

SK6513 40V, Low Quiescent Current, High Reliability LDO

GENERAL DESCRIPTION

The SK6513 series is a high accuracy, high input voltage low quiescent current, high speed, and low dropout liner regulator with high ripple rejection.

The input voltage is up to 40V and load current is upto 300mA at $V_{OUT}=5V$ & $V_{IN}=7V$. The device is manufactured with BCD process. The SK6513 offers over-current limit, soft start and over temperature protection to ensure the device working in well conditions.

The SK6513 regulators is available in standard SOT89-3L, SOT23-5L and SOT23-3L packages.

Standard products are Pb-free and Halogen-free.

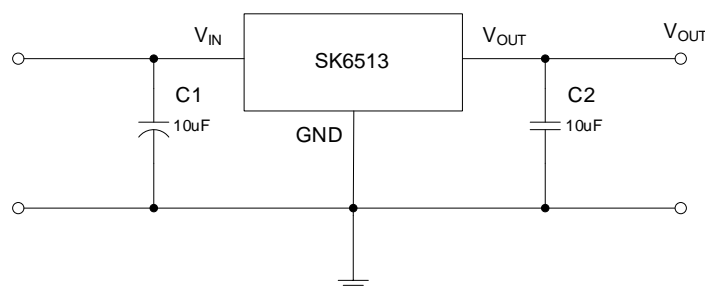
FEATURES

- Input voltage: 4.75V~40V
- Output voltage: 1.8V~5.7V
- Output accuracy: $<\pm 2\%$
- Output current: 150mA (Typ.)
Up to 300mA @ $V_{IN}=7V, V_{OUT}=5V$, SK6513T3A
- PSRR: 60dB @ 100Hz
- Dropout voltage: 600mV @ $I_{OUT}=100mA$
- Quiescent current: $4.2\mu A$ @ $V_{IN}=12V$ (Typ.)
- ESD HBM: 8KV
- Recommend capacitor: 10 μF

APPLICATIONS

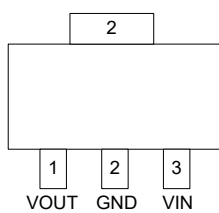
- Smart electric meter
- In-car entertainment
- Electric bicycle

TYPICAL APPLICATION CIRCUIT



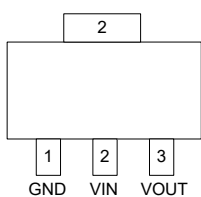
In plugging application, C_{IN} is recommended to use 10uF electrolytic capacitor or 10uF MLCC with 2ohm series resistors to prevent chip burning due to the large input voltage spike when plugging. See APPLICATION INFORMATION for more information.

PIN ASSIGNMENT



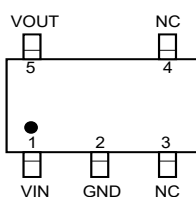
SOT89-3L (Top View)

SK6513T3A SOT89-3L



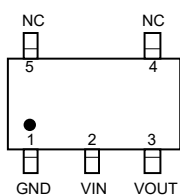
SOT89-3L (Top View)

SK6513T3B SOT89-3L



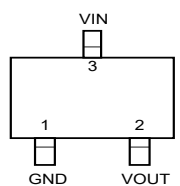
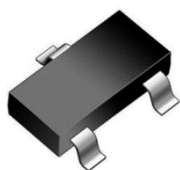
SOT23-5L (Top View)

SK6513S5A SOT23-5L



SOT23-5L (Top View)

SK6513S5B SOT23-5L



SOT23-3L (Top View)

SK6513S3 SOT23-3L

PIN DESCRIPTION

| PIN NO | SYMBOL | I/O | DESCRIPTION |
|-----------|--------|--------|-------------|
| SK6513T3A | | | |
| 1 | VOUT | O | Output |
| 2 | GND | Ground | Ground |
| 3 | VIN | Power | Input |

| PIN NO | SYMBOL | I/O | DESCRIPTION |
|-----------|--------|--------|-------------|
| SK6513T3B | | | |
| 1 | GND | Ground | Ground |
| 2 | VIN | Power | Input |
| 3 | VOUT | O | Output |

| PIN NO | SYMBOL | I/O | DESCRIPTION |
|-----------|--------|--------|-------------|
| SK6513S5A | | | |
| 1 | VIN | Power | Input |
| 2 | GND | Ground | Ground |
| 3 | NC | - | Not connect |
| 4 | NC | - | Not connect |
| 5 | VOUT | O | Output |

| PIN NO | SYMBOL | I/O | DESCRIPTION |
|-----------|--------|--------|-------------|
| SK6513S5B | | | |
| 1 | GND | Ground | Ground |
| 2 | VIN | Power | Input |
| 3 | VOUT | O | Output |
| 4 | NC | - | Not connect |
| 5 | NC | - | Not connect |

| PIN NO | SYMBOL | I/O | DESCRIPTION |
|----------|--------|--------|-------------|
| SK6513S3 | | | |
| 1 | GND | Ground | Ground |
| 2 | VOUT | O | Output |
| 3 | VIN | Power | Input |

ORDERING INFORMATION

| PART NO | PACAKGE | TEMPERATURE | TAPE & REEL |
|--------------|----------|--------------|---|
| SK6513T3A-XX | SOT89-3L | -40 ~ +105°C | 1000/REEL |
| SK6513T3B-XX | SOT89-3L | -40 ~ +105°C | 3.3V:2500/REEL Other Voltages: 1000/REEL |
| SK6513S5A-XX | SOT23-5L | -40 ~ +105°C | 3000/REEL |
| SK6513S5B-XX | SOT23-5L | -40 ~ +105°C | 3000/REEL |
| SK6513S3-XX | SOT23-3L | -40 ~ +105°C | 3000/REEL |

