



## DESCRIPTION

The MP175L is a primary-side regulator that provides accurate constant-voltage (CV) regulation without an optocoupler. The MP175L supports buck, buck-boost, boost, and flyback topologies. The MP175L has an integrated 700V MOSFET and high-voltage current source to simplify the structure and reduce costs.

The MP175L is a green-mode operation regulator. Both the peak current limit ( $I_{LIMIT}$ ) and switching frequency ( $f_{sw}$ ) decrease with decreasing load. This feature provides excellent efficiency under light-load conditions and improves the overall average efficiency.

The MP175L has multiple protection features, including over-temperature protection (OTP), VCC under-voltage lockout (UVLO), overload protection (OLP), short-circuit protection (SCP), brown-in protection, and open-loop detection (OLD).

These features make the MP175L an ideal regulator for offline, low-power applications, such as home appliances and standby power.

The MP175L is available in an SOIC-8 package.

## FEATURES

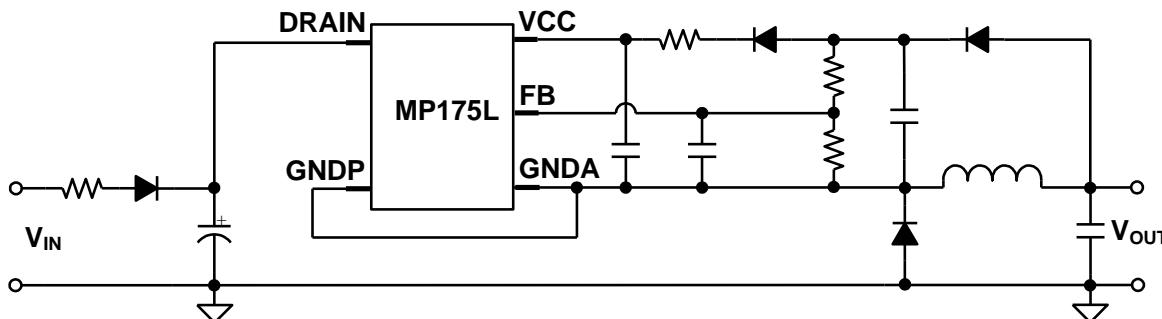
- Primary-Side Constant Voltage (CV) Control, Supporting Buck, Buck-Boost, Boost, and Flyback Topologies
- Integrated 700V/4.5Ω MOSFET
- Internal 700V High-Voltage Current Source
- <30mW No-Load Power Consumption
- Up to 9W Output Power ( $P_{OUT}$ )
- Maximum Continuous Conduction Mode (CCM) with an Output Current ( $I_{OUT}$ ) Up to 600mA
- Low VCC Operating Current
- Frequency Foldback
- Limited Maximum Frequency
- Peak-Current Compression
- Internally Biased VCC
- Over-Temperature Protection (OTP), Under-Voltage Lockout (UVLO), Overload Protection (OLP), Short-Circuit Protection (SCP), Open-Loop Detection (OLD), and Brown-In Protection
- Available in an SOIC-8 Package

## APPLICATIONS

- Home Appliances, White Goods, and Consumer Electronics
- Industrial Controls
- Standby Power

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## TYPICAL APPLICATION



**ORDERING INFORMATION**

Part Number*	Package	Top Marking	MSL Rating
MP175LGS	SOIC-8	See Below	2

\* For Tape & Reel, add suffix -Z (e.g. MP175LGS-Z).

**TOP MARKING**

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**MP175L**  
**LLLLLLLL**  
**MPSYWW**

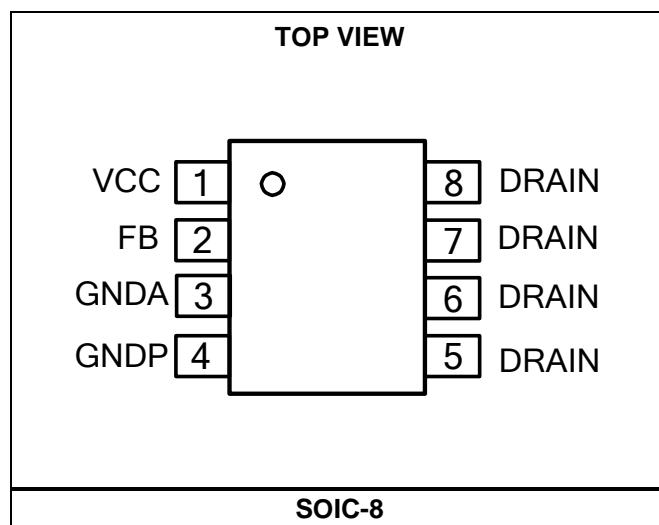
MP175L: Part number

LLLLLLLL: Lot number

MPS: MPS prefix

Y: Year code

WW: Week code

**PACKAGE REFERENCE**

## PIN FUNCTIONS

Pin #	Name	Description
1	VCC	Control circuit power supply.
2	FB	Regulator feedback.
3	GNDA	Short to GNDP in the application.
4	GNDP	IC power ground.
5, 6, 7, 8	DRAIN	Internal power MOSFET drain. DRAIN is the high-voltage current source regulator input.

ABSOLUTE MAXIMUM RATINGS <sup>(1)</sup>

DRAIN to GND.....	-0.3V to +700V
VCC to GND .....	-0.3V to +30V
FB to GND .....	-0.3V to +6.5V
Continuous power dissipation ( $T_A = 25^\circ\text{C}$ ) <sup>(2)</sup>	
SOIC-8 .....	1.64W
Junction temperature .....	150°C
Lead temperature .....	260°C
Storage temperature.....	-60°C to +150°C

## ESD Ratings

Human body model (HBM) .....	2kV
Charged device model (CDM).....	2kV

Recommended Operating Conditions <sup>(3)</sup>

Operating junction temp ( $T_J$ ) ....	-40°C to +125°C
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Thermal Resistance <sup>(4)</sup>

SOIC-8 .....	76.....35.....	°C/W
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## Notes:

- 1) Exceeding these ratings may damage the device.
- 2) The maximum allowable power dissipation is a function of the maximum junction temperature  $T_J$  (MAX), the junction-to-ambient thermal resistance  $\theta_{JA}$ , and the ambient temperature  $T_A$ . The maximum allowable continuous power dissipation at any ambient temperature is calculated by  $P_D$  (MAX) =  $(T_J$  (MAX) -  $T_A$ ) /  $\theta_{JA}$ . Exceeding the maximum allowable power dissipation can produce an excessive die temperature, which may cause the regulator to go into thermal shutdown. Internal thermal shutdown circuitry protects the device from permanent damage.
- 3) The device is not guaranteed to function outside of its operating conditions.
- 4) Measured on JESD51-7, 4-layer PCB.

## ELECTRICAL CHARACTERISTICS

V<sub>CC</sub> = 12V, T<sub>J</sub> = -40°C to +125°C, min and max values are guaranteed by characterization, typical values are tested at T<sub>J</sub> = 25°C, unless otherwise noted.

