

**SERIES: PES1-M | DESCRIPTION: DC-DC CONVERTER**
**FEATURES**

- 1 W isolated output
- smaller package
- single/dual unregulated outputs
- 3,000 Vdc isolation
- short circuit protection
- extended temperature range (-40~105°C)
- antistatic protection up to 8kV
- UL 60950-1 approval
- high efficiency at light load
- efficiency up to 82%



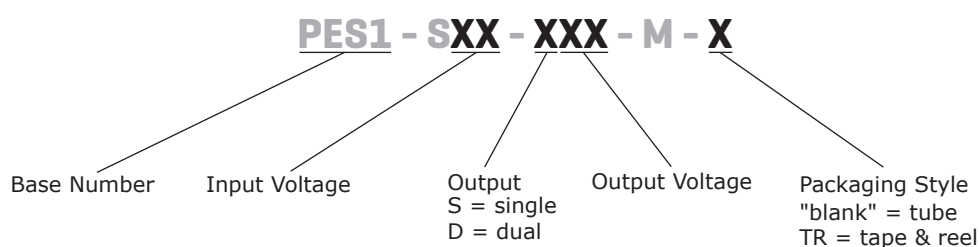
| MODEL                       | input voltage |             | output voltage<br>(Vdc) | output current |          | output power<br>max (W) | ripple and noise <sup>2</sup><br>typ (mVp-p) | efficiency<br>typ (%) |
|-----------------------------|---------------|-------------|-------------------------|----------------|----------|-------------------------|----------------------------------------------|-----------------------|
|                             | typ (Vdc)     | range (Vdc) |                         | min (mA)       | max (mA) |                         |                                              |                       |
| PES1-S3-S3-M                | 3.3           | 2.97~3.63   | 3.3                     | 30             | 303      | 1                       | 60                                           | 69                    |
| PES1-S3-S5-M <sup>1</sup>   | 3.3           | 2.97~3.63   | 5                       | 20             | 200      | 1                       | 60                                           | 74                    |
| PES1-S5-S3-M <sup>1</sup>   | 5             | 4.5~5.5     | 3.3                     | 30             | 303      | 1                       | 60                                           | 72                    |
| PES1-S5-S5-M <sup>1</sup>   | 5             | 4.5~5.5     | 5                       | 20             | 200      | 1                       | 60                                           | 80                    |
| PES1-S5-S9-M <sup>1</sup>   | 5             | 4.5~5.5     | 9                       | 12             | 111      | 1                       | 60                                           | 80                    |
| PES1-S5-S12-M <sup>1</sup>  | 5             | 4.5~5.5     | 12                      | 9              | 84       | 1                       | 60                                           | 80                    |
| PES1-S5-S15-M <sup>1</sup>  | 5             | 4.5~5.5     | 15                      | 7              | 67       | 1                       | 60                                           | 80                    |
| PES1-S5-S24-M <sup>1</sup>  | 5             | 4.5~5.5     | 24                      | 4              | 42       | 1                       | 60                                           | 80                    |
| PES1-S5-D5-M                | 5             | 4.5~5.5     | ±5                      | ±10            | ±100     | 1                       | 60                                           | 80                    |
| PES1-S5-D9-M                | 5             | 4.5~5.5     | ±9                      | ±6             | ±56      | 1                       | 60                                           | 80                    |
| PES1-S5-D12-M               | 5             | 4.5~5.5     | ±12                     | ±5             | ±42      | 1                       | 60                                           | 79                    |
| PES1-S5-D15-M               | 5             | 4.5~5.5     | ±15                     | ±3             | ±33      | 1                       | 60                                           | 81                    |
| PES1-S5-D24-M               | 5             | 4.5~5.5     | ±24                     | ±2             | ±21      | 1                       | 60                                           | 81                    |
| PES1-S12-S3-M <sup>1</sup>  | 12            | 10.8~13.2   | 3.3                     | 30             | 303      | 1                       | 60                                           | 72                    |
| PES1-S12-S5-M <sup>1</sup>  | 12            | 10.8~13.2   | 5                       | 20             | 200      | 1                       | 60                                           | 80                    |
| PES1-S12-S9-M <sup>1</sup>  | 12            | 10.8~13.2   | 9                       | 12             | 111      | 1                       | 60                                           | 80                    |
| PES1-S12-S12-M <sup>1</sup> | 12            | 10.8~13.2   | 12                      | 9              | 84       | 1                       | 60                                           | 80                    |
| PES1-S12-S15-M <sup>1</sup> | 12            | 10.8~13.2   | 15                      | 7              | 67       | 1                       | 60                                           | 80                    |
| PES1-S12-D5-M               | 12            | 10.8~13.2   | ±5                      | ±10            | ±100     | 1                       | 60                                           | 80                    |
| PES1-S12-D9-M               | 12            | 10.8~13.2   | ±9                      | ±6             | ±56      | 1                       | 60                                           | 80                    |
| PES1-S12-D12-M              | 12            | 10.8~13.2   | ±12                     | ±5             | ±42      | 1                       | 60                                           | 81                    |
| PES1-S12-D15-M              | 12            | 10.8~13.2   | ±15                     | ±3             | ±33      | 1                       | 60                                           | 81                    |
| PES1-S12-D24-M              | 12            | 10.8~13.2   | ±24                     | ±2             | ±21      | 1                       | 60                                           | 81                    |
| PES1-S15-S15-M              | 15            | 13.5~16.5   | 15                      | 7              | 67       | 1                       | 60                                           | 80                    |
| PES1-S24-S5-M <sup>1</sup>  | 24            | 21.6~26.4   | 5                       | 20             | 200      | 1                       | 60                                           | 80                    |
| PES1-S24-S9-M <sup>1</sup>  | 24            | 21.6~26.4   | 9                       | 12             | 111      | 1                       | 60                                           | 80                    |
| PES1-S24-S15-M <sup>1</sup> | 24            | 21.6~26.4   | 15                      | 7              | 67       | 1                       | 60                                           | 80                    |

