

## Rail Current Measurement IC



### General Description

The FP355 is a wide common mode range high side rail current measurement IC. It is suitable for power systems like battery charger or switching power supply applications. It includes a differential input amplifier and an NPN transistor with emitter output. With three external resistors, the rail current signal can be easily converted into an amplified voltage signal at the IC output pin. Also, the gain can be adjusted by changing the three external resistors values.

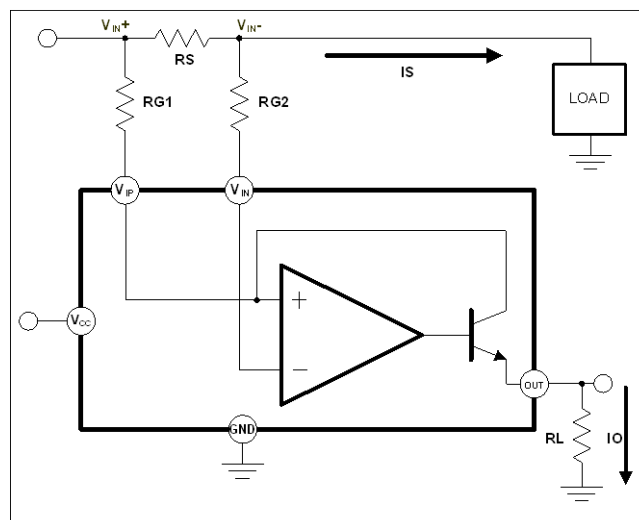
### Features

- Independent Power Supply Voltage: 2.7 to 28V
- Wide Input Common-Mode Voltage: 2.7 to 28V
- Source Current Emitter Output
- Three Resistors Gain Set-up
- Wide Temperature Range: -20°C to +125°C
- Package: SOT23-5L

### Applications

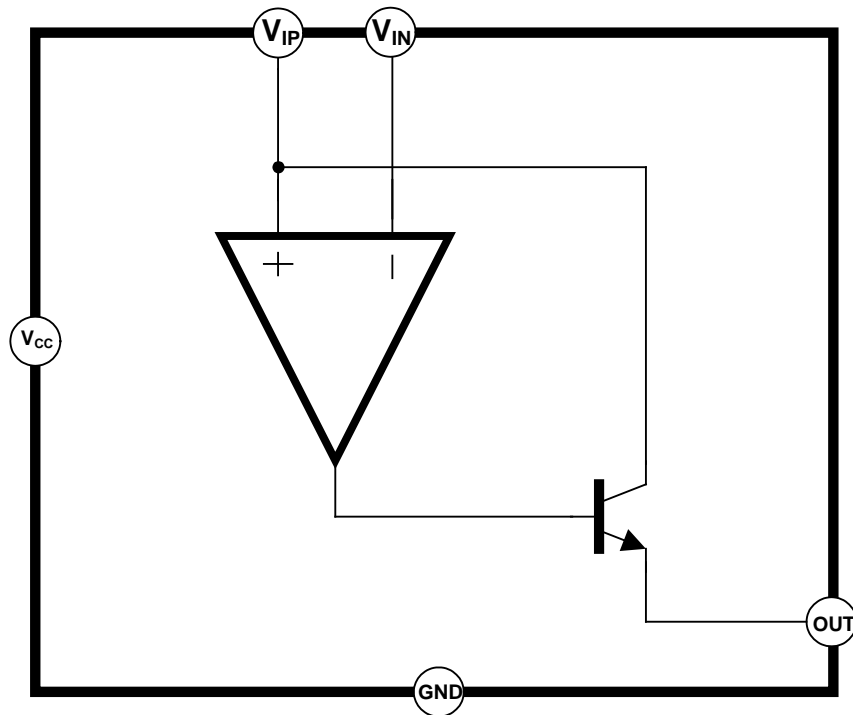
- Battery Charger
- High Side Rail Current Detector
- SPS (Adaptor)
- Current Sense Networking System

