ULTRA-SMALL PACKAGE PWM/PFM SWITCHING CONTROL STEP-UP SWITCHING REGULATOR

Description

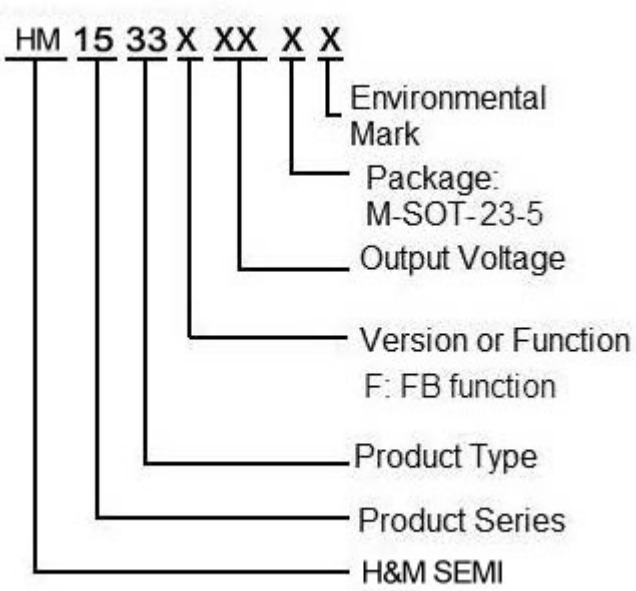
The HM1533 series is a CMOS step-up switching regulator which mainly consists of a reference voltage source, an oscillation circuit, an error amplifier, a phase compensation circuit, a PWM/PFM switching control circuit. With an external low-ON-resistance Nch Power MOS, this product is applicable to applications requiring high efficiency and high output current.

The HM1533 series switches its operation to the PFM control circuit whose duty ratio is 15 % with to the PWM/PFM switching control circuit under a light load and to prevent decline in the efficiency by IC operation current.

Feature

- Low voltage operation: Start-up is guaranteed from 0.9 V(I_{OUT} =1 mA)
- Duty ratio: Built-in PWM/PFM switching control circuit 15 to 78 % .
- oscillator frequency：1.0MHz
- External parts: coil, diode, capacitor, and transistor
- Output voltage range: 1.5V ~20V
- Output voltage accuracy：±2%
- Soft start function: 2 mS.
- PACKAGE：SOT23-5

Selection Guide

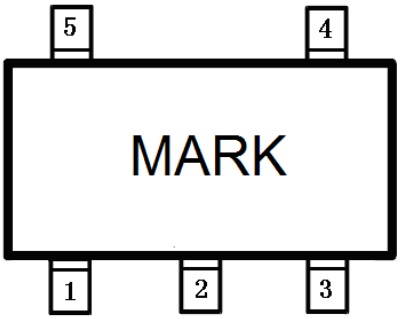


Typical Application

- MP3 players, digital audio players
- Digital cameras, GPS, wireless transceiver
- Portable devices

Pin Configuration

TYPE	POSFIX	PACKAGE	SWICHING TRANSISTOR	CE FUNCTION	VDD FUNCTION	FB FUNCTION	FEATURE
HM1533	M5	SOT23-5	External Transistor	Yes	Yes	Yes	Ext+FB



