TLV61220DBVR-TP

Low Start-up Synchronous Boost Converter

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Features

- Input voltage range 0.9V to 5.5V
- 94% Efficiency
- 700mA peak Internal Switch Current
- Up to 1.2MHz Switching Frequency
- Internal Soft Start
- Cycle by Cycle Current Limit
- Low Quiescent Current: 28uA(Typ)
- RoHS and Halogen free compliance
- Compact package: SOT23-6

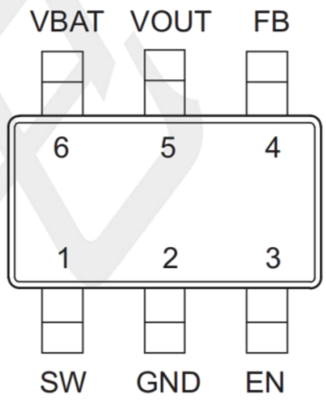
General Description

The is a synchronous boost converter with low quiescent current. The provides a power-supply solution for products powered by alkaline battery, NiCd or NiMH rechargeable battery, or one-cell Li-ion battery. The boost converter is based on a current mode control topology using synchronous rectification to obtain maximum efficiency at minimal quiescent current. The also allows the use of small external inductor and capacitors. Higher than 90% efficiency is achieved at 10-mA load from 1.5-V input to 2.2-V output conversion.

Applications

- Medical equipment
- Digital Camera
- PDAs, Handheld PCs
- Internet Audio Players
- 1 cell, 2 cell, and 3 cell Alkaline, NiCd or NiMH battery-powered appliances