### Typical Application Circuit



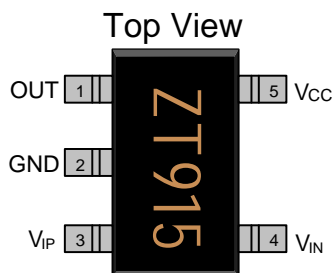
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## Function Block Diagram



## Pin Descriptions

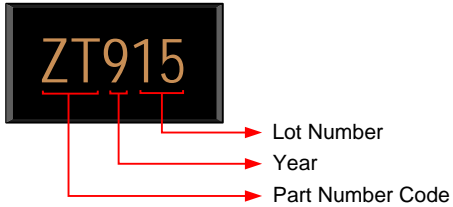
### SOT23-5L



Name	No.	I / O	Description
OUT	1	O	Current Detect Output
GND	2	P	IC Ground
V <sub>IP</sub>	3	I	Positive Input of Differential OPA
V <sub>IN</sub>	4	I	Negative Input of Differential OPA
V <sub>CC</sub>	5	P	IC Power Supply

## Marking Information

### SOT23-5L



**Lot Number:** Wafer lot number's last two digits

For Example: 1323~~86~~TB → 86

**Year:** Production year's last digit

**Part Number Code:** Part number identification code for this product. It should be always "ZT".

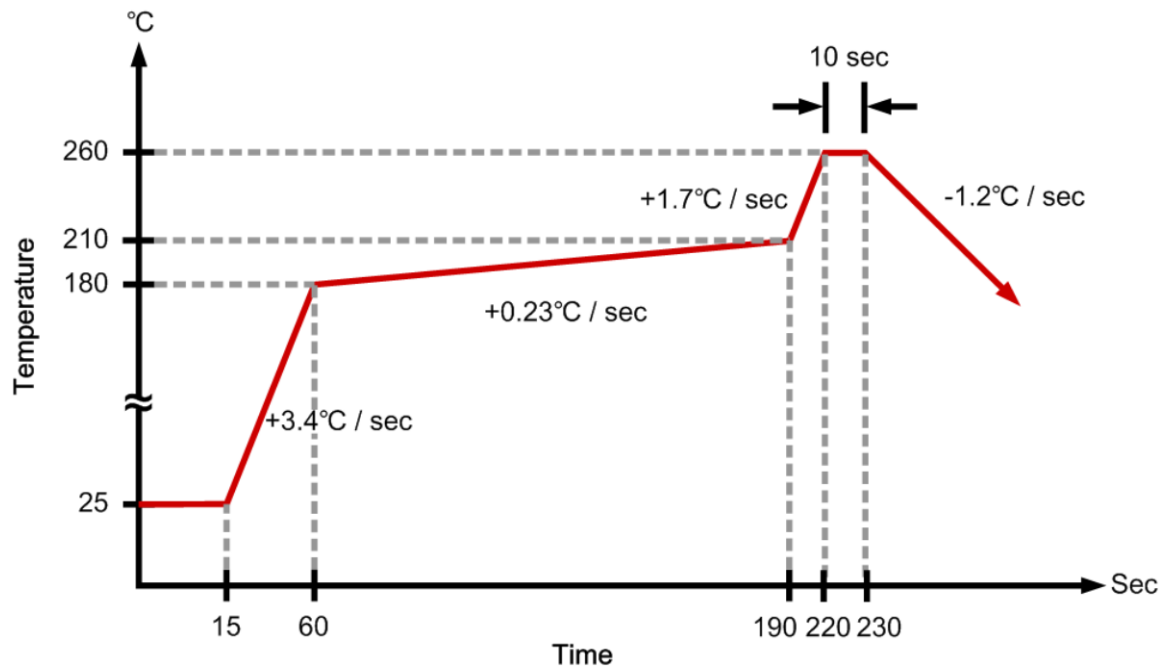
## Ordering Information

Part Number	Operating Temperature	Package	MOQ	Description
FP355KR-G1	-20°C ~ +125°C	SOT23-5L	3000EA	Tape & Reel

