



### FEATURES

- Efficiency up to 89%
- Wide input range, 9V-36V
- Package with Industry Standard Pinout
- Package Dimension:  
25.4 x25.4 x10.2mm (1.0" x1.0" x0.40")(No HSK)  
31.0 x25.4 x17.5mm (1.22" x1.00" x0.69")(HSK)
- Over voltage protection, hiccup mode
- Over current protection, hiccup mode
- Positive or Negative Remote ON/OFF
- Without tantalum capacitor inside module
- Operating Temperature range - 40°C to +85°C
- Input to Output Isolation: 1600VDC
- RoHs Compliant
- 3 Years Product Warranty
- Heat-sink is option
- UL60950, 2<sup>nd</sup> Edition, 2011-12-19 Recognized

The S24SE/S24DE family, the highest power density (30W) industrial input range 1"X1" isolated power converter whose pinout follows industry standard. The S24SE/S24DE series comes with a host of industry-standard features, such as over current protection, over voltage protection, over temperature protection and remote on/off. An optional heatsink is available for more extreme thermal requirements. All models have an ultra-wide 4:1 input voltage range (9V to 36V). With operating temperature of -40°C to +85°C, it is suitable for customers' critical applications, such as process control and automation, transportation, data communication and telecom equipment, test equipment, medical device and everywhere where space on the PCB is critical

### Model List

| Model Number | Input Voltage (Range) | Output Voltage | Output Current |      | Input Current (typ input voltage) |          | Load Regulation | Maxcapacitive Load | Efficiency (typ.) |
|--------------|-----------------------|----------------|----------------|------|-----------------------------------|----------|-----------------|--------------------|-------------------|
|              |                       |                | Max.           | Min. | @Max. Load                        | @No Load |                 |                    |                   |
|              |                       |                | mA             | mA   | mA(typ.)                          | mA(typ.) |                 | uF                 | %                 |
| S24SE3R307   | 24<br>(9 ~ 36)        | 3.3V           | 7500           | 0    | 1170                              | 55       | ±10             | 10000              | 88%               |
| S24SE05006   |                       | 5.0V           | 6000           | 0    | 1450                              | 55       | ±10             | 10000              | 89%               |
| S24SE12003   |                       | 12V            | 2500           | 0    | 1450                              | 20       | ±12             | 1000               | 88%               |
| S24SE15002   |                       | 15V            | 2000           | 0    | 1450                              | 20       | ±15             | 1000               | 88%               |
| S24DE12001   |                       | ±12V           | 1250           | 0    | 1450                              | 25       | ±120            | ±1000              | 88%               |
| S24DE15001   |                       | ±15V           | 1000           | 0    | 1450                              | 25       | ±150            | ±680               | 88%               |

### Input Characteristics

| Item                                   | Model                        | Min.               | Typ. | Max. | Unit |
|----------------------------------------|------------------------------|--------------------|------|------|------|
| Input Surge Voltage (100 msec)         | All Models                   |                    |      | 50   | VDC  |
| Input Turn-On Voltage Threshold        | All Models                   | 8                  | 8.5  | 9    | VDC  |
| Input Turn-Off Voltage Threshold       | All Models                   | 7                  | 7.5  | 8    | VDC  |
| Input Under-Voltage Lockout Hysteresis | All Models                   | 0.4                | 1    | 1.7  | VDC  |
| Off-Converter Input Current            | All Models                   |                    | 6    |      | mA   |
| Input reflected ripple current         | All Models, with 12uH, 20MHz |                    | 5    | 20   | mA   |
| Reverse Polarity Input Current         | All Models                   | ---                | ---  | 0.3  | A    |
| ON/OFF Control, Logic High             | All Models                   | 2.4                |      | 10   | VDC  |
| ON/OFF Control, Logic Low              | All Models                   | -0.7               |      | 0.8  | VDC  |
| Input Filter                           | All Models                   | Internal PI Filter |      |      |      |

### Output Characteristics

| Item                           | Conditions                                           | Min. | Typ. | Max. | Unit               |
|--------------------------------|------------------------------------------------------|------|------|------|--------------------|
| Output Voltage Accuracy        |                                                      | ---  | ±1.0 | ±2.0 | %Vo                |
| Output Voltage Balance         | Dual Output, Balanced Loads                          | ---  | ±1.0 | ±2.0 | %Vo                |
| Line Regulation                | Single output                                        |      | ±0.1 | ±0.2 | %Vo                |
|                                | Dual output                                          |      | ±0.1 | ±0.5 | %Vo                |
| Cross Regulation               | Dual output, Asymmetrical Load<br>25%-100% Full Load |      | ±2   | ±3   | %Vo                |
| Total Output Voltage Range     | Over Load, Line and Temperature                      | ---  | ---  | ±3   | %Vo                |
| Ripple & Noise                 | 12V, 15V, ±12V, ±15V                                 | ---  | 50   | ---  | mV <sub>P-P</sub>  |
| Ripple & Noise                 | 3.3V, 5.0V                                           |      | 50   | ---  | mV <sub>P-P</sub>  |
| Dynamic load response          | 50%-75% full load, 0.1A/μS                           |      | 3    |      | %Vo                |
| Output Over Current Protection | Output Voltage 10% Low, Hiccup                       | 110  |      | 160  | %I <sub>omax</sub> |
| Short Output Protection        | Long Term, Auto-recovery                             |      |      |      |                    |
| Output Over-Voltage Protection | Hiccup, Auto-recovery                                | 115  |      | 150  | %Vo                |
| Output Trim Range              | Single Output                                        | -10  |      | +10  | %Vo                |

