# Q80SV_150W Series

**150W 1/4th Brick DC/DC Power Modules**

Security Lab Industrial Metro

Input voltage: 14.4~170V continuous
12V/200V transient
Single output: 5V, 12V, 15V, 24V, 54V
Output power: 150W

## FEATURES

### Electrical

- Efficiency up to 90% @110Vin
- Meet requirements of EN50155
- Package with Industry Standard Pinout
- Dimension: 2.39''*1.54''*0.5''(60.8*39.2*12.7mm)
- Output over-voltage protection, Output over- current protection, Over temperature protection.
- Without tantalum capacitor inside module
- Operating Baseplate Temperature: - 40°C ~+105°C
- 4242VDC input to output reinforced isolation
- Applied to altitude up to 5000m

### Safety & Certificate

- UL60950-1, UL62368-1
- Fire & Smoke meet EN45545
- ISO 9001, TL 9000, ISO 14001, QS 9000, OHSAS18001 certified manufacturing facility

### Soldering Method

- Wave soldering
- Hand soldering

## Recommended Part Number

| Model Name | Input | Output | | Eff. @ 100% Load | Others |
|---|---|---|---|---|---|
| Q80SV05030PRFS | 24/48/72/110V (14.4~170V) | 5V | 30A | 88.3% @110V | Positive on/off, Threaded mounting hole No BUS pin |
| Q80SV12013PRFS | | 12V | 12.5A | 90% @110V | |
| Q80SV15010PRFS | | 15V | 10A | 89.5%@110V | |
| Q80SV24006PRFS | | 24V | 6.3A | 89.3% @110V | |
| Q80SV54003PRFS | | 54V | 2.8A | 89.5% @110V | |
| Q80SV12013PRHS | 24/48/72/110V (14.4~170V) | 12V | 12.5A | 90% @110V | Positive on/off, Threaded mounting hole, With BUS Pin hold up function |

## Part Numbering System

| Q | 80 | S | V | 12013 | P | R | F | A |
|---|---|---|---|---|---|---|---|---|
| Form Factor | Input Voltage | Number Of Outputs | Product Series | Output Voltage & Current | ON/OFF Logic | Pin Length | Option Code | Option Code |
| Q - 1/4 Brick | 80 - 14.4~170V | S - Single | V - Series Number | 05030 - 5.0V & 30A<br>12013 - 12V & 12.5A<br>15010 - 15V & 10A<br>24006 - 24V & 6.3A<br>54003 - 54V & 2.8A | P - Positive<br>N - Negative | R - 0.170" | F - RoHS 6/6 (Lead Free)<br>H – With BUS pin hold up function | A - unthreaded mounting hole<br>S - with threaded mounting hole(M3*0.5) |



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| Attribute \ Model | | | Q80SV05030 | Q80SV12013 | Q80SV15010 | Q80SV24006 | Q80SV54003 |
|---|---|---|---|---|---|---|---|
| INPUT | Voltage | Continuous | 14.4~170Vdc | | | | |
| | | Transient | 12V-14.4V/1s, 170V-200V/1s | | | | |
| | Current | @14.4Vin, full load | 13A | 12.5A | 12.5A | 12.5A | 12.5A |
| | | @110Vin, No load | 20mA | 20mA | 20mA | 20mA | 20mA |
| | | @Enable off & 110V | 15mA | | | | |
| | Efficiency | 110Vin, 100% load | 88.3% | 90.0% | 89.5% | 89.3% | 89.5% |
| | | 110Vin, 60% load | 87.1% | 88.5% | 88.5% | 88.6% | 88.1% |
| OUTPUT | Voltage Setting (72Vin,full load, 25℃) | | 5V±1% | 12V±1% | 15V±1% | 24V±1% | 54V±1% |
| | Current Rating | | 0~30A | 0~12.5A | 0~10.0A | 0~6.3A | 0~2.8A |
| | Voltage trim range Note1 | | -20~10% | -20~10% | -20~10% | -20~18% | -20%~10% |
| | Ripple & Noise Vpp Note2 | | <1.5% | <1.5% | <3% | <1.5% | <1.5% |
| | Output Regulation | Line | 0.2% Max | | | | |
| | | Load | 0.2% Max | | | | |
| | | Temperature | 0.004%/℃ | | | | |
| | Start-up Time Note3 | Delay from input | 250ms | | | | |
| | | Delay from on/off | 250ms | | | | |
| | | Rise time | 50ms | 25ms | 50ms | 50ms | 55ms |
| | Transient response Note4 | Voltage deviation | 5% | | | | |
| | | Response time | <1ms | | | | |
| | Output capacitance | | 0~ 10000uF | 0~ 10000uF | 100~ 5000uF | 0~ 5000uF | 0~ 1000uF |
| PROTECTION | Output Over Current (hiccup) | | 110%~190% Iomax | | | | |
| | Output Over Voltage (hiccup) | | 6~10V | 14~17V | 18~24V | 30~36V | 60~75V |
| | Input UVLO | On threshold | 12.2~13.8V | | | | |
| | | Off threshold | 9.5~12V | | | | |
| | | Hysteresis | 2.2V | | | | |
| | OTP shutdown | NTC temperature | 125 ℃ | | | | |
| | | Restart Hysteresis | 15 ℃ | | | | |
| ISOLATION | Voltage, Input to Output | | 4242Vdc | | | | |
| | Voltage, Input to baseplate | | 2250Vdc | | | | |
| | Voltage, Output to baseplate | | 2250Vdc | | | | |
| | Resistance (at 500Vdc) | | 100 MΩ min | | | | |
| ENVIRONMENT | Operating ambient temperature | | -40~85℃ | | | | |
| | Operating baseplate temperature | | -40~105℃ | | | | |
| | Storage temperature | | -40~125℃ | | | | |
| | Operating Humidity | | Max 95% | | | | |
| | Shock & Vibration | | EN 61373 | | | | |
| Enable control | Logic low | | -0.7~0.8V | | | | |
| | Logic high | | 2.5-5V | | | | |
| | Current ($V_{on/off}$=0V) | | 1mA max | | | | |
| | Voltage when floating | | <10V | | | | |
| Others | Switching Frequency | | 250kHz | | | | |
| | MTBF (72Vin,80% load,25℃) | | 597K hours | | | | |
| | Weight | | 86g | | | | |
| | Altitude | | 5000m | | | | |

Notes (All specifications valid at 72Vin,100% Rated load and 25℃ ambient, unless otherwise indicated.)

***1** Maximum output power & current of the module should not over rated output power & current.

***2** Ripple & Noise measurement bandwidth is 0-20MHz, Vin=72V, full load, Cout=100uF polymer +4.7uF ceramic.

***3** "Delay from input": from Vin reaching turn-on threshold to 10% Vout (pre-applied enable);

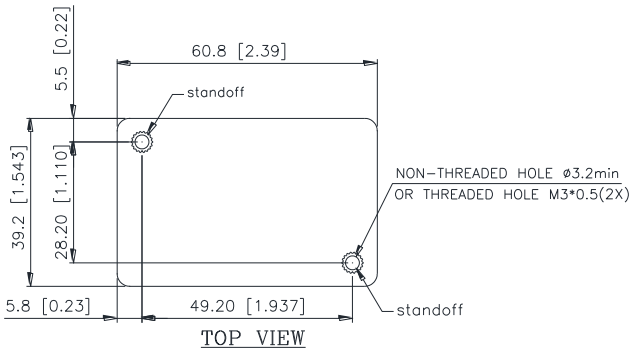
"Delay from on/off": From enable to 10% Vout (pre-applied Vin); "Rise time" From 10% to 90% Vout.

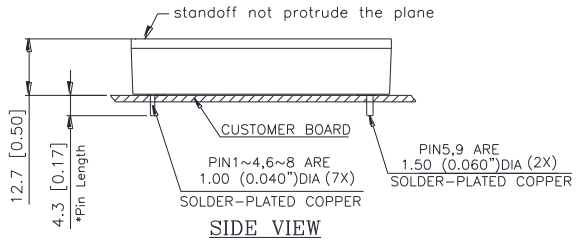
***4** Load transient test condition: 72Vin, 50% to 75% full load, 100uF Polymer Capacitor load cap, 0.1A/us.

