## Description

The CL9093 is a CMOS linear regulator that features low quiescent current, low output voltage noise, low dropout voltage and fast transient response. It guarantees delivery of 300mA output current, and it is available in adjustable output voltage from 0.8V to 4.6V.

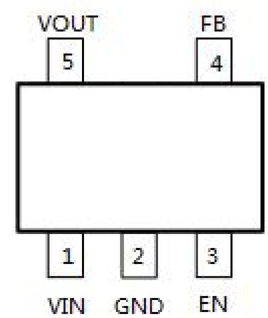
Based on its low quiescent current consumption and its less than 1μA shutdown mode, the CL9093 is ideal for battery- powered applications. The high power supply rejection ratio of the CL9093 holds well for low input voltages typically encountered in battery-operated systems. The regulator is stable with small ceramic captive loads (1μF typical).

## Features

- 300mA output current
- Adjustable output voltage range: 0.8V to 4.6V
- ±2% voltage initial accuracy
- Operating input voltage range: 2V to 6V
- Ultra low dropout voltage: 190mV @ 300mA
- Low quiescent current: 40μA
- <1μA shutdown current
- Short-circuit protection
- Over-temperature protection

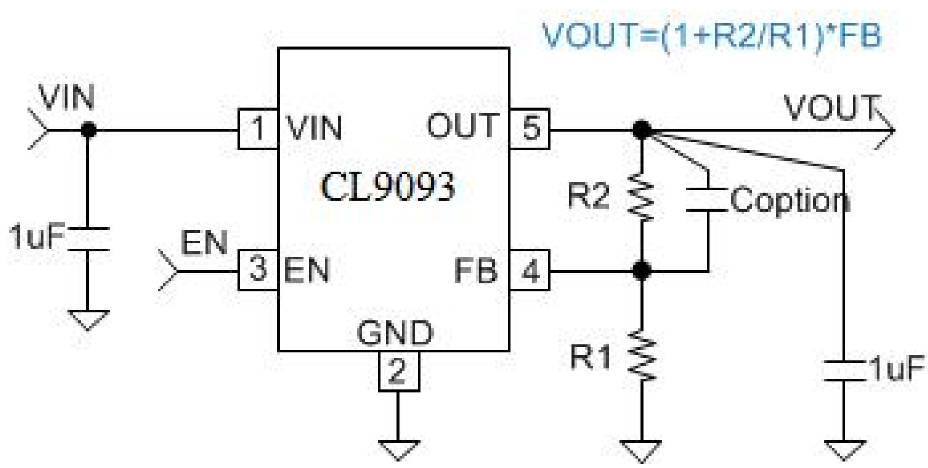
## Applications

- CDMA / GSM
- Portable communication equipment
- Camera modules
- Battery Powered Systems
- Portable Device

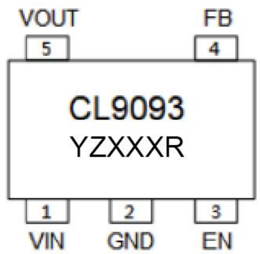



Package Type : SOT-23-5L

## Typical Application



## Pin Description

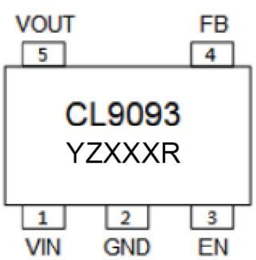



SOT23-5L

## Pin Description

| NO. | NAME | DESCRIPTION |
|---|---|---|
| 1 | VIN | IC power supply. |
| 2 | GND | IC ground. |
| 3 | EN | Enable pin, active high. |
| 4 | FB | Feedback input pin. Feedback voltage is set to be 0.8V. The output voltage can be expressed by the equation: $\mathrm{VOUT} = \frac{0.8\mathrm{V}}{\mathrm{R1}} \times (\mathrm{R1} + \mathrm{R2})$ |
| 5 | VOUT | IC output. |

