Evaluation Board Report

12V 3.6W ACDC power supply

<table>
<thead>
<tr>
<th>Design Specs</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>85-265</td>
<td>VAC</td>
</tr>
<tr>
<td>Output Voltage</td>
<td>12</td>
<td>VDC</td>
</tr>
<tr>
<td>Output Current</td>
<td>0.3</td>
<td>A</td>
</tr>
<tr>
<td>Isolation</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>MPS IC</td>
<td>MP174GJ</td>
<td></td>
</tr>
<tr>
<td>Application</td>
<td>Home Appliance, white goods, consumer electronics Industrial Controls Standby Power</td>
<td></td>
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Design Summary

EV174-J-00A evaluation board provides a reference design for a universal offline power supply with 12V, 0.3A output. It contains the complete specification of the power supply, a detailed circuit diagram, the entire bill of materials required to build the power supply, drawing of the power inductors and transformers, and test data of the most important performance.
DESCRIPTION

The EV174-J-00A Evaluation Board is designed to demonstrate the capabilities of MP174. The MP174 is a primary-side constant voltage regulator providing accurate constant voltage (CV) regulation without Opto-coupler. It supports Buck, Buck-Boost, Boost and Flyback topologies.

The EV174-J-00A Evaluation Board is designed as Buck application. EV174-J-00A typically drives a 3.6W with a 12V/300mA load from 85VAC to 265VAC, at 60/50Hz.

The EV174-J-00A has an excellent efficiency and meets IEC61000-4-5 surge immunity and EN55022 conducted EMI requirements. MP174 features various protections, including thermal shutdown (TSD), VCC under-voltage lockout (UVLO), over-load protection (OLP), short-circuit protection (SCP), and open loop protection.

MP174GJ is available in TSOT23-5 package.

FEATURES

- Primary-Side non-isolated Constant Voltage (CV) Control
- Integrated 700V13.5Ω MOSFET
- < 100mW No-load power consumption
- Up to 3.6W output power
- Peak-Current Control with Peak Current Compression
- Low Vcc operating current
- Limited Maximum Frequency
- Frequency Foldback
- Multiple Protections: SCP, OCP, OTP, and VCC UVLO
- Low Cost and Simple External circuit
- Internal high-voltage current source

ELECTRICAL SPECIFICATION

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
<th>Units</th>
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<tbody>
<tr>
<td>Input Voltage</td>
<td>V_IN</td>
<td>85 to 265</td>
<td>VAC</td>
</tr>
<tr>
<td>Output Voltage</td>
<td>V_OUT</td>
<td>12</td>
<td>V</td>
</tr>
<tr>
<td>Output Current</td>
<td>I_OUT</td>
<td>0.3</td>
<td>A</td>
</tr>
<tr>
<td>Output Power</td>
<td>P_OUT</td>
<td>3.6</td>
<td>W</td>
</tr>
<tr>
<td>Efficiency (full load)</td>
<td>η</td>
<td>&gt;75</td>
<td>%</td>
</tr>
</tbody>
</table>

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Warning: Although this board is designed to satisfy safety requirements, the engineering prototype has not been agency approved. Therefore, all testing should be performed using an isolation transformer to provide the AC input to the prototype board.
EV174-J-00A EVALUATION BOARD

**TOP VIEW**

**BOTTOM VIEW**

(L x W x H)  68mm x 28mm x 17mm

<table>
<thead>
<tr>
<th>Board Number</th>
<th>MPS IC Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>EV174-J-00A</td>
<td>MP174GJ</td>
</tr>
</tbody>
</table>
EVALUATION BOARD SCHEMATIC

Figure 1—Schematic
PCB LAYOUT (SINGLE-SIDED)