***5** Define that the maximum Vin rising rate is 100V/ms and the recommend output capacitance is 100uF.

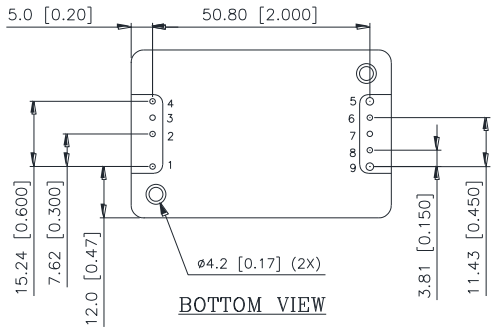
***6** The recommended external input capacitance is 100uF.

## Mechanical Drawing




*Standard pin tail length. Optional pin tail lengths shown in PART NUMBERING SYSTEM

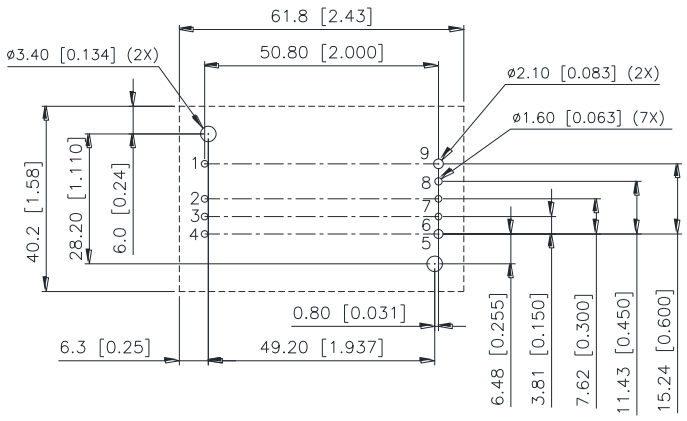



| PIN# | FUNCTION | OPTIONAL |
|---|---|---|
| 1 | Vin+ | |
| 2 | ON/OFF | |
| 3 | BUS | YES |
| 4 | Vin- | |
| 5 | Vout- | |
| 6 | Sense- | |
| 7 | Trim | |
| 8 | Sense+ | |
| 9 | Vout+ | |

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

Note: All pins are copper alloy with tin(Pb free) plated over nickel under-plating.

## Suggested Pad Layout




| PIN# | FUNCTION | OPTIONAL |
|---|---|---|
| 1 | Vin+ | |
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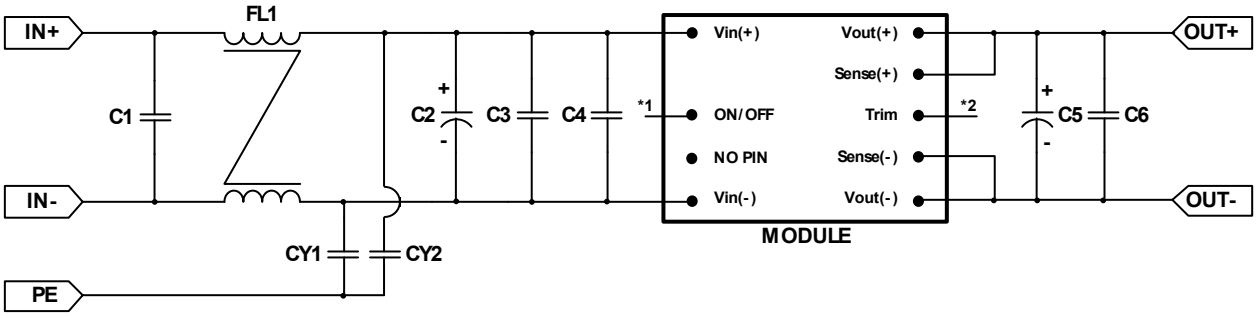
| 3 | BUS | YES |
| 4 | Vin- | |
| 5 | Vout- | |
| 6 | Sense- | |
| 7 | Trim | |
| 8 | Sense+ | |
| 9 | Vout+ | |

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

## Typical EMI Filter Circuit for EN55032 Class A Conducted Emission




* Compliance to EN50155

* 1, 2: Please refer to page12 for the remote On/Off (pin2) and Trim (pin7) implementation.

| Location | Vendor P/N | Description | Qty | Vendor | Purpose |
|---|---|---|---|---|---|
| C1 | D3D2H505KB00352 | 500V 5uF K S27.5 32*11*20 | 2 | FARATRONIC | EMC |
| FL1 | PH9455.155NL | 19A 1.62mH NPB SRF 10MHz | 1 | Pulse | EMC |
| CY1 | CS12-F2GA472MYNSAC | 250VAC 4700pF M F VI7.5 | 5 | TDK | EMC |
| CY2 | CS12-F2GA472MYNSAC | 250VAC 4700pF M F VI7.5 | 5 | TDK | EMC |
| C2 | EKXG251EC3221MMN3S | 250V 220uF M 18*31.5 | 1 | NCC | EMC |
| C3 | C1210X684K251TX | 250V 0.68uF K X7R 1210 | 3 | HOLY STONE | EMC |
| C4 | GRM32DR72E104KW01L | 250V 0.1uF K X7R 1210 | 1 | MURATA | EMC |
| C5 | 100PX100MEFCT810X16 | 100V 100uF M 10*16 | 1 | RUBYCON | RIPPLE |
| C6 | C1210X475K101TX | 100V 4.7uF K X7R 1210 | 1 | HOLY STONE | RIPPLE |

* The components for EMC purpose can be deleted if no EMC requirement.

## 1. Q80SV05030 (5V OUTPUT)

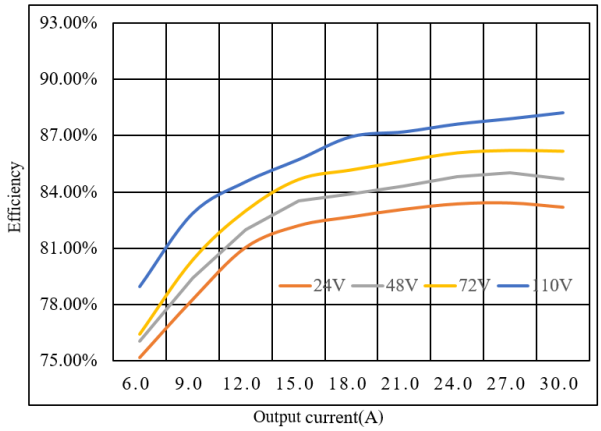



***Figure 1:*** *Efficiency vs. load current at 25°C.*

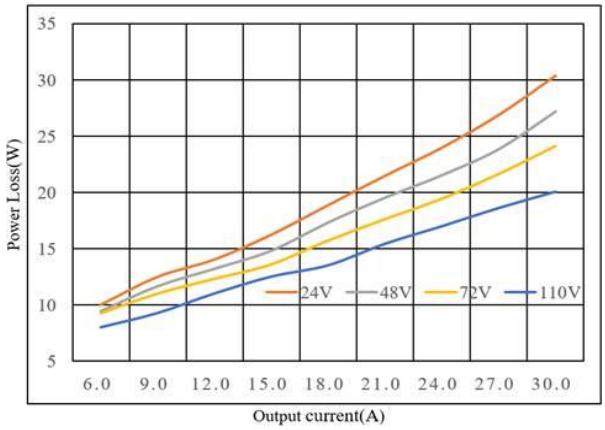



***Figure 2:*** *Power loss vs. load current at 25°C.*

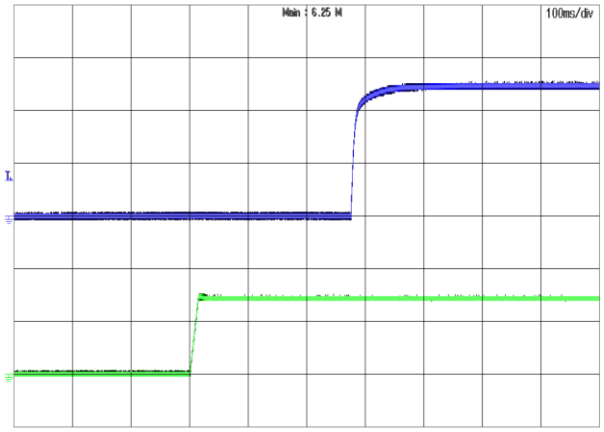



***Figure 3:*** *Turn-on transient at full load current (100ms/div).*
*Top Trace: Vout, 2V/div; Bottom Trace: Vin, 50V/div*

