

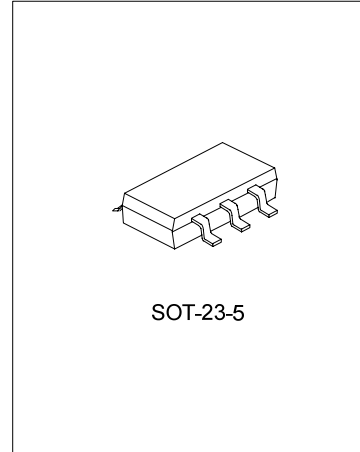
## 1.5MHz, 600mA, HIGH EFFICIENCY SYNCHRONOUS STEP-DOWN DC-DC CONVERTER

### DESCRIPTION

SC46208 is a synchronous step-down DC-DC converter with high efficiency. It adopts small flat package. The device features 2.5~5.5V input voltage, 600mA output current, peak current mode PWM and integrated compensation net, which is ideal for powering portable equipment that runs from a single cell Li+ battery without external components.

The device integrates an internal switch which eliminates the Schottky diode, 1.5MHz high frequency allows the periphery to adopt SMT inductor and capacitor, thus reduce the size of total solution. It can also run at 100% duty cycle for low dropout operation, that is lower than 1 $\mu$ A shutdown current and 20 $\mu$ A quiescent current in power saving mode. It extends battery life in portable system through increasing the efficiency under light loads.

SC46208 is available in an adjustable version and fixed version.



### FEATURES

- \* High efficiency up to 95%
- \* Automatic Power Saving Mode at light loads, only 20 $\mu$ A quiescent current.
- \* Wide input voltage range: +2.5V~+5.5V
- \* Output voltage range: 0.6V~VIN
- \* High output current 600mA
- \* Low dropout operation: 100%
- \* Shutdown current < 1 $\mu$ A
- \* 1.5MHz fixed frequency
- \* No Schottky diode required
- \* Thermal shutdown protection
- \* 4KV HBM ESD protection
- \* Small 5-pin SOT-23 package

### APPLICATION

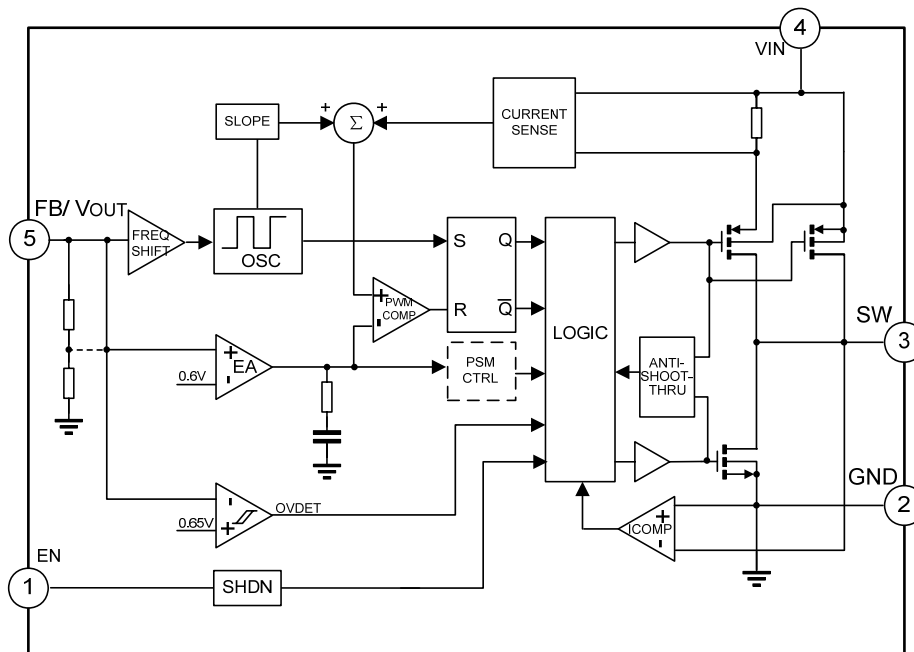
- \* Cellular Telephones
- \* PDAs
- \* Wireless Equipment
- \* MP3 player
- \* Digital Camera
- \* Portable Instruments