## Absolute Maximum Ratings

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply Voltage	$V_{CC}$		-0.3		28	V
Common Mode Inputs Voltage	$V_i$		-0.3		28	V
Differential Inputs Voltage ( $V_{IP} - V_{IN}$ )			-30		1.5	V
OUT Voltage			-0.3		28	V
Operating Temperature			-20		+125	°C
Storage Temperature			-55		+150	°C
Junction Temperature	$T_J$				+150	°C
Allowable Power Dissipation		$T_A=25^\circ\text{C}$			220	mW
Junction to Ambient Thermal Resistance	$\theta_{JA}$				+250	°C / W
Junction to Case Thermal Resistance	$\theta_{JC}$				+150	°C / W
SOT25 Lead Temperature (soldering, 10 sec)					+260	°C

## IR Re-flow Soldering Curve



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## Recommended Operating Conditions

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply Voltage	$V_{CC}$		2.7		28	V
Operating Temperature			-20		+125	°C

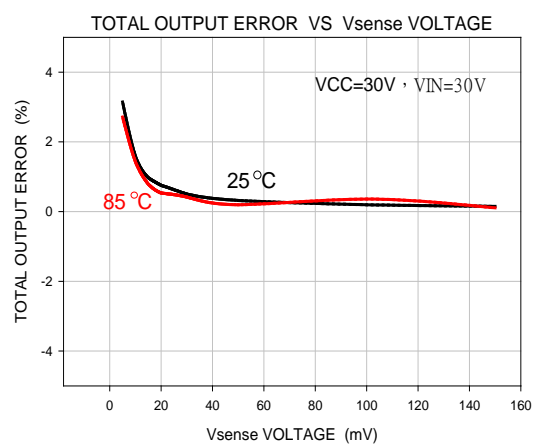
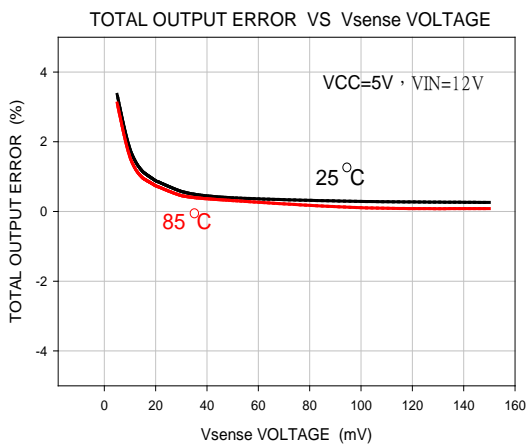
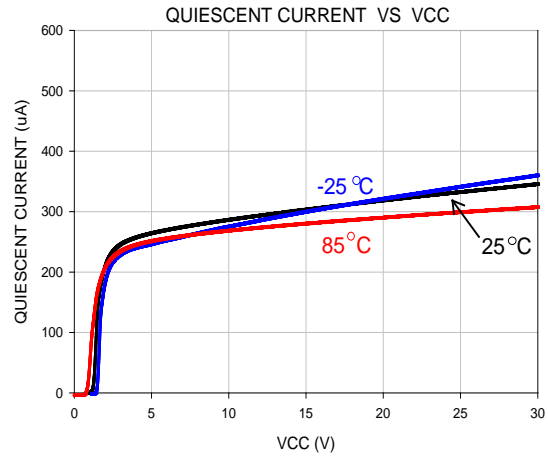
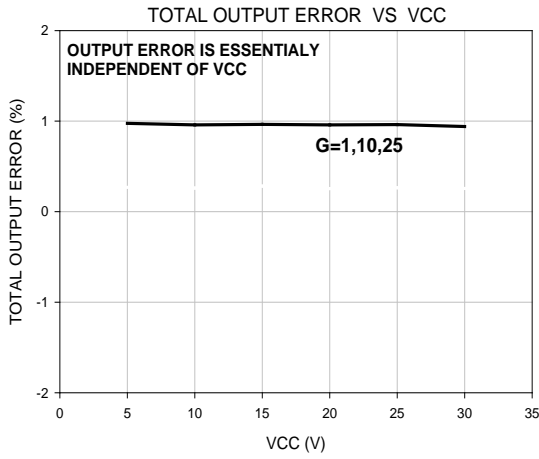
## DC Electrical Characteristics