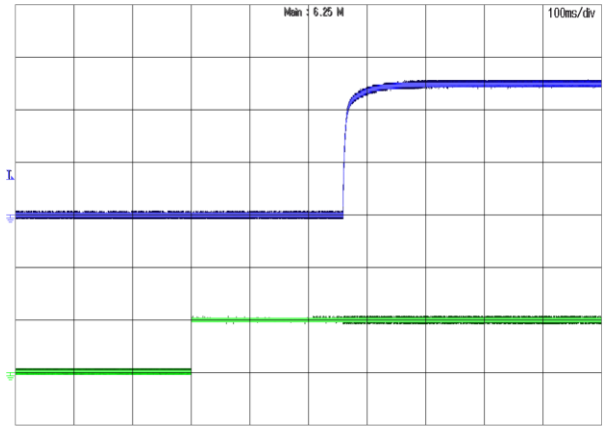



***Figure 4:*** *Turn-on transient at full load current (100ms/div).*
*Top Trace: Vout, 2V/div; Bottom Trace: ON/OFF, 5V/div*

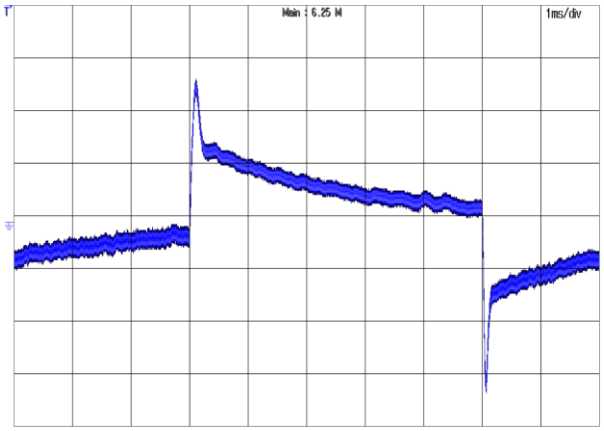



***Figure 5:*** *Output voltage response to step-change in load current (50%-75%-50% of full load; di/dt = 0.1A/μs).*
*Trace: Vout, 100mV/div; Time: 1ms/div*

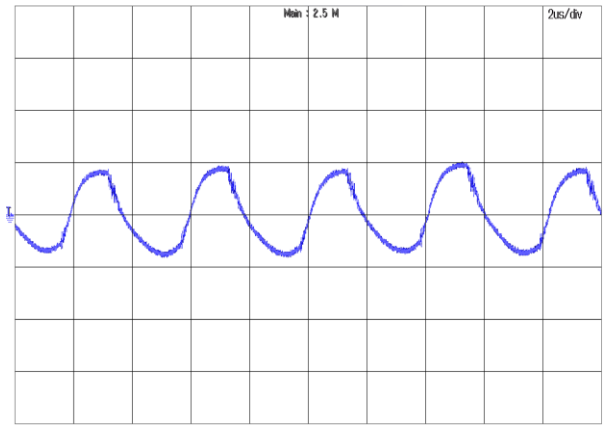



***Figure 6:*** *Output voltage ripple at Vin=72V and full load*
*Trace: Vout, 20mV/div, 2us/div; Bandwidth: 20 MHz.*

## 2. Q80SV12013 (12V OUTPUT)

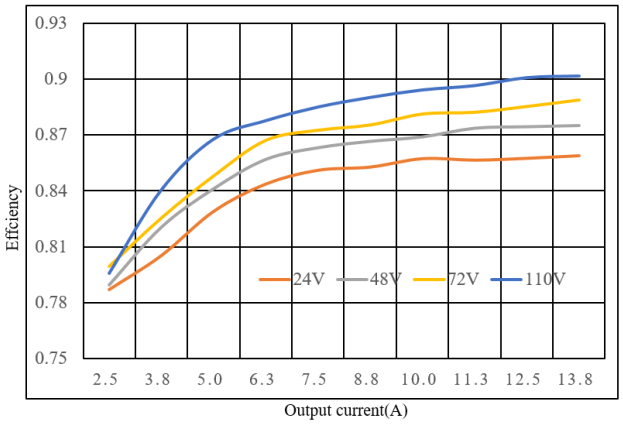



***Figure 7:*** *Efficiency vs. load current at 25°C.*

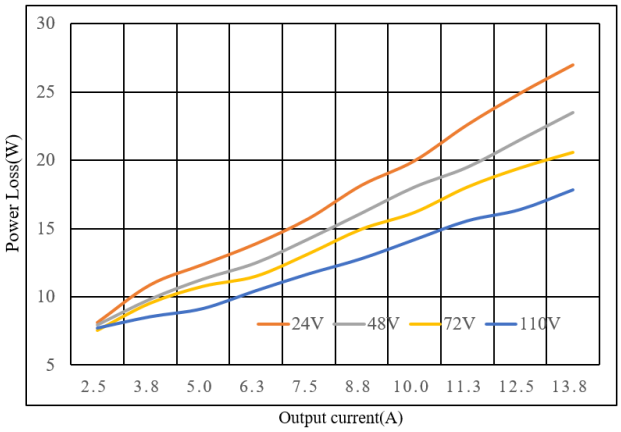



***Figure 8:*** *Power loss vs. load current at 25°C.*

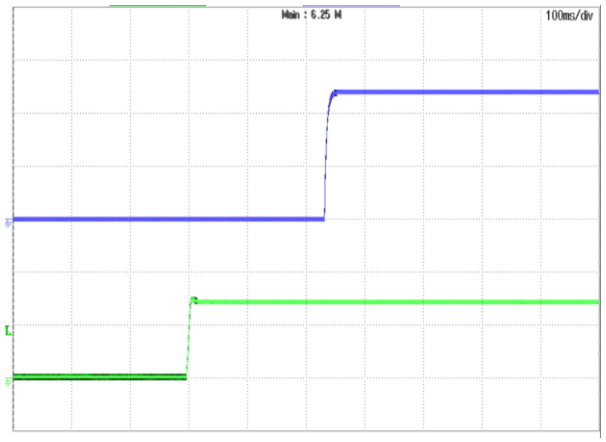



***Figure 9:*** *Turn-on transient at full load current (100ms/div).*
*Top Trace: Vout, 5V/div; Bottom Trace: Vin, 50V/div*

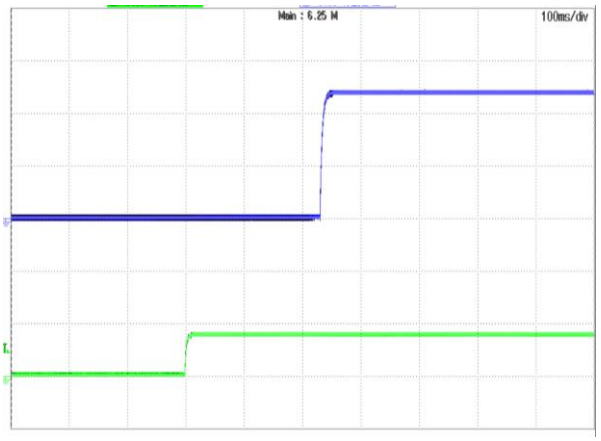



***Figure 10:*** *Turn-on transient at full load current (100ms/div).*
*Top Trace: Vout, 5V/div; Bottom Trace: ON/OFF, 5V/div*

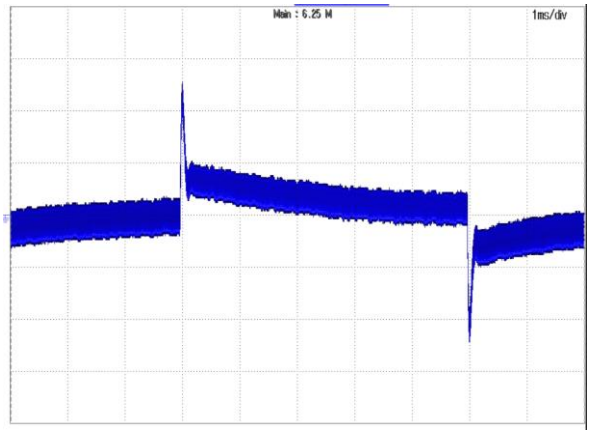



***Figure 11:*** *Output voltage response to step-change in load current (50%-75%-50% of full load; di/dt = 0.1A/μs).*
*Trace: Vout, 200mV/div; Time: 1ms/div*