**ORDERING INFORMATION**

Device no	Seal name	Package	Remark
SC46208XX	SC46208	6208	SOT-23-5
	SC4620810	20810	SOT-23-5
	SC4620812	20812	SOT-23-5
	SC4620815	20815	SOT-23-5
	SC4620818	20818	SOT-23-5
	SC4620825	20825	SOT-23-5
	SC4620833	20833	SOT-23-5
SC46208AXX	SC46208A	6208A	SOT-23-5
	SC46208A10	08A10	SOT-23-5
	SC46208A12	08A12	SOT-23-5
	SC46208A15	08A15	SOT-23-5
	SC46208A18	08A18	SOT-23-5
	SC46208A25	08A25	SOT-23-5
	SC46208A33	08A33	SOT-23-5

Note: "A" means no auto power saving mode  
 "xx" indicates the output voltage  
 Default: adjustable  
 10 :1.0V  
 12 :1.2V  
 15 :1.5V  
 18 :1.8V  
 25 :2.5V  
 33 :3.3V

**BLOCK DIAGRAM**



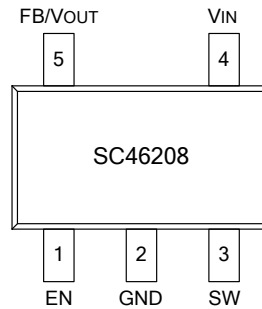
**ABSOLUTE MAXIMUM RATING**

Characteristics	Symbol	Rating	Unit
Input Supply Voltage $V_{IN}$	$V_{IN}$	-0.3 ~ +6	V
Enable Voltage EN	$V_{EN}$	-0.3 ~ $V_{IN}$	V
SW Voltage	$V_{SW}$	-0.3 ~ $V_{IN}+0.3$	V
Output Feedback Voltage	$V_{FB}$	-0.3 ~ +6	V
Operating Temperature	$T_{amb}$	-40 ~ + 85	°C
Storage Temperature	$T_{STG}$	-65 ~ +125	°C
ESD Characteristic(HBM)	ESD	4.0	KV

**ELECTRICAL CHARACTERISTICS**(unless otherwise noted,  $T_{amb}=25^{\circ}\text{C}$ ,  $V_{IN}=3.6\text{V}$ ,  $L=2.2\mu\text{H}$ ,  $C_{OUT}=10\mu\text{F}$ , load current  $I_{LOAD}=0$ )

Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit.
Input Voltage Range	$V_{IN}$		2.5		5.5	V
Feedback Voltage	$V_{FB}$	Only for adjustable version	0.585	0.6	0.615	V
Quiescent Current (Switch Off)	$I_{switch\ off}$	$FB=0.62\text{V}$ , or $V_{OUT}=103\%$		20	30	$\mu\text{A}$
Quiescent Current (Shutdown Mode)	$I_{SHDN}$	$EN=0\text{V}$		0.1	1	$\mu\text{A}$
Quiescent Current (PWM Mode)	$I_q$	$FB=0.5\text{V}$ , Or $V_{OUT}=90\%$		270	330	$\mu\text{A}$
Output Voltage Regulation	$\Delta V_{OUT}$			0.5		%
Output Voltage Load Regulation	$\Delta V_{LOAD}$	$0\text{mA} \leq I_L \leq 600\text{mA}$		0.1	1	mV/mA
Feedback Current	$I_{FB}$	Only for adjustable version	-50		50	nA
PMOS On Resistor	$R_{PMOS}$	$I_{SW}=100\text{mA}$		0.45	0.5	$\Omega$
NMOS On Resistor	$R_{NMOS}$	$I_{SW}=-100\text{mA}$		0.35	0.4	$\Omega$
PMOS Limit Current	$I_{LIMIT}$	$2.5\text{V} \leq V_{IN} \leq 5.5\text{V}$	0.75	1	1.25	A
Switch Frequency	$F_s$	$FB=0.6\text{V}$ , or $V_{OUT}=100\%$	1.3	1.5	1.7	MHz
		$FB=0\text{V}$ , or $V_{OUT}=0$		270		KHz
Max. Duty	$D_{MAX}$	$FB=0.5\text{V}$	100			%
Switch Leakage Current SW	$I_{LSW}$	$EN=0\text{V}$ , $SW=0\text{V}$ or $5\text{V}$ , $V_{IN}=3.6\text{V}$		$\pm 0.01$	$\pm 1$	$\mu\text{A}$
EN Input High Level	$V_H$	--	1.5			V
EN Input Low Level	$V_L$	--			0.3	V
EN Leakage Current	$I_{LEN}$		--	$\pm 0.01$	$\pm 1$	$\mu\text{A}$
Thermal Shutdown Temperature	$T_{j(sd)}$	--	--	150	--	°C
Thermal Shutdown Hysteresis Temperature	$T_{hyst}$	--	--	20	--	°C