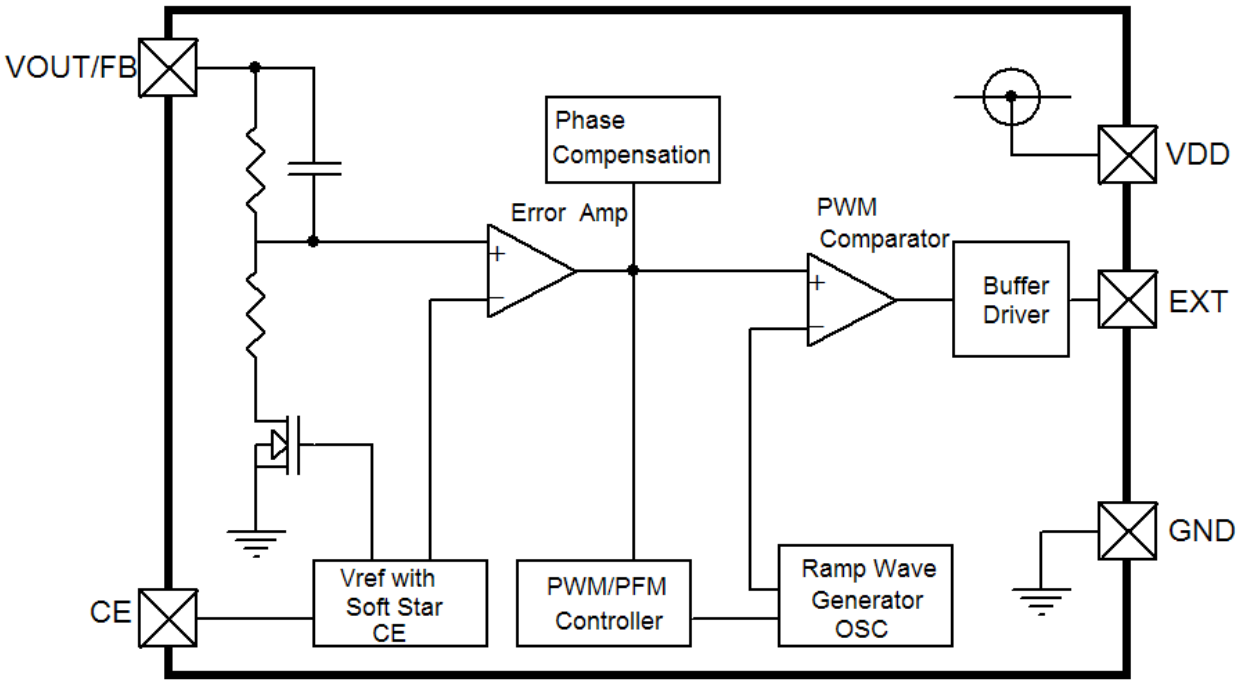
SOT-23-5

Pin information

HM1533

Pin Number	Pin Name	Function
SOT23-5		
1	FB	Feed Back voltage pin
2	VDD	IC power supply pin
3	CE	Shutdown pin
4	GND	GND pin
5	EXT	External transistor connection pin

Block Diagram



Absolute Maximum Rang

PARAMETER	SYMBOL	RATING	UNIT
VDD Pin Voltage	VDD	-0.3～6.5	V
EXT Pin Voltage	EXT	-0.3～VDD+0.3	V
CE Pin Voltage	V_{CE}	-0.3～Vin+0.3	V
EXT Pin Current	I_{EXT}	±1000	mA
Power Dissipation (SOT23-5)	Pd	250	mW
Operating Temperature Range	T_{Opr}	-25~+85	℃
Storage Temperature Range	T_{stg}	-40~+125	℃

Electrical Characteristics

HM1533

Measuring conditions：VDD=V_{CE}=3.3V，Topt=25℃。Unless otherwise specified。

Parameter	SYMBOL	CONDITION		MIN	TYP	MAX	UNIT	Circuit
Feedback voltage	V_{FB}	-		1.225	1.25	1.275	V	2
Input voltage	V_{IN}	-			-	6	V	2
Operation start voltage	V_{ST1}	I_{OUT}=1mA		-	-	0.9	V	2
Oscillation start voltage	V_{ST2}	No external parts, voltage applied to V_{OUT}		-	-	0.7	V	1
Operation holding voltage	V_{HLD}	I_{OUT}=1mA，Measured by decreasing VIN voltage gradually		0.7	-	-	V	2
Current consumption 1	I_{SS1}	V_{FB}=V_{FB}(S)× 0.95		-	200	-	μA	1
Current consumption 2	I_{SS2}	V_{FB}=1.5V		-	15	-	μA	1
Current consumption during shutdown	I_{SSS}	V_{CE}=0V		-	0.02	0.5	μA	1
EXT pin output current	I_{EXTH}	V_{EXT}=V_{OUT}-0.4V		-	-25	-	mA	1
	I_{EXTL}	V_{EXT}=0.4V		-	40	-	mA	1
Feed back voltagetemperature coefficient		Ta=-25-85℃		-	±50	-	ppm/℃	2
Oscillation frequency	Fosc	-		0.8	1.0	1.2	MHz	1
Max. duty ratio	MAXDUTY	V_{FB}=V_{FB}(S)× 0.95		-	78	-	%	1
PWM/PFM switchingduty ratio	PFMDUTY	V_{FB}=V_{FB}(S)× 1.5, no load		-	15	-	%	1
Shutdown pin input voltage	V_{SH}	Measured the oscillation at EXT pin		0.75	-	-	V	1
	V_{SL1}	Judged the stop of oscillation at EXT pin	V_{OUT}≥1.5V	-	-	0.3	V	1
	V_{SL2}		V_{OUT}<1.5V	-	-	0.2	V	1
Shutdown pin input voltage	I_{SH}	V_{CE}=V_{FB}(S)×0.95		-0.1	-	0.1	μA	1
	I_{SL}	V_{CE}=0V		-0.1	-	0.1	μA	1
Soft start time	tss	-		-	2	-	mS	2
Efficiency	EFFI	-		-	90	-	%	2

