# 20V, 3A Buck Switching Regulator

General Description

The FP6102 is a buck switching regulator for wide operating voltage application fields. The FP6102 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 3A Loading Capability
➢ Over Current Protection
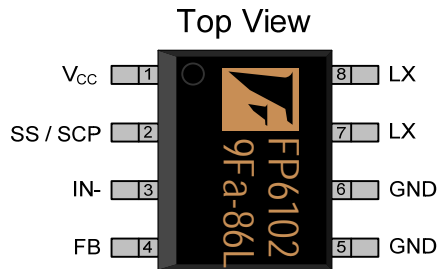➢ Package: SOP-8L

Typical Application Circuit

Website: http://www.feeling-tech.com.tw   Rev. 0.92
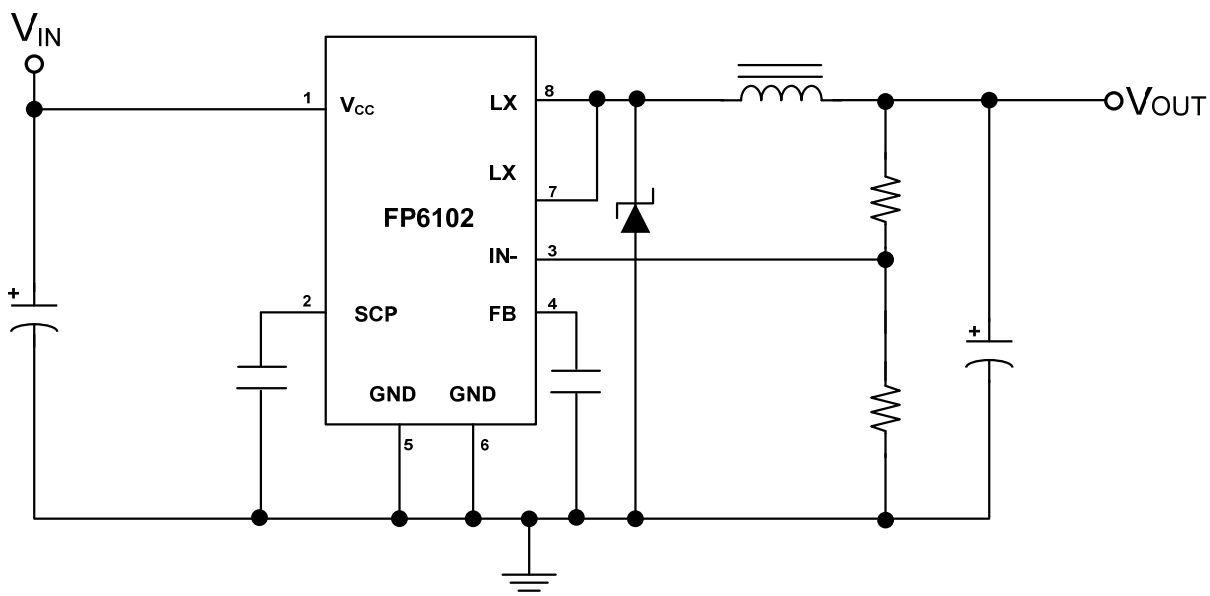
Function Block Diagram
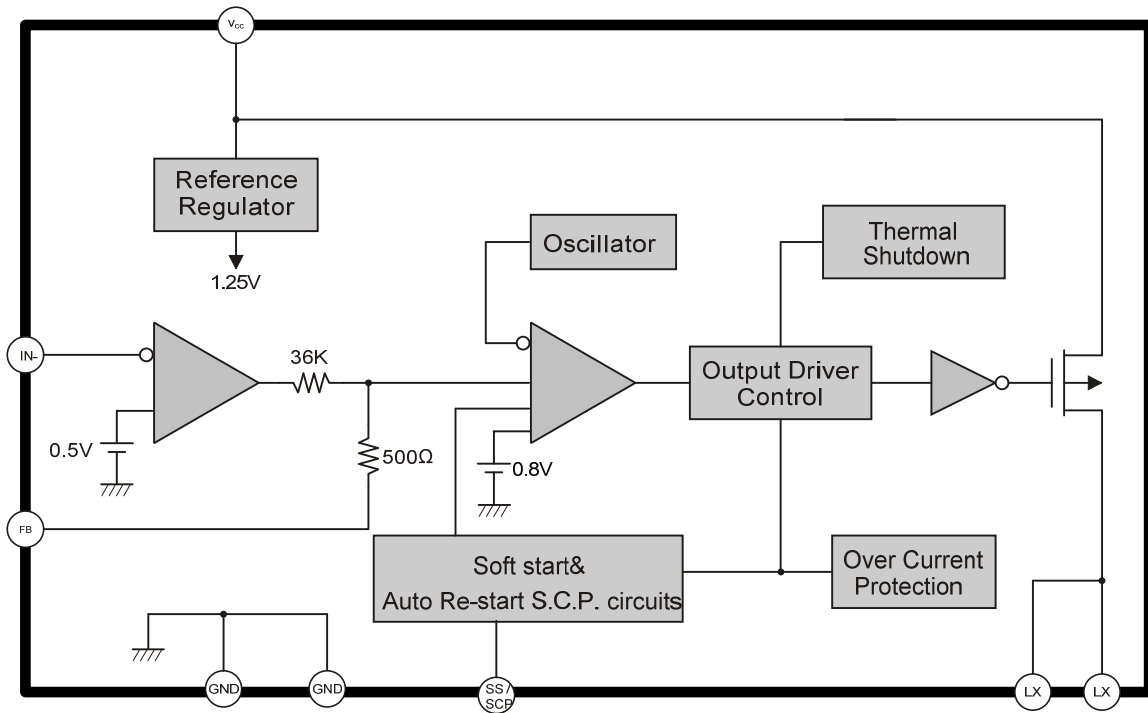
Pin Descriptions

