E1 SERIES  1 WATT PROGRAMABLE REGULATED HV DC/DC CONVERTERS

**FEATURES**

- Customer Selects Output Voltage
- Fully Regulated Outputs to + or - 8000 Vdc
- 0-100% Programmable Output
- High Stability (<0.005%/°C)
- Low Output Noise & EMI/RFI
- External Calibration Adjustment
- Continuous Short Circuit Protection
- UL & CE Pending

The E1 Series miniature regulated high voltage DC/DC converter offers a 100% programmable high voltage output using a 0-5Vdc analog signal. Their small size, low output ripple, and excellent regulation make them ideally suited for applications that demand a high degree of performance. All models will tolerate a short circuit indefinitely.

**ELECTRICAL SPECIFICATIONS**

- **Input Voltage Range**: 11.5V - 16Vdc
- **Output Voltage Accuracy**: +/- 1%
- **Line Regulation**: <0.05%
- **Load Regulation**: <0.05%
- **Output Ripple**: 0.002% P-P
- **Programming Voltage**: 0 - 5Vdc @ <100uA
- **Programming Linearity (5% to 100% Vout)**: <0.5%
- **Input Filter**: Low ESR Capacitor
- **Reverse Input Protection**: 50Vdc
- **Short Circuit Protection**: Continuous
- **Switching Frequency**: 180 - 250 kHz
- **Calibration Adjustment**: 5 to 10%
- **Response Time**: <250 ms (Full Load, full scale response)
- **Programming Voltage Shutdown**: > 5.2Vdc

**GENERAL SPECIFICATIONS**

- **Stability**: < 0.01% / Hr.
- **Temp. Stability**: +/- 0.005%/°C
- **Temp. (Operating, Case)**: -10 to +60°C
- **Temp. (Storage)**: -40 to +125°C
- **Humidity**: 0 to 95% (Non-Condensing)
- **Thermal Shock Limit**: 1°C / 10 Seconds
- **EMI/RFI**: Six Sided Shield
- **Derating**: None
- **Cooling**: Free-Air Convection
- **Certifications**: UL & CE Pending

**PHYSICAL SPECIFICATIONS**

- **Dimensions & Weight**: 1.1 x 1.4 x 0.5 inches @ 1.1 Oz
- **Dimensions & Weight**: 1.1 x 1.75 x 0.5 inches @ 1.3 Oz
- **Dimensions & Weight**: 1.1 x 2.6 x 0.5 inches @ 1.8 Oz
- **Case Material**: Nickle Plated Metal
  (With Non-Conductive Base Plate)

Tel (888) 894-4446  WWW.APOWERDESIGN.COM  Fax (603) 898-6534

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## Output Voltages from 100V to 2000Vdc