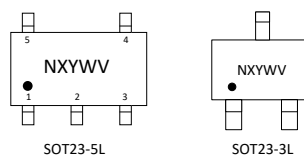
"XX": several fixed output voltages ranging from 1.8V to 5.7V. E.g. "33": $V_{OUT} = 3.3V$

PART NUMBER RULES

SK6513^[1]_[2]

| Code | Description |
|------|---|
| [1] | Package: S3: SOT23-3L S5A/S5B: SOT23-5L T3A/T3B: SOT89-3L |
| [2] | Voltage version: XX: several fixed output voltages ranging from 1.8V to 5.7V Example: 33: 3.3V |

MARKING DESCRIPTION



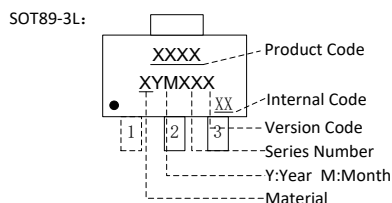
"N": product code, here use "O" stands for "SK6513S3", "Q" stands for "SK6513S5A", "P" stands for "SK6513S5B".

"X": Package factory.

"Y": Wafer foundry vendor.

"W": The week of manufacturing. "A" stands for week 1, "Z" stands for week 26, "A" stands for week 27, "Z" stands for week.

"V": Version code.



ABSOLUTE MAXIMUM RATINGS^(Note)

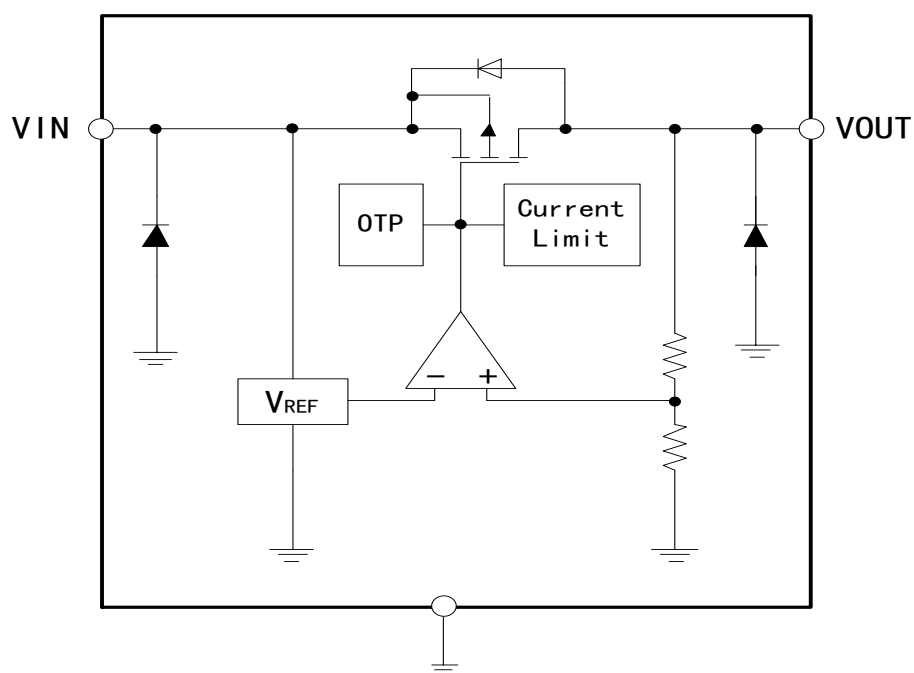
| SYMBOL | ITEMS | VALUE | UNIT |
|------------|--|-------------|------|
| V_{IN} | Input Voltage | -0.3~45 | V |
| V_{OUT} | Output Voltage | -0.3~6.5 | V |
| P_{DMAX} | Power Dissipation | OTP limited | W |
| T_J | Junction Temperature | -40~150 | °C |
| Tstg | Storage Temperature | -55 to 150 | °C |
| Tsolder | Package Lead Soldering Temperature (10s) | 260 | °C |
| ESD MM | Machine Mode | 200 | V |
| ESD HBM | Human Body Mode | 8000 | V |

Note: Exceed these limits to damage to the device. Exposure to absolute maximum rating conditions may affect device reliability.

RECOMMENDED OPERATING RANGE

| SYMBOL | ITEMS | VALUE | UNIT |
|-----------------|---------------------------|-------------|------|
| V_{IN} | V_{IN} Supply Voltage | 4.75to 40 | V |
| $R_{\theta JA}$ | Thermal Resistance on PCB | 45 | °C/W |
| T_{OPT} | Operating Temperature | -40 to +105 | °C |

