

## DESCRIPTION

The EV157-J-00B Evaluation Board is designed to demonstrate the dual output capabilities of MP157. The MP157 is a primary-side constant voltage regulator.

The EV157-J-00B is typically designed for small appliances which output 18V/0.3A and 5V/0.1A load from 85VAC to 265VAC, 50HZ/60HZ.

The EV157-J-00B has an excellent efficiency and meets IEC61000-4-5 surge immunity and EN55022 conducted EMI requirements. It has multi-protection function as open circuit protection, over load protection, short-circuit protection, and over-temperature protection, etc.

## ELECTRICAL SPECIFICATION

| Parameter              | Symbol     | Value     | Units |
|------------------------|------------|-----------|-------|
| Input Voltage          | $V_{IN}$   | 85 to 265 | VAC   |
| Output Voltage 1       | $V_{OUT1}$ | 18        | V     |
| Output Current 1       | $I_{OUT1}$ | 0.3       | A     |
| Output Voltage 2       | $V_{OUT2}$ | 5         | V     |
| Output Current 2       | $I_{OUT2}$ | 0.1       | A     |
| Output Power           | $P_{OUT}$  | 5.9       | W     |
| Efficiency (full load) | $\eta$     | >70       | %     |

## FEATURES

- Primary-Side non-isolated Constant Voltage Control (CV)
- Integrated 500V MOSFET with Minimal External Components
- Peak-Current Control with Peak Current Compression
- Limited Maximum Frequency and Frequency Foldback,
- Multiple Protections: SCP, OCP, OTP, and VCC UVLO
- Low Cost and Simple External circuit

## APPLICATIONS

- Small Appliances

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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.

## EV157-J-00B EVALUATION BOARD



**TOP VIEW**



**BOTTOM VIEW**

(L x W x H) 86mm x 18mm x 17mm

| Board Number | MPS IC Number |
|--------------|---------------|
| EV157-J-00B  | MP157GJ       |