Notes: 1. UL approved  
2. Ripple and noise are measured at 20 MHz BW by "parallel cable" method with 1  $\mu$ F ceramic and 10  $\mu$ F electrolytic capacitors on the output.

**MODEL  
(CONTINUED)**

|                             | input voltage |                | output voltage<br>(Vdc) | output current |             | output power<br>max<br>(W) | ripple and noise <sup>2</sup><br>typ<br>(mVp-p) | efficiency<br>typ<br>(%) |
|-----------------------------|---------------|----------------|-------------------------|----------------|-------------|----------------------------|-------------------------------------------------|--------------------------|
|                             | typ<br>(Vdc)  | range<br>(Vdc) |                         | min<br>(mA)    | max<br>(mA) |                            |                                                 |                          |
| PES1-S24-S24-M <sup>1</sup> | 24            | 21.6~26.4      | 24                      | 4              | 42          | 1                          | 60                                              | 80                       |
| PES1-S24-D5-M               | 24            | 21.6~26.4      | ±5                      | ±10            | ±100        | 1                          | 60                                              | 80                       |
| PES1-S24-D9-M               | 24            | 21.6~26.4      | ±9                      | ±6             | ±56         | 1                          | 60                                              | 80                       |
| PES1-S24-D12-M              | 24            | 21.6~26.4      | ±12                     | ±5             | ±42         | 1                          | 60                                              | 81                       |
| PES1-S24-D15-M              | 24            | 21.6~26.4      | ±15                     | ±3             | ±33         | 1                          | 60                                              | 82                       |
| PES1-S24-D24-M              | 24            | 21.6~26.4      | ±24                     | ±2             | ±21         | 1                          | 60                                              | 76                       |

Notes: 1. UL approved  
2. Ripple and noise are measured at 20 MHz BW by "parallel cable" method with 1 µF ceramic and 10 µF electrolytic capacitors on the output.

