

### DESCRIPTION

The MP2910 is a dual output with one synchronous buck PWM and one linear controller. The part is used to generate logic-supply voltages for PC based systems. MP2910 includes internal soft-start, frequency-compensation networks, power good signaling with specific sequence, and it comes all of the logic control, output adjustment, power monitoring and protection functions into a small footprint package. The part is operated at fixed 300 kHz frequency providing an optimum compromise between efficiency, external component size, and cost. The linear controller is implemented to drive an external MOSFET for regulation and it's adjustable by setting external resistors. Moreover the specific internal PG sequence and indicator is also implemented to conform to Intel® new platform requirement on FSB\_VTT power plane. An adjustable over-current protection (OCP) is proposed to monitor the voltage drop across the  $R_{DS(ON)}$  of the lower MOSFET for synchronous buck PWM DC-DC controller.

### FEATURES

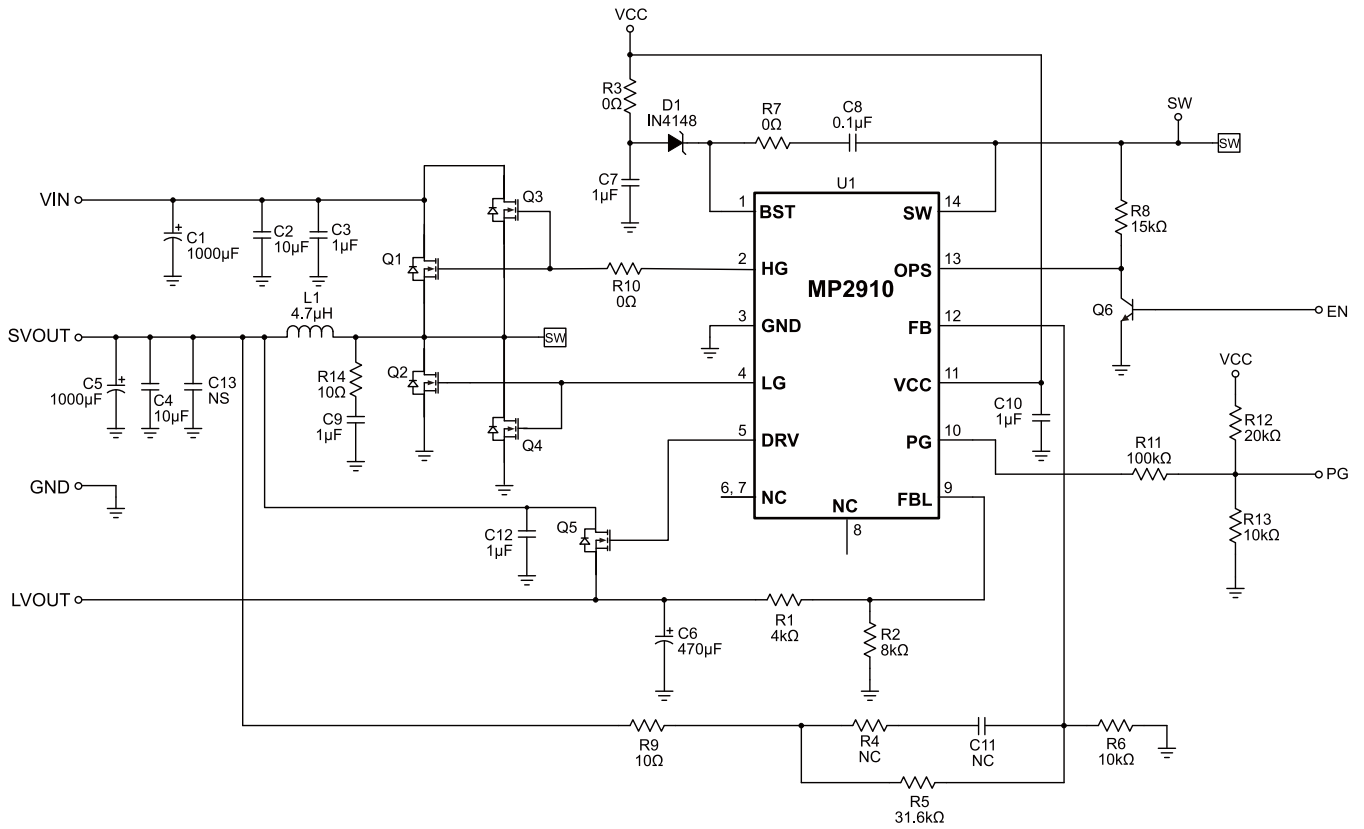
- Operating with 5V or 12V Supply Voltage
- Drives ALL Low Cost N-Channel MOSFETs
- Voltage Mode PWM Control
- 300kHz Fixed Frequency Oscillator
- Fast Transient Response:
  - High speed GM Amplifier
  - Full 0 to 100% Duty Ratio
- Internal Soft-Start
- Adaptive Non-Overlapping Gate Driver
- Over-Current Fault Monitor on MOSFET, No Current Sense Resistor Required
- Specific Power Good Indicator for Intel® Grantsdale FSB\_VTT Power Sequence
- Available in a SOIC-14 Package and a SOIC8E Package.

### APPLICATIONS

- Graphic Card
- Motherboard, Desktop Servers
- IA Equipments
- Telecomm Equipments
- High Power DC-DC Regulators