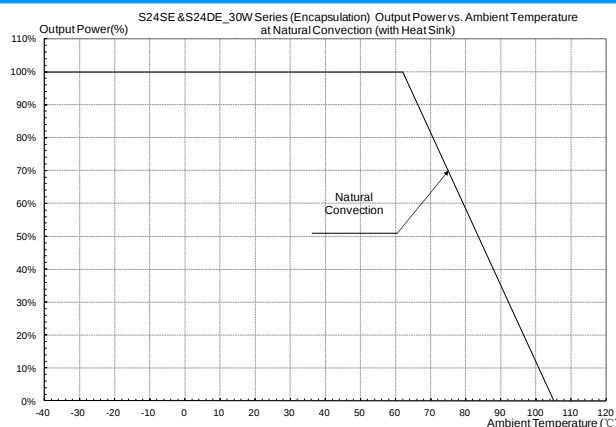
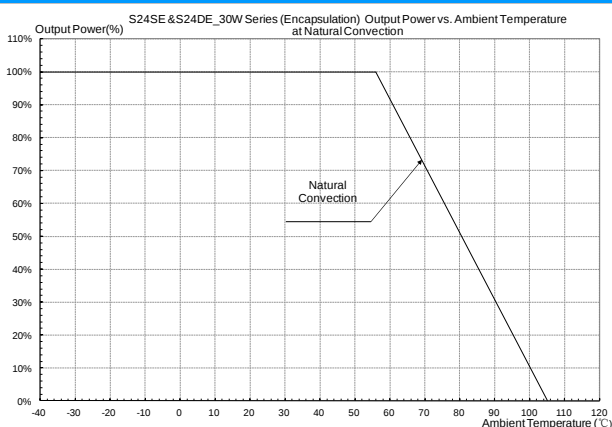
### General Characteristics

| Item                          | Conditions | Min. | Typ. | Max. | Unit |
|-------------------------------|------------|------|------|------|------|
| I/O Isolation Voltage (rated) |            | ---  | ---  | 1600 | VDC  |
| I/O Isolation Resistance      |            | 10   | ---  | ---  | MΩ   |
| I/O Isolation Capacitance     |            |      | 1100 |      | pF   |
| Switching Frequency           |            |      | 550  |      | KHz  |

### Environmental Specifications

| Parameter                                   | Conditions          | Min. | Max. | Unit     |
|---------------------------------------------|---------------------|------|------|----------|
| Operating Temperature Range (with Derating) | Ambient             | -40  | +85  | °C       |
| Case Temperature                            |                     | ---  | +105 | °C       |
| Storage Temperature Range                   |                     | -50  | +125 | °C       |
| Humidity (non condensing)                   |                     | ---  | 95   | % rel. H |
| Cooling                                     | Free-Air convection |      |      |          |

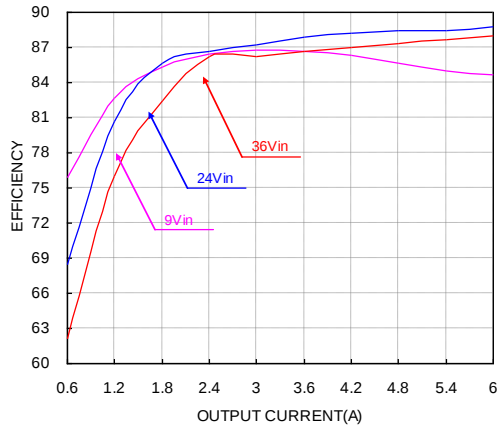
### Power Derating Curves (No Heat Sink and With Heat Sink)



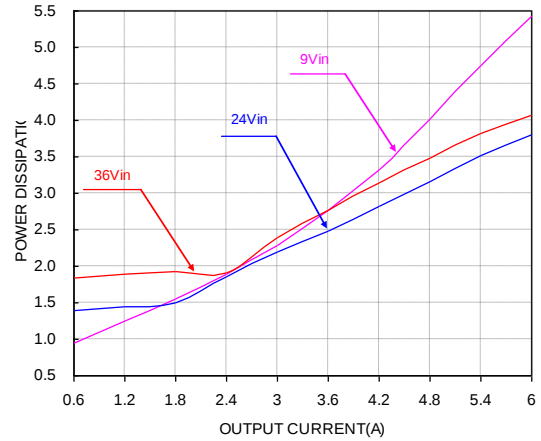
### Notes

- Specifications typical at Ta=+25°C, resistive load, nominal input voltage and rated output current unless otherwise noted.
- Ripple & Noise measurement bandwidth is 0-20MHz, with 10μF, tantalum capacitor and 1μF ceramic capacitor.
- All DC/DC converters should be externally fused at the front end for protection.
- Specifications are subject to change without notice.

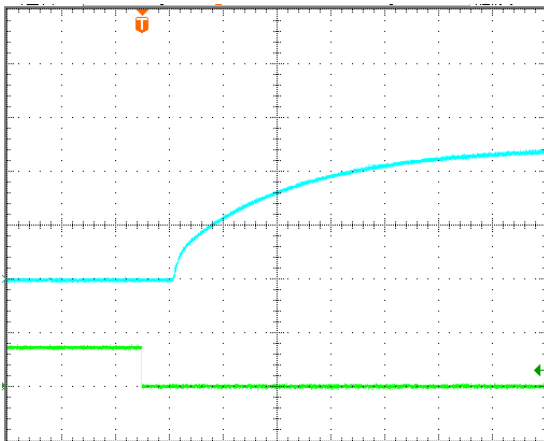
### ELECTRICAL CHARACTERISTICS CURVES - S24SE05006, 9-36VIN, 5.0V/6A



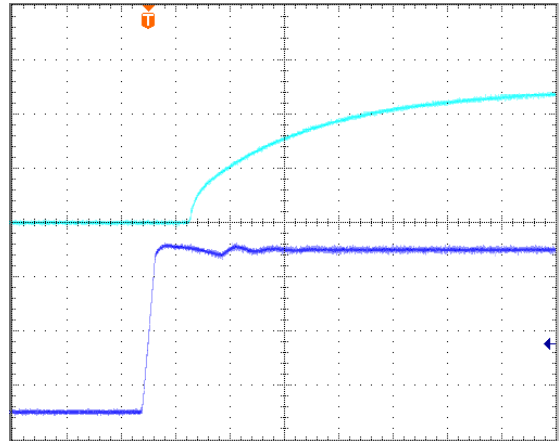
Efficiency vs. load current for various input voltage at 25°C.