### Representative Model Listing

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Input Current</th>
<th>Output Specifications</th>
<th>Regulation Load</th>
<th>Line</th>
<th>Switching Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-RoHS</strong></td>
<td><strong>RoHS</strong></td>
<td><strong>No Load</strong></td>
<td><strong>Full Load</strong></td>
<td><strong>Voltage</strong></td>
<td><strong>Ripple</strong></td>
</tr>
<tr>
<td>E1-P10</td>
<td>E1-P10/Y</td>
<td>&lt;50 mA</td>
<td>&lt;160 mA</td>
<td>0V to +100Vdc</td>
<td>&lt;0.75% (0.75V p-p)</td>
</tr>
<tr>
<td>E1-N10</td>
<td>E1-N10/Y</td>
<td>&lt;50 mA</td>
<td>&lt;160 mA</td>
<td>0V to -100Vdc</td>
<td>&lt;0.75% (0.75V p-p)</td>
</tr>
<tr>
<td>E1-P20</td>
<td>E1-P20/Y</td>
<td>&lt;50 mA</td>
<td>&lt;160 mA</td>
<td>0V to +200Vdc</td>
<td>&lt;0.05% (0.1V p-p)</td>
</tr>
<tr>
<td>E1-N20</td>
<td>E1-N20/Y</td>
<td>&lt;50 mA</td>
<td>&lt;160 mA</td>
<td>0V to -200Vdc</td>
<td>&lt;0.05% (0.1V p-p)</td>
</tr>
<tr>
<td>E1-P30</td>
<td>E1-P30/Y</td>
<td>&lt;50 mA</td>
<td>&lt;160 mA</td>
<td>0V to +300Vdc</td>
<td>&lt;0.03% (90mV p-p)</td>
</tr>
<tr>
<td>E1-N30</td>
<td>E1-N30/Y</td>
<td>&lt;50 mA</td>
<td>&lt;160 mA</td>
<td>0V to -300Vdc</td>
<td>&lt;0.03% (90mV p-p)</td>
</tr>
<tr>
<td>E1-P50</td>
<td>E1-P50/Y</td>
<td>&lt;50 mA</td>
<td>&lt;160 mA</td>
<td>0V to +500Vdc</td>
<td>&lt;0.004% (20mV p-p)</td>
</tr>
<tr>
<td>E1-N50</td>
<td>E1-N50/Y</td>
<td>&lt;50 mA</td>
<td>&lt;160 mA</td>
<td>0V to -500Vdc</td>
<td>&lt;0.005% (25mV p-p)</td>
</tr>
<tr>
<td>E1-P60</td>
<td>E1-P60/Y</td>
<td>&lt;90 mA</td>
<td>&lt;200 mA</td>
<td>0V to +600Vdc</td>
<td>&lt;0.003% (18mV p-p)</td>
</tr>
<tr>
<td>E1-N60</td>
<td>E1-N60/Y</td>
<td>&lt;90 mA</td>
<td>&lt;200 mA</td>
<td>0V to -600Vdc</td>
<td>&lt;0.003% (18mV p-p)</td>
</tr>
<tr>
<td>E1-P100</td>
<td>E1-P100/Y</td>
<td>&lt;90 mA</td>
<td>&lt;200 mA</td>
<td>0V to +1000Vdc</td>
<td>&lt;0.005% (50mV p-p)</td>
</tr>
<tr>
<td>E1-N100</td>
<td>E1-N100/Y</td>
<td>&lt;90 mA</td>
<td>&lt;200 mA</td>
<td>0V to -1000Vdc</td>
<td>&lt;0.002% (20mV p-p)</td>
</tr>
<tr>
<td>E1-P125</td>
<td>E1-P125/Y</td>
<td>&lt;100 mA</td>
<td>&lt;250 mA</td>
<td>0V to +1250Vdc</td>
<td>&lt;0.004% (50mV p-p)</td>
</tr>
<tr>
<td>E1-N125</td>
<td>E1-N125/Y</td>
<td>&lt;100 mA</td>
<td>&lt;250 mA</td>
<td>0V to -1250Vdc</td>
<td>&lt;0.003% (37mV p-p)</td>
</tr>
<tr>
<td>E1-P150</td>
<td>E1-P150/Y</td>
<td>&lt;100 mA</td>
<td>&lt;220 mA</td>
<td>0V to +1500Vdc</td>
<td>&lt;0.002% (30mV p-p)</td>
</tr>
<tr>
<td>E1-N150</td>
<td>E1-N150/Y</td>
<td>&lt;100 mA</td>
<td>&lt;220 mA</td>
<td>0V to -1500Vdc</td>
<td>&lt;0.002% (30mV p-p)</td>
</tr>
<tr>
<td>E1-P200</td>
<td>E1-P200/Y</td>
<td>&lt;100 mA</td>
<td>&lt;220 mA</td>
<td>0V to +2000Vdc</td>
<td>&lt;0.002% (40mV p-p)</td>
</tr>
<tr>
<td>E1-N200</td>
<td>E1-N200/Y</td>
<td>&lt;100 mA</td>
<td>&lt;220 mA</td>
<td>0V to -2000Vdc</td>
<td>&lt;0.002% (40mV p-p)</td>
</tr>
</tbody>
</table>

*Actual Output Voltage is 10X

Output Voltage Restriction applies to 1.1 x 1.4 x 0.5 inch Case Only

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**Customer Selects Output Voltage**

The E1 Series are designed such that the customer may order any output voltage (positive or negative) from 100Vdc to 2000Vdc at no additional charge.
E1 SERIES 1 WATT PROGRAMABLE REGULATED HV DC/DC CONVERTERS

OUTPUT VOLTAGES FROM 100V TO 2000VDC

<table>
<thead>
<tr>
<th>PIN #</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+ Input</td>
</tr>
<tr>
<td>2</td>
<td>Gnd</td>
</tr>
<tr>
<td>3</td>
<td>Control / Programming Voltage</td>
</tr>
<tr>
<td>4</td>
<td>HV Output</td>
</tr>
<tr>
<td>5</td>
<td>Case Gnd</td>
</tr>
</tbody>
</table>