Pin Configurations

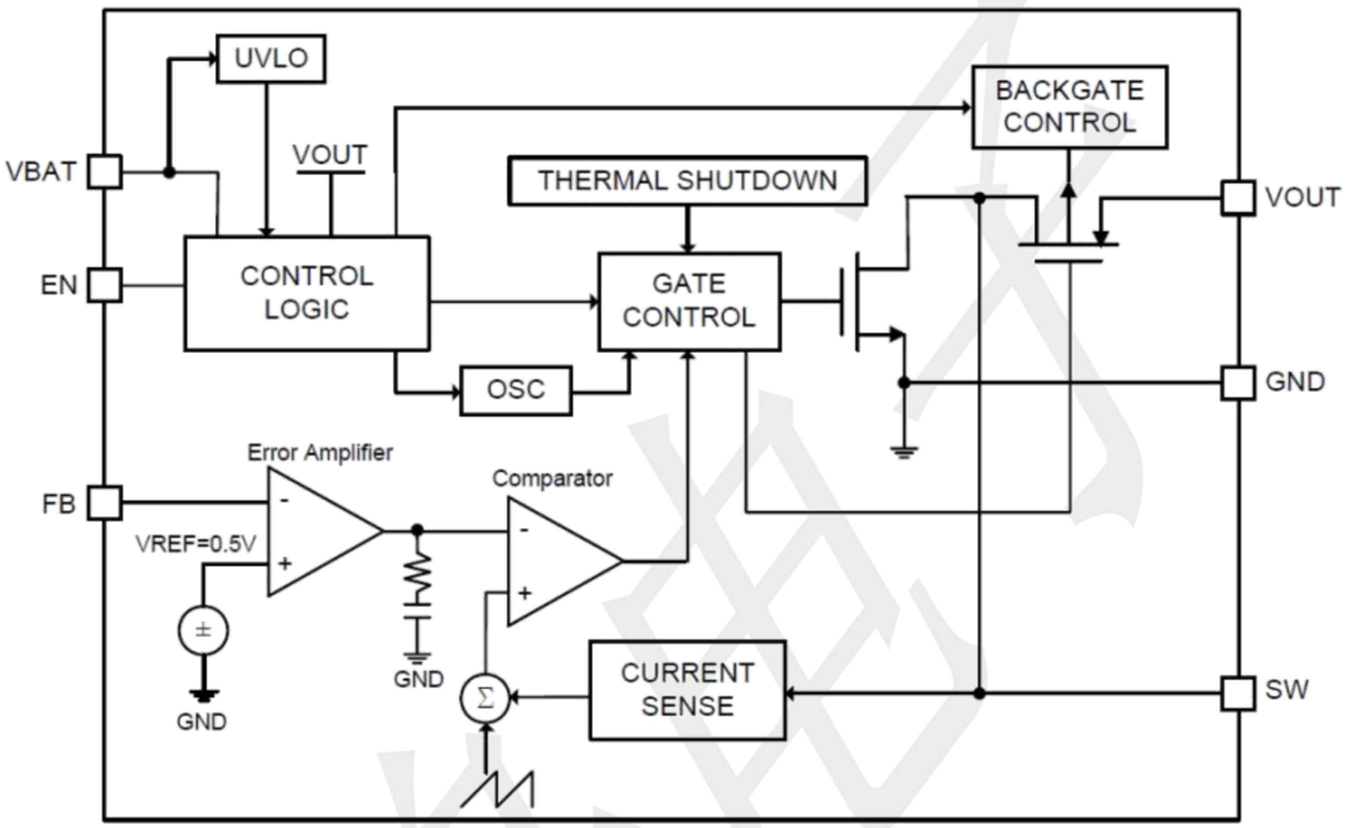


SOT23-5

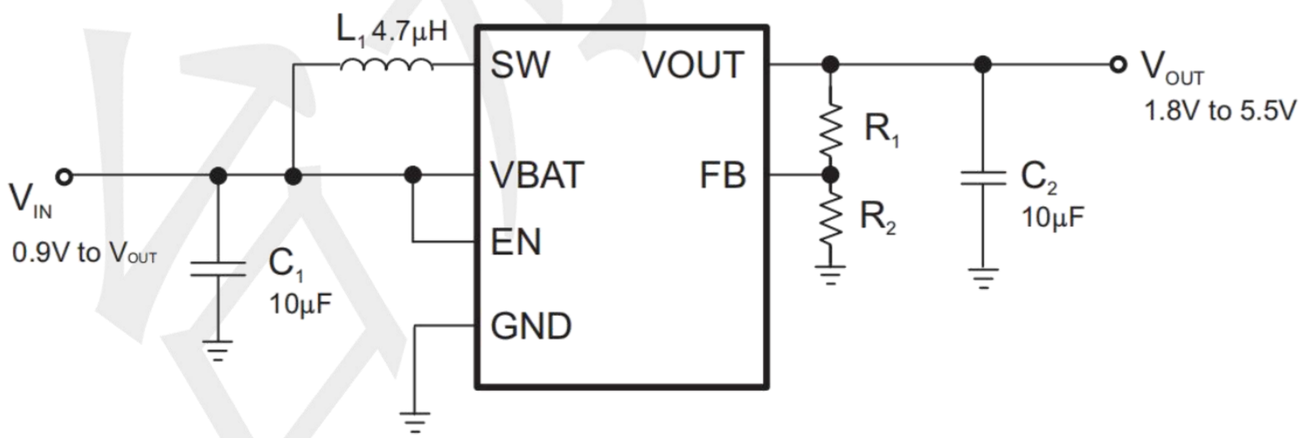
Pin Assignment

Pin Number	Pin Name	Pin Function
1	SW	Switch pin connected to the internal MOSFET switches and inductor terminal. Connect the inductor of the input to this pin.
2	GND	Analog ground pin.
3	EN	Enable pin
4	FB	Feedback Voltage
5	VOUT	Converter Output
6	VBAT	Supply Voltage

BLOCK DIAGRAM



Typical Application Circuit



Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)

PARAMETER		MIN	MAX	UNIT
VOUT	Continuous OUT voltage range	-0.3	6.5	V
SW	SW voltage range	-0.3	6.5	V
EN	EN pin voltage range	-0.3	VBAT	V
FB	FB, pin voltage range	-0.3	VBAT	V
PD	PD @ TA = 25°C	0.4		W
LT	Lead Temperature (Soldering, 10 sec.)	300		℃
Temperature	Junction Temperature , TJ	-40	125	℃
	Storage, Tstg	-65	150	℃
θ_{JA}	Thermal Resistance from Junction to ambient	250		°C/W

Note：

(1) The pressure listed below the absolute maximum rated value may cause permanent damage to the device. These are only pressure ratings and do not represent the device under these conditions or recommended operating conditions

Can operate normally under any other conditions except for the item. Prolonged exposure to absolute maximum rated conditions may affect the reliability of the device.