SIMPLIFIED BLOCK DIAGRAM



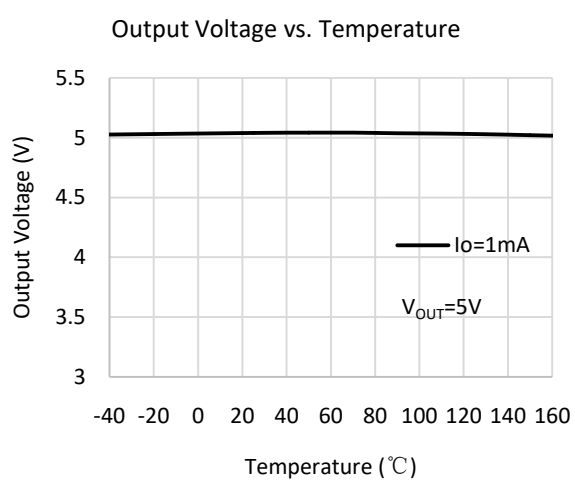
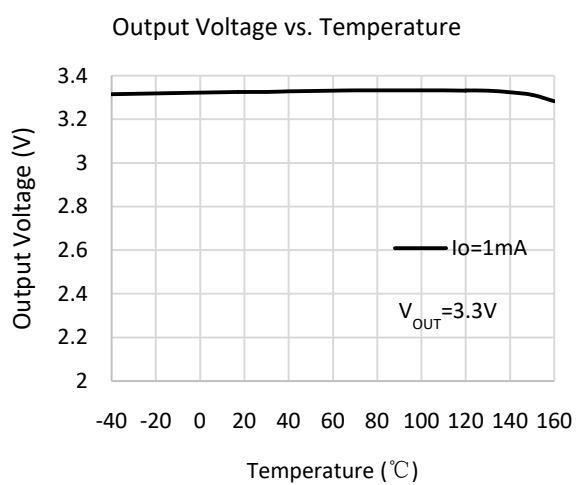
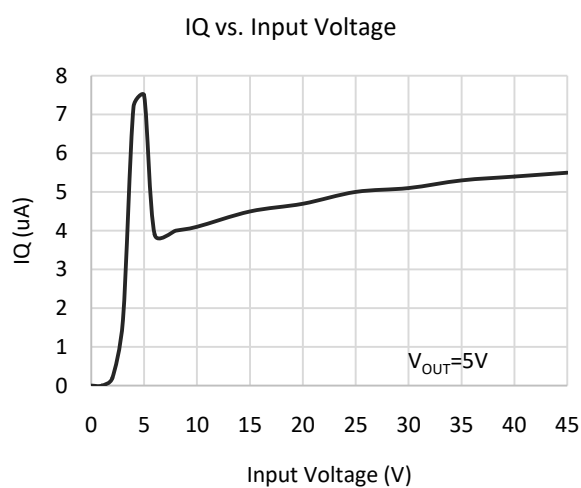
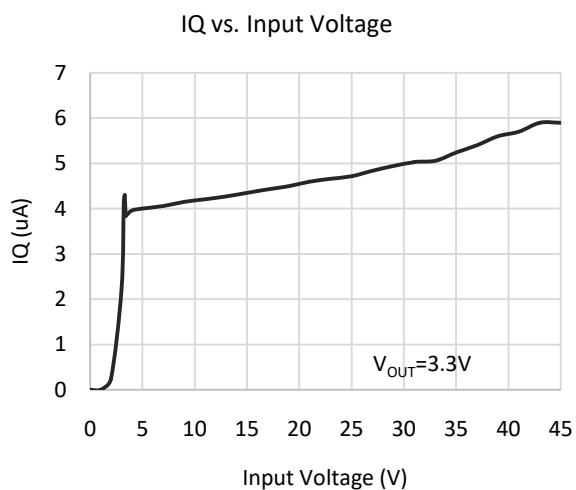
ELECTRICAL CHARACTERISTICS

