

## 120mA Negative Voltage Linear Regulator

REV: 00

### General Description

The LD6904 is a negative voltage, micropower linear regulator. It features wide input voltage, low-noise, low-dropout and low-quiescent current. The precision of feedback reference voltage is within  $\pm 1.5\%$  and output current reaches up to 120mA. The built-in output current limiting and thermal shutdown protection could prevent from fault conditions.

The LD6904 is available in a space saving SOT23-6 or SC70-6 package.

### Features

- $\pm 1.5\%$  feedback reference
- Shutdown current  $< 1\mu\text{A}$
- Negative voltage down to  $-11\text{V}$
- Thermal shutdown and current limit
- $V_{\text{OUT}}$  discharge function
- Soft start operation

### Applications

- Microcontroller Power
- Hand-Held Instruments

### Typical Application

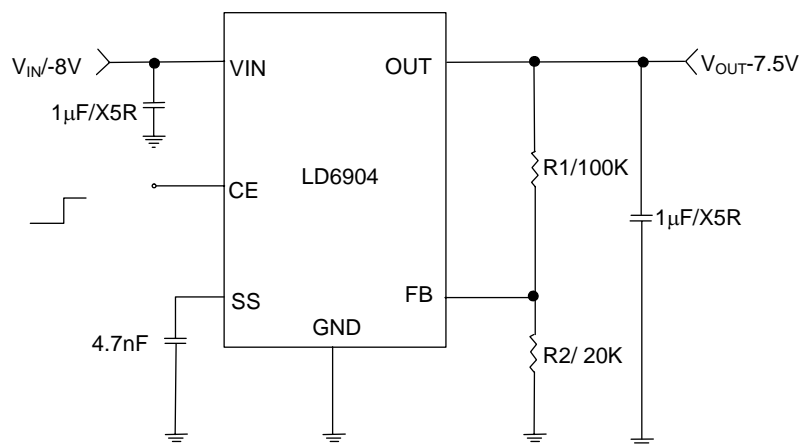
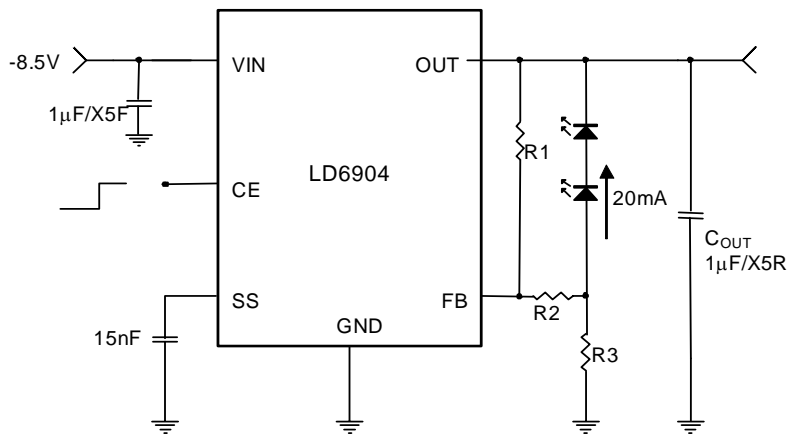


Fig.1 Negative voltage linear regulator application

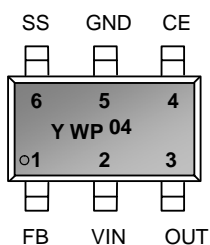


2WLED	
R1	62K
R2	3.24K
R3	47.5Ω

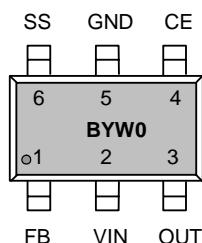
Fig.2 WLED driver application

## Pin Configuration

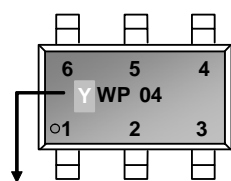
SOT-26 (TOP VIEW)



SC70-6 (TOP VIEW)



B : Product Code (A: LD6904)  
 Y : Year code (E: 2005, F: 2006...)  
 W : Week code  
 0 : Voltage code (0: adjustable)



