type | Compatible with standard PMBUS or not? | Data Format | Default value | Range limit | Data units | Expon-ent | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| VOUT_OV_FAULT_RESPONSE | 0x41 | Instructs what action to take in response to an output overvoltage fault. | R/W byte | Refer to below description; | Bit field | 0xB8 | / | N/A | / | / |
| VOUT_OV_WARN_LIMIT | 0x42 | Set a threshold causing an output voltage high warning. | R/W word | Yes | Vout Linear | 15 | 11~16 | V | -12 | Must be less than VOUT_OV_FAULT_LIMIT value |
| IOUT_OC_FAULT_LIMIT | 0x46 | Set the output overcurrent fault threshold. | R/W word | Yes | Iout Linear | 43 | 20~60 | A | -4 | Must be greater than IOUT_OC_WARN_LIMIT value |
| IOUT_OC_FAULT_RESPONSE | 0x47 | Instructs what action to take in response to an output overcurrent fault. | R/W byte | Refer to below description; | Bit field | 0xF8 | / | N/A | / | / |
| IOUT_OC_WARN_LIMIT | 0x4A | Set a threshold causing an output current high warning. | R/W word | Yes | Iout Linear | 36 | 10~40 | A | -4 | Must be less than IOUT_OC_FAULT_LIMIT value |
| OT_FAULT_LIMIT | 0x4F | Set the over temperature fault threshold. | R/W word | Yes | TEMP Linear | 125 | 25~140 | Deg. C | -2 | Must be greater than OT_WARN_LIMIT value |
| OT_FAULT_RESPONSE | 0x50 | Instructs what action to take in response to an over temperature fault. | R/W byte | Refer to below description; | Bit field | 0xB8 | / | N/A | / | / |
| OT_WARN_LIMIT | 0x51 | Set a threshold causing a temperature high warning. | R/W word | Yes | TEMP Linear | 115 | 25~125 | Deg. C | -2 | Must be less than OT_FAULT_LIMIT value |
| VIN_OV_FAULT_LIMIT | 0x55 | Set the input overvoltage fault threshold. | R/W word | Yes | Vin Linear | 110 | 48~110 | V | -3 | / |
| POWER_GOOD_ON | 0x5E | Sets the output voltage at which the bit 3 of STATUS_WORD high byte should be asserted. | R/W word | Yes | Vout Linear | 11 | 8.1 ~13.2 | V | -12 | Must be greater than POWER_GOOD_OFF value by 1.6V |
| POWER_GOOD_OFF | 0x5F | Sets the output voltage at which the bit 3 of STATUS_WORD high byte should be negated. | R/W word | Yes | Vout Linear | 9 | 8.1 ~13.2 | V | -12 | Must be less than POWER_GOOD_ON value by 1.6V |
| TON_DELAY | 0x60 | Sets the time from a start condition is received until the output voltage starts to rise | R/W word | Yes | Time Linear | 7 | 5~500 | ms | -1 | / |

| Command | Command Code | Command description | Transf-er type | Compatible with standard PMBUS or not? | Data Format | Default value | Range limit | Data units | Expon-ent | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| TON_RISE | 0x61 | Sets the time from the output starts to rise until the voltage has entered the regulation band. | R/W word | Yes | Time Linear | 28 | 15~500 | ms | -1 | / |
| STATUS_WORD | 0x79 | Returns the information with a summary of the module's fault/warning | Read word | Refer to below description; | Bit field | / | / | / | / | / |
| STATUS_VOUT | 0x7A | Returns the information of the module's output voltage related fault/warning | Read byte | Refer to below description; | Bit field | / | / | / | / | / |
| STATUS_IOUT | 0x7B | Returns the information of the module's output current related fault/warning | Read byte | Refer to below description; | Bit field | / | / | / | / | / |
| STATUS_INPUT | 0x7C | Returns the information of the module's input over voltage and under voltage fault | Read byte | Refer to below description; | Bit field | / | / | / | / | / |
| STATUS_TEMPERATURE | 0x7D | Returns the information of the module's temperature related fault/warning | Read byte | Refer to below description; | Bit field | / | / | / | / | / |
| STATUS_CML | 0x7E | Returns the information of the module's communication related faults. | Read byte | Refer to below description; | Bit field | / | / | / | / | / |
| READ_VIN | 0x88 | Returns the input voltage of the module | Read word | Yes | Vin Linear | / | / | Volts | / | / |
| READ_VOUT | 0x8B | Returns the output voltage of the module | Read word | Yes | Vout Linear | / | / | Volts | / | / |
| READ_IOUT | 0x8C | Returns the output current of the module | Read word | Yes | Iout Linear | / | / | Amps | / | / |
| READ_TEMPERATURE_1 | 0x8D | Returns the module's hot spot temperature of the module | Read word | Yes | TEMP Linear | / | / | Deg. C | / | / |
| PMBUS_REVISION | 0x98 | Reads the revision of the PMBus | Read byte | Yes | Bit field | 1.2 | / | / | / | / |

