

## 20V, 2A Buck Switching Regulator



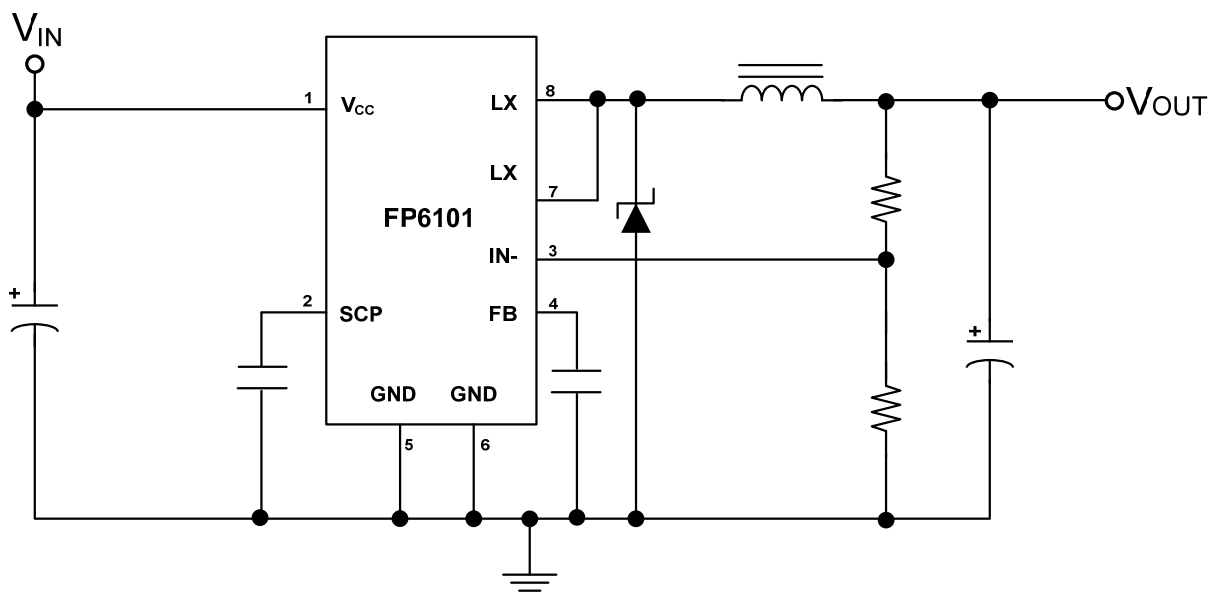
### General Description

The FP6101 is a buck switching regulator for wide operating voltage application fields. The FP6101 includes a high current P-MOSFET, high precision reference (0.5V) for comparing output voltage with a feedback amplifier, an internal dead-time controller and oscillator for controlling the maximum duty cycle and PWM frequency. It also has power-on programmable soft start time, short circuit PMOS turn-off and auto re-start protection functions.