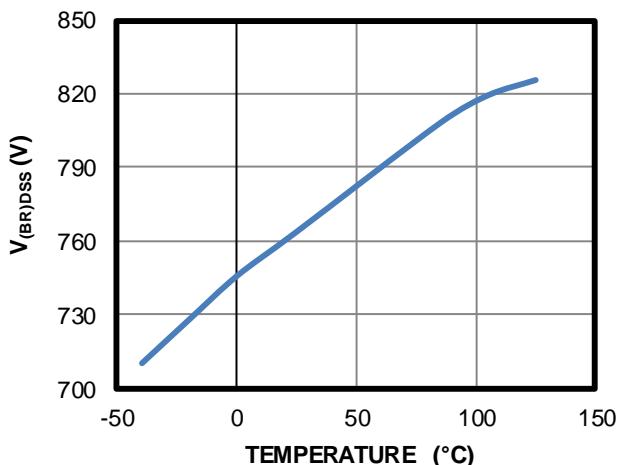
Parameter	Symbol	Condition	Min	Typ	Max	Units
<b>High-Voltage Current Source and Internal MOSFET (DRAIN)</b>						
Internal current-source regulator supply current	I <sub>REGULATOR</sub>	V <sub>CC</sub> = 4V, V <sub>DRAIN</sub> = 100V	3	4.5	6	mA
DRAIN leakage current	I <sub>LEAK</sub>	V <sub>DRAIN</sub> = 400V			40	µA
Breakdown voltage	V <sub>(BR)DSS</sub>	T <sub>J</sub> = 25°C	700			V
On resistance	R <sub>ON</sub>	T <sub>J</sub> = 25°C		4.5	6.5	Ω
Brown-in threshold	V <sub>DS_BI</sub>	T <sub>J</sub> = 25°C		40		V
<b>Supply Voltage (V<sub>CC</sub>) Management</b>						
Increasing V <sub>CC</sub> level at which the internal regulator turns off	V <sub>HV_OFF</sub>		8.4	9	9.6	V
Decreasing V <sub>CC</sub> level at which the internal regulator turns on	V <sub>HV_ON</sub>		7.9	8.5	9.1	V
HV regulator on and off hysteresis			200			mV
V <sub>CC</sub> under-voltage lockout (UVLO) threshold	V <sub>CCL</sub>		7	7.9	8.7	V
Decreasing V <sub>CC</sub> level at which the protection phase ends	V <sub>CC_PRO</sub>			3.5	4	V
IC consumption <sup>(5)</sup>	I <sub>CC</sub>	f <sub>SW</sub> = 40kHz, T <sub>J</sub> = 25°C		920	1070	µA
		MOSFET on		900	1050	
		MOSFET off	220	310	400	
Internal IC consumption under protection	I <sub>CC_PRO</sub>			40	65	µA
<b>Internal Current Sense</b>						
Peak current limit	I <sub>LIMIT</sub>	T <sub>J</sub> = 25°C	1.02	1.1	1.18	A
Leading-edge blanking (LEB) time	t <sub>LEB1</sub>			230		ns
Short-circuit protection (SCP) threshold	I <sub>SCP</sub>	T <sub>J</sub> = 25°C	135%	155%	175%	I <sub>LIMIT</sub>
LEB for SCP	t <sub>LEB2</sub>			200		ns
<b>Feedback (FB) Input</b>						
Minimum off time	t <sub>MINOFF</sub>		19.9	24	28.4	µs
Maximum on time	t <sub>MAXON</sub>		29.5	34	39.5	µs
MOSFET turn-on threshold	V <sub>FB</sub>		2.31	2.43	2.53	V
Overload protection (OLP) counter				4096		cycles
Open-loop detection (OLD)	V <sub>OLD</sub>		0.2	0.3	0.4	V
<b>Thermal Shutdown</b>						
Over-temperature protection (OTP) threshold <sup>(5)</sup>				150		°C

**Note:**

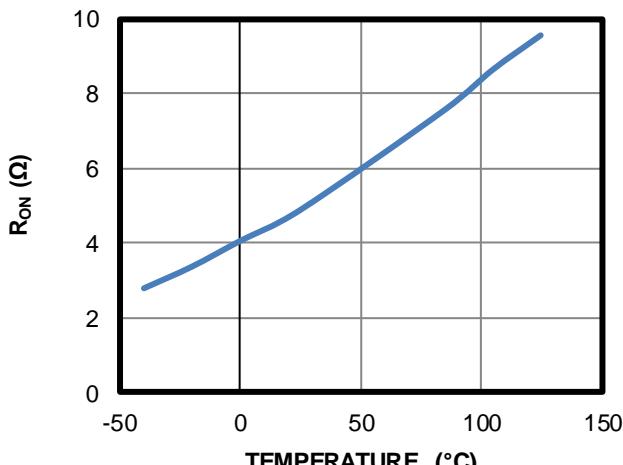
5) Guaranteed by design.