(2) All voltage values are based on the network ground terminal.

Recommended Operating Conditions

PARAMETER		MIN	MAX	UNIT
VBAT	Continuous input voltage range	0.9	5.5	V
VOUT	OUT voltage range	1.8	5.5	V
Temperature	Junction Temperature , TJ	-40	125	℃

Electrical Characteristics

(VBAT=0.9V to 5.5V, T_J=25℃, unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Minimum Input range for oscillation	V_{IN}		--	0.8	0.9	V
Minimum Input range for start up		R_{OUT} = 360Ω	--	0.9	1.1	V
Input range after start up			0.75	--	5.5	V
Output Voltage Range	V_{OUT}		1.8	--	5.5	V
Feedback Voltage	V_{FB}		0.49	0.50	0.51	V
Error Amp transconductance	G_M		--	45	--	uS
Oscillator Frequency	F_{OSC}		960	1200	1440	KHz
Max Duty	D_{MAX}		--	90	--	%
Switching Current Limit	I_{LIM}		700	850	1000	mA
PMOS On Resistance	R_{ONP}	V_{OUT}=3.3V, I_{SW}=500mA	--	250	--	mΩ
NMOS On Resistance	R_{ONN}	V_{OUT}=3.3V, I_{SW}=500mA	--	150	--	mΩ
Line Regulation			--	1	--	%
Load Regulation			--	1	--	%
Quiescent Current (no switching)	I_Q	I_O=0mA, V_{EN}=VBAT=1.2V, V_{OUT}=3.3V, (From V_{OUT} measure)	--	28	--	uA
Shutdown Current	I_{SD}	V_{EN}=0V, VBAT=1.2V	--	--	0.5	uA
Undervoltage Lockout Threshold	V_{UVLO}	VBAT falling	--	0.65	0.75	V
EN input low voltage	V_{IL}				0.3	V
EN input high voltage	VIH	VBAT>1.2V	1.2	--	--	V
		VBAT<1.2V	VBAT			
Thermal shutdown threshold	T_{SDN}		--	145	--	C
Thermal Shutdown Hysteresis	T_{SDNHY}		--	15	--	C

IC Operation Information

Basic Operation

The is based on a current-mode control topology with a fixed frequency pulse-width-modulator. The controller senses the current during the boost switch on, limits the maximum current flowing through the inductor and generates the current control loop. The small signal error in output is determined by the error amplifier on the FB pin, it is compared with an internal reference voltage for regulation. The control loop is internally compensated. Therefore no additional R-C network is required.

Synchronous Rectifier

The integrated an N-channel and a P-channel MOSFET to realize a synchronous rectifier. Because the commonly used Schottky diode is replaced with the internal PMOS switch, the power conversion efficiency reaches above 90%. A special function is applied to disconnect the direct path from the battery to the output during shutdown, which is realized by switching the bulk of the high-side PMOS. The benefit of this feature is that the battery is not depleted during shutdown, and therefore the battery life is extended.

Enable

The device is put into operation when EN is set high. It is put into shutdown when EN is set to GND. During shutdown, all internal circuitry is switched off, and the load is isolated from the input (as described in the Synchronous Rectifier Section).

Under Voltage Lockout

In order to prevent the malfunctioning of the device, the undervoltage lockout function is applied if the supply voltage on VBAT is lower than approximately 0.8V. When in operations, the battery is being discharged, the device enters shutdown once the VBAT voltage drops below approximately 0.8V.

Start up Cycle

When the device enables, it enters the first step of the startup cycle, the pre-charge phase. During pre-charge, the high-side PMOS switch is turned on until the output capacitor is charged to a value close to the input voltage. After pre-charge, the device starts switching with a fixed frequency of 60% duty until the output voltage reaches 1.8V. Once the output reaches 1.8V, the error amplifier controls the loop. Therefore the output goes to its nominal value.

Power-save Mode

The device enters power-save mode at loads for efficiency improvement. In power-save mode, the converter stops switching until the output voltage drops below a set threshold voltage. It ramps up the output voltage with several pulses, and returns to power-save mode once the output exceeds the set threshold.