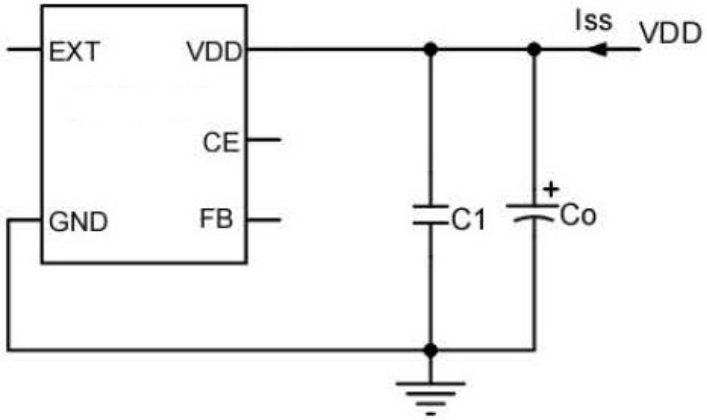
Note:

1. V_{OUT}(S) is the set output voltage value, and V_{OUT} is the typical value of the output voltage.
2. V_{OUT}(S) can be set by using the rate of V_{FB} and output voltage setting resistors (R1, R2).
3. V_{FB}(S) is the set output voltage value.
4. VDD/V_{OUT} separate type:

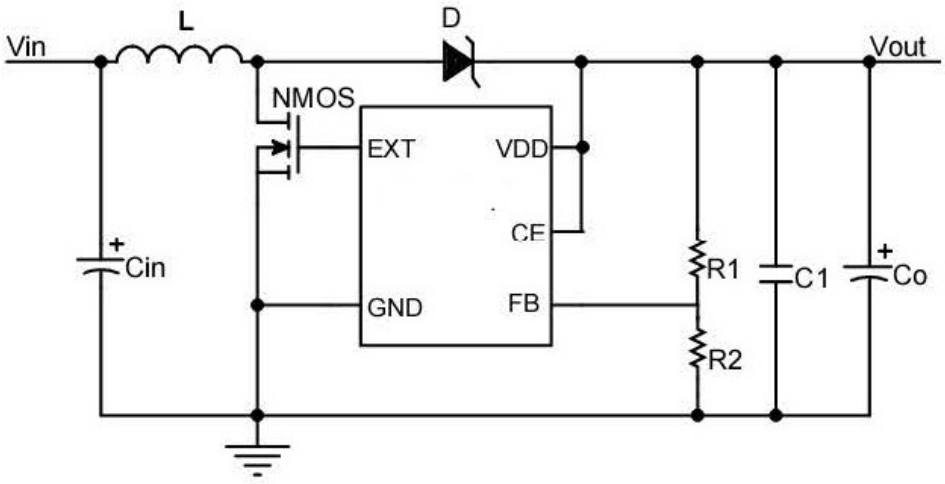
   1.8V≦VDD<6V is recommended to stabilize the output voltage and oscillation frequency.

Test Circuit

1.



2.



External parts（suggest）

1、Diode use Schottky diode such as IN5817 or IN5819 (forward voltage drop:0.2V)

2、Inductor：3.3μH（r<30mΩ）

3、Capacitor：ceramic capacitor 22μF（It is best to use two parallel connection ceramic capacitors）

4、Feed back resistors:R1+R2<50KΩ

External parts selection for DC/DC converter

The relationship between major characteristics of the step-up circuit and characteristics parameters of the external parts are shown in Figure 1.

For larger output current?	For high efficiency?		For smaller ripple voltage?
	Operation efficiency	Stand-by efficiency	
Smaller inductance	Larger inductance		
Smaller DC resistance of inductor			
Large output capacitance		Large output capacitance	
With MOSFET, smaller ON resistance	With MOSFET, smaller input capacitance		
With bipolar transistor, smaller external	With bipolar transistor, larger external resistance Rb		

Figure 1 Relationship between major characteristics of the step-up circuit and external parts

1. Inductor

An inductance has strong influence on maximum output current I_{OUT} and efficiency η.1.

