



## Evaluation Procedure

### Delta Delphi Series 48Vin S48SR and S48SS

The Delphi Series S48SR and S48SS, 48V input, single output, isolated DC/DC converters are the latest offering from one of the world's largest power supply manufacturers — Delta Electronics, Inc. With creative design technology and optimization of component placement, these converters possess outstanding electrical and thermal performance, as well as extremely high reliability under highly stressful operating conditions. All models are protected from abnormal input/output voltage and current conditions. An encapsulated version is available for the most robust performance in harsh environments.

This document guides the user through the evaluation procedures to qualify a Delphi module. The data shown in this Evaluation Procedure is for the 3.3V unit. Please refer to the appropriate technical data sheet for detailed performance and technical information for Delphi units with different output voltages.

### Delphi Series S48SR and S48SS



#### 1.0 Purpose

This document guides the user to perform electronic measurements on a Delphi S48SR, 15W or a S48SS, 15W DC/DC converter using the Delta Evaluation Board.

#### 2.0 Relevant Documentation

The document and general knowledge listed below is relevant to this evaluation procedure:

- 2.1 S48SR or S48SS Series Applicable Data Sheet
- 2.2 2"×1" Power Module Evaluation Board Schematic
- 2.3 2"×1" Power Module Evaluation Board Layout
- 2.4 General Test and Safety Procedures
- 2.5 ESD Protection



### 3.0 Equipment Required

- 3.1 (1) 0 ~ 80 V @ 0 ~10 A Power Supply (Chroma 6230K-80 or Equivalent)
- 3.2 (1) 4 Channel 150 MHz Oscilloscope, (1) 1× scope probe, (1) 10× scope probe (Yokogama DL 1540C or Equivalent)
- 3.3 (1) 4 1/2 Digital Multimeter (DVM3) (HP34401A or Equivalent)
- 3.4 (2) 3 1/2 Digital Multimeter (DVM1 and DVM2) (FLUKE 45 or Equivalent)
- 3.5 (1) 300W Electronic or Resistive Load (Chroma 6304)

### 4.0 Equipment Set-Up and Description

- 4.1 Connect one wire from the “+” lead of the Power Supply (Item 3.1) to the “10A” of the DVM1 (Item 3.4). Then connect one wire from the “Common” of the DVM1 to the “Vin +” pin of the Evaluation Board.
- 4.2 Connect one wire from the “-” lead of the Power Supply to the “Vin -” pin of the Evaluation Board. Note: Use 10 AWG wire or similar for all connections in sections 4.1 and 4.2. Use twisted pair to reduce noise coupling.
- 4.3 Connect the plus “+” and minus “-” connection wires from the multimeter (item 3.3) to the “SVin +” and “SVin -” Pin on the Evaluation Board. The multimeter is designated DVM2, above in Paragraph 3.0, Section 3.4.
- 4.4 Connect the plus “+” and minus “-” connection wires from the multimeter (item 3.3) to the “Sense +” and “Sense -” Pin on the Evaluation Board. The multimeter is designated DVM3, above in Paragraph 3.0, Section 3.3.
- 4.5 Connect a BNC cable (length less than 20 inches) from BNC1 of the Evaluation Board to Channel 1 of the oscilloscope (item 3.2).
- 4.6 Connect a BNC cable (length less than 20 inches) from BNC2 of the Evaluation Board to Channel 2 of the oscilloscope (item 3.2).
- 4.7 Connect the Positive and Negative power leads of the Electronic load (assuring correct polarity), or a resistive load to the Evaluation Board output terminal pin (“Vout +” for positive power lead and “Vout -” for the negative power lead).



## 5.0 Thermal of the Converter

It is imperative that sufficient airflow be provided to the converter at all times during all portions of testing. Please refer to the applicable data sheet for the proper cooling and derating necessary to achieve accurate results when testing the converter.

## 6.0 Tests Performed

The following tests are performed at room temperature +25 C.

### 6.1 Input Characteristics

- ◆ Input Voltage Range
- ◆ Under Voltage Lockout
- ◆ No Load Input Current
- ◆ Disable Input Current (applies to S48SS version only)

### 6.2 Output Characteristics

- ◆ Line Regulation
- ◆ Load Regulation
- ◆ Output Regulation
- ◆ Output Overvoltage Protection

### 6.3 Dynamic Characteristics

- ◆ Maximum Output Voltage Deviation (due to step change in load)
- ◆ Response time (due to step change in load)
- ◆ Soft Start Turn-On Time

### 6.4 Thermal Characteristics

- ◆ Efficiency





- 4) The converter may also be turned on by switching SW1 to the appropriate logic enable position and ramping the voltage manually or turning on the Power Supply with a preset output voltage (S48SS only).
- 5) Toggle SW1 to the "OFF" position after performing each test (S48SS only).