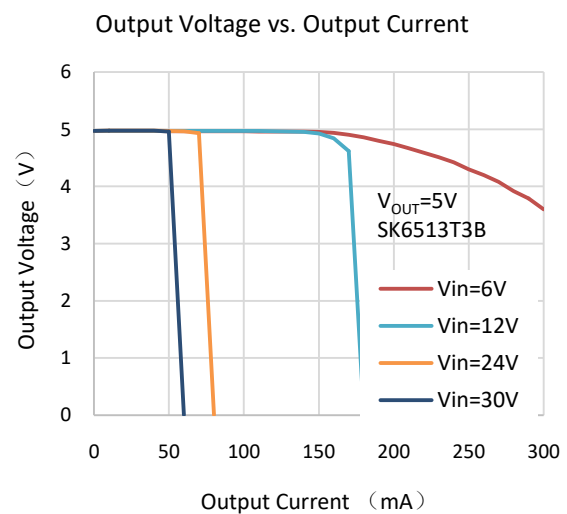
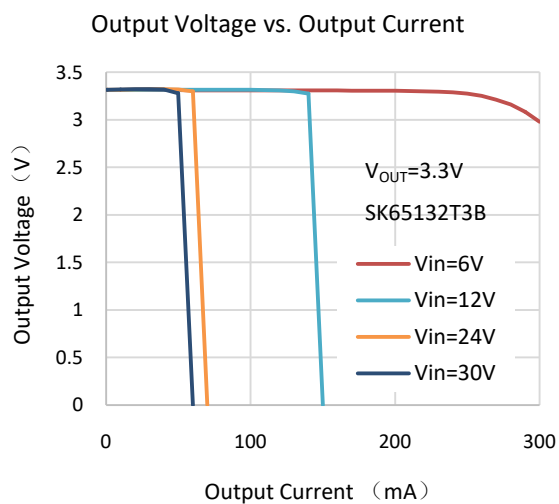
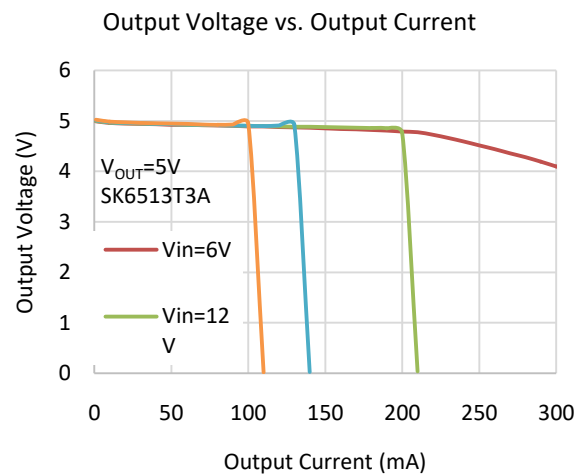
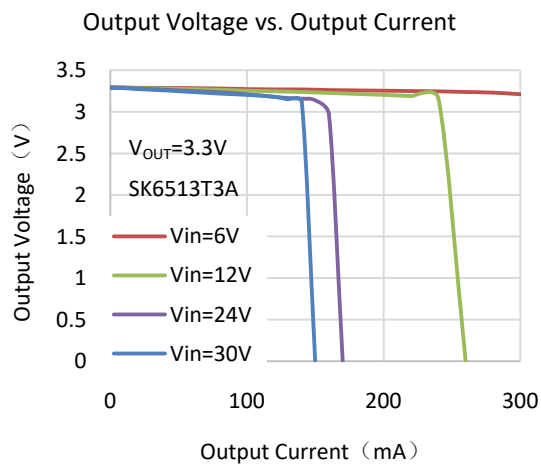
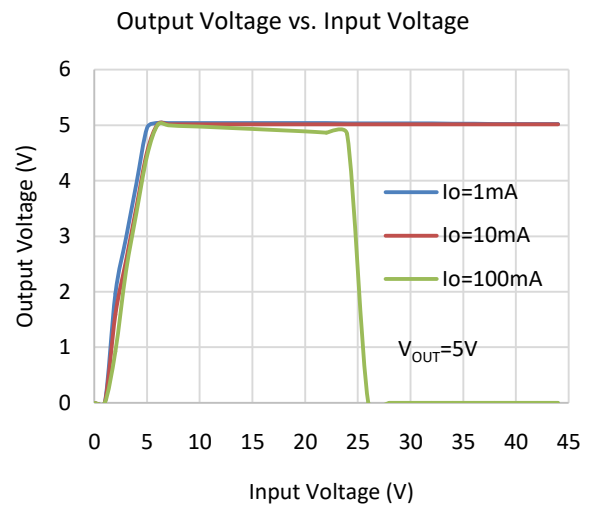
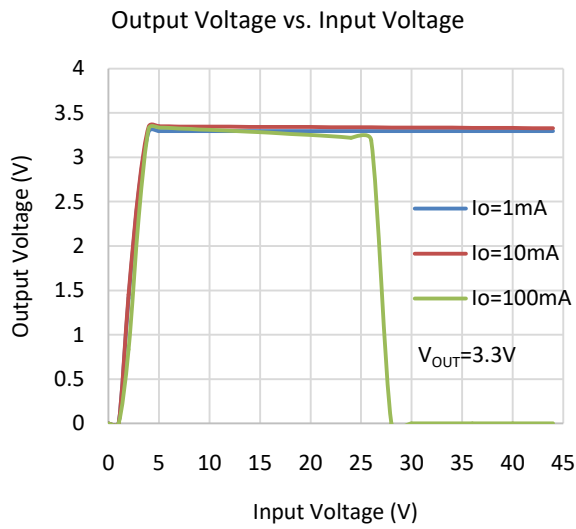
The following specifications apply for $V_{IN}=12V$, $T_A=25^{\circ}C$, $C_{IN}=C_{OUT}=10\mu F$, unless specified otherwise.

| SYMBOL | ITEMS | CONDITIONS | MIN | TYP | MAX | UNIT |
|-----------------------|-----------------------------|--|----------------------|-----------|----------------------|-----------------|
| V_{IN} | Input Range | $I_{OUT}=10mA$ | 4.75 | | 40 | V |
| V_{OUT} | Output Range | $I_{OUT}=10mA$ | $V_{OUT}\times 0.98$ | V_{OUT} | $V_{OUT}\times 1.02$ | V |
| ΔV_{OUT} | Output Voltage | $V_{IN} = 12V, I_{OUT} = 10mA$ | 4.9 | 5 | 5.1 | V |
| | | | 3.234 | 3.3 | 3.366 | |
| | | | 2.94 | 3.0 | 3.06 | |
| I_Q | Quiescent Current | $V_{IN}=7V, I_{OUT}=0$ | | 4 | 6 | μA |
| | | $V_{IN}=24V, I_{OUT}=0$ | | 4.6 | 6.7 | |
| | | $V_{IN}=40V, I_{OUT}=0$ | | 5.4 | 8.2 | |
| I_{OUT_PK} | Maximum Output Current | $V_{IN} - V_{OUT}=4V, R_L=1\Omega$ | | 500 | 550 | mA |
| V_{DROD} | Dropout Voltage | $I_{OUT}=10mA$ | | 60 | 90 | mV |
| | | $I_{OUT}=100mA$ | | 600 | 900 | |
| ΔV_{LINE} | Line Regulation | $V_{IN}=7\sim 24V, V_{OUT}=5V, I_{OUT}=1mA$ | | 0.02 | 0.03 | % / V |
| | | $V_{IN}=7\sim 45V, V_{OUT}=5V, I_{OUT}=1mA$ | | 0.08 | 0.1 | |
| ΔV_{LOAD} | Load Regulation | $V_{IN}=7V, I_{OUT}=1\sim 100mA$ | | 19 | 37 | mV |
| I_{SHORT} | Short Current | V_{OUT} Short to GND with 1Ω (1ms pulse), $V_{IN}=12V$ | | 180 | | mA |
| PSRR | Power Supply Rejection Rate | $V_{IN}=10V,$ $V_{PP}=0.5V,$ $I_{OUT}=1mA$ | $F=100Hz$ | | 60 | dB |
| | | | $F=1kHz$ | | 50 | |
| | | | $F=10kHz$ | | 40 | |
| e_{NO} | Output Noise Voltage | 10Hz to 100kHz, $C_{OUT}=10\mu F,$ $I_{OUT}=10mA$ | | ± 100 | | μV_{RMS} |
| T_{SD} | Thermal Shutdown Protection | $V_{IN}=12V, I_{OUT}=1mA$ | | 165 | | $^{\circ}C$ |
| $\Delta V_O/\Delta T$ | Temperature Coefficient | | | ± 0.5 | | mV/ $^{\circ}C$ |

