MICROPOWER VFM STEP-UP DC/DC Converter

❖ GENERAL DESCRIPTION

The AX5503 is a high efficiency VFM Step-up DC/DC converter for small, low input voltage or battery powered systems with ultra low quiescent supply current. The AX5503 accept a positive input voltage from start-up voltage to VOUT and convert it to a higher output voltage in the 2.2V to 5V range.

The AX5503 combine ultra low quiescent supply current and high efficiency to give maximum battery life. The high switching frequency and the internally limited peak inductor current permits the use of small, low cost inductors. Only three external components are needed an inductor a diode and an output capacitor.

The AX5503 is suitable to be used in battery powered equipment where low noise, low ripple and ultra low supply current are required. Operating shutdown function is outside controlling. If EN connects to GND, the IC was been shut down and than the supply current is lower to 1uA.The AX5503 is available in very small package: SOT-23-5L.

Typical applications are pagers, cameras and video camera, cellular telephones, wireless telephones, palmtop computer, battery backup supplies, battery powered equipment.

❖ FEATURES

- Very Low Supply Current is 22uA (typ.)
- Maximum shutdown current <1uA
- Output voltage is available form 2.2V to 5.0V by 0.1V steps
- Output Voltage Accuracy ±5%
- Output Current up to 100mA
- Low ripple and low noise
- Very low start-up voltage
- High efficiency (V_{OUT} = 5V TYP. 87%)
- Few external components
- Low profile: SOT-23-5L Pb-Free

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❖ BLOCK DIAGRAM

❖ PIN ASSIGNMENT

The package type: SOT-23-5L; the pin assignment is given by:

Name	Description
SW	Switch pin. Connect external inductor and diode here.
GND	Ground Pin
OUT	Output Voltage
EN	Chip Enable Pin

❖ ORDER/MARKING INFORMATION

Order Information	Top Marking
AX5503-XX X X Vout 22 : 2.2V 23 : 2.3V 24 : 2.4V : : 50 : 5.0V Package Type B: SOT-23-5L Packing Blank : Bag A : Taping	L L Y W X → ID code:internal WW:01~26 (A~Z) 　　27~52 (a~z) Year: A=2010 　　1=2011 Identification code

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Appendix

Part Number	Identification Code	Part Number	Identification Code
AX5503-2.2V	tA	AX5503-3.7V	tm
AX5503-2.3V	tB	AX5503-3.8V	tn
AX5503-2.4V	tD	AX5503-3.9V	to
AX5503-2.5V	ta	AX5503-4.0V	tp
AX5503-2.6V	tb	AX5503-4.1V	tq
AX5503-2.7V	tc	AX5503-4.2V	tr
AX5503-2.8V	td	AX5503-4.3V	ts
AX5503-2.9V	te	AX5503-4.4V	tt
AX5503-3.0V	tf	AX5503-4.5V	tu
AX5503-3.1V	tg	AX5503-4.6V	tv
AX5503-3.2V	th	AX5503-4.7V	tw
AX5503-3.3V	ti	AX5503-4.8V	tx
AX5503-3.4V	tj	AX5503-4.9V	ty
AX5503-3.5V	tk	AX5503-5.0V	tz
AX5503-3.6V	tl		

❖ **ABSOLUTE MAXIMUM RATINGS** (at T_A = 25°C)

Characteristics	Symbol	Rating	Unit
V_{IN} Pin Voltage	V_{IN}	5.5	V
SW Voltage	VSW	5.5	V
OUT Pin Voltage	V_{OUT}	5.5	V
EN Pin Voltage	V_{EN}	5.5	V
Storage Temperature Range	T_{STG}	-40 to +150	°C
Operating Junction Temperature Range	T_J	-20 to +100	°C
Power Dissipation	PD	(TJ-TA) / θJA	mW
Thermal Resistance from Junction to case	$θ_{JC}$	110	°C/W
Thermal Resistance from Junction to ambient	$θ_{JA}$	250	°C/W

Note: $θ_{JA}$ is measured with the PCB copper area of approximately 1 in^2 (Multi-layer).