IC Application Information

The boost converter is intended for systems powered by a single-cell, up to triple-cell alkaline, NiCd battery with a typical terminal voltage between 0.9V and 4.5V. It can also be used in systems powered by single-cell Li-ion or Li-polymer with a typical voltage between 2.5V and 4.2V. Additionally, a voltage source with a typical output voltage between 0.9V and 4.5V can power systems where the 61220is used. Due to the nature of the boost converters, the output voltage regulation is maintained only if the applied input voltage is lower than it.

Programming the Output Voltage

The output voltage of the is adjusted with an external resistor divider. The typical value of the voltage at the FB pin is 500mV. The maximum recommended value for the output is 5.5V. The current through the resistive divider should be 100 times greater than the current in the FB pin. The typical current into the FB pin is 10nA, and the voltage across R2 is typically 500mV. Therefore the value for R2 is recommended lower than 500kΩ, in order to set the current flows the divider higher than 1μA. From that, the value of R1, depending on the needed output voltage, is calculated in Equation 1:

$$R_1 = R_2 \times \left(\frac{V_{OUT}}{V_{FB}} - 1 \right) \quad (1)$$

Inductor Selection

A boost converter requires two main passive components, a boost inductor and a storage capacitor, for storing energy during the conversion. To select the boost inductor, it is recommended to keep the peak inductor current below the current limit threshold of the power switch. The highest peak current is estimated in Equation 2:

$$I_{PEAK} = I_{OUT} \times \frac{VOUT}{VBAT \times eff.} + VBAT \times \frac{1 - \frac{VBAT}{VOUT}}{2 \times L \times f} \quad (2)$$

Parameter f is the switching frequency and the eff. Can be determined by the typical characteristics graphs. The second parameter for choosing the inductor is the current ripple in the inductor. A smaller current ripple reduces the magnetic hysteresis losses in the inductor, the output voltage ripple and EMI. Typically, a current ripple less than 20% of the average inductance current is recommended. With these parameters, the value of the inductor is calculated in Equation 3:

$$L = \frac{VBAT \times (VOUT - VBAT)}{\Delta I_L \times f \times VOUT} \quad (3)$$

Parameter ΔIL is the ripple current in the inductor. The device is recommended to operate with the inductor of 2.2μH to 10μH, typically 4.7μH. Higher inductance is possible in some applications, while lower inductance may cause a sub-harmonic issue when the duty cycle> 0.5. DCR (DC resistance) of the inductor has to be taken into consideration for the efficiency decreases as it increases.

Input Capacitor

At least a 10μF input capacitor is recommended to improve transient behavior of the regulator and EMI behavior of the total power supply circuit. A ceramic capacitor or a tantalum capacitor with a 100nF ceramic capacitor in parallel, placed close to the IC, is recommended.

Output Capacitor

The major parameter to define the output capacitor is the allowed output voltage ripple of the converter. The ripple is determined by two parameters of the capacitor, the capacitance and the ESR. Supposing the ESR is zero, the minimum is estimated in Equation 4:

$$C_{min} = \frac{I_{OUT} \times (VOUT - VBAT)}{\Delta V \times f \times VOUT} \quad (4)$$

Parameter ΔV is the maximum allowed ripple of the output voltage. The ripple caused by the ESR is calculated in Equation 5:

$$\Delta V_{ESR} = I_{OUT} \times R_{ESR} \quad (5)$$

The total ripple is the sum of those caused by the capacitance and those caused by the ESR. Additional ripple is caused by load transients. With a chosen ripple of 10mV (at normal operation) and load transient considerations, a least output capacitor of 10μF is recommended.

