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
- UL 60950-1 approval
- high efficiency at light load
- efficiency up to 81%

MODEL

<table>
<thead>
<tr>
<th>MODEL</th>
<th>input voltage</th>
<th>output voltage</th>
<th>output current</th>
<th>output power</th>
<th>ripple and noise</th>
<th>efficiency</th>
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</thead>
<tbody>
<tr>
<td>PEM1-S3-S3-S</td>
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<td>3.3</td>
<td>30</td>
<td>303</td>
<td>1</td>
<td>60</td>
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<td>3.3</td>
<td>5</td>
<td>20</td>
<td>200</td>
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<td>PEM1-S5-S3-S</td>
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<td>4.5~5.5</td>
<td>30</td>
<td>303</td>
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<td>60</td>
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<tr>
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<td>60</td>
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<tr>
<td>PEM1-S5-15-S</td>
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<td>7</td>
<td>67</td>
<td>60</td>
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<td>60</td>
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<tr>
<td>PEM1-S5-24-S</td>
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<td>5</td>
<td>42</td>
<td>60</td>
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<td>60</td>
</tr>
<tr>
<td>PEM1-S5-D3-S</td>
<td>5</td>
<td>4.5~5.5</td>
<td>±3.3</td>
<td>±15</td>
<td>±152</td>
<td>1</td>
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<td>PEM1-S5-D5-S</td>
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<td>±5</td>
<td>±10</td>
<td>±100</td>
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<td>PEM1-S5-D12-S</td>
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<td>4.5~5.5</td>
<td>±12</td>
<td>±5</td>
<td>±42</td>
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</tr>
<tr>
<td>PEM1-S5-D15-S</td>
<td>5</td>
<td>4.5~5.5</td>
<td>±15</td>
<td>±4</td>
<td>±33</td>
<td>1</td>
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<td>4.5~5.5</td>
<td>±24</td>
<td>±2</td>
<td>±21</td>
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</tr>
<tr>
<td>PEM1-S12-S3-S</td>
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<td>10.8~13.2</td>
<td>30</td>
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<td>60</td>
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<tr>
<td>PEM1-S12-S5-S</td>
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<td>10.8~13.2</td>
<td>5</td>
<td>200</td>
<td>1</td>
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<tr>
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<td>10.8~13.2</td>
<td>9</td>
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<td>60</td>
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<tr>
<td>PEM1-S12-15-S</td>
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<td>10.8~13.2</td>
<td>15</td>
<td>67</td>
<td>1</td>
<td>60</td>
</tr>
<tr>
<td>PEM1-S12-D3-S</td>
<td>12</td>
<td>10.8~13.2</td>
<td>±3.3</td>
<td>±15</td>
<td>±152</td>
<td>1</td>
</tr>
<tr>
<td>PEM1-S12-D5-S</td>
<td>12</td>
<td>10.8~13.2</td>
<td>±5</td>
<td>±10</td>
<td>±100</td>
<td>1</td>
</tr>
<tr>
<td>PEM1-S12-D12-S</td>
<td>12</td>
<td>10.8~13.2</td>
<td>±12</td>
<td>±5</td>
<td>±42</td>
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</tr>
<tr>
<td>PEM1-S12-D15-S</td>
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<td>10.8~13.2</td>
<td>±15</td>
<td>±4</td>
<td>±33</td>
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<tr>
<td>PEM1-S15-S3-S</td>
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<td>13.5~16.5</td>
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<td>200</td>
<td>1</td>
<td>60</td>
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<tr>
<td>PEM1-S15-S12-S</td>
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<td>13.5~16.5</td>
<td>12</td>
<td>83</td>
<td>1</td>
<td>60</td>
</tr>
<tr>
<td>PEM1-S15-S15-S</td>
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<td>13.5~16.5</td>
<td>15</td>
<td>67</td>
<td>1</td>
<td>60</td>
</tr>
<tr>
<td>PEM1-S15-D5-S</td>
<td>15</td>
<td>13.5~16.5</td>
<td>±5</td>
<td>±10</td>
<td>±100</td>
<td>1</td>
</tr>
<tr>
<td>PEM1-S15-D15-S</td>
<td>15</td>
<td>13.5~16.5</td>
<td>±15</td>
<td>±4</td>
<td>±33</td>
<td>1</td>
</tr>
<tr>
<td>PEM1-S24-S3-S</td>
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<td>21.6~26.4</td>
<td>3.3</td>
<td>300</td>
<td>1</td>
<td>60</td>
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<tr>
<td>PEM1-S24-S5-S</td>
<td>24</td>
<td>21.6~26.4</td>
<td>5</td>
<td>200</td>
<td>1</td>
<td>60</td>
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</tbody>
</table>

