

Non-Synchronous PWM Boost Controller



General Description

The FP5138B is a boost switching regulator controller IC for battery-used applications. The FP5138B includes a totem-pole output stage for driving NPN transistor or N-MOS, high precision reference (0.5V) for comparing output voltage by feedback amplifier, precision maximum duty cycle control, programmable soft start with short circuit protection function and operating mode control between operation and standby mode.

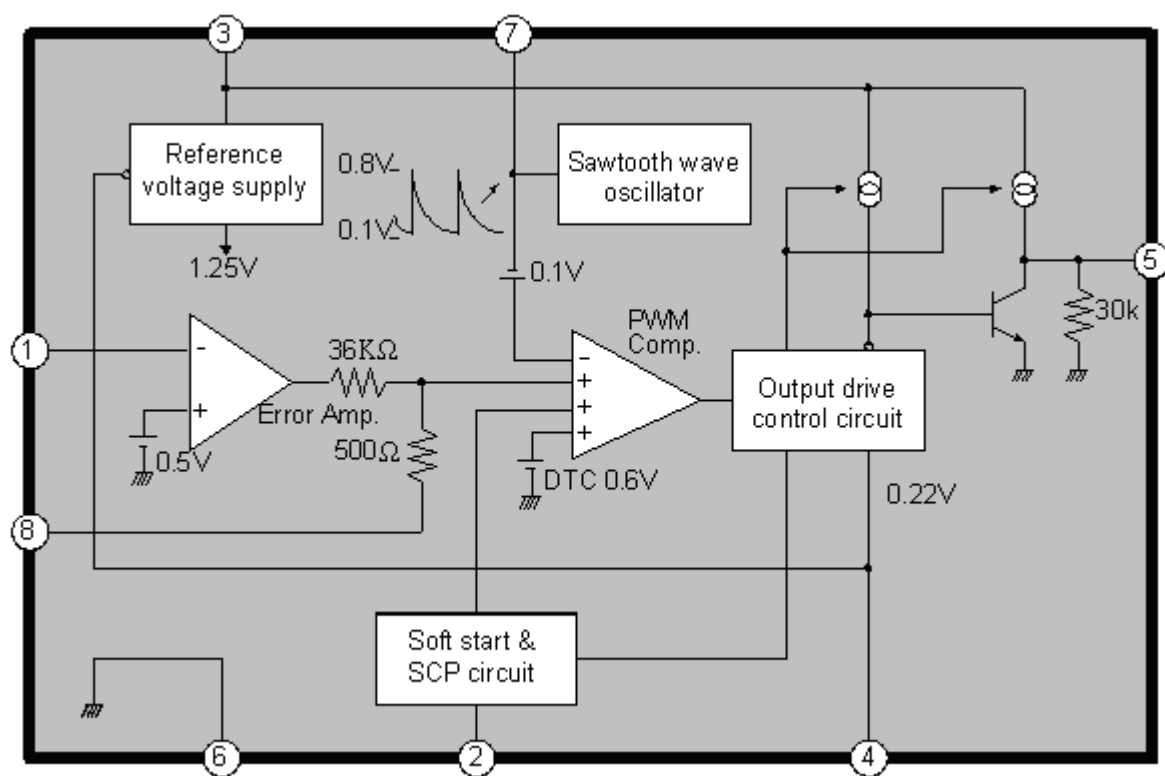
Features

- Wide Supply Voltage Operating Range: 1.8 to 15V
- Reference Voltage Precision: 2%
- Low Current Consumption: 5.5mA in Operation Mode
- Low Current Consumption: 1 μ A in Standby Mode
- High Oscillator Frequency: 1MHz max.
- Programmable Soft Start Function (SS)
- Short Circuit Protection Function (SCP)
- Totem-Pole Output with Adjustable ON / OFF Current (for NPN Transistors or n-Channel MOSFET)
- Logic Level Control Stand-by Mode Function
- Package: SOP-8L (EP), SOP-8L and TSSOP-8L and MSOP-8L

Applications

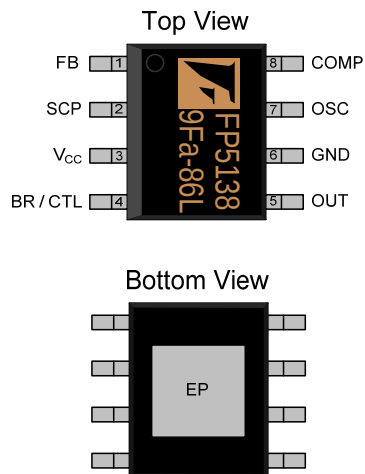
- Digital Camera
- PDA
- Portable Equipment

Function Block Diagram



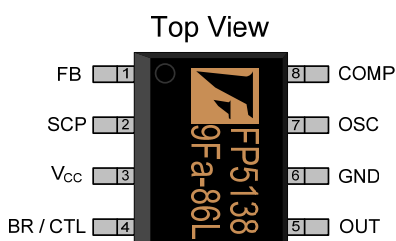
Pin Descriptions

SOP-8L (EP)



Name	No.	I / O	Description
FB	1	I	Error Amplifier Inverting Input
SCP	2	I	Soft Start and SCP Function Connect a Capacitor to this pin
V _{CC}	3	P	IC power supply
BR / CTL	4	I	Output Current Setting and Control
OUT	5	O	Totem-Pole Output
GND	6	P	IC Ground
OSC	7	I	Oscillator Output: Connect Capacitor and Resistor to this pin for Frequency Adjustment
COMP	8	O	Error Amplifier Compensation Output
EP	9	P	Exposed PAD is GND