Figure 2—Top Layer

Figure 3—Bottom Layer
## EV174-J-00A BILL OF MATERIALS

<table>
<thead>
<tr>
<th>Qty</th>
<th>Ref</th>
<th>Value</th>
<th>Description</th>
<th>Package</th>
<th>Manufacture</th>
<th>Manufacture_PN</th>
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<tbody>
<tr>
<td>1</td>
<td>C1</td>
<td>220nF</td>
<td>Ceramic Capacitor; 16V; X7R</td>
<td>0603</td>
<td>muRata</td>
<td>GRM188R71C224KA01D</td>
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<tr>
<td>1</td>
<td>C2</td>
<td>2.2uF</td>
<td>Ceramic Capacitor; 10V; X7R</td>
<td>0603</td>
<td>muRata</td>
<td>GRM188R71A225KE15D</td>
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<tr>
<td>1</td>
<td>C3</td>
<td>1nF</td>
<td>Ceramic Capacitor; 50V; X7R</td>
<td>0603</td>
<td>muRata</td>
<td>GRM188R71H102KA01D</td>
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<tr>
<td>2</td>
<td>C4, C5</td>
<td>10uF</td>
<td>Electrolytic Capacitor; 400V; 20%</td>
<td>DIP</td>
<td>Any</td>
<td>Any</td>
</tr>
<tr>
<td>1</td>
<td>C6</td>
<td>100uF</td>
<td>Electrolytic Capacitor; 35V</td>
<td>DIP</td>
<td>Jianghai</td>
<td>CD287-35V100</td>
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<tr>
<td>1</td>
<td>C7</td>
<td>1uF</td>
<td>Ceramic Capacitor; 16V; X7R</td>
<td>0603</td>
<td>muRata</td>
<td>GRM188R71C105KA12D</td>
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<td>1</td>
<td>D1</td>
<td>1N4148WS</td>
<td>Diode; 75V; 0.15A</td>
<td>SOD-323</td>
<td>Diodes</td>
<td>1N4148WS-7-F</td>
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<tr>
<td>5</td>
<td>D2, D3, D4, D6, D7</td>
<td>1N4007</td>
<td>Diode; 1000V; 1A</td>
<td>DO-41</td>
<td>Diodes</td>
<td>1N4007</td>
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<tr>
<td>1</td>
<td>D5</td>
<td>STTH1R06</td>
<td>Diode; 600V; 1A</td>
<td>DO-41</td>
<td>ST</td>
<td>STTH1R06</td>
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<td>1</td>
<td>F1</td>
<td>10Ω</td>
<td>Resistor; 5%; 1W</td>
<td>DIP</td>
<td>Yageo</td>
<td>FKN1WSJT-52-10R</td>
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<tr>
<td>1</td>
<td>L1</td>
<td>1mH</td>
<td>Inductor; 1000uH; 8Ω; 0.1A</td>
<td>DIP</td>
<td>Any</td>
<td>Any</td>
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<tr>
<td>1</td>
<td>L2</td>
<td>1.2mH</td>
<td>Inductor; 1.2mH; 1.8Ω; 400mA</td>
<td>DIP</td>
<td>Emei</td>
<td>DR9X12P2M1.2-00</td>
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<tr>
<td>1</td>
<td>R1</td>
<td>19.1kΩ</td>
<td>Film Resistor; 1%</td>
<td>0603</td>
<td>Yageo</td>
<td>RC0603FR-0719K1L</td>
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<tr>
<td>1</td>
<td>R2</td>
<td>24kΩ</td>
<td>Film Resistor; 1%</td>
<td>0603</td>
<td>Yageo</td>
<td>RC0603FR-0724KL</td>
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<tr>
<td>1</td>
<td>R4</td>
<td>4.99kΩ</td>
<td>Film Resistor; 1%</td>
<td>0603</td>
<td>Yageo</td>
<td>RC0603FR-074K99L</td>
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<tr>
<td>1</td>
<td>R6</td>
<td>3kΩ</td>
<td>Film Resistor; 1%</td>
<td>1206</td>
<td>Yageo</td>
<td>RC1206FR-073KL</td>
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<tr>
<td>1</td>
<td>U1</td>
<td>MP174</td>
<td>Primary side regulator</td>
<td>TSOT23-5</td>
<td>MPS</td>
<td>MP174GJ</td>
</tr>
</tbody>
</table>
CIRCUIT DESCRIPTION

The EV174-J-00A is configured in a buck regulator topology, it uses primary-side-control which can mostly simplify the schematic and get a cost effective BOM. It can also achieve accurate constant voltage and acceptable cross regulation.

F1 is used to protect circuit from component failure or some excessive short events; also it can restrain the inrush current.

C4, L1 and C5 compose π filter to guarantee the conducted EMI meet standard EN55022. C2 and C3 are also used for energy storage and protecting against line surge.

R2, C2, and D1 are used as VCC power supply. Though MP174 is equipped with an internal high voltage current source, using this circuit can achieve better efficiency.

C1 is the sample-hold capacitor, used for reflecting output voltage. R1 and R4 are resistor divider for detecting output voltage by sampling voltage on C1.

D5 is the freewheeling diode. For universal voltage applications, use a diode with a 600V reverse block voltage. Ultra-fast recovery diode is recommended for better efficiency.

C6 and C7 are output capacitors for 12V output. C6 should be low ESR electrolytic capacitor for better output ripple. C7 is ceramic capacitor to reduce high frequency voltage ripple. R6 is dummy load to lower the output voltage of 12V rail at no load condition.

Surge Performance

Line to Line 1kV surge tested according to IEC61000-4-5.

<table>
<thead>
<tr>
<th>Surge Level (V)</th>
<th>Input Voltage (VAC)</th>
<th>Injection Location</th>
<th>Injection Phase (°)</th>
<th>Test Result (Pass/Fail)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>230</td>
<td>L to N</td>
<td>0</td>
<td>Pass</td>
</tr>
<tr>
<td>1000</td>
<td>230</td>
<td>L to N</td>
<td>90</td>
<td>Pass</td>
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<tr>
<td>1000</td>
<td>230</td>
<td>L to N</td>
<td>180</td>
<td>Pass</td>
</tr>
<tr>
<td>1000</td>
<td>230</td>
<td>L to N</td>
<td>270</td>
<td>Pass</td>
</tr>
<tr>
<td>-1000</td>
<td>230</td>
<td>L to N</td>
<td>0</td>
<td>Pass</td>
</tr>
<tr>
<td>-1000</td>
<td>230</td>
<td>L to N</td>
<td>90</td>
<td>Pass</td>
</tr>
<tr>
<td>-1000</td>
<td>230</td>
<td>L to N</td>
<td>180</td>
<td>Pass</td>
</tr>
<tr>
<td>-1000</td>
<td>230</td>
<td>L to N</td>
<td>270</td>
<td>Pass</td>
</tr>
</tbody>
</table>