| Command | Command Code | Command description | Transf-er type | Compatible with standard PMBUS or not? | Data Format | Default value | Range limit | Data units | Expon-ent | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| MFR_ C2_Configure | 0xE1 | Configures the C2 pin (secondary on/off pin) function and logic; | R/W byte | Refer to below description; | Bit field | 0x00 | / | / | / | / |

# FEATURES DESCRIPTIONS (CON.)

### OPERATION [0x01]

| Bit number | Purpose | Bit Value | Meaning | Default Settings，0x80 |
|---|---|---|---|---|
| 7: | Enable/Disable the module | 1 | Output is enabled | 1 |
| | | 0 | Output is disabled | |
| 6:0 | Reserved | | | 0000000 |

### ON_OFF_CONFIG [0x02]

| Bit number | Purpose | Bit Value | Meaning | Default Settings，0x1D (negative) /0x1F (positive) |
|---|---|---|---|---|
| 7:5 | Reserved | | | 000 |
| 4 | Controls how the unit responds to the primary on/off pin and the OPERATION command; | 1 | Module does not power up until commanded by the primary ON/OFF pin and the OPERATION | 1 |
| | | 0 | Module power up at any time regardless of the state of the primary ON/OFF pin and the OPERATION | |
| 3 | Controls how the unit responds to the OPERATION command | 1 | Module responds to the 7 bit in the OPERATION | 1 |
| | | 0 | Module ignores the 7 bit in the OPERATION | |
| 2 | Controls how the unit responds to the primary on/off pin | 1 | Module requires the primary ON/OFF pin to be asserted to start the unit | 1 |
| | | 0 | Module ignores the state of the primary ON/OFF pin | |
| 1 | Control logic of primay on/off pin | 1 | Positive Logic | 0, negative; 1, positive. |
| | | 0 | Negative Logic | |
| 0 | Unit turn off delay time control | 1 | Shut down the module with 0 delay cycle | 1 |

### VOUT_OV_FAULT_RESPONSE [0x41]

| Bit number | Purpose | Bit Value | Meaning | Default Settings，0xB8 |
|---|---|---|---|---|
| 7:6 | Response settings | 10 | Unit shuts down and responds according to the retry settings | 10 |
| 5:3 | Retry setting | 111 | Unit continuously restarts while fault is present until commanded off | 111 |
| | | 000 | Unit does not attempt to restart on fault | |
| 2:0 | Delay time setting | 000 | No delay supported | 000 |

### IOUT_OC_FAULT_RESPONSE [0x47]

| Bit number | Purpose | Bit Value | Meaning | Default Settings，0xF8 |
|---|---|---|---|---|
| 7:6 | Response settings | 11 | Unit shuts down and responds according to the retry settings | 11, |
| 5:3 | Retry settings | 111 | Unit continuously restarts while fault is present until commanded off | 111 |
| | | 000 | Unit does not attempt to restart on fault | |
| 2:0 | Delay time setting | 000 | No delay supported | 000 |