SOP-8L

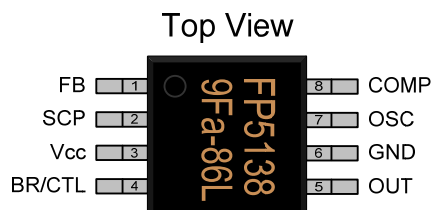


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TSSOP-8L



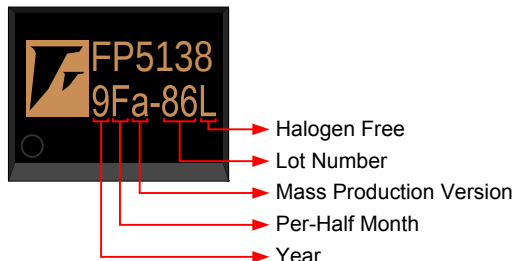
MSOP-8L



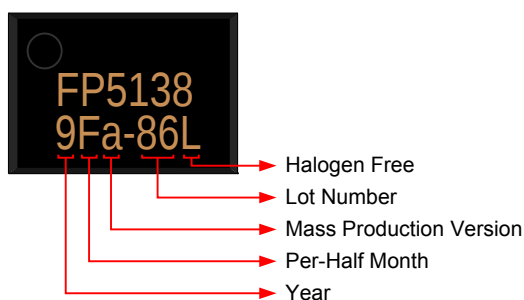
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IC Date Code Identification

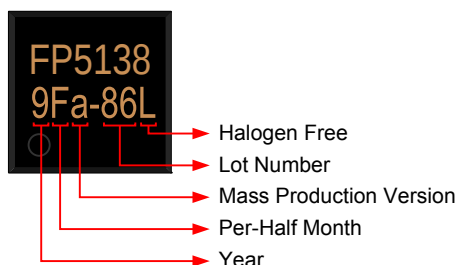
SOP-8L / SOP-8L (EP)



TSSOP-8L



MSOP-8L



Halogen Free: Halogen free product indicator

Lot Number: Wafer lot number's last two digits

For Example: 132386TB → 86

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

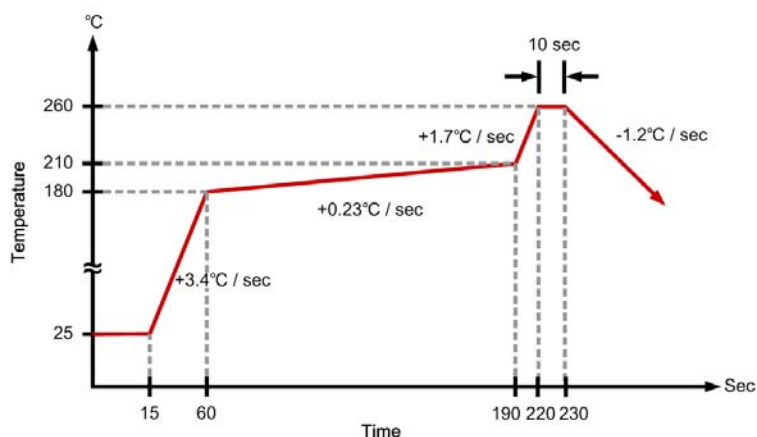
Ordering Information

Part Number	Operating Temperature	Package	MOQ	Description
FP5138BD-LF	-10°C ~ +85°C	SOP-8L	100EA	Tube
FP5138BDR-LF	-10°C ~ +85°C	SOP-8L	2500EA	Tape & Reel
FP5138BW-LF	-10°C ~ +85°C	TSSOP-8L	160EA	Tube
FP5138BWR-LF	-10°C ~ +85°C	TSSOP-8L	2500EA	Tape & Reel
FP5138BT-LF	-10°C ~ +85°C	MSOP-8L	80EA	Tube
FP5138BTR-LF	-10°C ~ +85°C	MSOP-8L	2500EA	Tape & Reel
FP5138BX-LF	-10°C ~ +85°C	SOP-8L (EP)	100EA	Tube
FP5138BXR-LF	-10°C ~ +85°C	SOP-8L (EP)	2500EA	Tape & Reel

Absolute Maximum Ratings

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power Supply Voltage	V_{IN}				15	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
		MSOP-8L, $T_A \leq +25^\circ\text{C}$			400	mW
		TTSOP-8L, $T_A \leq +25^\circ\text{C}$			400	mW
		SOP-8L (EP), $T_A \leq +25^\circ\text{C}$			600	mW
Operating Temperature			-10		+85	°C
Storage Temperature			-55		+125	°C
Junction Breakdown Temperature	T_J	SOP 8L			+125	°C
Lead Temperature		SOP-8L, soldering, 10 sec			+260	°C
		TSSOP-8L, soldering, 10 sec			+260	°C
		MSOP-8L, soldering, 10 sec			+260	°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		15	V
Operating Temperature			-10		+85	°C