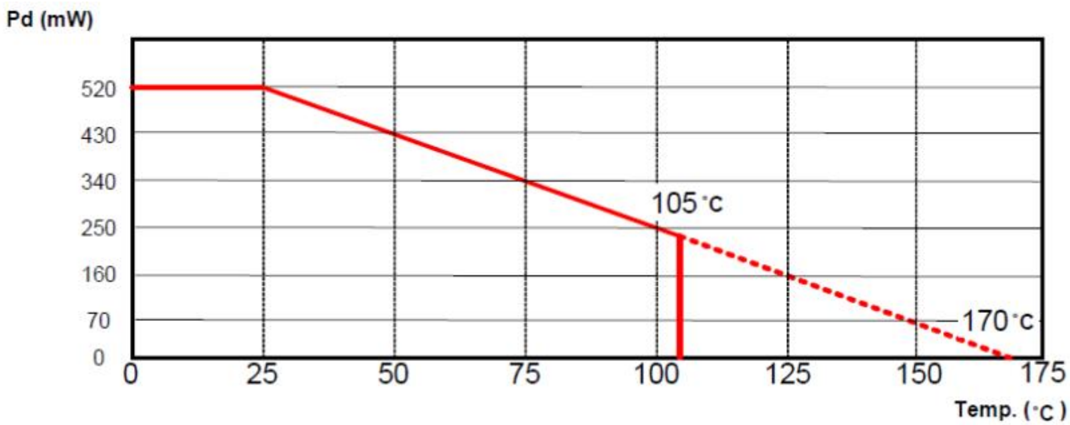
## Marking Information




| PACKAGE | MARKING | MARKING DESCRIPTION |
|---|---|---|
| See left figure | CL9093 | Model |
| | Y | Year |
| | Z | Period |
| | XXX | Batch number |
| | R | Code |

## Absolute Maximum Ratings (Note 1)

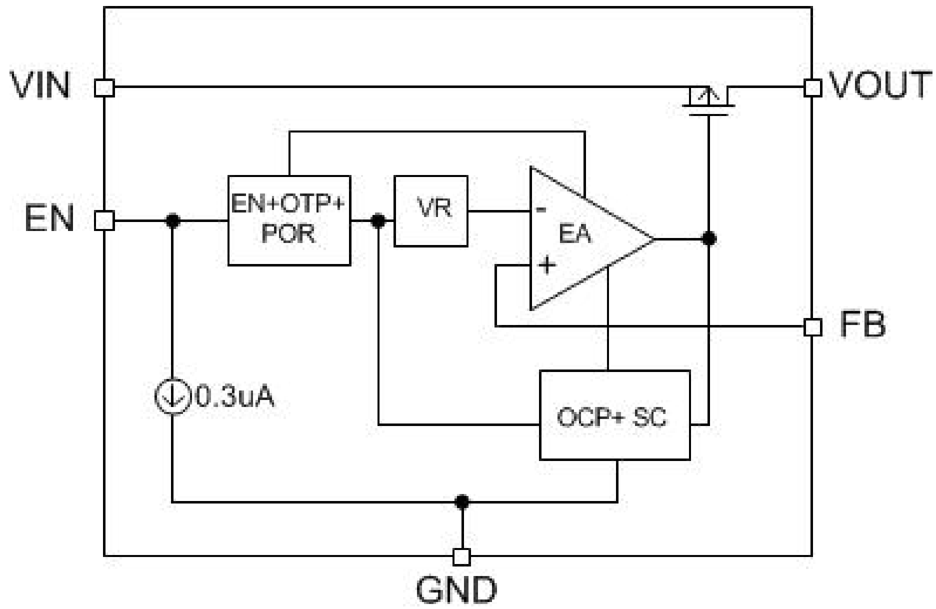
| PARAMETER | SYMBOL | VALUE | UNIT |
|---|---|---|---|
| Supply voltage | $V_{IN}$ | $-0.3 < V_{IN} < 6$ | V |
| Output current | $I_{out}$ | 300 | mA |
| Output voltage | $V_{out}$ | $-0.3 < V_{OUT} < V_{IN}+0.3$ | V |
| EN to GND | $V_{EN}$ | $-0.3 < V_{EN} < 6$ | V |
| Package power dissipation at TA≦25°C | $P_{D\_SOT23-5}$ | 455 | mW |
| Operating temperature | $T_{Opr}$ | -40 to +85 | ℃ |
| Storage temperature | $T_{stg}$ | -55 to +125 | ℃ |
| Soldering temperature<br>Soldering time | $T_{solder}$ | 260, 10s | ℃ |
| ESD (Human Body Model) (Note 2) | $V_{ESD\_HBM}$ | 2000 | V |
| ESD (Machine Model) (Note 2) | $V_{ESD\_MM}$ | 200 | V |