# FEATURES DESCRIPTIONS (CON.)

### OT_FAULT_RESPONSE [0x50]

| Bit number | Purpose | Bit Value | Meaning | Default Settings，0xB8 |
|---|---|---|---|---|
| 7:6 | Response settings | 10 | Unit shuts down and responds according to the retry settings | 10, |
| 5:3 | Retry settings | 111 | Unit continuously restarts while fault is present until commanded off | 111 |
| | | 000 | Unit does not attempt to restart on fault | |
| 2:0 | Delay time setting | 000 | No delay supported | 000 |

### STATUS_WORD [0x79]

**High byte**

| Bit number | Purpose | Bit Value | Meaning |
|---|---|---|---|
| 7 | An output over voltage fault or warning | 1 | Occurred |
| | | 0 | No Occurred |
| 6 | An output over current fault or warning | 1 | Occurred |
| | | 0 | No Occurred |
| 5 | An input voltage fault, including over voltage and undervoltage | 1 | Occurred |
| | | 0 | No Occurred |
| 4 | Reserved | | |
| 3 | Power_Good | 1 | is negated |
| | | 0 | ok |
| 2:0 | Reserved | | |

**Low byte**

| Bit number | Purpose | Bit Value | Meaning |
|---|---|---|---|
| 7 | Reserved | | |
| 6 | OFF (The unit is not providing power to the output, regardless of the reason) | 1 | Occurred |
| | | 0 | No Occurred |
| 5 | An output over voltage fault | 1 | Occurred |
| | | 0 | No Occurred |
| 4 | An output over current fault | 1 | Occurred |
| | | 0 | No Occurred |
| 3 | An input under voltage fault | 1 | Occurred |
| | | 0 | No Occurred |
| 2 | A temperature fault or warning | 1 | Occurred |
| | | 0 | No Occurred |
| 1 | CML (A communications, memory or logic fault) | 1 | Occurred； |
| | | 0 | No Occurred |
| 0 | Reserved | | |

# FEATURES DESCRIPTIONS (CON.)

### STATUS_VOUT [0x7A]

| Bit number | Purpose | Bit Value | Meaning |
|---|---|---|---|
| 7 | Output over voltage fault | 1 | Occurred； |
| | | 0 | No Occurred |
| 6 | Output over voltage warning | 1 | Occurred； |
| | | 0 | No Occurred |
| 5:0 | Reserved | | |

### STATUS_IOUT [0x7B]

| Bit number | Purpose | Bit Value | Meaning |
|---|---|---|---|
| 7 | Output over current fault | 1 | Occurred； |
| | | 0 | No Occurred |
| 6 | Reserved | | |
| 5 | Output over current warning | 1 | Occurred； |
| | | 0 | No Occurred |
| 4:0 | Reserved | | |

### STATUS_INPUT [0x7C]

| Bit number | Purpose | Bit Value | Meaning |
|---|---|---|---|
| 7 | Input over voltage fault | 1 | Occurred； |
| | | 0 | No Occurred |
| 6: 5 | Reserved | | |
| 4 | Input under voltage fault | 1 | Occurred； |
| | | 0 | No Occurred |
| 3:0 | Reserved | | |

### STATUS_TEMPERATURE [0x7D]

| Bit number | Purpose | Bit Value | Meaning |
|---|---|---|---|
| 7 | Over temperature fault | 1 | Occurred； |
| | | 0 | No Occurred |
| 6 | Over temperature warning | 1 | Occurred； |
| | | 0 | No Occurred |
| 5:0 | Reserved | | |

### STATUS_CML [0x7E]

| Bit number | Purpose | Bit Value | Meaning |
|---|---|---|---|
| 7 | Invalid/Unsupported Command Received | 1 | Occurred； |
| | | 0 | No Occurred |
| 6 | Invalid/Unsupported Data Received | 1 | Occurred； |
| | | 0 | No Occurred |
| 5 | Packet Error Check Failed | 1 | Occurred； |
| | | 0 | No Occurred |
| 4:0 | Reserved | | |