**PART NUMBER KEY****INPUT**

| parameter               | conditions/description  | min  | typ | max  | units |
|-------------------------|-------------------------|------|-----|------|-------|
| operating input voltage | 3.3 Vdc input models    | 2.97 | 3.3 | 3.63 | Vdc   |
|                         | 5 Vdc input models      | 4.5  | 5   | 5.5  | Vdc   |
|                         | 12 Vdc input models     | 10.8 | 12  | 13.2 | Vdc   |
|                         | 15 Vdc input models     | 13.5 | 15  | 16.5 | Vdc   |
|                         | 24 Vdc input models     | 21.6 | 24  | 26.4 | Vdc   |
| surge voltage           | for maximum of 1 second |      |     |      |       |
|                         | 3.3 Vdc input models    | -0.7 |     | 5    | Vdc   |
|                         | 5 Vdc input models      | -0.7 |     | 9    | Vdc   |
|                         | 12 Vdc input models     | -0.7 |     | 18   | Vdc   |
|                         | 15 Vdc input models     | -0.7 |     | 21   | Vdc   |
|                         | 24 Vdc input models     | -0.7 |     | 30   | Vdc   |
| filter                  | capacitance filter      |      |     |      |       |

**OUTPUT**

| parameter               | conditions/description              | min | typ | max   | units |
|-------------------------|-------------------------------------|-----|-----|-------|-------|
| line regulation         | for Vin change of 1%                |     |     |       |       |
|                         | 3.3 Vdc output models               |     |     | ±1.5  | %     |
|                         | all other models                    |     |     | ±1.2  | %     |
| load regulation         | measured from 10% load to full load |     |     |       |       |
|                         | 3.3 Vdc output models               |     | 18  |       | %     |
|                         | 5 Vdc output models                 |     | 12  |       | %     |
|                         | 9 Vdc output models                 |     | 9   |       | %     |
|                         | 12 Vdc output models                |     | 8   |       | %     |
|                         | 15 Vdc output models                |     | 7   |       | %     |
|                         | 24 Vdc output models                |     | 6   |       | %     |
| voltage accuracy        | see tolerance envelope curve        |     |     |       |       |
| switching frequency     | 100% load, nominal input voltage    |     | 100 |       | kHz   |
| temperature coefficient | 100% load                           |     |     | ±0.03 | %/°C  |

## PROTECTIONS

| parameter                             | conditions/description                                                          | min | typ | max | units |
|---------------------------------------|---------------------------------------------------------------------------------|-----|-----|-----|-------|
| short circuit protection <sup>1</sup> | PES1-S5-S/D24-M and 24 Vdc input models<br>all other models: automatic recovery |     |     | 1   | s     |

Note: 1. The supply voltage must be discontinued at the end of the short circuit duration

## SAFETY AND COMPLIANCE

| parameter                     | conditions/description                                                                                                 | min       | typ | max | units |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------|-----------|-----|-----|-------|
| isolation voltage             | input to output for 1 minute at 1 mA max.                                                                              | 3,000     |     |     | Vdc   |
| isolation resistance          | input to output at 500 Vdc                                                                                             | 1,000     |     |     | MΩ    |
| safety approvals <sup>2</sup> | UL 60950-1                                                                                                             |           |     |     |       |
| conducted emissions           | CISPR22/EN55022 class B (external circuit required, see Figure 1)                                                      |           |     |     |       |
| radiated emissions            | CISPR22/EN55022 class B (external circuit required, see Figure 1)                                                      |           |     |     |       |
| ESD                           | IEC/EN61000-4-2, class B, contact ± 8kV for single outputs<br>IEC/EN61000-4-2, class B, contact ± 6kV for dual outputs |           |     |     |       |
| MTBF                          | as per MIL-HDBK-217F @ 25°C                                                                                            | 3,500,000 |     |     | hours |
| RoHS                          | 2011/65/EU                                                                                                             |           |     |     |       |