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❖ ELECTRICAL CHARACTERISTICS

(V_{IN} = 1.8V, V_{OUT} = 3V, I_{OUT}=10mA, T_A = 25°C, unless otherwise specified)

Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Output Voltage Accuracy	$\triangle V_{OUT}$		-5	-	+5	%
Start-up Voltage(V_{IN}-V_F) **(Note1)**	$V_{START\text{-}UP}$	I_{OUT}=1mA,Vcc=V_{OUT} V_{IN} =rising from 0 to 2V	-	0.65	0.9	V
Hold-on Voltage	V_{HOLD}	I_{OUT}=1mA,Vcc= V_{OUT} V_{IN} =falling from 2 to 0V	0.6	-	-	V
Supply Current	I_{SUPPLY}	No Load	-	22	-	uA
Shutdown Current	I_{SD}	V_{EN}=0V	-	-	1	uA
Internal Switch R_{DSON}	$R_{LX(DSON)}$	I_{LX}=150mA	-	850	-	mΩ
Internal Leakage Current	$I_{LX(leak)}$	V_{LX}=4V, Forced V_{OUT}=3.8V	-	-	0.5	uA
Maximum Oscillator Frequency	F_{OSC}		-	150	-	KHz
Oscillator Duty On	D_{ON}	To be measure on SW pin	-	77	-	%
Enable Input Threshold	V_{ENH}	Driver ON	0.75	-	-	V
	V_{ENL}	Driver OFF	-	-	0.2	
Enable Input Current	I_{ENH}	V_{EN}=V_{IN}	-	-	0.1	uA
	I_{ENL}	V_{EN}=0V	-	-	-0.1	
Efficiency	η	V_{OUT}=2.5V~3.0V, I_{OUT}=50mA	-	82	-	%
		V_{OUT}=3.1V~4.0V, I_{OUT}=50mA	-	83	-	%
		V_{OUT}=4.1V~5.0V, I_{OUT}=50mA	-	87	-	%

Note1: The minimum input voltage for the IC start-up is strictly a function of the VF catch diode.

❖ APPLICATION CIRCUIT
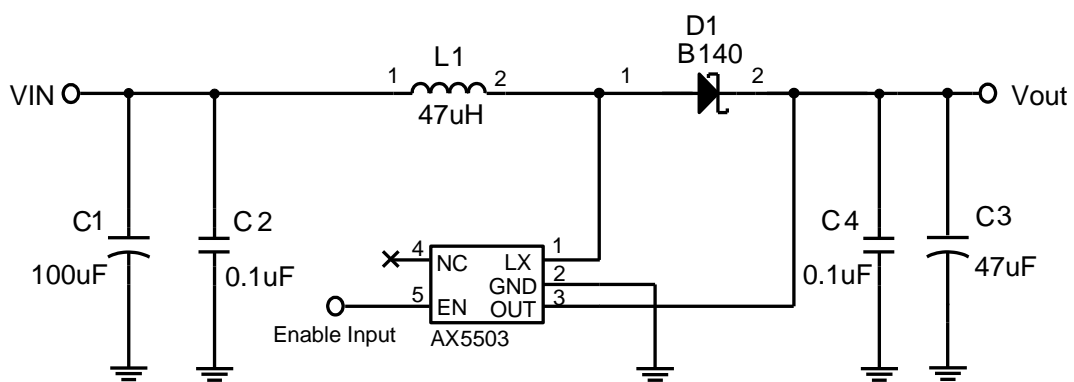
❖ **OPERATION**

The AX5503 architecture is built around a VFM CONTROL logic core, switching frequency is set through a built in oscillator. T_{ON} time is fixed (Typ. 5uS) while T_{OFF} time is determined by the error amplifier output, a logic signal coming from the comparison made by the Error Amplifier Stage between the signal coming from the output voltage divider network and the internal Band-Gap voltage reference (Vref). T_{OFF} reaches a minimum (Typ. 1.7uS) when heavy load conditions are met (Clock frequency 150KHz). An over current conditions, through the internal power switch, causes a voltage drop $V_{LX}=R_{DSON}$ x I_{SW} and the V_{LX} limiter block forces the internal switch to be off, so narrowing T_{ON} time and limiting internal power dissipation. In this case the switching frequency may be higher than the 150KHz set by the internal clock generator.

VFM control ensures very low quiescent current and high conversion efficiency even with very light loads. Since the Output Voltage pin is also used as the device Supply Voltage, the versions with higher output voltage present an higher internal supply voltage that results in lower power switch R_{DSON}, slightly greater output power and higher efficiency. Moreover, bootstrapping allows the input voltage to sag to 0.6V (at I_{OUT}=1mA) once the system is started. If the input voltage exceeds the output voltage, the output will follow the input, however, the input or output voltage must not be forced above 5.5V.