## PIN CONFIGURATION



## PIN DESCRIPTION

Pin no.	Pin name	I/O	Descriptions
1	EN	I	Enable input port, this pin should not float.
2	GND	--	Ground.
3	SW	I/O	Power switch which connect to inductor and output voltage.
4	VIN	--	Supply input pin.
5	FB/VOUT	I	Output voltage feedback pin. In the adjustable version, this pin used for connecting external resistive divider.

## FUNCTION DESCRIPTIONS

SC46208 is a 1.5MHz constant frequency, current mode PWM step-down converter. The device integrates PMOS switch and a NMOS synchronous rectifier. It also includes a voltage reference, error amplifier, oscillator, PWM comparator, current comparator, slope compensation, current sense, logic driver, etc...

In normal PWM mode, in one cycle, when the oscillator sets RS trigger, internal PMOS conduct, while PWM comparator resets the RS trigger, PMOS is cut off, the peak current of inductor is controlled by error amplifier output. When PMOS is off, the synchronous NMOS will be turned on and stay on until the inductor current reverses (controlled by current comparator ICOMP) or the next clock cycle begins.

SC46208(SC46208A has no auto power saving mode) detects the load current automatically, when the load current decreases to a threshold(related to the input/output voltage and inductance), the system starts power saving mode. In this mode, the dissipation current is only 20 $\mu$ A, thus to improve the conversion efficiency under light loads. Pay attention to the ripple of output voltage, you can add a phase-lead capacitor (pF grade) between the VOUT and FB to reduce the ripple in power saving mode.

### Dropout Operation

When the input voltage decreases toward the value of output voltage, the duty increases, and the input voltage decrease more, PMOS switch on in one cycle and the duty reaches 100%. The output voltage then is the input voltage minus the voltage drop across the PMOS switch and the inductor.

### Short Circuit Protection

When the output is short to ground, the frequency of internal oscillator decreases to 270KHz in order to remain

enough attenuation time for inductor, thus prevent it from running away. When the output voltage increases, the frequency increases to 1.5MHz gradually.

### Over Voltage Detection

When the over-voltage detect circuit detects the output voltage is more than 6% of the set value, it will shutdown the PMOS switch to prevent the output voltage from over-shoot until the voltage drops to set value.

### Current Limit and Thermal Shutdown

Current limit is implemented through internal comparator, it limits the PMOS current in the 1000mA in one cycle, thus to protect the SC46208 in over load condition.

When the die temperature is over 150°C due to the long time over load operation, SC46208 is shutdown automatically until the temperature lower to normal state, the hysteresis temperature during this period is about 20°C.