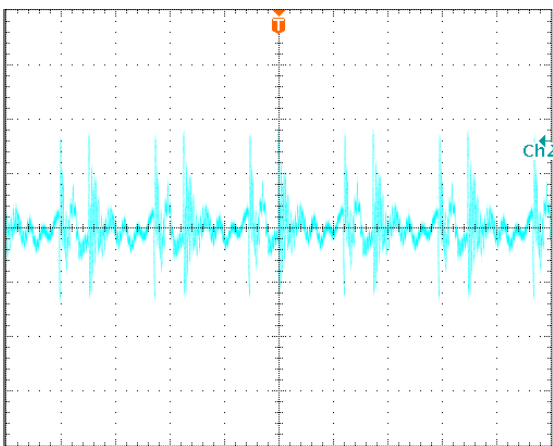
Full load input characteristics at room temperature.



Turn-on transient at full load current (10ms/div).  
Top Trace: Vout; 2V/div; Bottom Trace: ON/OFF input: 5V/div.

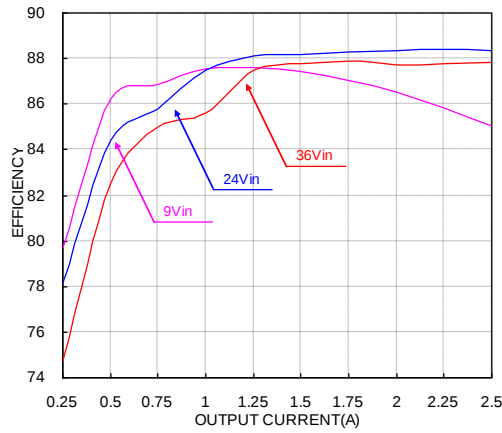


Turn-on transient at full load current (10 ms/div).  
Top Trace: Vout; 2V/div; Bottom Trace: input voltage: 8V/div.

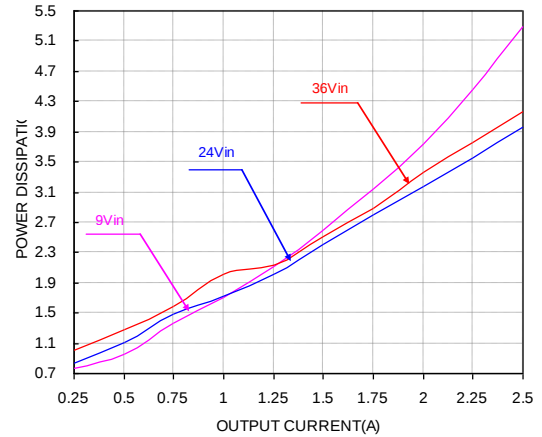


Output voltage ripple at nominal input voltage and max load current (20 mV/div, 2us/div)  
Load cap: 10μF, tantalum capacitor and 1μF ceramic capacitor.  
Bandwidth: 20 MHz.

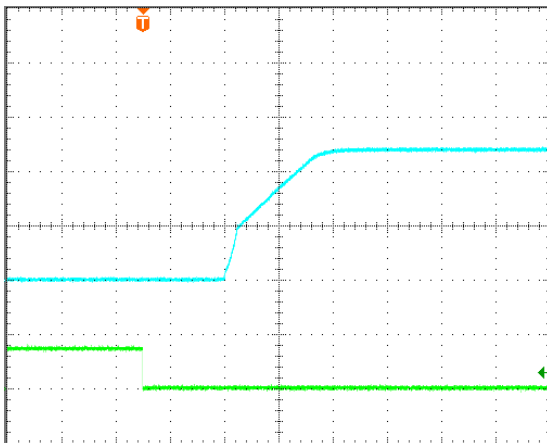
### ELECTRICAL CHARACTERISTICS CURVES - S24SE12003, 9-36VIN, 12V/2.5A



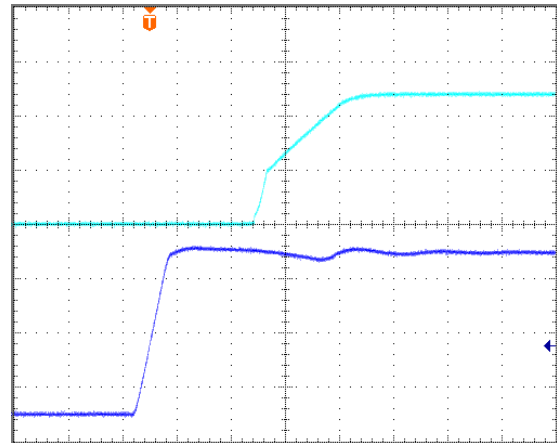
Efficiency vs. load current for various input voltage at 25°C.



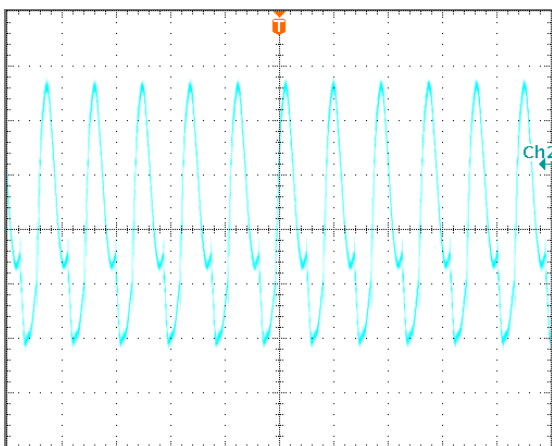
Power dissipation vs. load current at 25°C.



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

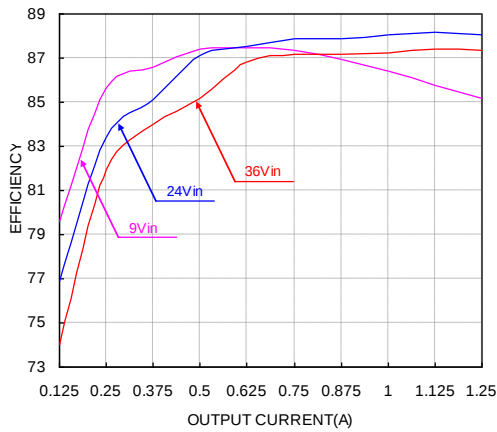


Turn-on transient at full load current (4 ms/div).  
Top Trace: Vout; 5V/div; Bottom Trace: input voltage: 8V/div.