❖ **APPLICATION INFORMATION**

Input/output Capacitor Selection

The Output Ripple Voltage, as well as the Efficiency, is strictly related to the behavior of these elements. The output ripple voltage is the product of the peak inductor current and the output capacitor Equivalent Series Resistance (ESR). Best performances are obtained with good high frequency characteristics capacitors and low ESR. The best compromise for the value of the Output Capacitance is 47μF Tantalum Capacitor; Lower values may cause higher Output Ripple Voltage and lower Efficiency without compromising the functionality of the device.

An Input Capacitor is required to compensate, if present, the series impedance between the Supply Voltage Source and the Input Voltage of the Application.

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Inductor Selection

A 47μH inductor is recommended for most AX5503 applications. However, the inductance value is not critical, and the AX5503 will work with inductors in the 33μH to 120μH.

Diode Selection

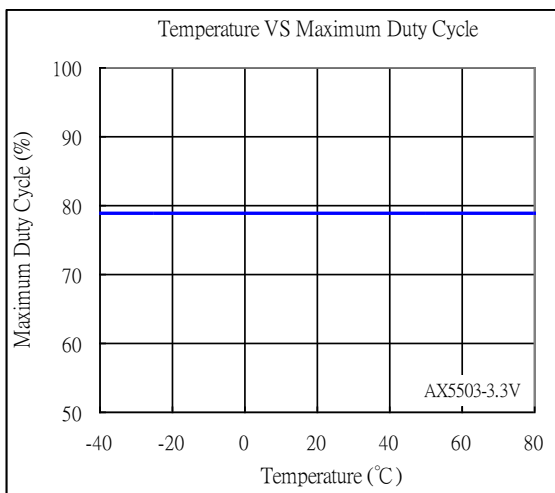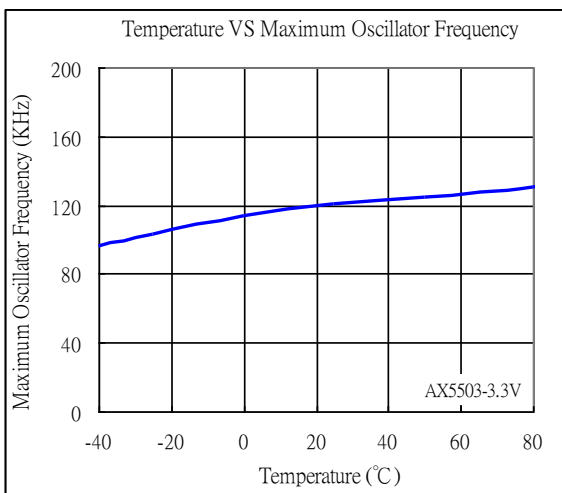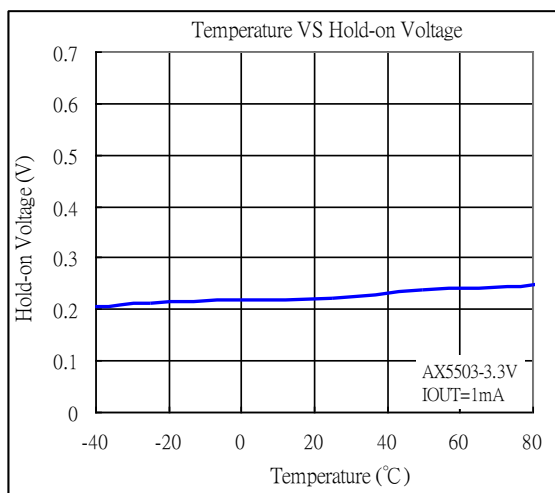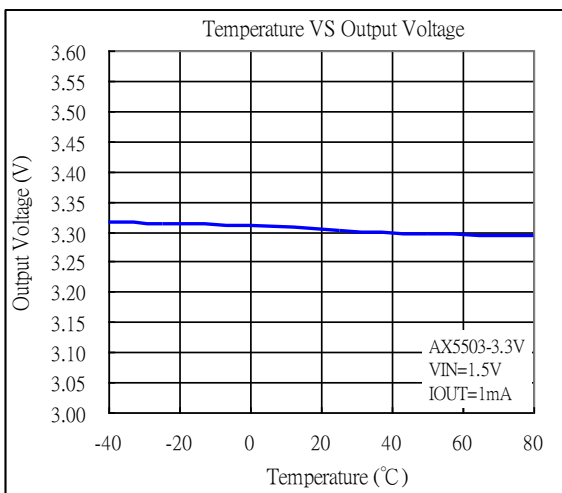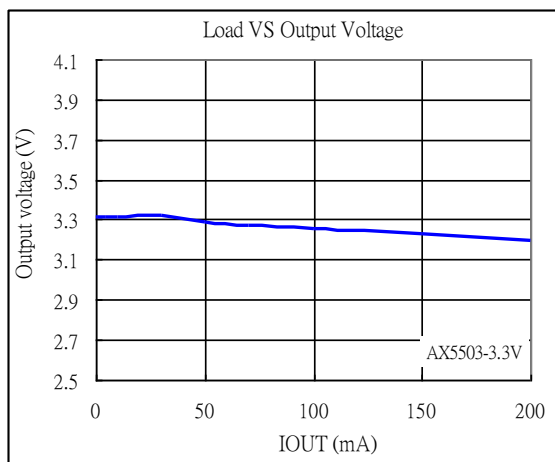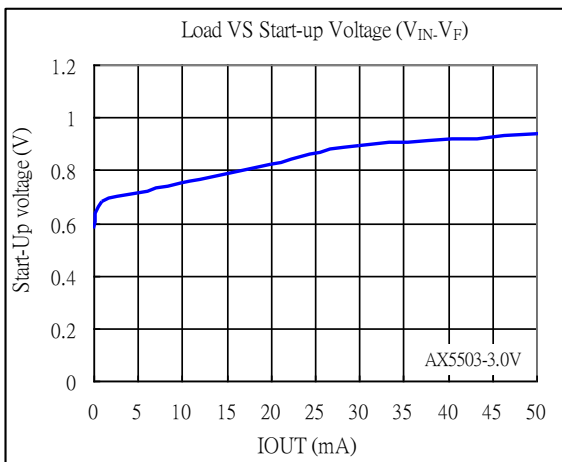Schottky diodes with higher current ratings usually have lower forward voltage drop, larger diode capacitance and fast reverse recovery, it is the ideal choices for AX5503 applications. The forward voltage drop of a Schottky diode represents the conduction losses in the system, while the diode capacitance (C_T or C_D) represents the switching losses. For diode selection, both forward voltage drop and diode capacitance need to be considered.
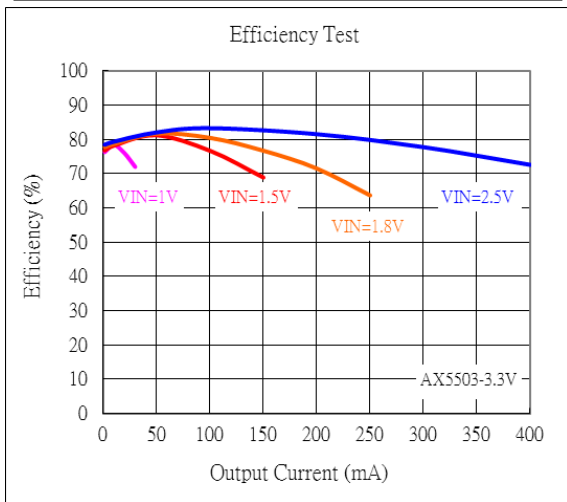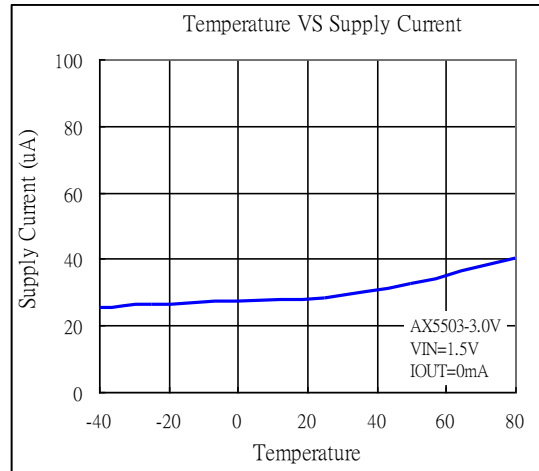
PCB layout guide