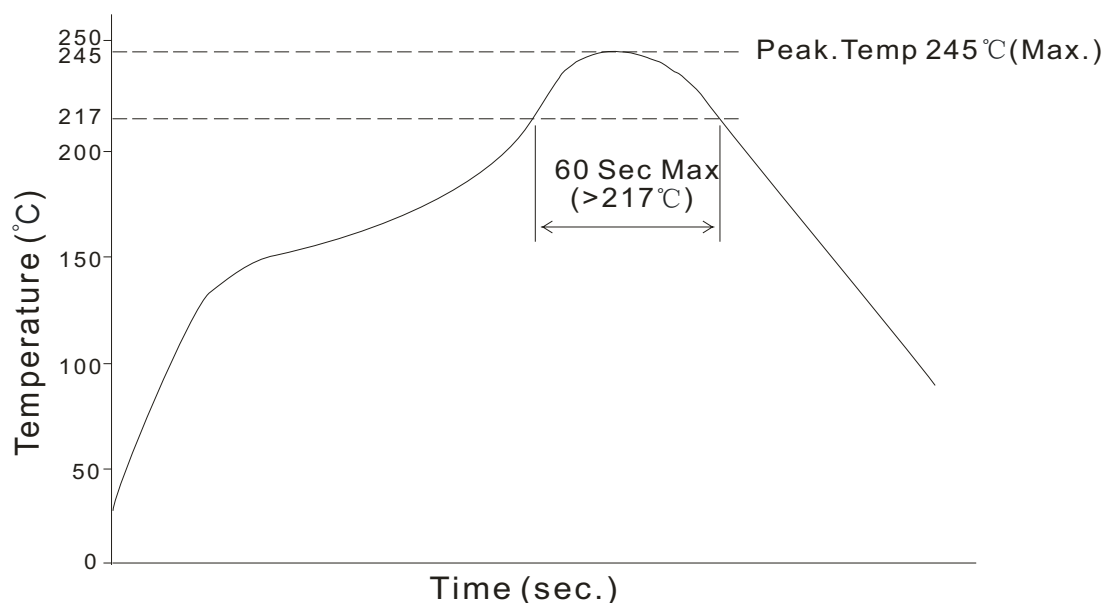
Note: 2. See specific models noted on page 1 & 2.

## ENVIRONMENTAL

| parameter             | conditions/description  | min | typ | max | units |
|-----------------------|-------------------------|-----|-----|-----|-------|
| operating temperature | see derating curve      | -40 |     | 105 | °C    |
| storage temperature   |                         | -55 |     | 125 | °C    |
| storage humidity      | non-condensing          |     |     | 95  | %     |
| temperature rise      | at full load, Ta = 25°C |     | 25  |     | °C    |

## SOLDERABILITY

| parameter        | conditions/description          | min | typ | max | units |
|------------------|---------------------------------|-----|-----|-----|-------|
| hand soldering   | 1.5 mm from case for 10 seconds |     |     | 300 | °C    |
| reflow soldering | see reflow soldering profile    |     |     | 245 | °C    |



## MECHANICAL

| parameter     | conditions/description                                                               | min | typ        | max | units    |
|---------------|--------------------------------------------------------------------------------------|-----|------------|-----|----------|
| dimensions    | single output models: 12.70 x 8.30 x 7.25<br>dual output models: 15.24 x 8.30 x 7.25 |     |            |     | mm<br>mm |
| case material | epoxy resin (UL94-V0)                                                                |     |            |     |          |
| weight        | single output models<br>dual output models                                           |     | 1.6<br>2.0 |     | g<br>g   |

## MECHANICAL DRAWING

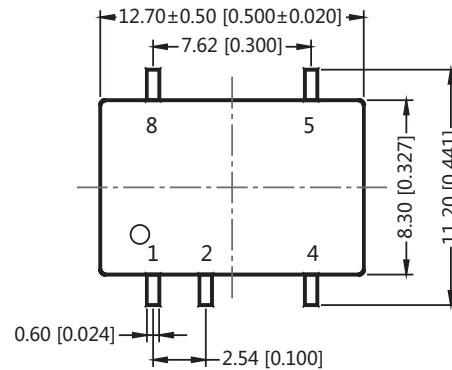
### SINGLE OUTPUT MODELS

units: mm[inch]

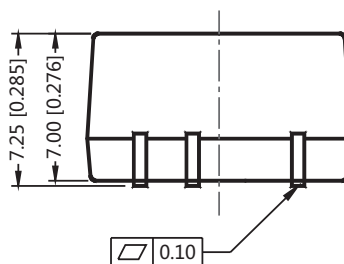
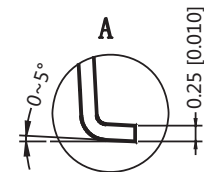
tolerance:  $\pm 0.25$  [ $\pm 0.010$ ]pin section tolerance:  $\pm 0.10$  [ $\pm 0.004$ ]

| PIN CONNECTIONS |          |
|-----------------|----------|
| PIN             | Function |
| 1               | GND      |
| 2               | Vin      |
| 4               | 0V       |
| 5               | +Vo      |
| 8               | NC       |