## TYPICAL CHARACTERISTICS

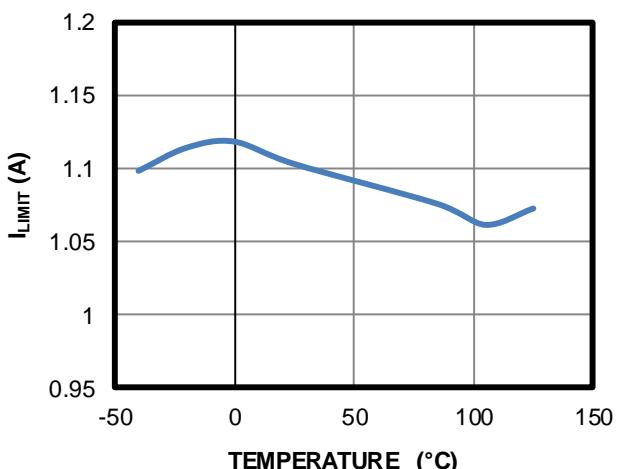
Breakdown Voltage vs.  
Temperature



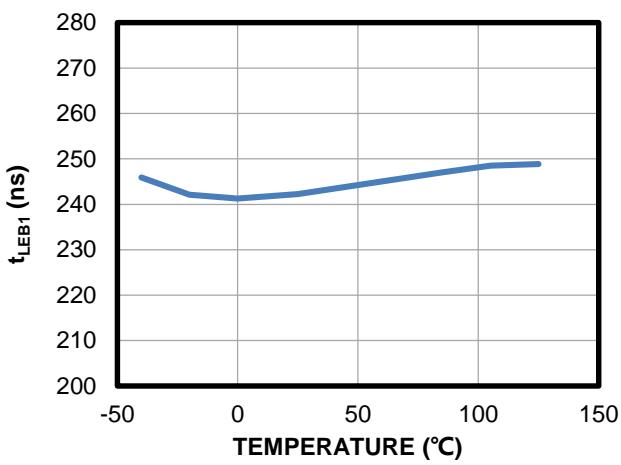
On Resistance vs. Temperature



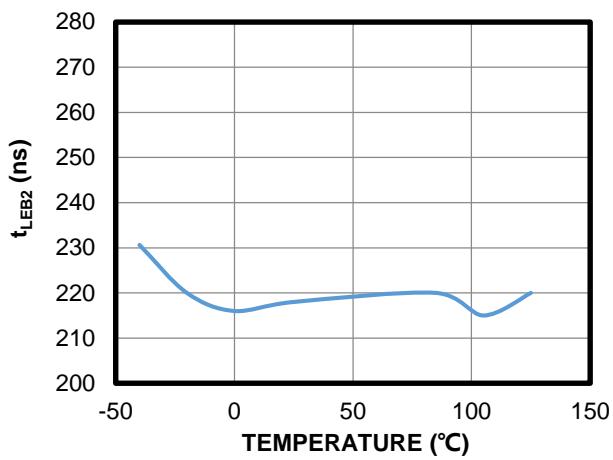
Peak Current Limit vs.  
Temperature



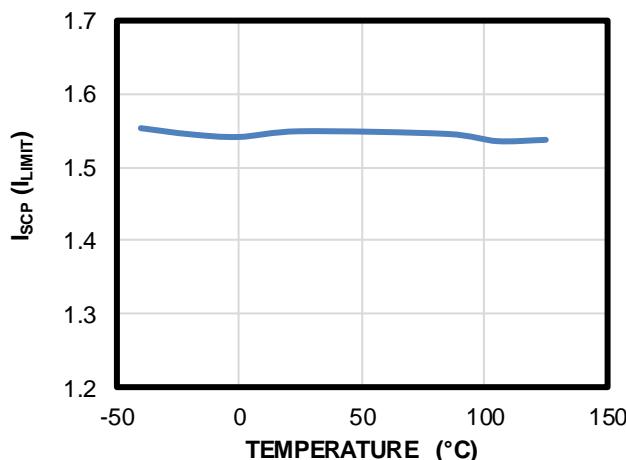
Leading-Edge Blanking Time vs.  
Temperature

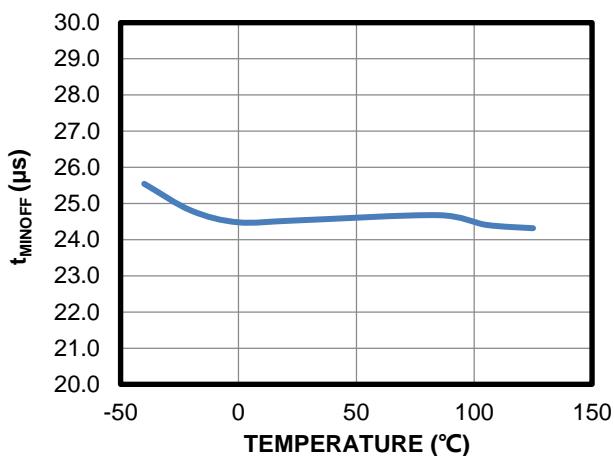
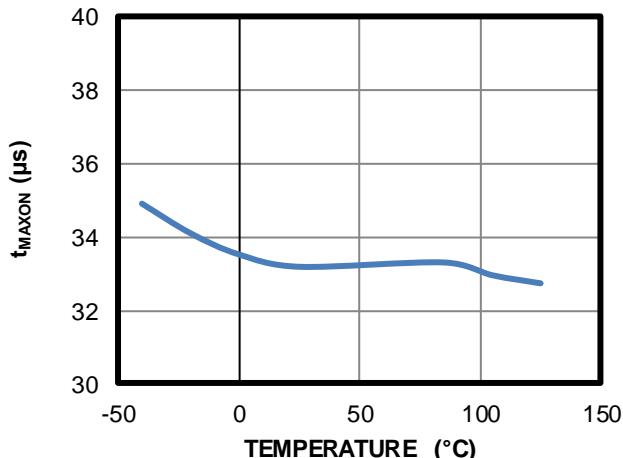
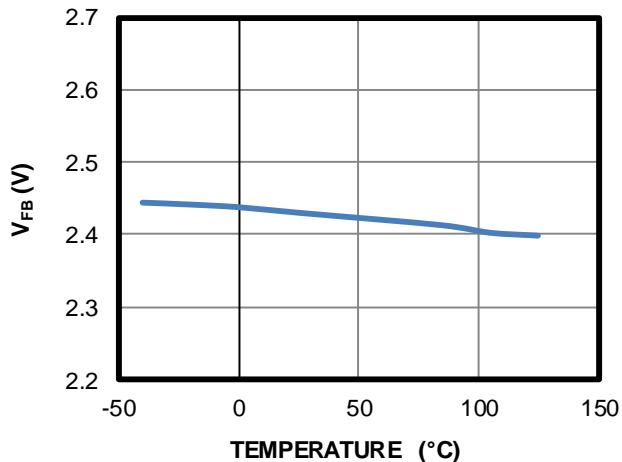
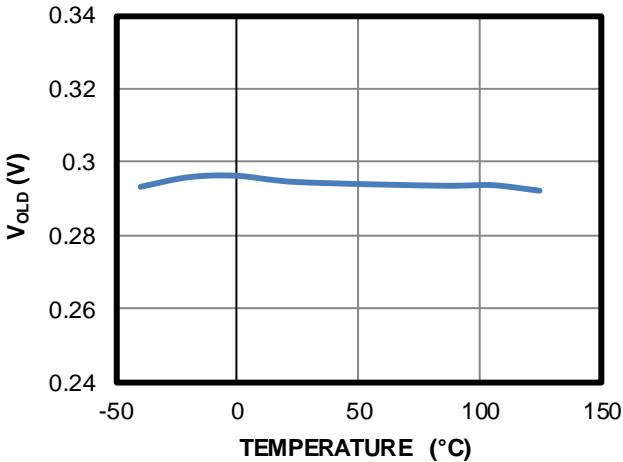
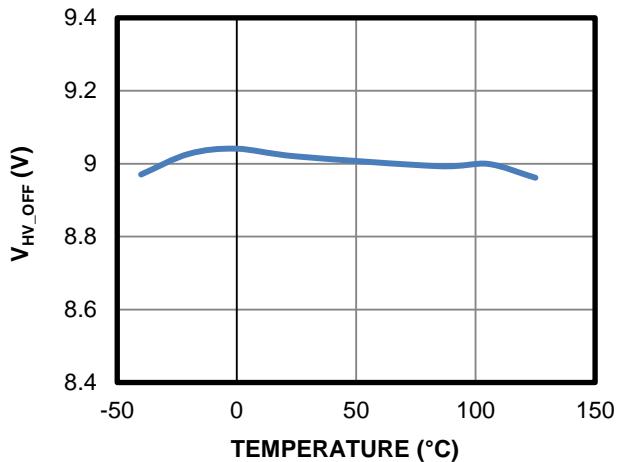
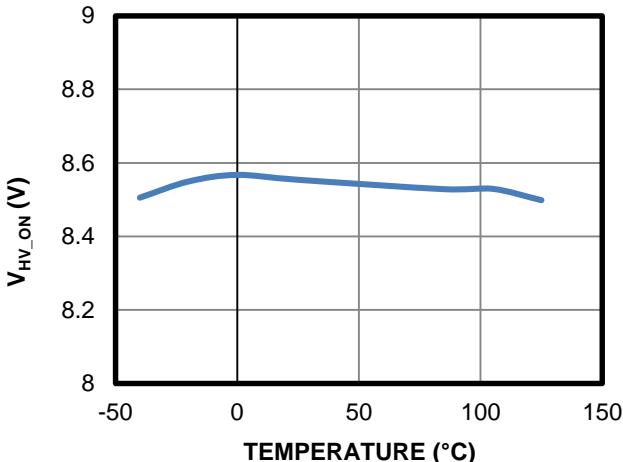


