

Low Voltage DC / DC Buck Controller



General Description

The FP5108 is a buck topology switching regulator controller for low operating voltage applications field. The FP5108 includes a totem-pole single output stage for driving PNP transistor or P-MOS, high precision reference (0.5V) for comparing output voltage with feedback amplifier, an internal duty control for controlling the maximum duty cycle, programmable soft start with short circuit protection and external shutdown control.

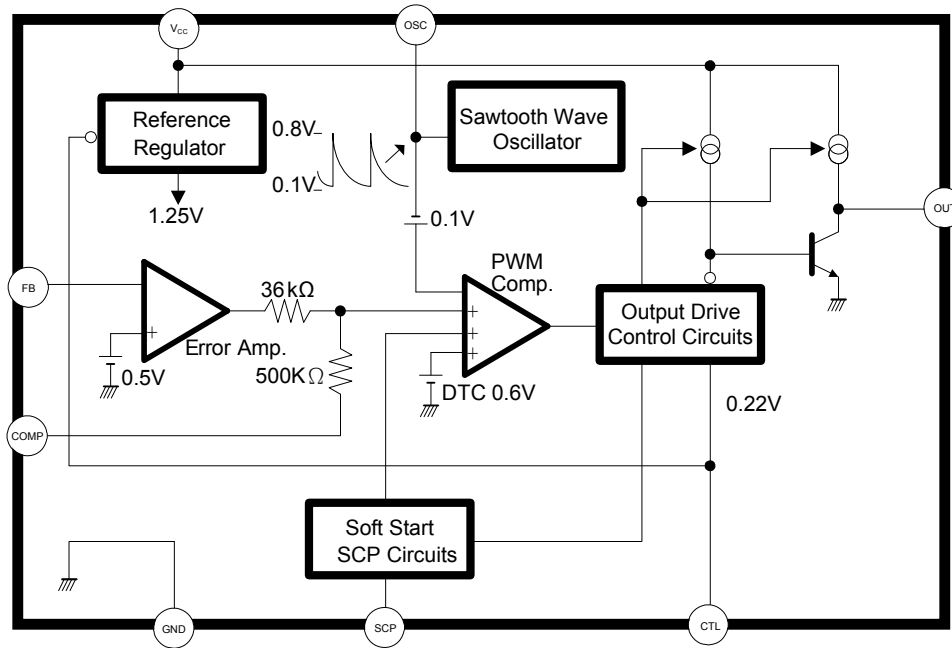
Features

- Wide Supply Voltage Operating Range: 1.8 to 12V
- Precision Feedback Reference Voltage: 0.5V ($\pm 2\%$)
- High Speed Oscillator Frequency: 600KHz max.
- Low Current Consumption: Operation Mode 5.5mA
- Low Current Consumption: Shutdown Mode 1 μ A
- Programmable Soft Start Function (SS)
- Short Circuit Protection Function (SCP)
- Totem-pole Output
- Shutdown Function with Adjustable Driving Current
- Package: SOP-8L, SOP-8L (EP), TSSOP-8L and MSOP-8L

Applications

- Low Input Voltage DC / DC Converter
- Battery used Equipment
- Low Output Voltage DC / DC Converter

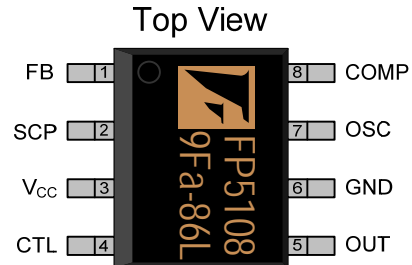
Function Block Diagram



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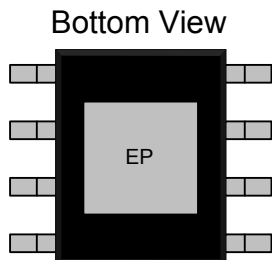
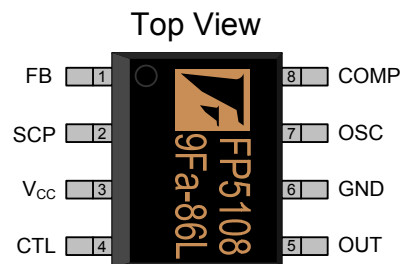
Pin Descriptions

SOP-8L



Name	No.	I / O	Description
FB	1	I	Error amplifier Inverting input
SCP	2	I	Connected a Capacitor Soft Start and SCP Function pin
V _{CC}	3	P	IC Power Supply
CTL	4	I	Shutdown or Adjust Driving Current pin
OUT	5	O	Totem-pole Output
GND	6	P	IC Ground
OSC	7	I	Capacitor and Resistor Connected for Adjusting the Oscillation Frequency
COMP	8	O	Error Amplifier Compensation Output

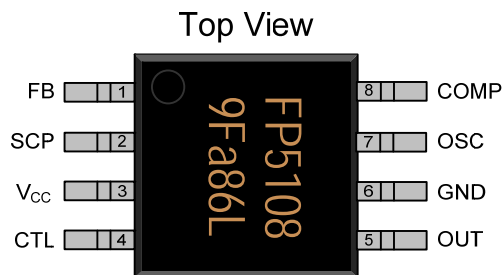
SOP-8L (EP)