### MFR_ C2_Configure [0xE1]

| Bit number | Purpose | Bit Value | Meaning | Default Settings，0x00 |
|---|---|---|---|---|
| 7:2 | Reserved | | | 000000 |
| 1 | Secondary ON/OFF Configuration | 1 | AND – Primary and Secondary side on/off | 0 |
| | | 0 | C2 is ignored | |
| 0 | Secondary side on/off Logic | 1 | Positive Logic | 0 |
| | | 0 | Negative Logic | |

# FEATURES DESCRIPTIONS (CON.)

### Output Voltage Adjustment (TRIM)

To increase or decrease the output voltage set point, connect an external resistor between the TRIM pin and either the Vo(+) or Vo(-). The TRIM pin should be left open if this feature is not used. Below Trim equation is only adapt to the module without droop current sharing option code; For the module with droop current sharing option code, please contact Delta's technical support team.

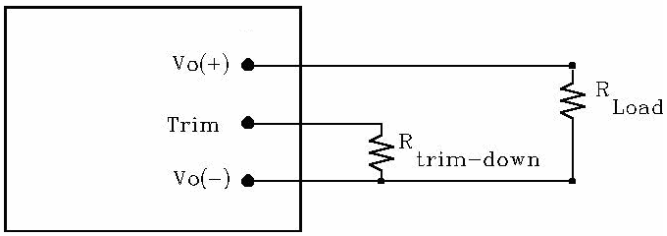



***Figure 19:*** *Circuit configuration for trim-down (decrease output voltage)*

If the external resistor is connected between the TRIM and Vo (-) pins, the output voltage set point decreases (Fig. 19). The external resistor value required to obtain a percentage of output voltage change △% is defined as:

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

Ex. When Trim-down -10% (12V×0.9=10.8V)

$$Rtrim-down = \left[\frac{511}{10} - 10.2\right](K\Omega) = 40.9(K\Omega)$$

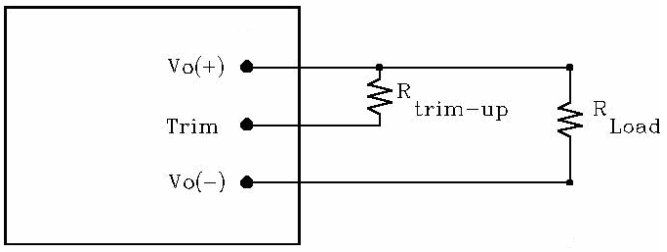



***Figure 20:*** *Circuit configuration for trim-up (increase output voltage)*

If the external resistor is connected between the TRIM and Vo (+) the output voltage set point increases (Fig. 20). The external resistor value required to obtain a percentage output voltage change △% is defined as:

$$Rtrim-up = \frac{5.11Vo\,(100+\Delta)}{1.225\,\Delta} - \frac{511}{\Delta} - 10.2(K\Omega)$$

Ex. When Trim-up +10% (12V×1.1=13.2V)

$$Rtrim-up = \frac{5.11\times12\times(100+10)}{1.225\times10} - \frac{511}{10} - 10.2 = 489.3(K\Omega)$$

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

# THERMAL CONSIDERATIONS

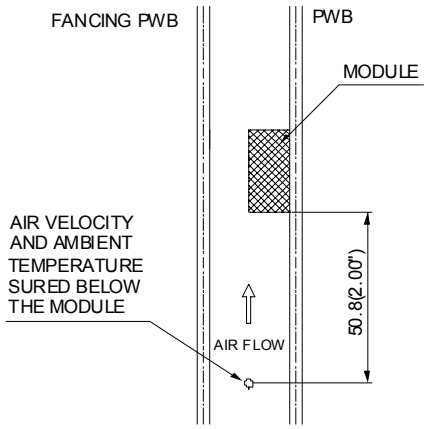
Thermal management is an important part of the system design. To ensure proper, reliable operation, sufficient cooling of the power module is needed over the entire temperature range of the module. Convection cooling is usually the dominant mode of heat transfer.