Dimensions are in Inches  
[Metric equivalents in brackets]
E1 SERIES 1 WATT PROGRAMABLE REGULATED HV DC/DC CONVERTERS

OUTPUT VOLTAGES FROM 2100V TO 4000VDC

<table>
<thead>
<tr>
<th>MODEL NUMBER</th>
<th>INPUT CURRENT</th>
<th>NO LOAD</th>
<th>FULL LOAD</th>
<th>VOLTAGE</th>
<th>RIPPLE</th>
<th>CURRENT</th>
<th>REGULATION</th>
<th>SWITCHING FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1-P250</td>
<td>E1-P250/Y</td>
<td>&lt;100 mA</td>
<td>&lt;250 mA</td>
<td>0V to +2500Vdc</td>
<td>&lt;0.1% (2.5V p-p)</td>
<td>0 - 0.4mA</td>
<td>&lt;0.05% &lt;0.05%</td>
<td>190 kHz</td>
</tr>
<tr>
<td>E1-N250</td>
<td>E1-N250/Y</td>
<td>&lt;100 mA</td>
<td>&lt;250 mA</td>
<td>0V to -2500Vdc</td>
<td>&lt;0.2% (5.0V p-p)</td>
<td>0 - 0.4mA</td>
<td>&lt;0.05% &lt;0.05%</td>
<td>190 kHz</td>
</tr>
<tr>
<td>E1-P300</td>
<td>E1-P300/Y</td>
<td>&lt;100 mA</td>
<td>&lt;250 mA</td>
<td>0V to +3000Vdc</td>
<td>&lt;0.1% (3.0V p-p)</td>
<td>0 - 0.33mA</td>
<td>&lt;0.05% &lt;0.05%</td>
<td>190 kHz</td>
</tr>
<tr>
<td>E1-N300</td>
<td>E1-N300/Y</td>
<td>&lt;100mA</td>
<td>&lt;250 mA</td>
<td>0V to -3000Vdc</td>
<td>&lt;0.2% (6.0V p-p)</td>
<td>0 - 0.33mA</td>
<td>&lt;0.05% &lt;0.05%</td>
<td>190 kHz</td>
</tr>
<tr>
<td>E1-P400</td>
<td>E1-P400/Y</td>
<td>&lt;100 mA</td>
<td>&lt;250 mA</td>
<td>0V to +4000Vdc</td>
<td>&lt;0.1% (4.0V p-p)</td>
<td>0 - 0.25mA</td>
<td>&lt;0.05% &lt;0.05%</td>
<td>190 kHz</td>
</tr>
<tr>
<td>E1-N400</td>
<td>E1-N400/Y</td>
<td>&lt;100 mA</td>
<td>&lt;250 mA</td>
<td>0V to -4000Vdc</td>
<td>&lt;0.1% (4.0V p-p)</td>
<td>0 - 0.25mA</td>
<td>&lt;0.05% &lt;0.05%</td>
<td>190 kHz</td>
</tr>
</tbody>
</table>

Output Voltage Restriction applies to 1.1 x 1.75 x 0.5 inches Case Only

*ACTUAL OUTPUT VOLTAGE IS 10X

Customer Selects Output Voltage *

The E1 Series are designed such that the customer may order any output voltage (positive or negative) from 2100Vdc to 4000Vdc at no additional charge.
E1 SERIES 1 WATT PROGRAMABLE REGULATED HV DC/DC CONVERTERS

OUTPUT VOLTAGES FROM 2100V TO 4000VDC

<table>
<thead>
<tr>
<th>PIN #</th>
<th>FUNCTION</th>
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<tr>
<td>1</td>
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<td>4</td>
<td>HV Output</td>
</tr>
<tr>
<td>5</td>
<td>Case Gnd</td>
</tr>
</tbody>
</table>

Pin - 0.04 [1.02] Dia.
Tin Plated Brass
Matte Finish 5 Plc

0.20 [5.08] Min. Pin Length
1.75 [44.45]

Cal. ADJ

Bottom View

Dimensions are in Inches
[Metric equivalents in brackets]
# E1 SERIES 1 WATT PROGRAMABLE REGULATED HV DC/DC CONVERTERS