## Recommended Operating Conditions

| PARAMETER | SYMBOL | LIMITS | UNIT |
|---|---|---|---|
| VIN to GND | $V_{IN}$ | 2 to 6 | V |
| Junction temperature | $T_J$ | - 40 to 125 | °C |
| Operating temperature range | $T_A$ | -40 to 85 | °C |

## Functional Block Diagram



## Electrical Characteristics

(Vin=Vout+1V,Cin=Cout=10μF,$T_A$=25℃, unless otherwise specified)

| PARAMETER | SYMBOL | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| Feedback voltage ($V_{FB}$) | $V_{FB}$ | $T_A$ = 25°C | | 0.784 | 0.8 | 0.816 | V |
| FB Input current | $I_{FB}$ | | | | 0 | 1 | μA |
| Supply voltage | $V_{IN}$ | | | 2 | | 6 | V |
| Supply current | $I_{VIN}$ | Unload | | | 40 | | μA |
| Standby current | $I_{STBY}$ | $V_{EN}$ = 0V | | | 0 | 1 | μA |
| Output current(Note 3) | $I_{OUT}$ | | | 300(Note 4) | | | mA |
| Soft-start time | $T_{SS}$ | | | | 50 | | μs |
| EN input voltage high | $V_{ENH}$ | $V_{IN}$ = 5V | | 1.2 | | | V |
| EN input voltage low | $V_{ENL}$ | $V_{IN}$ = 5V | | | | 0.4 | V |
| EN input current | $I_{EN}$ | $V_{EN}$ = $V_{IN}$ = 5V | | | 0.3 | | μA |
| Dropout voltage (Note 5) | $V_{DROP}$ | $V_{OUT}$ = 3.3V | $I_{OUT}$=150mA | | 95 | | mV |
| | | | $I_{OUT}$=300mA | | 190 | | mV |
| Limit current | $I_{lim}$ | | | | 0.5 | | A |
| Short current | $I_{short}$ | $V_{OUT}$ < 0.2V | | | 0.17 | | A |
| Line regulation | $\triangle V_{LNR}$ | $V_{IN}$ = $V_{OUT}$+1V to 5.5V, $I_{OUT}$ = 1mA | | | 0.03 | 0.2 | %/V |
| Load regulation | $\triangle V_{LDR}$ | $V_{IN}$ = $V_{OUT}$+1V, $I_{OUT}$ = 1mA to 300mA | | | 2 | 15 | mV |
| Power supply rejection ratio | PSRR | Freq = 1kHz, $I_{OUT}$ = 30mA | | | 70 | | dB |
| Thermal shutdown temperature | $T_{SD}$ | $T_J$ Rising | | | 155 | | °C |
| Thermal shutdown returned temperature | | | | | 125 | | °C |

**Note 1.** Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

**Note 2.** Devices are ESD sensitive. Handling precaution is recommended.

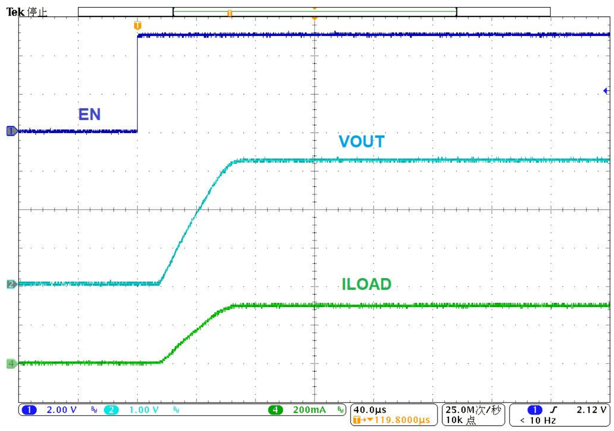
**Note 3.** The output current at which the output voltage becomes 95% of $V_{OUT}$ after gradually increasing the output current.