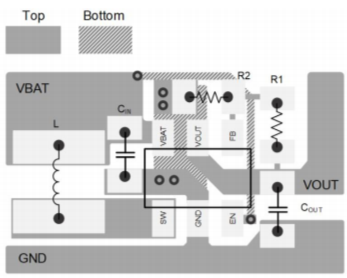
Thermal Considerations

The maximum recommended junction temperature (TJ) of the is 145°C. The thermal resistance of the SOT-23-6 package is RJθA= 240°C/W. The specified regulator operation is assured to a maximum ambient temperature TA of 85°C. Therefore, the maximum power dissipation is about 250mW according to Equation 6. More power can be dissipated if the maximum ambient temperature of the application is lower.

$$P_{D(MAX)} = \frac{T_{J(MAX)} - T_A}{R_{\theta JA}} = \frac{145°C - 85°C}{240°C/W} = 250mW \quad (6)$$

Layout Considerations

The layout is an important step in the design, especially at high-peak currents and high switching frequencies. It may cause serious problems in stability and EMI if not being carefully done. Wide and short traces are applied for the main current path and for the power ground traces. The input capacitor, the output capacitor, and the inductor should be place as close as possible to the IC. To minimize the effects of ground noise, we use a common ground node for the power ground and another for the control ground. These ground nodes are connected at any place close to the IC. To avoid ground shift problems, short traces are applied to control the ground as well.



Typical Operating Characteristics

($V_{IN} = V_{OUT} + 1V$, $I_{OUT} = 1mA$, $C_{IN} = C_{OUT} = 1uF$, $T_J = 25$℃, unless otherwise specified)