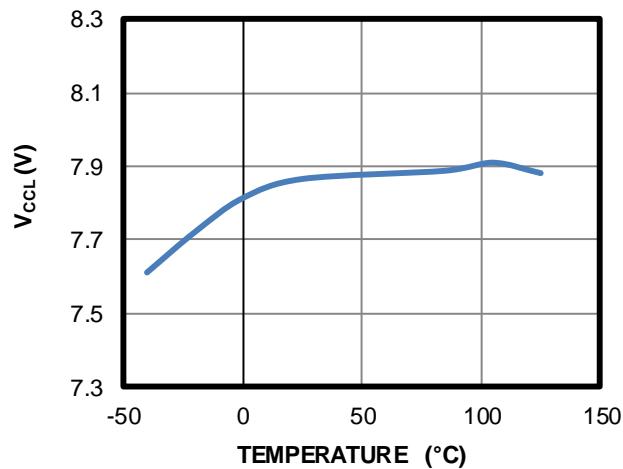
Leading-Edge Blanking Time  
for SCP vs. Temperature



SCP Threshold vs. Temperature



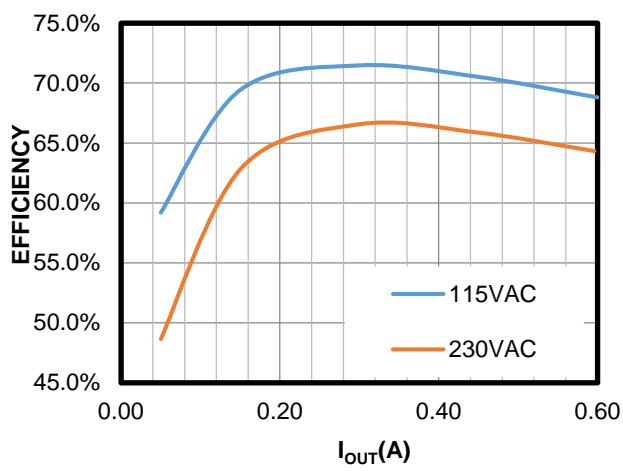
**TYPICAL CHARACTERISTICS (continued)**
**Minimum Off Time vs.  
Temperature**

**Maximum On Time vs.  
Temperature**

**MOSFET Turn-On Threshold vs.  
Temperature**

**Open-Loop Detection vs.  
Temperature**

**Increasing VCC Level at which the  
Internal Regulator Turns Off vs.  
Temperature**

**Decreasing VCC Level at which the  
Internal Regulator Turns On vs.  
Temperature**


**TYPICAL CHARACTERISTICS (continued)****V<sub>CC</sub> Under-Voltage Lockout  
Threshold vs. Temperature**

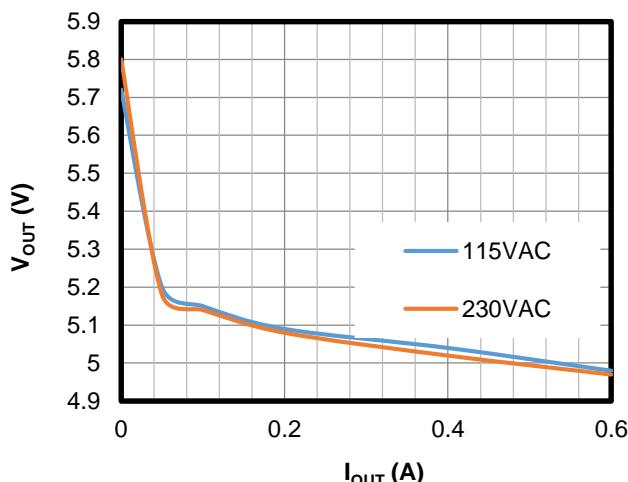
## TYPICAL PERFORMANCE CHARACTERISTICS

Performance waveforms are tested with the evaluation board,  $V_{IN} = 230V_{AC}$ ,  $V_{OUT} = 5V$ ,  $I_{OUT} = 600mA$ ,  $T_A = 25^\circ C$ , unless otherwise noted.

Efficiency vs. Output Current



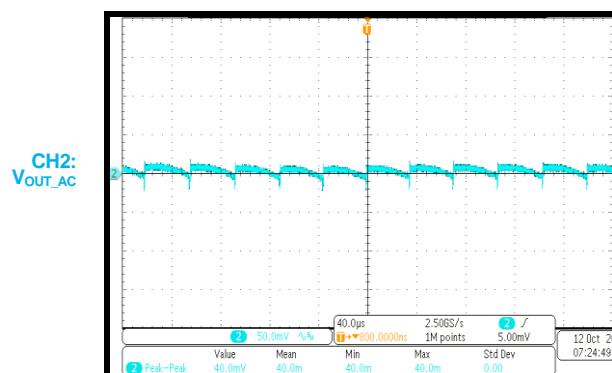
Load Regulation



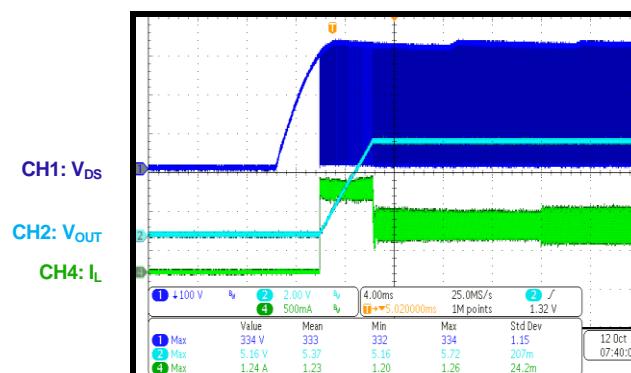
## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Performance waveforms are tested with the evaluation board,  $V_{IN} = 230V_{AC}$ ,  $V_{OUT} = 5V$ ,  $I_{OUT} = 600mA$ ,  $T_A = 25^\circ C$ , unless otherwise noted.