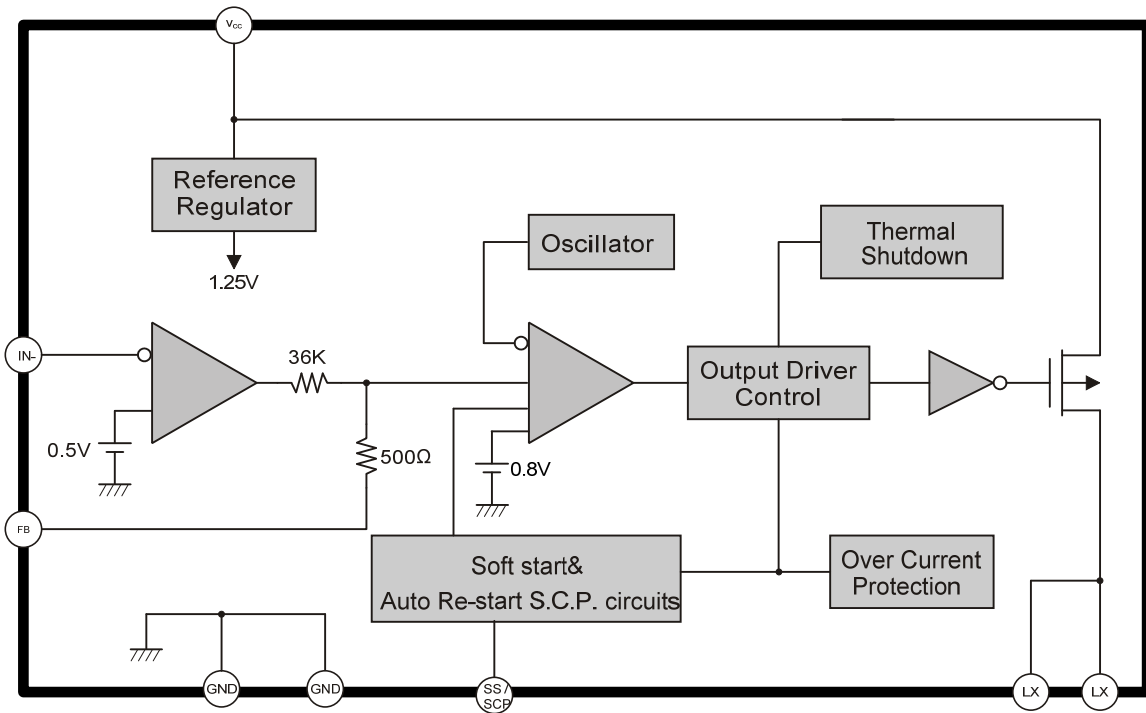
### Features

- Precision Feedback Reference Voltage: 0.5V (2%)
- Wide Supply Voltage Operating Range: 3.6 to 20V
- Low Current Consumption: 3mA
- Internal Fixed Oscillator Frequency: 340KHz (Typ.)
- Internal Soft-Start Function (SS)
- Short Circuit Shutdown and Auto Re-start function (ARSCP)
- Built-in P-MOSFET for 2A Loading Capability
- Over Current Protection
- Package: SOP-8L

### Typical Application Circuit

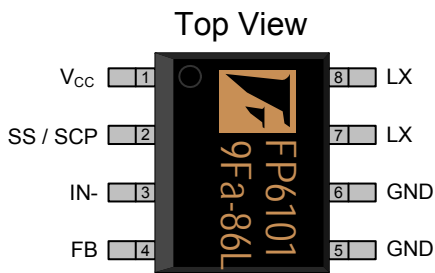


## Function Block Diagram



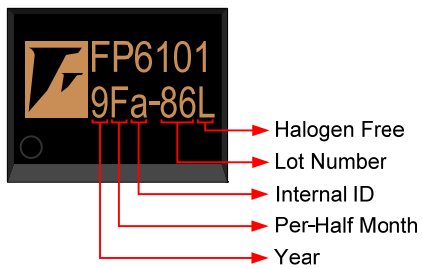
## Pin Descriptions

### SOP-8L



Name	No.	I / O	Description
V <sub>CC</sub>	1	P	Power Supply (PMOS Source)
SS / SCP	2	I	Connecting with a Soft-start & ARSCP Timing Capacitor
IN-	3	I	Error Amplifier Inverting Input
FB	4	O	Error Amplifier Compensation Output
GND	5	P	IC Ground
GND	6	P	IC Ground
LX	7	O	PMOS High Current Output
LX	8	O	PMOS High Current Output

## Marking Information



**Halogen Free:** Halogen free product indicator

**Lot Number:** Wafer lot number's last two digits

For Example: 1323~~86~~TB → 86

**Mass Production Version:** Mass production mask version

**Per-Half Month:** Production period indicated in half month time unit

For Example: January → A (Front Half Month), B (Last Half Month)

February → C (Front Half Month), D (Last Half Month)