Name	No.	I / O	Description
FB	1	I	Error amplifier Inverting input
SCP	2	I	Connected a Capacitor Soft Start and SCP Function pin
V _{CC}	3	P	IC Power Supply
CTL	4	I	Shutdown or Adjust Driving Current pin
OUT	5	O	Totem-pole Output
GND	6	P	IC Ground
OSC	7	I	Capacitor and Resistor Connected for adjusting the Oscillation Frequency
COMP	8	O	Error Amplifier Compensation Output
EP	9	P	Exposed PAD. Must connect to GND

TSSOP-8L

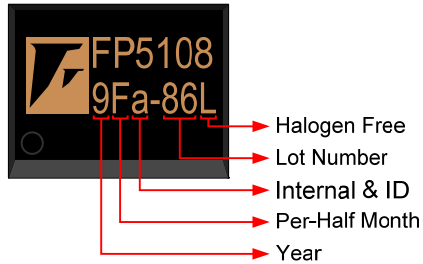

Name	No.	I / O	Description
FB	1	I	Error amplifier Inverting input
SCP	2	I	Connected a Capacitor Soft Start and SCP Function pin
V _{CC}	3	P	IC Power Supply
CTL	4	I	Shutdown or Adjust Driving Current pin
OUT	5	O	Totem-pole Output
GND	6	P	IC Ground
OSC	7	I	Capacitor and Resistor Connected for adjusting the Oscillation Frequency
COMP	8	O	Error Amplifier Compensation Output

MSOP-8L


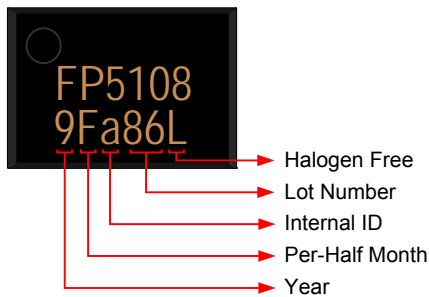
Name	No.	I / O	Description
FB	1	I	Error amplifier Inverting input
SCP	2	I	Connected a Capacitor Soft Start and SCP Function pin
V _{CC}	3	P	IC Power Supply
CTL	4	I	Shutdown or Adjust Driving Current pin
OUT	5	O	Totem-pole Output
GND	6	P	IC Ground
OSC	7	I	Capacitor and Resistor Connected for adjusting the Oscillation Frequency
COMP	8	O	Error Amplifier Compensation Output

Marking Information

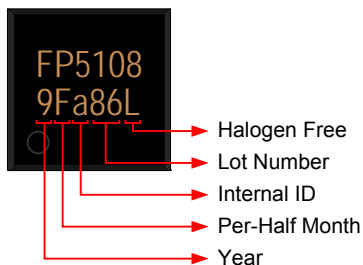
SOP-8L & SOP-8L (EP)



TSSOP-8L



MSOP-8L



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

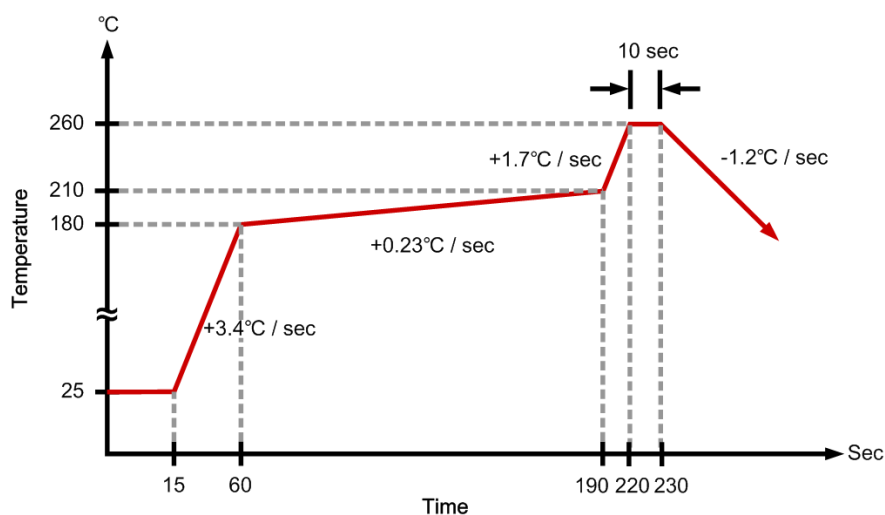
Ordering Information

Part Number	Operating Temperature	Package	MOQ	Description
FP5108DR-LF	-10°C ~ +85°C	SOP-8L	2500EA	Tape & Reel
FP5108XR-LF	-10°C ~ +85°C	SOP-8L (EP)	2500EA	Tape & Reel
FP5108WR-LF	-10°C ~ +85°C	TSSOP-8L	2500EA	Tape & Reel
FP5108TR-LF	-10°C ~ +85°C	MSOP-8L	2500EA	Tape & Reel

Absolute Maximum Ratings

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power Supply Voltage	V_{IN}				12	V
Output Source Current			-50			mA
Output Sink Current					50	mA
Allowable Power Dissipation		SOP-8L, $T_A \leq +25^\circ\text{C}$			570	mW
		SOP-8L (EP), $T_A \leq +25^\circ\text{C}$			400	mW
		TSSOP-8L (EP), $T_A \leq +25^\circ\text{C}$			400	mW
		MSOP-8L (EP), $T_A \leq +25^\circ\text{C}$			600	mW
Thermal Resistance Junction to Ambient		(SOP package)			+175	$^\circ\text{C} / \text{W}$
Storage Temperature			-55		+125	$^\circ\text{C}$
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			1.8		12	V
Operating Temperature			-10		+85	°C