## EVALUATION BOARD SCHEMATIC

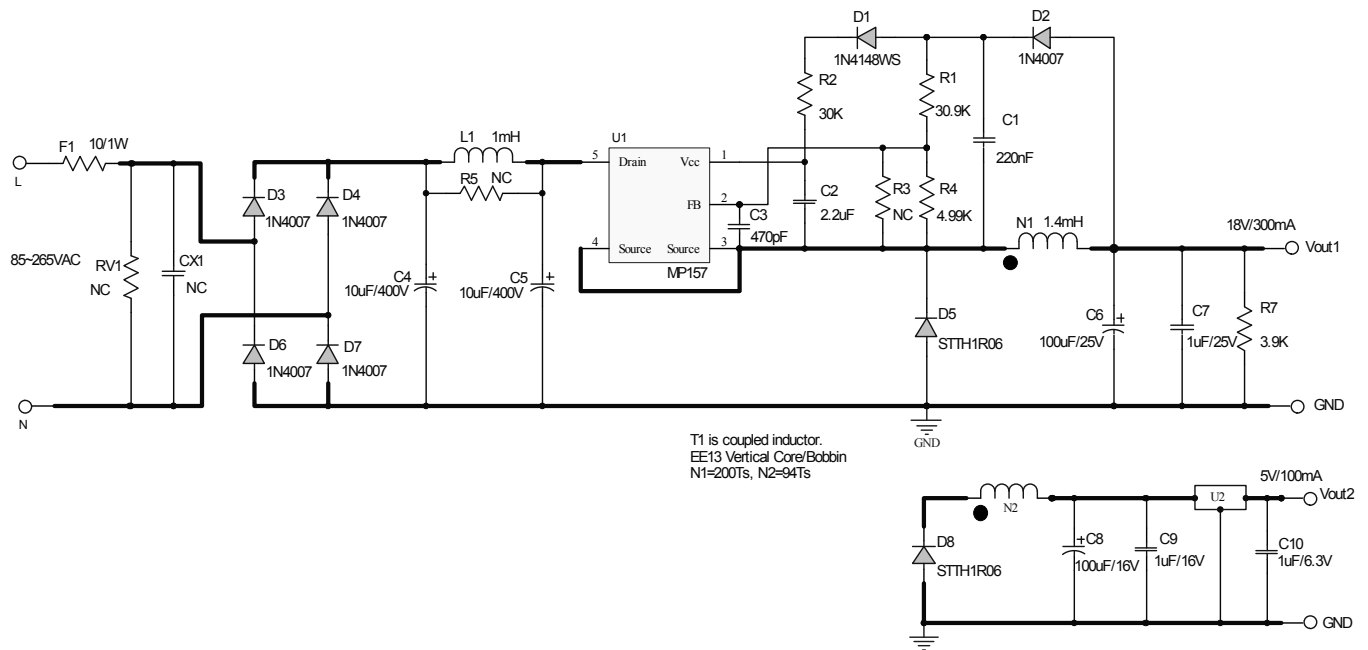


Figure 1—Schematic

## PCB LAYOUT (SINGLE-SIDED)

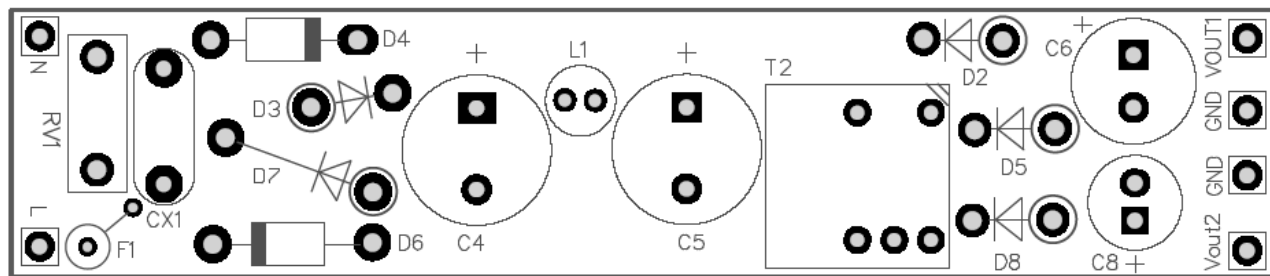


Figure 2—Top Layer

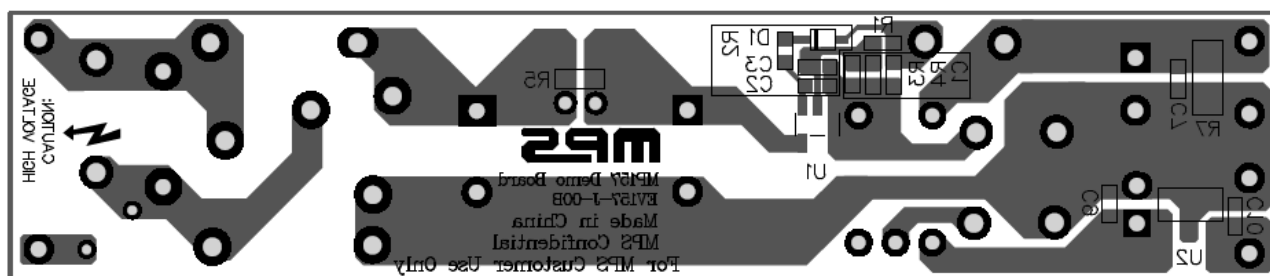


Figure 3—Bottom Layer

## CIRCUIT DESCRIPTION

The EV157-J-00B 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  $\pi$  filter to guarantee the conducted EMI meet standard EN55022.

R2, C2, and D1 are used as VCC power supply. Though MP157 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.

T1 is power transformer; it has two coupling windings to achieve dual output.

D5 is freewheeling diode for 18V output. Select a diode with a maximum reverse block voltage rating that exceeds the maximum input voltage. 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 18V output. C6 should be low ESR electrolytic capacitor for better output ripple. C7 is ceramic capacitor to reduce high frequency voltage ripple. R7 is dummy load to lower the output voltage of 18V rail at no load condition.

D8 is freewheeling diode for 5V output. Simply select a diode same as D5.

C8 and C9 are output capacitors for 5V output. C9 should be low ESR electrolytic capacitor for better load regulation. C9 is ceramic capacitor to reduce high frequency voltage ripple.

U2 is three terminals voltage regulator for precise 5V output. C10 is output capacitor for U3.