SOP-8L

Top View

Name	No.	I / O	Description
V$_{CC}$	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
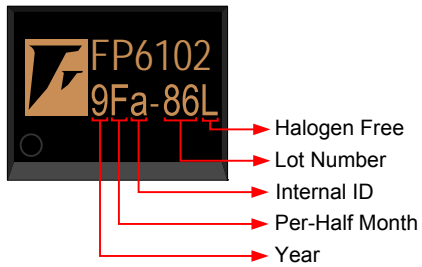
Halogen Free: Halogen free product indicator

Lot Number: Wafer lot number's last two digits

For Example: 132386TB → 86

Internal ID: Internal Identification Code

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

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Ordering Information

Part Number	Operating Temperature	Package	MOQ	Description
FP6102DR-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 $T_A \leqq$ +25°C			650	mW
Junction to Ambient Thermal Resistance	θ_{JA}				+175	°C / W
Junction to Case Thermal Resistance	θ_{JC}				+45	°C / W
Operating Temperature			-25		+85	°C
ESD Susceptibility		HBM (Human Body Mode)	2			KV
		MM (Machine Mode)	200			V
Storage Temperature	T_S	SOP-8L	-55		+125	°C
SOP-8L Lead Temperature		(soldering, 10 sec)			+260	°C

Suggested IR Re-flow Soldering Curve
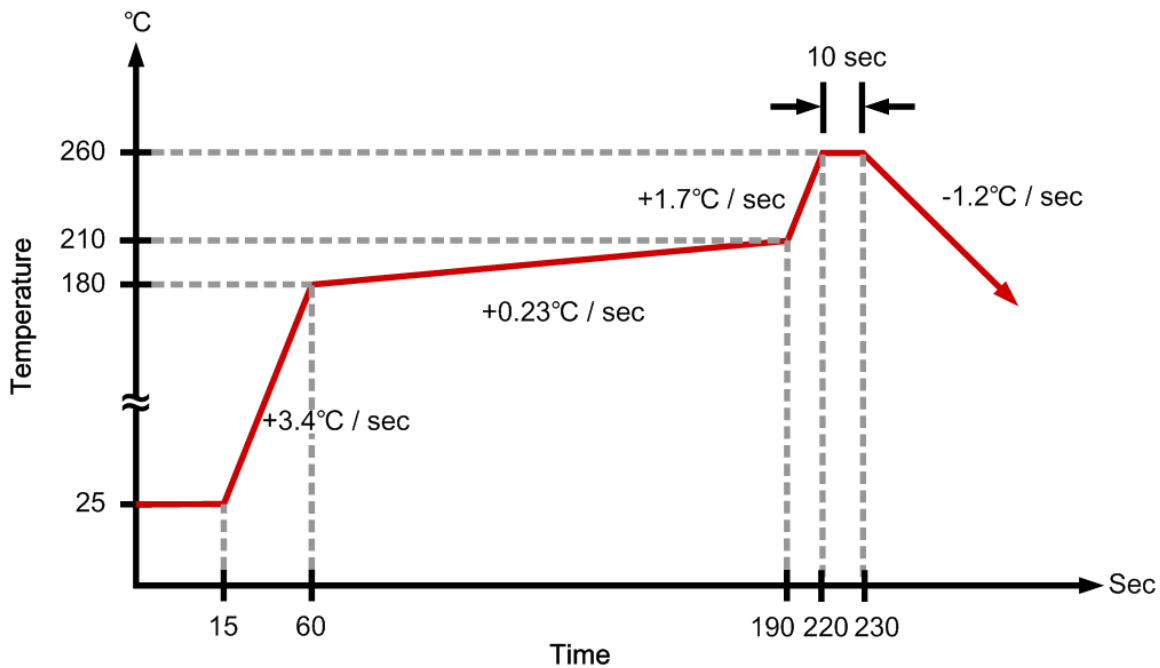
Recommended Operating Conditions

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

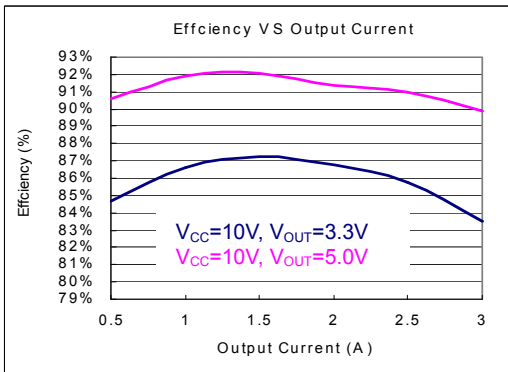## DC Electrical Characteristics (V_{CC}=6V, T_A = 25°C, unless otherwise noted)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Reference						