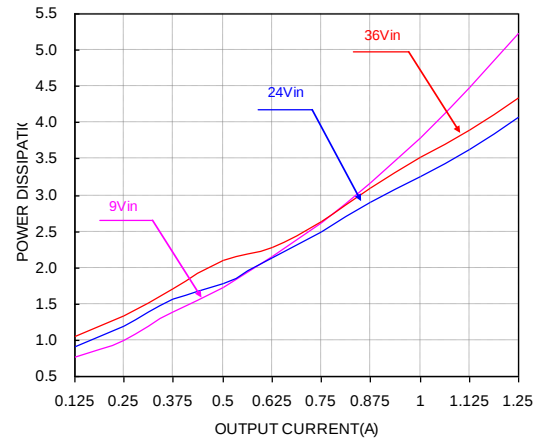


Output voltage ripple at nominal input voltage and max load current 10 mV/div, 2us/div  
Load cap: 10μF, tantalum capacitor and 1μF ceramic capacitor.  
Bandwidth: 20 MHz.

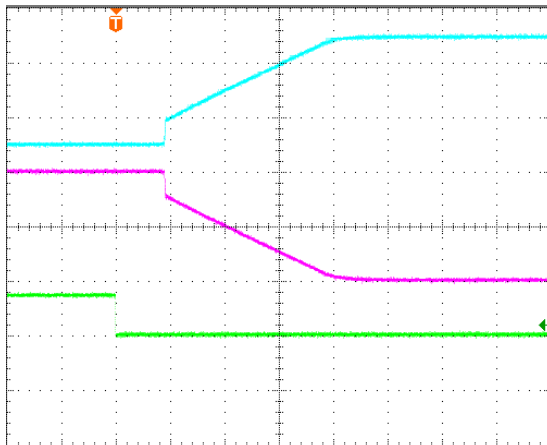
### ELECTRICAL CHARACTERISTICS CURVES - S24DE12001, 9-36VIN, $\pm 12V/1.25A$



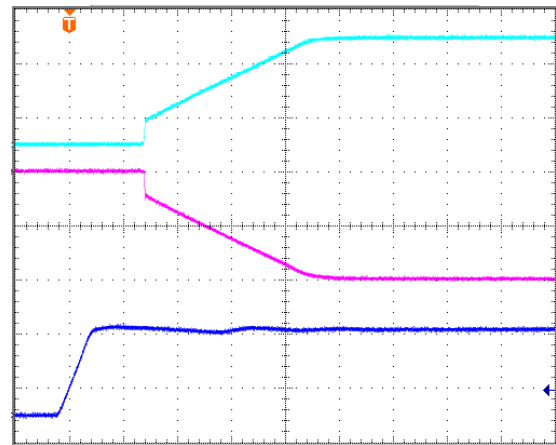
Efficiency vs. load current for various input voltage at 25°C.



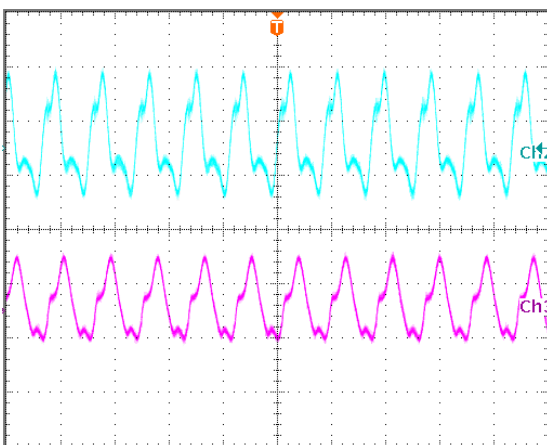
Power dissipation vs. load current at 25°C.



Turn-on transient at full load current (4ms/div).  
Top two Traces: Vout; 6V/div; Bottom Trace: ON/OFF input: 5V/div.

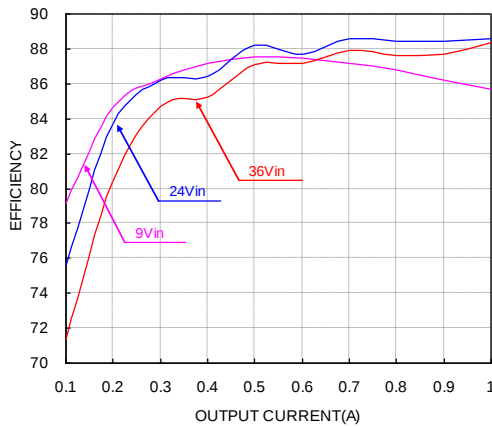


Turn-on transient at full load current (4 ms/div).  
Top two Traces: Vout; 6V/div; Bottom Trace: input voltage: 15V/div.

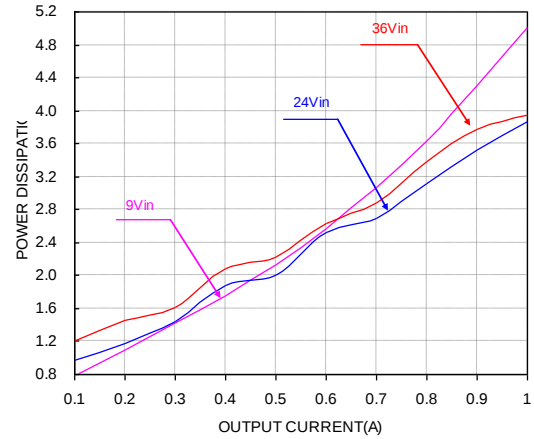


Output voltage ripple at nominal input voltage and max load current Top trace +12V, 10 mV/div, Bottom trace -12V, 20mV/div, 2 $\mu$ s/div.  
Load cap: 10 $\mu$ F, tantalum capacitor and 1 $\mu$ F ceramic capacitor.  
Bandwidth: 20 MHz.