**EV157-J-00B BILL OF MATERIALS**

| Qty    | Ref                               | Value                                                                                                                                                                                                                                       | Description                     | Package  | Manufacturer | Manufacturer_P/N     |
|--------|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|----------|--------------|----------------------|
| 1      | CX1                               | NC                                                                                                                                                                                                                                          | No Connected                    |          |              |                      |
| 1      | C1                                | 220nF                                                                                                                                                                                                                                       | Ceramic Capacitor;<br>25V;X5R   | 0603     | Murata       | GRM188R71E224KA01D   |
| 1      | C2                                | 2.2μF                                                                                                                                                                                                                                       | Ceramic Capacitor;<br>10V;X7R   | 0603     | Murata       | GRM188R71A225KE15D   |
| 1      | C3                                | 470pF                                                                                                                                                                                                                                       | Ceramic Capacitor;<br>50V;C0G   | 0603     | Murata       | GRM1885C1H471JA01D   |
| 2      | C4, C5                            | 10μF/400V                                                                                                                                                                                                                                   | Electrolytic Capacitor;<br>400V | DIP      | Ltec         | TY Series, 10uF/400V |
| 1      | L1                                | 1mH                                                                                                                                                                                                                                         | Inductor;1mH;<br>60m;0.25A      | DIP      | Würth        | 7447462102           |
| 1      | C6                                | 100μF                                                                                                                                                                                                                                       | Electrolytic Capacitor;25V      | DIP      | Rubycon      | 25YXF100M6.3X11      |
| 1      | C7                                | 1μF                                                                                                                                                                                                                                         | Ceramic Capacitor;<br>25V;X7R   | 0603     | TDK          | C2012X7R1E105K       |
| 1      | C8                                | 100μF                                                                                                                                                                                                                                       | Electrolytic Capacitor;16V      | DIP      | 江海           | CD11C-16V100         |
| 1      | C9                                | 1μF                                                                                                                                                                                                                                         | Ceramic Capacitor;<br>16V;X7R   | 0603     | TDK          | C1608X7R1C105K       |
| 1      | C10                               | 1μF                                                                                                                                                                                                                                         | Ceramic Capacitor;<br>6.3V;X5R  | 0603     | Murata       | GRM188R60J105KA01D   |
| 1      | D1                                | 1N4148WS                                                                                                                                                                                                                                    | Diode;75V;0.15A                 | SOD323   | Diodes       | 1N4148WS-7-F         |
| 5      | D2, D3, D4,<br>D6, D7             | 1N4007                                                                                                                                                                                                                                      | Diode;1000V;1A                  | DO-41    | Diodes       | 1N4007               |
| 2      | D5, D8                            | STTH1R06                                                                                                                                                                                                                                    | Diode;600V;1A                   | DO-41    | ST           | STTH1R06             |
| 1      | F1                                | 10Ω                                                                                                                                                                                                                                         | Fuse Resistor;5%;1W             | DIP      | Yageo        | FKN1WSJT-52-10N      |
| 1      | R1                                | 30.9kΩ                                                                                                                                                                                                                                      | Film Resistor;1%                | 0603     | Yageo        | RC0603FR-0730K9L     |
| 1      | R2                                | 30kΩ                                                                                                                                                                                                                                        | Film Resistor;1%                | 0603     | Yageo        | RC0603FR-0730KL      |
| 1      | R3                                | NC                                                                                                                                                                                                                                          | No Connected                    |          |              |                      |
| 1      | R4                                | 4.99kΩ                                                                                                                                                                                                                                      | Film Resistor;1%                | 0603     | Yageo        | RC0603FR-074K99L     |
| 1      | R5                                | NC                                                                                                                                                                                                                                          | No Connected                    |          |              |                      |
| 1      | R7                                | 3.9k                                                                                                                                                                                                                                        | Film Resistor;1%                | 1206     | Yageo        | RC1206FR-073K9L      |
| 1      | RV1                               | NC                                                                                                                                                                                                                                          | No Connected                    |          |              |                      |
| 1      | T1                                | 1.4mH                                                                                                                                                                                                                                       | N1:N2=200:94                    | EE13     | Würth        | 750342025            |
|        |                                   |                                                                                                                                                                                                                                             |                                 |          | Emei         | FX0336               |
| 1      | U1                                | MP157                                                                                                                                                                                                                                       | Buck regulator                  | TSOT23-5 | MPS          | MP157GJ              |
| 1      | U2                                | L78L05ACUTR                                                                                                                                                                                                                                 | LDO, 5V, 100mA                  | SOT89    | ANY          |                      |
| 6      | L, N, Vout1,<br>GND, Vout2<br>GND |                                                                                                                                                                                                                                             | Connector, 1mm                  |          |              |                      |
| Notes: |                                   | (1) Würth transformer sample request please log on website: <a href="http://www.we-online.com">www.we-online.com</a><br>(2) Emei transformer sample request please log on website: <a href="http://www.emeigroup.com">www.emeigroup.com</a> |                                 |          |              |                      |

# TRANSFORMER SPECIFICATION

## Electrical Diagram

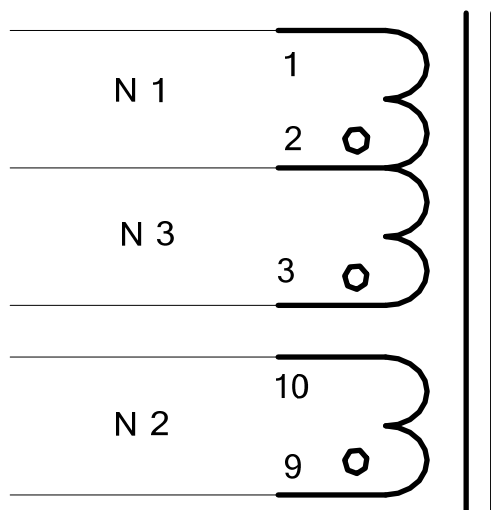


Figure 4—Transformer Electrical Diagram

### Notes:

1. Remove pin2, 4, 5, 6, 7, 8.
2. One layer tape is between each layer winding. 1 layers tape is at the outside of last winding