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

### Thermal Testing Setup

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

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




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

***Figure 21:*** *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)

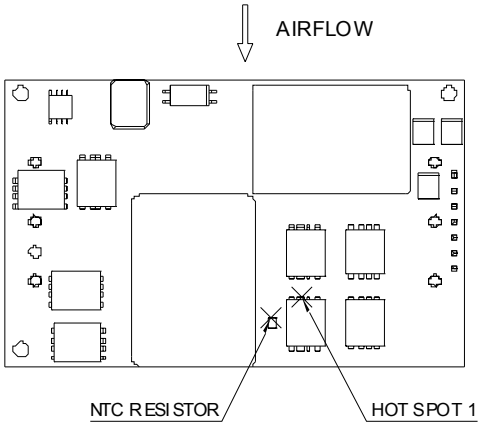



***Figure 22:*** ** Hot spot 1& NTC resistor temperature measured points*

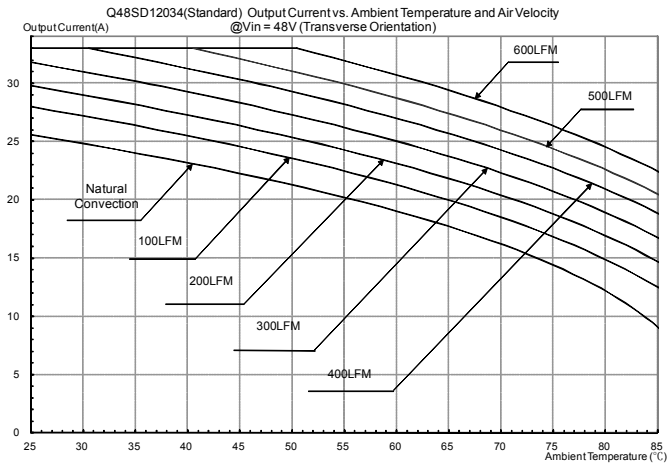



***Figure 23:*** *Output current vs. ambient temperature and air velocity @Vin=48V(Transverse Orientation, airflow from Vin+ to Vin-, without heat spreader)*