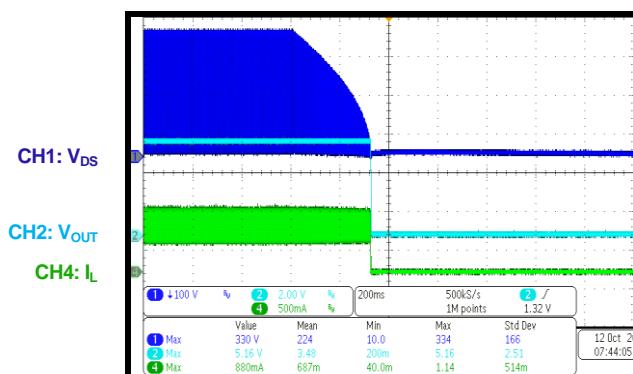
### Ripple



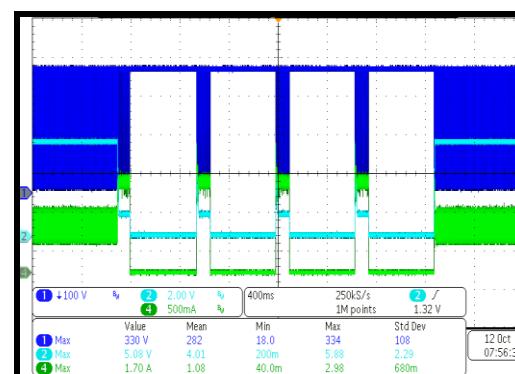
### Start-Up



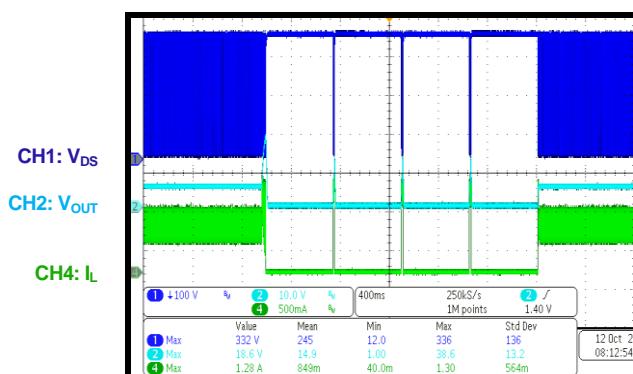
### Shutdown



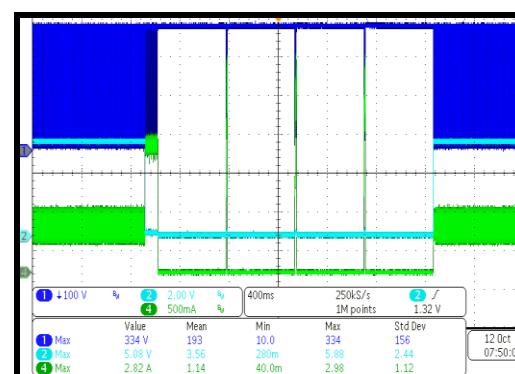
### OLP Entry and Recovery

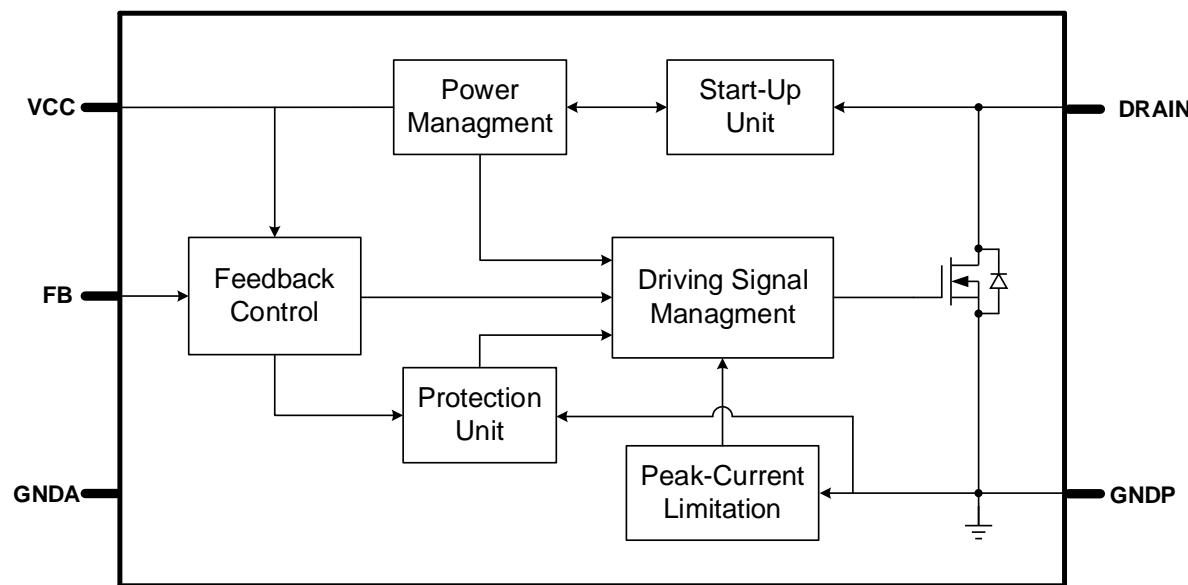


### Open Loop Entry and Recovery



### SCP Entry and Recovery



**FUNCTIONAL BLOCK DIAGRAM****Figure 1: Functional Block Diagram**

## OPERATION

The MP175L is a green-mode operation regulator. The peak current limit ( $I_{LIMIT}$ ) and the switching frequency ( $f_{SW}$ ) both decrease as the load decreases. As a result, the MP175L offers excellent light-load efficiency and improves average efficiency. The Typical Application diagram on page 1 shows a regular buck configuration.

### Start-Up and Under-Voltage Lockout (UVLO)

The internal high-voltage current-source regulator supplies the VCC pin from DRAIN. When VCC is charged to the increasing supply voltage level ( $V_{HV\_OFF}$ ), the internal high-voltage current source turns off. Subsequently, the IC is ready for switching until the drain-to-source voltage reaches the brown-in threshold ( $V_{DS\_BI}$ ) before UVLO occurs. If VCC falls below the decreasing VCC level ( $V_{HV\_ON}$ ), then the internal high-voltage current source turns on to charge the external VCC capacitor. Therefore, the MP175L can work with a small VCC capacitor (in the low  $\mu$ F range).

UVLO makes the IC stop switching when VCC falls below the VCC UVLO threshold ( $V_{CCL}$ ), preventing errors caused by an insufficient supply voltage. The IC remains off until the supply voltage (Vcc) is charged to  $V_{HV\_OFF}$  again (see Figure 2).