**Year:** Production year's last digit

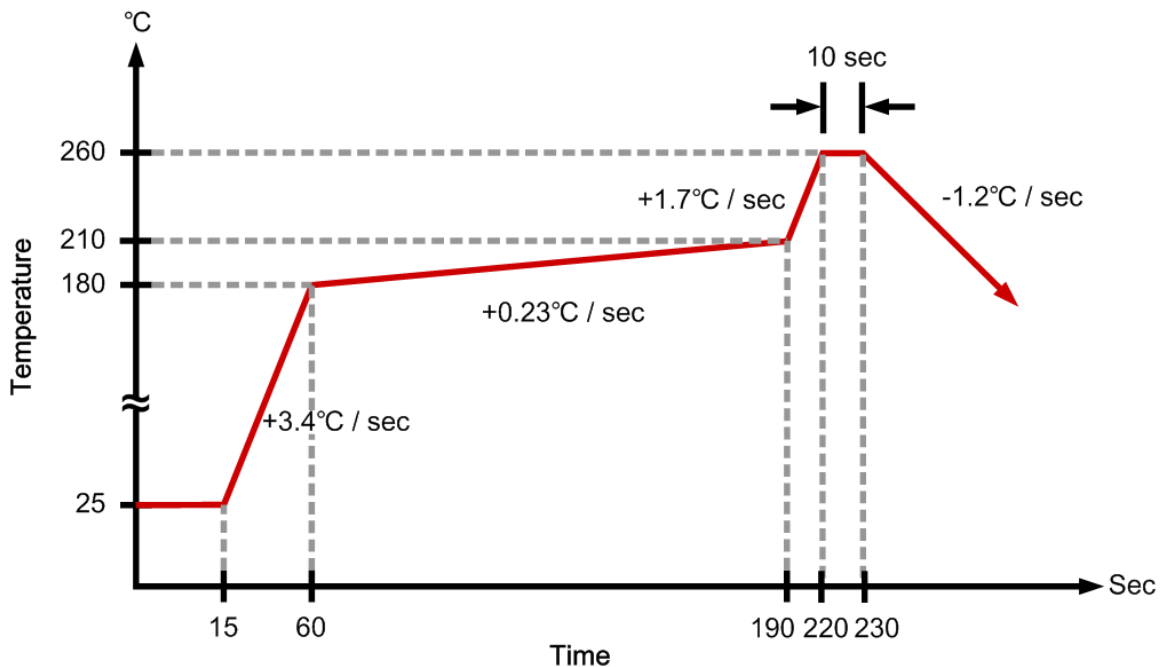
## Ordering Information

Part Number	Operating Temperature	Package	MOQ	Description
FP6101DR-LF	-25°C ~ +85°C	SOP-8L	2500 EA	Tape & Reel

## Absolute Maximum Ratings

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power Supply Voltage	$V_{CC}$				21	V
Output Source Current					3	A
Error Amplifier Inverting Input			-0.3		1.2	V
Allowable Power Dissipation	$P_D$	SOP-8L $T_A \leq +25^\circ\text{C}$			650	mW
Junction to Ambient Thermal Resistance	$\theta_{JA}$				+175	$^\circ\text{C} / \text{W}$
Junction to Case Thermal Resistance	$\theta_{JC}$				+45	$^\circ\text{C} / \text{W}$
Operating Temperature			-25		+85	$^\circ\text{C}$
ESD Susceptibility		HBM (Human Body Mode)	2			KV
		MM (Machine Mode)	200			V
Storage Temperature	$T_S$	SOP-8L	-55		+125	$^\circ\text{C}$
SOP-8L Lead Temperature		(soldering, 10 sec)			+260	$^\circ\text{C}$

## Suggested IR Re-flow Soldering Curve



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## Recommended Operating Conditions

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply Voltage	$V_{CC}$		3.6		20	V
Operating Temperature			-25		85	°C