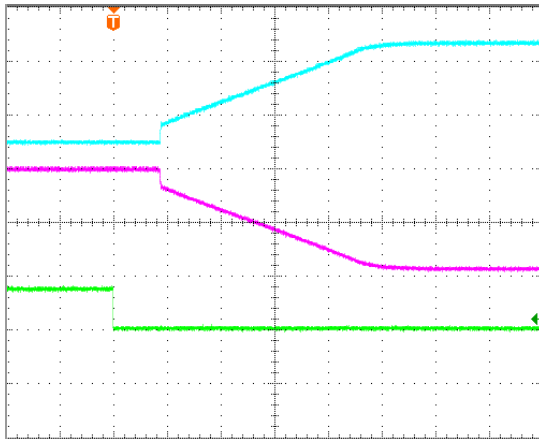
### ELECTRICAL CHARACTERISTICS CURVES - S24DE15001, 9-36VIN, $\pm 15V/1.0A$



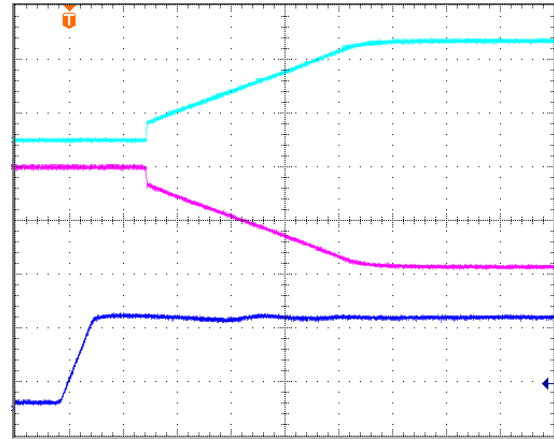
Efficiency vs. load current for various input voltage at 25°C.



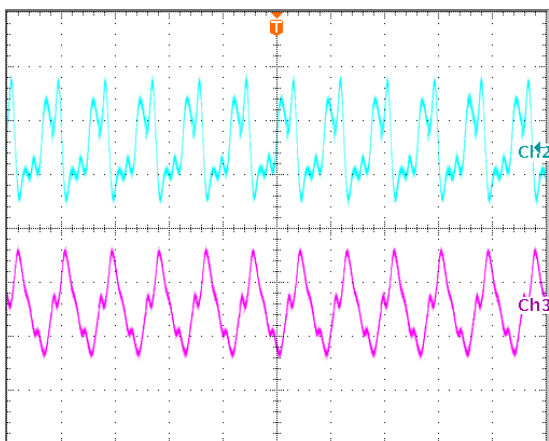
Power dissipation vs. load current at 25°C.



Turn-on transient at full load current (4ms/div).  
Top two traces: V<sub>out</sub>; 8V/div; Bottom Trace: ON/OFF input: 5V/div.



Turn-on transient at full load current (4ms/div).  
Top two traces: V<sub>out</sub>; 8V/div; Bottom Trace: input voltage: 15V/div.



Output voltage ripple at nominal input voltage and max load current Top trace +15V, 10 mV/div, Bottom trace -15V, 20mV/div, 2us/div.

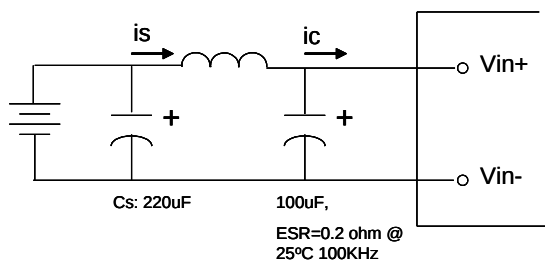
Load cap: 10 $\mu$ F, tantalum capacitor and 1 $\mu$ F ceramic capacitor.  
Bandwidth: 20 MHz.

### DESIGN CONSIDERATIONS

#### Input Source Impedance

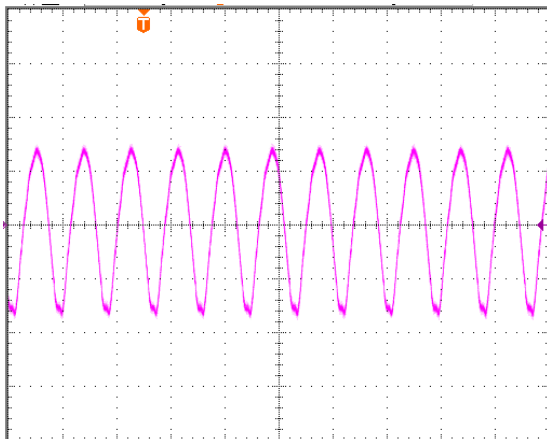
The impedance of the input source connecting to the DC/DC power modules will interact with the modules and affect the stability. A low ac-impedance input source is recommended. If the source inductance is more than a few  $\mu\text{H}$ , we advise a  $47\mu\text{F}$  electrolytic capacitor mounted close to the input of the module to improve the stability.

#### Input Reflected Ripple Current

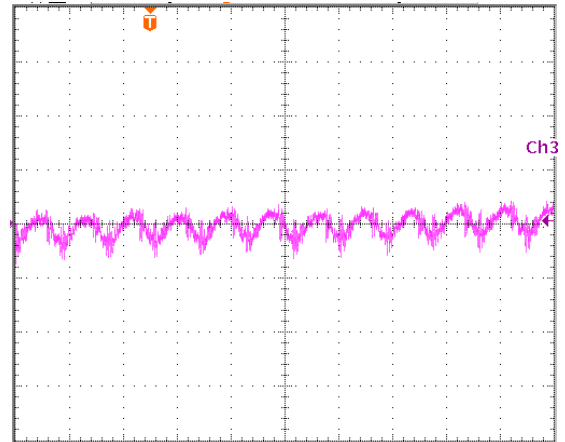


Test set-up diagram showing measurement points for Input Terminal Ripple Current and Input Reflected Ripple Current.

Measured input reflected-ripple current with a simulated source Inductance (LTEST) of  $12\mu\text{H}$ . Capacitor Cs offset possible battery impedance.

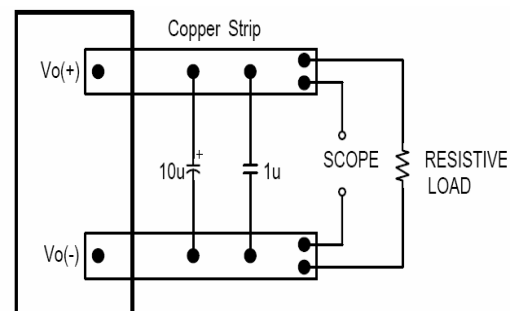


Input Terminal Ripple Current,  $i_c$ , at full rated output current and nominal input voltage with  $12\mu\text{H}$  source impedance and  $100\mu\text{F}$  electrolytic capacitor ( $100\text{ mA/div}$ ,  $2\mu\text{s/div}$ ).



