DESCRIPTION

A7530 is CMOS-based PFM step-up DC-DC converter. The converter can start up by supply voltage as low as 0.8V input Voltage. Quiescent current drawn from power source is as low as 7uA. All of these features make A7530 be suitable for the portable devices, which are supplied by a single battery to four-cell batteries.

To reduce the noise caused by the switch regulator, A7530 is well considerate in circuit design and manufacture. So that the interferer to other circuits by the device is reduced greatly.

A7530 integrates stable reference circuits and trimming technology, so it can afford high precision and low temperature-drift coefficient of the output voltage.

A7530 can be switch on or off easily by CE pin, to minimize the standby supply current in SOT-25 package.

A7530 is available in SOT-25 and SOT-89 packages.

ORDERING INFORMATION

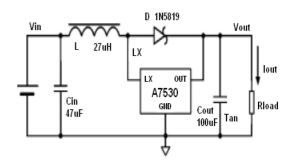| Package Type		Part Number
SOT-25	E5	A7530E5R-XXY
SOT-89-3	K3	A7530K3R-XXY
Note	XX: Output Voltage 25=2.5V, 33=3.3V…60= 6.0V Y: Function Type 1: W/O Enable Circuit 2: With Enable Circuit R: Tape & Reel	
AiT provides all Pb free products		

FEATURES

- Deliver 200mA at 3.3V Output Voltage with 1.8V Input Voltage
- Low start-up voltage(when the output current is 1mA) 0.8V
- The converter output voltage can be adjusted from 2.5V~6.0V (In 0.1V step)
- Output voltage accuracy (±2%)
- Low temperature-drift coefficient of the output voltage (±100ppm/℃)
- Only three external components are necessary: An inductor, a Schottky diode and an output filter capacitor
- High power conversion efficiency (85%)
- Low quiescent current drawn from power source (<7uA)
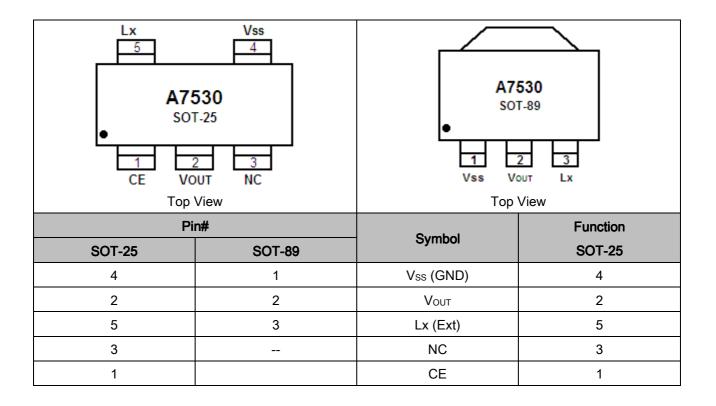- Available in SOT-25 and SOT-89 package

APPLICATION

- Power source for PDA, DSC, MP3 Player, electronic toy and wireless mouse
- Power source for a single or dual-cell battery-powered equipments
- Power source for LED

Typical Application

PIN DESCRIPTION

Top View

Top View

Pin#		Symbol	Function
SOT-25	SOT-89		SOT-25
4	1	Vss (GND)	4
2	2	Vout	2
5	3	Lx (Ext)	5
3	--	NC	3
1		CE	1

Function Type

Type (Y)	Function
1	Internal Tr. Driver, W/O Enable Circuit
2	Internal Tr. Driver, W/Enable Circuit

ABSOLUTE MAXIMUM RATINGS

Input Voltage Range	0.3V~+6V
Input Voltage: Vi(LX)	0.3V ~ (Vout+0.3V)
CE Pin Voltage	0.3V ~ (Vout+0.3V)
LX Pin Output Current	0.7A
Maximum Power Dissipation, Pd T=25°C	
SOT-25	0.15W
SOT-89	0.5W
Maximum Junction Temperature	+150°C
Operating Free-air Temperature Range	-20 °C ~+80 °C
Storage Temperature Range	-40°C ~ +125°C
Lead Temperature and time	260°C ,10s

Stresses above may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the Electrical Characteristics is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Recommended Operation Conditions

	Min.	NOM	Max.	Unit
Input voltage range	0.8		V_{OUT}	V
Inductor	10	27	100	μH
Input Capacitor	0	≧10		μF
Output Capacitor	47	100	220	μF
Operating Junction Temperature	-20		85	°C

Suggestion: Use tantalum capacitor to reduce the ripple of the output voltage.

ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
V_{OUT}	Output Voltage		2.450	2.5	2.55	V
			2.646	2.7	2.754	
			2.94	3.0	3.06	
			3.234	3.3	3.366	
			3.528	3.6	3.672	
			3.920	4.0	4.080	
			4.900	5.0	5.100	
			5.880	6.0	6.120	
V_{IN}	Input Voltage				6	V
I_{IN}	Input Current	I_{OUT}= 0mA, V_{IN}= V_{OUT} x 0.6		12	15	uA
V_{START}	Start-up Voltage	I_{OUT}= 1mA, V_{IN}= 0→2V		0.8	0.9	V
V_{HOLD}	Hold-on Voltage	I_{OUT}= 1mA, V_{IN}= 2→0V	0.6	0.7		
I_{DD}	Quiescent Current Drawn From Power Source	Without external components, V_{OUT} = V_{OUT} x 1.05		4	7	uA
R_{SWON}	Switch ON Resistance			0.4	0.5	Ω
ILX_{LEAK}	LX leakage current	V_{OUT} = Vlx= 6V			0.5	uA
V_{CEH}	CE "H" threshold voltage	V_{CE}: 0→2V	0.6	0.9		V
V_{CEL}	CE "L" threshold voltage	V_{CE}: 2→0V		0.3	0.6	V
Fosc	Oscillator Frequency	LX on "L" side, V_{OUT} = V_{OUT} x 0.96	300	350	400	kHz
MAX_{DTY}	Oscillator Duty Cycle	On (Vlx "L") side	70	75	80	%
η	Efficiency			85		%

Note:

1. Diode: Schottky type, such as: 1N5817, 1N5819, 1N5822

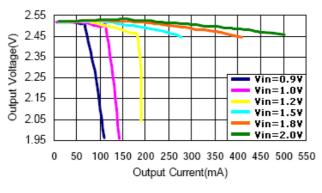2. Inductor: 27uH (R<0.5Ω)

3. Capacitor: 100uF (Tantalum type)

TYPICAL PERFORMANCE CHARACTERISTICS

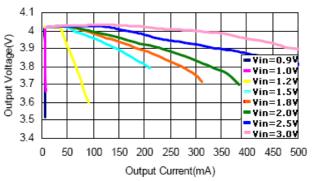C_{IN}=47uF, C_{OUT}=100uF, L=10uH, T_{OPT}=25°C, unless otherwise noted.
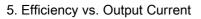
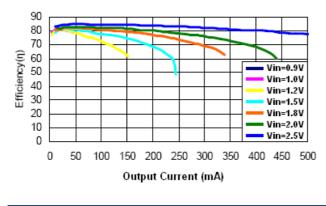1. Output Voltage vs. Output Current

   A7530K3-251

2. Output Voltage vs. Output Current

   A7530K3-331

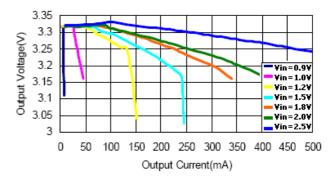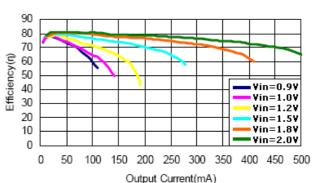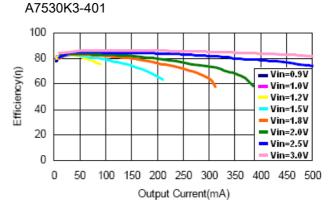3. Output Voltage vs. Output Current

   A7530K3-401

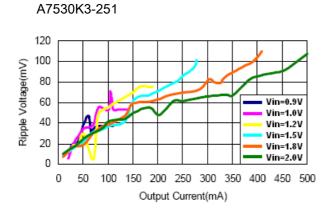4. Efficiency vs. Output Current
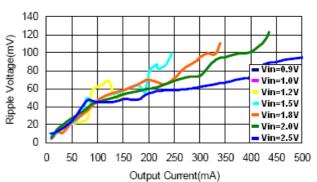
   A7530K3-251