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)**

<table>
<thead>
<tr>
<th>MODEL</th>
<th>INPUT voltage</th>
<th>OUTPUT voltage</th>
<th>OUTPUT CURRENT</th>
<th>OUTPUT POWER</th>
<th>RIPPLE AND NOISE</th>
<th>EFFICIENCY</th>
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</thead>
<tbody>
<tr>
<td>PEM1-S24-S12-S¹</td>
<td>24</td>
<td>21.6~26.4</td>
<td>12</td>
<td>9</td>
<td>83</td>
<td>1</td>
</tr>
<tr>
<td>PEM1-S24-S15-S¹</td>
<td>24</td>
<td>21.6~26.4</td>
<td>15</td>
<td>7</td>
<td>67</td>
<td>1</td>
</tr>
<tr>
<td>PEM1-S24-S24-S¹</td>
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<td>21.6~26.4</td>
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<tr>
<td>PEM1-S24-D3-S¹</td>
<td>24</td>
<td>21.6~26.4</td>
<td>±3.3</td>
<td>±15</td>
<td>±152</td>
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</tr>
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<td>PEM1-S24-D12-S¹</td>
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<td>21.6~26.4</td>
<td>±12</td>
<td>±5</td>
<td>±42</td>
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<td>PEM1-S24-D15-S¹</td>
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<td>21.6~26.4</td>
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<td>±4</td>
<td>±33</td>
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<td>21.6~26.4</td>
<td>±24</td>
<td>±2</td>
<td>±21</td>
<td>1</td>
</tr>
</tbody>
</table>

**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

**PEM1 - SXX - XXX -S**

- **Base Number**
- **Input Voltage**
- **Output Voltage**
- **Package Style**
- **S = single**
- **D = dual**

### INPUT

<table>
<thead>
<tr>
<th>parameter</th>
<th>conditions/description</th>
<th>min</th>
<th>typ</th>
<th>max</th>
<th>units</th>
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</thead>
<tbody>
<tr>
<td>operating input voltage</td>
<td>for maximum of 1 second</td>
<td>-0.7</td>
<td>5</td>
<td>Vdc</td>
<td></td>
</tr>
<tr>
<td>surge voltage</td>
<td>3.3 Vdc input models</td>
<td>-0.7</td>
<td>9</td>
<td>Vdc</td>
<td></td>
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<td></td>
<td>5 Vdc input models</td>
<td>-0.7</td>
<td>18</td>
<td>Vdc</td>
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</tr>
<tr>
<td></td>
<td>12 Vdc input models</td>
<td>-0.7</td>
<td>21</td>
<td>Vdc</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15 Vdc input models</td>
<td>-0.7</td>
<td>30</td>
<td>Vdc</td>
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</table>

**Filter**
- capacitance filter

### OUTPUT

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<th>parameter</th>
<th>conditions/description</th>
<th>min</th>
<th>typ</th>
<th>max</th>
<th>units</th>
</tr>
</thead>
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<td>line regulation</td>
<td>for Vin change of 1%</td>
<td>±1.5</td>
<td>%</td>
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<tr>
<td>load regulation</td>
<td>measure from 10% load to full load</td>
<td>18</td>
<td>%</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>3.3 Vdc input models</td>
<td>12</td>
<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 Vdc input models</td>
<td>8</td>
<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15 Vdc input models</td>
<td>6</td>
<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>voltage accuracy</td>
<td>see tolerance envelope curve</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>voltage balance</td>
<td>dual output, balanced loads</td>
<td>±0.5</td>
<td>±1</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>switching frequency</td>
<td>at full load, nominal input voltage</td>
<td>100</td>
<td>kHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>temperature coefficient</td>
<td>at full load</td>
<td>±0.03</td>
<td>%/°C</td>
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PROTECTIONS