DC Electrical Characteristics ($V_{CC} = +2V$, $T_A = 25^\circ C$, 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}	$V_{SCP} = 0V$	-1.5	-1.0	-0.7	μA
Soft Start Threshold Voltage	V_{SST}		0.8	0.9	1.0	V
Short Circuit Protection Section (SCP)						
Input Source Current	I_{SCP}	$V_{SCP} = 0V$	-1.5	-1.0	-0.7	μA
SCP 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						
Standby Current	$I_{STANDBY}$	Pin 4 is open or $= V_{CC}$			1	μA
Average Current Consumption	I_{AVE}	$R_B = 390\Omega$, $V_{CC} = 0 \sim 15V$		5.0	10	mA
Error Amplifier Section						
Input Threshold Voltage	V_{FB}	$V_{COMP} = 450mV$	495	500	505	mV
V_T Change With Voltage	$\Delta V_{FB} / \Delta V$	$V_{CC} = 2V$ to $15V$		5	20	mV
V_T Change With Temperature	$\Delta V_{FB} / \Delta T$	$T_A = -10^\circ C$ 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}	$V_{COMP} = 450$ mV		-40	-24	μA
Output Sink Current	I_{SINK}	$V_{COMP} = 450$ mV	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
	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
	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
Internal Pull-Down Resistor	R_O		20	30	40	k Ω
Output Current Setting / Control section						
Pin Voltage	V_{BR}	$R_B=390\Omega$	0.15	0.22	0.3	V
Output Current Setting Resistance	R_B		300	390	5000	Ω
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

Typical Operating Characteristics

($V_{CC}=2V$, $T_A=25^{\circ}C$, unless otherwise noted)

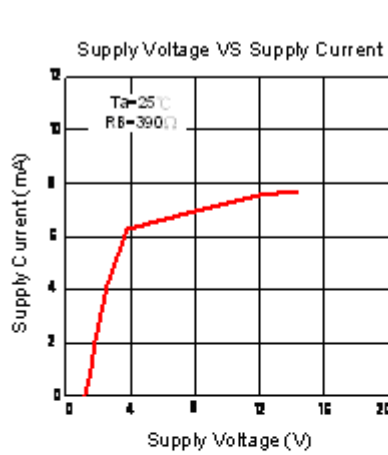


Figure 1

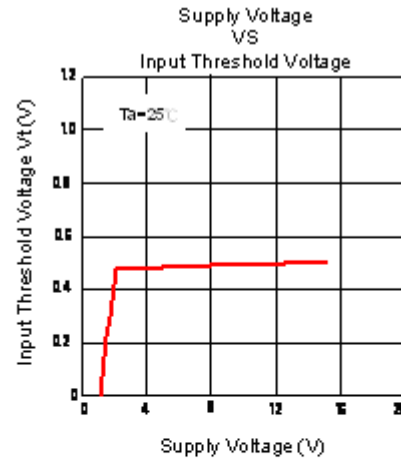


Figure 2

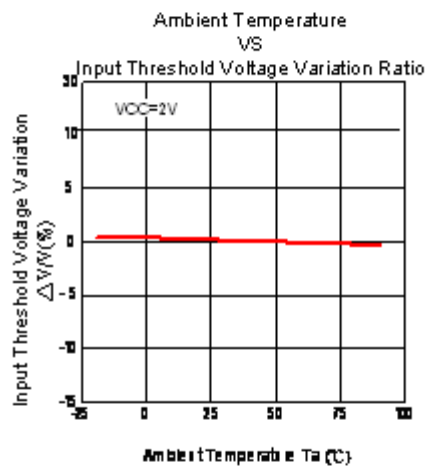


Figure 3

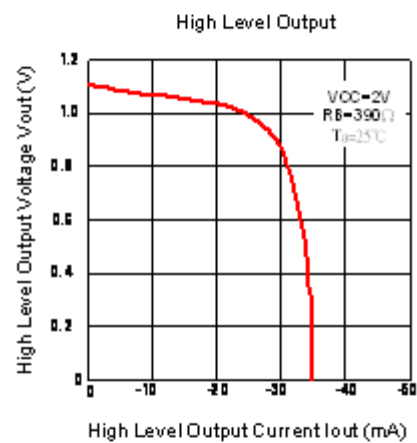


Figure 4

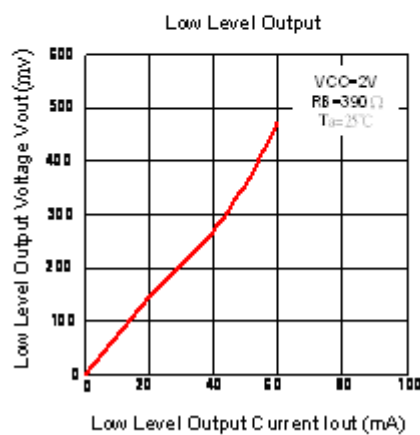


Figure 5

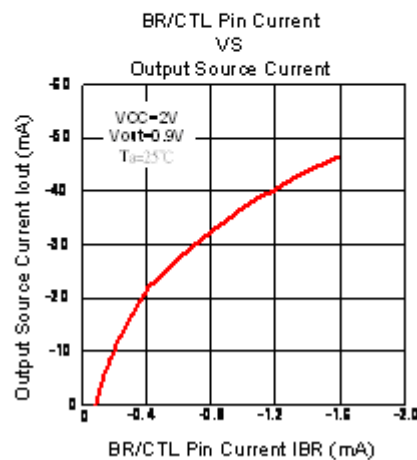


Figure 6

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Function Description

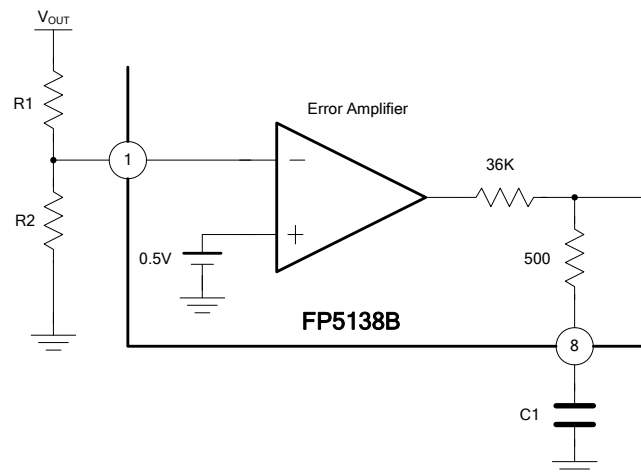
Voltage Reference

A 1.25V regulator operating from V_{CC} is used to power the FP5138B internal circuitry. 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 figure12):