## Winding Diagram

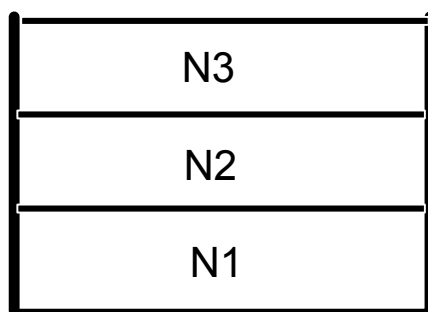


Figure 5—Winding Diagram

## Winding Order

| Tapes (T) | Winding | Start-End | Wire Diameter (Ø) | Turns ( T ) | Tube |
|-----------|---------|-----------|-------------------|-------------|------|
| 0         | N1      | 3—> 2     | 0.23*1            | 106         | None |
| 1         |         | 9—> 10    | 0.15*1            | 94          | None |
| 1         | N3      | 2—> 1     | 0.23*1            | 94          | None |
| 1         |         |           |                   |             |      |

## Electrical Specifications

|                            |                                                                  |           |
|----------------------------|------------------------------------------------------------------|-----------|
| <b>Electrical Strength</b> | 60 seconds 60Hz, from PRI. to SEC.                               | 500VAC    |
|                            | 60 seconds 60Hz, from PRI. to CORE.                              | 500VAC    |
|                            | 60 seconds 60Hz, from SEC. to CORE.                              | 500VAC    |
| <b>Primary Inductance</b>  | Pins 1 - 3, all other windings open, measured at 60kHz, 0.1 VRMS | 1.4mH±10% |

## Materials

| Item | Description                                      |
|------|--------------------------------------------------|
| 1    | Core: EE13, PC40                                 |
| 2    | Bobbin: EE13, 4+4PIN                             |
| 3    | Wire:Φ0.15mm,, 2UEW, Class B                     |
| 4    | Wire:Φ0.23mm,, 2UEW, Class B                     |
| 6    | Tape: 7.5mm(W)×0.06mm(TH)                        |
| 7    | Varnish: JOHN C. DOLPH CO, BC-346A or equivalent |
| 8    | Solder Bar: CHEN NAN: SN99.5/Cu0.5 or equivalent |
|      |                                                  |

## Surge Test

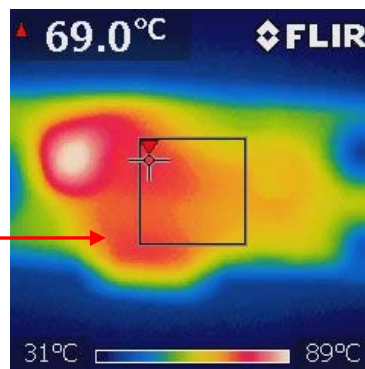
Line to Line 1kV surge tested according to IEC61000-4-5.

Input voltage was set at 230VAC/50Hz. Output was loaded at full load and operation was verified following each surge event.

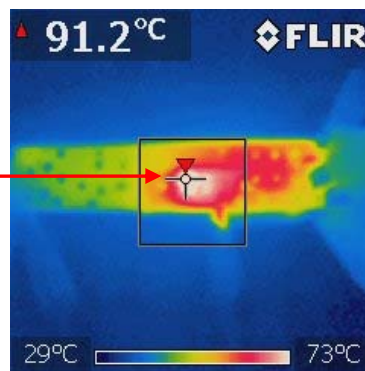
| Surge Level (V) | Input Voltage (VAC) | Injection Location | Injection Phase (°) | Test Result (Pass/Fail) |
|-----------------|---------------------|--------------------|---------------------|-------------------------|
| 1000            | 230                 | L to N             | 0                   | Pass                    |
| 1000            | 230                 | L to N             | 90                  | Pass                    |
| 1000            | 230                 | L to N             | 180                 | Pass                    |
| 1000            | 230                 | L to N             | 270                 | Pass                    |
| -1000           | 230                 | L to N             | 0                   | Pass                    |
| -1000           | 230                 | L to N             | 90                  | Pass                    |
| -1000           | 230                 | L to N             | 180                 | Pass                    |
| -1000           | 230                 | L to N             | 270                 | Pass                    |

### Thermal Test

Test with 115Vac input and full load condition,  $T_a=30^{\circ}\text{C}$



**Top Layer**



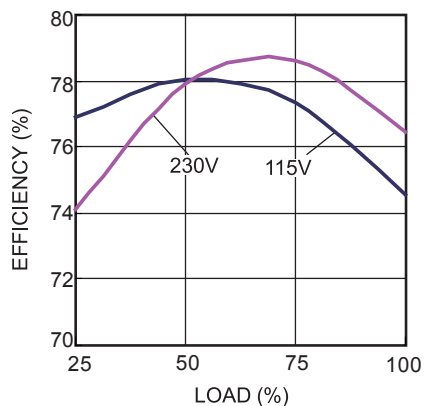
**Bottom Layer**

## EVB TEST RESULTS

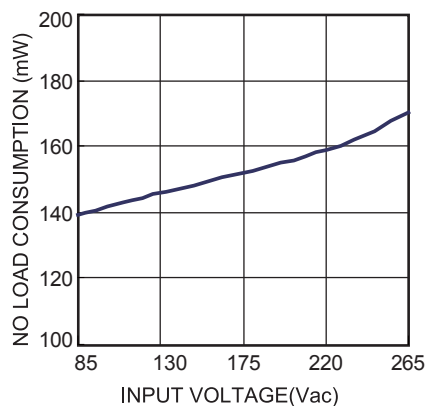
Performance waveforms are tested on the evaluation board.