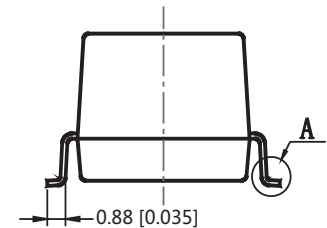
NC: No Connection



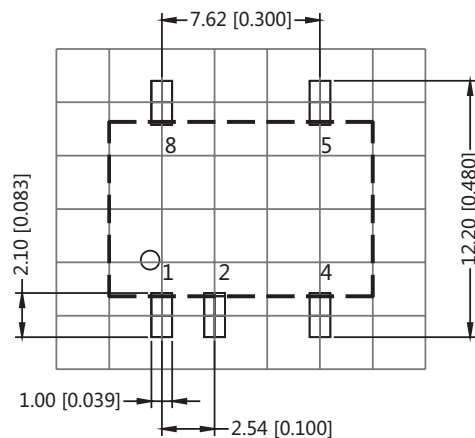
Top View



Front View



Right View



Note: Grid 2.54\*2.54mm

Top View

## MECHANICAL DRAWING (CONTINUED)

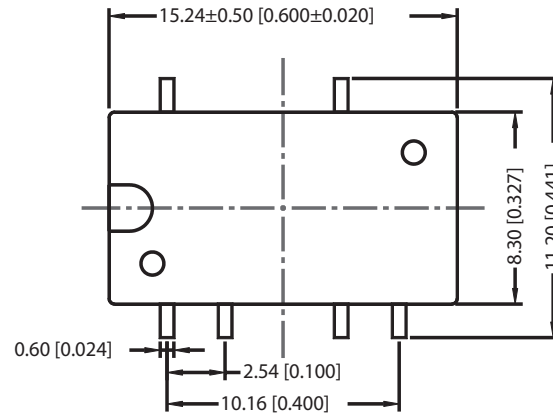
### DUAL OUTPUT MODELS

units: mm[inch]

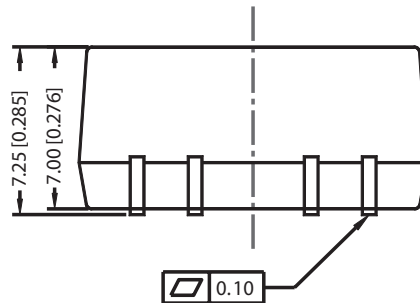
tolerance:  $\pm 0.25[\pm 0.010]$ pin section tolerance:  $\pm 0.10[\pm 0.004]$ 

| PIN CONNECTIONS |                 |
|-----------------|-----------------|
| PIN             | Function        |
| 1               | GND             |
| 2               | V <sub>in</sub> |
| 4               | 0V              |
| 5               | -V <sub>o</sub> |
| 7               | +V <sub>o</sub> |
| 10              | NC              |