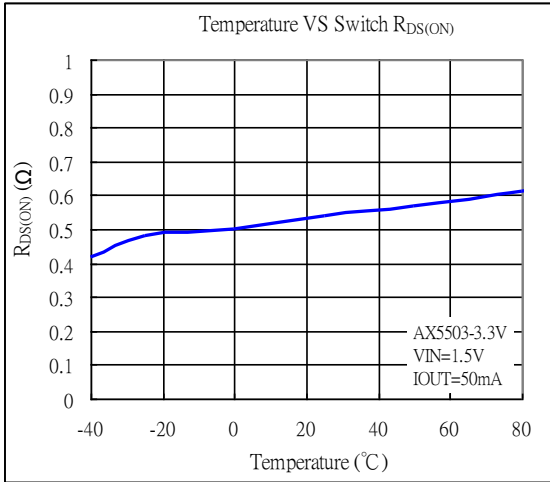When laying out the PC board, the following suggestions should be taken to ensure proper operation of the AX5503. These items are also illustrated graphically in below.

1. The power traces, including the GND trace, the SW trace and the V_{IN} trace should be kept short, direct and wide to allow large current flow. Put enough multiply-layer pads when they need to change the trace layer.

2. Do not trace signal line under inductor.

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❖ **TYPICAL CHARACTERISTICS**

Load VS Start-up Voltage (V_{IN}-V_F)

AX5503-3.0V

Load VS Output Voltage

AX5503-3.3V

Temperature VS Output Voltage

AX5503-3.3V
VIN=1.5V
IOUT=1mA

Temperature VS Hold-on Voltage

AX5503-3.3V
IOUT=1mA

Temperature VS Maximum Oscillator Frequency

AX5503-3.3V

Temperature VS Maximum Duty Cycle

AX5503-3.3V

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❖ TYPICAL CHARACTERISTICS (CONTINUOUS)

Temperature VS Switch $R_{DS(ON)}$

AX5503-3.3V
VIN=1.5V
IOUT=50mA

Temperature VS Supply Current

AX5503-3.0V
VIN=1.5V
IOUT=0mA

Efficiency Test

VIN=1V   VIN=1.5V   VIN=2.5V
VIN=1.8V

AX5503-3.3V

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❖ **PACKAGE OUTLINES**

JEDEC outline: MO-178 AA
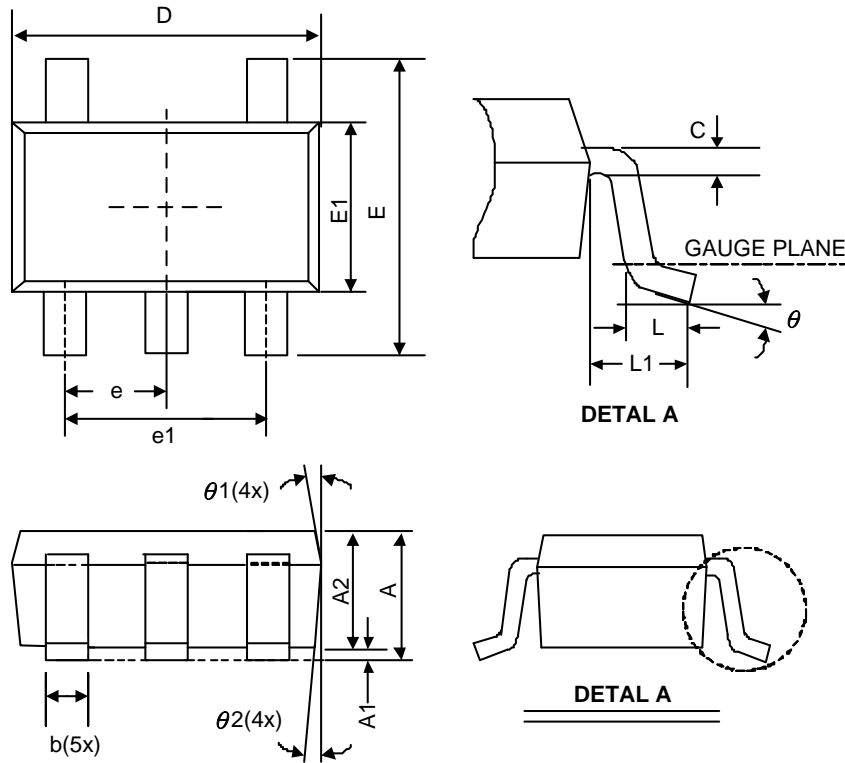
Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	1.45	-	-	0.057
A1	0	0.08	0.15	0	0.003	0.006
A2	0.9	1.1	1.3	0.035	0.043	0.051
b	0.3	0.4	0.5	0.012	0.016	0.02
C	0.08	0.15	0.22	0.003	0.006	0.009
D	2.7	2.9	3.1	0.106	0.114	0.122
E1	1.4	1.6	1.8	0.055	0.063	0.071
E	2.6	2.8	3	0.102	0.11	0.118
L	0.3	0.45	0.6	0.012	0.018	0.024
L1	0.5	0.6	0.7	0.02	0.024	0.028
e1	1.9 BSC			0.075 BSC		
e	0.95 BSC			0.037 BSC		
θ	0º	4º	8º	0º	4º	8º
$\theta 1$	5º	10º	15º	5º	10º	15º
$\theta 2$	5º	10º	15º	5º	10º	15º

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