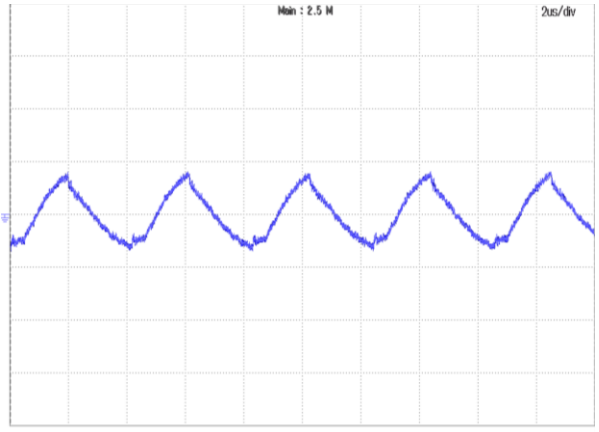



***Figure 12:*** *Output voltage ripple at Vin=72V and full load*
*Trace: Vout, 100mV/div, 2us/div; Bandwidth: 20 MHz.*

## 3. Q80SV15010 (15V OUTPUT)

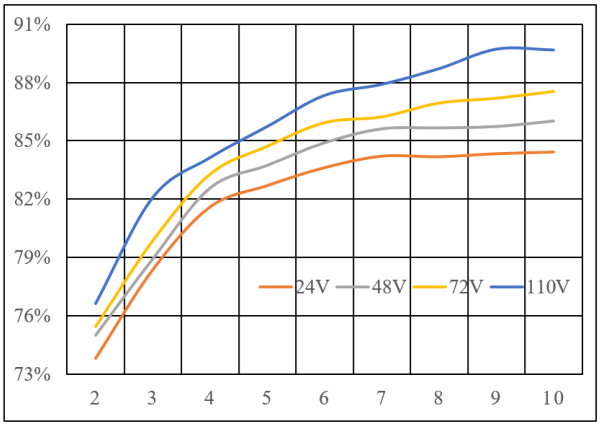



***Figure 13:*** *Efficiency vs. load current at 25°C.*

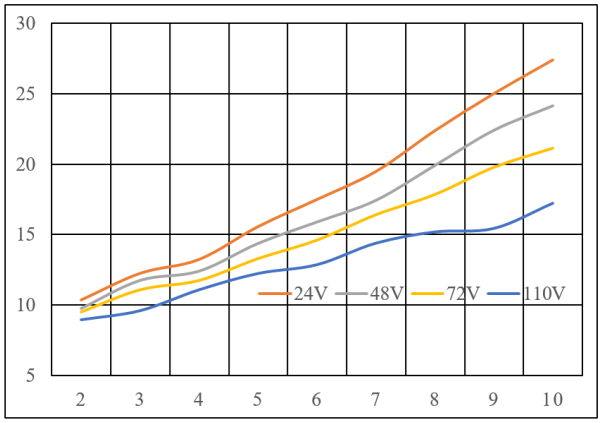



***Figure 14:*** *Power loss vs. load current at 25°C.*

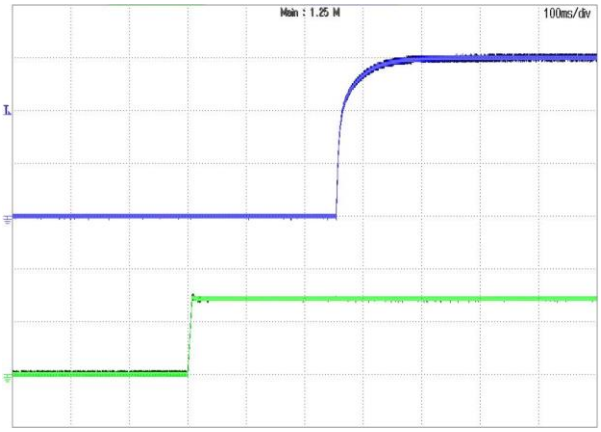



***Figure 15:*** *Turn-on transient at full load current (100ms/div).*
*Top Trace: Vout, 5V/div; Bottom Trace: Vin, 50V/div*

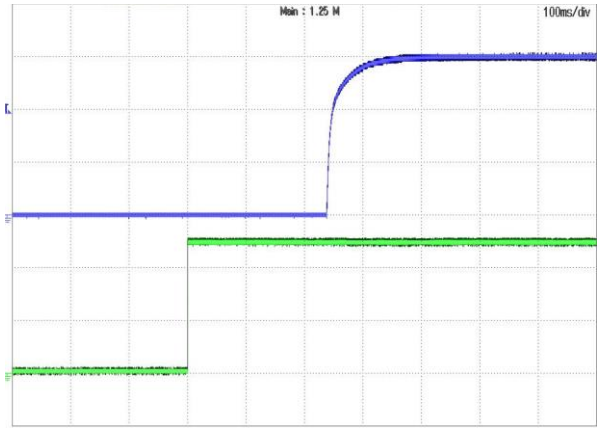



***Figure 16:*** *Turn-on transient at full load current (100ms/div).*
*Top Trace: Vout, 5V/div; Bottom Trace: ON/OFF, 5V/div*

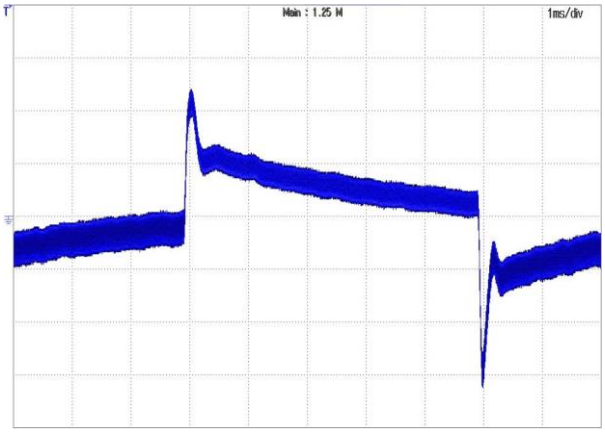



***Figure 17:*** *Output voltage response to step-change in load current (50%-75%-50% of full load; di/dt = 0.1A/μs).*
*Trace: Vout, 200mV/div; Time: 1ms/div*