**Note 4.** The output current can be at least this value. Due to restrictions on the package power dissipation, this value may not be satisfied. Attention should be paid to the power dissipation of the package when the output current is large.
The specification is guaranteed by design.

**Note 5.** The dropout voltage is defined as $V_{IN}$ - $V_{OUT}$, which is measured when $V_{OUT}$ is 98%*$V_{OUT}$.

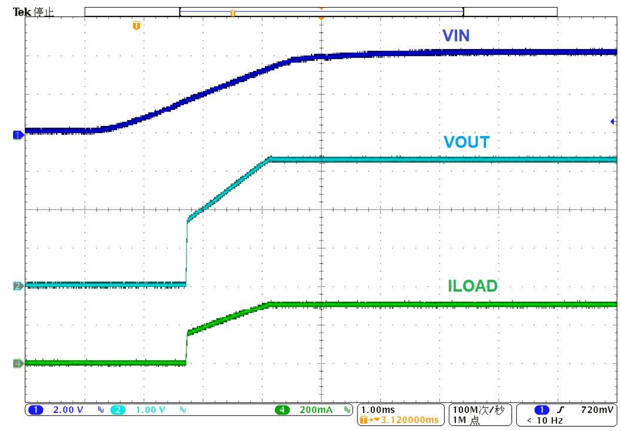
## Typical Characteristics

( $T_A$ = 25°C, $C_{IN}$=1μF, $C_{OUT}$=2.2μF, unless otherwise specified)