## DC Electrical Characteristics ( $V_{CC}=6V$ , $T_A = 25^\circ C$ , unless otherwise noted)

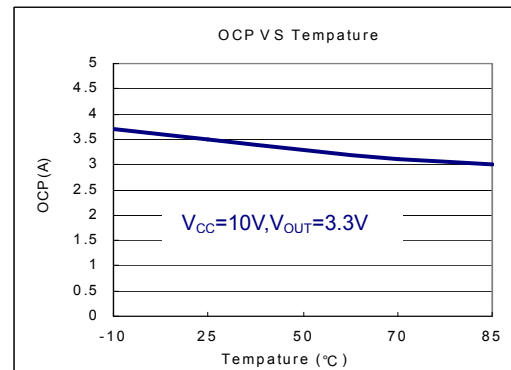
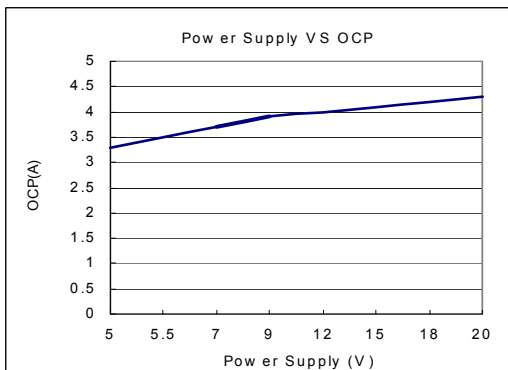
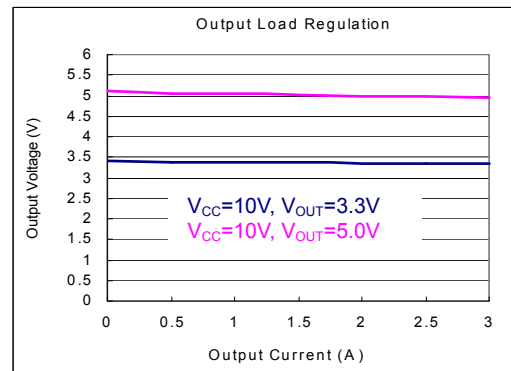
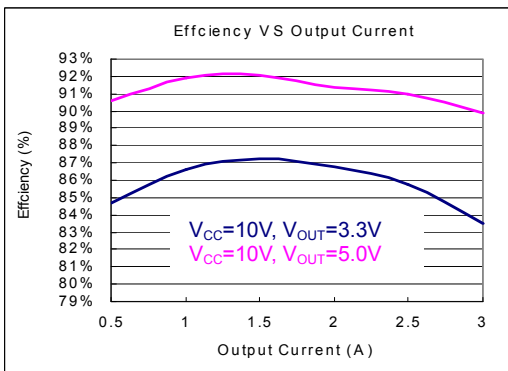
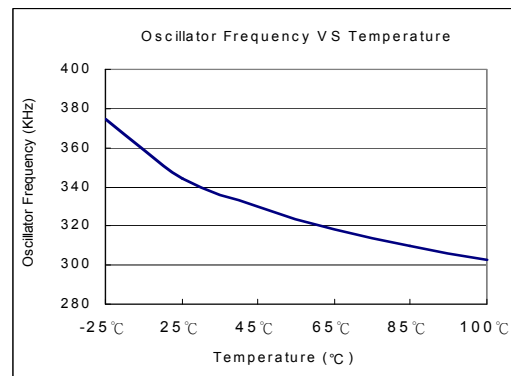
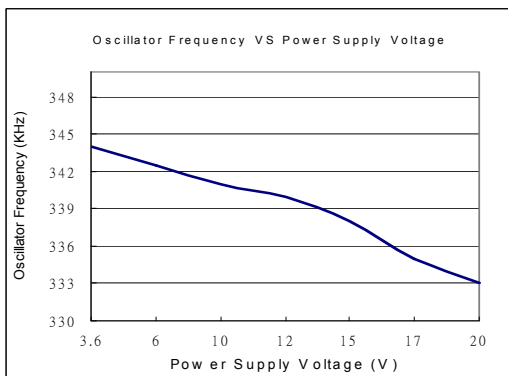
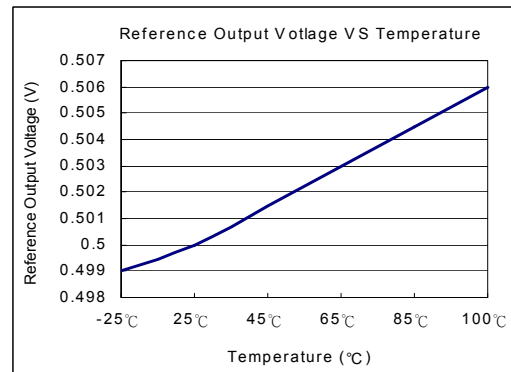
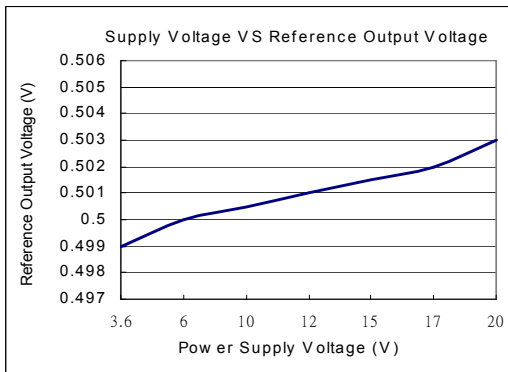
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
<b>Reference</b>						
Output Voltage	$V_{REF}$	IN- connected to FB	0.490	0.5	0.510	V
Input Regulation	$\Delta V_{REF}$	$V_{CC}=3.6$ to $20$ V		2	12.5	mV
Output Voltage Change with Temperature	$\Delta V_{REF} / V_{REF}$	$T_A = -25$ to $+25^\circ C$		1	2	%
		$T_A = +25$ to $+85^\circ C$		1	2	%
<b>Soft Start Section (S.S.)</b>						
S.C.P. Source Current	$I_{SS}$	$V_{SS}=0V$	-17	-12	-7	$\mu A$
Soft Start Threshold Voltage	$V_{SST}$		0.9	1.0	1.1	V
<b>Short Circuit Protection Section (S.C.P.)</b>						
S.C.P. Source Current	$I_{SCP}$	$V_{SCP}=0V$	-17	-12	-7	$\mu A$