## APPLICATION NOTES

Referring to typical application circuit of fig 1, the components selection begins with inductor L, then CIN and COUT:

### Inductor Selection

The SC46208 can utilize small surface mount and chip inductors due to its fast 1.5MHz switching frequency. For most applications the SC46208 operates with inductors of 1μH to 4.7μH. The large inductance will decrease the ripple current, but high inductance values will also increase the PCB size, and the low inductance value result in high ripple currents. The ripple also relative with the VIN and VOUT:

$$I_{\text{ripple}} = \frac{1}{f_s} \times \frac{V_{\text{IN}} - V_{\text{OUT}}}{L} \times \frac{V_{\text{OUT}}}{V_{\text{IN}}}$$

The rating current of inductor is equal to half of the max. load current adds half the max. ripple current ,to handle the peak inductor current without saturating. Choose inductor ripple current  $I_{\text{ripple}}$  approximately 40% of the maximum load current  $I_{\text{LOAD(max)}}$  , so the rating current  $I_{\text{sat}}$  satisfied with following formula:

$$I_{\text{sat}} > I_{\text{LOAD(max)}} + \frac{1}{2} I_{\text{ripple}} = (1 + 20\%) I_{\text{LOAD(max)}}$$

The max. load current is 600mA, for most applications, the inductor of 720mA rating value is enough; for higher efficiency, please select choose an inductor with low DC series resistance (DCR). To reduce the noise, use a shielded bobbin inductor.

### Capacitor Selection

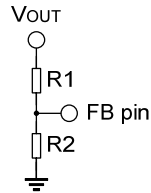
The low ESR capacitor is required to keep the output voltage ripple small. There, the multilayer ceramic capacitor is recommended due to their low ESR and small size. In the most applications, 10-22μF output capacitors are enough, higher capacitor can be used to reduce the output ripple and improve transient response.

The low ESR input capacitor reduces the surge current drawn from the input and switching noise from the device. Ceramic capacitor is the best selection for input capacitor, and the capacitor should be as near as possible to chip. A 4.7μF ceramic capacitor is sufficient for most applications.

Ceramic capacitors with X5R or X7R dielectrics are highly recommended because of their low ESR and small temperature coefficients.

### Setting The Output Voltage

For voltage adjustable version, SC46208 adjusts the output voltage through two serial resistors, refer to fig.1. We can calculate the output voltage through the following equation:  $V_{OUT} = (1 + \frac{R1}{R2}) \times 0.6V$



Refers to fig.1, the selection of resistor R1, R2 should give attention to the quiescent power and external interfere. Higher impedance reduces the quiescent current ( $I=0.6V/R2$ ), and lower resistance gives better noise immunity, and is less sensitive to interference, layout parasitics and FB node leakage current. A proper value of feed-forward capacitor C1 can improve the noise immunity of the feedback loops, especially in an improper layout.