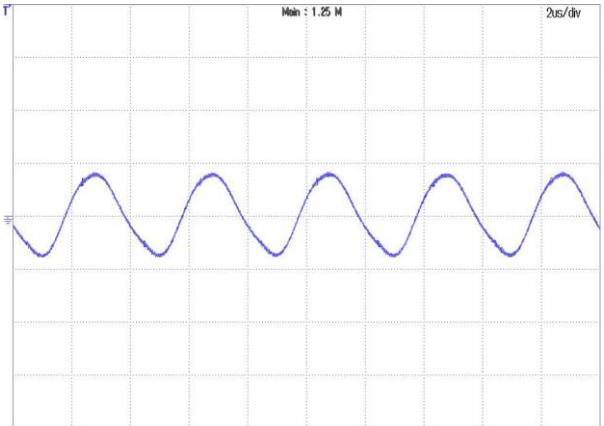



***Figure 18:*** *Output voltage ripple at Vin=72V and full load*
*Trace: Vout, 100 mV/div, 2us/div; Bandwidth: 20 MHz.*

## 4. Q80SV24006 (24V OUTPUT)

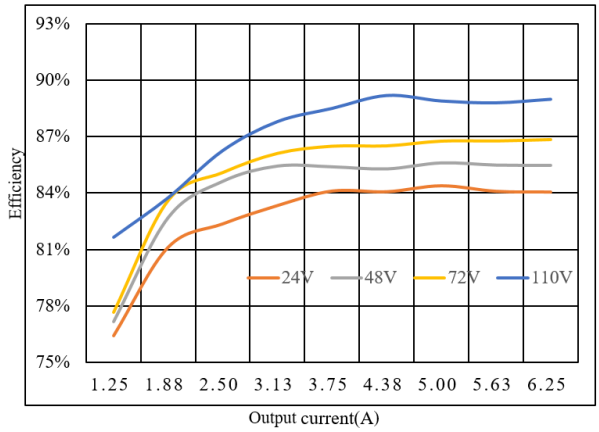



***Figure 19:*** *Efficiency vs. load current at 25°C.*

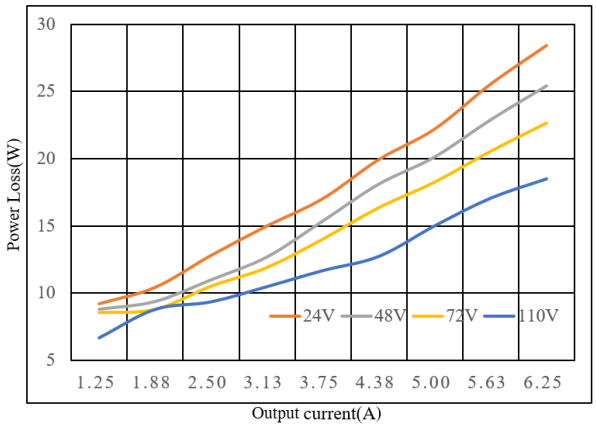



***Figure 20:*** *Power loss vs. load current at 25°C.*

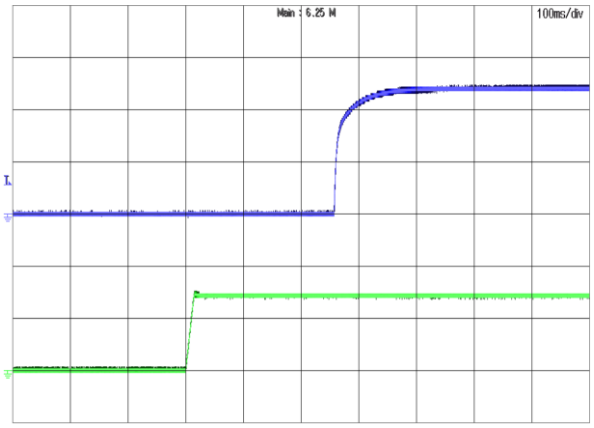



***Figure 21:*** *Turn-on transient at full load current (100ms/div).*
*Top Trace: Vout, 5V/div; Bottom Trace: Vin, 50V/div*

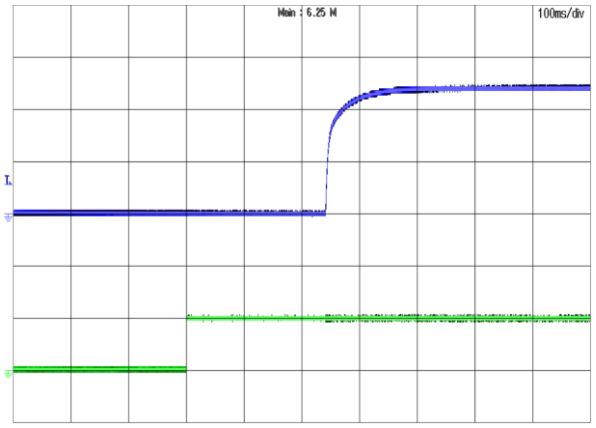



***Figure 22:*** *Turn-on transient at full load current (100ms/div).*
*Top Trace: Vout, 5V/div; Bottom Trace: ON/OFF, 5V/div*

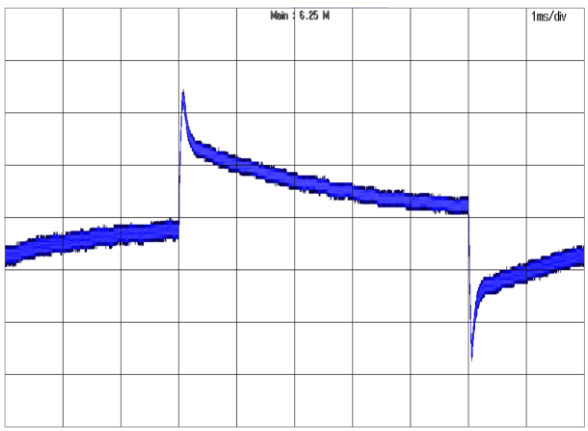



***Figure 23:*** *Output voltage response to step-change in load current (50%-75%-50% of full load; di/dt = 0.1A/μs).*
*Trace: Vout, 300mV/div; Time: 1ms/div*