## 8.0 Test and Evaluation

### 8.1 Input Characteristic

#### 8.1.1 Input Voltage Range

The Delphi S48SS3R304NR and S48SR3R304ER DC/DC converters will operate at full load from 36V<sub>in</sub> to 75V<sub>in</sub>, steady state. The converter features input under-voltage protection which will not allow the converter to start up unless the input voltage exceeds the turn-on voltage threshold.

##### Test

- 1) Turn on the fan.
- 2) Set the enable switch SW1 to the appropriate logic enable position (defined in Section 7.1. S48SS only).
- 3) Set the input voltage to desired operating point while monitoring DVM2.
- 4) Test the input under voltage circuit while observing DVM2, DVM3 and Channel 1, Channel 2 of the oscilloscope. Increase the input voltage until the output of the converter reaches stability (3.3 volts.) This will occur between 33.8 and 35.8 volts (please refer to the datasheet for the detailed specification).

#### 8.1.2 No Load Input Current

##### Test

- 1) Turn on the fan.
- 2) Set the enable switch SW1 to the appropriate logic enable position (S48SS only).
- 3) Set the input voltage to desired operating point while monitoring DVM2.
- 4) Remove the electronic or the resistive load (output load)
- 5) Note the input current from DVM1.
- 6) The following is the result of the No load Input Current of the DC/DC converter. The No Load Input Current will be around 25 mA (please refer to the datasheet for the detailed specification).





### 8.1.3 Input Current Module Off (S48SS only)

#### Test

- 1) Set the enable switch SW1 to the appropriate logic enable position to disable the power supply (as defined in Section 7.1).
- 2) Adjust the input power supply to the desired operating point of interest while monitoring DVM2.
- 3) Note the input current from DVM1.
- 4) This reading is the result of the Disable Input Current of the DC/DC converter. The Disable Input current will be around 1 mA (please refer to the datasheet for the detailed specification).

## 8.2 Output Characteristic

### 8.2.1 Line Regulation

Line Regulation is defined as the percentage change in output voltage caused by varying the input voltage over the specified range (36 to 75 volts) while the output load and temperature remain constant.

#### Test

- 1) Turn on the fan.
- 2) Set the enable switch SW1 to the appropriate logic enable position (S48SS only).
- 3) Set the output power to the desired operating point.
- 4) Adjust the input voltage across the converter's input range (36 to 75 volts) while monitoring DVM3.
- 5) Note the maximum +/- deviation of the output voltage over the full range of the input operating voltage.

### 8.2.2 Load Regulation

Load Regulation is defined as the percentage change in output voltage caused by varying the output load current over the specified range (no load to full load) while the input voltage and temperature remain constant.

#### Test

- 1) Turn on the fan.
- 2) Set the enable switch SW1 to the appropriate logic enable position (S48SS only).
- 3) Set the input voltage to the desired operating point.
- 4) Adjust the output load across the converter's operating load range (no load to full load).
- 5) Note the maximum +/- deviation of the output voltage over the full range of the operating load range.



### 8.2.3 Output Ripple

Output Ripple is defined as the periodic AC component at the DC/DC converters output voltage. The output ripple is measured in Peak to Peak and RMS values, both done with a specific bandwidth.

#### Test

- 1) Turn on the fan.
- 2) Set the enable switch SW1 to the appropriate logic enable position.
- 3) Adjust the input voltage and output load to the desired operating point (S48SS only).
- 4) Adjust Channel 2 on the oscilloscope to be AC coupled @ 2uS / Div and 50mV/Div to use the 20 MHz bandwidth of the scope.
- 5) The output ripple of the DC/DC converter is measured at full load operating power.

## 8.3 Dynamic Characteristics

### 8.3.1 Output Voltage Deviation

Output Voltage Deviation is defined as the response of the converter to a sudden step change in the output load current. The output voltage deviation is characterized by two important parameters: Maximum Output Voltage Deviation and Response Time, which is the length of time that the output voltage takes to return to 1% of its specified value (please refer to the datasheet for the detailed specification).