5. Efficiency vs. Output Current

   A7530K3-331

6. Efficiency vs. Output Current

   A7530K3-401

7. Ripple vs. Output Current
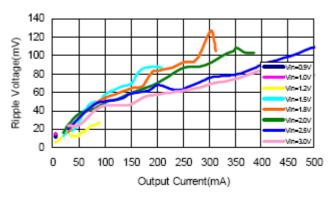   A7530K3-251

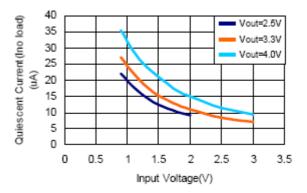8. Ripple vs. Output Current
   A7530K3-331

9. Ripple vs. Output Current
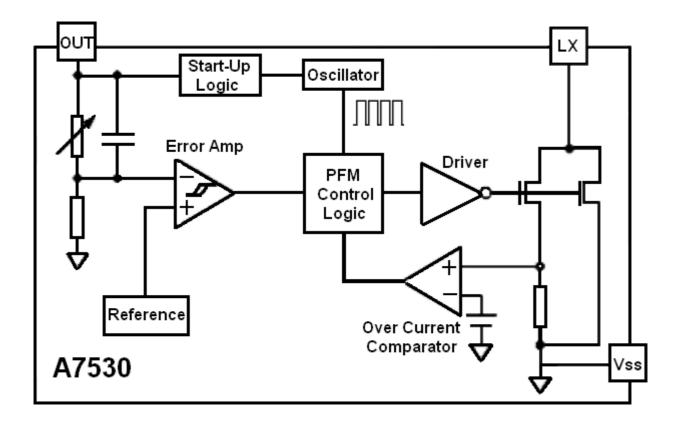   A7530K3-401

10. Ino Load vs. Input Voltage
    A7530K3 (Quiescent Current)

BLOCK DIAGRAM

DETAILED INFORMATION

The A7530 is boost structure, voltage-type pulse-frequency modulation (PFM) step-up DC-DC converter. Only three external components are necessary: an inductor, a output fitter capacitor and a schottky diode. And the converter's low noise and low ripple output voltage can be adjusted from 2.5V to 5.0V, 0.1V step. By using the depletion techniques, the quiescent current drawn from power source is lower than 7uA. The high efficiency device consists of resistors for output voltage detection and trimming, a start-up voltage circuit, an oscillator, a reference circuit, a PFM control circuit, a switch protection circuit and a driver transistor.

The PFM control circuit is the core of the A7530 IC. This block controls power switch on duty cycle to stabilize output voltage by calculating results of other blocks which sense input voltage, output voltage, output current and load conditions. In PFM modulation system, the frequency and pulse width is fixed. The duty cycle is adjusted by skipping pulses, so that switch on-time is changed based on the conditions such as input voltage, output current and load. The oscillate block inside A7530 provides fixed frequency and pulse width wave.

The reference circuit provides stable reference voltage to output stable output voltage. Because internal trimming technology is used, the chip output changes less than ±2%. At the same time, the problem of temperature-drift coefficient of output voltage is considered in design, so temperature-drift coefficient of output voltage is less than 100ppm/℃.

High-gain differential error amplifier guarantees stable output voltage at difference input voltage and load. IN order to reduce ripple and noise, the error amplifier is designed with high band-with.

Tough at very low load condition, the quiescent current of chip does affect efficiency certainly. The four main energy loss of Boost structure DC-DC converter in full load are the ESR of inductor, the voltage of Schottky diode, on resistor of internal N-channel MOSFET and its driver. In order to improve the efficiency, A7530 integrates low on-resistor N-channel MOSFET and well design driver circuits. The switch energy loss is limited at very low level.

Selection of the external components.

Thus it can be seen, the inductor and schottky diode affect the conversion efficiency greatly. The inductor and the capacitor also have great influence on the output voltage ripple of the converter. So it is necessary to choose a suitable inductor, a capacitor and a right schottky diode, to obtain high efficiency, low ripple and low noise.