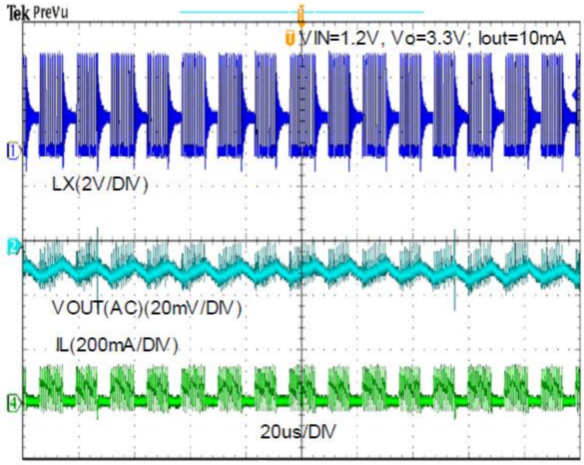


Fig 1. V_{IN} = 1.2V, V_{OUT} = 3.3V power save mode

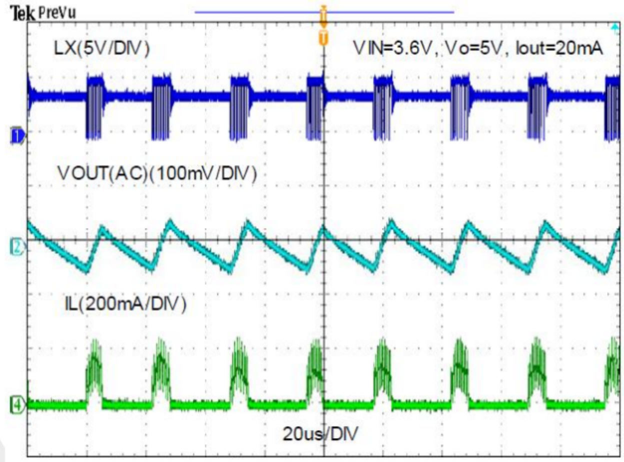


Fig 2. V_{IN} = 3.6V, V_{OUT} = 5.0V power save mode

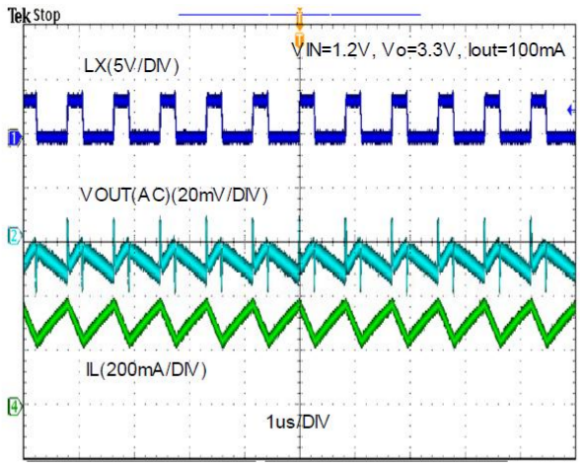


Fig 3. VIN = 1.2V, VOUT = 3.3V continuous mode

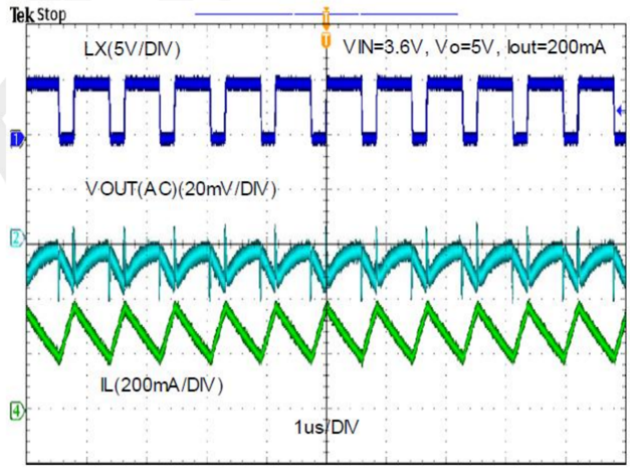


Fig 4. VIN = 3.6V, VOUT = 5.0V continuous mode

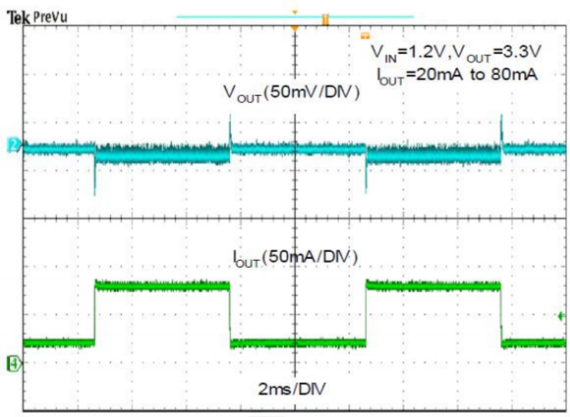


Fig 5. VIN = 1.2V, VOUT = 3.3V load transient

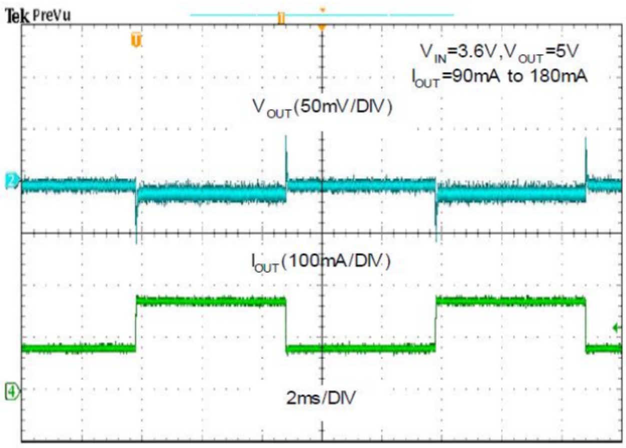


Fig 6. VIN = 3.6V, VOUT = 5.0V load transient

Typical Operating Characteristics

($V_{IN} = V_{OUT} + 1V$, $I_{OUT} = 1mA$, $C_{IN} = C_{OUT} = 1uF$, $T_J = 25℃$, unless otherwise specified)