Input reflected ripple current,  $i_s$ , through a  $12\mu\text{H}$  source inductor at nominal input voltage and rated load current ( $5\text{ mA/div}$ ,  $2\mu\text{s/div}$ )

#### Output Ripple Noise



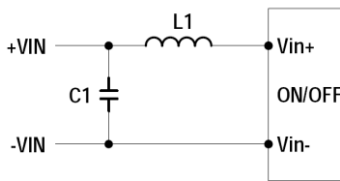
Output voltage ripple test setup.

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

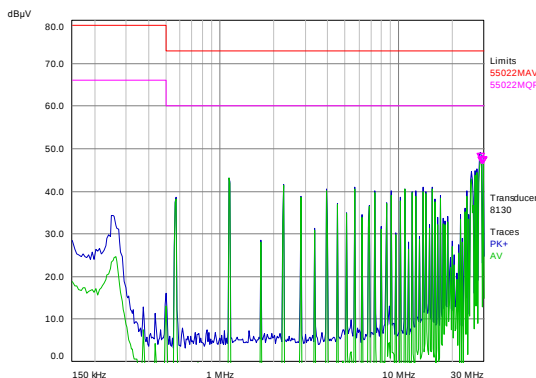
#### Layout and EMI considerations

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. An external input filter module is available for easier EMC compliance design. Below is the reference design for an input filter to pass EN55022 (VDE0878) class A(both q. peak and average).



$L1=1\mu H$

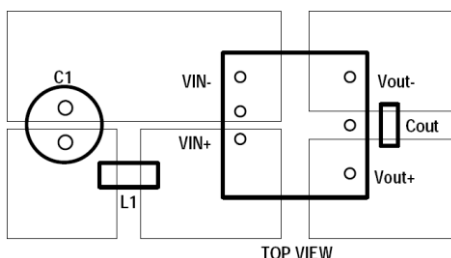
$C1=47\mu F/50V$ , electrolytic capacitor



Test Result:

At  $T = +25^{\circ}C$ , Typical input voltage and full load.

Green is quasi peak mode; Blue is average mode.



#### Recommended PCB Layout

It is suggested to use multiple layers PCB and large size copper on system board which connect to pins of module, that can achieve better thermal performance.

### FEATURES DESCRIPTIONS

#### Over-Current Protection

The modules include an internal output over-current protection circuit, which will endure current limiting for an unlimited duration during output overload. If the output current exceeds the OCP set point, the modules will shut down (hiccup mode).

The modules will try to restart after shutdown. If the overload condition still exists, the module will shut down again. This restart trial will continue until the overload condition is corrected.

#### Over-Voltage Protection

The modules include an internal output over-voltage protection circuit, which monitors the voltage on the output terminals. If this voltage exceeds the over-voltage set point, the modules will shut down, and then restart after a hiccup-time (hiccup mode).

If latch mode is needed, please contact with Delta.

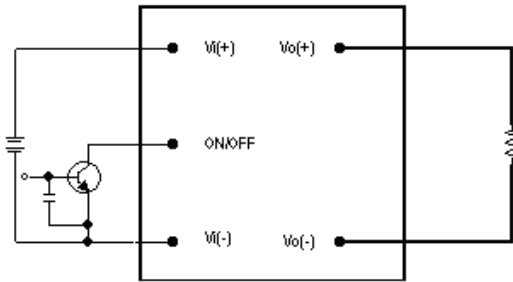
#### Over-Temperature Protection

The over-temperature protection consists of circuitry that provides protection from thermal damage. If the temperature exceeds the over-temperature threshold the module will shut down. The module will restart after the temperature is within specification.

#### Remote On/Off

The remote on/off feature on the module can be either negative or positive logic. Negative logic turns the module on during a logic low and off during a logic high. Positive logic turns the modules on during a logic high and off during a logic low.

Remote on/off can be controlled by an external switch between the on/off terminal and the Vi (-) terminal. The switch can be an open collector or open drain. For negative logic if the remote on/off feature is not used, please short the on/off pin to Vi (-). For positive logic if the remote on/off feature is not used, please leave the on/off pin to floating.



Remote on/off implementation

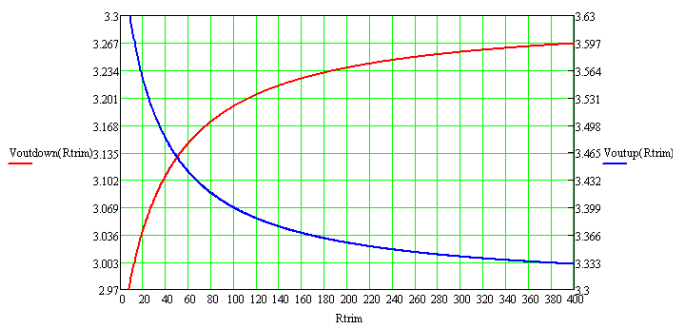
### Output Voltage Adjustment(TRIM)

Only single output modules has output adjust function. To increase the output voltage set point, connect an external resistor between the TRIM pin and the Vout(-).

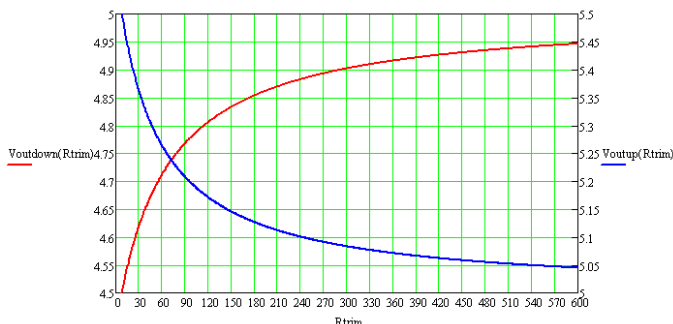
To decrease the output voltage set point, connect an external resistor between the TRIM pin and the Vout(+).