#### Test -S48SS & S48SR

- 1) Turn on the fan.
- 2) Set the enable switch SW1 to the appropriate logic enable position (S48SS only).
- 3) Adjust the input voltage to the desired operating point.
- 4) Set Channel 2 on the oscilloscope to be AC coupled and to 50mV/Div and 5mS/Div. Set the trigger to auto and adjust the trigger point for a negative going pulse.
- 5) Set the Electronic Load in dynamic mode and set it for the desired load transient.
- 6) Measure the positive Peak or negative Peak deviation and response time of the output voltage during the load transient.



### 8.3.2 Soft Start Turn-On Time

Soft Start Turn-On Time is defined as the time it takes for the output to rise to within 95% of its final value from the time when the converter is enabled. The rise time is deliberately made slower to reduce the inrush current and to eliminate any overshoot in the output voltage.

#### **Test -S48SR & S48SS ( turn on the module by using the input power supply)**

- 1) Turn on the fan.
- 2) Set the enable switch SW1 to the appropriate logic enable position (S48SS only).
- 3) Turn on the input Power Supply and set it to the desired operating point.
- 4) Set the input Power Supply disable by an external switch or use the input Power Supply internal disable function.
- 5) Set Channel 1 on the oscilloscope to be DC coupled and to 1V/Div.
- 6) Connect a coaxial cable from Channel 1 to BNC2 on the Evaluation Board.
- 7) Set Channel 2 on the oscilloscope to be DC coupled and to 20V/Div.
- 8) Connect a coaxial cable from Channel 2 to BNC1 on the Evaluation Board.
- 9) Set the Timebase to 10 mS/Div.
- 10) Set the Trigger for a one time event and set the Trigger level at approximately 2V on Channel 1.
- 11) Enable the input Power Supply to supply power and record the waveforms on the oscilloscope.

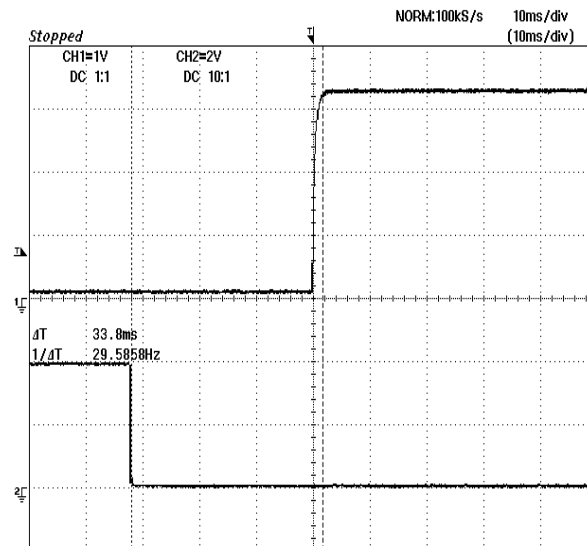
#### **Test-S48SS (turn on the module by using the Remote on/off feature)**

- 1) Turn on the fan.
- 2) Set the enable switch SW1 to the appropriate logic disable position.
- 3) Turn on the input Power Supply and set the input voltage to the desired operating point.
- 4) Set Channel 1 on the oscilloscope to be DC coupled and to 1V/Div.
- 5) Connect a coaxial cable from Channel 1 to BNC2 on the Evaluation Board.
- 6) Set Channel 2 on the oscilloscope to be DC coupled and to 2V/Div.
- 7) Set the Timebase to 10 mS/Div.
- 8) Set the Trigger for a one time event and set the Trigger level to approximately 2V on Channel 2.
- 9) Connect the 10X probe (Channel 2) to the "ON/OFF" test point on the evaluation board and connect the ground clip to the "Vin -" pin on the evaluation board.
- 10) Set the enable switch SW1 to the appropriate logic position to enable power and record the waveforms on the oscilloscope.





Note: Different electronic loads may have dramatically different results because of their input characteristics during Turn-On. If the Turn-On appears abnormal, replace with an actual resistive load of appropriate value. The Soft Start Turn-On Time of the converter provided in the Evaluation Kit was measured with the Electronic Load set at 4.5A.



## 8.4 Thermal Characteristics

### 8.4.1 Efficiency

Efficiency is the ratio of total output power to the input power. It is typically measured at full load and nominal input voltage.

#### Test

- 1) Turn on the fan.
- 2) Set the enable switch SW1 to the appropriate logic enable position (S48SS only).
- 3) Adjust the input voltage to the desired operation point.
- 4) Set the Electronic Load to the desired operating point..
- 5) Read and note the +3.3 output voltage (DVM3) and input voltage (DVM2).
- 6) Read and note the input and output currents from the DVM1 and the Electronic Load.