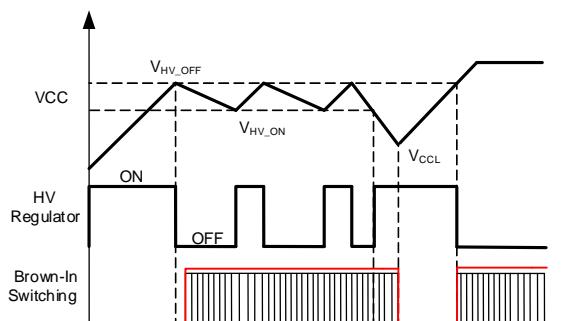


Figure 2: Start-Up and UVLO Operation

### Soft Start (SS)

The soft start (SS) period, which occurs whenever the chip begins switching, prevents the inductor current from overshooting.

The MP175L implements SS by gradually decreasing the minimum off time in eight steps. Table 1 shows the sequence pattern for SS.

During SS, short-circuit protection (SCP), overload protection (OLP), and open-loop detection (OLD) are disabled.

Table 1: SS Sequence Pattern

Step	Min Off Time ( $\mu$ s)	Cycles
1	48	16
2	36	16
3	24	32
4	20	64
5	18	128
6	16	128
7	14	128
8	13	128

### Constant-Voltage (CV) Operation

The MP175L is a constant-voltage (CV) regulator that regulates the output voltage ( $V_{OUT}$ ) using the feedback (FB) voltage, depending on the external divider set-up.

Figure 3 shows that the internal MOSFET is turned on when the FB voltage falls below the MOSFET turn-on threshold ( $V_{FB}$ ), and is turned off based on  $I_{LIMIT}$ .  $V_{FB}$  is the reference voltage for the FB pin.

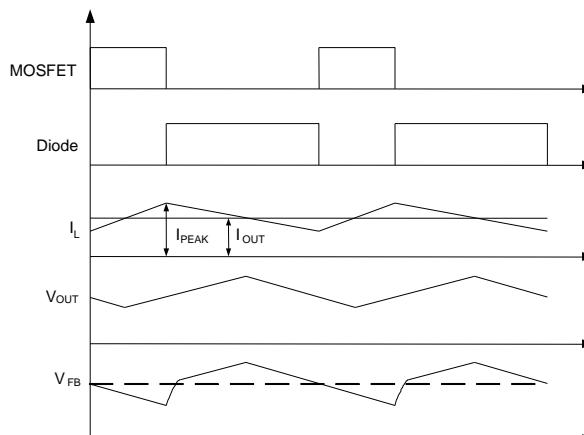


Figure 3: Constant-Voltage Regulation

In this way, the FB voltage is regulated at the reference voltage.  $V_{OUT}$  can be calculated using Equation (1):

$$V_{OUT} = V_{FB} \times \frac{R_{UP} + R_{LOW}}{R_{LOW}} \quad (1)$$

### Frequency Foldback and Peak-Current Compression

Due to the MP175L's constant voltage regulation scheme, the high-voltage regulator's switching frequency ( $f_{SW}$ ) decreases as the load decreases. As a result, the MP175L can achieve excellent efficiency under light-load conditions.

$f_{SW}$  can be estimated using Equation (2) for continuous conduction mode (CCM) and Equation (3) for discontinuous conduction mode (DCM):

$$f_{SW} = \frac{(V_{IN} - V_{OUT})}{2L \times (I_{PEAK} - I_{OUT})} \times \frac{V_{OUT}}{V_{IN}} \quad (2)$$

$$f_{SW} = \frac{2(V_{IN} - V_{OUT})}{L \times I_{PEAK}^2} \times \frac{I_{OUT} \times V_{OUT}}{V_{IN}} \quad (3)$$

As  $f_{SW}$  decreases,  $I_{LIMIT}$  also decreases to minimize audible noise when the frequency drops down to the audible range.  $I_{LIMIT}$  can be estimated using Equation (4):

$$I_{PEAK} = I_{LIMIT} - (40mA/\mu s) \times (t_{OFF} - t_{MINOFF}) \quad (4)$$

The minimum peak current ( $I_{PEAK}$ ) is limited internally.

### Overload Protection (OLP)

The MP175L's maximum output power ( $P_{OUT}$ ) is limited by  $t_{MINOFF}$  and  $I_{LIMIT}$ . The MP175L is considered to be in an overload condition when working under a  $t_{MINOFF}$ , which indicates a maximum  $f_{SW}$ .

When the MP175L works at a  $t_{MINOFF}$ , the overload protection (OLP) counter begins counting the switching cycle. If the counter reaches 4096 cycles, OLP is triggered. The OLP counter helps prevent OLP from triggering falsely during start-up or load transition.

The overload state is also affected by external settings, such as  $V_{IN}$ ,  $V_{OUT}$ , and inductor value. OLP helps avoid overstress operation of the system in most cases.

### Short-Circuit Protection (SCP)

The MP175L monitors  $I_{PEAK}$ , and shuts down if  $I_{PEAK}$  exceeds the SCP threshold. Once the fault condition is removed, the power supply resumes normal operation.

### Over-Temperature Protection (OTP)

Over-temperature protection (OTP) is triggered when the junction temperature ( $T_J$ ) exceeds the thermal shutdown threshold to prevent any thermally induced damage to the chip.

### Brown-In Protection

The MP175L integrates a brown-in function by sampling the drain-to-source voltage ( $V_{DS}$ ). After the IC stops switching,  $V_{DS}$  must exceed the brown-in threshold ( $V_{DS\_BI}$ ) before the IC can start to work again.

Brown-in protection prevents switching after shutdown.

### Open-Loop Detection (OLD)

If  $V_{FB}$  is below the OLD threshold ( $V_{OLD}$ ), the IC stops switching and a restart cycle begins. During SS, OLD is blanked.

To use OLD, the FB capacitor should be separated from the VCC capacitor. For circuit design recommendations, see the FB Set-Up section on page 13.

OLD is disabled when the VCC capacitor functions as an FB capacitor.

### Leading-Edge Blanking (LEB)

An internal LEB unit prevents premature switching pulse termination due to a start-up spike. Start-up spikes are caused by parasitic capacitance and reverse recovery of the freewheeling diode. During the blanking time, the current comparator is disabled and cannot turn off the internal MOSFET (see Figure 4).

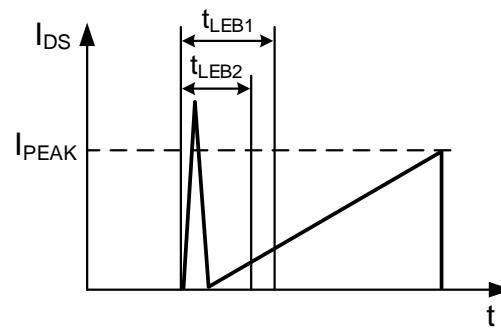


Figure 4: Leading-Edge Blanking Time

## APPLICATION INFORMATION

### Selecting the Input Capacitor

The input capacitor supplies the DC input voltage ( $V_{IN}$ ) to the converter. Figure 5 shows the typical DC bus voltage waveform of a half-wave rectifier and full-wave rectifier.