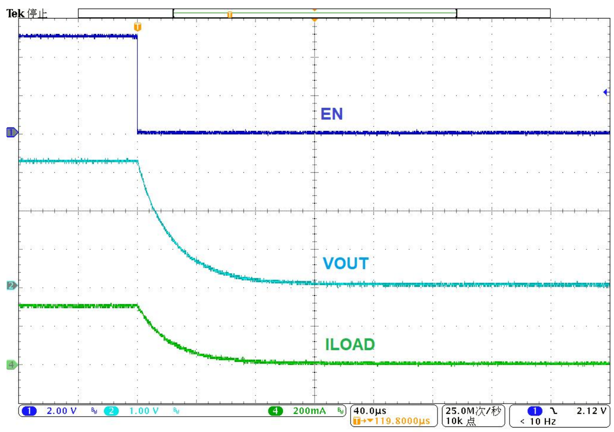

**EN Turn On**

**VIN=4.3V, VOUT=3.3V, ROUT=11ohm**



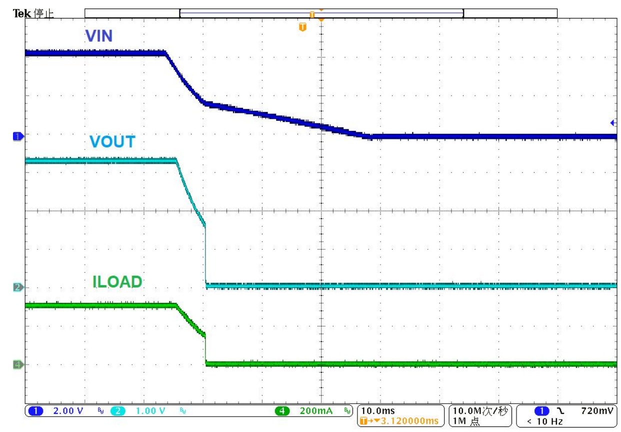

**VIN Power On**

**VIN=4.3V, VOUT=3.3V, ROUT=11ohm**



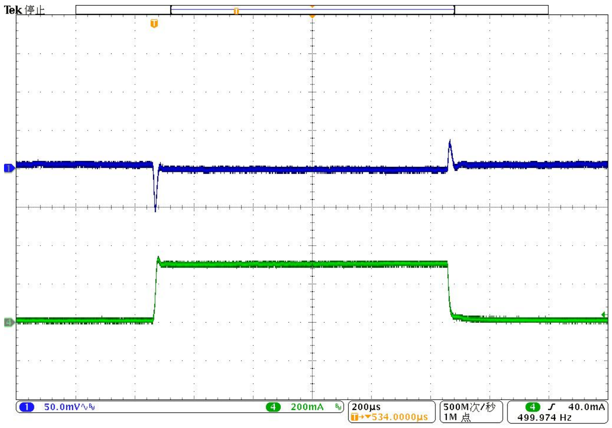

**EN Turn Off**

**VIN=4.3V, VOUT=3.3V, ROUT=11ohm**



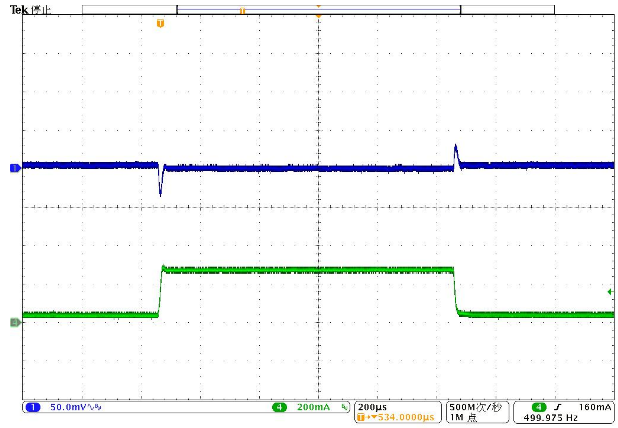

**VIN Power Off**

**VIN=4.3V, VOUT=3.3V, ROUT=11ohm**



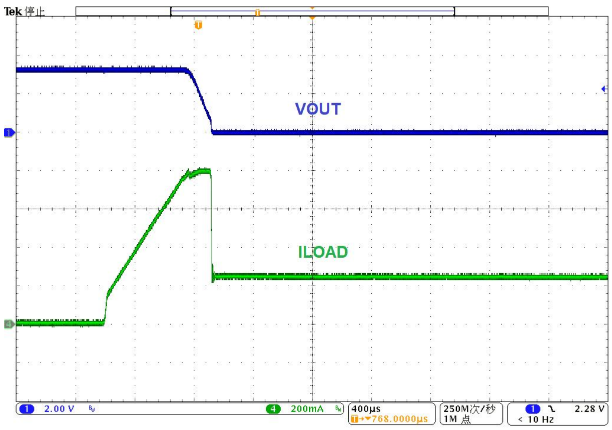
**Load Transient Response**

**VIN=4.3V, VOUT=3.3V, IOUT=0mA-300mA-0mA**



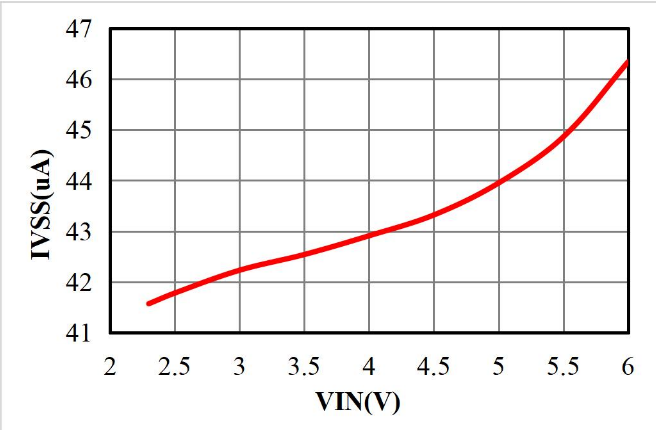
**Load Transient Response**

**VIN=4.3V, VOUT=3.3V, IOUT=30mA-270mA-30mA**



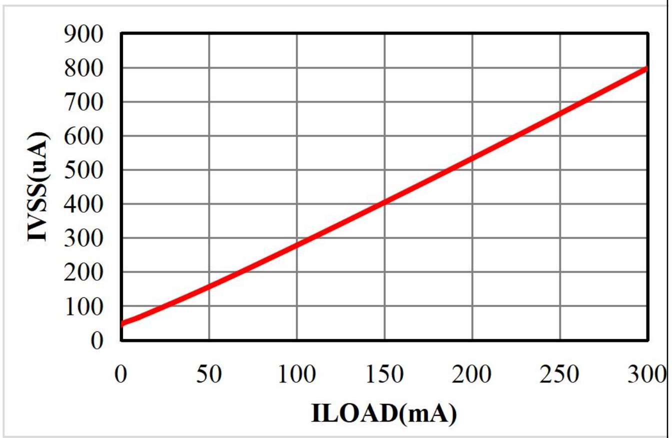

**OCP**

**VIN=4.3V,VOUT=3.3V**



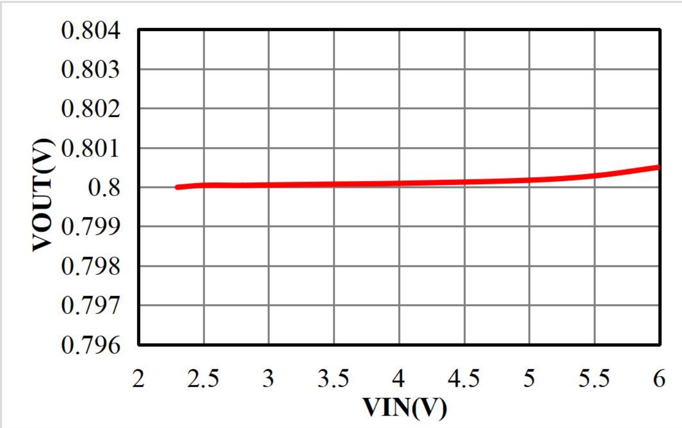

**Quiescent Current vs. Input Voltage**

**VIN=2.3V~6.0V, VOUT=0.8V, ILOAD=0**



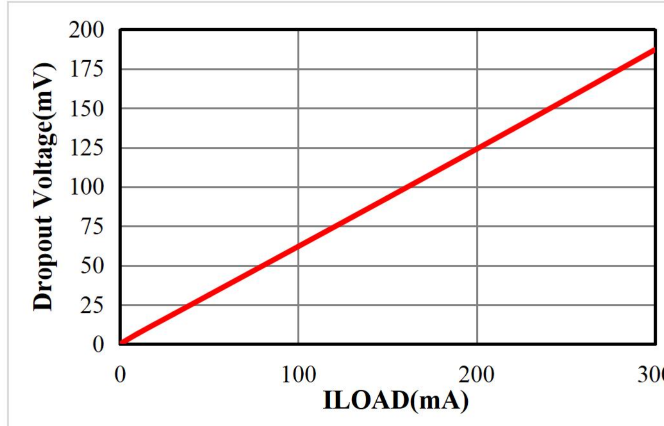

**Quiescent Current vs. Output Current**

**VIN=2.3V, VOUT=0.8V, ILOAD=0mA~300mA**




**Output Voltage vs. Input Voltage**

**VIN=2.3V~6.0V, VOUT=0.8V, ILOAD=1mA**




**Dropout Voltage VS. Output Current**

**VOUT=3.3V ILOAD=0~300mA**

## Application Information

### Input Capacitor

A 1μF input capacitor or greater located as close as possible to the IC is necessary to ensure device stability. This capacitor will provide a low impedance path for unwanted AC signals or noise modulated onto the input voltage. The X7R or X5R capacitor should be used for reliable performance over temperature range.

Place the capacitors physically as close as possible to the device with wide and direct PCB traces. A good input capacitor will limit the influence of input trace inductance and source resistance during load current changes.

### Output Capacitor

The CL9093 is specifically designed to employ ceramic output capacitors as low as 1μF, ceramic X7R or X5R type due to its low capacitance variations over the specified temperature range.

The ceramic output capacitors connected as close as possible to the output and ground pins.

### Foldback Current Limit

The device has an internal current limit circuit that protects the regulator during transient high-load current faults or shorting events. Output current is internally limited to 500mA typical.

The CL9093 will source this current when the output voltage drops down from the nominal output voltage. If the output voltage is less than 0.2V, the short circuit current protection starts and maintains the loading current to 170mA. The current limit and short circuit protection will work properly over the whole temperature and input voltage ranges. There is no limitation for the short circuit duration.