SCP Re-start / Hold Time	$T_{RE} / T_{HOLD}$	$V_{FB}=0V$		1/8		
S.C.P. Threshold Voltage	$V_{SCP}$	$V_{FB}>450mV$	1.0	1.15	1.2	V
	$V_{SB}$	$V_{FB}<450mV$		0.1	0.15	V
<b>Output Section</b>						
Oscillation Frequency	f			340		KHz
Frequency Change with Voltage	$\Delta f / \Delta V$	$V_{CC}=3.6V$ to $20V$		5		%
Frequency Change with Temperature	$\Delta f / \Delta T$	$T_A = -25^\circ C$ to $+85^\circ C$		5		%
<b>Thermal Shutdown Section</b>						
Thermal Shutdown Temperature				+145		°C
<b>Idle Period Adjustment Section</b>						
Maximum Duty Cycle	$T_{DUTY}$	$V_{IN}=0.2V$		90		%
<b>Total Device Section</b>						
Average Supply Current	$I_{AVE}$			3.8	5	mA
<b>Output Section</b>						
PMOS D-S Voltage	$V_{DSS}$	$V=0.1V$		-20		V
PMOS Source Current	$I_D$			-2		A
PMOS On Resistance	$R_{DS(ON)}$	$V_{CC}=5.0V, V_{IN}=0V$		70	150	m $\Omega$
		$V_{CC}=10V, V_{IN}=0V$		42	90	
Output Leakage Current	$I_L$			5		$\mu A$
<b>Over Current Protection Section</b>						
PMOS OCP Current	$I_{OCP}$			3		A