DC Electrical Characteristics ($V_{CC}=5V$, $V_{CH1}=12V$, unless otherwise noted)

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Under Voltage Lock-Out Section (UVLO)						
Low Threshold Voltage	V_{LOW}				0.9	V
Upper Threshold Voltage	V_{UPPER}		1.1	1.3	1.5	V
Soft Start Section (SS)						
Input Source Current	I_{SS}	$V_{SS}=0V$	-1.5	-1.0	-0.7	μA
Soft Start Threshold Voltage	V_{SST}		0.8	0.9	1.0	V
Short Circuit Protection Section (S.C.P.)						
Input Source Current	I_{SCP}	$V_{SCP}=0V$	-1.5	-1.0	-0.7	μA
S.C.P. Threshold Voltage	V_{SCP}		0.7	0.8	0.9	V
Oscillator Section						
Oscillation Frequency	f	$R_T=3.0K\Omega$, $C_T=270pF$	400	500	600	KHz
Frequency Change with Voltage	$\Delta f / \Delta V$	$V_{CC}=2V$ to 15V		2	10	%
Frequency Change with Temperature	$\Delta f / \Delta T$	$T_A = 0^\circ C$ to $85^\circ C$		5		%
Idle Period Adjustment Section						
Maximum Duty Cycle	T_{DUTY}	$R_T=3.0k\Omega$, $C_T=270pF$, $V_{FB}=0.8V$	75		85	%
Total Device Section						
Stand-by Current	$I_{STANDBY}$	Pin4 is Open or V_{CC}			1	μA
Average Supply Current	I_{AVE}	$R_B=390\Omega$, $V_{CC}=0\sim 20V$		5.0	10	mA
Error Amplifier Section						
Input Threshold Voltage	V_{FB}	$V_{COMP}=450mV$	480	500	520	mV
V_T Change with Voltage	$\frac{\Delta V_{FB}}{\Delta V}$	$V_{CC}=2V$ to 15V		5	20	mV
V_T Change with Temperature	$\frac{\Delta V_{FB}}{\Delta T}$	$T_A = -10^\circ C$ to $85^\circ C$		1		%
Input Bias Current	I_B		-1.0	-0.2	1.0	μA
Voltage Gain	A_V			100		V / V
Frequency Bandwidth	BW	$A_V=0$ dB		6		MHz
Output Voltage Swing Positive	V_{POS}		0.78	0.87		V
Output Voltage Swing Negative	V_{NEG}			0.05	0.2	V
Output Source Current	I_{SOURCE}	$V_{COMP}=450mV$		-40	-24	μA
Output Sink Current	I_{SINK}	$V_{COMP}=450mV$	24	40		μA

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Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Output Section						
Output High Voltage	V_{OH1}	$R_B=390\Omega, I_O=-15mA$	1.0	1.2		V
Output High Voltage	V_{OH2}	$R_B=750\Omega, I_O=-10mA, V_{CC}=1.8V$	0.8	1.0		V
Output Saturation Voltage	V_{OL1}	$R_B=390\Omega, I_O=15mA$		0.1	0.2	V
Output Saturation Voltage	V_{OL2}	$R_B=750\Omega, I_O=10mA, V_{CC}=1.8V$		0.1	0.2	V
Output Source Current	$I_{OSOURCE}$	$R_B=390\Omega, V_O=0.9V$		-40	-20	mA
Output Sink Current	I_{OSINK}	$R_B=390\Omega, V_O=0.3V$	30	40		mA
Output Current Setting / Control Section						
Pin Voltage	V_{BR}	$R_B=390\Omega$	0.15	0.22	0.3	V
Input off Condition	I_{OFF}		-20		0	μA
Input on Condition	I_{ON}				-45	μA
Pin Current Range	I_{BR}		-1.8		-0.1	mA