**TYPICAL APPLICATION CIRCUIT**

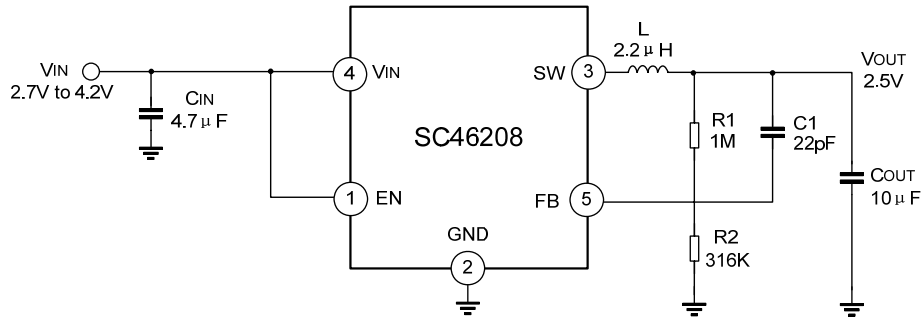


Fig. 1: Output voltage adjustable regulator, single battery to 2.5V converter

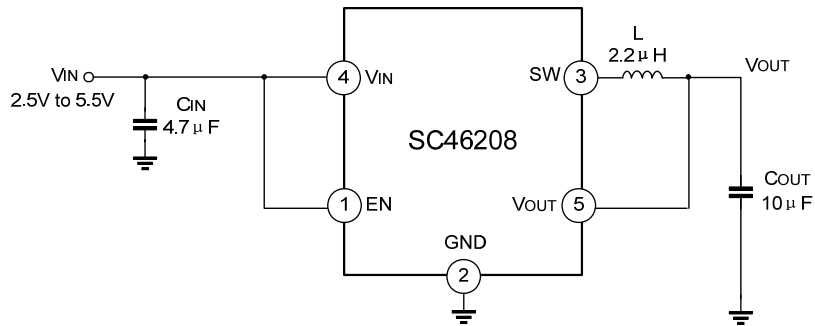
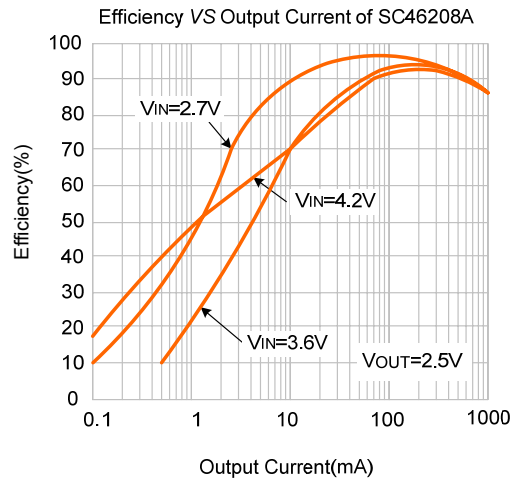
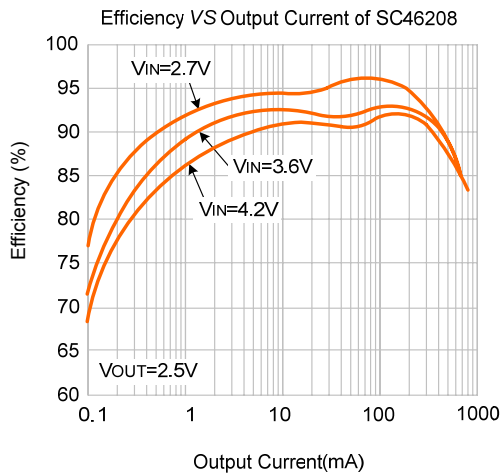
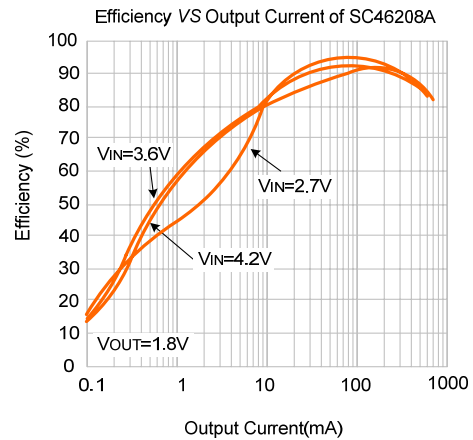
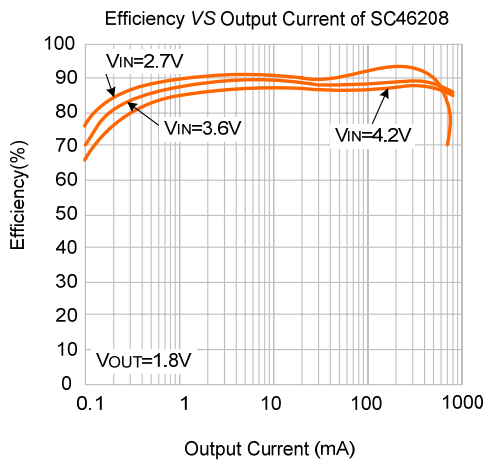
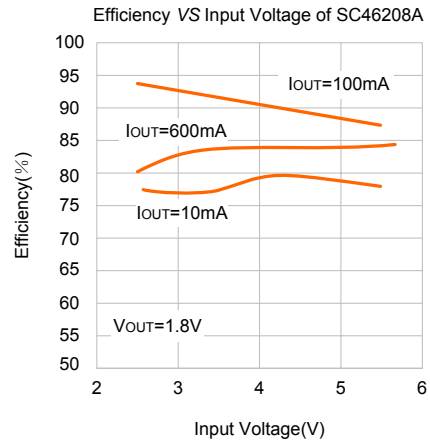
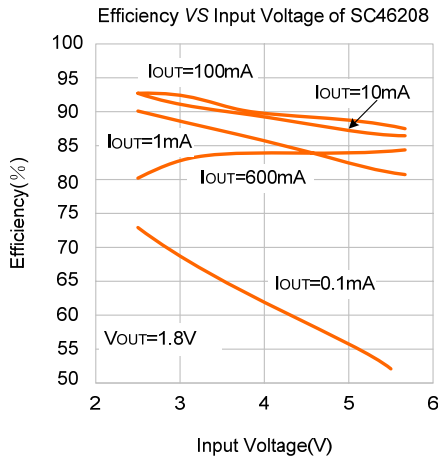