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**TYPICAL APPLICATION**



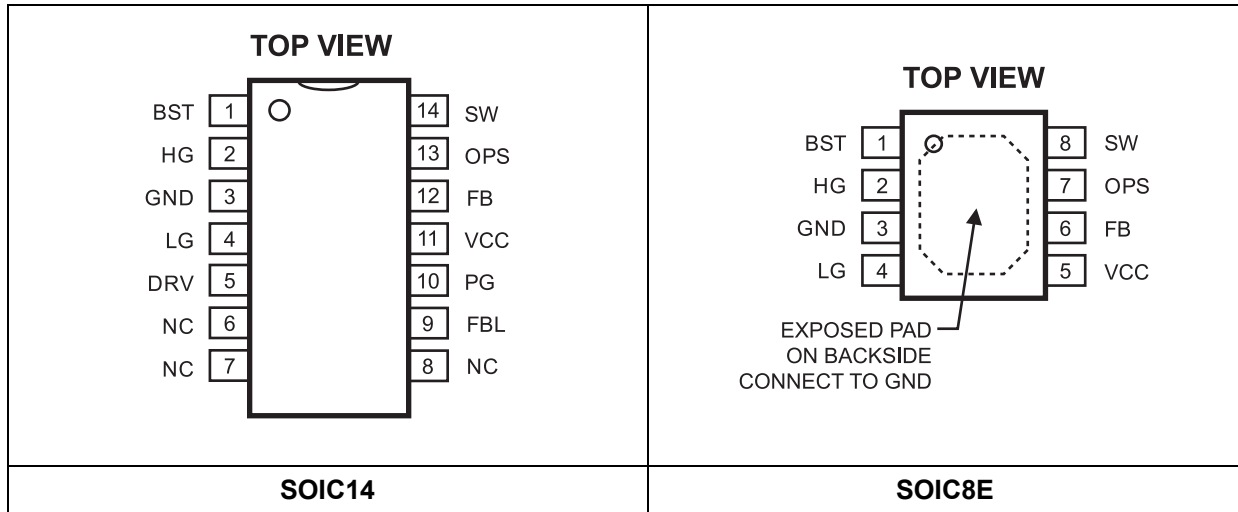
**ORDERING INFORMATION**

Part Number	Package	Top Marking	Free Air Temperature (T <sub>A</sub> )
MP2910ES*	SOIC14	MP2910ES	-20°C to +85°C
MP2910EN**	SOIC8E	MP2910EN	

\* For Tape & Reel, add suffix -Z (e.g. MP2910ES-Z);  
For RoHS, compliant packaging, add suffix -LF (e.g. MP MP2910ES-LF-Z).

\*\* For Tape & Reel, add suffix -Z (e.g. MP2910EN-Z);  
For RoHS, compliant packaging, add suffix -LF (e.g. MP MP2910EN-LF-Z).

**PACKAGE REFERENCE**



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

Supply Voltage V <sub>CC</sub> .....	16V
BST, V <sub>BST</sub> -V <sub>SW</sub> .....	16V
SW to GND .....	
DC .....	-5 to 15V
<200nS .....	-10 to 30V
HG .....	V <sub>SW</sub> -0.3V to V <sub>BST</sub> +0.3V
LG .....	-0.3V to V <sub>CC</sub> +0.3V
All Other Pins .....	-0.3V to +6V
Continuous Power Dissipation (T <sub>A</sub> = +25°C) <sup>(2)</sup>	
SOIC14 .....	1.5W
SOIC8E .....	2.6W
Junction Temperature .....	150°C
Lead Temperature .....	260°C
Storage Temperature .....	-65°C to +150°C

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

Supply Voltage V <sub>CC</sub> .....	5V ± 5%, 12 ± 10%
Operating Junct. Temp (T <sub>J</sub> ) .....	-20°C to +125°C
Ambient Temperature range .....	-20°C to +85°C

**Thermal Resistance** <sup>(4)</sup>

	θ <sub>JA</sub>	θ <sub>JC</sub>
SOIC8E .....	48	10
SOIC14 .....	86	38

**Notes:**

- 1) Exceeding these ratings may damage the device.
- 2) The maximum allowable power dissipation is a function of the maximum junction temperature T<sub>J</sub>(MAX), the junction-to-ambient thermal resistance θ<sub>JA</sub>, and the ambient temperature T<sub>A</sub>. The maximum allowable continuous power dissipation at any ambient temperature is calculated by P<sub>D</sub>(MAX)=(T<sub>J</sub>(MAX)-T<sub>A</sub>)/ θ<sub>JA</sub>. Exceeding the maximum allowable power dissipation will cause excessive die temperature, and the regulator will 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

$V_{CC} = 5V/12V$ ,  $T_A = 25^{\circ}C$ , unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ	Max	Units
<b>Supply Current</b>						
Nominal Supply Current	$I_{CC}$	UGATE AND LGATE OPEN		2.7	4	mA
<b>Power-On Reset</b>						
POR Threshold	$V_{CCRTH}$	$V_{CC}$ Rising	3.8	4.1	4.4	V
Hysteresis	$V_{CCHYS}$		0.15	0.4		V
<b>Switcher Reference</b>						
Reference Voltage	$V_{REF}$	$V_{CC}=12V$	0.784	0.8	0.816	V
<b>Oscillator</b>						
Free Running Frequency	$f_{OSC}$	$V_{CC}=12V$	240	290	340	kHz
Ramp Amplitude	$\Delta V_{OSC}$			1.5		V
<b>Error Amplifier</b>						
EA Transconductance	$G_m$			0.2		ms
Open Loop DC Gain	$A_o$			85		DB
<b>Linear Regulator</b>						
DRV Driver Source	$I_{DS}$	$V_{DRV}=6V$		2.3		mA
Reference Voltage	$V_{REF}$	$V_{CC}=12V$	0.784	0.8	0.816	V
<b>PWM Controller Gate Drivers (<math>V_{CC}=12V</math>)</b>						
Upper Gate Source	$I_{HG}$	$V_{BST} - V_{SW} = 12V$ $V_{HG} - V_{SW} = 6V$	0.6	1		A
Upper Gate Sink	$R_{HG}$	$V_{BST} - V_{SW} = 12V$ $V_{HG} - V_{SW} = 1V$		4	6	$\Omega$
Lower Gate Source	$I_{LG}$	$V_{CC} = 12V, V_{LG} = 6V$	0.6	1		A
Lower Gate Sink	$R_{LG}$	$V_{CC} = 12V, V_{LG} = 1V$		2.8	3.8	$\Omega$
Dead Time	$T_{DT}$			25	100	ns
<b>Protection</b>						
FB Under-Voltage Trip		FB Falling	75	82.5	90	%
FBL Under-Voltage Trip		FB and FBL Falling	75	82.5	90	%
OC Current Source	$I_{OC}$	$V_{SW} = 0V$		38		$\mu A$
Soft-Start Interval	$T_{SS}$			2.5		ms
<b>Power Good</b>						
Power Good Rising Threshold		$V_{CC}=12V$		90		%
Power Good Hysteresis		$V_{CC}=12V$		10		%
PG Sink Capability		$V_{CC}=12V, 1mA$		0.02	0.4	V
Power Good Rising Delay		$V_{CC}=12V$	1	4	10	ms
Power Good Falling Delay		$V_{CC}=12V$		15		$\mu s$