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Typical Characteristics

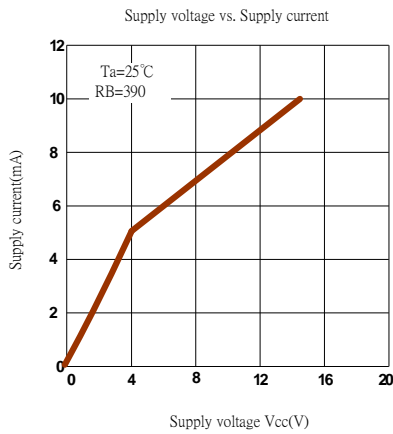


Figure 1

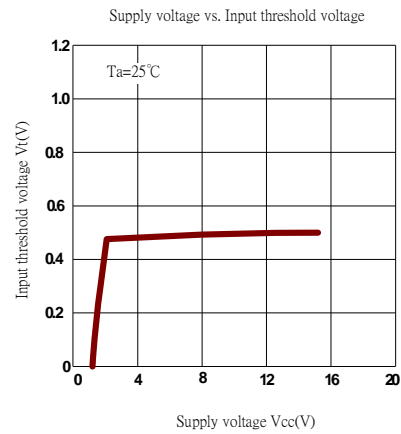


Figure 2

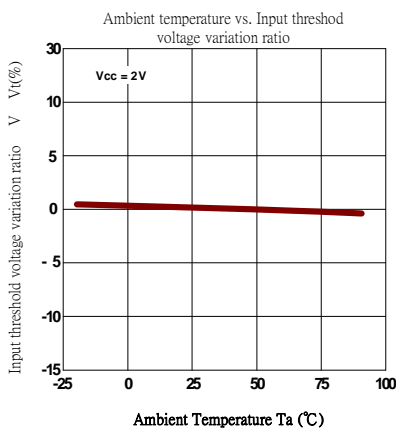


Figure 3

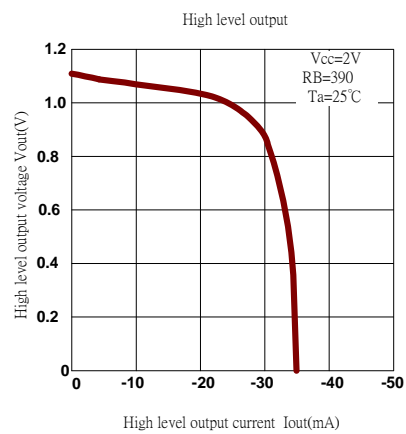


Figure 4

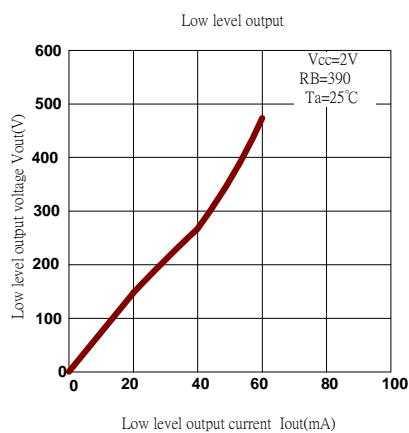


Figure 5

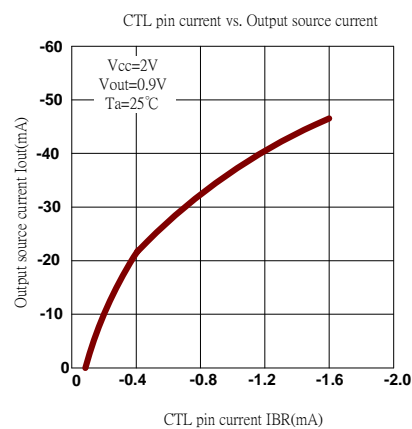


Figure 6

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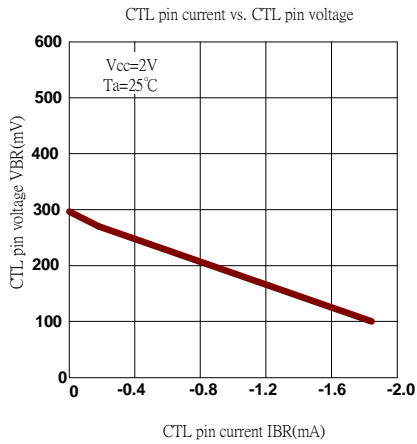


Figure 7

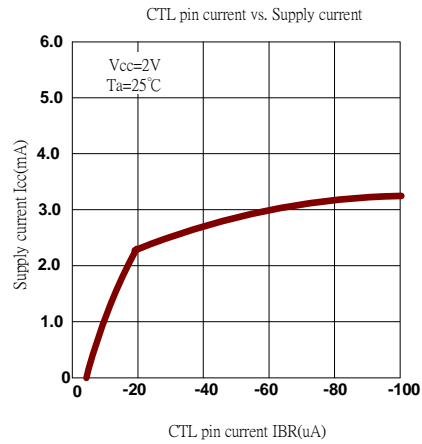
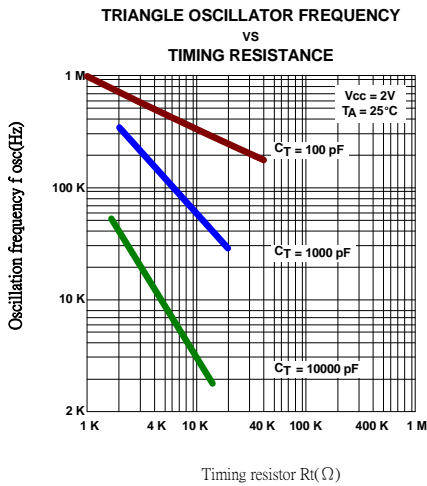


Figure 8



Timing resistor Rt(Ω)