Fig.2: Output voltage fixed regulator

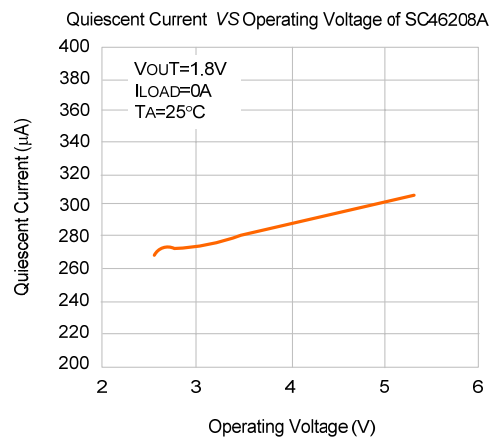
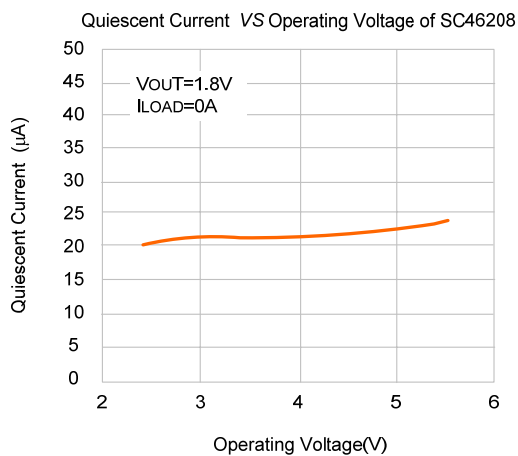
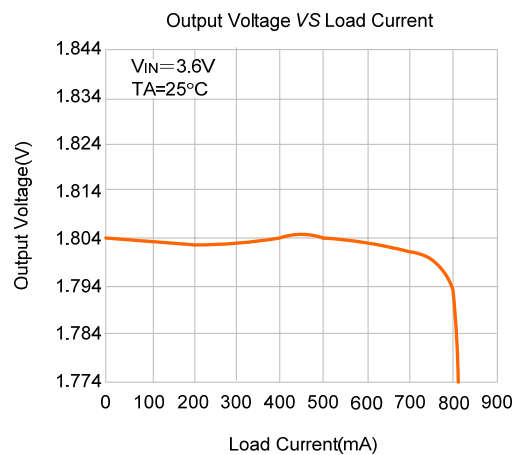
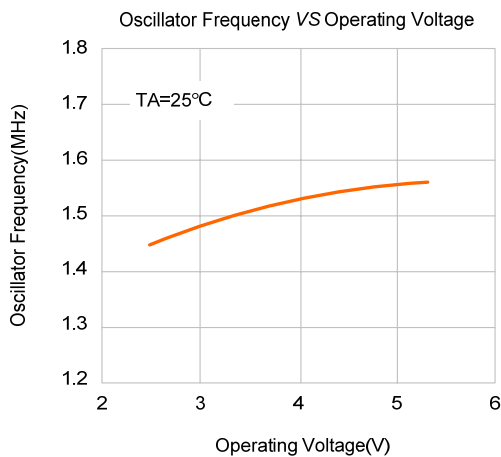
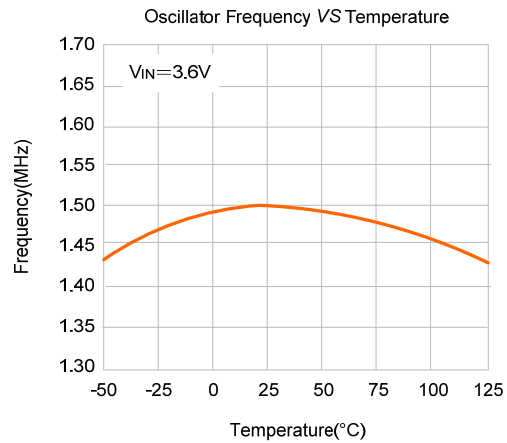
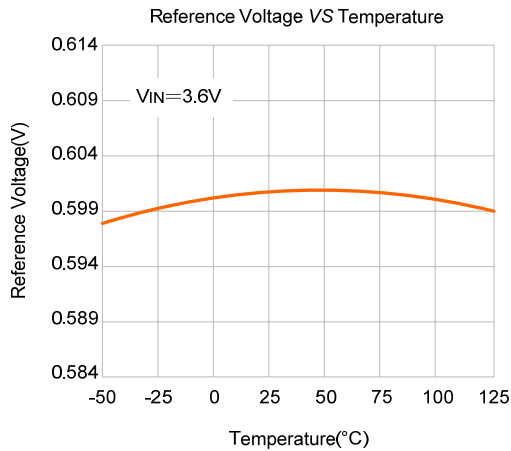
Note: The circuit and parameters are reference only, please set the parameters of the real application circuit based on the real test.

