

**SERIES:** PEM1-S | **DESCRIPTION:** DC-DC CONVERTER**FEATURES**

- 1 W isolated output
- smaller package
- single/dual unregulated output
- 3,000 Vdc isolation
- short circuit protection
- extended temperature range (-40~105°C)
- antistatic protection up to 8kV
- high efficiency at light load
- efficiency up to 81%
- EN 62368-1



| MODEL                       | 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) |                            |   |                          |
| PEM1-S3-S3-S                | 3.3           | 2.97~3.63      | 3.3                     | 30             | 303         | 1                          | 60  | 73                       |
| PEM1-S3-S5-S                | 3.3           | 2.97~3.63      | 5                       | 20             | 200         | 1                          | 60  | 78                       |
| PEM1-S5-S3-S                | 5             | 4.5~5.5        | 3.3                     | 30             | 303         | 1                          | 60  | 73                       |
| PEM1-S5-S5-S <sup>1</sup>   | 5             | 4.5~5.5        | 5                       | 20             | 200         | 1                          | 60  | 80                       |
| PEM1-S5-S12-S <sup>1</sup>  | 5             | 4.5~5.5        | 12                      | 9              | 83          | 1                          | 60  | 80                       |
| PEM1-S5-S15-S <sup>1</sup>  | 5             | 4.5~5.5        | 15                      | 7              | 67          | 1                          | 60  | 81                       |
| PEM1-S5-S24-S <sup>1</sup>  | 5             | 4.5~5.5        | 24                      | 5              | 42          | 1                          | 60  | 81                       |
| PEM1-S5-D3-S                | 5             | 4.5~5.5        | ±3.3                    | ±15            | ±152        | 1                          | 60  | 73                       |
| PEM1-S5-D5-S <sup>1</sup>   | 5             | 4.5~5.5        | ±5                      | ±10            | ±100        | 1                          | 60  | 80                       |
| PEM1-S5-D12-S <sup>1</sup>  | 5             | 4.5~5.5        | ±12                     | ±5             | ±42         | 1                          | 60  | 80                       |
| PEM1-S5-D15-S <sup>1</sup>  | 5             | 4.5~5.5        | ±15                     | ±4             | ±33         | 1                          | 60  | 81                       |
| PEM1-S5-D24-S <sup>1</sup>  | 5             | 4.5~5.5        | ±24                     | ±2             | ±21         | 1                          | 60  | 81                       |
| PEM1-S12-S3-S               | 12            | 10.8~13.2      | 3.3                     | 30             | 303         | 1                          | 60  | 75                       |
| PEM1-S12-S5-S <sup>1</sup>  | 12            | 10.8~13.2      | 5                       | 20             | 200         | 1                          | 60  | 80                       |
| PEM1-S12-S12-S <sup>1</sup> | 12            | 10.8~13.2      | 12                      | 9              | 83          | 1                          | 60  | 80                       |
| PEM1-S12-S15-S <sup>1</sup> | 12            | 10.8~13.2      | 15                      | 7              | 67          | 1                          | 60  | 81                       |
| PEM1-S12-D3-S               | 12            | 10.8~13.2      | ±3.3                    | ±15            | ±152        | 1                          | 60  | 74                       |
| PEM1-S12-D5-S <sup>1</sup>  | 12            | 10.8~13.2      | ±5                      | ±10            | ±100        | 1                          | 60  | 80                       |
| PEM1-S12-D12-S <sup>1</sup> | 12            | 10.8~13.2      | ±12                     | ±5             | ±42         | 1                          | 60  | 81                       |
| PEM1-S12-D15-S <sup>1</sup> | 12            | 10.8~13.2      | ±15                     | ±4             | ±33         | 1                          | 60  | 81                       |
| PEM1-S15-S5-S               | 15            | 13.5~16.5      | 5                       | 20             | 200         | 1                          | 60  | 80                       |
| PEM1-S15-S12-S              | 15            | 13.5~16.5      | 12                      | 9              | 83          | 1                          | 60  | 80                       |
| PEM1-S15-S15-S              | 15            | 13.5~16.5      | 15                      | 7              | 67          | 1                          | 60  | 81                       |
| PEM1-S15-D5-S               | 15            | 13.5~16.5      | ±5                      | ±10            | ±100        | 1                          | 60  | 80                       |
| PEM1-S15-D15-S              | 15            | 13.5~16.5      | ±15                     | ±4             | ±33         | 1                          | 60  | 81                       |
| PEM1-S24-S3-S               | 24            | 21.6~26.4      | 3.3                     | 30             | 303         | 1                          | 60  | 75                       |
| PEM1-S24-S5-S <sup>1</sup>  | 24            | 21.6~26.4      | 5                       | 20             | 200         | 1                          | 60  | 79                       |