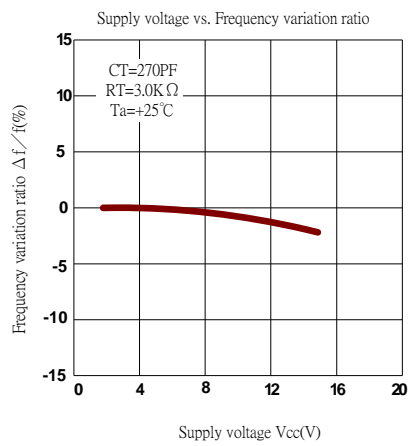


Figure 10

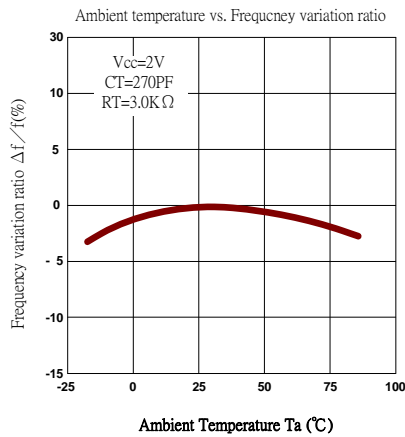


Figure 11

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Timing Waveform

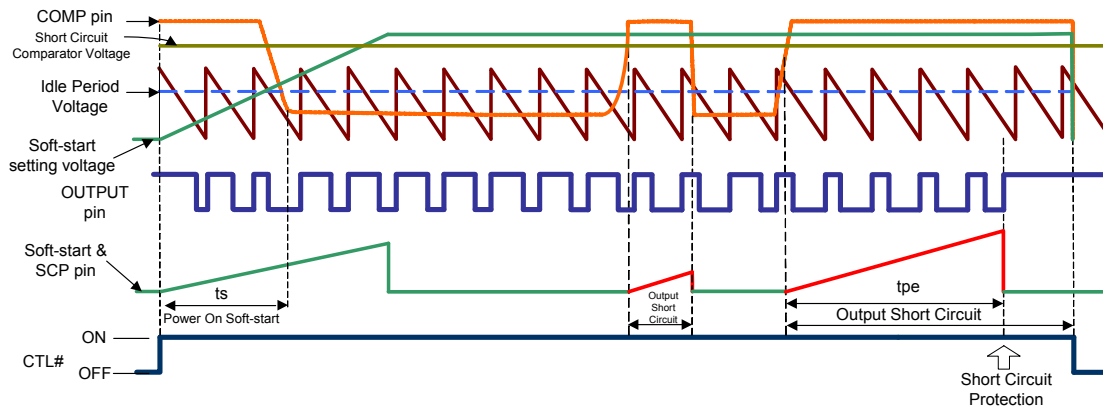


Figure12. FP5108 Timing Diagram

Function Description

Voltage Reference

1.25V regulator operating from V_{CC} is used to power the internal circuitry of the FP5108. An internal resistive divider provides 0.5V reference for the error amplifier, Soft-start (typ. 0.9V) and SCP (typ. 0.8V) circuits.

Error Amplifier

The error amplifier compares a sample of the DC-DC converter output voltage to the 0.5V reference and generates an error signal for the PWM comparator. Output voltage of DC-DC converter is setting with the resistor divider using the following expression (see figure 13)

$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) \times 0.5$$

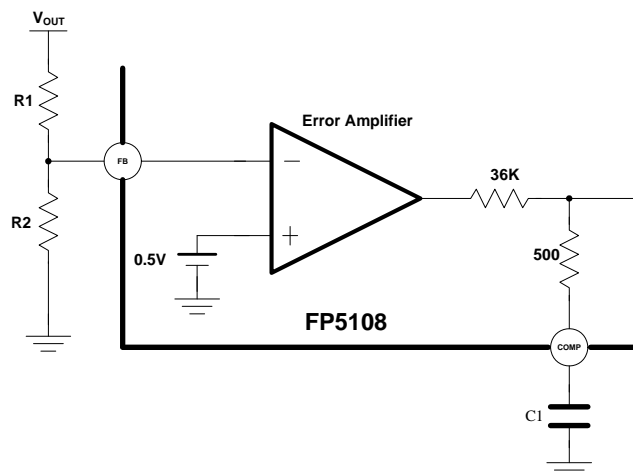


Figure13. Error Amplifier with Feedback Resistance Divider

Oscillator

The oscillator frequency can be set from 20KHz to 500KHz by connecting a resistor and a capacitor at OSC pin of FP5108 to ground. The oscillator frequency can be determined by using the graph shown in figure 9.

The oscillator output is a sawtooth wave with a minimum value of approximately 0.1V and a maximum value of approximately 0.6V. The PWM comparator compares the oscillator voltage with error amplifier output voltage; internal DTC voltage (typ. 0.6V) and soft start setting voltage. When the sawtooth wave voltage is lower than above three-output voltage, the output of FP5108 is low (Driving for PNP transistor or PMOS).

Under Voltage Lockout (UVLO)

The under voltage lockout circuits turn the output off and whenever the supply voltage drops too low (approximately 0.9V at 25°C) for proper operation. A hysteresis voltage of 200mV eliminates false triggering on noise and chattering.

Soft Start / Short-Circuit Protection (S.S. / S.C.P.)

The soft start is functional after power on, and the interval of soft start time is determined by a capacitor connected to SCP pin (pin 2). When soft start function finished, the internal soft start voltage is setting high, but external SCP pin is setting low in order to change to short circuit detection / protection function.

The time of soft start is following expression:

$$T_{ss}[\text{ms}] = 0.35 \times C[\mu\text{F}]$$

The short circuit protection is functional due to a heavy loading drop and output of error amplifier (COMP pin) is maintain a V_{POS} (typ. 0.87V), the capacitor is charged to SCP threshold voltage (typ. 0.8V), then FP5108 output is turn-off (internal pull-high) and the capacitor is discharged to low state.

$$T_{scp}[\text{ms}] = 0.8 \times C[\mu\text{F}]$$

Output Transistor

FP5108 will be shutdown immediately whenever COMP voltage is lower than 0.4V. The mean is hard to maintain the output voltage during maximum duty cycle under short-circuit, and the PWM output are off until power restart.