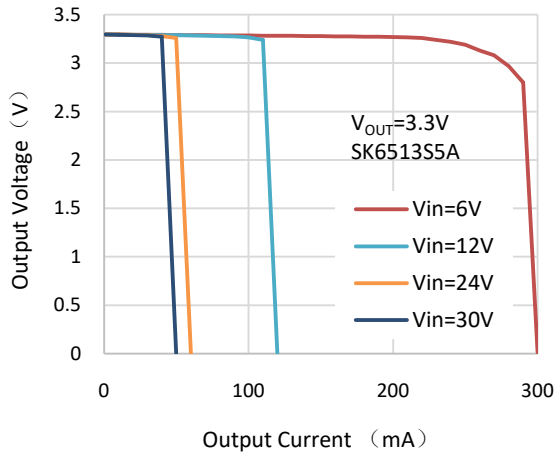
TYPICAL PERFORMANCE CHARACTERISTICS

$C_{IN}=10\mu F$, $C_{OUT}=10\mu F$, $T_{OPT}=25^{\circ}C$, unless specified otherwise.(SK6513T3APackage)

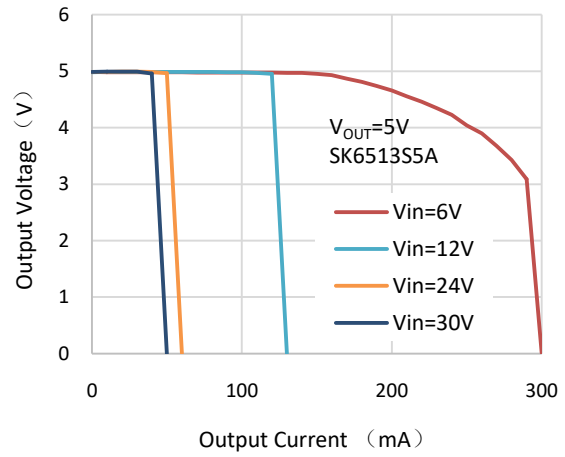




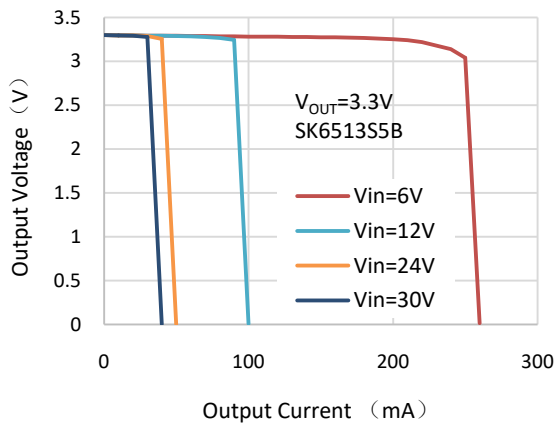
Output Voltage vs. Output Current



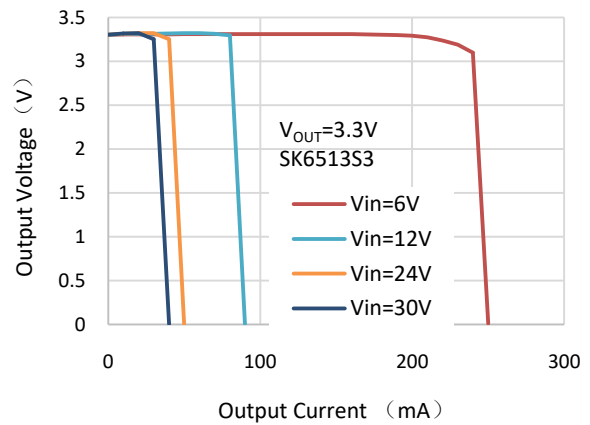