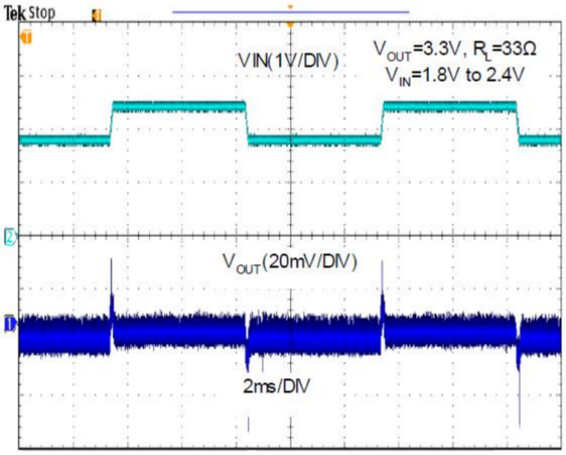


Fig 7. Line Transient Response

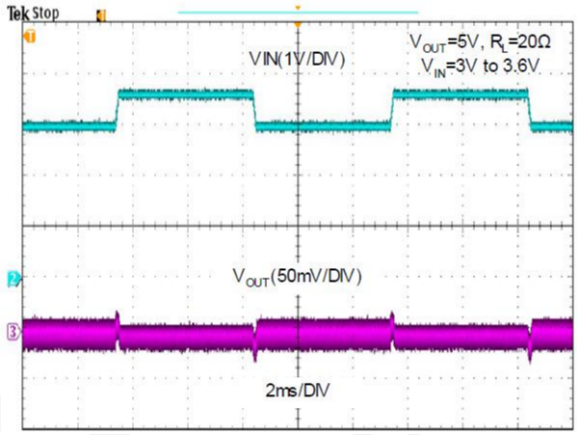


Fig 8. Line Transient Response

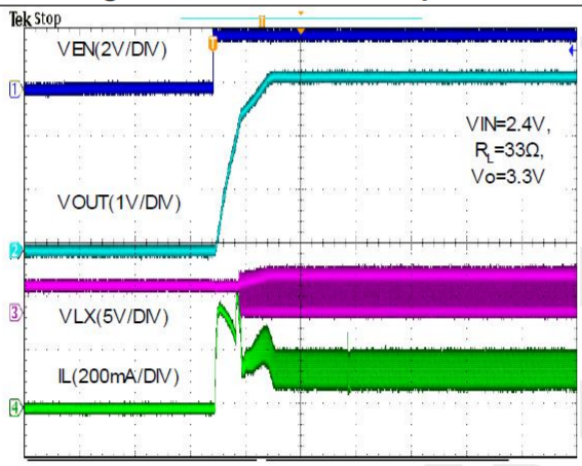


Fig 9. Enable Start up

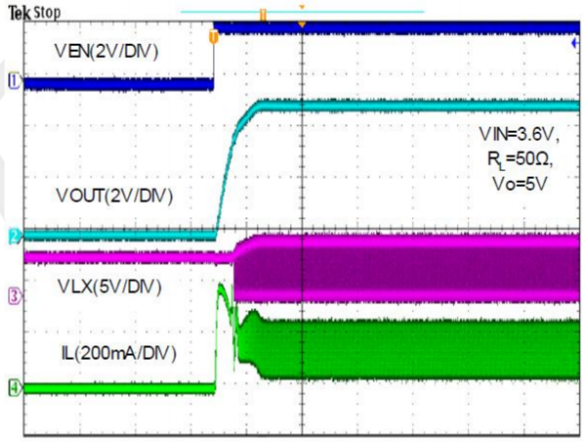


Fig 10. Enable Start up