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Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
<b>Error Amplifier Section</b>						
Input Bias Current	$I_B$		-1.0	-0.2	1.0	$\mu A$
Voltage Gain	$A_V$			100		V / V
Frequency Bandwidth	BW	$A_V=0$ dB		6	2	MHz
Output voltage Swing Positive	$V_{POS}$	$V_{IN-}=0.3V$	0.78	0.87		V
Output voltage Swing Negative	$V_{NEG}$	$V_{IN-}=0.7V$		0.05	0.2	V
Output Source Current	$I_{SOURCE}$	$V_{FB}=500mV$		-45	-30	$\mu A$
Output Sink Current	$I_{SINK}$		30	45		$\mu A$

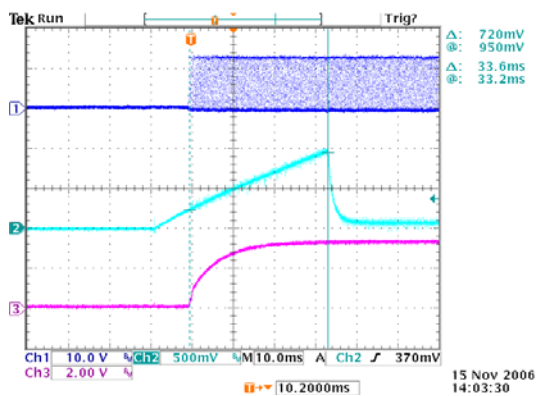
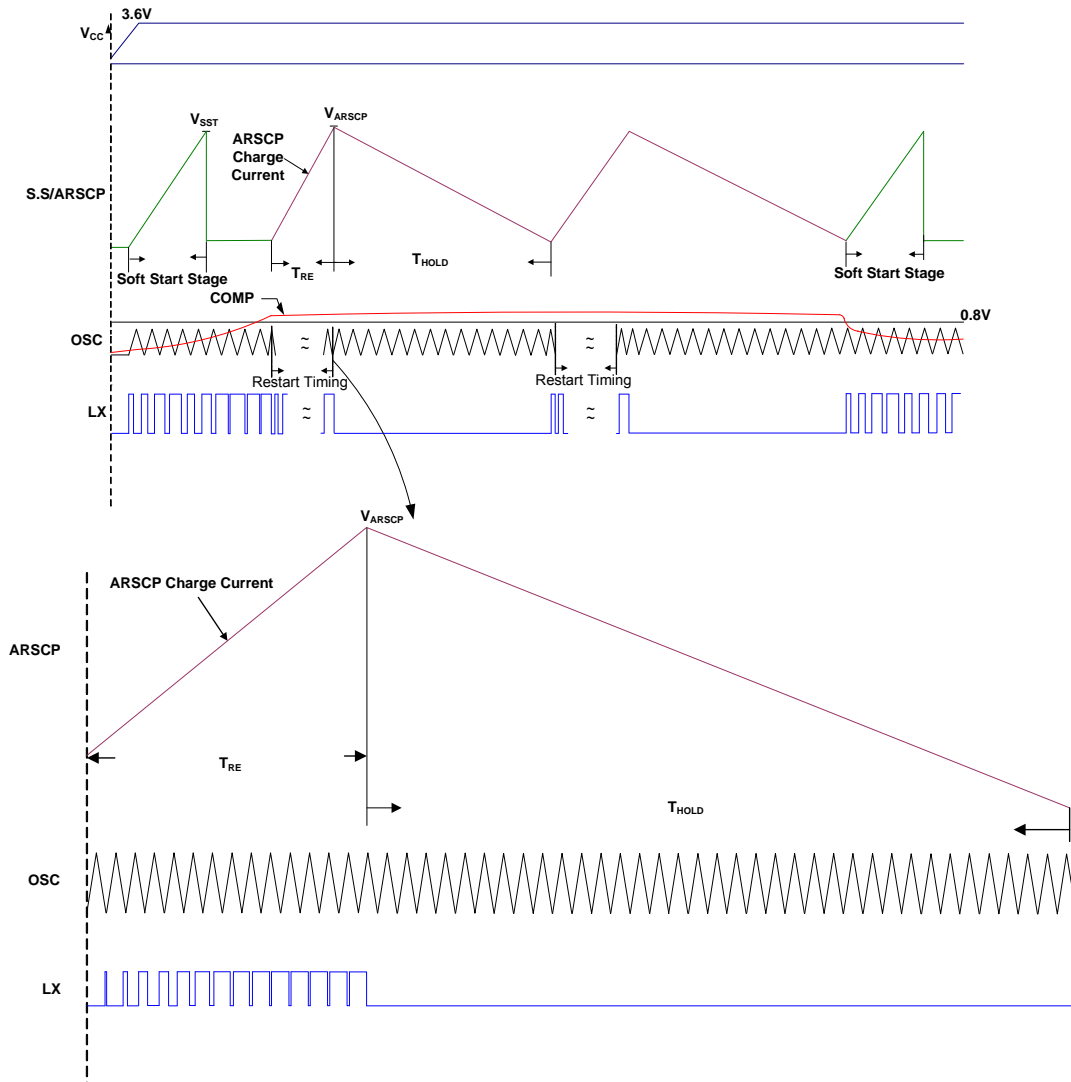
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## Typical Operating Characteristics

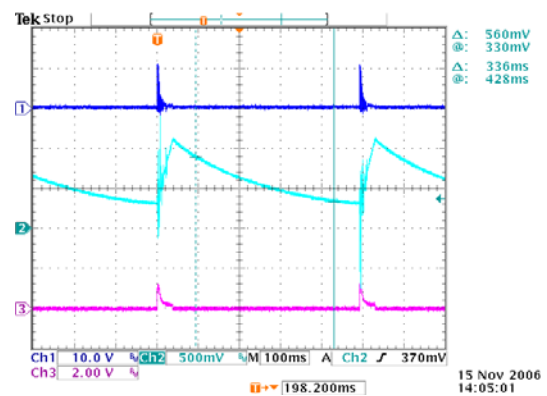


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### Timing Waveform



CH1 LX CH2 SS / SCP CH3  $V_{out}$



CH1 LX CH2 SS / SCP CH3  $V_{out}$

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## Function Description

### Voltage Reference

FP6101 includes a 1.25V reference generator. This reference voltage is divided by a resistive divider to provide a 0.5V precision reference voltage for the non-inverting terminal of error amplifier and a 1.0V threshold voltage for the SCP comparator.

### Error Amplifier

The error amplifier compares a sample of the DC-DC converter output voltage with the 0.5V reference ( $V_{REF}$ ) to generate an error signal for the PWM comparator. Output voltage of the DC-DC converter is setting by the external resistor divider with following equation (see figure 1):