**TYPICAL ELECTRICAL CHARACTERISTICS CURVES** ( $T_{amb}=25^{\circ}C$ , unless otherwise specified)

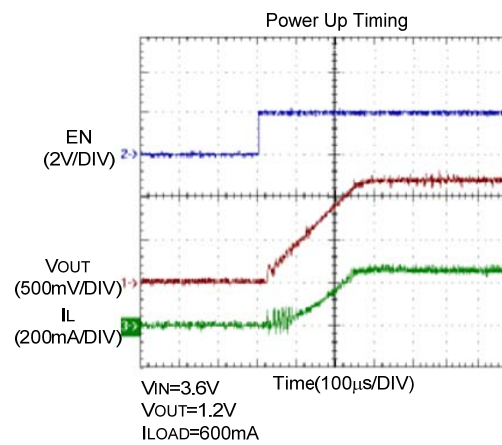
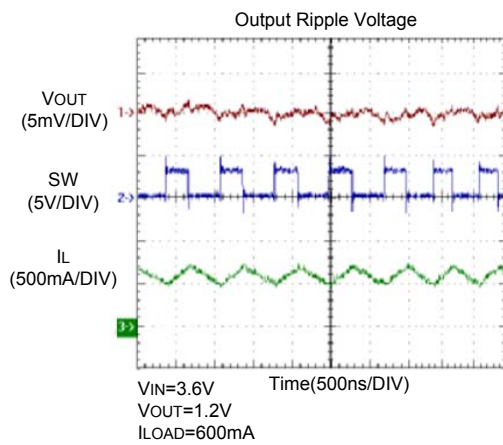
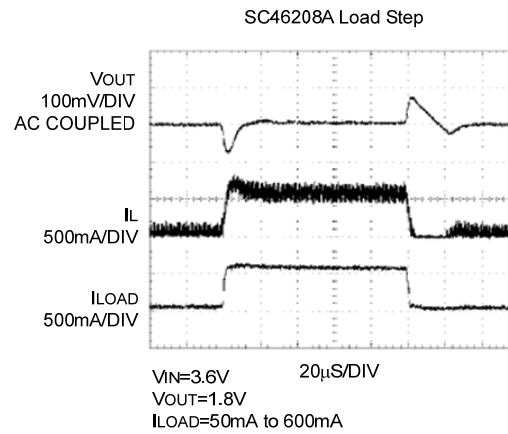
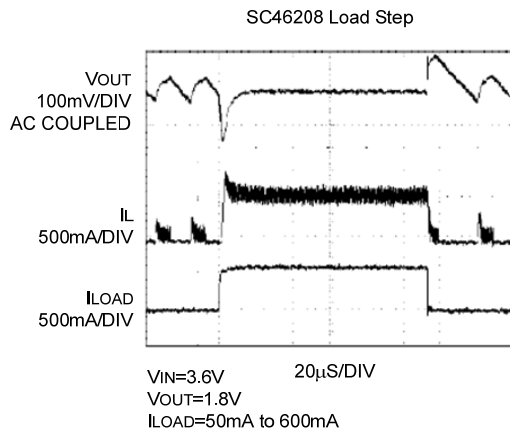