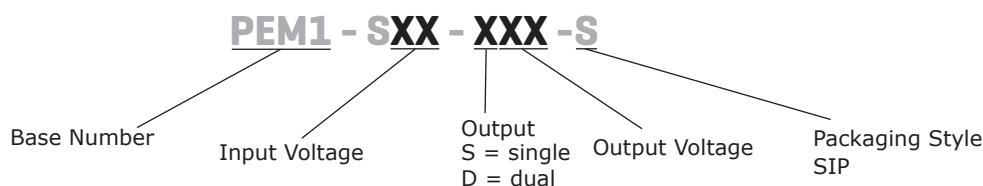
Notes: 1. UL approved  
 2. Ripple and noise are measured at 20 MHz BW by "parallel cable" method with 1 µF ceramic and 10 µF electrolytic capacitors on the output.

**MODEL  
(CONTINUED)**

|                             | input voltage |             | output voltage | output current |          | output power | ripple and noise <sup>2</sup> | efficiency |
|-----------------------------|---------------|-------------|----------------|----------------|----------|--------------|-------------------------------|------------|
|                             | typ (Vdc)     | range (Vdc) | (Vdc)          | min (mA)       | max (mA) | max (W)      | typ (mVp-p)                   | typ (%)    |
| PEM1-S24-S12-S <sup>1</sup> | 24            | 21.6~26.4   | 12             | 9              | 83       | 1            | 60                            | 81         |
| PEM1-S24-S15-S <sup>1</sup> | 24            | 21.6~26.4   | 15             | 7              | 67       | 1            | 60                            | 81         |
| PEM1-S24-S24-S <sup>1</sup> | 24            | 21.6~26.4   | 24             | 5              | 42       | 1            | 60                            | 81         |
| PEM1-S24-D3-S               | 24            | 21.6~26.4   | ±3.3           | ±15            | ±152     | 1            | 60                            | 73         |
| PEM1-S24-D5-S <sup>1</sup>  | 24            | 21.6~26.4   | ±5             | ±10            | ±100     | 1            | 60                            | 80         |
| PEM1-S24-D12-S <sup>1</sup> | 24            | 21.6~26.4   | ±12            | ±5             | ±42      | 1            | 60                            | 81         |
| PEM1-S24-D15-S <sup>1</sup> | 24            | 21.6~26.4   | ±15            | ±4             | ±33      | 1            | 60                            | 79         |
| PEM1-S24-D24-S <sup>1</sup> | 24            | 21.6~26.4   | ±24            | ±2             | ±21      | 1            | 60                            | 80         |

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         | measure from 10% load to full load  |     |      |       |       |
|                         | 3.3 Vdc input models                |     | 18   |       | %     |
|                         | 5 Vdc input models                  |     | 12   |       | %     |
|                         | 12 Vdc input models                 |     | 8    |       | %     |
|                         | 15 Vdc input models                 |     | 7    |       | %     |
|                         | 24 Vdc input models                 |     | 6    |       | %     |
| voltage accuracy        | see tolerance envelope curve        |     |      |       |       |
| voltage balance         | dual output, balanced loads         |     | ±0.5 | ±1    | %     |
| switching frequency     | at full load, nominal input voltage |     | 100  |       | kHz   |
| temperature coefficient | at full load                        |     |      | ±0.03 | %/°C  |

## PROTECTIONS

| parameter                             | conditions/description | min | typ | max | units |
|---------------------------------------|------------------------|-----|-----|-----|-------|
| short circuit protection <sup>1</sup> |                        |     |     | 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, 1 mA max. leakage current  | 3,000     |     |     | Vdc   |
| isolation resistance          | input to output at 500 Vdc   | 1,000     |     |     | MΩ    |
| isolation capacitance         | input to output, 100KHz, 0.1V  |           | 20  |     | pF    |
| safety approvals <sup>2</sup> | certified to 62368-1: EN<br>certified to 60950-1: UL   |           |     |     |       |
| 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 pages 1 & 2.