$$V_{OUT} = \left(1 + \frac{R_1}{R_2}\right) \times V_{REF}$$

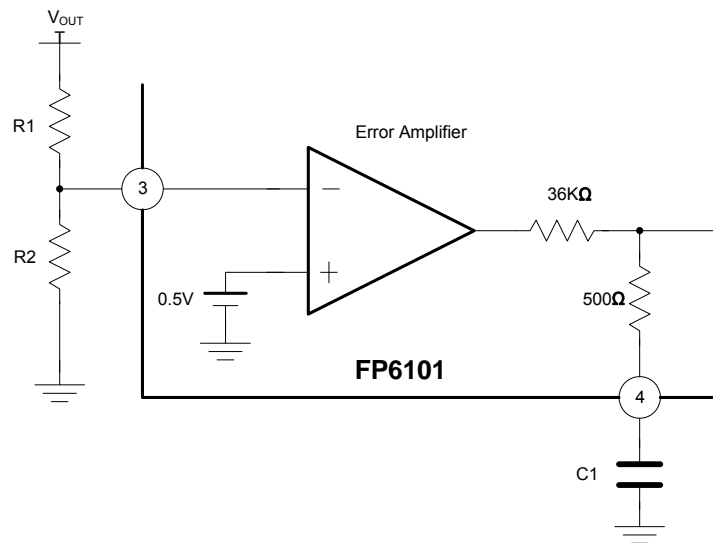


Figure 1 Error Amplifier with Feedback Resistor Divider

### Oscillator

The fixed PWM frequency is generated by an internal RC oscillator. Its typical value is 340KHz.

### Soft Start/ Short-circuit protection (S.S. / S.C.P.)

The Soft Start function works after power on. The interval of Soft Start time is determined by a capacitor connected to SCP pin (pin 2). After Soft Start function finished, the internal Soft Start clamp voltage is setting high, but external SCP pin is discharged to low. Thus FP6101 turns on short circuit detection / protection function.

The Soft Start time is:

$$T_{SS}(\text{Sec}) = 0.07 \times C_{SCP}(\text{in } \mu\text{F})$$

When a heavy loading or short circuit condition make output voltage to drop too much, the error amplifier output (FB pin) will rise to very high. Once FB pin voltage exceeds  $V_{POS}$  (typ. 1.0V), the short circuit protection function is triggered. The output switching MOS will be turned off. The SCP capacitor will be charged until its potential exceeds SCP threshold voltage (typ. 1.2V) and then discharged to low.

The time of short circuit protection is:

$$T_{RE}(\text{Sec}) = \frac{V \times C_{SCP}}{I} = \frac{(V_{TH} - V_{SS-Start}) \times C_{SCP}}{I_{source}} = 0.09 \times C_{SCP}(\text{in } \mu\text{F})$$

Restart timing of short circuit protection is:

$$T_{HOLD}(\text{Sec}) = 8 \times T_{RE}(\text{Sec})$$

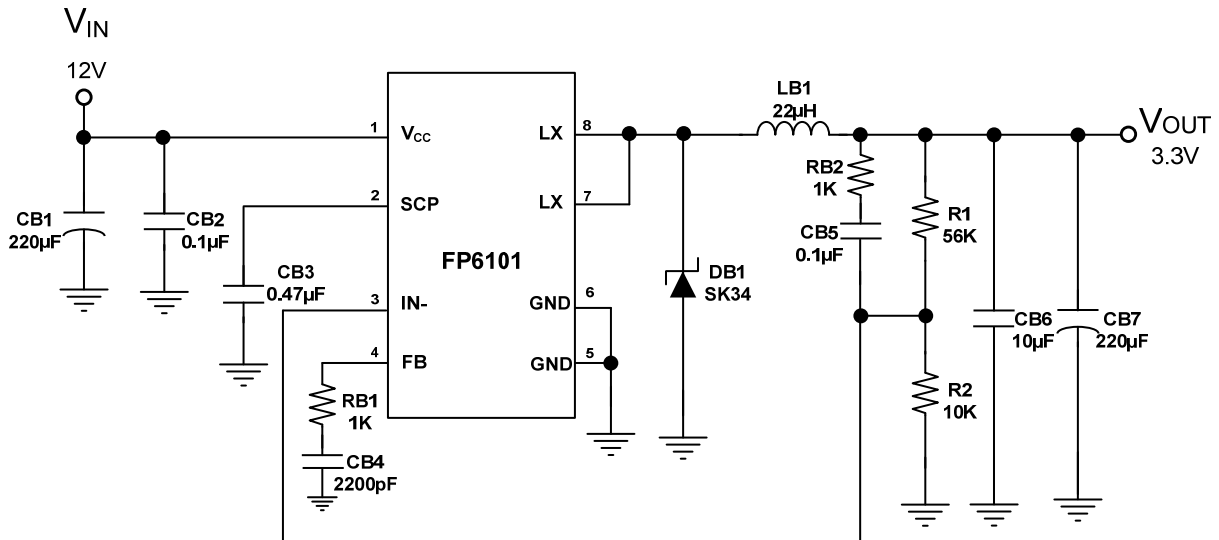
### Thermal Protection

When a heavy loading makes chip internal temperature exceeds 145°C, the thermal protection function is triggered. The FP6101 turns off its output and starts Short Circuit Protection function. After the IC is cooled down to its internal temperature below 145°C, it will turn on the output and execute Soft-Start function again.