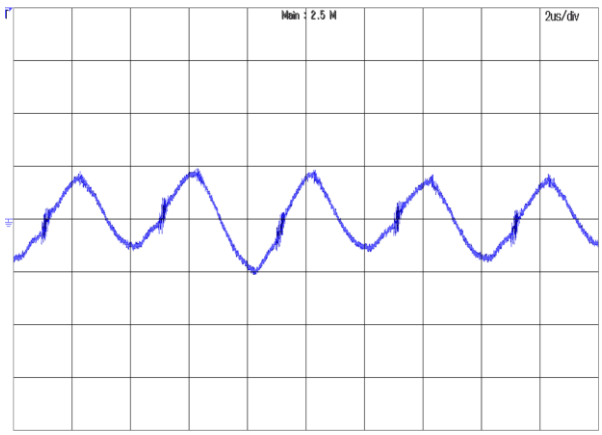



***Figure 24:*** *Output voltage ripple at Vin=72V and full load*
*Trace: Vout, 100 mV/div, 2us/div; Bandwidth: 20 MHz.*

## 5. Q80SV54003 (54V OUTPUT)

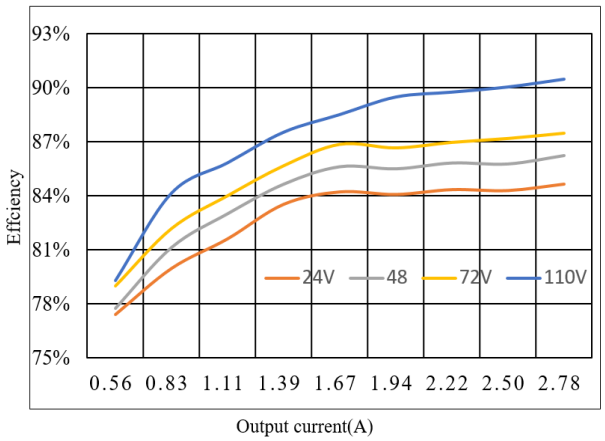



***Figure 25:*** *Efficiency vs. load current at 25°C.*

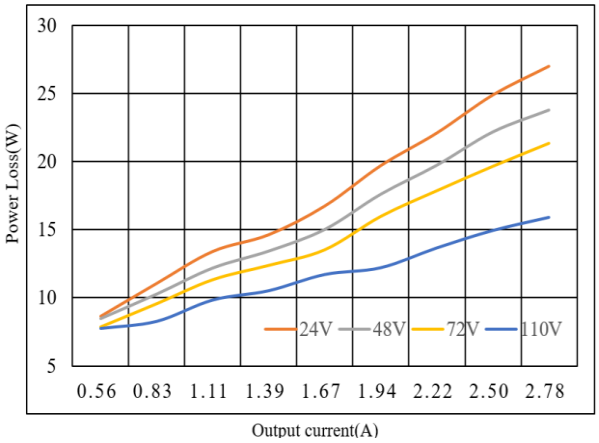



***Figure 26:*** *Power loss vs. load current at 25°C.*

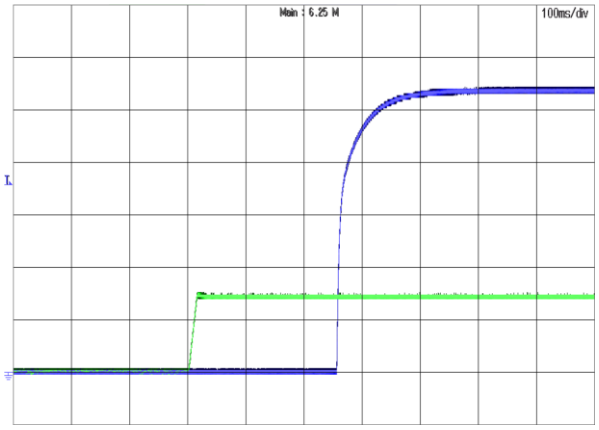



***Figure 27:*** *Turn-on transient at full load current (100ms/div).*

*Top Trace: Vout, 10V/div; Bottom Trace: Vin, 50V/div*

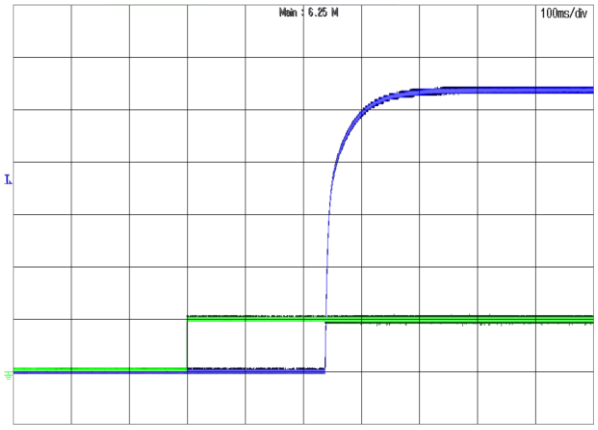



***Figure 28:*** *Turn-on transient at full load current (100ms/div).*

*Top Trace: Vout, 10V/div; Bottom Trace: ON/OFF, 5V/div*

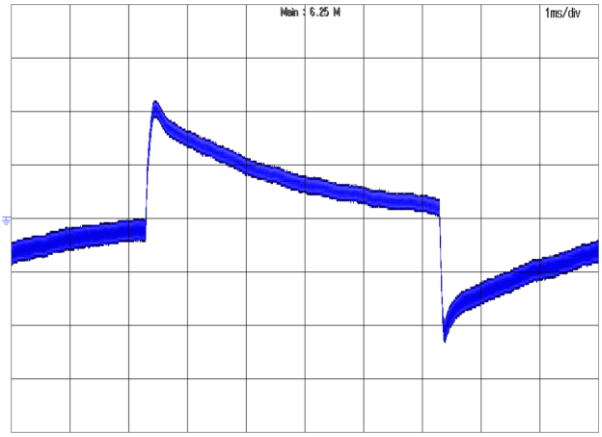



***Figure 29:*** *Output voltage response to step-change in load current (50%-75%-50% of full load; di/dt = 0.1A/μs).*

*Trace: Vout, 500mV/div; Time: 1ms/div*

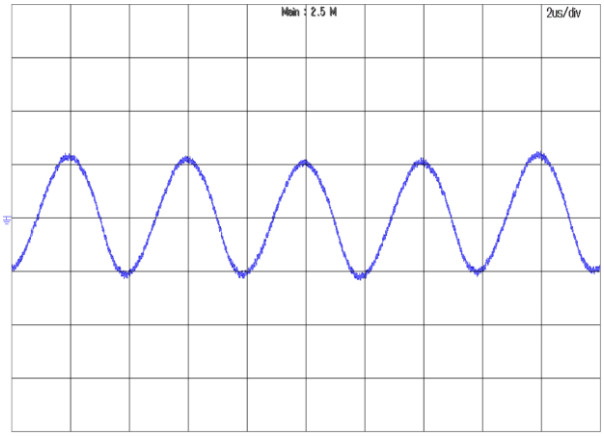


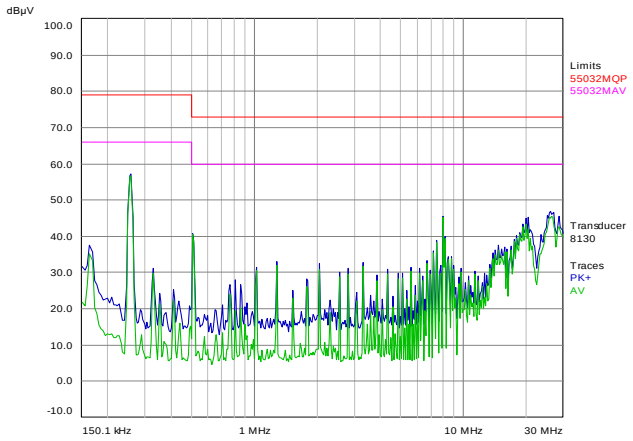

***Figure 30:*** *Output voltage ripple at Vin=72V and full load*

*Trace: Vout, 100 mV/div, 2us/div; Bandwidth: 20 MHz.*

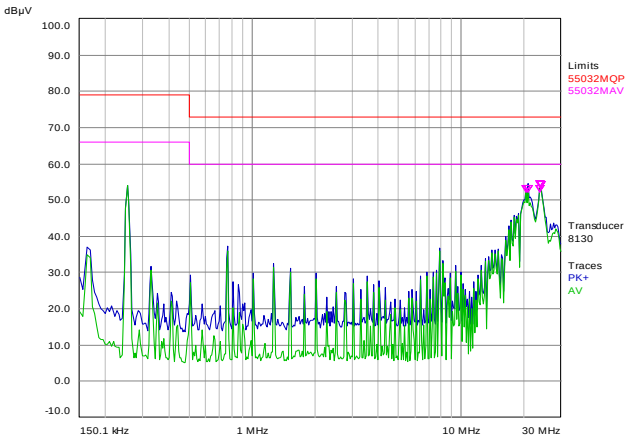
## Layout and EMI Considerations

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.

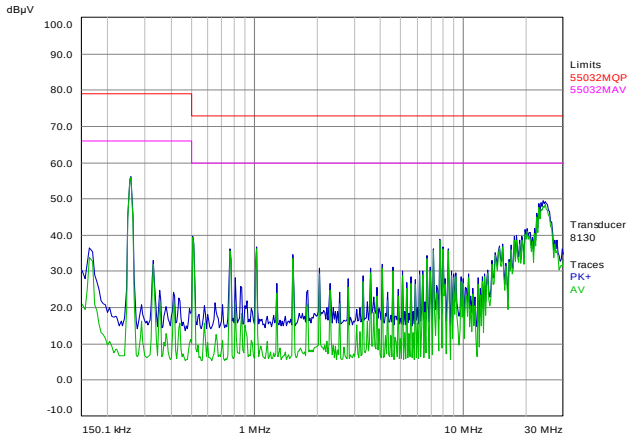
Below is the EN55032 Class A Conducted Emission test result using typical EMI filter circuit.
At T = +25°C, Typical input voltage and full load.



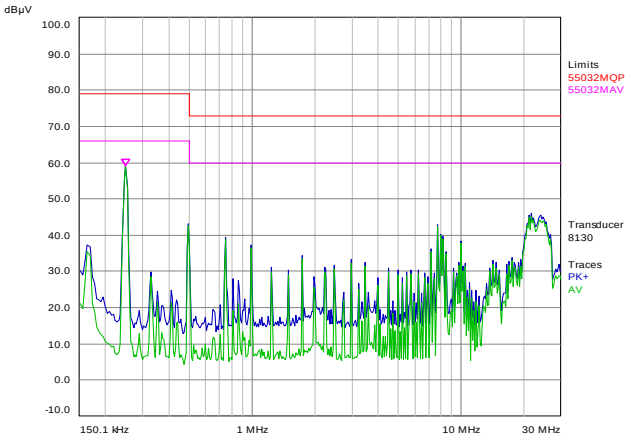

***Q80SV05030***



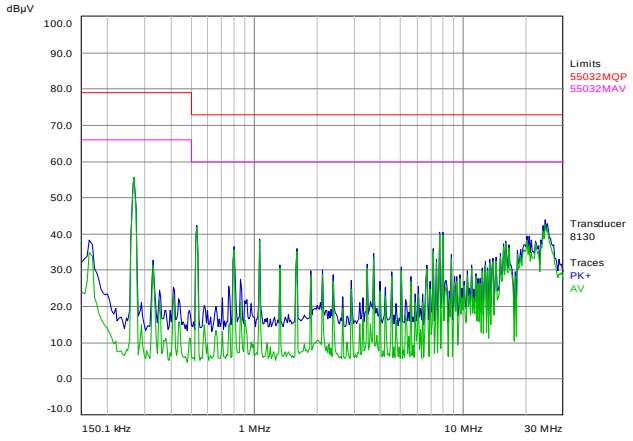

***Q80SV12013***




***Q80SV15010***




***Q80SV24006***




***Q80SV54003***

## Protection Features

**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 module will shut down, and always try to restart (hiccup mode) until the over current condition is corrected.