### OTP Protection

A Thermal shutdown protection circuit disables the CL9093 when the junction temperature of the pass transistor rises to 155°C (typical). Thermal shutdown hysteresis assures that the device resets (turns on) when the temperature falls to 125°C (typical).

The thermal shutdown feature provides the protection against overheating due to some application failure and it is not intended to be used as a normal working function.

### Enable

The LDO uses the EN pin to enable its operation. If the EN pin voltage is < 0.4 V, the regulator will be turned off, reducing the supply current to less than 1μA. If the EN pin voltage is > 1.2 V, the regulator will be turned on. The EN pin has internal pull−down current source with value of 0.3μA (typical), which assures the device is turned off when the EN pin is unconnected.

### Power Dissipation

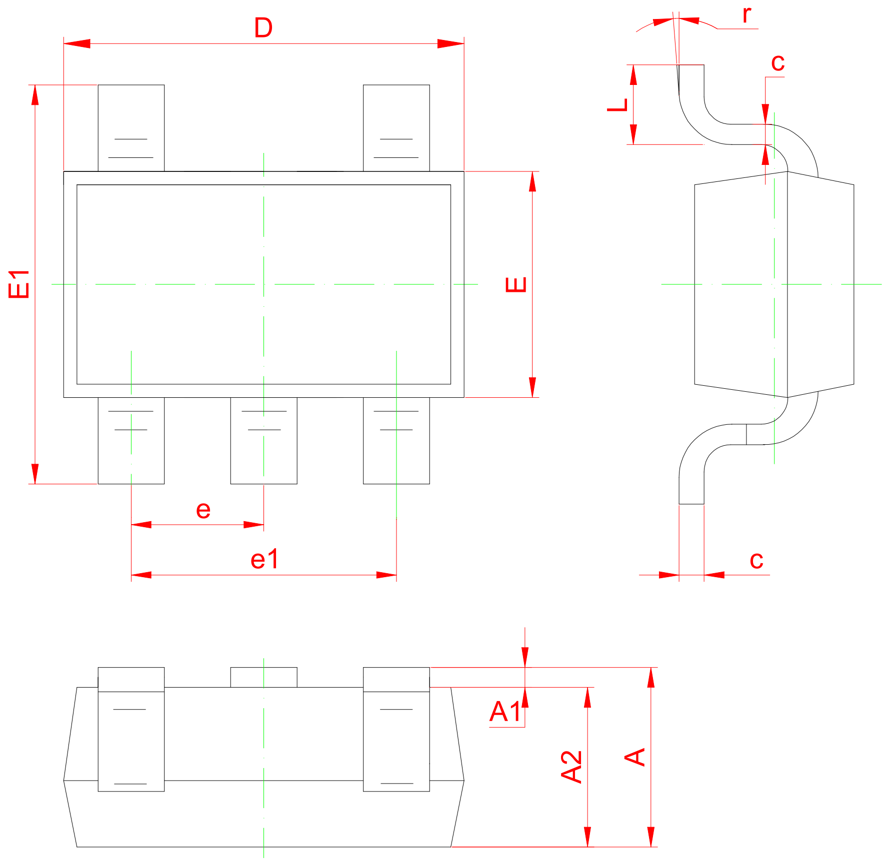
Power dissipation caused by voltage drop across the LDO and by the output current flowing through the device needs to be dissipated out from the chip. The maximum power dissipation is dependent on the PCB layout, number of used Cu layers, Cu layers thickness and the ambient temperature.

Power dissipation in the regulator depends on the input-to-output voltage difference and load conditions.

$$PD = (V_{IN} - V_{OUT}) \times I_{OUT}$$

Power dissipation can be minimized, and thus greater efficiency achieved, by proper selection of the system voltage rails.To avoid thermally overloading the CL9093, refrain from exceeding the absolute maximum junction temperature rating of 155°C under continuous operating condition. Over-stressing the regulator with high loading currents and elevated input-to-output differential voltages can increase the IC die temperature significantly.

## Package Information: SOT23-5L




| 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 |
| r | 0º | 8º | 0º | 8º |

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