# **ULTRA-SMALL PACKAGE PWM/PFM SWITCHING CONTROL**

# STEP-UP SWITCHING REGULATOR

### Description

The JTM1533 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 JTM1533 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.

### **Selection Guide**



### Feature

- Low voltage operation: Start-up is guaranteed
  from 0.9 V(Iout =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

## **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
JTM1533	M5	SOT23-5	External Transistor	Yes	Yes	Yes	Ext+FB



SOT-23-5

## **Pin information**

### JTM1533

Pin Number	Pin Name	Function	
SOT23-5	1 III Nullie		
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	Vce	-0.3~Vin+0.3	V
EXT Pin Current	Iext	±1000	mA
Power Dissipation (SOT23-5)	Pd	250	mW
Operating Temperature Range	Topr	-25~+85	C
Storage Temperature Range	Tstg	-40~+125	C

# Electrical Characteristics

#### HM1533

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Measuring conditions: VDD=V\_{\tiny CE}=3.3V. Topt=25°C. Unless otherwise specified.

Parameter	SYMBOL	CONDITION		MIN	TYP	MAX	UNIT	Circuit
Feedback voltage	V <sub>FB</sub>				1.25	1.275	V	2
Inputvoltage	Vin				-	6	V	2
Operation start voltage	V <sub>ST1</sub>	lout=1mA				0.9	V	2
Os cillation start voltage	$V_{\rm ST2}$	No external parts, voltage applied to V <sub>our</sub>			-	0.7	v	1
Operation holding voltage	VHID	lour−1m A. Meas∎ed b grad∎allγ	γ de creasing VIN voltage	0.7	-		V	2
Currentconsumption 1	I <sub>SS1</sub>	V <sub>F0</sub> =V <sub>F0</sub> (S)×0.95			200		μA	1
Currentconsumption 2	882	V <sub>F0</sub> =1 <i>5</i> V		-	15		μA	1
Current consumption duringshutdown	655	V <b>-0</b> V	-	0.02	0.5	μA	1	
EXT pin output	EXTH	V <sub>EXT</sub> =V <sub>OUT</sub> -0.4V		-	-25		mA	1
current	EXTL	VEXT-0.4V	-	40		mΑ	1	
Feed black voltagetemperature coefficient		Ta=-25-8510		-	±50		ppm/⊂	2
Oscillation frequency	Fosc	-		0.8	1.0	12	MHz	1
Ma×. duty ratio	MAXDUTY	V <sub>F0</sub> =V <sub>F0</sub> (S)×0.95			78		2	1
PW M/PFM switchingduty ratio	PFMDUTY	V <sub>F0</sub> −V <sub>F0</sub> (S)×1.5,∎o load			15		2	1
Shutdown pin input voltage	$V_{\rm SH}$	Measured the oscillation	ı atEXTplı	0.75			V	1
	$V_{\rm SL1}$	J∎dged tale stop of	V <sub>our</sub> ≥ 1.5V	-		0.3	V	1
	$V_{\rm SL2}$	oscillation at EXT pin	V <sub>001</sub> <1.5V	-	-	02	V	1
Shutdown pin input voltage	SH	Vcs=VFa⊗×0.95		-0.1	-	0.1	μA	1
	I <sub>SL</sub>	V_c= <b>0</b> V		-0.1		0.1	μA	1
Soft start time	tss	-		-	2		mS	2
Efficiency	EFFI	-		-	90		7.	2

Note:

- 1. Vout(S) is the set output voltage value, and Vout is the typical value of the output voltage.
- 2. Vout(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/Vout separate type:

 $1.8V \le VDD < 6V$  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: 3.3 $\mu$ H (r<30m $\Omega$ )
- 3. Capacitor: ceramic capacitor  $22\mu F$  (It is best to use two parallel connection ceramic capacitors)
- 4、Feed back resistors:R1+R2<50K $\Omega$

## 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 high	efficiency?		
For larger output current?	Operation efficiency	Stand-by efficiency	For smaller ripple voltage?	
Smaller inductance	Larger inductance			
S	maller DC resistance of inductor			
Large output capacitance	Large output capacitance			
With MOSFET, smaller ON resistance	With MC	apacitance		
With bipolar transistor,	With bipolar transistor, larger external			
smaller external resisitance Rb	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 lour and efficiency n.1.

Figure 2 shows the relation between  $I_{OUT}$ , and  $\eta$  characteristics to L of JTM1533.





The peak current (IPK) increases by decreasing L and the stability of a circuit improves and IOUT increases. If L is

furthermore made small, efficiency falls and in running short, Iout decreases. ( Based on the current drive capability

of external switching transistor.)

The loss of IPK 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, IouT 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 JTM1533.

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 IPK 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.

IPK in uncontinuous mode is calculated from the following equation:

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

Fosc = oscillation frequency, VDD = 0.4 V.

#### 2. Diode

Use an external diode that meets the following requirements:

- Low forward voltage: (VF<0.3 V)
- · High switching speed: (50 ns max.)
- Reverse voltage: Vout + VF or more
- · Rated current: Ірк or more

### 3. Capacitor (CIN, Co)

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  $10\mu$ F for the JTM1533.

An output capacitor (Cout), 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 JTM1533. 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 Cout 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 Vour, 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 VouT 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**



## **Typical Performance Characteristics**



E1

# Package Dimension

Package type:SOT23-5

Unit:mm(inch)



ЫМ	Millim	eters	Inches		
	Min	Мах	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	
В	0.2	0.5	0.0078	0.0196	
С	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	
е	0.95	REF	0.0374REF		
e1	1.90	REF	0.0748REF		
L	0.10	0.60	0.0039	0.0236	
a	0°	30 <sup>°</sup>	0°	30 <sup>°</sup>	