## OUTPUT VOLTAGES FROM 4100V TO 8000VDC

<table>
<thead>
<tr>
<th>MODEL NUMBER</th>
<th>INPUT CURRENT</th>
<th>NO LOAD</th>
<th>FULL LOAD</th>
<th>VOLTAGE</th>
<th>RIPPLE</th>
<th>CURRENT</th>
<th>REGULATION</th>
<th>SWITCHING FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1-P500</td>
<td>E1-P500/Y</td>
<td>&lt;100 mA</td>
<td>&lt;230 mA</td>
<td>0V to +5000Vdc</td>
<td>&lt;0.1% (5.0V p-p)</td>
<td>0 - 0.2mA</td>
<td>&lt;0.05%</td>
<td>&lt;0.05%</td>
</tr>
<tr>
<td>E1-N500</td>
<td>E1-N500/Y</td>
<td>&lt;100 mA</td>
<td>&lt;230 mA</td>
<td>0V to -5000Vdc</td>
<td>&lt;0.1% (5.0V p-p)</td>
<td>0 - 0.2mA</td>
<td>&lt;0.05%</td>
<td>&lt;0.05%</td>
</tr>
<tr>
<td>E1-P600</td>
<td>E1-P600/Y</td>
<td>&lt;100 mA</td>
<td>&lt;230 mA</td>
<td>0V to +6000Vdc</td>
<td>&lt;0.1% (6.0V p-p)</td>
<td>0 - 0.166mA</td>
<td>&lt;0.05%</td>
<td>&lt;0.05%</td>
</tr>
<tr>
<td>E1-N600</td>
<td>E1-N600/Y</td>
<td>&lt;100mA</td>
<td>&lt;230 mA</td>
<td>0V to -6000Vdc</td>
<td>&lt;0.1% (6.0V p-p)</td>
<td>0 - 0.166mA</td>
<td>&lt;0.05%</td>
<td>&lt;0.05%</td>
</tr>
<tr>
<td>E1-P800</td>
<td>E1-P800/Y</td>
<td>&lt;150 mA</td>
<td>&lt;230 mA</td>
<td>0V to +8000Vdc</td>
<td>&lt;0.15% (12V p-p)</td>
<td>0 - 0.125mA</td>
<td>&lt;0.05%</td>
<td>&lt;0.05%</td>
</tr>
<tr>
<td>E1-N800</td>
<td>E1-N800/Y</td>
<td>&lt;150 mA</td>
<td>&lt;230 mA</td>
<td>0V to -8000Vdc</td>
<td>&lt;0.15% (12V p-p)</td>
<td>0 - 0.125mA</td>
<td>&lt;0.05%</td>
<td>&lt;0.05%</td>
</tr>
</tbody>
</table>

**Output Voltage Restriction applies to 1.1 x 2.6 x 0.5 inches Case Only**

*ACTUAL OUTPUT VOLTAGE IS 10X*
E1 SERIES 1 WATT PROGRAMABLE REGULATED HV DC/DC CONVERTERS

OUTPUT VOLTAGES FROM 4100V TO 8000VDC

Dimensions are in Inches
[Metric equivalents in brackets]

<table>
<thead>
<tr>
<th>PIN #</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+ Input</td>
</tr>
<tr>
<td>2</td>
<td>Gnd</td>
</tr>
<tr>
<td>3</td>
<td>Control / Programming Voltage</td>
</tr>
<tr>
<td>4</td>
<td>HV Return</td>
</tr>
<tr>
<td>5</td>
<td>Case Gnd</td>
</tr>
</tbody>
</table>

Dimensions are in Inches
[Metric equivalents in brackets]
APPLICATION NOTES

INRUSH CURRENT

The inrush current of the E1 Series has been kept as low as possible. However, a series resistor may be inserted in the input line to limit this current further.

REVERSE INPUT PROTECTION

The E1 Series is equipped with reverse input protection. The converter will fold-back the input power whenever a reverse circuit is applied to its output and automatically recover after the overload condition is removed.

SHORT CIRCUIT PROTECTION

The E1 Series is equipped with short circuit protection. The converter will fold-back the input power whenever a short circuit is applied to its output and automatically recover after the overload condition is removed.

RIPPLE AND NOISE

Figure below shows a typical output voltage ripple waveform, measured at full rated load current with no additional output filtering. External low ESR capacitors may be added across output to further reduce ripple.