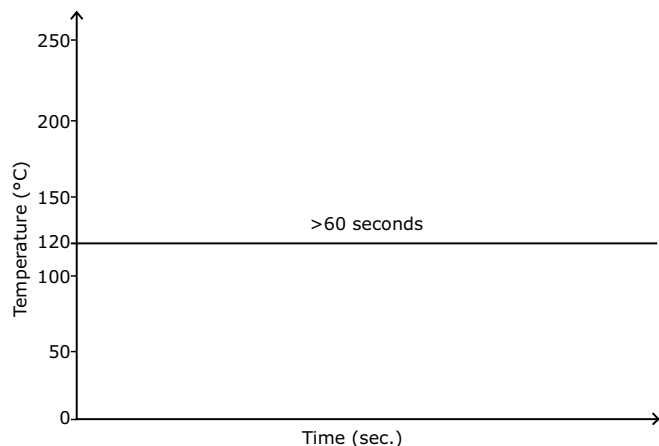
## ENVIRONMENTAL

| 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 Ta = 25°C           |     | 25  |     | °C    |

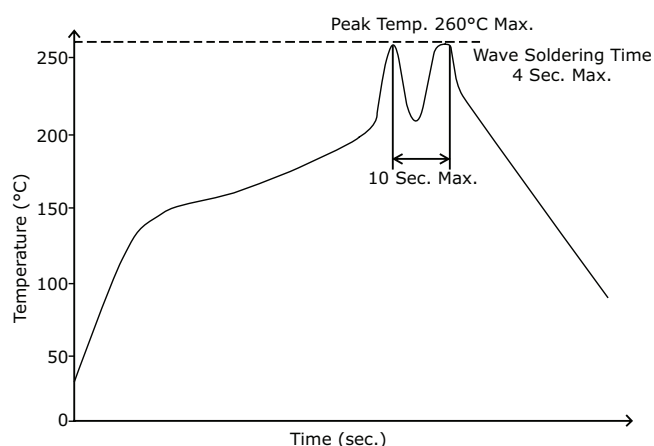
## SOLDERABILITY

| parameter                   | conditions/description          | min | typ | max | units |
|-----------------------------|---------------------------------|-----|-----|-----|-------|
| hand soldering              | 1.5 mm from case for 10 seconds |     |     | 300 | °C    |
| wave soldering <sup>3</sup> | see wave soldering profile      |     |     | 260 | °C    |

Notes: 3. Preheat conditions: At 120°C for over 1 minute.



**Preheat Profile**



**Wave Soldering Profile**

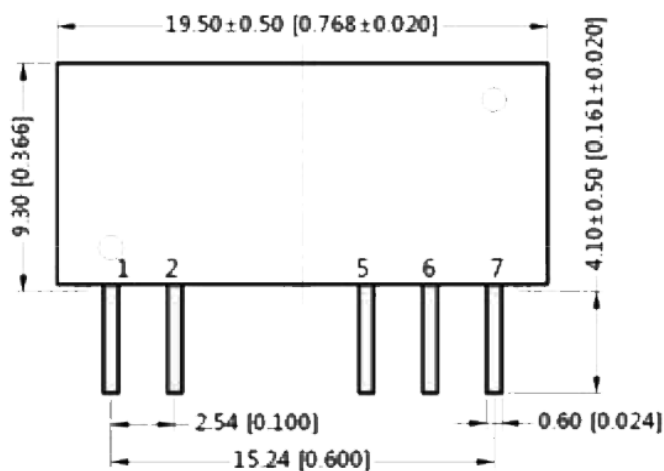
## MECHANICAL

| parameter     | conditions/description                           | min | typ | max | units |
|---------------|--|-----|-----|-----|-------|
| dimensions    | 19.50 x 6.00 x 9.30 (0.768 x 0.236 x 0.366 inch) |     |     |     | mm    |
| case material | epoxy resin (UL94-V0)                            |     |     |     |       |
| weight        |  |     | 2.4 |     | g     |