Figure 2 shows the relation between I_{OUT}, and η characteristics to L of HM1533.

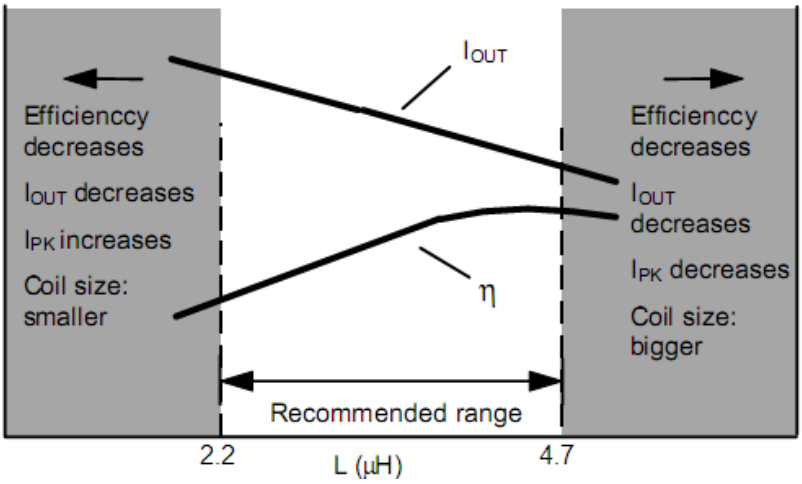


Figure 2 L－I_{OUT} and η characteristics

The peak current (I_{PK}) increases by decreasing L and the stability of a circuit improves and I_{OUT} increases. If L is furthermore made small, efficiency falls and in running short, I_{OUT} decreases. (Based on the current drive capability

of external switching transistor.)

The loss of I_{PK} by the switching transistor decreases by increasing L and the efficiency becomes maximum at a certain L value. Further increasing L decreases efficiency due to the loss of DC resistance of the coil. Also, I_{OUT} decreases, too.

Oscillation frequency is higher, smaller one can be chose and also makes coil smaller. The recommended inductances are 2.2 to 4.7 μH inductor for HM1533.

Choose a value for L by referring to the reference data because the maximum output current is due to the input voltage in an actual case. Choose an inductor so that I_{PK} does not exceed the allowable current. Exceeding the allowable current of the inductor causes magnetic saturation, remarkable low efficiency and destruction of the IC chip due to a large current.

I_{PK} in uncontinuous mode is calculated from the following equation:

$$I_{PK} = \sqrt{\frac{2I_{OUT}(V_{OUT} + V_D - V_{IN})}{f_{OSC}.L}}(A)$$

Fosc = oscillation frequency, V_{DD} =0.4 V.

2. Diode

Use an external diode that meets the following requirements:

• Low forward voltage: (V_F<0.3 V)

• High switching speed: (50 ns max.)

• Reverse voltage: V_{OUT} + V_F or more

• Rated current: I_{PK} or more

3. Capacitor (C_{IN}, C_O)

To improve efficiency, an input capacitor (C_{IN}) lowers the power supply impedance and averages the input current. Select C_{IN} according to the impedance of the power supply used. The recommended capacitance is 10μF for the HM1533.

An output capacitor (C_{OUT}), which is used to smooth the output voltage, requires a capacitance larger than that of the step-down type because the current is intermittently supplied from the input to the output side in the step-up type. A 22μF ceramic capacitor is recommended for the HM1533. However, a higher capacitance is recommended if the output voltage is high or the load current is large. If the output voltage or load current is low, about 10μF can be used without problems.

Select C_{OUT} after sufficient evaluation with actual application.

A ceramic capacitor can be used for both the input and output.

4. Enhancement MOS FET type

For a MOS FET, an N-channel power MOS FET should be used. Because the gate voltage and current of the external power MOS FET are supplied from the stepped up output voltage V_{OUT}, the MOS FET is driven more effectively. Depending on the MOS FET you use in your device, there is a chance of a current overrun at power ON. Thoroughly test all settings with your device before deciding on which one to use. Also, try to use a MOS FET with the input capacitance of 700 pF or less.

Since the ON resistor of the MOS FET might depend on the difference between the output voltage V_{OUT} and the threshold voltage of MOS FET, and affect the output current as well as the efficiency, the threshold voltage should be low. When the output voltage is low, the circuit operates only when the MOS FET has the threshold voltage lower than the output voltage.