$V_{IN}=85\text{-}265\text{VAC}$ ,  $V_{OUT1}=18\text{V}$ ,  $I_{OUT1}=0.3\text{A}$ ,  $V_{OUT2}=5\text{V}$ ,  $I_{OUT2}=0.1\text{A}$ , CC Mode Load,  $T_a=30^\circ\text{C}$

**Efficiency**

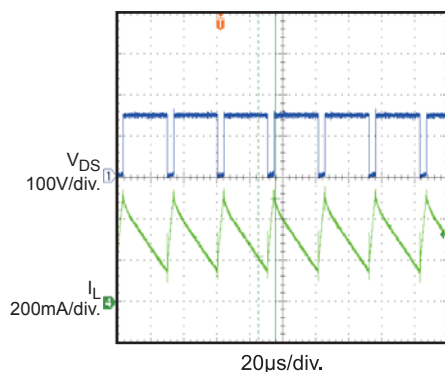


**No Load Consumption**



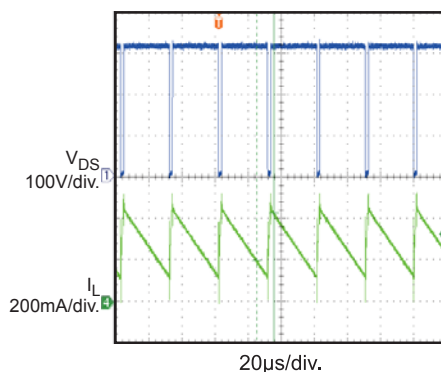
**Steady State**

$V_{IN} = 115\text{VAC}$ , Full Load



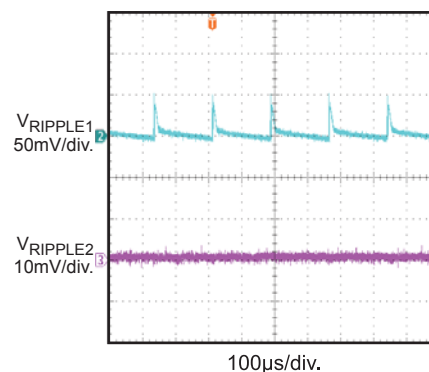
**Steady State**

$V_{IN} = 230\text{VAC}$ , Full Load



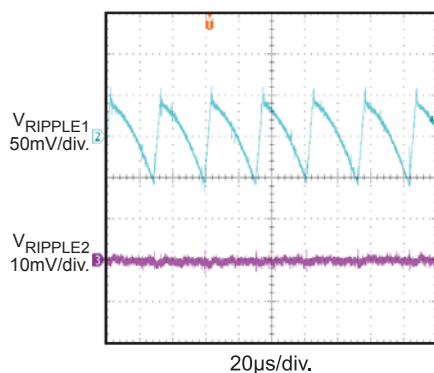
**Output Ripple**

$V_{IN} = 115\text{VAC}$ , No Load



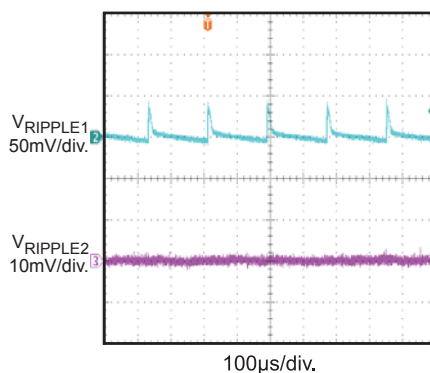
**Output Ripple**

$V_{IN} = 115\text{VAC}$ , Full Load



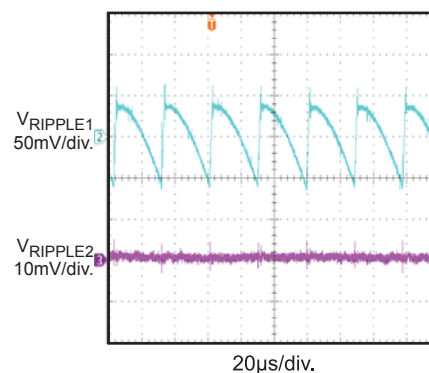
**Output Ripple**

$V_{IN} = 230\text{VAC}$ , No Load



**Output Ripple**

$V_{IN} = 230\text{VAC}$ , Full Load



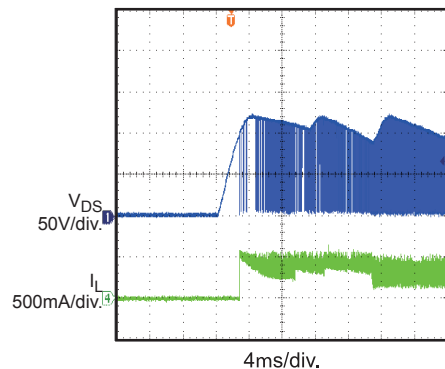
## EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board.