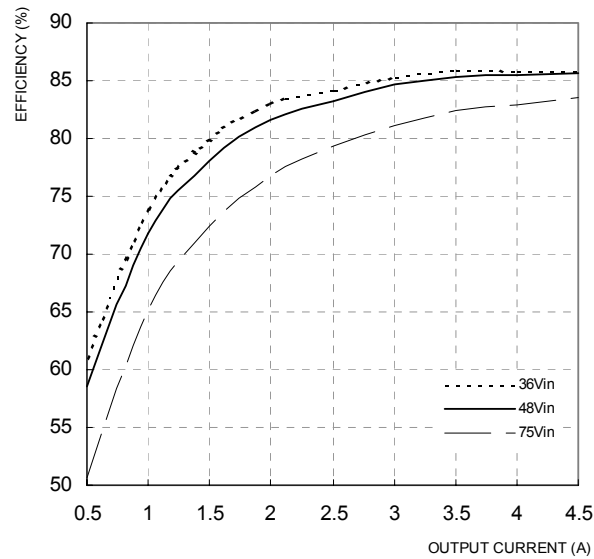
7) Use the following formulas to calculate the efficiency:

$$\text{Efficiency} = (\text{Pout} / \text{Pin}) \times 100(\%)$$

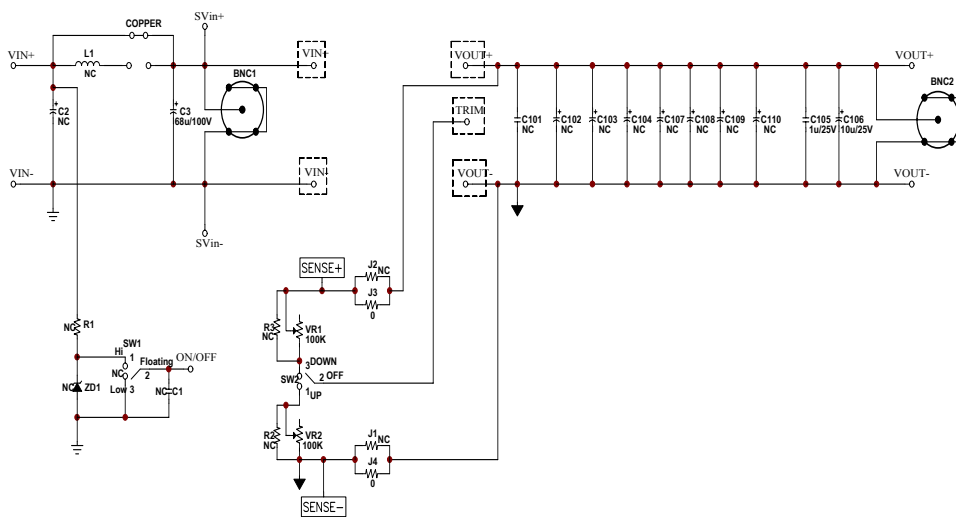
$$\text{Pin} = \text{Iin} \times \text{Vin}$$

$$\text{Pout} = \text{Iout} \times \text{Vout}$$

The following graph shows the efficiency results of the S48SS/S48SR converters measured at different operating points.