The PB freed package is identified in embossed font

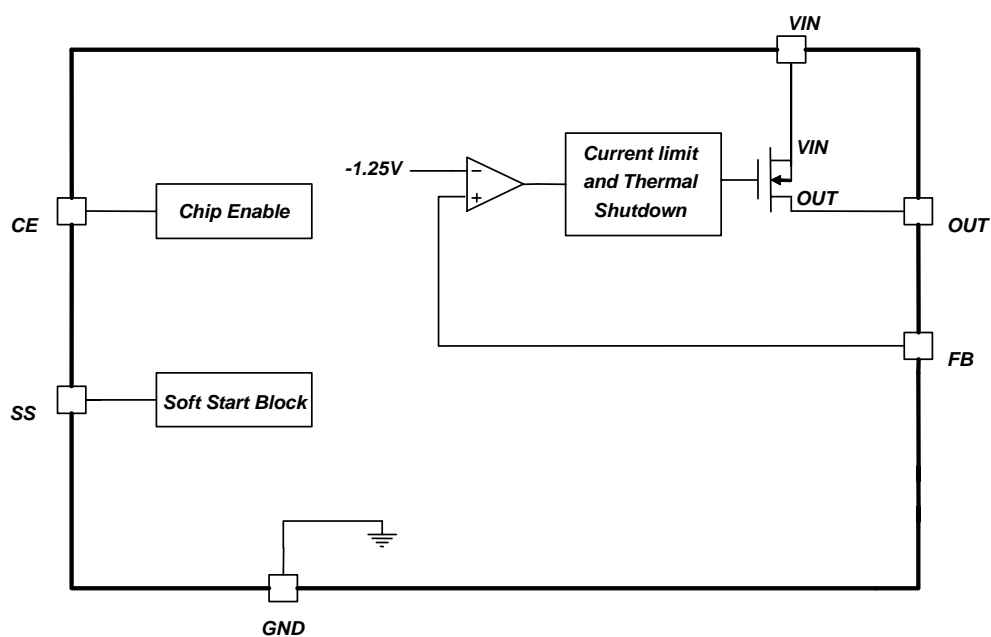
YY, Y : Year code (D: 2004, E: 2005.....)  
 WW, W: Week code  
 P : LD69.  
 (Product family code)  
 ## : Production code

## Ordering Information

Part number	Package	TOP MARK	Shipping
LD6904 PL	SOT-26 (PB FREE)	YWP/04	3000 /tape & reel
LD6904 GL	SOT-26 (Green Compound)	YWP/04	3000 /tape & reel
LD6904 PU	SC70 (PB FREE)	BYW0	3000 /tape & reel
LD6904 GU	SC70 (Green Compound)	BYW0	3000 /tape & reel

**Pin Descriptions**

PIN	NAME	FUNCTION
1	FB	Output Feedback
2	VIN	Input Voltage
3	OUT	Regulator Output
4	CE	Chip Enable, High=Enable, Low=Disable Note that this pin is high impedance. There should be a pull low resistor connected to GND, when this pin is floating.
5	GND	IC GND
6	SS	This pin combines noise reduction and soft start function. Connect a capacitor to GND to adjust soft start time. $C_{ss} > 1\text{nF}$ is recommended.

**Block Diagram**


**Absolute Maximum Ratings**

VIN and FB Pin.....	-12V~+0.3V
OUT Pin.....	VIN-0.3V~ +0.3V
CE, Pin.....	-0.3V~ 5V
SS, Pin.....	-5V~0.3V
Power dissipation @Ta=25°C.....	300mW
Operating Temperature Range.....	-30°C to 85°C
Operating Junction Temperature.....	125°C
Storage Temperature Range.....	-55°C to 125°C
Package Thermal Resistance SOT23-6.....	250°C/W
Package Thermal Resistance SC70-6.....	333°C/W
Lead temperature (SC70-6, Soldering, 10sec).....	260°C
ESD Level (Human Body Model).....	2KV
ESD Level (Machine Model).....	200V

**Caution:**

Stresses beyond the ratings specified in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

**Electrical Characteristics**

( $T_A = +25^\circ\text{C}$  unless otherwise stated,  $V_{IN} = -10\text{V}$ ,  $C_E = 3.3\text{V}$ ,  $I_{LOAD} = 5\mu\text{A}$ ,  $C_{IN} = 1\mu\text{F}$ ,  $C_{OUT} = 1\mu\text{F}$ )

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
<b>INPUT POWER</b>					
Input Voltage		-11	-	-5	V
Nominal Supply Current	$C_E = 3.3\text{V}$	-	70	100	$\mu\text{A}$
Shutdown Supply Current	$C_E = \text{GND}$	-		1	$\mu\text{A}$
<b>REFERENCE VOLTAGE</b>					
Feedback Reference	$\text{FB} = \text{OUT}$ $V_{IN} = -6\text{V to } -11\text{V}$ , $I_{LOAD} = 1\text{mA}$		-1.25		V
Reference Voltage Tolerance		-1.5		+1.5	%
Feedback Input Current	$V_{FB} = -1.3\text{V}$		10		nA
<b>OUTPUT</b>					
Output Current Limit	$V_{IN} = -8\text{V}$	120	150	-	mA
Load Regulation	$I_{LOAD} = 1\text{mA to } 120\text{mA}$			0.8	%
Output Reverse Leakage Current	$V_{in} = \text{unconnected}$ , Out set to -5V		50		$\mu\text{A}$
Dropout Voltage	$I_{LOAD} = 60\text{mA}$		0.15	0.25	V
Ripple Rejection	$F = 120\text{Hz}$ , $e_{in} = 1\text{Vrms}$ , $i_{out} = 10\text{mA}$	-	60		dB
	$F = 10\text{KHz}$ , $e_{in} = 1\text{Vrms}$ , $i_{out} = 10\text{mA}$	-	50		dB
Discharge Current	$C_E = \text{High to Low}$	-	60		mA
<b>Soft Start</b>					
Soft Start Current		-	3	-	$\mu\text{A}$
<b>CE</b>					
CE Input Current	$C_E = 3.3\text{V}$		-	10	$\mu\text{A}$
CE Input Level	Enable	2.0	-	-	V
	Disable	-	-	0.6	V
<b>THERMAL PROTECTION</b>					
Thermal Protection	$V_{OUT}$ short to GND		145		$^\circ\text{C}$
Hysteresis			30		$^\circ\text{C}$