$V_{IN}=85\text{-}265\text{VAC}$ ,  $V_{OUT1}=18\text{V}$ ,  $I_{OUT1}=0.3\text{A}$ ,  $V_{OUT2}=5\text{V}$ ,  $I_{OUT2}=0.1\text{A}$ , CC Mode Load,  $T_a=30^\circ\text{C}$

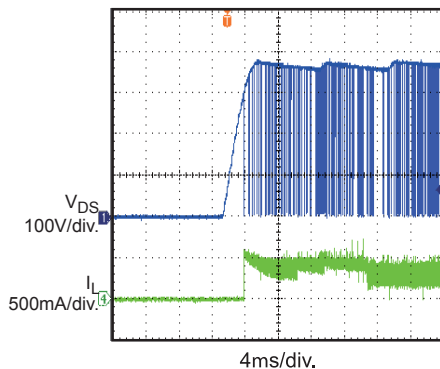
### Soft Start

$V_{IN} = 85\text{VAC}$



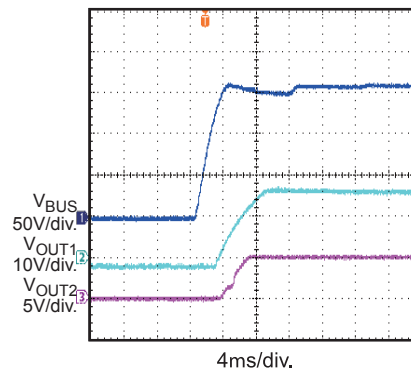
### Soft Start

$V_{IN} = 265\text{VAC}$



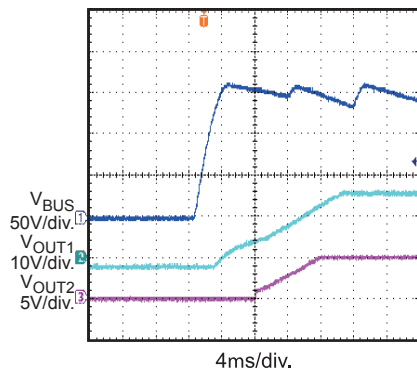
### Turn-on Delay

$V_{IN} = 115\text{VAC}$ , No Load



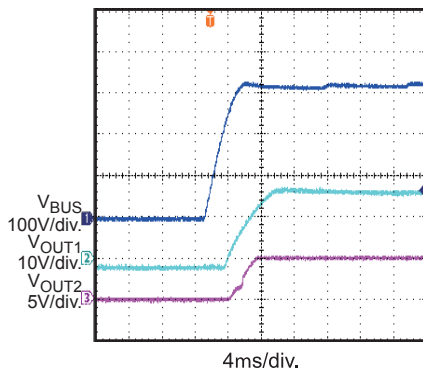
### Turn-on Delay

$V_{IN} = 115\text{VAC}$ , Full Load



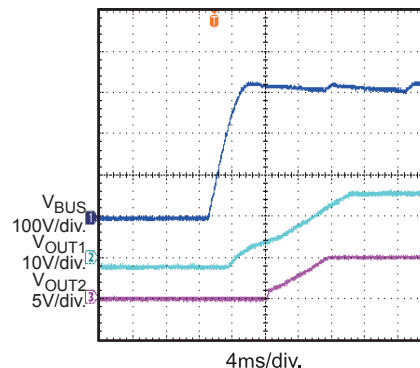
### Turn-on Delay

$V_{IN} = 230\text{VAC}$ , No Load



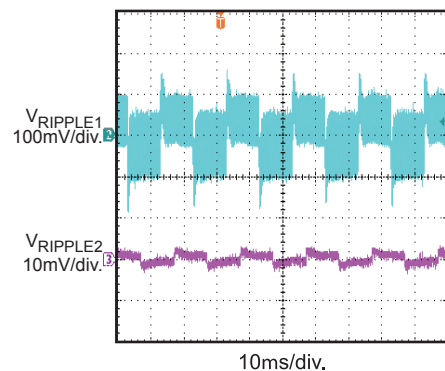