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



.Figure 12 Error Amplifier with Feedback resistance divider

Oscillator

The oscillator frequency can be set from 20KHz to 1MHz by connecting a resistor and a capacitor at OSC pin of FP5138B 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 0.8V. The PWM comparator compares the oscillator voltage with error amplifier output voltage, internal maximum duty control voltage (typ. 0.6V) and soft start setting voltage. When the sawtooth wave voltage is lower than all of above three-output voltage, the output of FP5138B is high (Turn on external NPN transistor or NMOS).

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 (SS / SCP)

The soft start is functional after power on. 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:

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

The short circuit protection is functional due to a heavy loading drop and output of error amplifier (COMP pin) is maintain larger than V_{POS} (typ. 0.9V), the capacitor is charged until SCP threshold voltage (typ. 0.8V), then FP5138B output is disable (internal pull-low) and the capacitor is discharged to low.

The time of short circuit protection is:

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

Output transistor

The FP5138B has a totem-pole transistor with a 40mA source/sink current rating to drive an external NPN transistor or NMOS directly. The driving current capability depends on a resistor R that is connected to BR/CTL pin (Pin4) of FP5138B. (see figure 13)

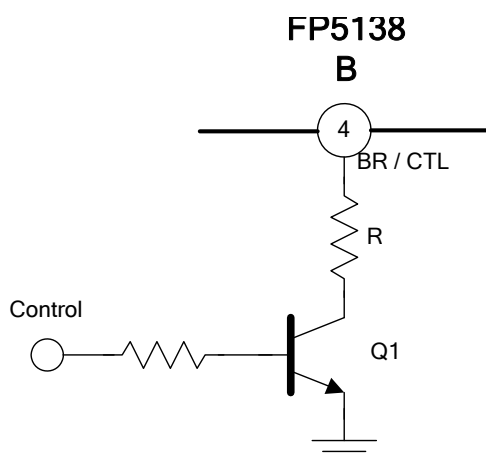
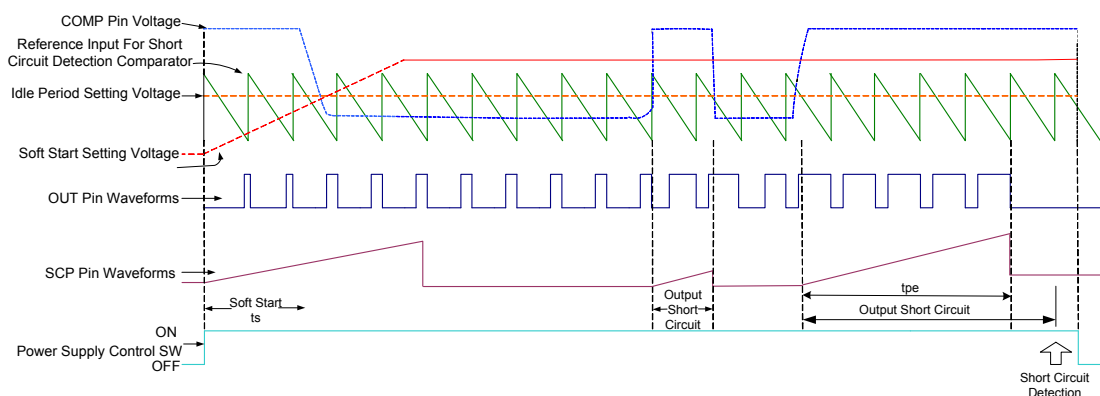


Figure 13 Output transistor driving control circuit

BR/CTL pin can also use to control the output of FP5138B for disable or enable function of system.

Control Pin	Q1	BR/CTL Pin	Output Transistor Function	Mode
Low	Off	Open	Disable	Stand-by
High	On	Bias Current	Enable	Operation