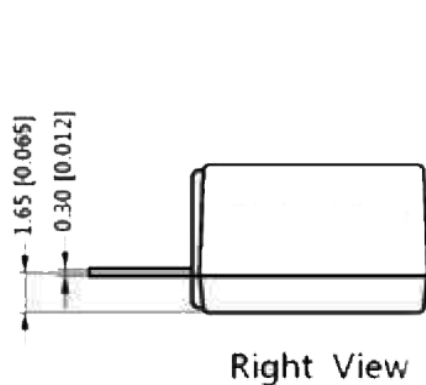
## MECHANICAL DRAWING

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

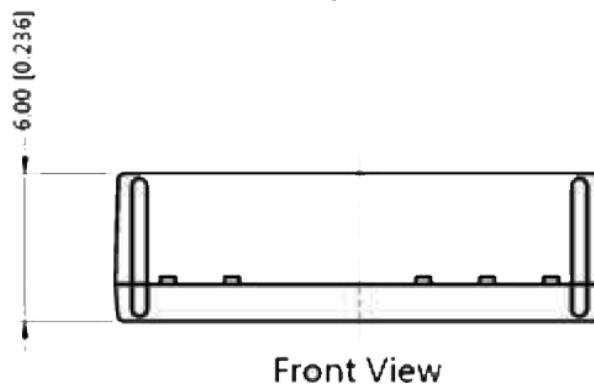
| PIN CONNECTIONS |               |             |
|-----------------|---------------|-------------|
| PIN             | Single Output | Dual Output |
| 1               | Vin           | Vin         |
| 2               | GND           | GND         |
| 5               | 0V            | -Vo         |
| 6               | No Pin        | 0V          |
| 7               | +Vo           | +Vo         |