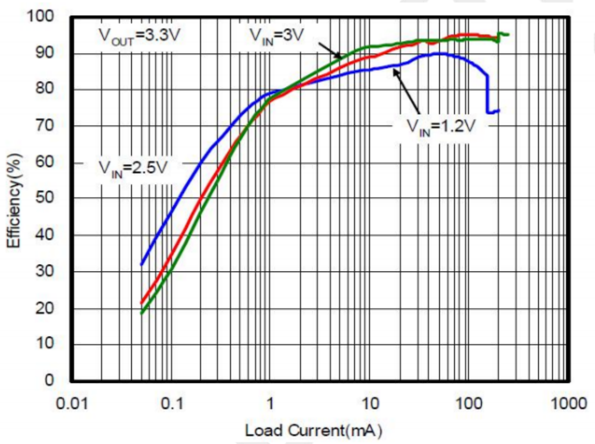


Fig 11. Efficiency vs Output Current

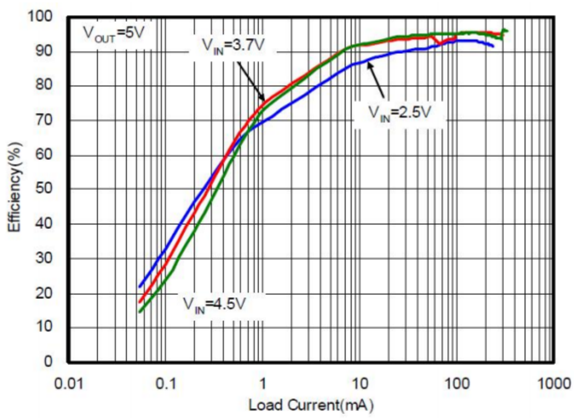
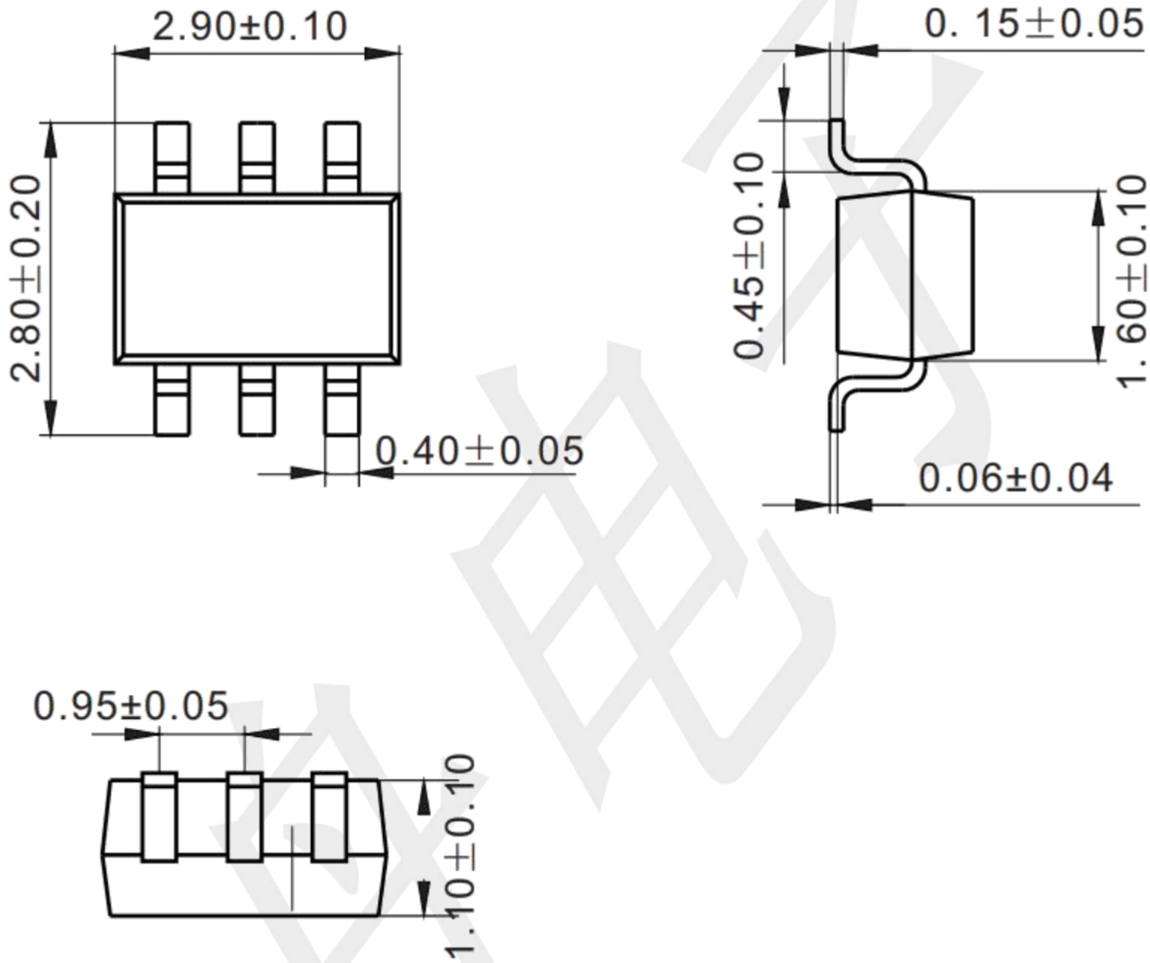


Fig 12. Efficiency vs Output Current

Package informantion (Unit: mm)

SOT23-6



Mounting Pad Layout (unit: mm)