( $V_{CC}=5V$ ,  $V_{IN}^+=12V$ ,  $R_{OUT}=125K\Omega$ ,  $T_A=-20^{\circ}C\sim 125^{\circ}C$ , unless otherwise noted)

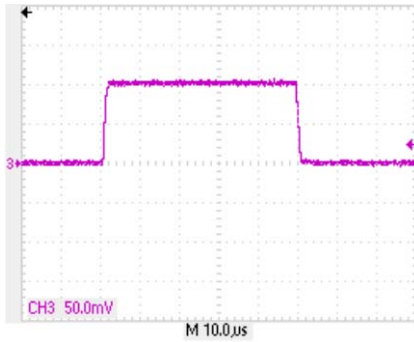
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Full Scale Sense Voltage	$V_{SENSE}$	$V_{SENSE}=V_{IN}^+ - V_{IN}^-$		100	500	mV
Common-Mode Input Voltage	$V_{CM}$		2.7		28	V
Common-Mode Rejection	CMRR	$V_{IN}^+=2.7V$ to 28V, $V_{SENSE}=50mV$	100	120		dB
Input Offset Voltage vs temp	$V_{OFFSET(TA)}$	$T_{MIN}$ to $T_{MAX}$		4		$\mu V / ^{\circ}C$
Input Offset Voltage vs $V_{CC}$	$V_{OFFSET(VCC)}$	$V_{CC}=2.7V$ to 28V, $V_{SENSE}=50mV$		2.5	10	$\mu V/V$
Input Bias Current	$I_{BIAS}$	$V_{IP}, V_{IN}$		2		$\mu A$
Non-linearity Error	NLE	$V_{SENSE}=10mV$ to 150mV			$\pm 1$	%
Total Output Error	TOE	$V_{SENSE}=100mV$			$\pm 2$	%
Output Impedance	$R_{OUT}$			1  5		$G\Omega  pF$
Voltage Swing to $V_{CC}$	$V_{SCC}$			$V_{CC}-0.8$		V
Voltage Swing to $V_{CM}$	$V_{SCM}$			$V_{CM}-0.5$		V
Bandwidth	BW	$R_{OUT}=125K\Omega$		32		kHz
Settling Time	$T_s$	5V Step, $R_{OUT}=125K\Omega$		30		$\mu S$
Total Output-Current Noise	$I_{NOISE}$	BW=100KHz		3		nA
Operating Voltage Range	$V_{CC}$		2.7		28	V
Quiescent Current	$I_{CC}$	$V_{SENSE}=0$ , $V_{CC}=28V$		400		$\mu A$

## Typical Operating Characteristics

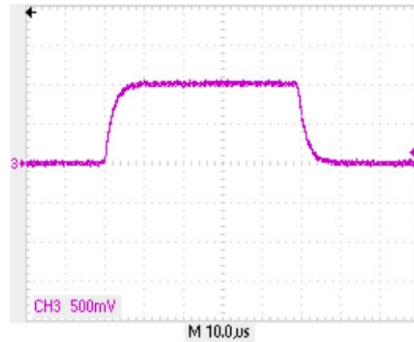
( $V_{CC}=5V$ ,  $V_{IN}=12V$ ,  $T_A=25^\circ C$ , unless otherwise noted)



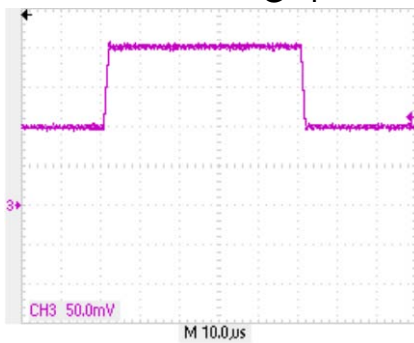
$V_{OUT}$  (RG1=RG2=1K $\Omega$ )