## THERMAL CURVES (WITH HEAT SPREADER)

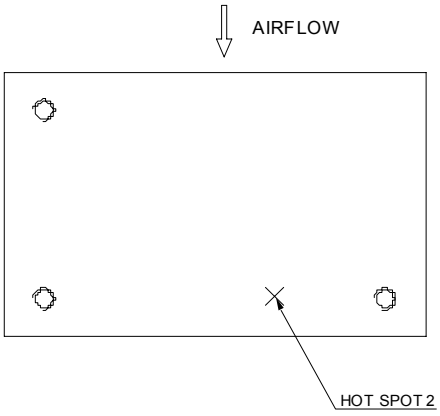



***Figure 24:*** ** Hot spot 2 temperature measured point*

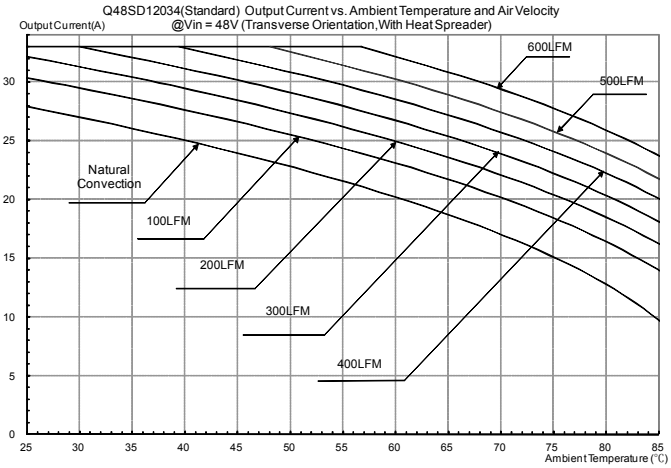
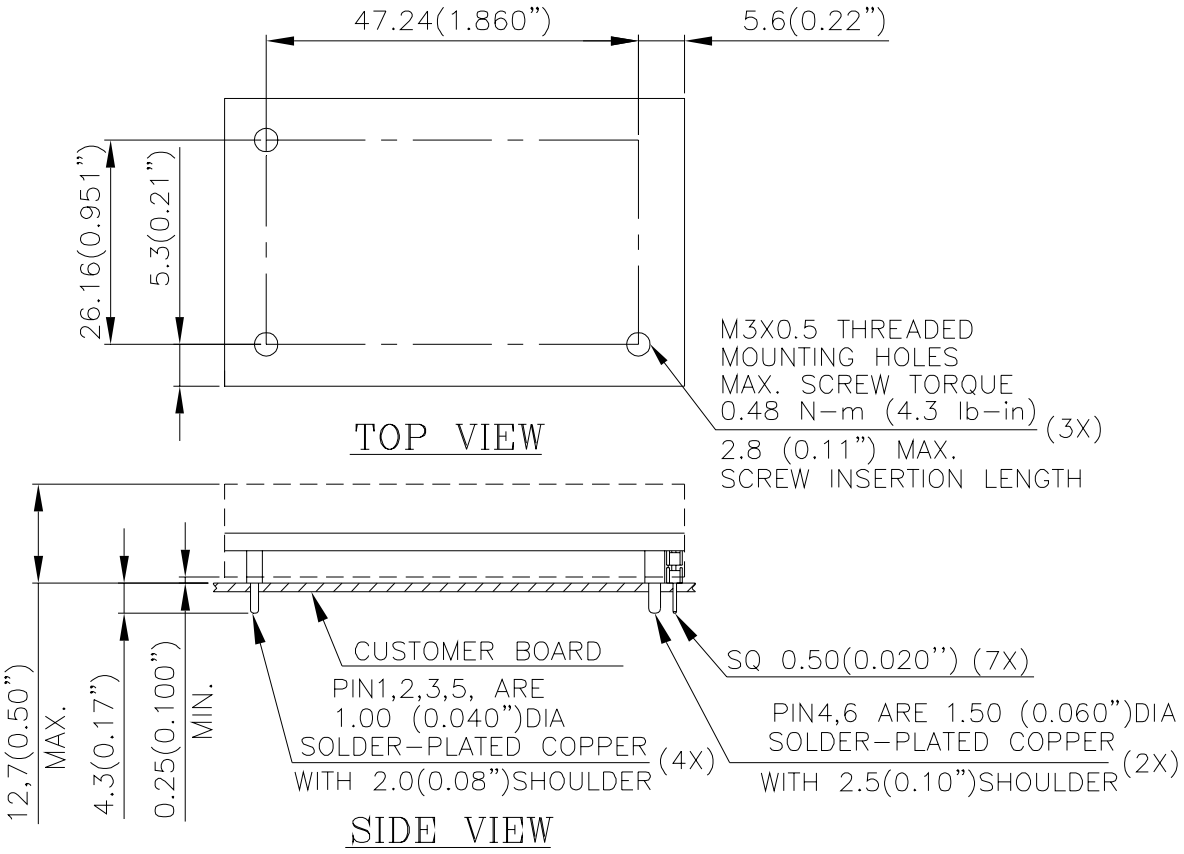
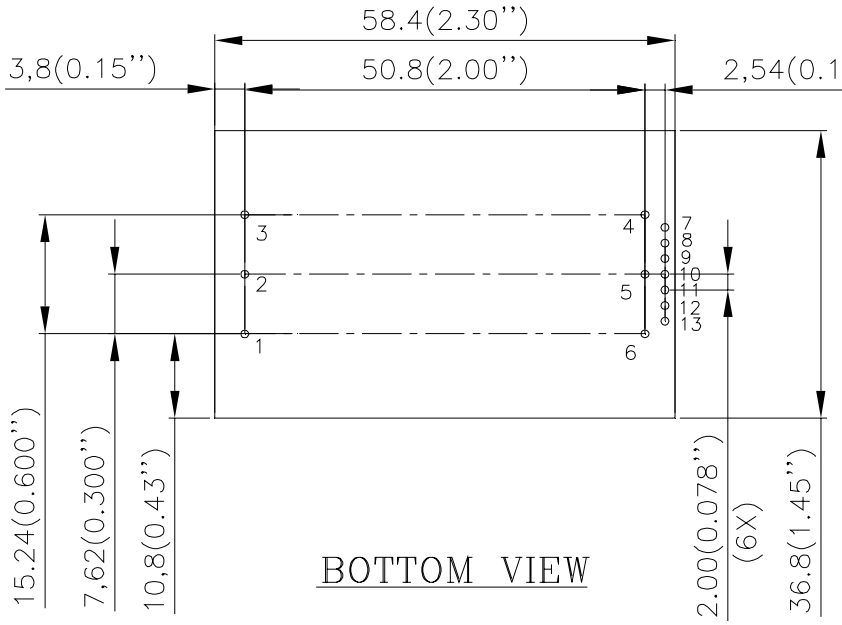