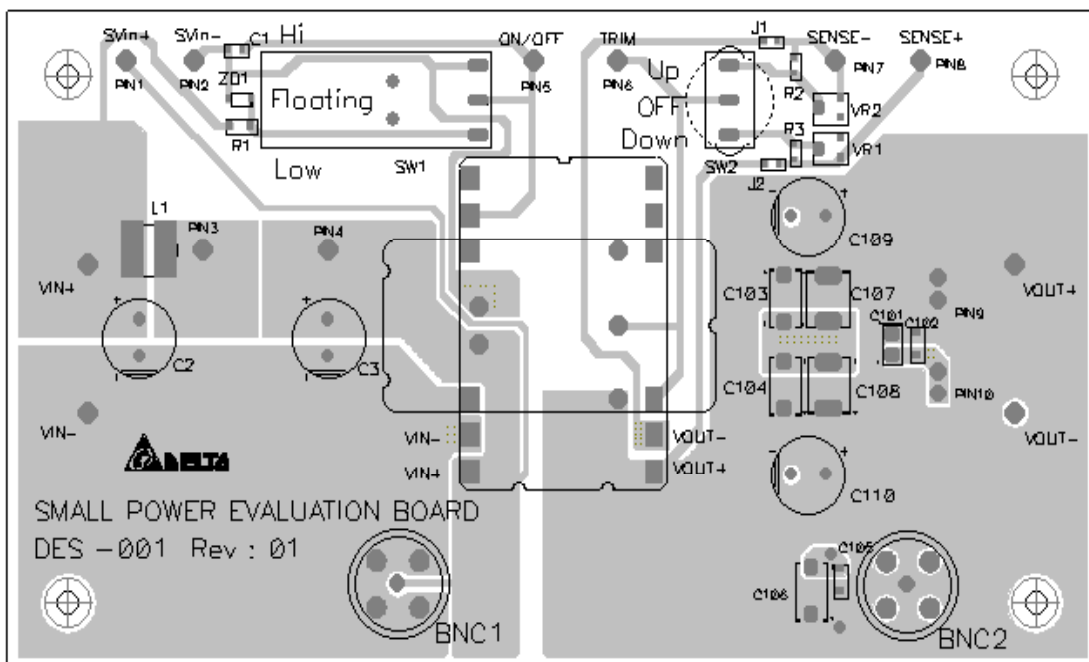


### Appendix A- Evaluation Board Schematic



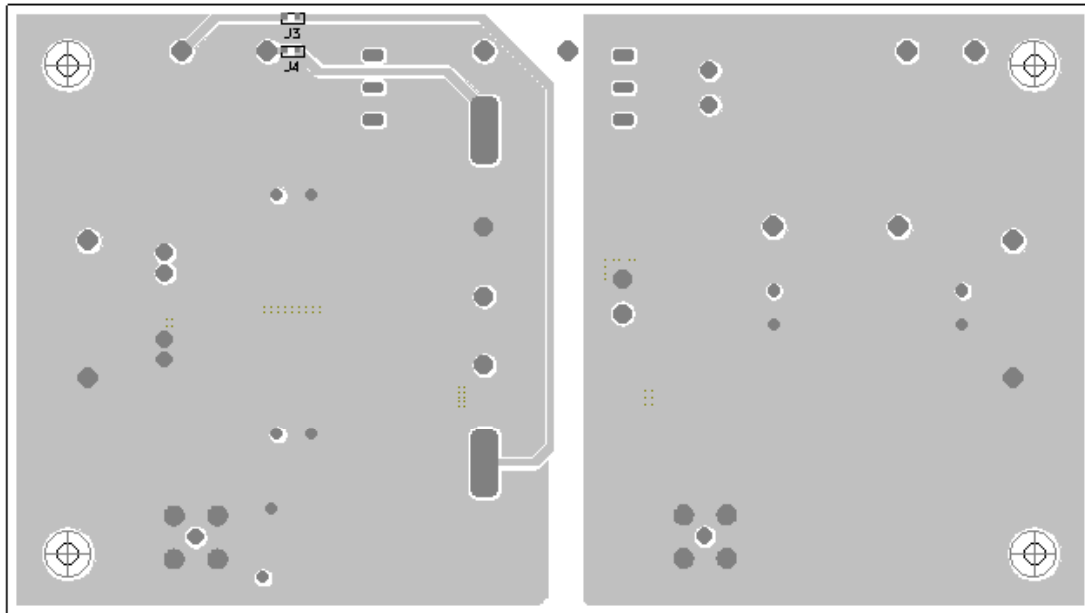


## Appendix B - Evaluation Board Layout (Top View)





## Appendix C- Evaluation Board Layout (Bottom View)



### CONTACT DATA: [www.deltaww.com](http://www.deltaww.com)

#### USA:

Telephone:  
 East Coast: (888) 335 8201  
 West Coast: (888) 335 8208  
 Fax: (978) 656 3964  
 Email: [DCDC@delta-corp.com](mailto:DCDC@delta-corp.com)

#### Europe:

Telephone:  
 France: +33 1 6485 1212  
 Germany: +49 89 370 62 897  
 UK: +44 777 195 6299  
 Fax: +33 1 6485 1212  
 Email: [DCDC@euro.delta-corp.com](mailto:DCDC@euro.delta-corp.com)

#### Asia:

Telephone: +886 3 4526107 x6202  
 Fax: +886 3 4331707  
 Email: [DCDC@delta.com.tw](mailto:DCDC@delta.com.tw)

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