Timing Waveform



FP5138B Timing Diagram

Application Information

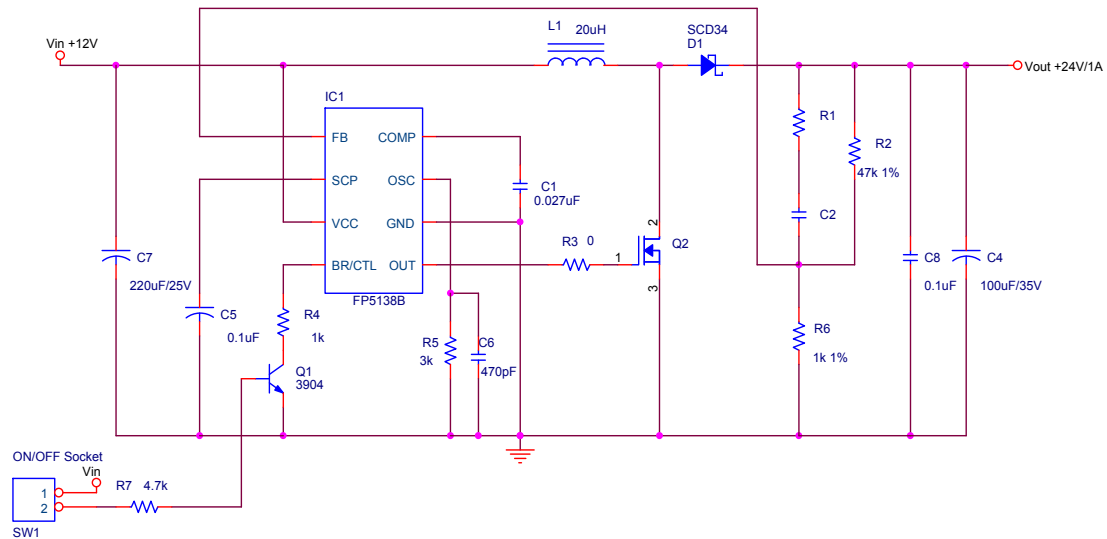


Figure 14 DC12V to DC24V Boost Regulator

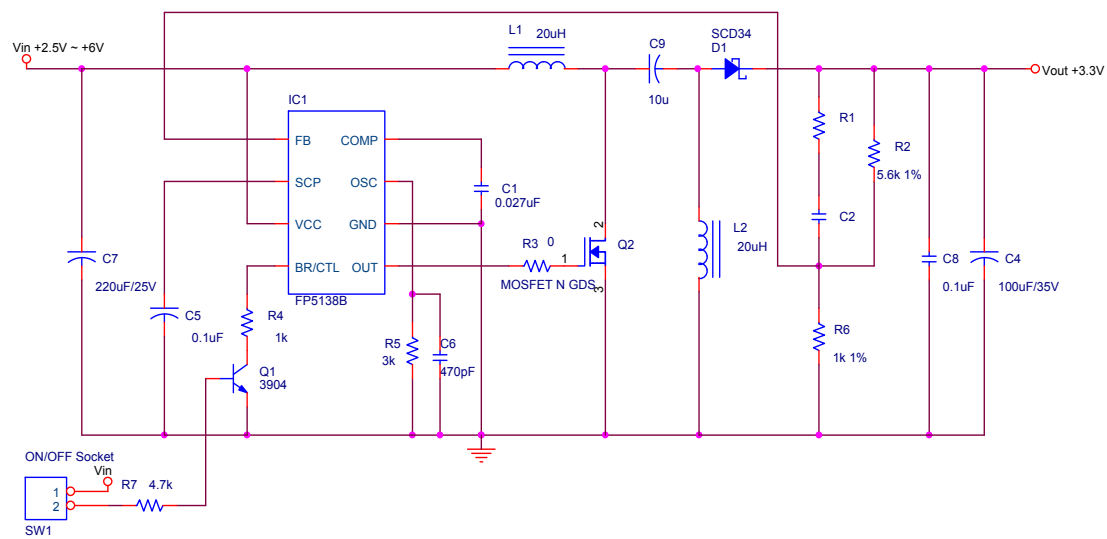


Figure 15 DC2.5V~DC6V to DC3.3V SEPIC Regulator

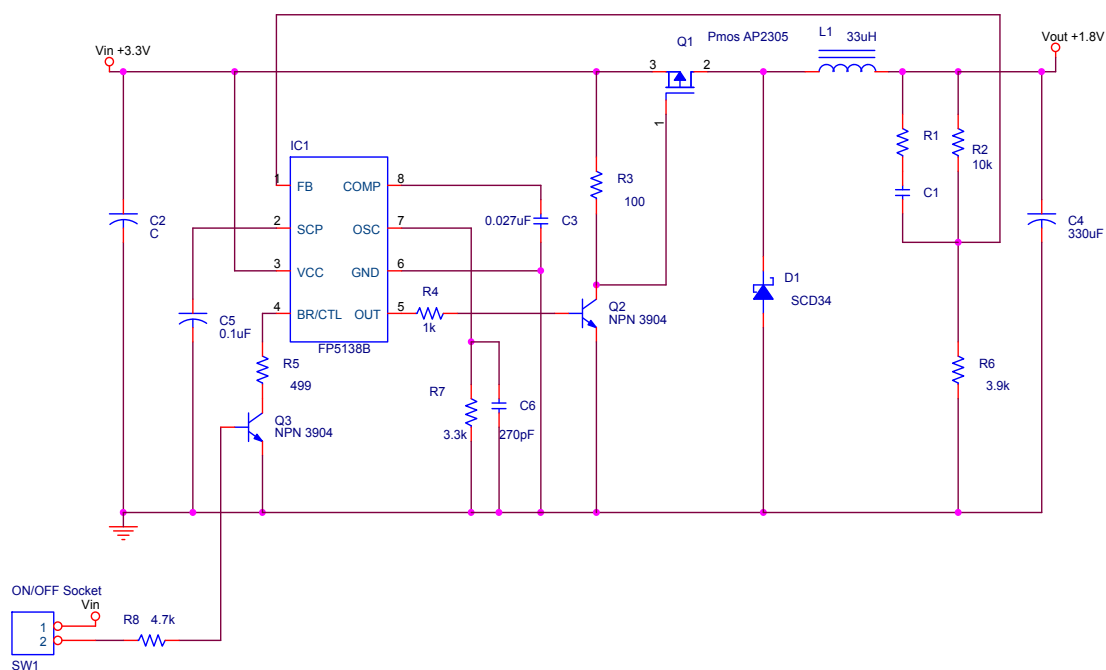