The board can pass 2kV surge test by simple using 2 10ohm/1W fuse resistor, as the circuit show below.
### EVB TEST RESULTS

Performance waveforms are tested on the evaluation board. 
\( V_{IN}=85\text{–}265\,\text{V}_{AC}, \quad V_{OUT}=12\,\text{V}, \quad I_{OUT1}=0.3\,\text{A} \, \text{CC Mode Load}, \quad T_A=22^\circ\text{C} \)

#### Efficiency vs. No Load Consumption

- **Efficiency**
  - Operating voltages: 115\,\text{V}_{AC}, 230\,\text{V}_{AC}
- **No Load Consumption**
  - Operating voltages: 85\,\text{V}, 130\,\text{V}, 175\,\text{V}, 220\,\text{V}, 265\,\text{V}_{AC}

#### Steady State

- **Steady State**
  - \( V_{IN}=115\,\text{V}_{AC}, \) Full Load
- **Steady State**
  - \( V_{IN}=230\,\text{V}_{AC}, \) Full Load
- **Output Ripple**
  - \( V_{IN}=115\,\text{V}_{AC}, \) No Load
  - \( V_{IN}=230\,\text{V}_{AC}, \) Full Load

#### Waveforms

- **Output Ripple**
  - \( V_{RIPPLE}\,\text{50mV/div.} \)
  - Time scales: 40\,\mu\text{s/div.}, 200\,\mu\text{s/div.}

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**Notes:**
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- www.MonolithicPower.com
EVB TEST RESULTS (continued)

Performance waveforms are tested on the evaluation board.
$V_{IN} = 85\text{-}265\text{V}_{AC}$, $V_{OUT} = 12\text{V}$, $I_{OUT1} = 0.3\text{A}$ CC Mode Load, $T_A = 22^\circ\text{C}$

- **Soft Start**
  $V_{IN} = 85\text{V}_{AC}$

- **Soft Start**
  $V_{IN} = 265\text{V}_{AC}$

- **Turn-On Delay**
  $V_{IN} = 115\text{V}_{AC}$, No Load

- **Turn-On Delay**
  $V_{IN} = 230\text{V}_{AC}$, No Load

- **Turn-On Delay**
  $V_{IN} = 230\text{V}_{AC}$, Full Load

- **Turn-On Delay**
  $V_{IN} = 115\text{V}_{AC}$, Full Load

- **Load Transient**
  $V_{IN} = 115\text{V}_{AC}$, 25%-50% Load

- **Load Transient**
  $V_{IN} = 115\text{V}_{AC}$, 50%-75% Load

- **Load Transient**
  $V_{IN} = 230\text{V}_{AC}$, 25%-50% Load
EVB TEST RESULTS (continued)

Performance waveforms are tested on the evaluation board.
$V_{IN}=85$-265$V_{AC}$, $V_{OUT}=12V$, $I_{OUT1}=0.3A$ CC Mode Load, $T_A=22^\circ C$

**Load Transient**
$V_{IN}=230V_{AC}$, 50%-75% Load

**OTP**
$V_{IN}=230V_{AC}$

**SCP**
$V_{IN}=230V_{AC}$

**Open Loop Protection**
$V_{IN}=230V_{AC}$, No Load

**Open Loop Protection**
$V_{IN}=230V_{AC}$, Full Load
EVB TEST RESULTS (continued)

Performance waveforms are tested on the evaluation board. \( V_{IN}=85-265\text{V}_{AC}, \ V_{OUT}=12\text{V}, \ I_{OUT1}=0.3\text{A CC Mode Load, } T_A=22^\circ\text{C} \)

**Conducted EMI**

Two-Wire Input, \( V_{IN}=115\text{V}_{AC} \), L Line

Two-Wire Input, \( V_{IN}=115\text{V}_{AC} \), N Line

Two-Wire Input, \( V_{IN}=230\text{V}_{AC} \), L Line

Two-Wire Input, \( V_{IN}=230\text{V}_{AC} \), N Line
QUICK START GUIDE

1. Preset Power Supply to $85\text{VAC} \leq V_{\text{IN}} \leq 265\text{VAC}$.
2. Turn Power Supply off.
3. Connect the Line and Neutral terminals of the power supply output to L and N port. For three-wire input application, make OUTPUT GND connected to Earth.
4. Connect Different Load to Corresponding Outputs:
   a. Positive (+): 12V OUT
   b. Negative (−): GND
5. Turn Power Supply on after making connections.

Contact Information
To request this evaluation board, please refer to your local sales offices which can be found from:
http://www.monolithicpower.com/Company/Contact-Us

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