### Over Current Protection

When FP6101 senses driver current over 3A, it will initiate OCP function and enters ARSCP function. After current drops below 3A, FP6101 turns on the output and continues PWM operation.

## Typical Application



FP6101 Basic DC-DC Regulator Circuit

### For example:

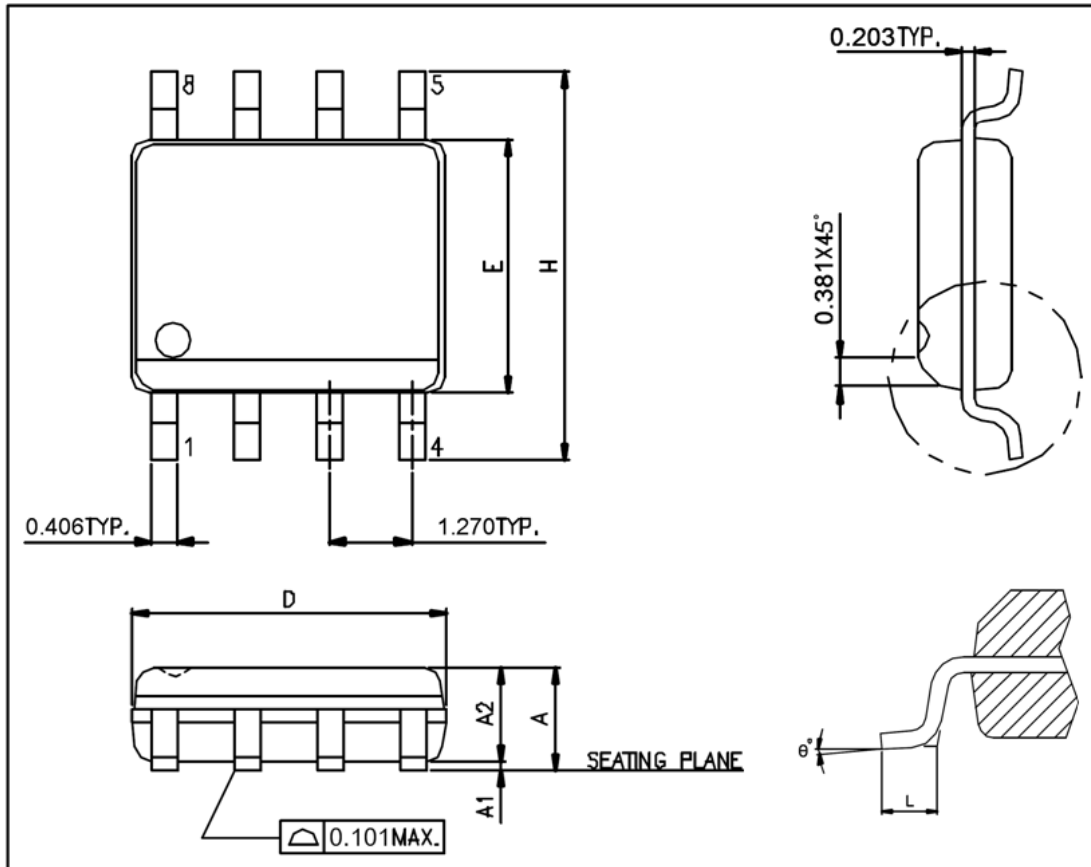
The  $V_{IN}$  power supply is 12V and the  $V_{OUT}$  is designed for 3.3V / 2A solution.

The output voltage equation is:

$$V_{OUT} = \left(1 + \frac{R_1}{R_2}\right) \times V_{REF} = \left(1 + \frac{56K\Omega}{10K\Omega}\right) \times 0.5V = 3.30V$$

## Package Outline

### SOP-8L



Symbols	Min. (mm)	Max. (mm)
A	1.346	1.752
A1	0.101	0.254
A2	1.092	1.498
D	4.800	4.978
E	3.810	3.987
H	5.791	6.197
L	0.406	1.270
$\theta^\circ$	0°	8°

#### Note:

1. Package dimensions are in compliance with JEDEC Outline: MS-012 AA.
2. Dimension "D" does not include molding flash, protrusions or gate burrs.
3. Dimension "E" does not include inter-lead flash, or protrusions.

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