5. Precautions

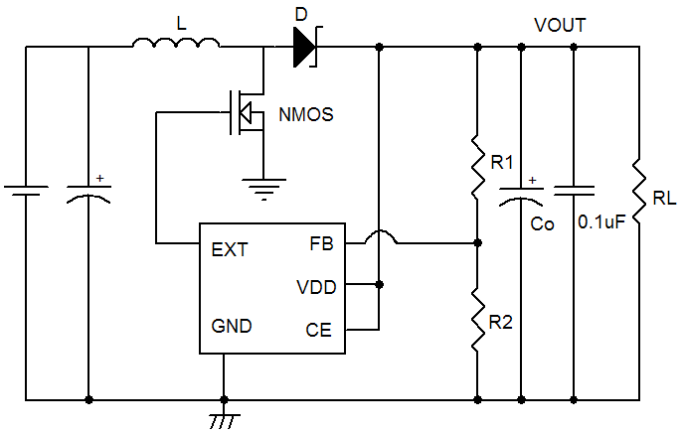
● Mount external capacitors, a diode, and a coil as close as possible to the IC.

● Unique ripple voltage and spike noise occur in switching regulators. Because they largely depend on the coil and the capacitor used, check them using an actually mounted model.

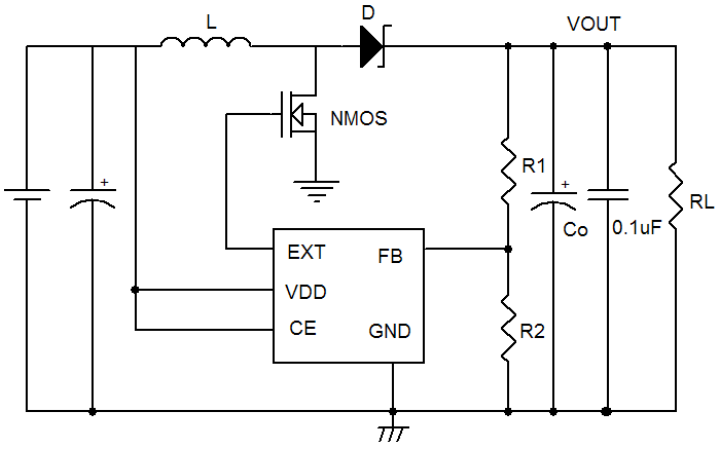
●Make sure dissipation of the switching transistor (especially at a high temperature) does not exceed the allowable power dissipation of the package.

●The performance of this IC varies depending on the design of the PCB patterns, peripheral circuits and external parts. Thoroughly test all settings with your device. Also, try to use recommended external parts.