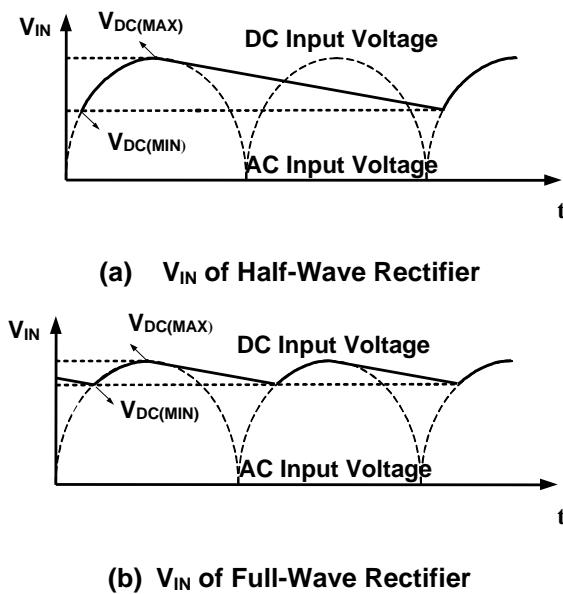


Figure 5: Input Voltage Waveforms

Typically, a half-wave rectifier requires an input capacitor rated at  $3\mu F/W$  for the universal input condition. When using a full-wave rectifier, the input capacitor should be between  $1.5\mu F/W$  and  $2\mu F/W$  for the universal input condition. A half-wave rectifier is recommended for  $<2W$  output applications. A full-wave rectifier is recommended for  $>2W$  output applications.

Avoid using an input capacitor that is too small, since it may not hold the DC voltage high for long enough. A low DC  $V_{IN}$  can lead to bad thermal performance. If  $V_{IN}$  is very low, the MOSFET on time may reach the maximum on time ( $t_{MAXON}$ ).

### Selecting the Inductor

The MP175L has a  $t_{MINOFF}$  limit that determines the maximum  $P_{OUT}$ . Since  $I_{LIMIT}$  is fixed, the maximum power ( $P_{OMAX}$ ) increases as the inductance increases. Using a small inductance may lead to insufficient output power, but a larger inductance results in an inappropriate OLP point.

It is recommended to select an inductor with the minimum inductance needed to meet the

overload requirement. The  $I_{LIMIT}$  and  $t_{MINOFF}$  tolerances should also be considered for mass production. The OLP point can be estimated using Equation (5) for CCM or Equation (6) for DCM:

$$P_{OMAX} = V_{OUT} \times (I_{LIMIT} - \frac{V_{OUT} \times t_{MINOFF}}{2L}) \quad (5)$$

$$P_{OMAX} = \frac{1}{2} L \times I_{LIMIT}^2 \times \frac{1}{t_{MINOFF}} \quad (6)$$

To reduce costs, use a standard, off-the-shelf inductor with at least the calculated value.

### Freewheeling Diode

The diode should be selected based on the maximum  $V_{IN}$  and  $I_{PEAK}$ .

Since the freewheeling diode's reverse recovery can affect efficiency and circuit operation in CCM, it is recommended to use an ultra-fast reverse recovery diode, such as the STTH2R06.

### Selecting the Output Capacitor

The output capacitor ( $C_{OUT}$ ) is required to maintain the DC  $V_{OUT}$ . The  $V_{OUT}$  ripple can be estimated using Equation (7) for CCM or Equation (8) for DCM:

$$V_{OUT\_RIPPLE} = \frac{\Delta I}{8f_{SW} \times C_{OUT}} + \Delta I \times R_{ESR} \quad (7)$$

$$V_{OUT\_RIPPLE} = \frac{I_{OUT}}{f_{SW} \times C_{OUT}} \left( \frac{I_{PEAK} - I_{OUT}}{I_{PEAK}} \right)^2 + I_{PEAK} \times R_{ESR} \quad (8)$$

It is recommended to use low-ESR electrolytic or ceramic capacitors to reduce the  $V_{OUT}$  ripple.

### FB Set-Up

Two kinds of FB set-ups are recommended for the MP175L (see Figure 6 and Figure 7 on page 14). The FB set-up can be selected according to cost and performance requirements.

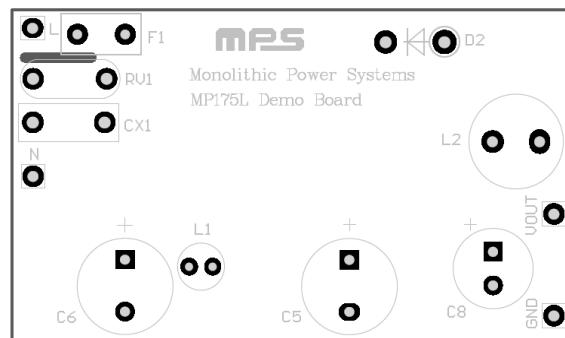
Figure 6 on page 14 shows the typical external FB circuit with the OLD function enabled. C1 is a dedicated FB capacitor, isolated from VCC via D2. This prevents VCC from interfering with the FB pin's operation. Both the VCC capacitor and FB loop can be adjusted. The set-up shown in Figure 6 is recommended for most



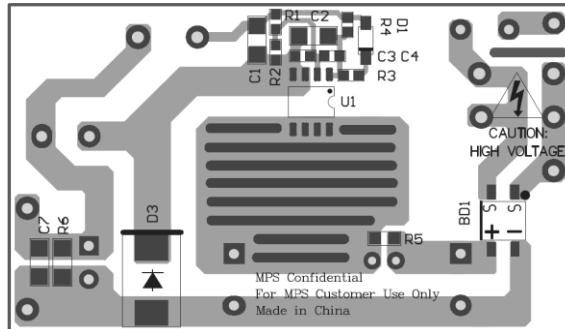
### PCB Layout Guidelines

PCB layout is critical for reliable operation, as well as good EMI and thermal performance. For the best performance, refer to Figure 9 and follow the guidelines below:

1. Minimize the loop area formed by the input capacitor, the MP175L's internal MOSFET, the freewheeling diode, the inductor, and the output capacitor.
2. Place the power inductor far away from the input filter while minimizing the loop area.
3. Keep the AC input loop as small as possible to prevent noise coupling.
4. Place a bypass capacitor (about 1nF) between FB and GND, as close to the IC as possible.
5. Connect a large copper area to DRAIN for better thermal performance.