The maximum adjust range is  $\pm 10\%$ , the TRIM pin should be left open if this feature is not used.

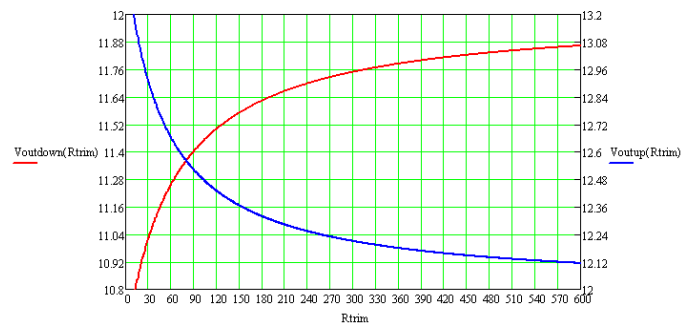
For 3.3V single output(Kohm):



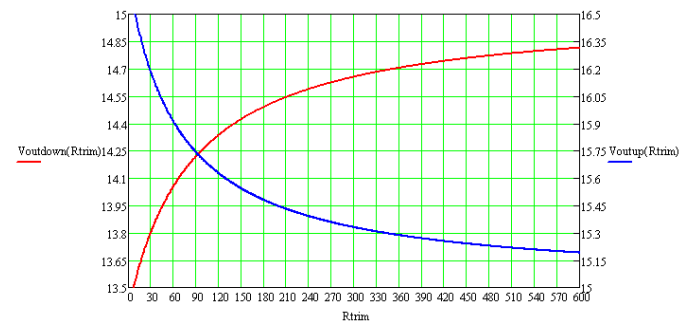
For 5V single output(Kohm):



For 12V single output(Kohm):



For 15V single output(Kohm):



For example:

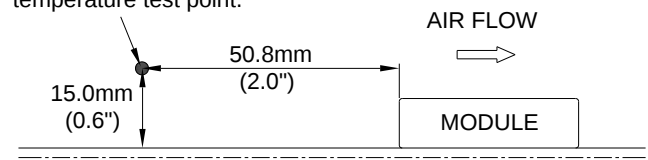
When need trim up to 3.4V, then the external resistor should be 100Kohm between trim pin and Vout- pin.

When need trim down to 3.1V, then the external resistor should be 40Kohm between trim pin and Vout+ pin.

### THERMAL CONSIDERATIONS

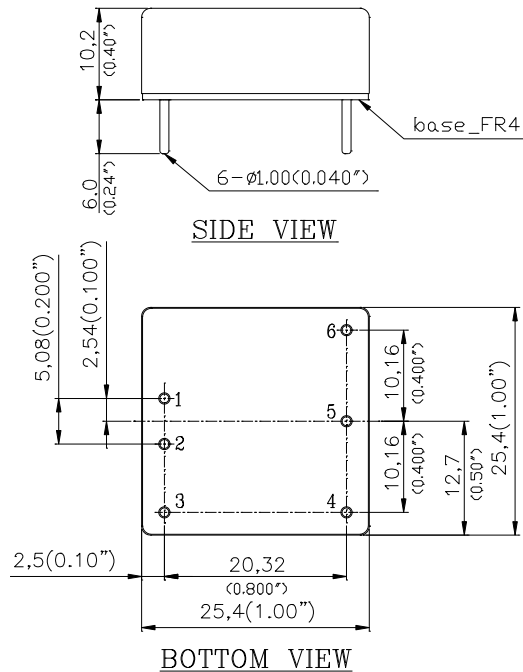
Heat can be removed by increasing airflow over the module. To enhance system reliability, the power module's case temperature should always be operated below 105°C. If the case temperature exceeds the maximum operating temperature, reliability of the unit may be affected.

Air velocity and ambient temperature test point.



### Mechanical Drawing

#### Mechanical Dimensions



#### Pin Connections

| Pin | Single Output Function | Dual Output Function |
|-----|------------------------|----------------------|
| 1   | Vin+                   | Vin+                 |
| 2   | Vin-                   | Vin-                 |
| 3   | On/off                 | On/off               |
| 4   | Vout-                  | Vout-                |
| 5   | Trim                   | Common               |
| 6   | Vout+                  | Vout+                |

#### Physical outline

Case Size: 25.4\*25.4\*9.5(1.0"\*1.0"\*0.38")

Case material: Al alloy, anodize black

Baseplate material: Non-conductive FR-4

Pin material: Brass; finish: Matte Tin plating and Nickel under plating

Pin length: refer part numbering system

Weight: 17.5 grams

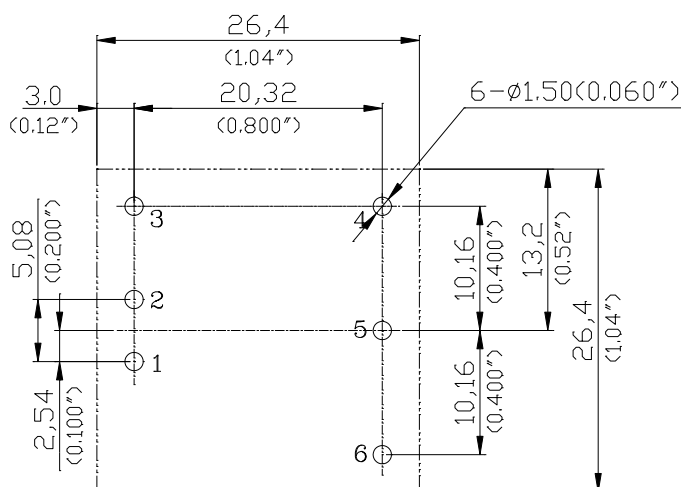
- All dimensions in mm (inches)
- Tolerance: X.X±0.5 (X.XX±0.02)  
X.XX±0.25 (X.XXX±0.010)
- Pins Diameter : ±0.10(±0.004)