Figure 16 DC3.3V to DC1.8V Buck Regulator

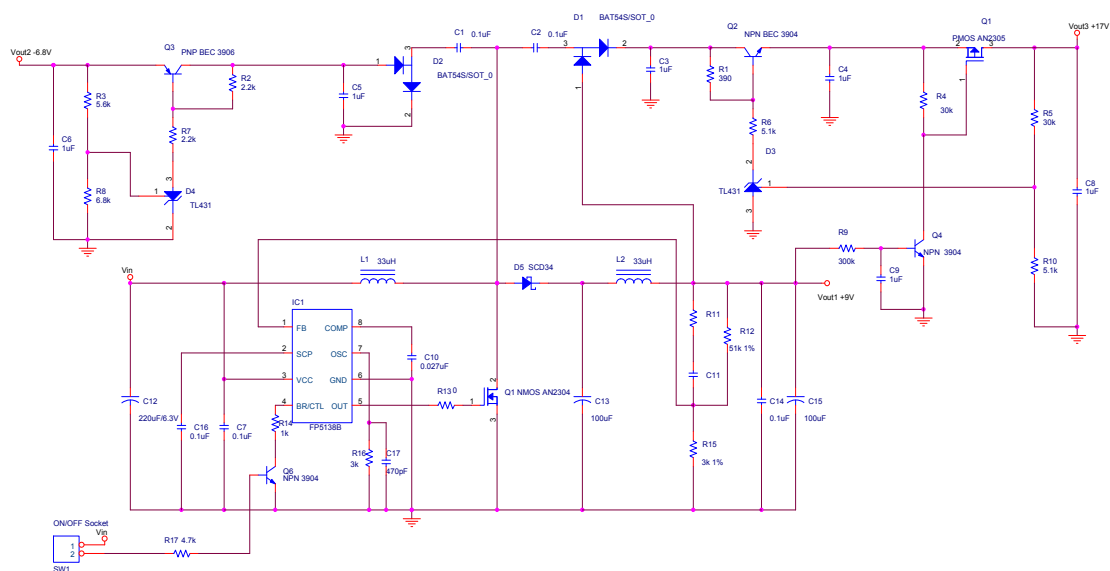


Figure 17 Charge Pump DC-DC Converter Circuits

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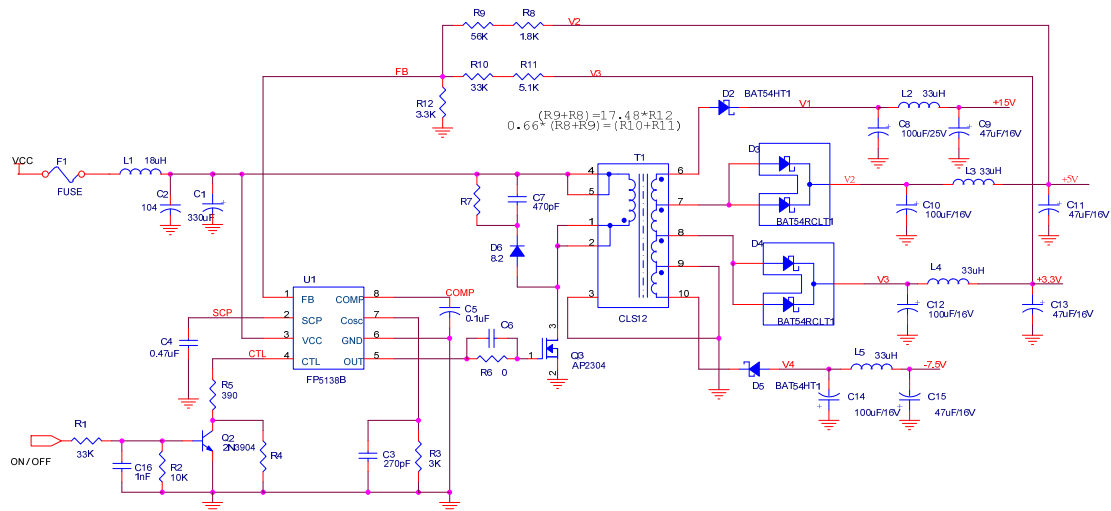
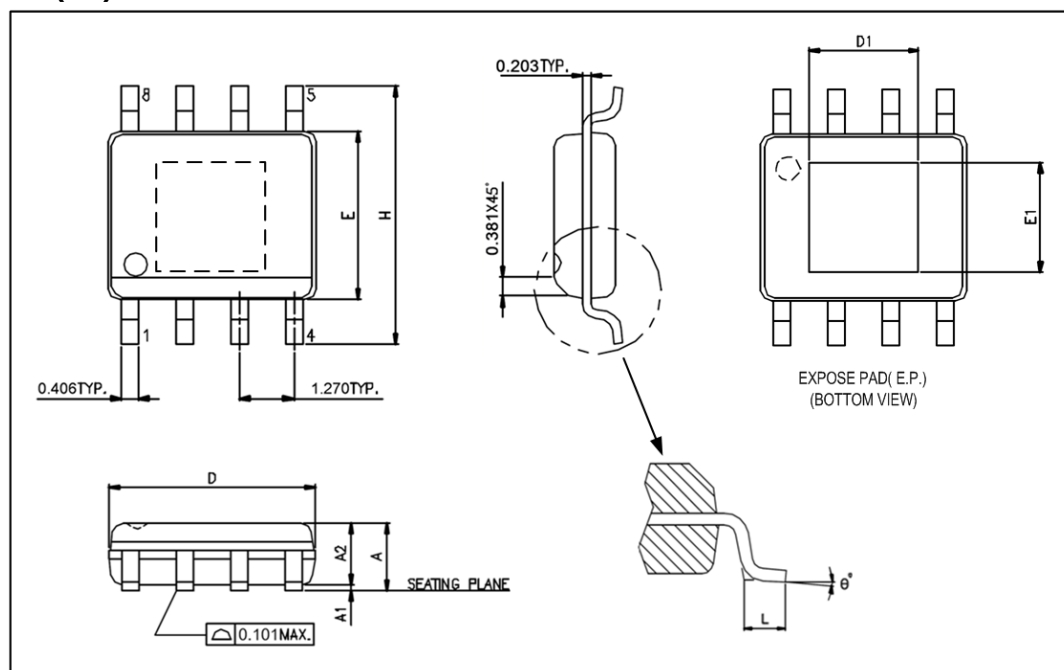