***Figure 25:*** *Output current vs. ambient temperature and air velocity @Vin=48V(Transverse Orientation, airflow from Vin+ to Vin-,with heat spreader)*

## MECHANICAL DRAWING (WITH HEAT SPREADER)

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

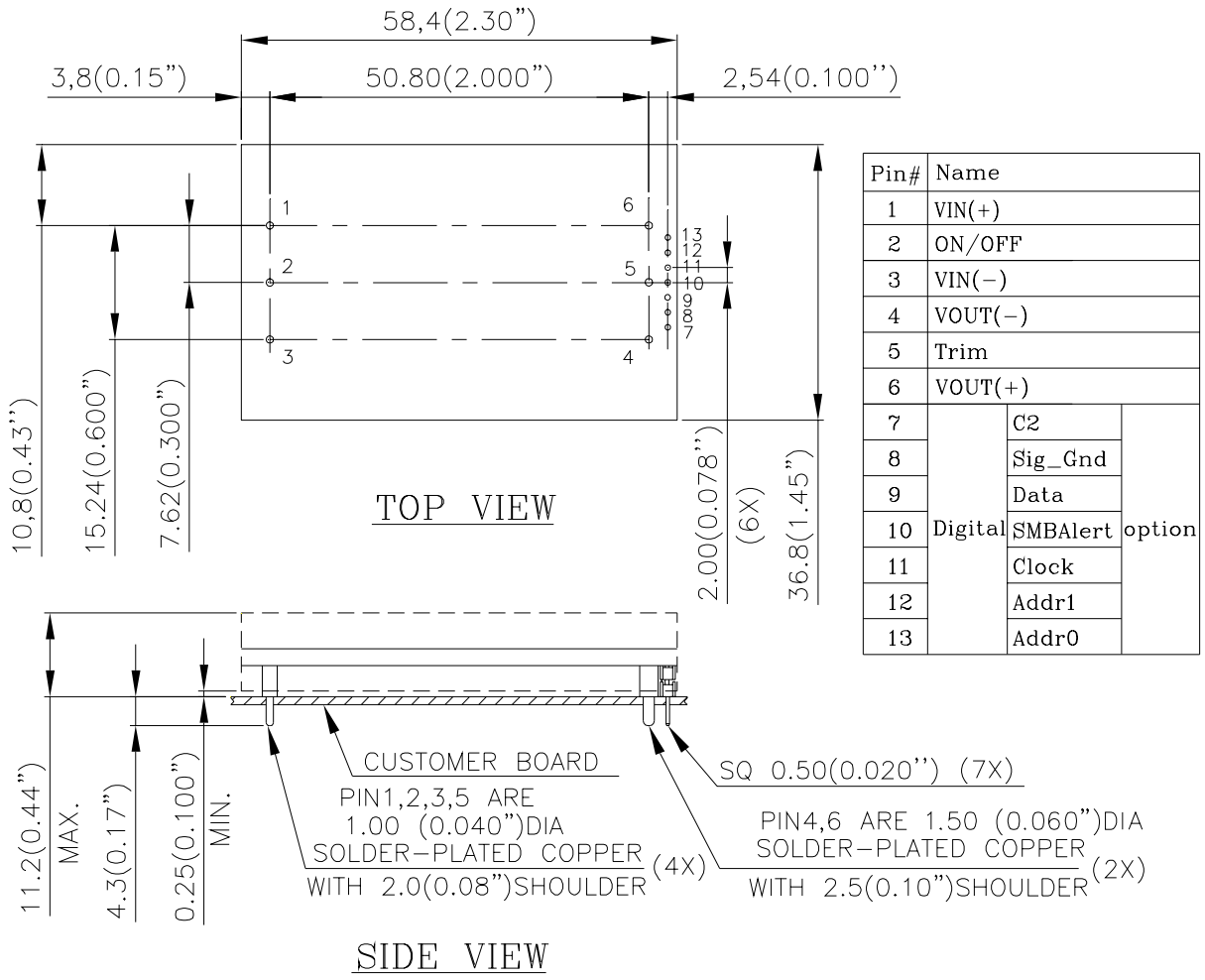



| Pin# | Name | | |
|---|---|---|---|
| 1 | VIN(+) | | |
| 2 | ON/OFF | | |
| 3 | VIN(-) | | |
| 4 | VOUT(-) | | |
| 5 | Trim | | |
| 6 | VOUT(+) | | |
| 7 | Digital | C2 | option |
| 8 | | Sig_Gnd | |
| 9 | | Data | |
| 10 | | SMBAlert | |
| 11 | | Clock | |
| 12 | | Addr1 | |
| 13 | | Addr0 | |

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

## MECHANICAL DRAWING (WITHOUT HEAT SPREADER)




| Pin# | Name | | |
|---|---|---|---|
| 1 | VIN(+) | | |
| 2 | ON/OFF | | |
| 3 | VIN(−) | | |
| 4 | VOUT(−) | | |
| 5 | Trim | | |
| 6 | VOUT(+) | | |
| 7 | Digital | C2 | option |
| 8 | | Sig_Gnd | |
| 9 | | Data | |
| 10 | | SMBAlert | |
| 11 | | Clock | |
| 12 | | Addr1 | |
| 13 | | Addr0 | |

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

**Pin Specification:**

| | |
|---|---|
| Pins 1-3&5 | 1.00mm (0.040") diameter (All pins are copper with matte Tin plating over Nickel under plating) |
| Pins 4 &6 | 1.50mm (0.059") diameter (All pins are copper with matte Tin plating over Nickel under plating) |