#### Application notice:

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

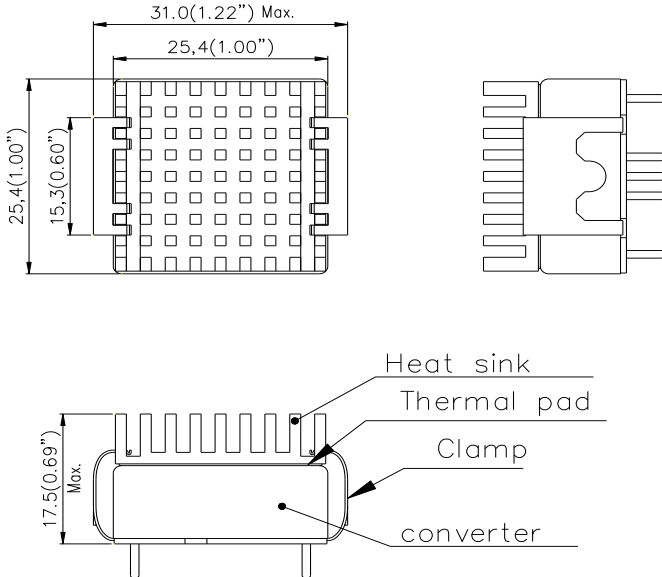
Recommended layout refer below

### RECOMMENDED LAYOUT



| PIN | Single  | Dual    |
|-----|---------|---------|
| 1   | Vin(+)  | Vin(+)  |
| 2   | Vin(-)  | Vin(-)  |
| 3   | ON/OFF  | ON/OFF  |
| 4   | Vout(-) | Vout(-) |
| 5   | Trim    | Comm    |
| 6   | Vout(+) | Vout(+) |

### Mechanical Drawing with heat sink(optional)

| Mechanical Dimensions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Physical Outline                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |           |  |                   |  |                       |  |                |   |       |  |                        |  |                        |   |             |  |                   |  |                                |   |                          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------|--|-------------------|--|-----------------------|--|----------------|---|-------|--|------------------------|--|------------------------|---|-------------|--|-------------------|--|--------------------------------|---|--------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                           | <table><tr><td>1</td><td>Heat sink</td></tr><tr><td></td><td>Material: Al-6063</td></tr><tr><td></td><td>Finish: anodize black</td></tr><tr><td></td><td>Weight: 4grams</td></tr><tr><td>2</td><td>Clamp</td></tr><tr><td></td><td>Material: spring steel</td></tr><tr><td></td><td>Finish: Nickel plating</td></tr><tr><td>3</td><td>Thermal pad</td></tr><tr><td></td><td>Material: Sil-pad</td></tr><tr><td></td><td>Thermal conductivity: 1.6W/m-K</td></tr><tr><td>4</td><td>Model weight: 22.5 grams</td></tr></table> <p>➤ All dimensions in mm (inches)</p> <p>➤ Tolerance: X.X±0.5 (X.XX±0.02)<br/>X.XX±0.25 ( X.XXX±0.010)</p> | 1 | Heat sink |  | Material: Al-6063 |  | Finish: anodize black |  | Weight: 4grams | 2 | Clamp |  | Material: spring steel |  | Finish: Nickel plating | 3 | Thermal pad |  | Material: Sil-pad |  | Thermal conductivity: 1.6W/m-K | 4 | Model weight: 22.5 grams |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Heat sink                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |           |  |                   |  |                       |  |                |   |       |  |                        |  |                        |   |             |  |                   |  |                                |   |                          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Material: Al-6063                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |           |  |                   |  |                       |  |                |   |       |  |                        |  |                        |   |             |  |                   |  |                                |   |                          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Finish: anodize black                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |           |  |                   |  |                       |  |                |   |       |  |                        |  |                        |   |             |  |                   |  |                                |   |                          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Weight: 4grams                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |           |  |                   |  |                       |  |                |   |       |  |                        |  |                        |   |             |  |                   |  |                                |   |                          |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Clamp                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |           |  |                   |  |                       |  |                |   |       |  |                        |  |                        |   |             |  |                   |  |                                |   |                          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Material: spring steel                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |           |  |                   |  |                       |  |                |   |       |  |                        |  |                        |   |             |  |                   |  |                                |   |                          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Finish: Nickel plating                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |           |  |                   |  |                       |  |                |   |       |  |                        |  |                        |   |             |  |                   |  |                                |   |                          |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Thermal pad                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |           |  |                   |  |                       |  |                |   |       |  |                        |  |                        |   |             |  |                   |  |                                |   |                          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Material: Sil-pad                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |           |  |                   |  |                       |  |                |   |       |  |                        |  |                        |   |             |  |                   |  |                                |   |                          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Thermal conductivity: 1.6W/m-K                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |           |  |                   |  |                       |  |                |   |       |  |                        |  |                        |   |             |  |                   |  |                                |   |                          |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Model weight: 22.5 grams                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |           |  |                   |  |                       |  |                |   |       |  |                        |  |                        |   |             |  |                   |  |                                |   |                          |
| <p>Note:</p> <ol style="list-style-type: none"><li>add heat sink to help heat dissipation and increase reliability of convert oprating at high ambient temperature</li><li>please refer derating curve while upgrate the operating temperature of converter</li><li>heat sink will be mounted for volume orders, separated heat sink only be supplied for prototype</li><li>for model with heat sink option, the recommended layout only need note the length more larger than without heat sink</li></ol> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |           |  |                   |  |                       |  |                |   |       |  |                        |  |                        |   |             |  |                   |  |                                |   |                          |

### Part Numbering System

| S           | 24            | S                      | E              | 050            | 06             | N            | D          | F                        | A                               |
|-------------|---------------|------------------------|----------------|----------------|----------------|--------------|------------|--------------------------|---------------------------------|
| Form factor | Input voltage | Number of output       | Product series | Output voltage | Output current | On/off logic | Pin length |                          | Option Code                     |
| S           | 24 – 9~36V    | S - Single<br>D - Dual | E - Series No. | 050 – 5.0V     | 06 - 6A        | N - Negative | D - 0.24"  | F - RoHS 6/6 (Lead Free) | A – Standard. (with metal case) |
|             |               |                        |                |                |                | P - Positive | T - 0.22"  |                          | H – With heat sink              |
|             |               |                        |                |                |                |              | R - 0.17"  |                          |                                 |

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