Output Voltage vs. Output Current



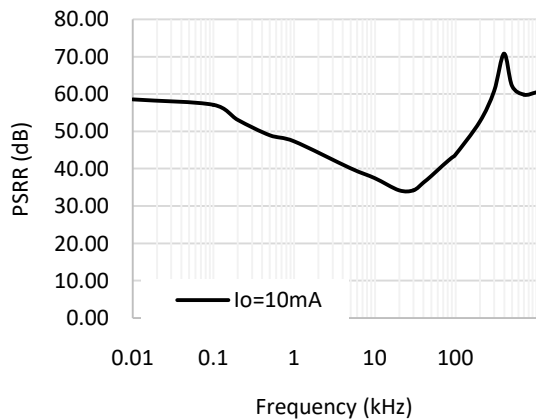
Output Voltage vs. Output Current



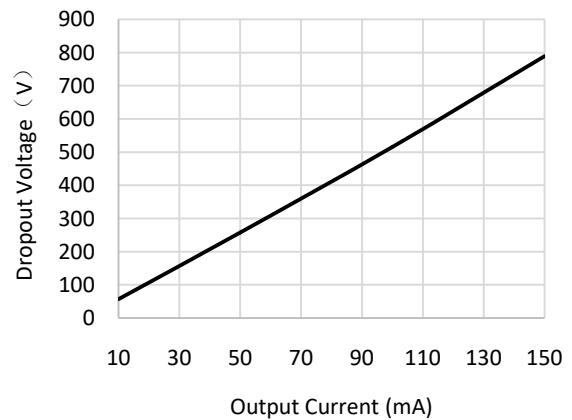
Output Voltage vs. Output Current

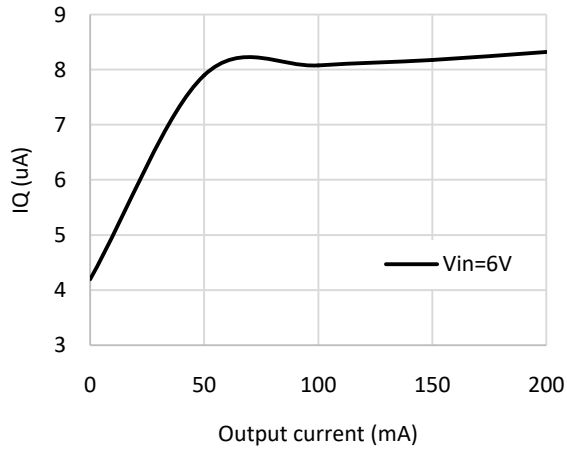
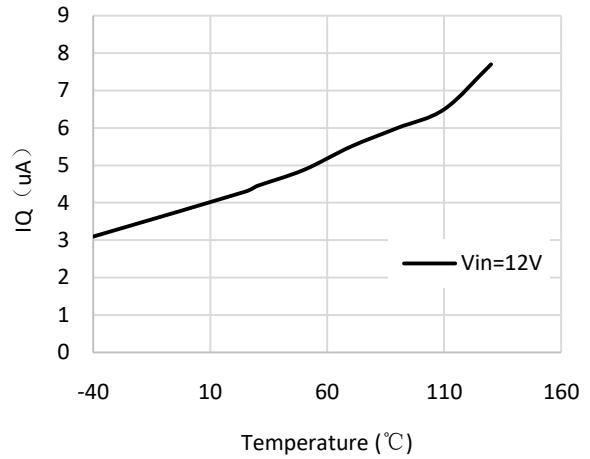
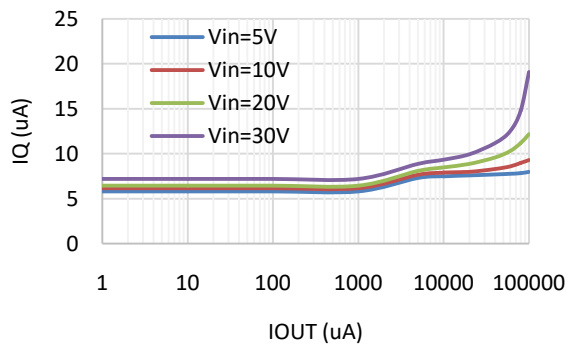
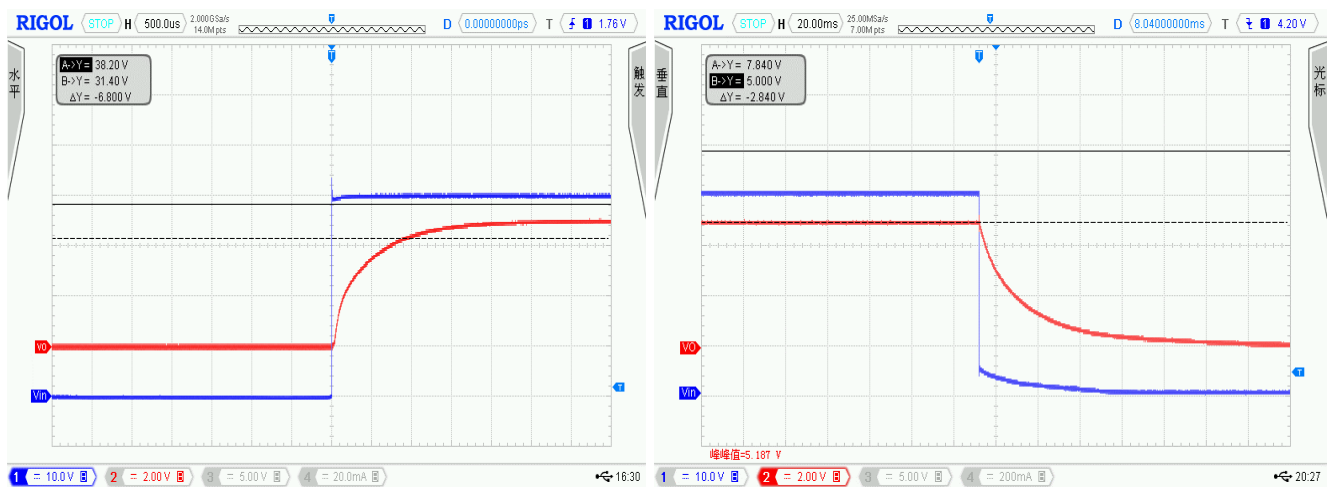