Figure 18 Flyback Multi-output DC-DC Converter Circuits

Package Outline

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°

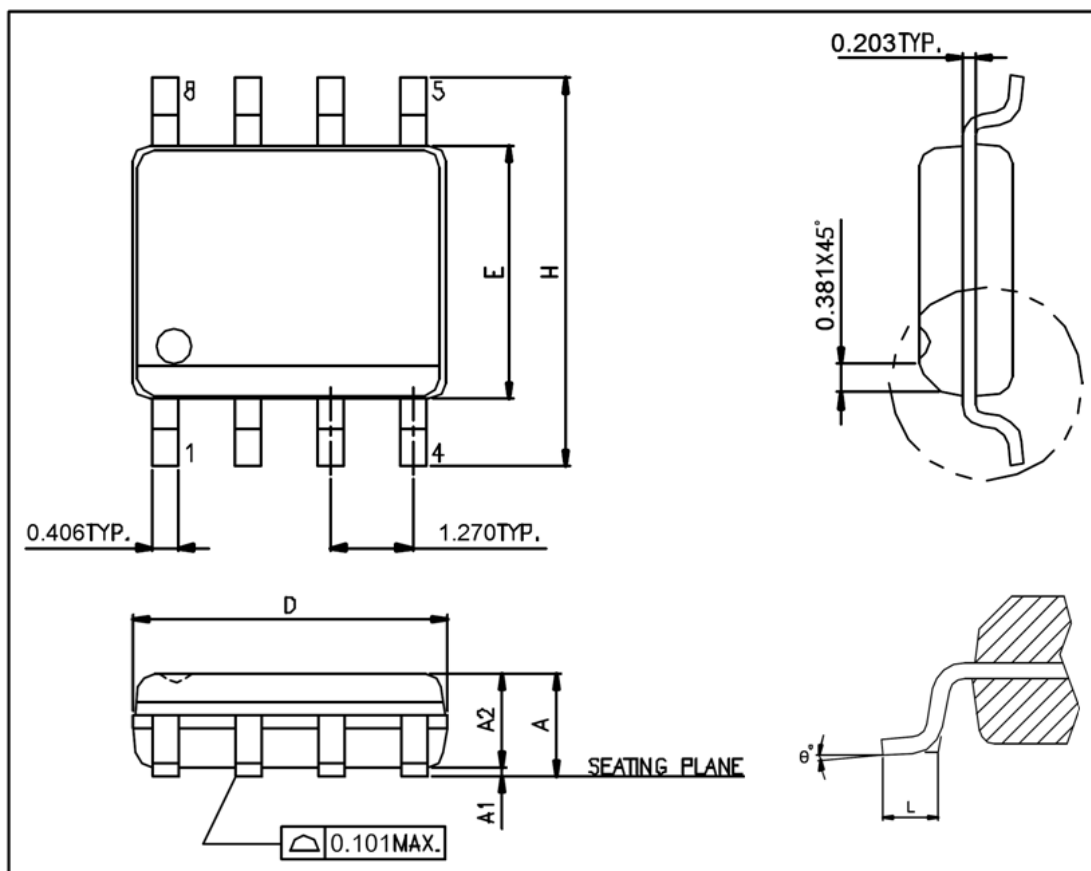
Exposed PAD Dimensions:

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

Note:

- Package dimensions are in compliance with JEDEC outline: MO-178 AA.
- Dimension "D" does not include molding flash, protrusions or gate burrs.
- Dimension "E" does not include inter-lead flash or protrusions.