Top Layer

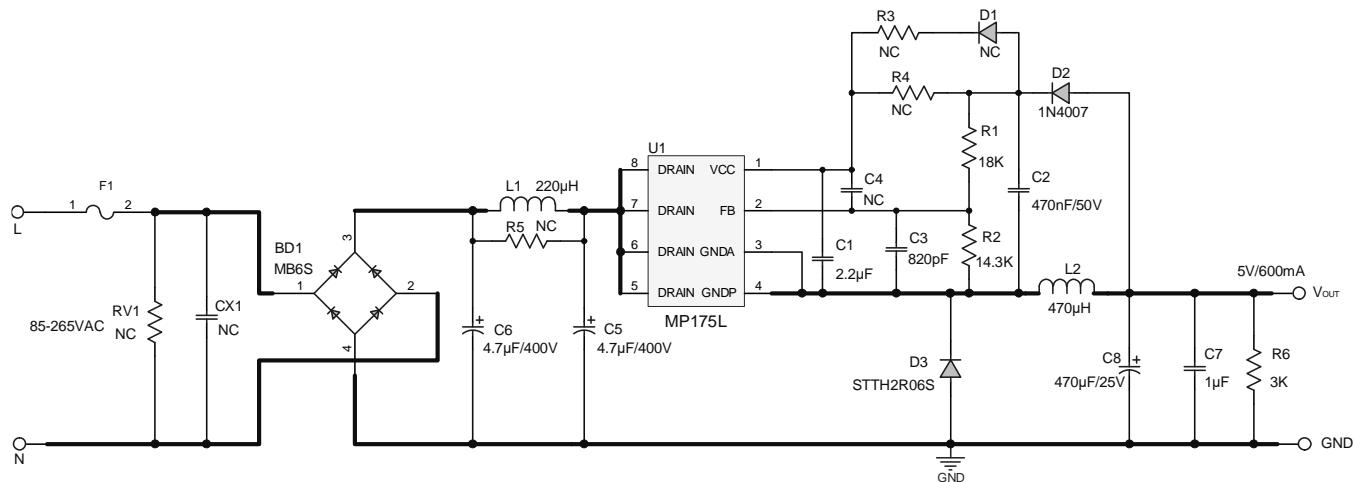


Bottom Layer

Figure 9: Recommended PCB Layout

## TYPICAL APPLICATION CIRCUIT

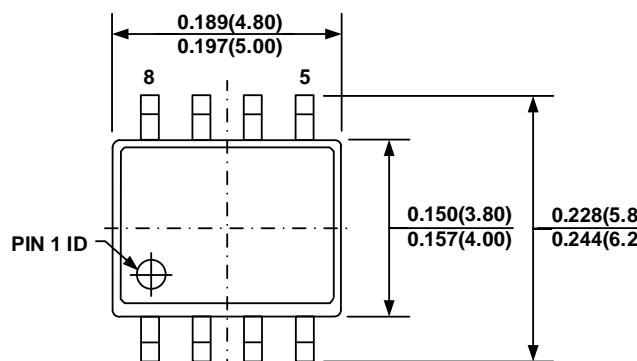
Figure 10 shows a typical application example of an 5V/600mA, non-isolated power supply using the MP175L.



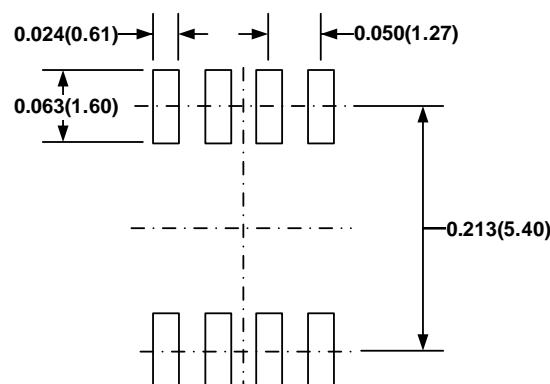
**Figure 10: Typical Application with Universal Input and 5V/600mA Output**

## PACKAGE INFORMATION

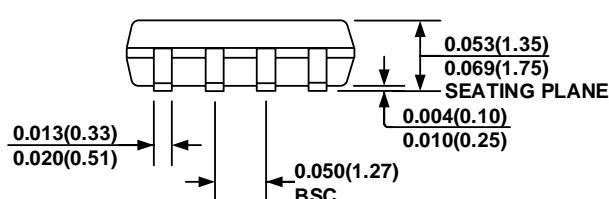
### SOIC-8



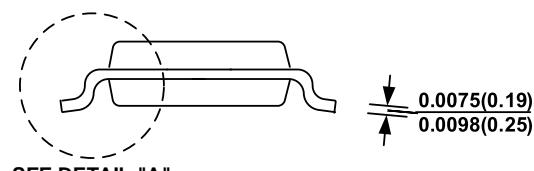
TOP VIEW



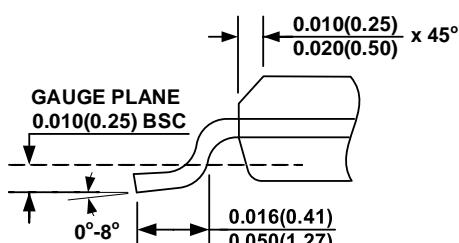
RECOMMENDED LAND PATTERN



FRONT VIEW



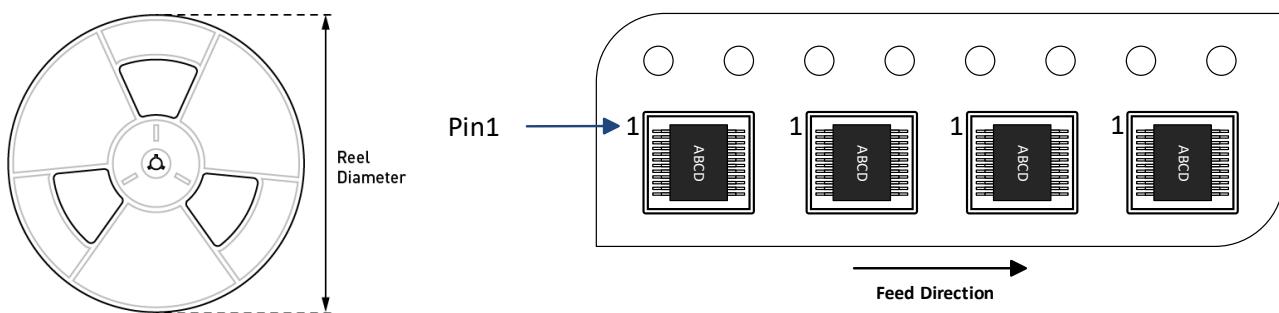
SIDE VIEW



DETAIL "A"

### NOTE:

- 1) CONTROL DIMENSION IS IN INCHES. DIMENSION IN BRACKET IS IN MILLIMETERS.
- 2) PACKAGE LENGTH DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.
- 3) PACKAGE WIDTH DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS.
- 4) LEAD COPLANARITY (BOTTOM OF LEADS AFTER FORMING) SHALL BE 0.004" INCHES MAX.
- 5) DRAWING CONFORMS TO JEDEC MS-012, VARIATION AA.
- 6) DRAWING IS NOT TO SCALE.

**CARRIER INFORMATION**

Part Number	Package Description	Quantity/ Reel	Quantity/ Tube	Quantity/ Tray	Reel Diameter	Carrier Tape Width	Carrier Tape Pitch
MP175LGS-Z	SOIC-8	2500	100	N/A	13in	12mm	8mm

**REVISION HISTORY**

Revision #	Revision Date	Description	Pages Updated
1.0	12/06/2021	Initial Release	-

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