Output Voltage	V_{REF}	IN- Connected to FB	0.490	0.5	0.510	V
Input Regulation	$\triangle V_{REF}$	V_{CC}=3.6 to 20 V		2	12.5	mV
Output Voltage Change with Temperature	$\triangle V_{REF}$ / V_{REF}	T_A= -25 to +25°C		1	2	%
		T_A= +25 to +85°C		1	2	%
Soft Start Section (S.S.)						
S.C.P. Source Current	I_{SS}	V_{SS}=0V	-17	-12	-7	µA
Soft Start Threshold Voltage	V_{SST}		0.9	1.0	1.1	V
Short Circuit Protection Section (S.C.P.)						
S.C.P. Source Current	I_{SCP}	V_{SCP}= 0V	-17	-12	-7	µA
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
Output Section						
Oscillation Frequency	f			340		KHz
Frequency Change with Voltage	Δf / ΔV	V_{CC}=3.6V to 20V		5		%
Frequency Change with Temperature	Δf / ΔT	T_A = -25°C to +85°C		5		%
Thermal Shutdown Section						
Thermal Shutdown Temperature				+145		°C
Idle Period Adjustment Section						
Maximum Duty Cycle	T_{DUTY}	V_{IN}=0.2V		90		%
Total Device Section						
Average Supply Current	I_{AVE}			3.8	5	mA
Output Section						
PMOS D-S Voltage	V_{DSS}	V=0.1V		-20		V
PMOS Source Current	I_D			-3		A
PMOS On Resistance	$R_{DS(ON)}$	V_{CC}=4.5V,V_{IN}=0V		40.5	52	mΩ
		V_{CC}=10V,V_{IN}=0V		64	87	
Output Leakage Current	I_L	V_{DS}=-24V,V_{GS}=0V			-1	µA
Over Current Protection Section						
PMOS OCP Current	I_{OCP}			4		A