| Pins 7-13 | SQ 0.50mm(0.020") ( All pins are copper with gold flash plating) |

## PART NUMBERING SYSTEM

| Q | 48 | S | D | 120 | 34 | N | R | F | A | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Type of Product** | **Input Voltage** | **Number of Outputs** | **Product Series** | **Output Voltage** | **Output Current** | **ON/OFF Logic** | **Pin Length /Type** | | **Option Code** | | | | |
| Q- Quarter Brick | 48- 36~75V | S- Single | D – Full digital control | 120 - 12V | 34 - 34A | N - Negative | K – 0.110'' N - 0.145" R - 0.170" | F- RoHS 6/6 (Lead Free) | | Droop Current Sharing | Trim pin | PMBus pin | Heat spreader |
| | | | | | | | | | A | Yes | Has, but no function | Yes | No |
| | | | | | | | | | B | No | Yes | No | No |
| | | | | | | | | | C | No | Yes | No | Yes |
| | | | | | | | | | H | Yes | Has, but no function | Yes | Yes |
| | | | | | | | | | G | No | Yes | Yes | Yes |

## MODEL LIST

| MODEL NAME | INPUT | | OUTPUT | | EFF @ 100% LOAD |
|---|---|---|---|---|---|
| Q48SD12034NRFA | 36V~75V | 12.5A | 12V | 34A | 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 office.


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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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