**Over-Voltage Protection:**
The modules include an internal output over-voltage protection circuit, which monitors the voltage on the output terminals. If this voltage exceeds the over-voltage set point, the module will shut down, and always try to restart until the over current condition is corrected

**Over-Temperature Protection:**
The over-temperature protection consists of circuitry that provides protection from thermal damage. If the over-temperature is detected the module will shut down, and restart after the temperature is within specification.

**Remote On/off(Pin2):**
The remote On/Off feature on the module can be either negative or positive logic depend on the part number options on the first page.

For Negative logic version: turns the module on during an external logic low and off during a logic high. If the remote on/off feature is not used, please short the On/Off pin to Vin(-).

For Positive logic version: turns the modules on during an external logic high and off during a logic low. If the remote On/Off feature is not used, please leave the On/Off pin to floating.

Remote On/Off can be controlled by an external switch between the On/Off terminal and the Vin(-) terminal. The switch can be an open collector or open drain, as showed in below picture (figure 31)

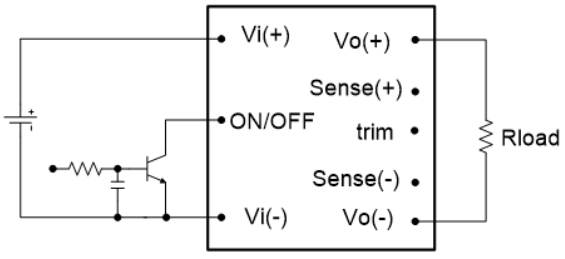



**Figure 31:** Remote On/Off Implementation

**Trim (PIN7):**
To increase or decrease the output voltage set point, connect an external resistor between the TRIM pin and SENSE (+) pin or SENSE (-) pin. The TRIM pin should be left open if this feature is not used.

Take Q80SV12013 as example, for trim down, the external resistor value required to obtain a percentage of output voltage change $\Delta$ is defined as:

$$R_{trim-down} = \left[\frac{5.11}{\Delta} - 10.22\right](K\Omega)$$

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

$$R_{trim-down} = \left[\frac{5.11}{10\%} - 10.22\right](K\Omega) = 40.88(K\Omega)$$

For trim up, the external resistor value required to obtain a percentage output voltage change $\Delta$ is defined as:

$$R_{trim-up} = \left[\frac{45}{\Delta} + 40\right]K\Omega$$

Ex. When Trim-up +10% (12V×110%=13.2V)

$$R_{trim-up} = \left[\frac{45}{10\%} + 40\right] = 490(K\Omega)$$

| | Rtrim-up /kohm | Rtrim-down /kohm |
|---|---|---|
| **Q80SV05030** | $\frac{15.8}{\Delta}+10.6$ | $\frac{5.11}{\Delta}-10.22$ |
| **Q80SV12013** | $\frac{45}{\Delta}+40$ | $\frac{5.11}{\Delta}-10.22$ |
| **Q80SV15010** | $\frac{57.46}{\Delta}+52.35$ | $\frac{5.11}{\Delta}-10.22$ |
| **Q80SV24006** | $\frac{95}{\Delta}+90$ | $\frac{5.11}{\Delta}-10.22$ |
| **Q80SV54003** | $\frac{220}{\Delta}+215$ | $\frac{5.11}{\Delta}-10.22$ |

## 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., EN 60950-1: 2006 + A11: 2009 + A1: 2010 + A12: 2011 + A2: 2013, IEC 60950-1: 2005, 2nd Edition + A1: 2009 + A2: 2013, CSA C22.2 No. 60950-1-07, 2nd Edition, 2014-10 and UL 60950-1, 2nd Edition, 2014-10-14, EN 62368-1: 2014, IEC 62368-1: 2014, CSA C22.2 No. 62368-1-14, 2nd Edition and UL 62368-1, 2nd Edition, if the system in which the power module is to be used must meet safety agency requirements.

Reinforced insulation is provided between the input and output of the module. Input is considered as secondary hazardous voltage which main transient is up to 1500Vpk and output is considered as SELV circuit. The input source must be insulated from the ac mains by reinforced or double insulation. The input terminals of the module are not considered as operator accessible.

A SELV reliability test may require when install 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.

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-blow fuse with 25A 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.

## Bus Function(Pin3)

An electrolytic cap (C7) about 400uF connected between BUS and Vin- is necessary. The cap provides/absorb transient power and make the DCDC operating stable.

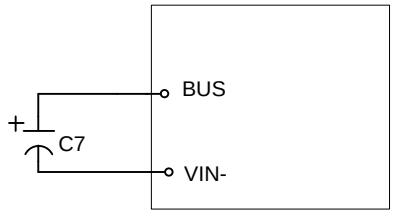



**Figure 32** BUS pin circuit

The bus pin is a voltage source depends on input voltage, the relationship is showed in below table and also the recommended rated voltage of C7

| Vin/V | 24 | 48 | 72 | 96 | 110 | 170 |
|---|---|---|---|---|---|---|
| Vbus/V | 86 | 86 | 86 | 96 | 110 | 170 |
| Vrate of C7 | >=100V | | | >=160V | | >=200V |

### The hold-up time circuit(Pin3)

Hold-up time circuit comprises R1, D1, C8, showed in figure 33. The capacity of C8 decides the hold-up time during interruption of input power. The relationship is showed in below table. The maximum hold-up time is 30ms, and is not able to be enlarged by adding more cap. The rated voltage of C8 is same with C7.

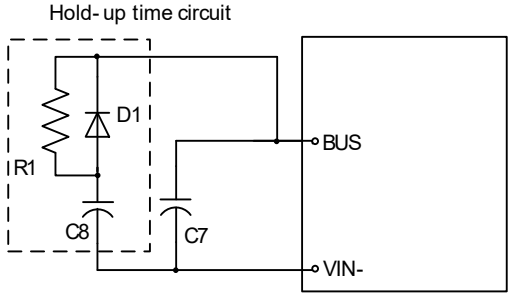



**Figure 33** hold-up time circuit

| Vin / Cap | 24V | 36V | 48V | 72V | 96V | 110V | 170V |
|---|---|---|---|---|---|---|---|
| For 10 mS | 1000uF | | | | 750uF | 520uF | 200uF |
| For 30 mS | 2540uF | | | | 1740uF | 1220uF | 450uF |

During start up, R1 endures a high pulse power, and should be selected carefully. The power is related to Vin and capacitance of C8. We recommend part number for R1 as below:
R1=WHS7-100RJT07 (TT Electronics) 100ohm.

Note: BUS pin function is only for Q80SVxxxxxxHx.
Other models no bus pin.

## 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.

## Thermal Considerations

The thermal curve is based on the test setup shown as figure 34. The module is mounted on an Al plate and was cooled by cooling liquid.

Figure 35 shows the location to monitor the temperature of the module's baseplate. The baseplate temperature in thermal curve is a reference for customer to make thermal evaluation and make sure the module is operated under allowable temperature.