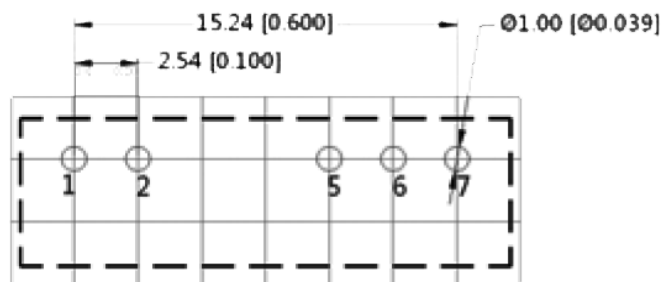
Top View



Right View

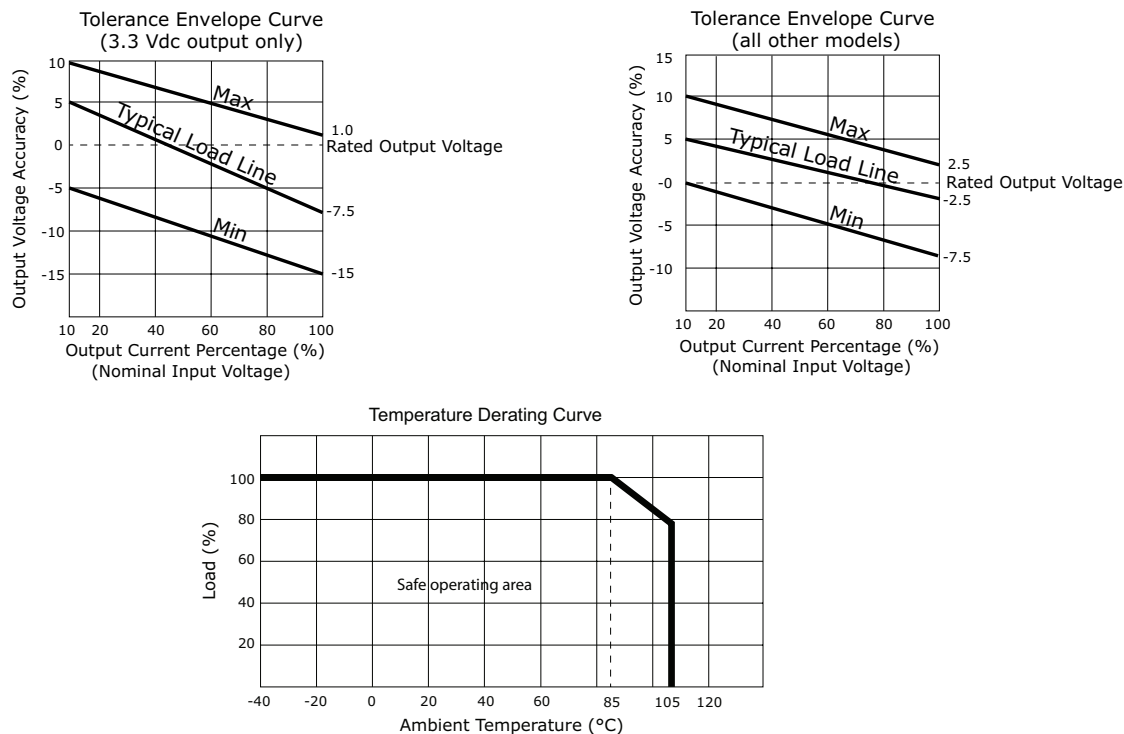


Front View

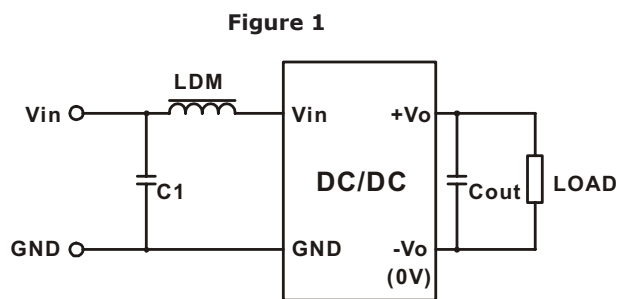


Note: Grid 2.54\*2.54mm

## DERATING CURVES



## EMC RECOMMENDED CIRCUIT



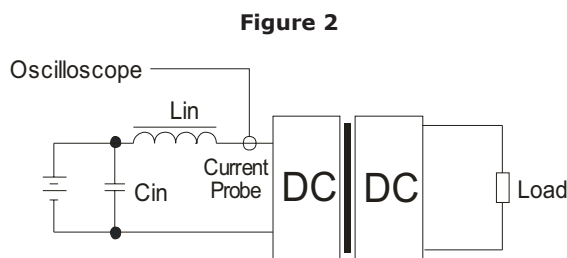
**Table 1**

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 3 for Cout values.

## TEST CONFIGURATION



**Table 2**

External components

|     |                              |
|-----|------------------------------|
| Lin | 4.7μH                        |
| Cin | 220μF, ESR < 1.0Ω at 100 kHz |

Note: Input reflected-ripple current is measured with an inductor Lin and Capacitor Cin to simulate source impedance.

## 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 3 & Table 3). 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 4).

Figure 3

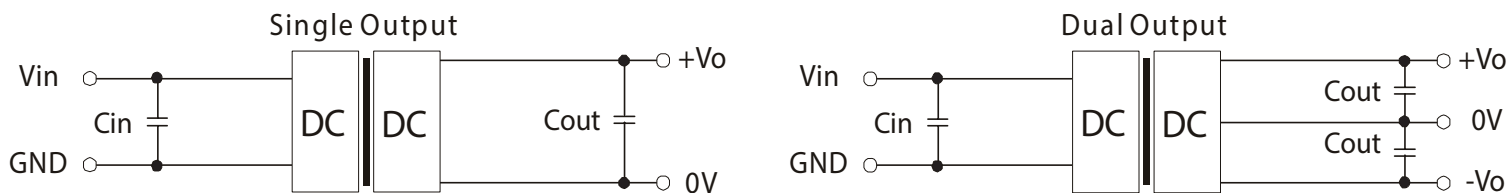


Table 3

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

Note: It's not recommended to connect any external capacitors in applications with less than 0.5 watt output.

Table 4

| Single Vout (Vdc) | Max. Capacitive Load (μF) | Dual Vout (Vdc) | Max. Capacitive Load <sup>1</sup> (μF) |
|-------------------|---------------------------|-----------------|--|
| 3.3               | 220                       | 3.3             | 100                                    |
| 5                 | 220                       | 5               | 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 model PEM1-S15-S12-S   | 07/29/2013 |
| 1.02 | added new models   | 02/14/2014 |
| 1.03 | added UL approval to some models                                     | 09/16/2014 |
| 1.04 | added UL approval to some models                                     | 01/14/2015 |
| 1.05 | updated tolerance envelope curves                                    | 02/10/2016 |
| 1.06 | added wave soldering preheat conditions, updated emc recommendations | 12/04/2017 |
| 1.07 | safeties updated in features and safety line                         | 01/18/2021 |

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



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