Typical Application Circuit

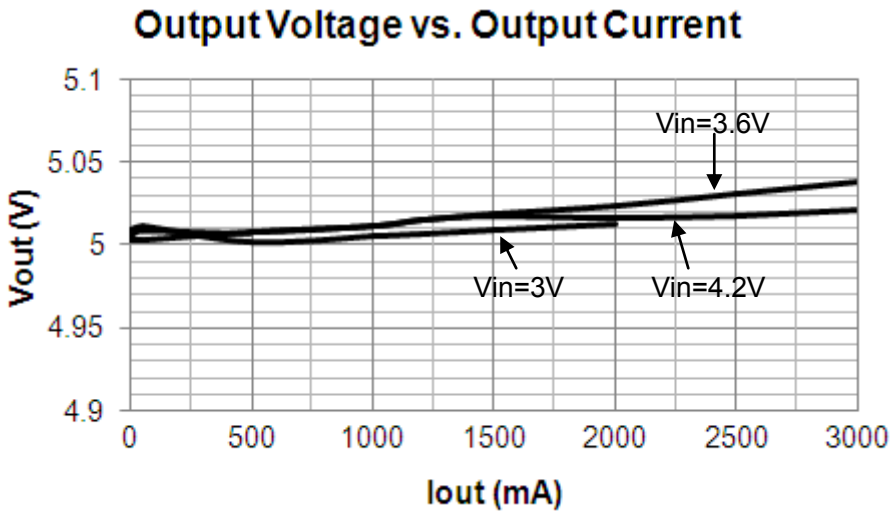


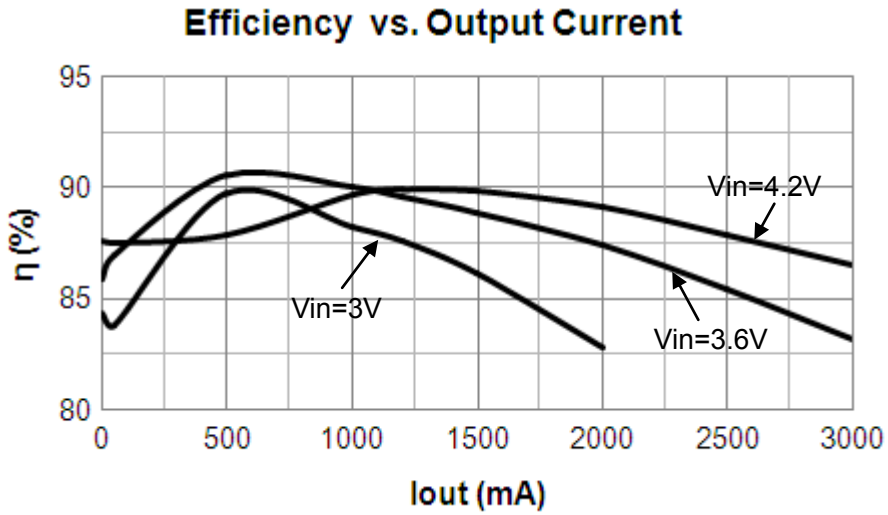
For FB and external 1



For FB and external 2

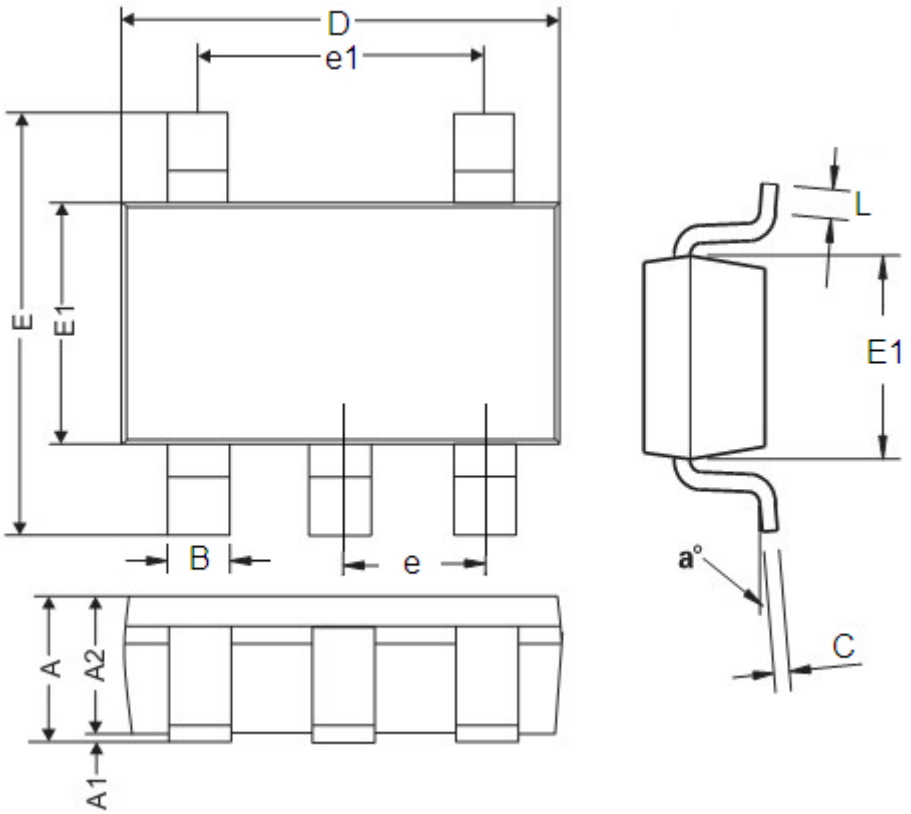
Typical Performance Characteristics





Package Dimension

Package type:SOT23-5 **Unit:mm(inch)**



DIM	Millimeters		Inches	
	Min	Max	Min	Max
A	0.9	1.45	0.0354	0.0570
A1	0	0.15	0	0.0059
A2	0.9	1.3	0.0354	0.0511
B	0.2	0.5	0.0078	0.0196
C	0.09	0.26	0.0035	0.0102
D	2.7	3.10	0.1062	0.1220
E	2.2	3.2	0.0866	0.1181
E1	1.30	1.80	0.0511	0.0708
e	0.95REF		0.0374REF	
e1	1.90REF		0.0748REF	
L	0.10	0.60	0.0039	0.0236
a^0	0^0	30^0	0^0	30^0