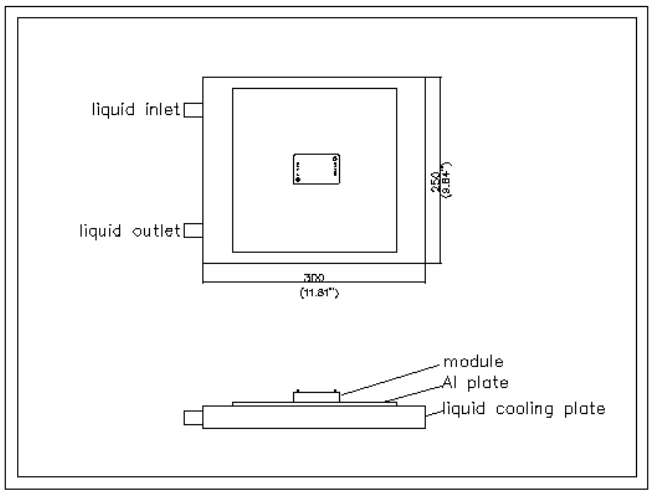



***Figure 34:*** Thermal Test setup

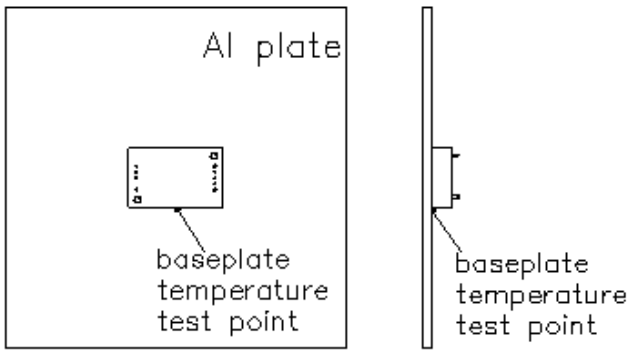



***Figure 35:*** Temperature measured point

## Thermal Curves (Base Plate Is Attached To Cold Plate)

### Thermal Curves (Q80SV05030)

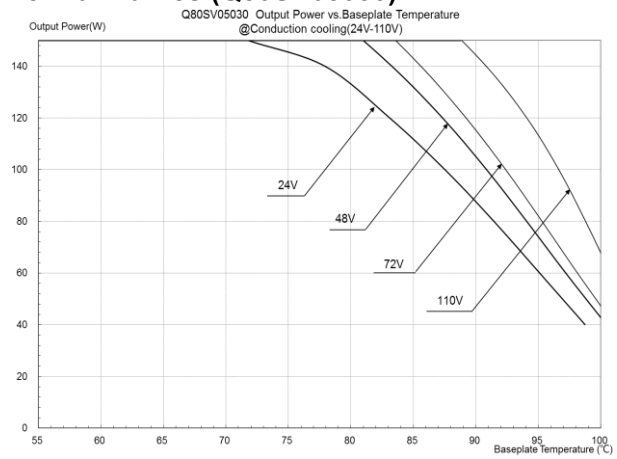



**Figure 36:** Output power vs. base plate temperature @$V_{in}$=24~110V $V_{out}$=5V

### Thermal Curves (Q80SV12013 & Q80SV15010)

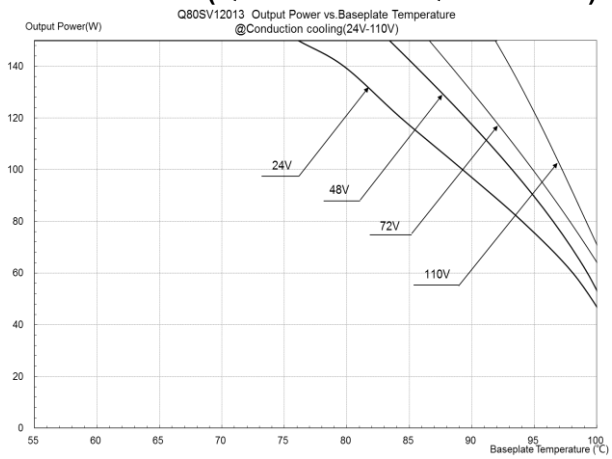



**Figure 37:** Output power vs. base plate temperature @$V_{in}$=24~110V $V_{out}$=12V or 15V

### Thermal Curves (Q80SV24006)

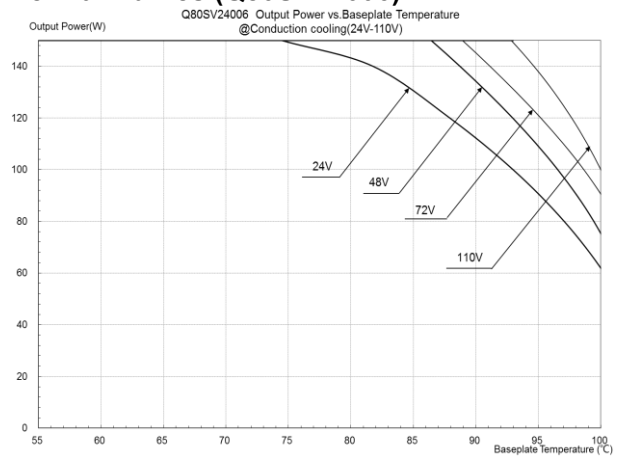



**Figure 38:** Output power vs. base plate temperature @$V_{in}$=24~110V $V_{out}$=24V

### Thermal Curves (Q80SV54003)

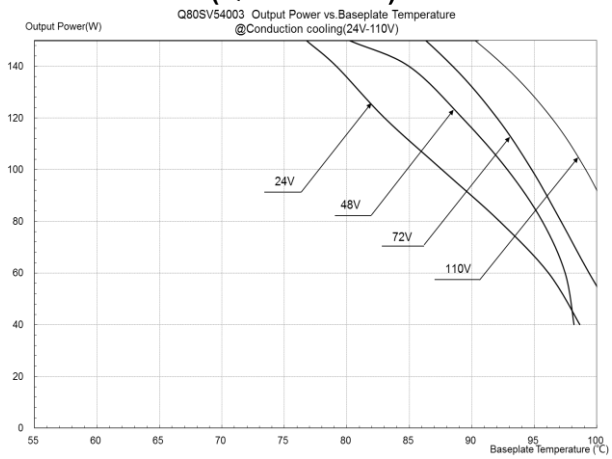



**Figure 39:** Output power vs. base plate temperature @$V_{in}$=24~110V $V_{out}$=54V

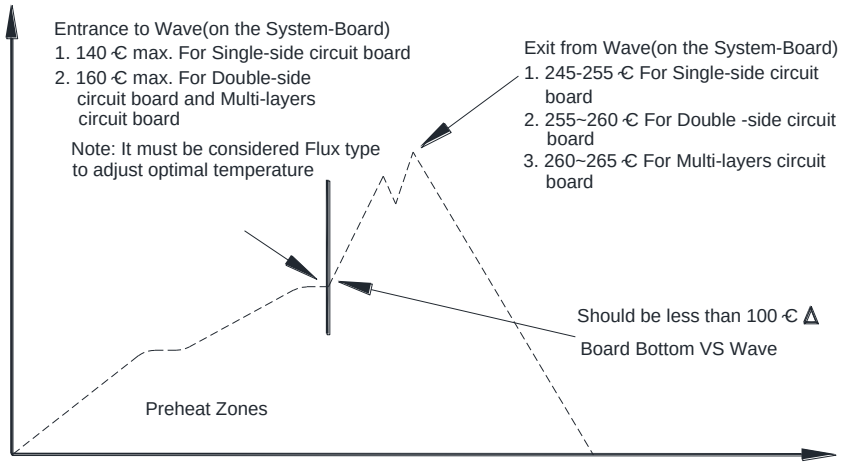
## Soldering Method

Generally, as the most common mass soldering method for the solder attachment, wave soldering is used for through-hole power modules and reflow soldering is used for surface-mount ones. Delta recommended soldering methods and process parameters are provided in this document for solder attachment of power modules onto system board. SAC305 is the suggested lead-free solder alloy for all soldering methods. The soldering temperature profile presented in this document is based on SAC305 solder alloy.

Reflow soldering is not a suggested method for through-hole power modules due to many process and reliability concerns, and reflow is prohibited for potting model.

## Wave Soldering (Lead-free)

Delta's power modules are designed to be compatible with single-wave or dual wave soldering. The suggested soldering process must keep the power module's internal temperature below the critical temperature of 217℃continuously. The recommended wave-soldering profile is shown below:




*Recommended Temperature Profile for Lead-free Wave Soldering*
*Note: The temperature is measured on solder joint of pins of power module.*

The typical recommended (for double-side circuit board) preheat temperature is 115+/-10℃ on the top side (component side) of the circuit board. The circuit-board bottom-side preheat temperature is typically recommended to be greater than 135℃ and preferably within 100℃of the solder-wave temperature. A maximum recommended preheat up rate is 3℃/s. A maximum recommended solder pot temperature is 255+/-5℃ with solder-wave dwell time of 3~6 seconds. The cooling down rate is typically recommended to be 6℃/s maximum.

## Hand Soldering (Lead Free)

Hand soldering is the least preferred method because the amount of solder applied, the time the soldering iron is held on the joint, the temperature of the iron, and the temperature of the solder joint are variable. The recommended hand soldering guideline is listed in Table below. The suggested soldering process must keep the power module's internal temperature below the critical temperature of 217℃continuously.

| Parameter | Single-side Circuit Board | Double-side Circuit Board | Multi-layers Circuit Board |
|---|---|---|---|
| Soldering Iron Wattage<br>Tip Temperature | 90<br>385+/-10℃ | 90<br>420+/-10℃ | 90<br>420+/-10℃ |
| Soldering Time | 2 ~ 6 seconds | 4 ~ 10 seconds | 4 ~ 10 seconds |

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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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