### Turn-on Delay

$V_{IN} = 230\text{VAC}$ , Full Load



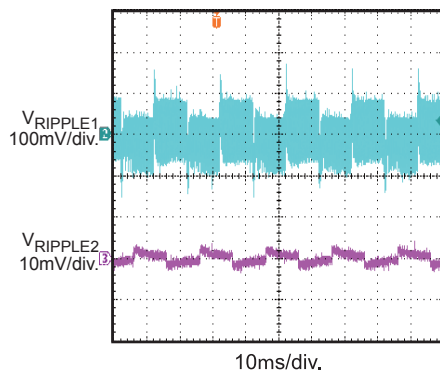
### Load Transient

$V_{IN} = 115\text{VAC}$ ,  
25% Load to 50% Load



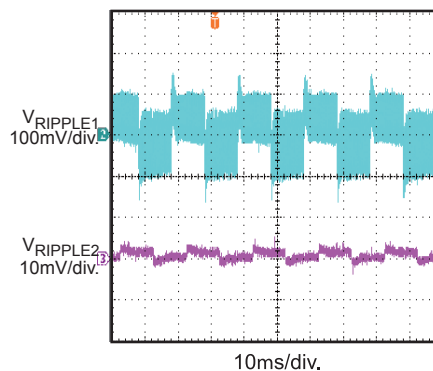
### Load Transient

$V_{IN} = 115\text{VAC}$ ,  
50% Load to 75% Load



### Load Transient

$V_{IN} = 230\text{VAC}$ ,  
25% Load to 50% Load



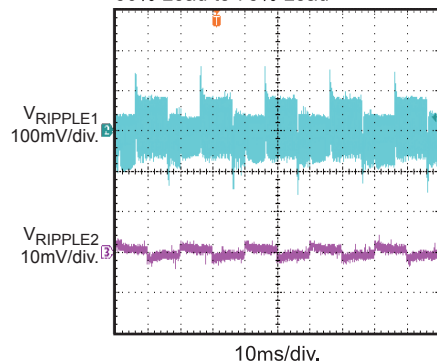
## EVB TEST RESULTS *(continued)*

Performance waveforms are tested on the evaluation board.

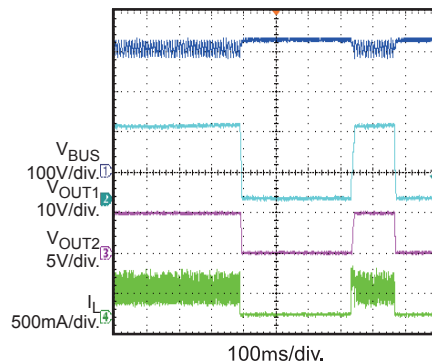
$V_{IN}=85\text{-}265\text{VAC}$ ,  $V_{OUT1}=18\text{V}$ ,  $I_{OUT1}=0.3\text{A}$ ,  $V_{OUT2}=5\text{V}$ ,  $I_{OUT2}=0.1\text{A}$ , CC Mode Load,  $T_a=30^{\circ}\text{C}$