<table>
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<th>max</th>
<th>units</th>
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<td>short circuit protection(^1)</td>
<td></td>
<td>1</td>
<td>s</td>
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Note: 1. The supply voltage must be discontinued at the end of the short circuit duration.

SAFETY AND COMPLIANCE

<table>
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<th>min</th>
<th>typ</th>
<th>max</th>
<th>units</th>
</tr>
</thead>
<tbody>
<tr>
<td>isolation voltage</td>
<td>input to output for 1 minute, 1 mA max. leakage current</td>
<td>3,000</td>
<td>Vdc</td>
<td></td>
<td></td>
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<tr>
<td>isolation resistance</td>
<td>input to output at 500 Vdc</td>
<td>1,000</td>
<td>MΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>isolation capacitance</td>
<td>input to output, 100KHz, 0.1V</td>
<td>20</td>
<td>pF</td>
<td></td>
<td></td>
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<tr>
<td>safety approvals(^2)</td>
<td>UL 60950-1</td>
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<td>conducted emissions</td>
<td>CISPR22/EN55022, class B (external circuit required, see Figure 1)</td>
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<td>radiated emissions</td>
<td>CISPR22/EN55022, class B (external circuit required, see Figure 1)</td>
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<tr>
<td>ESD</td>
<td>IEC/EN61000-4-2, class B, contact ± 8kV for single outputs</td>
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<tr>
<td></td>
<td>IEC/EN61000-4-2, class B, contact ± 6kV for dual outputs</td>
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<tr>
<td>MTBF</td>
<td>as per MIL-HDBK-217F @ 25°C</td>
<td>3,500,000</td>
<td>hours</td>
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<td></td>
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<td>RoHS</td>
<td>2011/65/EU</td>
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Note: 2. See specific models noted on pages 1 & 2.

ENVIRONMENTAL

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<th>max</th>
<th>units</th>
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</thead>
<tbody>
<tr>
<td>operating temperature</td>
<td>see derating curve</td>
<td>-40</td>
<td>105</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>storage temperature</td>
<td></td>
<td>-55</td>
<td>125</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>storage humidity</td>
<td>non-condensing</td>
<td></td>
<td>95</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>temperature rise</td>
<td>at Ta = 25°C</td>
<td></td>
<td>25</td>
<td>°C</td>
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SOLDERABILITY

<table>
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<th>conditions/description</th>
<th>min</th>
<th>typ</th>
<th>max</th>
<th>units</th>
</tr>
</thead>
<tbody>
<tr>
<td>hand soldering</td>
<td>1.5 mm from case for 10 seconds</td>
<td>300</td>
<td>°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>wave soldering(^3)</td>
<td>see wave soldering profile</td>
<td>260</td>
<td>°C</td>
<td></td>
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</table>

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

<table>
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<th>parameter</th>
<th>conditions/description</th>
<th>min</th>
<th>typ</th>
<th>max</th>
<th>units</th>
</tr>
</thead>
<tbody>
<tr>
<td>dimensions</td>
<td>19.50 x 6.00 x 9.30 (0.768 x 0.236 x 0.366 inch)</td>
<td></td>
<td></td>
<td></td>
<td>mm</td>
</tr>
<tr>
<td>case material</td>
<td>epoxy resin (UL94-V0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>weight</td>
<td></td>
<td>2.4</td>
<td></td>
<td></td>
<td>g</td>
</tr>
</tbody>
</table>

MECHANICAL DRAWING

units: mm[inch]
tolerance: ±0.25[±0.010]
pin section tolerance: ±0.10[±0.004]