Before discussion, we define $D \equiv V_{OUT} - V_{IN} / V_{OUT}$.

1. Inductor Selection

Above all, we should define the minimum value of the inductor that can ensure the boost DC-DC to operate in the continuous current-mode condition.

$$L_{MIN} \geqq [D(1-D)^2 R_L] / 2f$$

The above expression is got under conditions of continuous current mode, neglect schottky diode's voltage, ESR of both inductor and capacitor. The actual value is greater that it. If inductor's value is less than L_{MIN}, the efficiency of DC-DC converter will drop greatly, and the DC-DC circuit will not be stable.

Secondly, consider the ripple of the output voltage,

$$\Delta I = D . V_{IN} / Lf$$

$$I_{MAX} = V_{IN} / (1-D)^2 R_L + D V_{IN} / 2Lf$$

If inductor value is too small, the current ripple through it will be great. Then the current through diode and power switch will be great. Because the power switch on chip is not ideal switch, the energy of switch will improve. The efficiency will fall.

Thirdly, in general, smaller inductor values supply more output current while larger values start up with lower input voltage and acquire high efficiency.

An inductor value of 3uH to 1mH works well in most applications. If DC-DC converter delivers large output current (for example: output current is great than 50mA), large inductor value is recommended in order to improve efficiency. If DC-DC must output very large current at low input supply voltage, small inductor value is recommended.

The ESR of inductor will effects efficiency greatly. Suppose ESR value of inductor is r_L, R_{load} is load resistor, then the energy can be calculated by following expression:

$$\Delta \eta \approx r_L / R_{load} (1 - D)^2$$

For example: input 1.5V, output is 3.0V, $R_{load}=20\Omega$, $r_L=0.5\Omega$. The energy loss is 10%. Consider all above, inductor value of 47uH, ESR<0.5Ω is recommended in most applications. Large value is recommended in high efficiency applications and smaller value is recommended.

2. Capacitor Selection

Ignore ESR of capacitor, the ripple of output voltage is:

$$R = \Delta V_{OUT} / V_{OUT} = D / R_{load} \, Cf$$

So large value capacitor is needed to reduce ripple. But too large capacitor value will slow down system reaction and cost will improve. So 100uF capacitor is recommended. Larger capacitor value will be used in large output current system. If output current is small (<10mA), small value is needed.

Consider ESR of capacitor, ripple will increase:

$$R' = r + (I_{MAX} \, . \, R_{ESR}) / V_{OUT}$$

When current is large, ripple caused by ESR will be main factor. It may be greater than 100mV. The ESR will affect efficiency and increase energy loss. So low-ESR capacitor (for example: tantalum capacitor) is recommend or connect two or more filter capacitors in parallel.

3. Diode Selection

Rectifier diode will affect efficiency greatly, though a common diode (such as 1N4148) will work well for light load, it will reduce about 5%~10% efficiency for heavy load. For optimum performance, a schottky diode (such as 1N5817, 1N5819, 1N5822) is recommended.
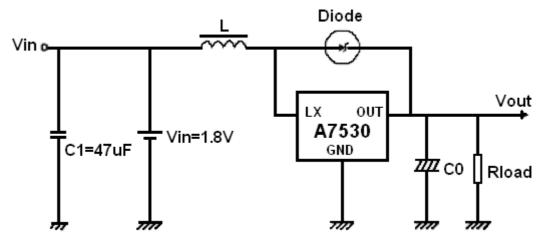
4. Input capacitor

If supply voltage is stable, the DC-DC circuit can output low ripple, low noise and stable voltage without input capacitor. If voltage source is far away form DC-DC circuit, input capacitor value greater than 10uF is recommended.
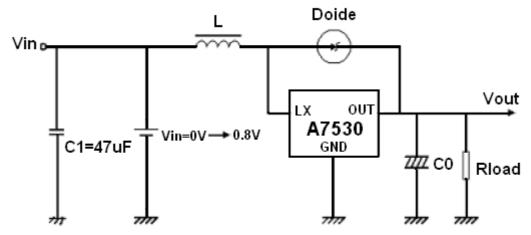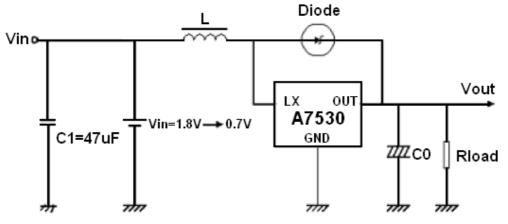
TEST CIRCUITS:

a). Output voltage test circuit (I_{LOAD}= 1mA)

b). Start-up voltage test circuit (I_{LOAD}= 1mA)
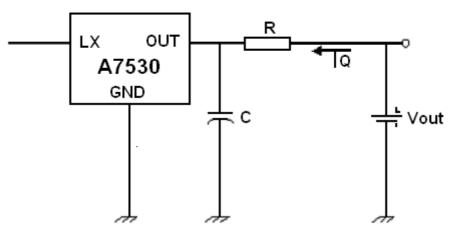

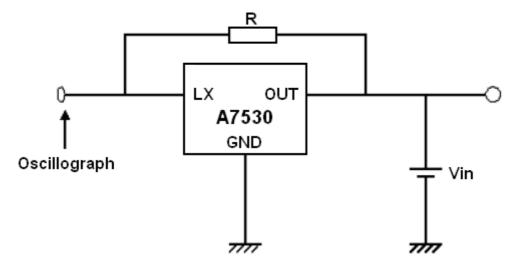c). Hold-on voltage test circuit (I_{LOAD}= 1mA)

d). Quiescent current test circuit

Note: $V_{OUT}=V_{OUT}$ x1.05, R=1KΩ, C=0.1Uf
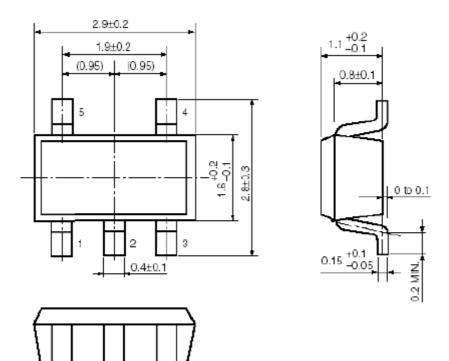
e). Oscillator frequency and duty cycle test circuit

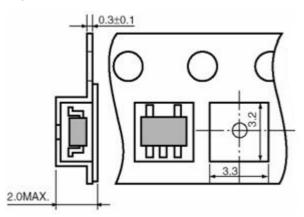

Note: $V_{IN}=V_{OUT}$ x0.95, R=1KΩ
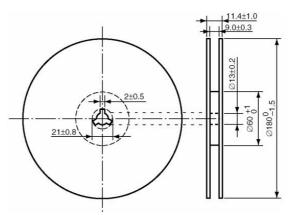
PACKAGE INFORMATION

Dimension in SOT-25   (Unit: mm)
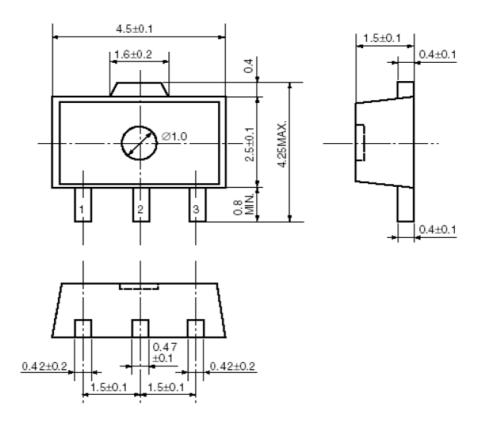
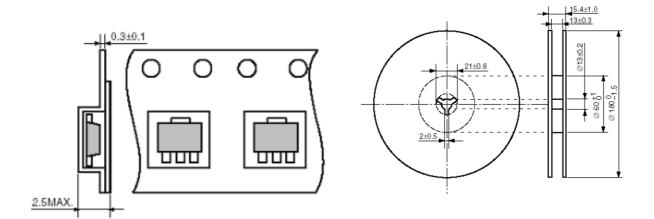Tape Dimension

Reel Dimension

Dimension in SOT-89-3   (Unit: mm)

Tape Dimension

Reel Dimension

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