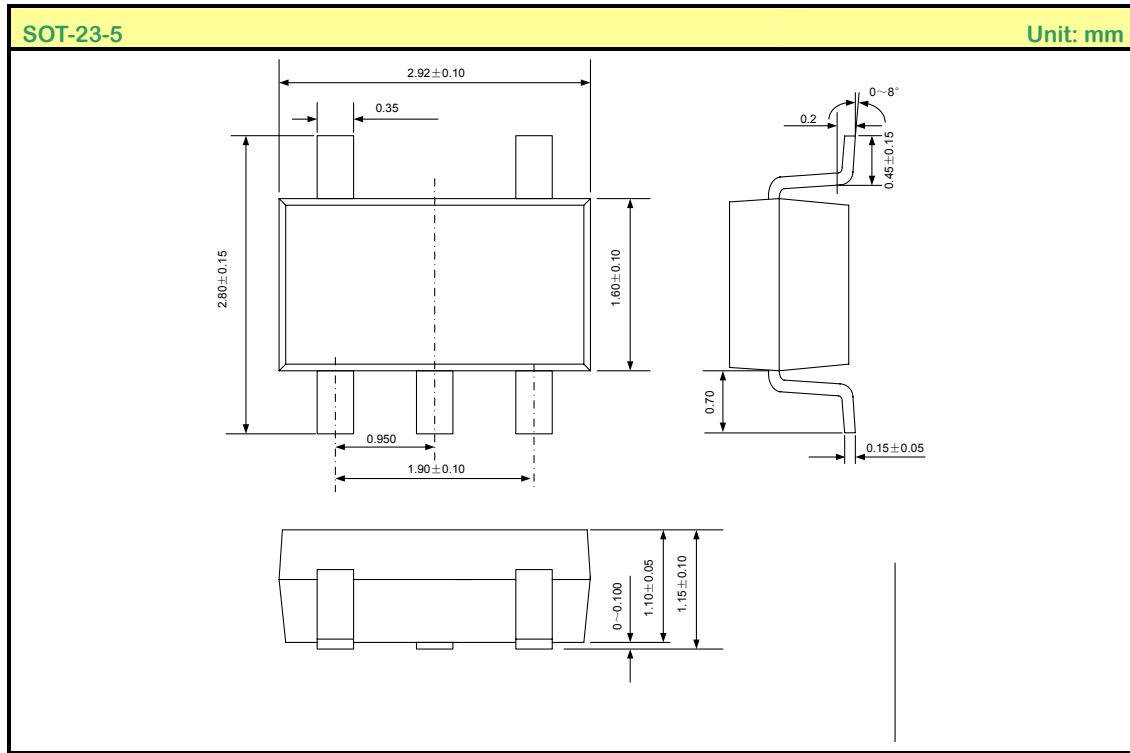
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**PACKAGE OUTLINE**



**HANDLING MOS DEVICES:**

Electrostatic charges can exist in many things. All of our MOS devices are internally protected against electrostatic discharge but they can be damaged if the following precautions are not taken:

- Persons at a work bench should be earthed via a wrist strap.
- Equipment cases should be earthed.
- All tools used during assembly, including soldering tools and solder baths, must be earthed.
- MOS devices should be packed for dispatch in antistatic/conductive containers.

Note: Silan reserves the right to make changes without notice in this specification for the improvement of the design and performance.  
Silan will supply the best possible product for customers.