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Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Error Amplifier Section						
Input Bias Current	I_B		-1.0	-0.2	1.0	µA
Voltage Gain	Av			100		V / V
Frequency Bandwidth	BW	Av=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	µA
Output Sink Current	I_{SINK}		-30	45		µA

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Typical Operating Characteristics
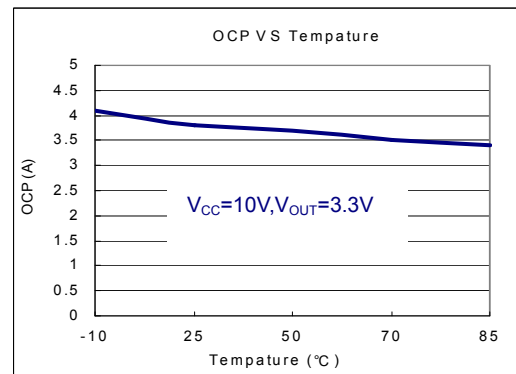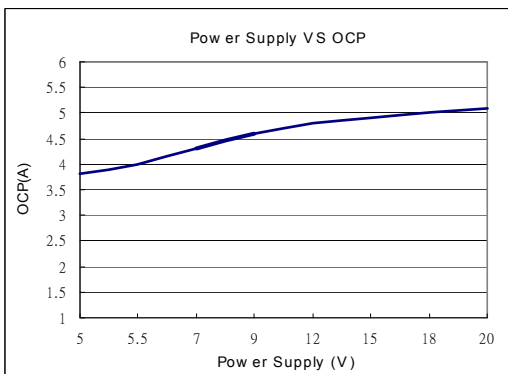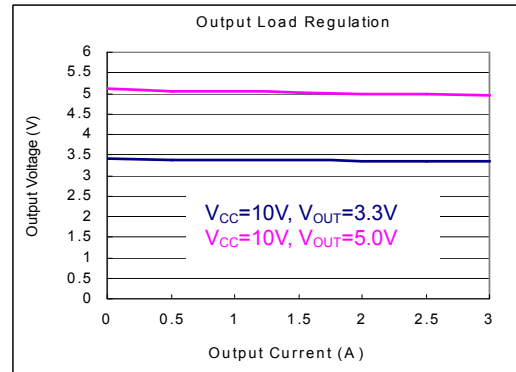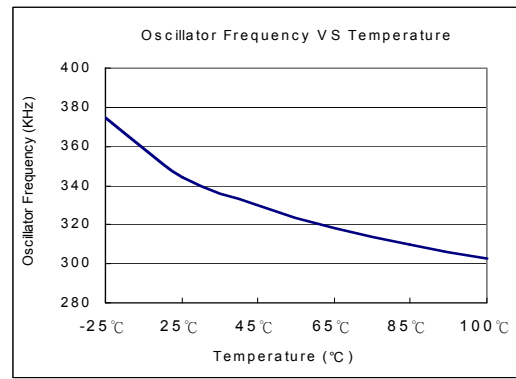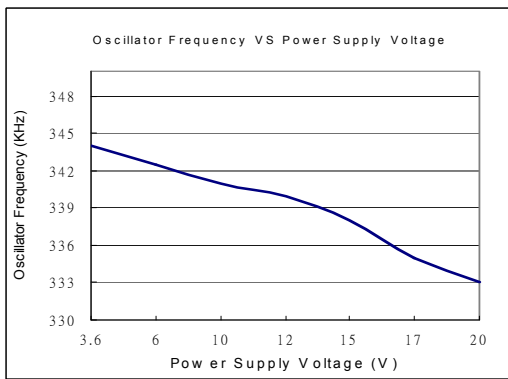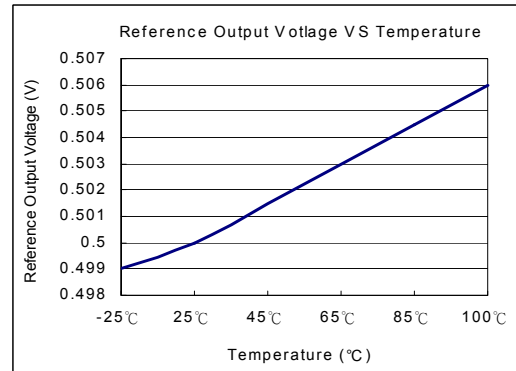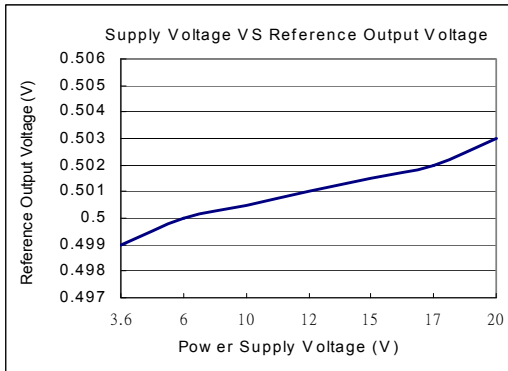
Supply Voltage VS Reference Output Voltage