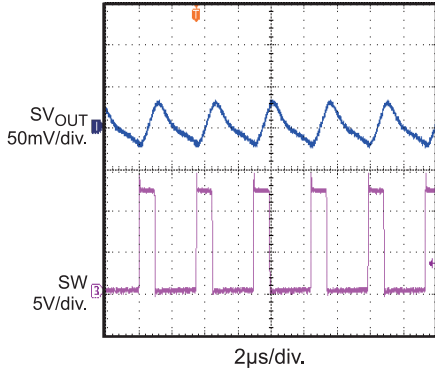
## PIN FUNCTIONS

SOIC14 Pin #	SOIC8E Pin #	Name	Description
1	1	BST	Bootstrap supply pin for the upper gate driver. Connect the bootstrap capacitor between BST pin and the SW pin
2	2	HG	Upper gate driver output. Connect to gate of the high side power N-MOSFET.
3	3	GND	Both signal and power ground for the IC
4	4	LG	Lower gate drive output. Connect to gate of the low-side power N-MOSFET
5		DRV	This pin provides the drive for the linear regulator's pass transistor/MOSFET.
6, 7, 8		NC	No internal connection
9		FBL	Linear regulator feedback voltage.
10		PG	PG is an open-drain output used to indicate that the regulator is within normal operating voltage ranges
11	5	V <sub>CC</sub>	Connect this pin to a well-decoupled 5V or 12V bias supply. It is also the positive supply for the lower gate driver, LG.
12	6	FB	Switcher feedback voltage. This pin is the inverting input of the error amplifier.
13	7	OPS	This pin provides multi-function of the over-current setting, HG turn-on POR sensing, and shut-down features.
14	8	SW	Connect this pin to the source of the upper MOSFET and the drain of the lower MOSFET.

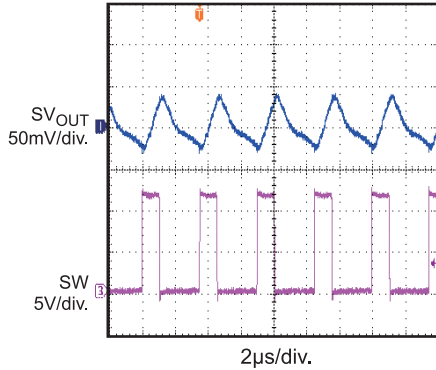
**TYPICAL PERFORMANCE CHARACTERISTICS**

$V_{IN}=12V$ ,  $S_{V_{OUT}}=3.3V$ ,  $L_1=4.7\mu F$ ,  $C_5=1000\mu F$ ,  $L_{Vout}=1.2V$ ,  $T_A=25^\circ C$ , unless otherwise noted.

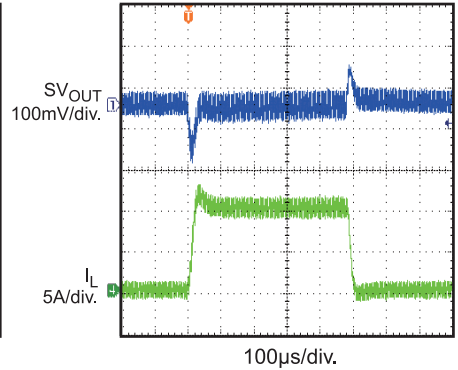
**Output Ripple**  
 $V_{CC}=12V$ ,  $I_{LOAD}=0A$



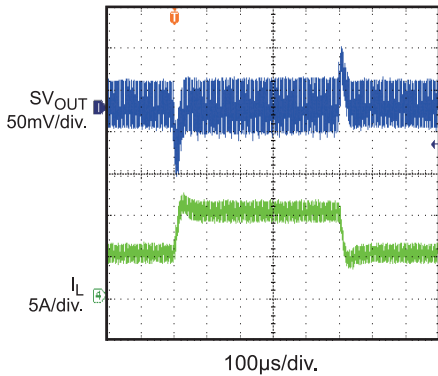
**Output Ripple**  
 $V_{CC}=12V$ ,  $I_{LOAD}=10A$



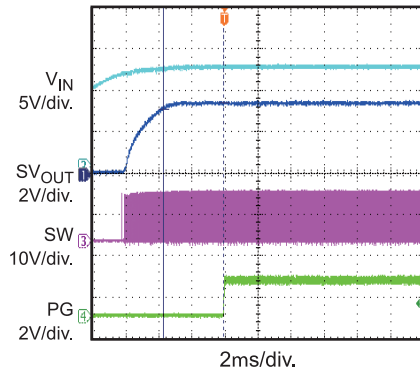
**Tansient Response**  
 $I_{OUT}=0A$  to  $10A$  resistive load,  
slew rate= $2.5A/\mu s$



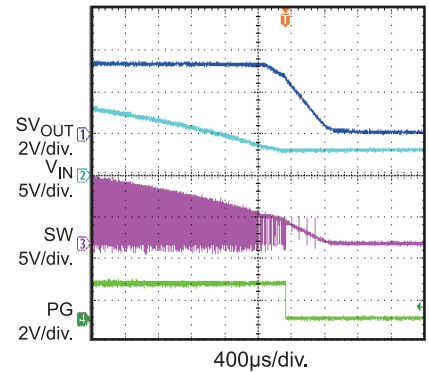
**Tansient Response**  
 $I_{OUT}=5A$  to  $10A$  resistive load,  
slew rate= $2.5A/\mu s$



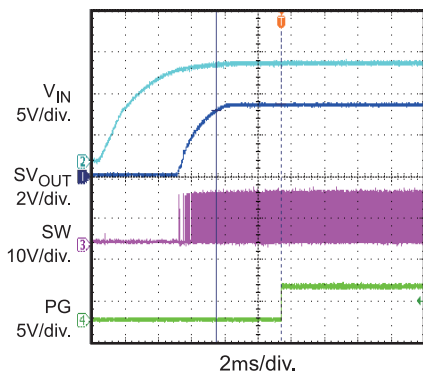
**Power Good**  
 $V_{CC}=5V$ ,  $I_{LOAD}=5A$



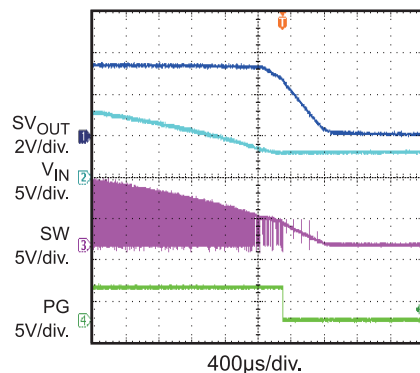
**Power Good**  
 $V_{CC}=5V$ ,  $I_{LOAD}=5A$



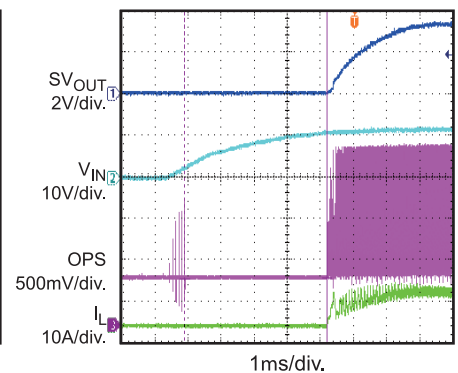
**Power Good**  
 $V_{CC}=12V$ ,  $I_{LOAD}=5A$