PIN CONNECTIONS

<table>
<thead>
<tr>
<th>PIN</th>
<th>Single Output</th>
<th>Dual Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vin</td>
<td>Vin</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>GND</td>
</tr>
<tr>
<td>5</td>
<td>0V</td>
<td>-Vo</td>
</tr>
<tr>
<td>6</td>
<td>No Pin</td>
<td>0V</td>
</tr>
<tr>
<td>7</td>
<td>+Vo</td>
<td>+Vo</td>
</tr>
</tbody>
</table>

Note: Grid 2.54*2.54mm
DERATING CURVES

Tolerance Envelope Curve (3.3 Vdc output only)

Tolerance Envelope Curve (all other models)

Temperature Derating Curve

EMC RECOMMENDED CIRCUIT

Recommended external circuit components

<table>
<thead>
<tr>
<th>Vin (Vdc)</th>
<th>C1</th>
<th>LDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.3</td>
<td>4.7μF/50V</td>
<td>6.8μH</td>
</tr>
<tr>
<td>5</td>
<td>4.7μF/50V</td>
<td>6.8μH</td>
</tr>
<tr>
<td>12</td>
<td>4.7μF/50V</td>
<td>6.8μH</td>
</tr>
<tr>
<td>15</td>
<td>4.7μF/50V</td>
<td>6.8μH</td>
</tr>
<tr>
<td>24</td>
<td>4.7μF/50V</td>
<td>6.8μH</td>
</tr>
</tbody>
</table>

Note: 1. See Table 3 for Cout values.

TEST CONFIGURATION

External components

<table>
<thead>
<tr>
<th>Lin</th>
<th>4.7μH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cin</td>
<td>220μF, ESR &lt; 1.0Ω at 100 kHz</td>
</tr>
</tbody>
</table>

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

![Single Output Diagram](vin-gnd-dc-vo-cin-dc-cout-vo)

![Dual Output Diagram](vin-gnd-dc-vo-cin-dc-cout-vo)

### Table 3

<table>
<thead>
<tr>
<th>Vin (Vdc)</th>
<th>Cin (µF)</th>
<th>Single Vo (Vdc)</th>
<th>Cout (µF)</th>
<th>Dual Vo (Vdc)</th>
<th>Cout (µF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.3</td>
<td>4.7</td>
<td>3.3</td>
<td>10</td>
<td>±3.3</td>
<td>4.7</td>
</tr>
<tr>
<td>5</td>
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<td>10</td>
<td>±5</td>
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<td>±12</td>
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<td>15</td>
<td>2.2</td>
<td>15</td>
<td>1</td>
<td>±15</td>
<td>0.47</td>
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<td>24</td>
<td>1</td>
<td>24</td>
<td>1</td>
<td>±24</td>
<td>0.47</td>
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</tbody>
</table>

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

### Table 4

<table>
<thead>
<tr>
<th>Single Vout (Vdc)</th>
<th>Max. Capacitive Load (µF)</th>
<th>Dual Vout (Vdc)</th>
<th>Max. Capacitive Load (µF)</th>
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<tbody>
<tr>
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<td>100</td>
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</tr>
<tr>
<td>24</td>
<td>220</td>
<td>24</td>
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</tr>
</tbody>
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Note: 1. For each output.
## REVISION HISTORY

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<tr>
<th>rev.</th>
<th>description</th>
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<tr>
<td>1.0</td>
<td>initial release</td>
<td>03/19/2013</td>
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<tr>
<td>1.01</td>
<td>added model PEM1-S15-S12-S</td>
<td>07/29/2013</td>
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<tr>
<td>1.02</td>
<td>added new models</td>
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<td>1.03</td>
<td>added UL approval to some models</td>
<td>09/16/2014</td>
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<td>1.04</td>
<td>added UL approval to some models</td>
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<tr>
<td>1.05</td>
<td>updated tolerance envelope curves</td>
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<tr>
<td>1.06</td>
<td>added wave soldering preheat conditions, updated emc recommendations</td>
<td>12/04/2017</td>
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The revision history provided is for informational purposes only and is believed to be accurate.