Reference Output Votlage VS Temperature

Oscillator Frequency VS Power Supply Voltage

Oscillator Frequency VS Temperature

Effciency VS Output Current

V_{CC}=10V, V_{OUT}=3.3V
V_{CC}=10V, V_{OUT}=5.0V

Output Load Regulation

V_{CC}=10V, V_{OUT}=3.3V
V_{CC}=10V, V_{OUT}=5.0V

Power Supply VS OCP

OCP VS Tempature

V_{CC}=10V,V_{OUT}=3.3V

Timing Waveform

CH1 LX CH2 SS / SCP CH3 V_OUT

CH1 LX CH2 SS / SCP CH3 V_OUT

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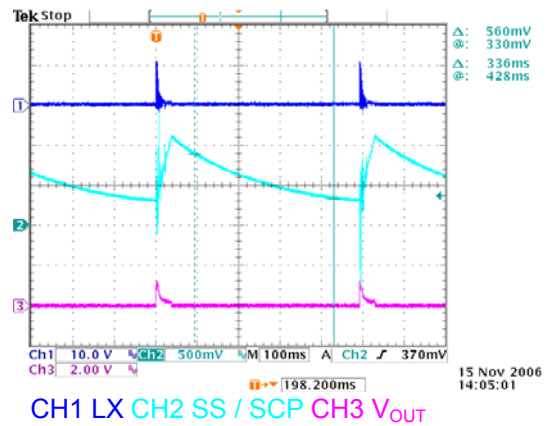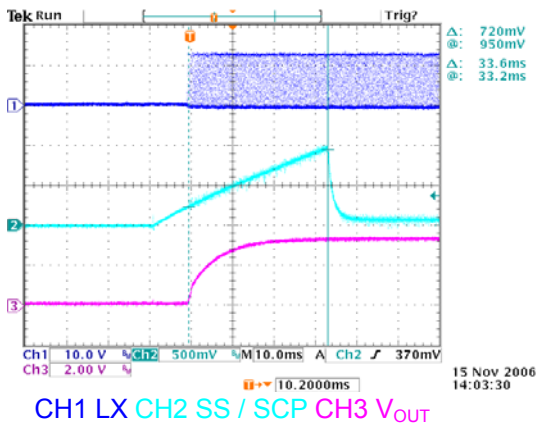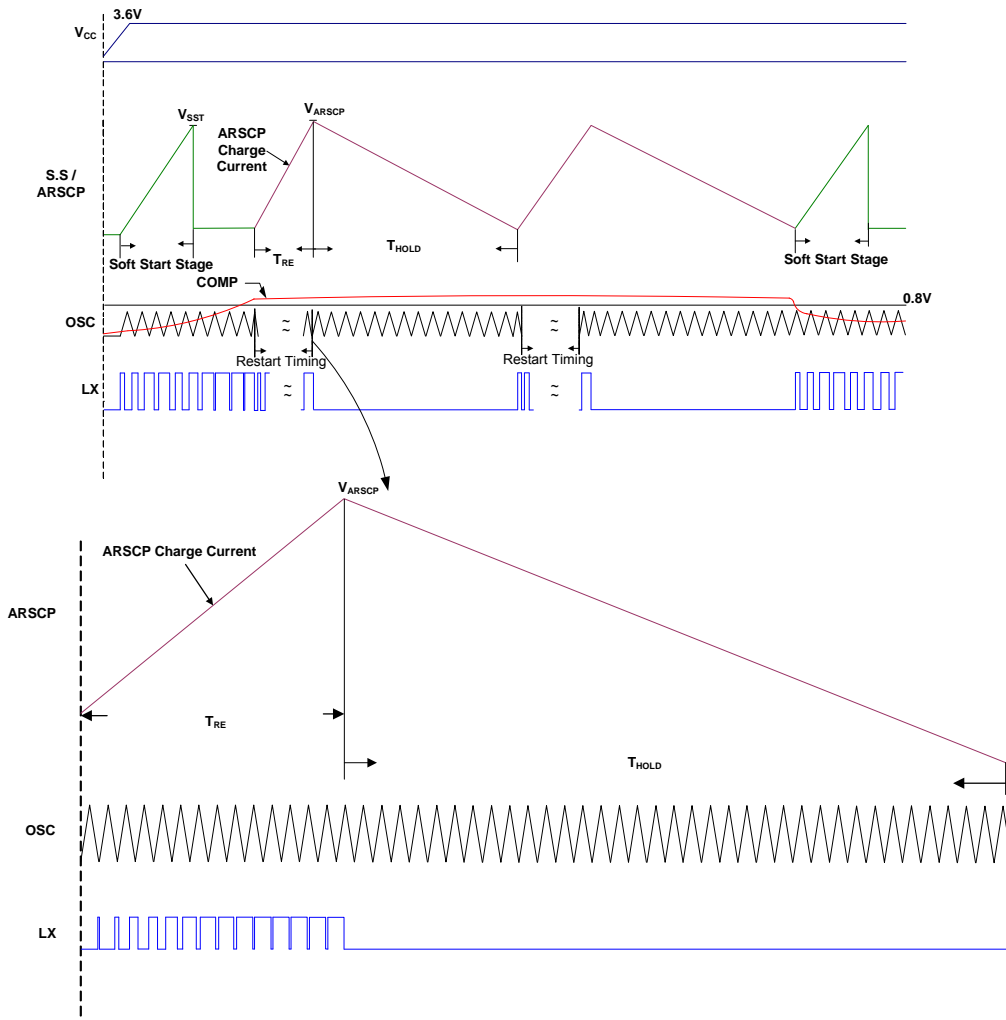
Function Description

Voltage Reference

FP6102 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):