**Power Good**  
 $V_{CC}=12V$ ,  $I_{LOAD}=5A$

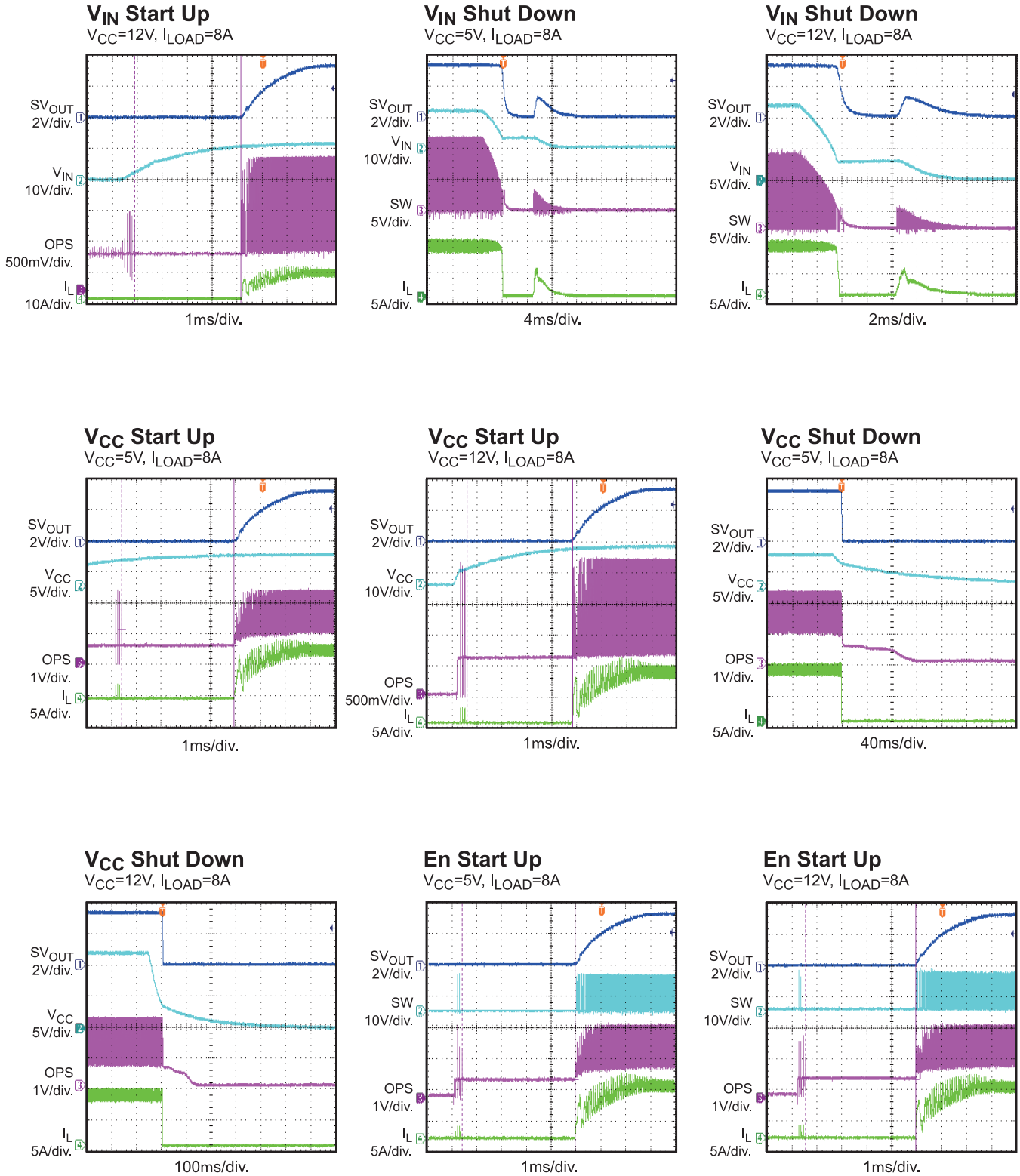


**VIN Start Up**  
 $V_{CC}=5V$ ,  $I_{LOAD}=8A$



**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

$V_{IN}=12V$ ,  $S_{V_{OUT}}=3.3V$ ,  $L_1=4.7\mu F$ ,  $C_5=1000\mu F$ ,  $L_{Vout}=1.2V$ ,  $T_A=25^\circ C$ , unless otherwise noted.

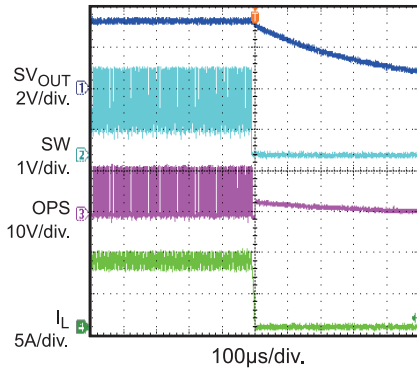


**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

$V_{IN}=12V$ ,  $S_{V_{OUT}}=3.3V$ ,  $L_1=4.7\mu F$ ,  $C_5=1000\mu F$ ,  $L_{Vout}=1.2V$ ,  $T_A=25^\circ C$ , unless otherwise noted.