### Load Transient

$V_{IN} = 230\text{VAC}$ ,  
50% Load to 75% Load

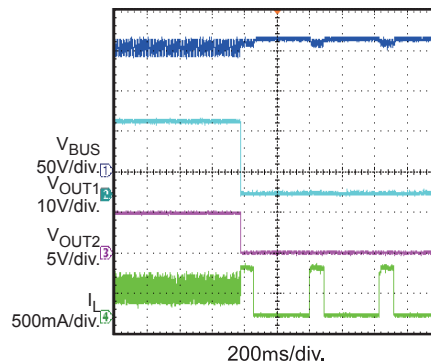


### OTP



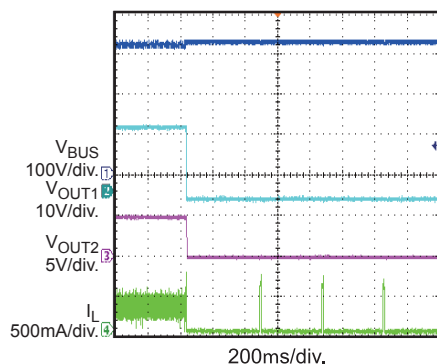
### SCP

$V_{IN} = 115\text{VAC}$



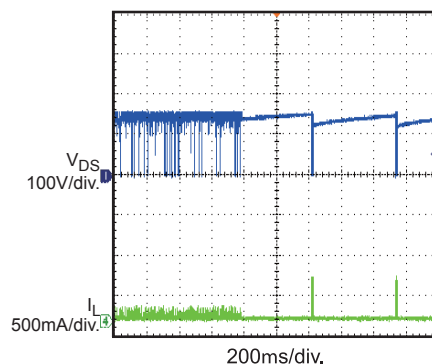
### SCP

$V_{IN} = 230\text{VAC}$



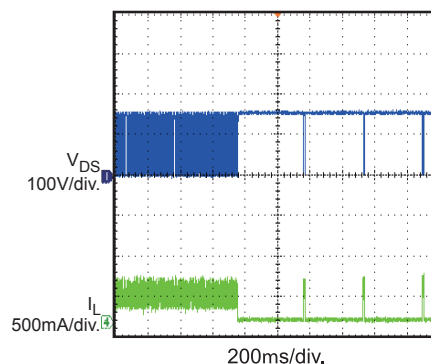
### Open Loop Protection

$V_{IN} = 115\text{VAC}$ , No Load



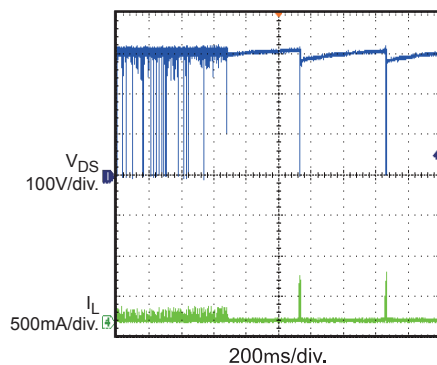
### Open Loop Protection

$V_{IN} = 115\text{VAC}$ , Full Load



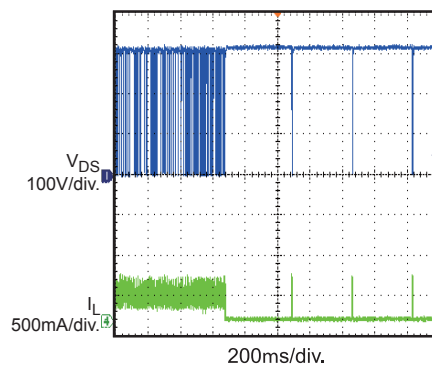
### Open Loop Protection

$V_{IN} = 230\text{VAC}$ , No Load



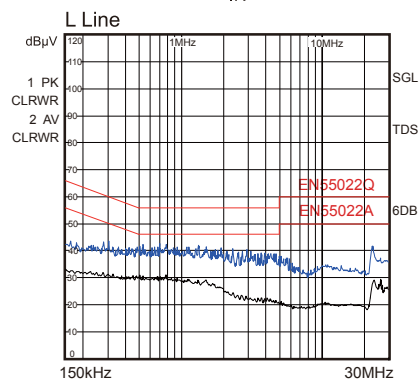
### Open Loop Protection

$V_{IN} = 230\text{VAC}$ , Full Load



### Conducted EMI

Two-Wire Input,  $V_{IN} = 115\text{VAC}$



## EVB TEST RESULTS *(continued)*

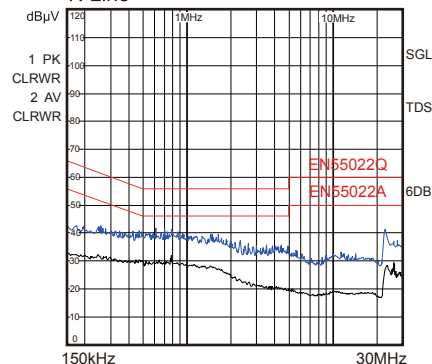
Performance waveforms are tested on the evaluation board.

$V_{IN}=85\text{-}265\text{VAC}$ ,  $V_{OUT1}=18\text{V}$ ,  $I_{OUT1}=0.3\text{A}$ ,  $V_{OUT2}=5\text{V}$ ,  $I_{OUT2}=0.1\text{A}$ , CC Mode Load,  $T_a=30^{\circ}\text{C}$

### Conducted EMI

Two-Wire Input,  $V_{IN}=115\text{VAC}$

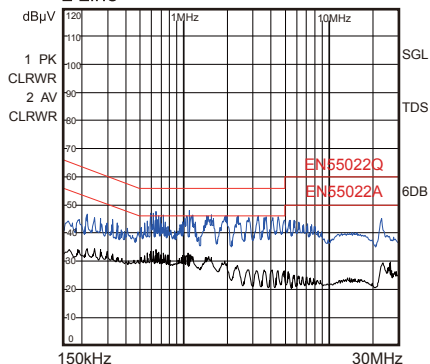
N Line



### Conducted EMI

Two-Wire Input,  $V_{IN}=230\text{VAC}$

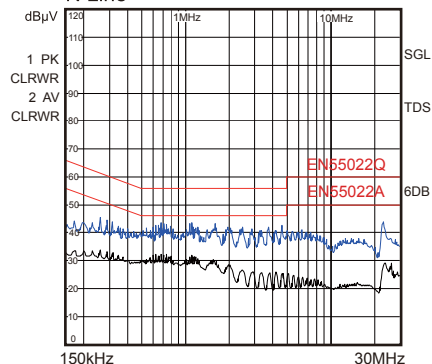
L Line



### Conducted EMI

Two-Wire Input,  $V_{IN}=230\text{VAC}$

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.
4. Connect Different Load to Corresponding Outputs :
  - a. Positive 1 (+): 18V OUT
  - b. Positive 2 (+): 5V OUT
  - c. Negative (-): GND
5. Turn Power Supply on after making connections.

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