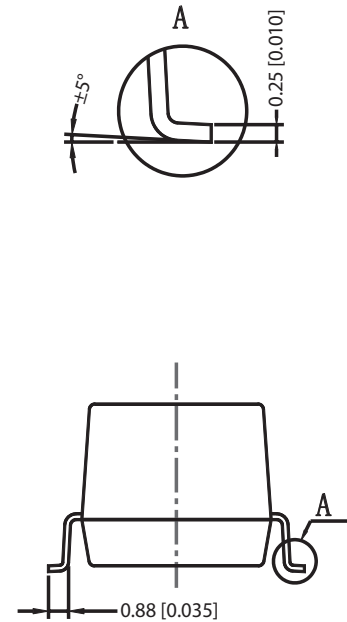
NC: No Connection



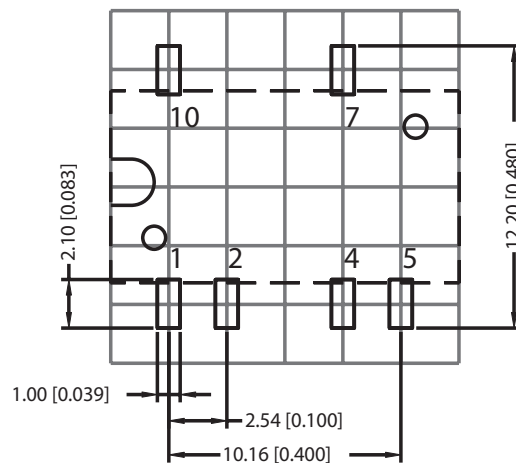
Top View



Front View



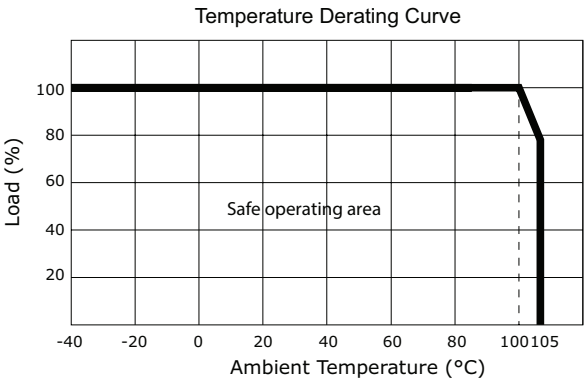
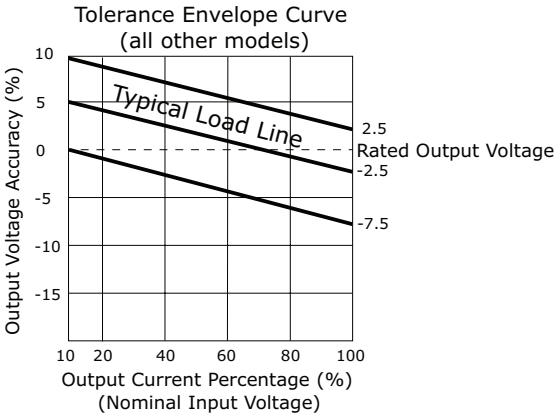
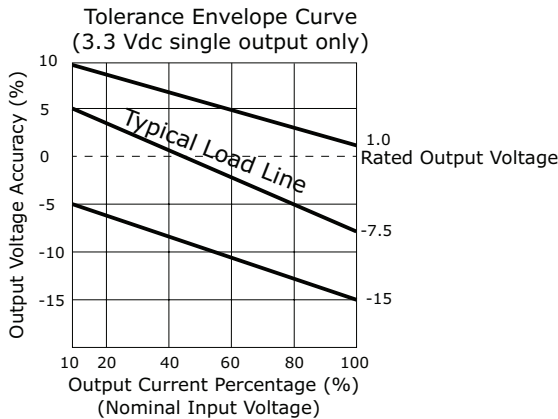
Right View



Note : Grid 2.54\*2.54mm

Top View

DERATING CURVES



EMC RECOMMENDED CIRCUIT

Figure 1

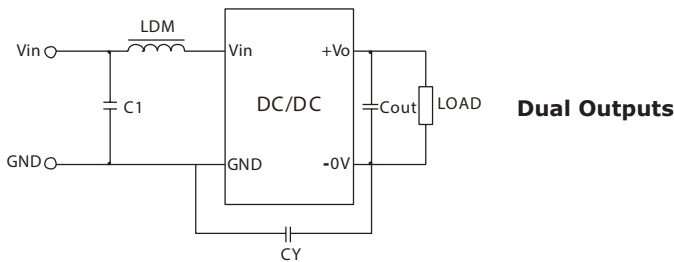
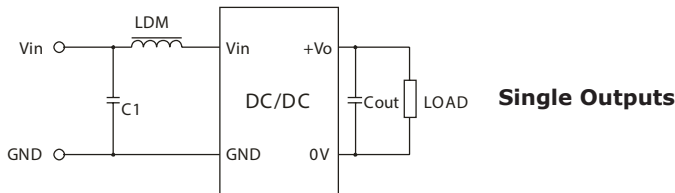


Table 1

| Recommended external circuit components |           |       |
|-----------------------------------------|-----------|-------|
| Vin (Vdc)                               | C1        | LDM   |
| 3.3                                     | 4.7μF/50V | 6.8μH |
| 5                                       | 4.7μF/50V | 6.8μH |
| 12                                      | 4.7μF/50V | 6.8μH |
| 15                                      | 4.7μF/50V | 6.8μH |
| 24                                      | 4.7μF/50V | 6.8μH |

Note: 1. See Table 2 for Cout values.  
2. CY: 1nF/3kV for 24 Vdc input dual output models, PES1-S5-D24-M, and PES1-S12-D24-M only

## APPLICATION NOTES

### 1. Output load requirement

To ensure this module can operate efficiently and reliably, the minimum output load may not be less than 10% of the full load during operation. If the actual output power is low, connect a resistor at the output end in parallel to increase the load.