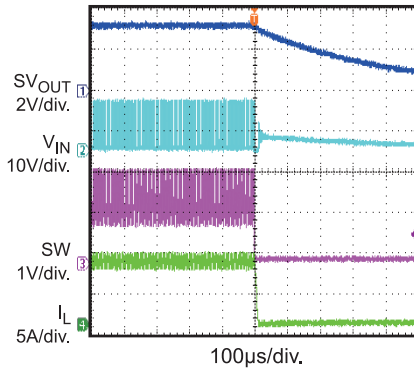
**En Shut Down**

$V_{CC}=5V$ ,  $I_{LOAD}=8A$



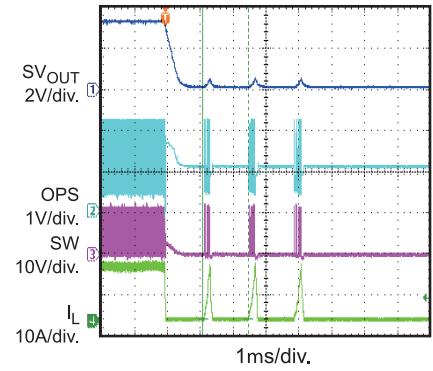
**En Shut Down**

$V_{CC}=12V$ ,  $I_{LOAD}=8A$



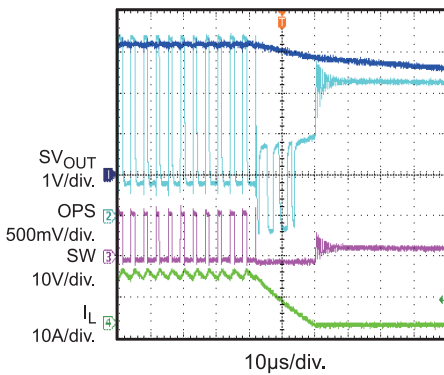
**OCP**

$V_{CC}=12V$ ,  $I_{OCSET}=12.3A$ ,  
 $R_{OCSET}=13.7k\Omega$



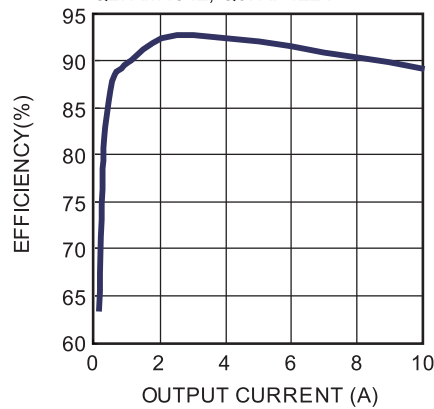
**OCP**

$V_{CC}=12V$ ,  $I_{OCSET}=12.3A$ ,  
 $R_{OCSET}=13.7k\Omega$



**Efficiency**

$V_{CC}=5V$ ,  
MOSFET Q1&Q4: NC  
Q2: AM4842, Q3: AP4224





## FUNCTION BLOCK DIAGRAM

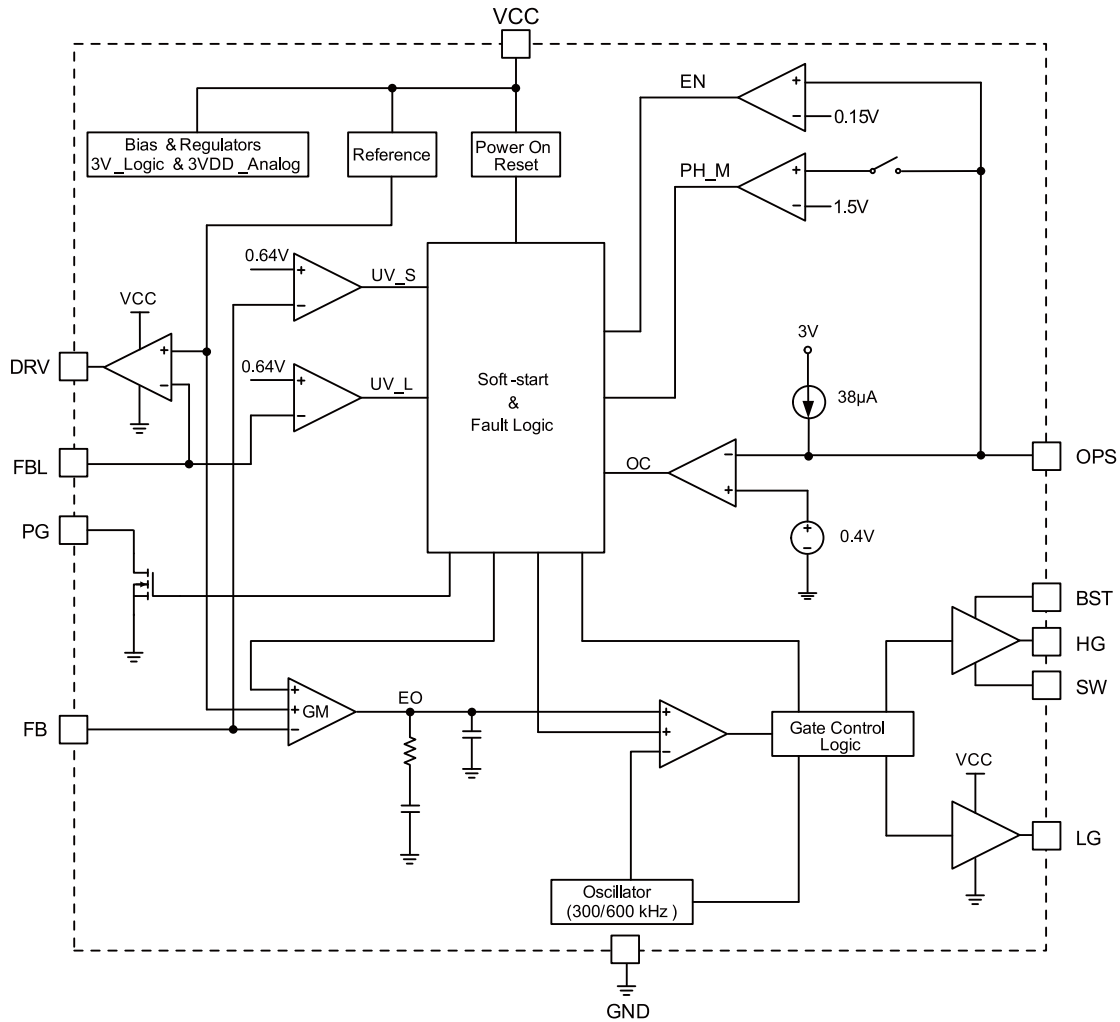
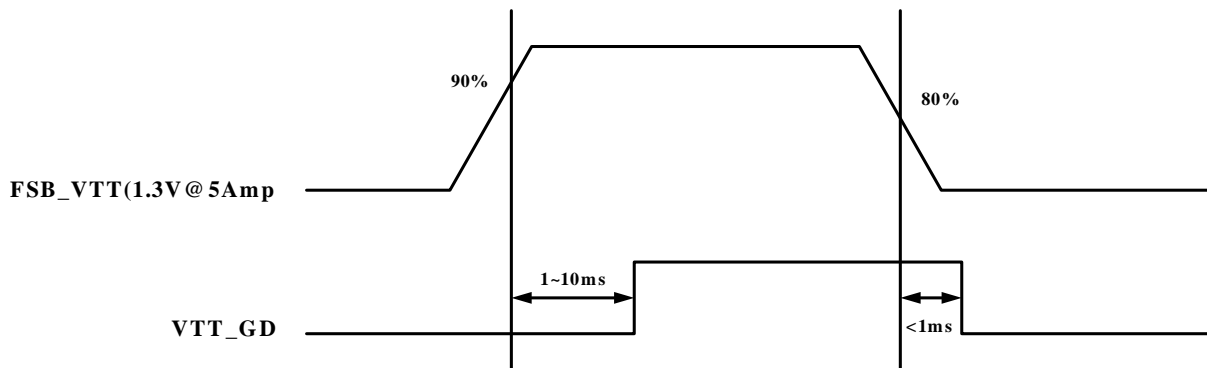