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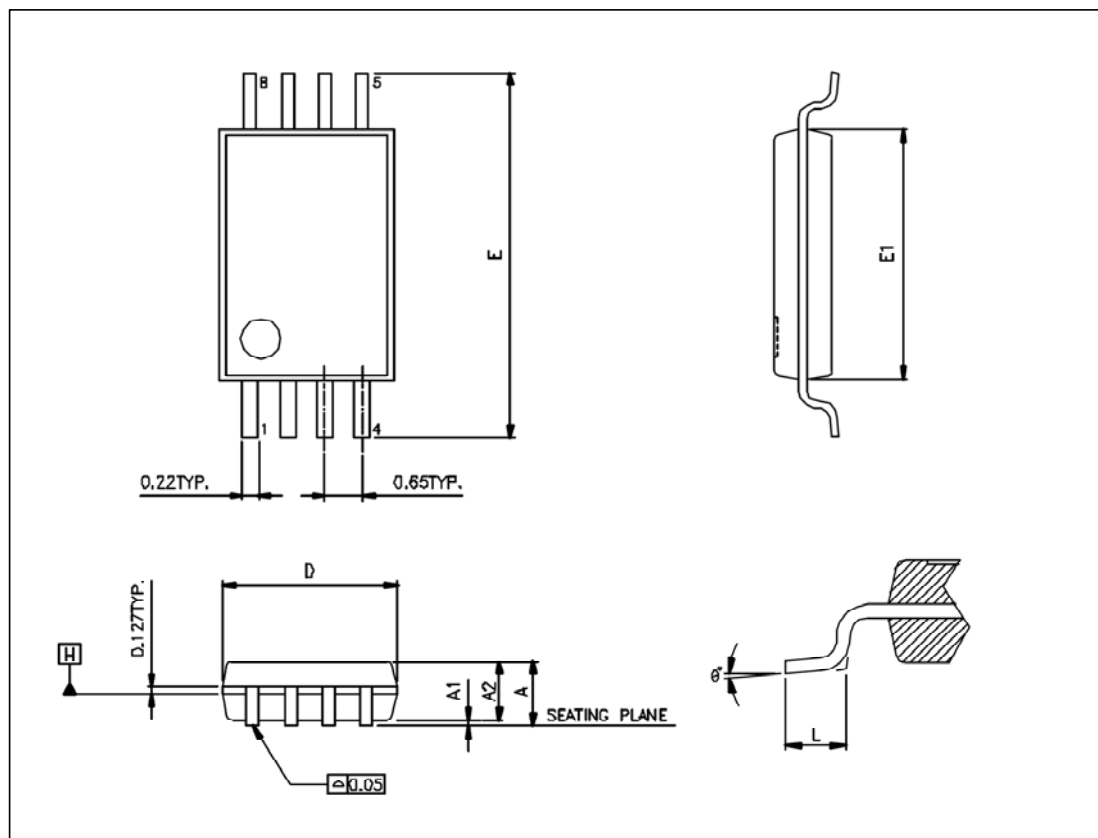
SOP-8L

UNIT: mm

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°

Notes:

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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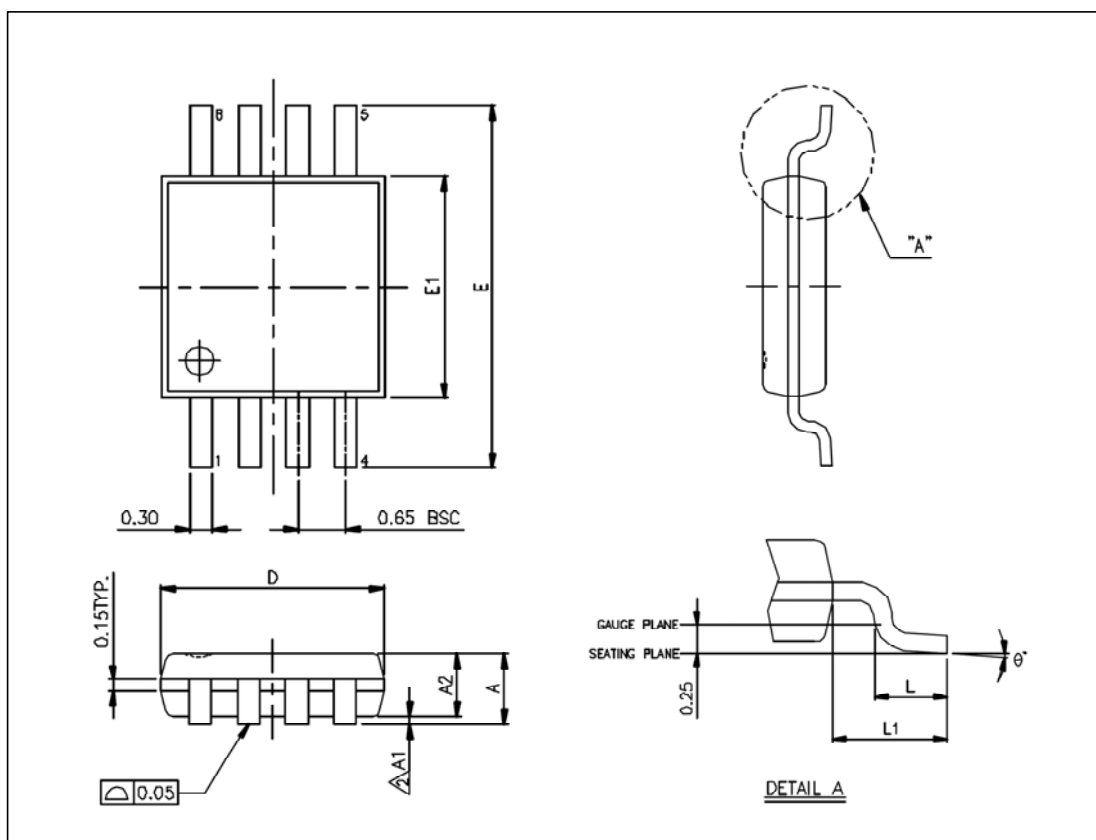
TSSOP-8L

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°

Notes:

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°

Notes:

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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