## Typical Performance Characteristics

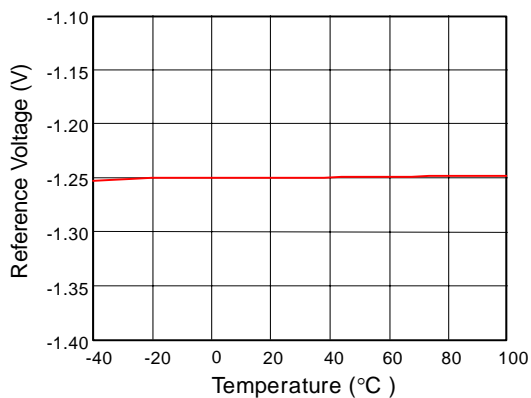


Fig. 1 Reference voltage vs. Temperature

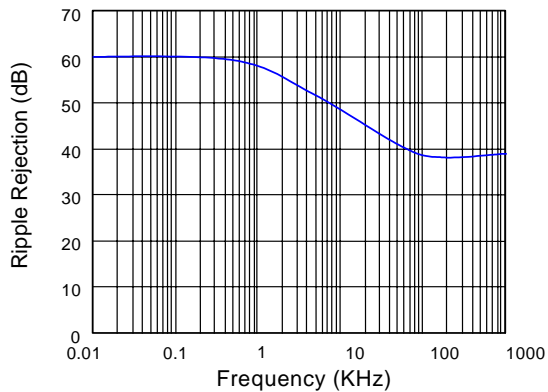


Fig. 2 Ripple Rejection vs. frequency

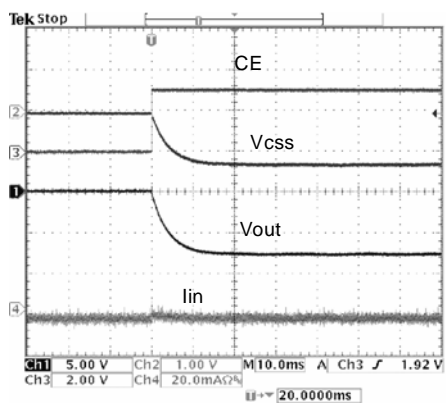


Fig. 3 Start Up Waveform  $C_{SS}=10nF$

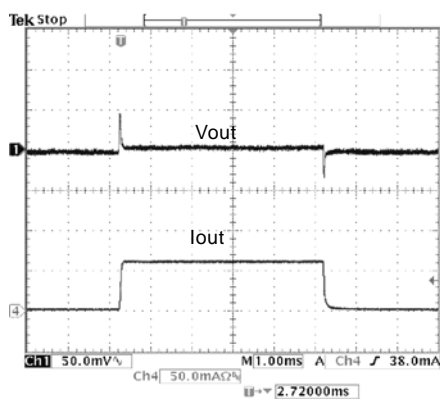


Fig. 4 Load Transient Response

## Application Information

### Capacitor Selection

An input capacitor is necessary to place between the input and GND to stabilize  $V_{IN}$ . The input capacitor should be at least  $1\mu\text{F}$  to obtain beneficial effect. Higher values will improve more line transient response.

The LD6904 requires an output capacitor to stabilize the internal control loop. For the application of  $V_{OUT} < -5\text{V}$ , the output capacitor should be at least  $1\mu\text{F}$  with ESR less than  $1\Omega$ . In the range of  $V_{OUT} = -1.25\text{V} \sim -5\text{V}$ , it's necessary to choose a capacitor at least  $2.2\mu\text{F}$  and with ESR less than  $1\Omega$ . Higher output capacitor values can improve the load transient response, stability and PSRR. The output capacitor should not be located far away than 5mm from the OUT pin.

It's recommended to use those types of X5R or X7R capacitors for input and output capacitors.