Figure 1 — Function Block Diagram

## TIMING DIAGRAM

### Specific Power Sequence for LDO



## OPERATION

The MP2910 is a 5V/12V synchronous buck PWM DC/DC and linear power controller. It adopts voltage mode PWM control and includes internal soft-start, frequency-compensation networks, power good signaling with specific sequence. The part is operated at fixed 300 kHz frequency providing an optimum compromise between efficiency, external component size, and cost. The linear controller is implemented to drive an external MOSFET for regulation and it's adjustable by setting external resistors. An adjustable over-current protection (OCP) is proposed to monitor the voltage drop across the  $R_{DS(ON)}$  of the lower MOSFET for synchronous buck PWM DC-DC controller.

### VCC Under-Voltage Lockout (UVLO)

VCC Under-voltage lockout (UVLO) is implemented to protect the chip from operating at insufficient supply voltage. The MP2910 UVLO's rising threshold is about 4.1V with a hysteresis of 400mV. It's not-latch protection.

### Internal Soft-Start

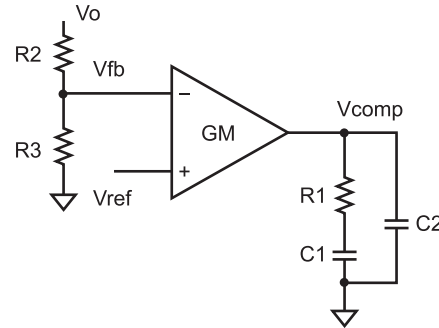
The soft-start is employed to prevent the converter output voltage from overshooting during startup. When the chip starts, the internal circuitry generates a soft-start voltage (SS) ramping up from 0V. When it is lower than the internal reference (REF), SS overrides REF so the error amplifier uses SS as the reference. The output voltage smoothly ramps up with the SS voltage. When SS is higher than REF, REF regains control. The circuit enters into steady stage operation. The SS time's typical value is 2.5ms.

### Power Good Indicator

The PG pin is the open drain of a MOSFET, it should be connected to supply power by a resistor network. When the FB voltage reaches 90% of REF voltage, the PG pin is pulled high after an about 4ms delay. When the FB voltage drops to 80% of REF voltage, the PG pin will be pulled low.

### Internal Loop Compensation

MP2910 is a voltage mode buck controller with internal loop compensation using a high gain transconductance error amplifier as shown in Figure 2.



**Figure 2 — Compensation Loop with Transconductance Error Amplifier**

The pole and zero of the compensation network are:

$$f_p = \frac{1}{2\pi \times R_1 \times C_2}$$

$$f_z = \frac{1}{2\pi \times R_1 \times C_1}$$

MP2910 internal compensation network parameters:

$$GM=0.2mS, R_1=75k\Omega, C_1=2.5nF, C_2=5pF$$

### OPS (Over Current Setting, VIN Power on Reset and Shutdown) (Pin 13)

#### OCP (Over Current Setting)

MP2910 senses the low-side MOSFET's  $R_{DS(ON)}$  to set the over current trip point. Connect an over current setting resistor  $R_{OCSET}$  from this pin to SW (Pin 14), then the over current trip point can be estimated according to the following equation:

$$I_{OCSET} = \frac{38\mu A \times R_{OCSET} - 0.4V}{R_{DS(ON)} \text{ of the low-side MOSFET}}$$

The over current trip point is very sensitive to external parasitic capacitance because the OPS pin function is similar to RC charging/discharging circuit.

When OCP is triggered, a hiccup restart sequence will be initialized and only 4 times of trigger are allowed to latch off (Refer to OCP waveforms as shown in Typical Performance Characteristics).

#### **VIN\_POR (VIN Power On Reset)**

Before  $V_{IN}$  is ready, the HG pin will continuously generate a 10kHz clock with 1% duty cycle.  $V_{IN}$  is recognized ready by sensing the voltage of OPS pin crossing 1.5V four times (rising & falling).  $R_{OCSET}$  must be lower than 39.5k $\Omega$ , otherwise, an internal 38 $\mu$ A current source flowing through  $R_{OCSET}$  will keep the voltage of OPS pin always higher than 1.5V. If so, the VIN\_POR function will be disabled. It is highly recommended that  $R_{OCSET}$  be lower than 30k $\Omega$ .

#### **Shutdown**

Connect a small transistor from the OPS pin to ground, then enabling the transistor can shutdown the MP2910 as shown in typical application circuit.

#### **UVP (Under Voltage Protection)**

To protect against UV, the voltage of FB and FBL pins is monitored in MP2910. The UV threshold typical value is 82.5% of the FB or FBL rated value. Once UVP\_FBL is triggered, a hiccup restart sequence will be initialized and only 4 times of trigger are allowed to latch off. During soft-start interval hiccup is disabled. UVP\_FB has some difference from OCP and UVP\_FBL, it will always trigger  $V_{IN}$  Power sensing even after 4 times hiccup. So the controller will restart when the voltage of FB pin recovers.

## APPLICATION INFORMATION

### Setting the Output Voltage

The output voltage is set by using a resistive voltage divider from the output voltage to FB pin. First, choose a value for the feedback resistor R6, e.g. 10kΩ, and then R5 is determined as follows:

$$R_5 = \frac{V_{OUT} - V_{REF}}{V_{REF}} \times R_6$$

### Selecting the Inductor

An inductor with a DC current rating of at least 25% higher than the maximum load current is recommended for most applications. A larger value inductor will result in less ripple current and lower output ripple voltage. However, the larger value inductor has a larger physical size, higher series resistance, and/or lower saturation current. Generally, choose the inductor ripple current approximately 30% of the maximum load current, then the inductance value can be calculated by:

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times f_s}$$

where  $V_{OUT}$  is the output voltage,  $V_{IN}$  is the input voltage,  $f_s$  is the 300KHz switching frequency, and  $\Delta I_L$  is the peak-to-peak inductor ripple current.