STARTUP TRANSIENT

Figure below shows a typical output voltage during turn-on, measured at no load current with no additional output filtering.

Figure below shows a typical output voltage during turn-on, measured at full rated load current with no additional output filtering.
APPLICATION NOTES

LOAD TRANSIENT

Figure below shows a typical output voltage response, measured during a transition from full rated load current to no load current with no additional output filtering.

PROGRAMMING VOLTAGE

A 0V to +5V signal will program the power supply for 0 to 100% rated output voltage. The input impedance for this control pin is typically 100KΩ. If the programming signal exceeds 5.2Vdc the converter will shutdown and automatically recover when the programming signal returns to within normal operating range.

OUTPUT VOLTAGE TRACKING

The output voltage tracks the Control pin (Pin 3) within 0.5% from 5% to 100% of output voltage.

Figure below show a typical plot of both the actual and calculated output voltage as a function of control voltage.

Operating Conditions:
Nominal Input Voltage = Fixed
Output Load = Resistive (fixed at full output current @ 100% output voltage)
APPLICATION NOTES

Connection Diagrams

The figures below show standard configurations for the E1 Series converter with output voltages up to 2kV.

**Single Output Configuration**

![Diagram of Single Output Configuration]

**Dual Output Configuration**

![Diagram of Dual Output Configuration]

The figures below show standard configurations for the E1 Series converter with output voltages from 2.1kV to 4kV.

**Single Output Configuration**

![Diagram of Single Output Configuration]

**Dual Output Configuration**

![Diagram of Dual Output Configuration]

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NOTE:

An internal RC network connects the Case (Pin 5) to Gnd (Pin 2).

No more than 50 volts potential between the case ground (Pin 5) and the circuit ground (Pin 2) otherwise, the supply may be permanently damaged.

Case pin (Pin 5) should be connected to ground for optimum operation.

The ratings of Dₓ should be 1.5 times the maximum current and voltage expected in each branch.
APPLICATION NOTES

Connection Diagrams

The figures below show standard configurations for the E1 Series converter with output voltages from 4.1kV to 8kV.

Single Output Configuration

Dual Output Configuration

NOTE:

An internal RC network connects the Case (Pin 5) to Gnd (Pins 2 and 4).

No more than 50 volts potential between the case ground (Pin 5) and the circuit ground (Pins 2 and 4) otherwise, the supply may be permanently damaged.

Case pin (Pin 5) should be connected to ground for optimum operation.

The ratings of Dx should be 1.5 times the maximum current and voltage expected in each branch.
APPLICATION NOTES

CLEANING AGENTS

In order to avoid possible damage, any penetration of cleaning fluids must be prevented, since the power supplies are not hermetically sealed.

TECHNICAL REVISIONS

The appearance of products, including safety agency certifications pictured on labels, may change depending on the date manufactured. Specifications are subject to change without notice.

NUCLEAR AND MEDICAL APPLICATIONS

American Power Design products are not designed, intended for use in, or authorized for use as critical components in life support systems, equipment used in hazardous environments, or nuclear control systems without the express written consent of American Power Design, Inc.

SAFETY REQUIREMENTS

The converters are designed to meet North American and International safety regulatory requirements per UL 60950-1/CSA 22.2 No. 60950-1-07 Second Edition, IEC 60950-1:2005, and EN 60950-1:2006. To comply with safety agencies requirements, an input line fuse must be used external to the converter. The table below provides the recommended fuse rating for use with this family of products.

<table>
<thead>
<tr>
<th>Input Voltage Range</th>
<th>Fuse Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.5-16Vdc</td>
<td>0.5A</td>
</tr>
</tbody>
</table>

If one input fuse is used for a group of modules, the maximum fuse rating should not exceed 10A.

WARRANTY

All products manufactured by American Power Design, Inc. (APD) are warranted to be free of defects due to material or workmanship for a period of one year from date of shipment. At our option, APD will repair or replace any non-conforming product. APD expressly disclaims any liability for consequential or incidental damages resulting from the use or misuse of its products by the purchaser or others. This warranty is in lieu of all warranties expressed or implied, including the warranties of merchantability. No other warranties, obligations, or liabilities are expressed or implied. All products being returned for repair require a return material authorization (RMA) assigned by APD prior to return shipment.