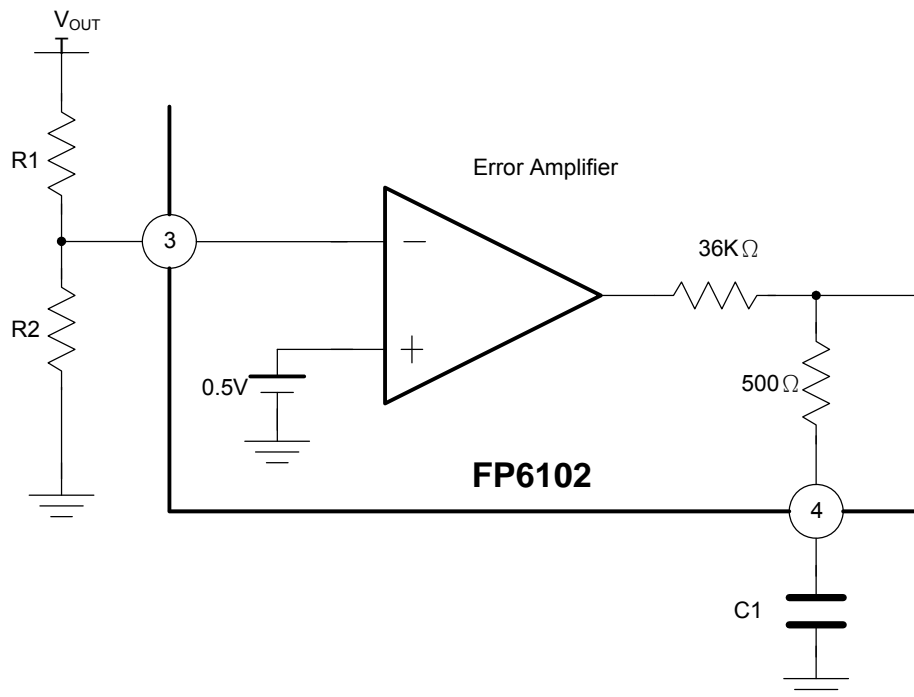$$V_{OUT} = \left(1 + \frac{R_1}{R_2}\right) \times V_{REF}$$

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 FP6102 turns on short circuit detection / protection function.

The Soft Start time is:

$$Tss\,(Sec\,) = 0.07 \times C_{SCP}\,(in\,\mu F)$$

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:

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

Restart timing of short circuit protection is:

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

Thermal Protection

When a heavy loading makes chip internal temperature exceeds 145°C, the thermal protection function is triggered. The FP6102 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 FP6102 senses driver current over 4A, it will initiate OCP function and enters ARSCP function. After current drops below 3A, FP6102 turns on the output and continues PWM operation.