The maximum inductor peak current is:

$$I_{L(MAX)} = I_{LOAD} + \frac{\Delta I_L}{2}$$

where  $I_{LOAD}$  is the load current.

### Input Capacitor Selection

Since the input capacitor absorbs the input switching current, it requires an adequate ripple current rating. The selection of input capacitor is mainly based on its maximum ripple current capability. The RMS value of ripple current flowing through the input capacitor is described as:

$$I_{RMS} = I_{LOAD} \sqrt{\frac{V_{OUT}}{V_{IN}} \left(1 - \frac{V_{OUT}}{V_{IN}}\right)}$$

The worst-case condition occurs at  $V_{IN} = 2V_{OUT}$ , where  $I_{RMS} = I_{LOAD}/2$ . So, the input capacitor you

selected must be capable of handling this ripple current.

### Output Capacitor Selection

The output capacitor keeps output voltage ripple small and ensures regulation loop stability. The output capacitor impedance should be low at the switching frequency. The output voltage ripple can be estimated by:

$$\Delta V_{OUT} = \frac{V_{OUT}}{f_s \times L} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right) \times \left(R_{ESR} + \frac{1}{8 \times f_s \times C_O}\right)$$

where  $C_O$  is the output capacitance value and  $R_{ESR}$  is the equivalent series resistance (ESR) value of the output capacitor.

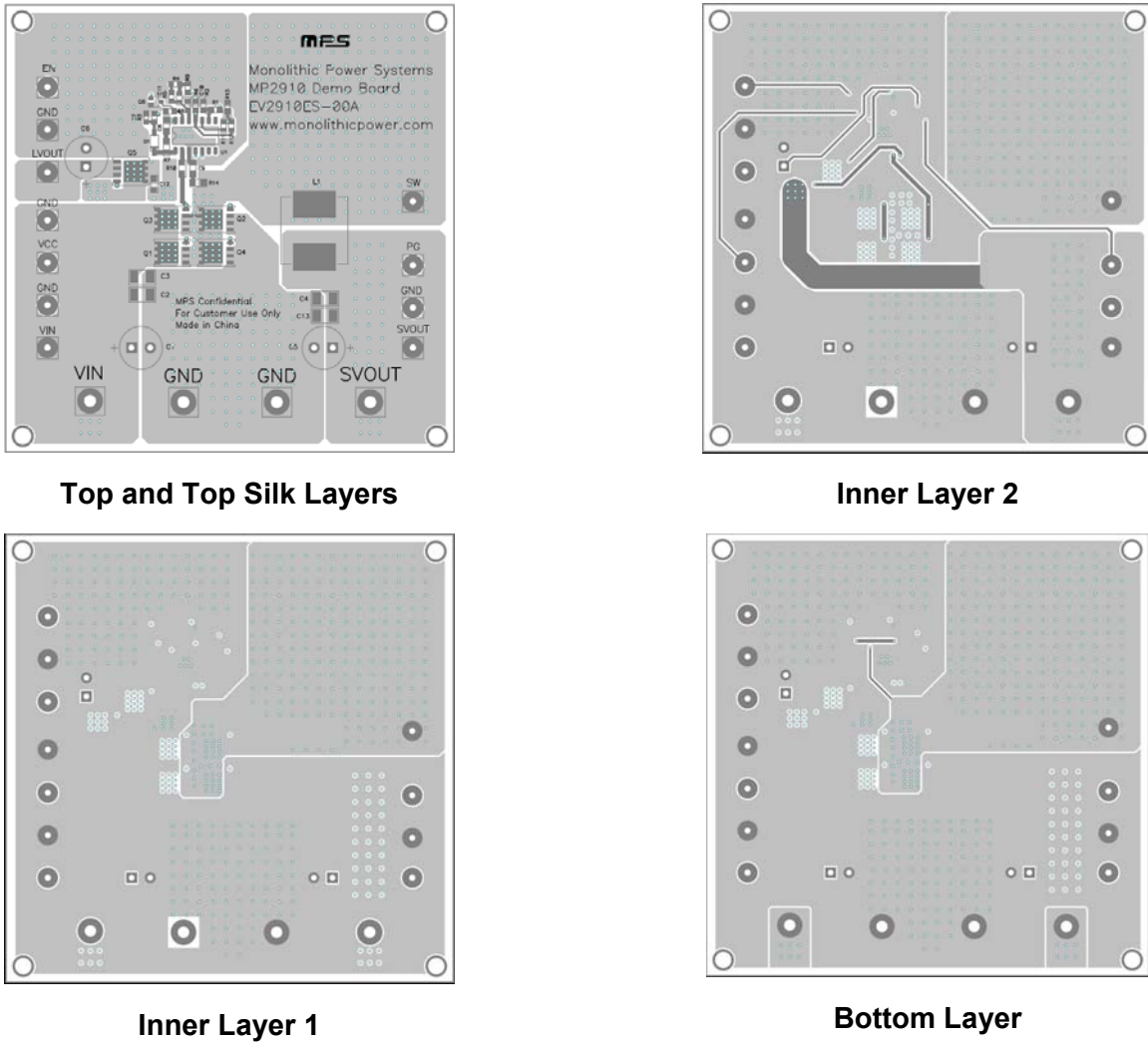
For tantalum or electrolytic capacitor application, the ESR dominates the impedance at the switching frequency. So the above formula can be approximated as:

$$\Delta V_{OUT} = \frac{V_{OUT}}{f_s \times L} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right) \times R_{ESR}$$

### PCB Layout Guide

PCB layout is very important to achieve stable operation. A multi-layer PCB is highly recommended. The high current paths (GND,  $V_{IN}$  and SW) should be placed very close to the device with short, direct and wide traces. A RC low pass filter is recommended for  $V_{CC}$  supply. The  $V_{CC}$  decoupling capacitor must be placed as close to  $V_{CC}$  pin and GND pin as possible. The external feedback resistors should be placed next to the FB and FBL pins.