### 2. Overload Protection

Under normal operating conditions, the output circuit of this product has no protection against overload. The simplest method to add this is to add a circuit breaker to the circuit.

### 3. Recommended circuit

If you want to further decrease the input/output ripple, you can increase the capacitance accordingly or choose capacitors with low ESR(see Figure 2 & Table 2). However, the capacitance of the output filter capacitor must be appropriate. If the capacitance is too high, a startup problem might arise. For every channel of the output, to ensure safe and reliable operation, the maximum capacitance must be less than the maximum capacitive load (see Table 3).

Figure 2

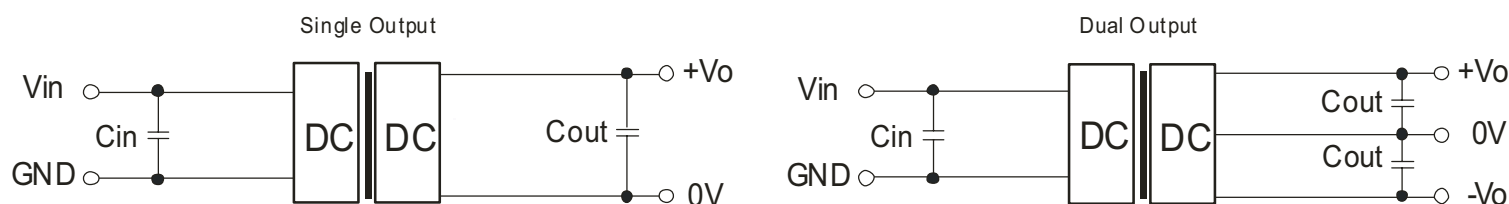


Table 2

| Vin (Vdc) | Cin (μF) | Single Vo (Vdc) | Cout (μF) | Dual Vo (Vdc) | Cout (μF) |
|-----------|----------|-----------------|-----------|---------------|-----------|
| 3.3       | 4.7      | 3.3             | 10        | --            | --        |
| 5         | 4.7      | 5               | 10        | ±5            | 4.7       |
| --        | --       | 9               | 4.7       | ±9            | 2.2       |
| 12        | 2.2      | 12              | 2.2       | ±12           | 1         |
| 15        | 2.2      | 15              | 1         | ±15           | 1         |
| 24        | 1        | 24              | 0.47      | ±24           | 0.47      |

Table 3

| Single Vout (Vdc) | Max. Capacitive Load (μF) | Dual Vout (Vdc) | Max. Capacitive Load <sup>1</sup> (μF) |
|-------------------|---------------------------|-----------------|----------------------------------------|
| 3.3               | 220                       | --              | --                                     |
| 5                 | 220                       | 5               | 100                                    |
| 9                 | 220                       | 9               | 100                                    |
| 12                | 220                       | 12              | 100                                    |
| 15                | 220                       | 15              | 100                                    |
| 24                | 220                       | 24              | 100                                    |

Note: 1. For each output.

Note: 1. Operation under minimum load will not damage the converter; however, they may not meet all specifications listed.

2. Max. capacitive load tested at input voltage range and full load.

3. It is recommended to use either ceramic capacitors or electrolytic capacitors on the input and the output. Using tantalum capacitors may increase the risk of failure.

4. All specifications measured at: Ta=25°C, humidity<75%, nominal input voltage and rated output load, unless otherwise specified.

## REVISION HISTORY

| rev. | description                       | date       |
|------|-----------------------------------|------------|
| 1.0  | initial release                   | 03/19/2013 |
| 1.01 | added models, updated spec        | 04/04/2014 |
| 1.02 | added UL approval to some models  | 10/21/2014 |
| 1.03 | updated tolerance envelope curves | 06/26/2015 |

The revision history provided is for informational purposes only and is believed to be accurate.



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