Typical Application
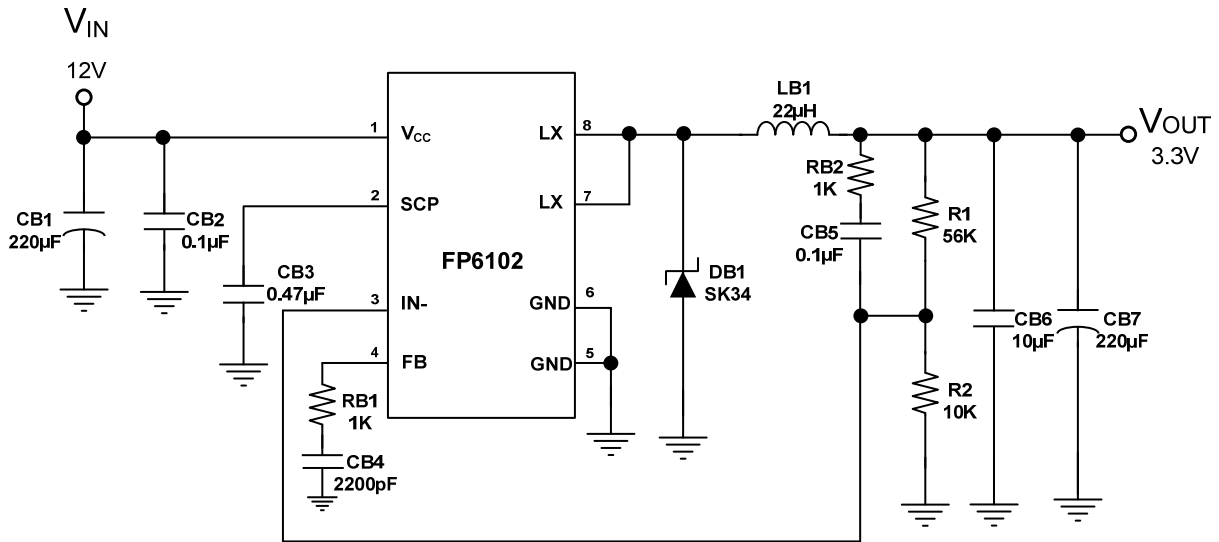
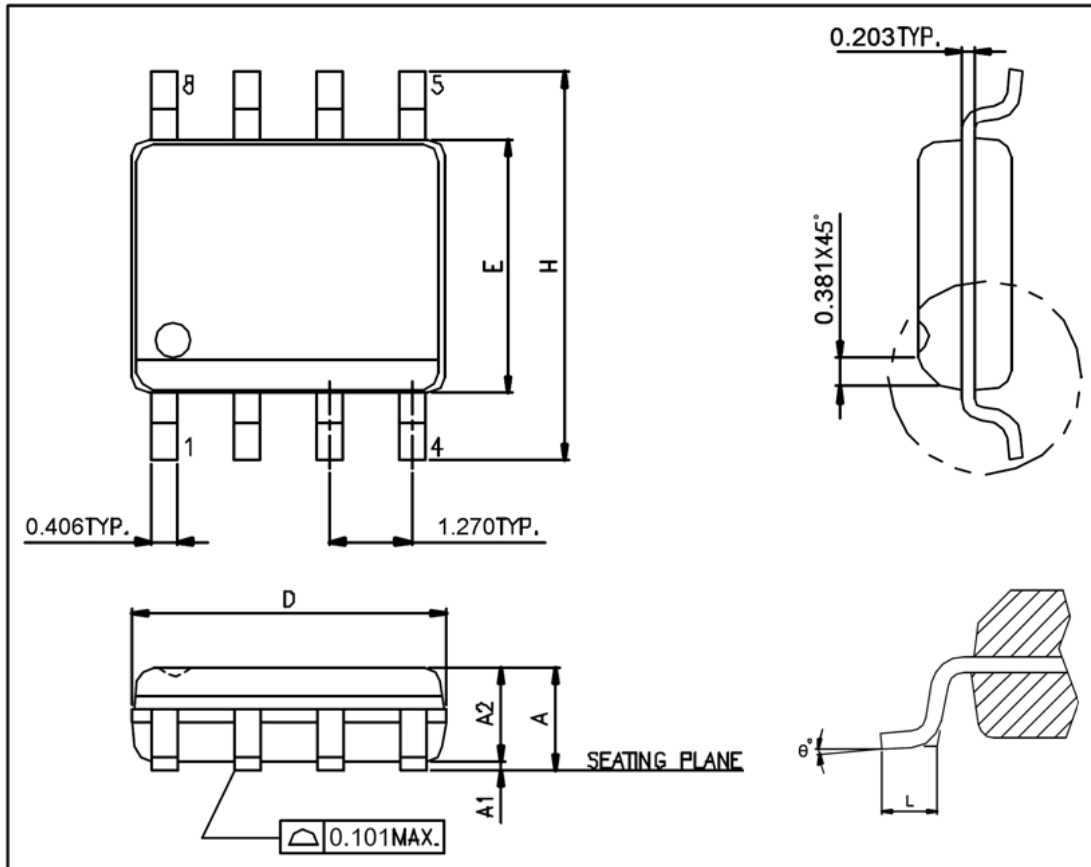FP6102 Basic DC-DC Regulator Circuit

For example:

The V_{IN} power supply is 12V and the V_{OUT} is designed for 3.3V / 3A solution.

The output voltage formula 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
θ°	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.