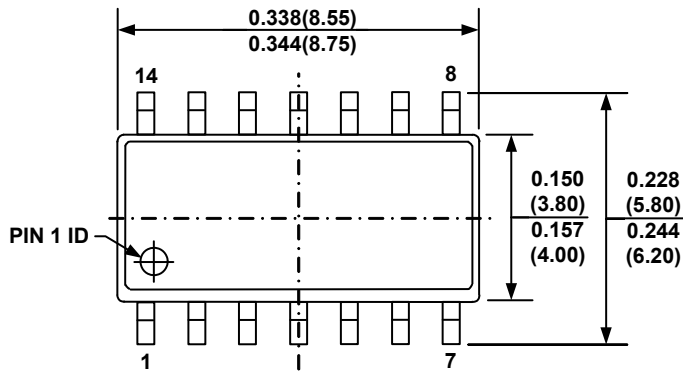
Below PCB layout files are our test board for your reference:



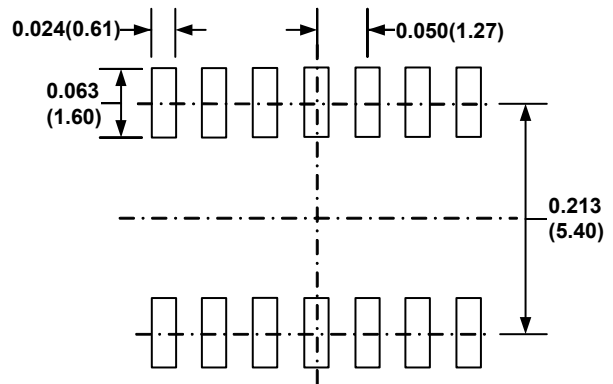
**Figure 3 — MP2910DS PCB Layout**

**PACKAGE INFORMATION**

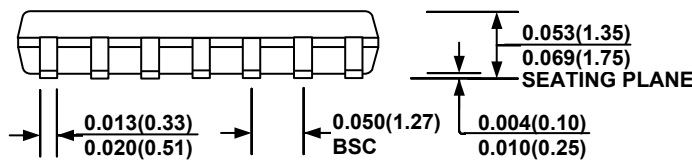
**SOIC14**



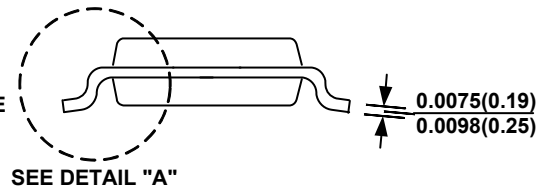
**TOP VIEW**



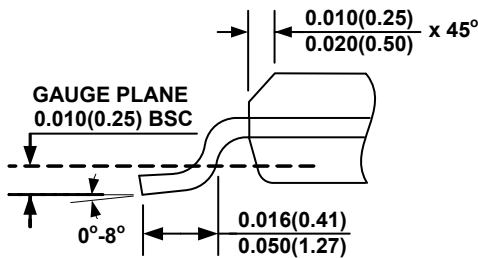
**RECOMMENDED LAND PATTERN**



**FRONT VIEW**



**SIDE VIEW**

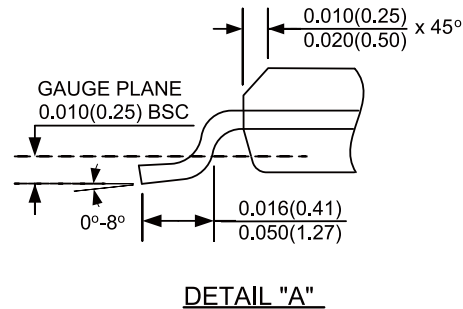
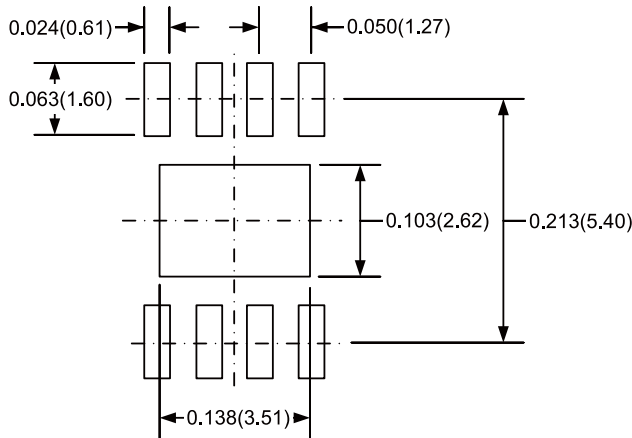
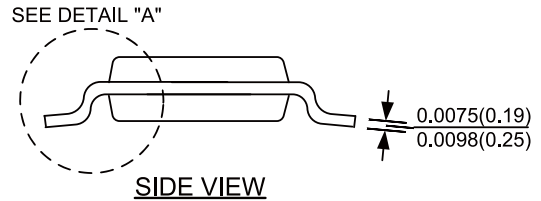
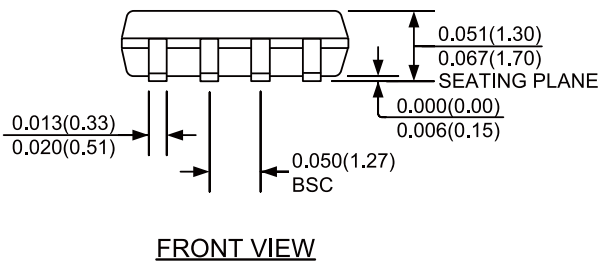
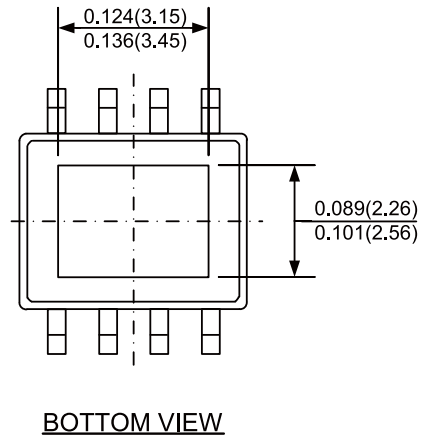
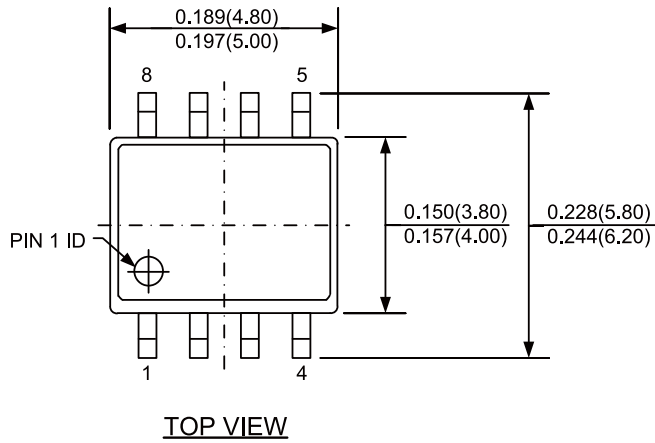


**DETAIL "A"**

**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 AB.
- 6) DRAWING IS NOT TO SCALE.

**SOIC8E (EXPOSED PAD)**



**NOTE:**

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