PSRR vs. Frequency



Dropout Voltage vs. Output Current



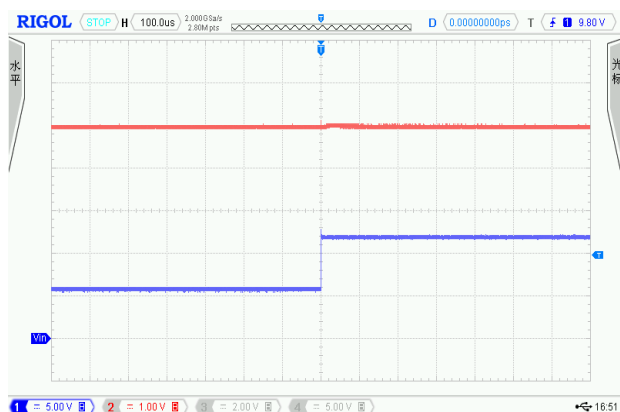
IQ vs. Output current

IQ vs. Temperature

IQ vs. IOU

Power ON/OFF
CH1: V_{IN} CH2: V_{OUT}
 $V_{IN}=40V$ $I_{OUT}=1mA$ $V_{OUT}=5V$


Line Transient

CH1: V_{IN} CH2: V_{OUT}

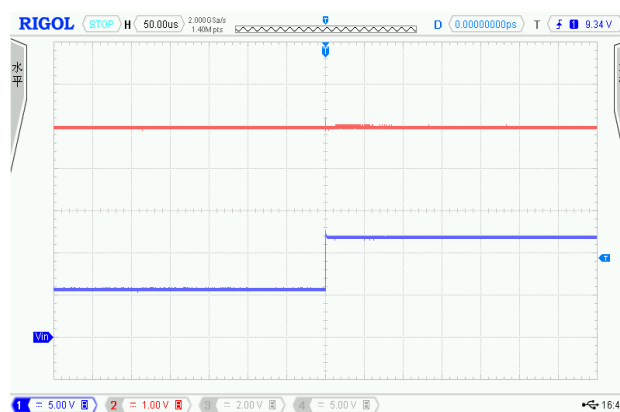
$V_{IN}=6V-12V$ $I_{OUT}=1mA$

$V_{OUT}=5V$



$V_{IN}=6V-12V$ $I_{OUT}=10mA$

$V_{OUT}=5V$



APPLICATION INFORMATION

INPUT CAPACITOR

An input capacitor of $10\mu F$ is required between the V_{IN} and GND pin. The capacitor shall be placed as close as possible to V_{IN} pin, and the use of electrolytic capacitors is recommended. The tolerance and temperature coefficient must be considered in order to ensure the capacitor work within the operation range over the full range of temperature and operating conditions.

OUTPUT CAPACITOR

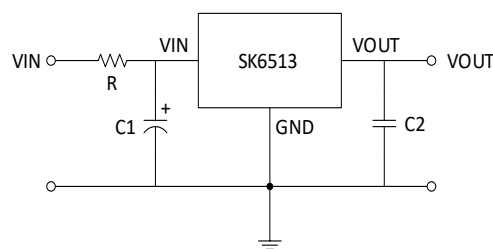
In applications, it is important to select the output capacitor for stable operation. The minimum capacitance for stable and correct operation is $1\mu F$. The capacitance tolerance should be $\pm 30\%$ or better over the operation temperature range. The recommended capacitor type is MLCC.

NO-LOAD STABILITY

The SK6513 will remain stable and in regulation with no external load. This is especially important in CMOS RAM keep-alive applications.

TYPICAL CIRCUIT

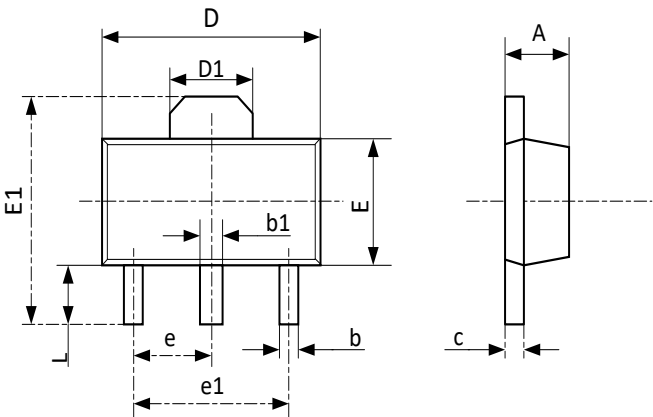
The following figure shows a typical application circuit for the SK6513 devices. The value of external components shall be chosen carefully, depending on the application. In plugging application, because the overshoot caused by the insertion and withdrawal of power on the chip may damage the chip, it is recommended that V_{IN} be less than 30V and the input voltage spike should not exceed 45V.



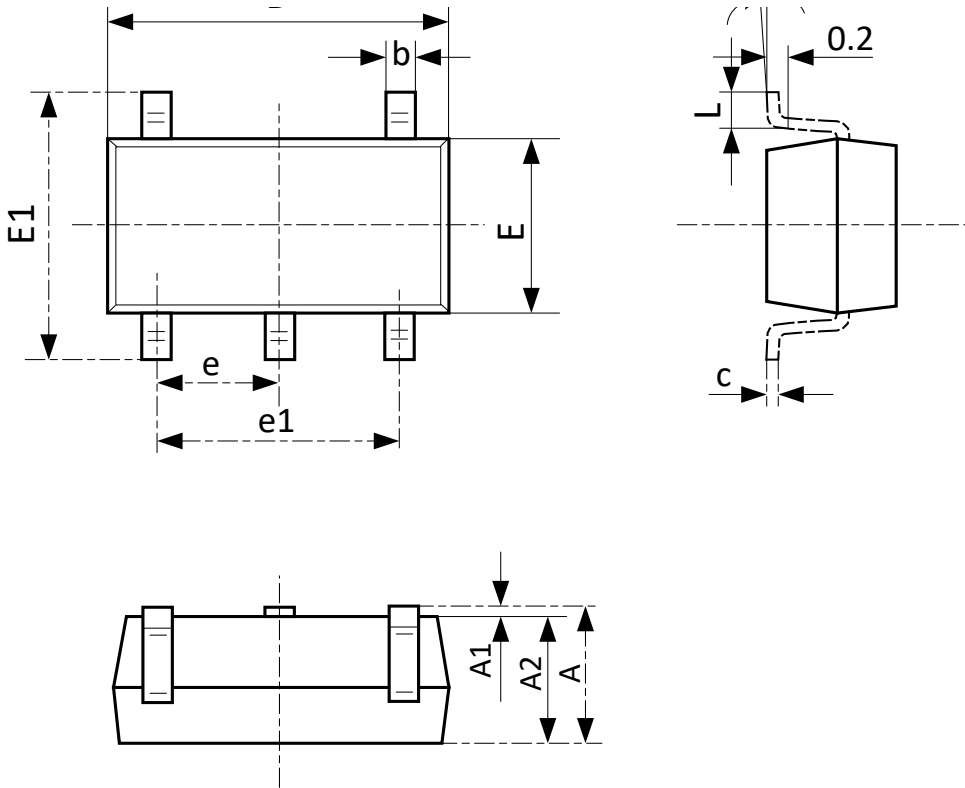
In plugging application, it is suggested that R, C1 are selected as following:

1. $C1=10\mu F \sim 100\mu F$ electrolytic capacitor with maximum voltage greater than 50V, $R=0$
2. $C1=1\mu F \sim 10\mu F$ MLCC with maximum voltage greater than 50V and $R=2\Omega$ in the type of 1206 - the resistor shall be carefully chosen to make sure enough margin to sustain the surge current during plugging.

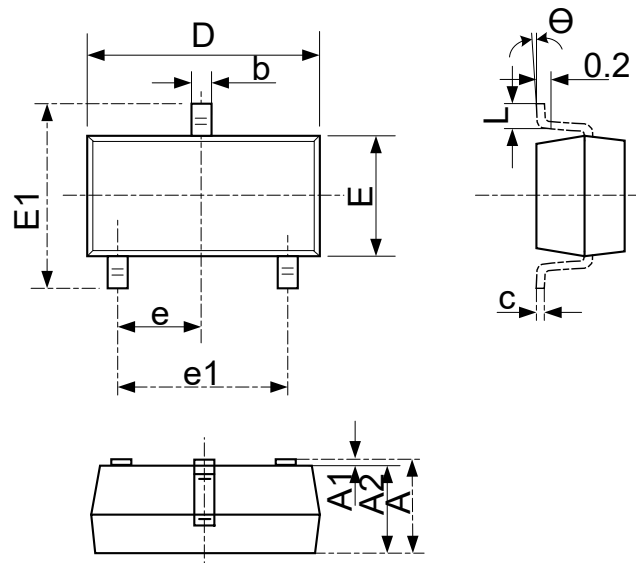
PACKAGE OUTLINE

| Package | SOT89-3L | Devices per reel | 1000PCS | Unit | mm |
|--|---------------------------|------------------|----------------------|-------|----|
| Package Dimension: | | | | | |
|  | | | | | |
| Symbol | Dimensions In Millimeters | | Dimensions In Inches | | |
| | Min | Max | Min | Max | |
| A | 1.400 | 1.600 | 0.055 | 0.063 | |
| b | 0.320 | 0.520 | 0.013 | 0.020 | |
| b1 | 0.400 | 0.580 | 0.016 | 0.023 | |
| c | 0.350 | 0.440 | 0.014 | 0.017 | |
| D | 4.400 | 4.600 | 0.173 | 0.181 | |
| D1 | 1.550 REF | | 0.061 REF | | |
| E | 2.300 | 2.600 | 0.091 | 0.102 | |
| E1 | 3.940 | 4.250 | 0.155 | 0.167 | |
| e | 1.500 TYP | | 0.060 TYP | | |
| e1 | 3.000 TYP | | 0.118 TYP | | |
| L | 0.900 | 1.200 | 0.035 | 0.047 | |

PACKAGE OUTLINE

| Package | SOT23-5L | Devices per reel | 3000PCS | Unit | mm |
|---|---------------------------|------------------|----------------------|-------|----|
| Package Dimension: | | | | | |
|  | | | | | |
| Symbol | Dimensions In Millimeters | | Dimensions In Inches | | |
| | Min | Max | Min | Max | |
| A | 1.050 | 1.250 | 0.041 | 0.049 | |
| A1 | 0.000 | 0.100 | 0.000 | 0.004 | |
| A2 | 1.050 | 1.150 | 0.041 | 0.045 | |
| b | 0.300 | 0.500 | 0.012 | 0.020 | |
| c | 0.100 | 0.200 | 0.004 | 0.008 | |
| D | 2.820 | 3.020 | 0.111 | 0.119 | |
| E | 1.500 | 1.700 | 0.059 | 0.067 | |
| E1 | 2.650 | 2.950 | 0.104 | 0.116 | |
| e | 0.950(BSC) | | 0.037(BSC) | | |
| e1 | 1.800 | 2.000 | 0.071 | 0.079 | |
| L | 0.300 | 0.600 | 0.012 | 0.024 | |
| θ | 0°C | 8°C | 0°C | 8°C | |

PACKAGE OUTLINE

| Package | SOT23-3L | Devices per reel | 3000PCS | Unit | mm |
|---|---------------------------|------------------|----------------------|-------|----|
| Package Dimension: | | | | | |
|  | | | | | |
| Symbol | Dimensions In Millimeters | | Dimensions In Inches | | |
| | Min | Max | Min | Max | |
| A | 1.050 | 1.250 | 0.041 | 0.049 | |
| A1 | 0.000 | 0.100 | 0.000 | 0.004 | |
| A2 | 1.050 | 1.150 | 0.041 | 0.045 | |
| b | 0.300 | 0.500 | 0.012 | 0.020 | |
| c | 0.100 | 0.200 | 0.004 | 0.008 | |
| D | 2.820 | 3.020 | 0.111 | 0.119 | |
| E | 1.500 | 1.700 | 0.059 | 0.067 | |
| E1 | 2.650 | 2.950 | 0.104 | 0.116 | |
| e | 0.950(BSC) | | 0.037(BSC) | | |
| e1 | 1.800 | 2.000 | 0.071 | 0.079 | |
| L | 0.300 | 0.600 | 0.012 | 0.024 | |
| θ | 0°C | 8°C | 0°C | 8°C | |