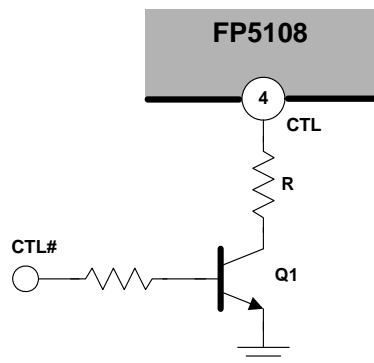


Figure14. Output Transistor Driving Control Circuit

CTL pin can also use to control the output of FP5108 for shutdown or re-start function of system.

CTL# Control Pin	Q1	CTL Pin	Output Transistor Function	Mode
Low	Off	High	Disable	Shutdown
High	On	Bias Current	Enable	Operation

Application Information

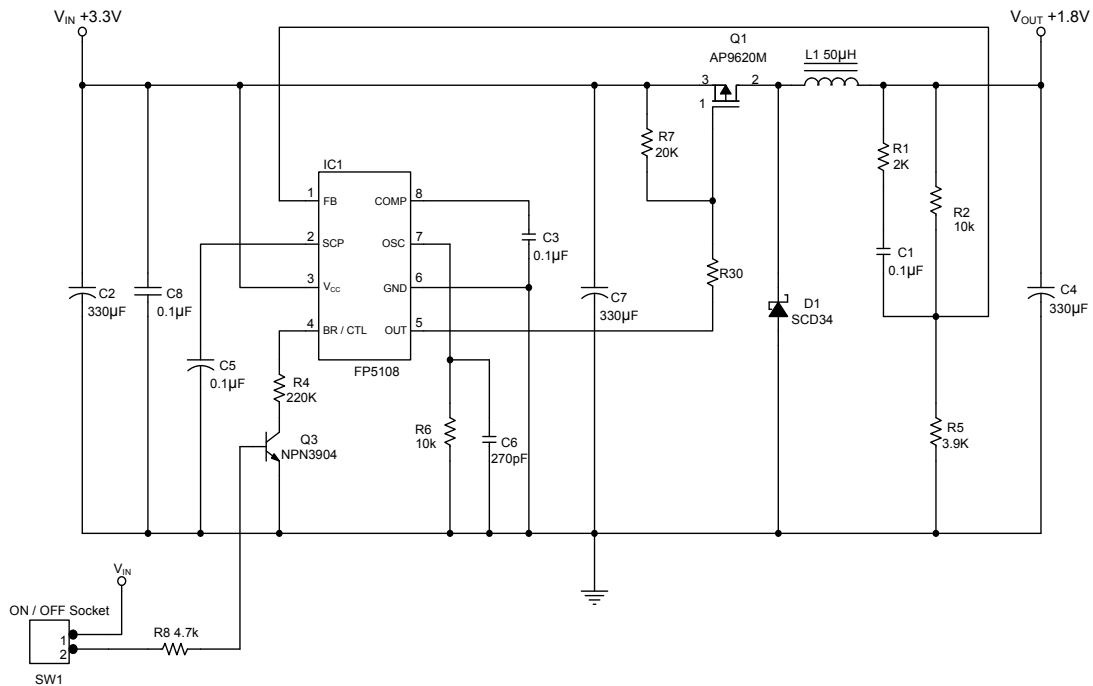


Figure15. FP5108 Basic Buck Converter Circuits

For example:

The Vin is 3.3VDC, and Vout is 1.8V with 2.5A load.
The output voltage equation is:

$$V_{OUT} = \left(1 + \frac{R2}{R5}\right) \times V_{FB} = \left(1 + \frac{10K}{3.9K}\right) \times 0.5V = 1.78V$$

The Soft-start time:

$$T_{ss} = 0.35 \times C5 = 0.35 \times 0.1 = 35ms$$

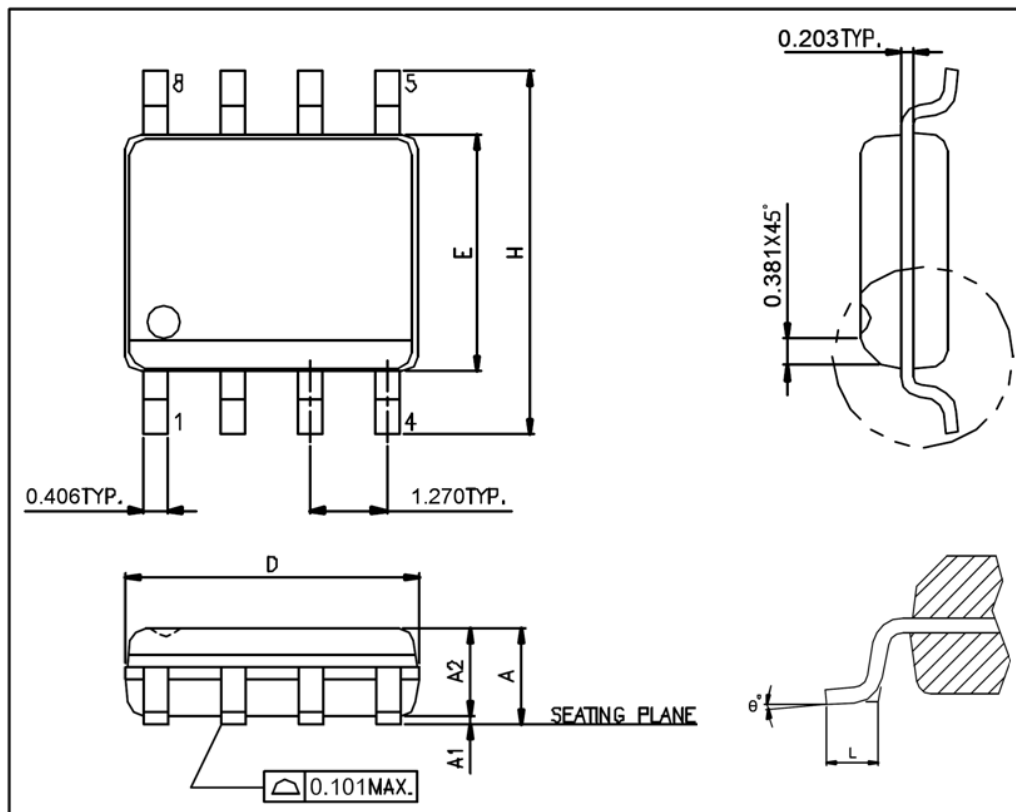
The SCP time:

$$T_{scp} = 0.8 \times C5 = 0.8 \times 0.1 = 80ms$$

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Package Outline

SOP-8L



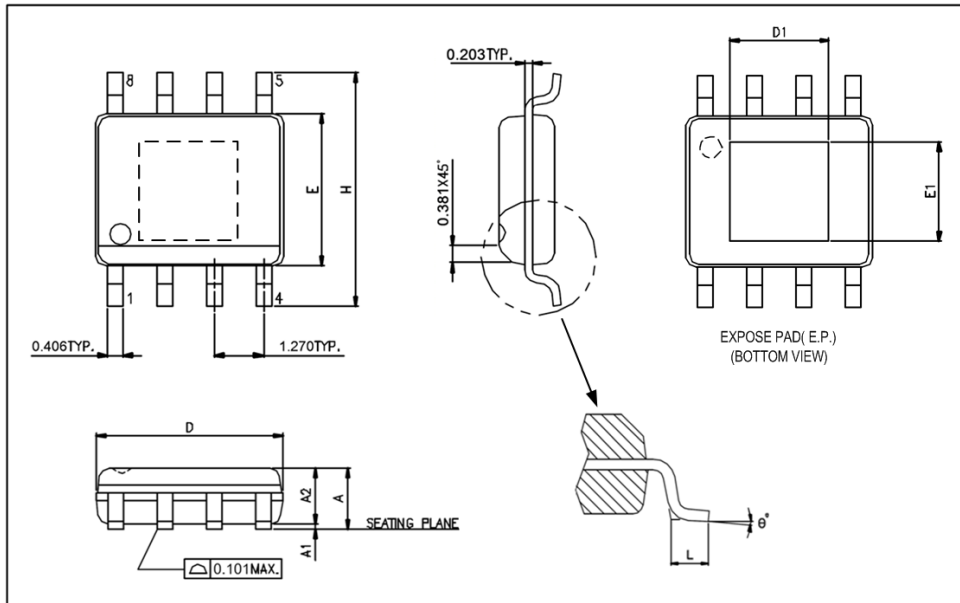
UNIT: mm

Symbols	Min. (mm)	Max. (mm)
A	1.346	1.752
A1	0.101	0.254
A2	1.244	1.651
D	9.804	10.007
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 AC.
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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SOP-8L (EP)

UNIT: mm

Symbols	Min. (mm)	Max. (mm)
A	1.346	1.752
A1	0.050	0.152
A2		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°

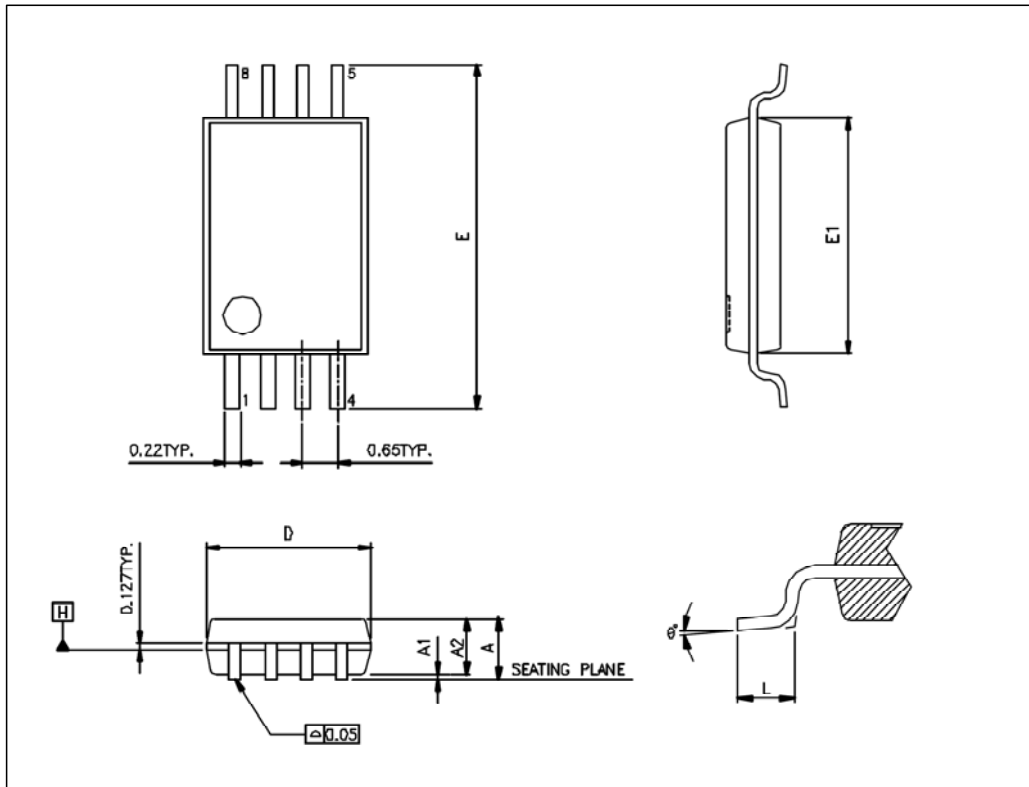
Exposed PAD Dimensions:

Symbols	Min. (mm)	Max. (mm)
E1		2.184 REF
D1		2.971 REF

Note:

1. Package dimensions are in compliance with JEDEC outline: MO-178 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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TSSOP-8L

UNIT: mm

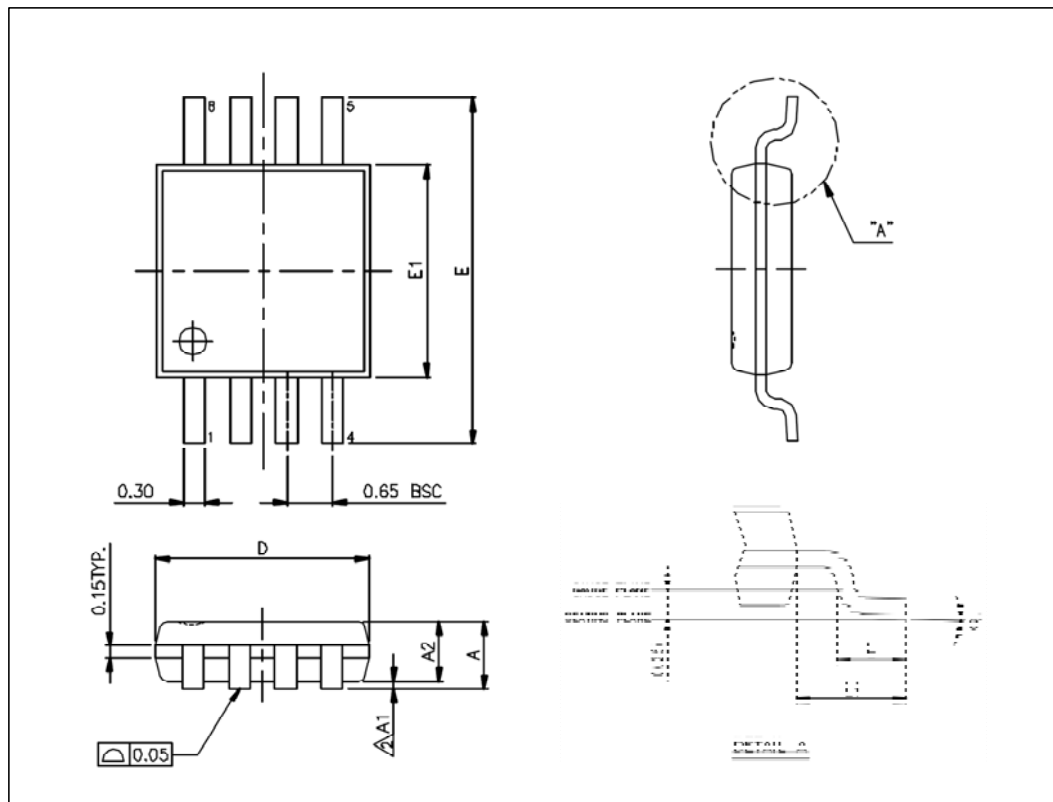
Symbols	Min. (mm)	Max. (mm)
A		1.200
A1	0.050	0.150
A2	0.960	1.060
D	2.900	3.100
E	6.400 BSC	
E1	4.300	4.500
L	0.450	0.750
θ°	0°	8°

Note:

1. Package dimensions are in compliance with JEDEC outline: MO-153 AA.
2. Dimension "D" does not include molding flash, protrusions or gate burrs.
3. Dimension "E1" does not include inter-lead flash or protrusions.

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MSOP-8L



UNIT: mm

Symbols	Min. (mm)	Max. (mm)
A		1.100
A1	0.000	0.150
A2	0.750	0.950
D	3.000 BSC	
E	4.900 BSC	
E1	3.000 BSC	
L	0.400	0.800
L1	0.950 REF	
θ°	0°	8°

Note:

1. Package dimensions are in compliance with JEDEC outline: MO-187 AA.
2. Dimension "D" does not include molding flash, protrusions or gate burrs.
3. Dimension "E1" does not include inter-lead flash or protrusions.

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