### Current Limit

The output current is limited at 150mA (typical). When current limit engages, the output voltage scales back linearly until the overcurrent condition ends. Beware not to exceed the power dissipation ratings of the package.

### Thermal Consideration

When the junction temperature exceeds  $T_J = 145^\circ\text{C}$ , the thermal sensor will turn off the pass transistor and allow the IC to cool down. The thermal sensor turns the pass transistor on after the IC's junction temperature is cooled down by  $30^\circ\text{C}$  (typical). For continue operation, do not exceed absolute maximum operation junction temperature

$T_J = 125^\circ\text{C}$ . The maximum power dissipation depends on the thermal resistance of IC package, PCB layout, airflow and  $P_{D(\text{MAX})} = (T_{J(\text{MAX})} - T_A) / \theta_{JA}$  temperature difference between junctions to ambient.

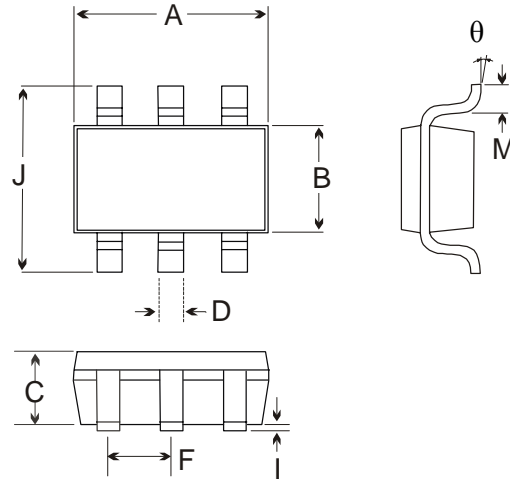
$\theta_{JA}$ : Package Thermal Resistance

Ex: the maximum power dissipation at  $T_a = 25^\circ\text{C}$  can be obtained by the following formula.

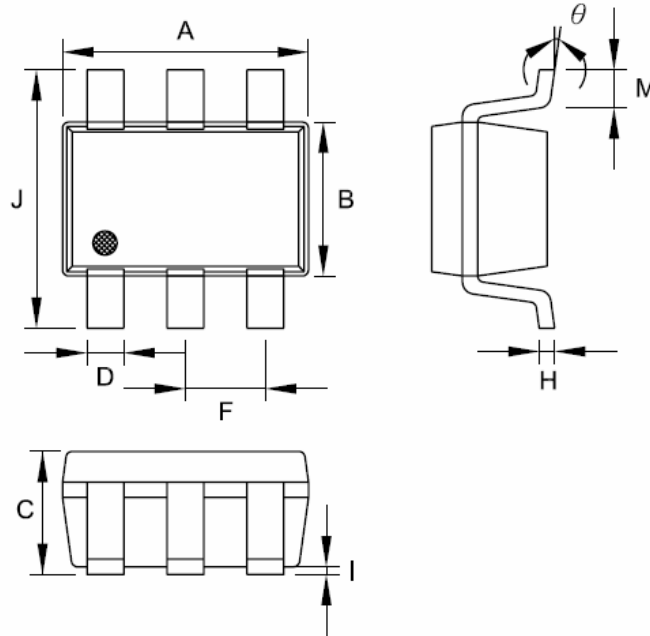
$$P_{D(\text{MAX})} = (125^\circ\text{C} - 25^\circ\text{C}) / 250 = 400\text{mW} \text{ (SOT23-6 package)}$$

$$P_{D(\text{MAX})} = (125^\circ\text{C} - 25^\circ\text{C}) / 333 = 300\text{mW} \text{ (SC70-6 package)}$$



**Package Information**
**SOT-26**


Symbol	Dimension in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	2.692	3.099	0.106	0.122
B	1.397	1.803	0.055	0.071
C	-----	1.450	-----	0.058
D	0.300	0.550	0.012	0.022
F	0.838	1.041	0.033	0.041
I	0.050	0.150	0.002	0.006
J	2.600	3.000	0.102	0.118
M	0.300	0.600	0.012	0.024
θ	0	10°	0	10°

**SC70-6**


Symbol	Dimension in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.80	2.20	0.071	0.087
B	1.15	1.35	0.045	0.053
C	0.80	1.10	0.031	0.043
D	0.15	0.40	0.006	0.016
F	0.65 TYP.		0.026 TYP.	
H	0.08	0.25	0.003	0.010
I	0.00	0.10	0.000	0.004
J	1.80	2.40	0.071	0.094
M	0.10	0.46	0.004	0.018
$\theta$	0°	12°	0°	12°

**Important Notice**

Leadtrend Technology Corp. reserves the right to make changes or corrections to its products at any time without notice. Customers should verify the datasheets are current and complete before placing order.

**Revision History**

Rev.	Date	Change Notice
00	6/5/06	Original Specification.