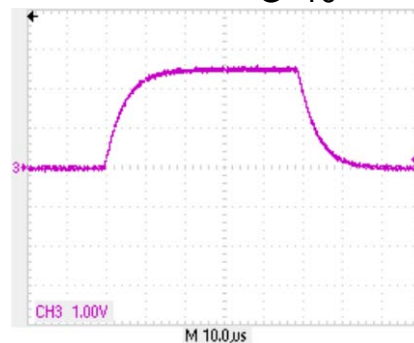
G=1



G=10

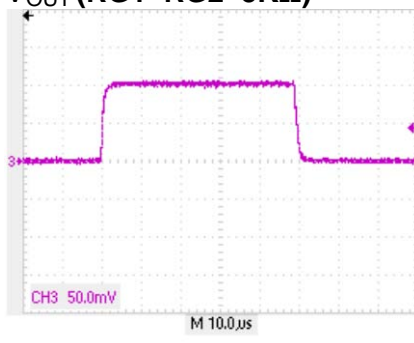


G=1

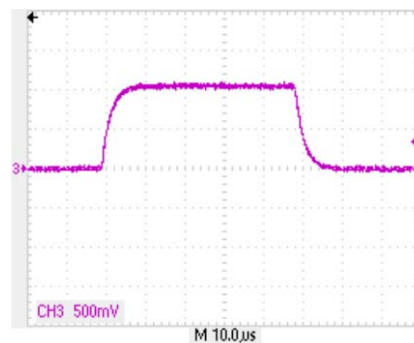


G=25

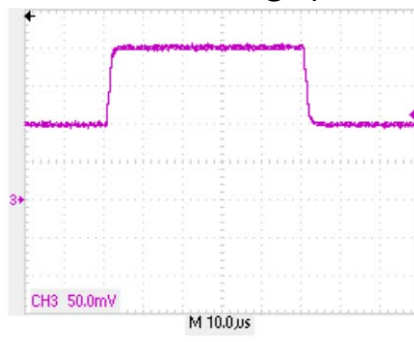
$V_{OUT}$  (RG1=RG2=5K $\Omega$ )



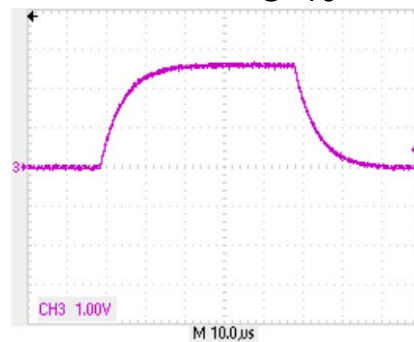
G=1



G=10



G=1



G=25

## Function Description

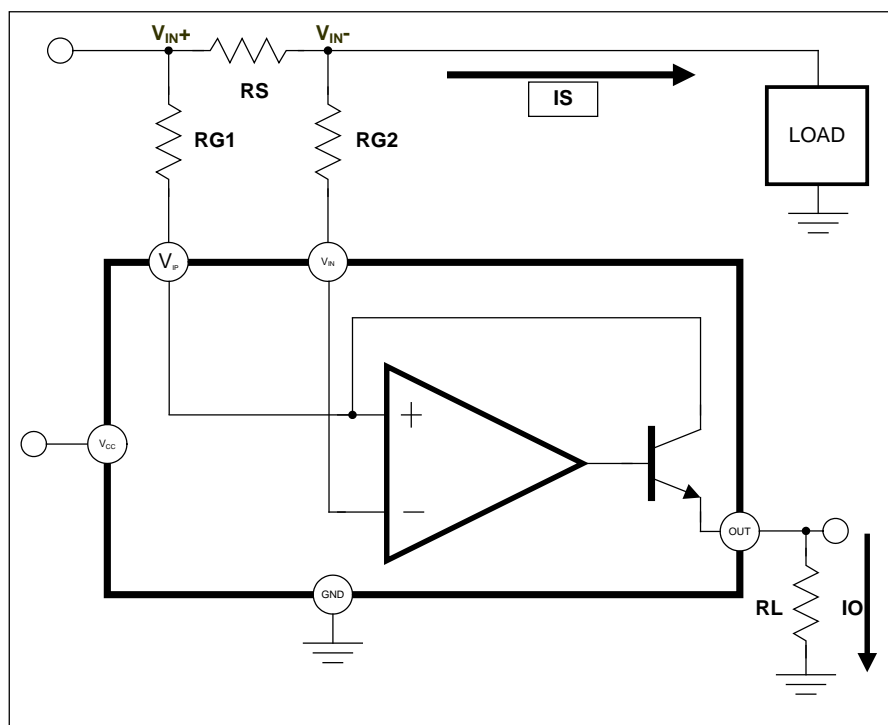
Figure 1 shows the FP355 basic application circuit, the load current ( $I_S$ ) flows from power supply and generates a voltage difference ( $V_{IN}^+ - V_{IN}^-$ ) at the sense resistor ( $R_S$ ). Assume internal NPN transistor collector current is same as emitter current ( $I_O$ ) and  $V_{IP}$  is very close  $V_{IN}$ , the FP355 transfer function is:

$$I_O = \frac{V_{IN}^+ - V_{IN}^-}{R_{G1}} \quad \text{---- (1)}$$

In the circuit of Figure 1, the ( $V_{IN}^+ - V_{IN}^-$ ), is equal to  $I_S \times R_S$  and the output voltage (OUT) is equal to  $I_O \times R_L$ . The final transfer function for rail current measurement in this application is:

$$V_{OUT} = G \times I_S \times R_S \quad \text{---- (2)}$$

$$G = R_L / R_{G1} \quad \text{---- (3)}$$

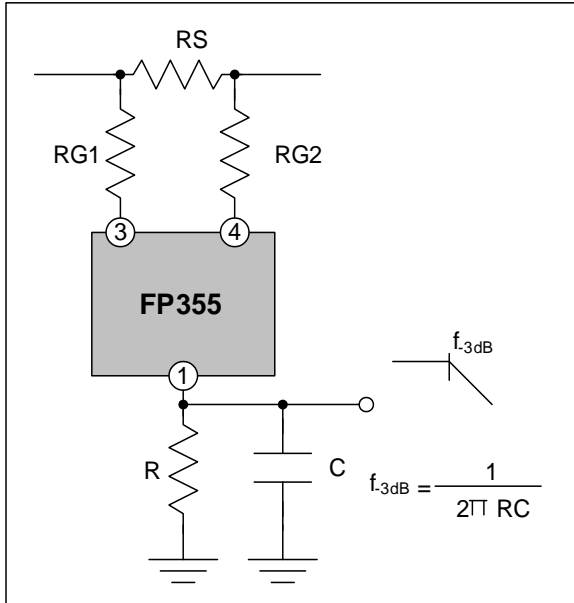


**Figure 1 Current Measurement Circuit**

### Note:

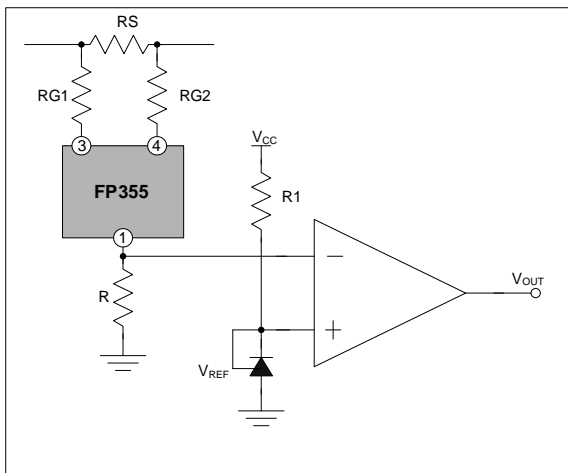
1. The minimum operating voltages of  $V_{CC}$ ,  $V_{IP}$  and  $V_{IN}$  are 2.7V. If these supply voltages are lower than 2.7V, the transfer function at output of FP355 is no longer applicable.
2. Do not force a  $V_{IN}$  voltage larger than  $V_{IP} + 15V$ . This condition would generate a leakage current and an incorrect voltage at FP355 output.





**Figure 2 Output R-C Delay Circuit**

Figure 2 shows a simple method to delay the converting time. When a transient voltage happens at sense resistor ( $R_S$ ), the IC would change sourcing current ( $I_o$ ) to the output and generate a voltage change at the output. The RC circuit will delay a time during output change.

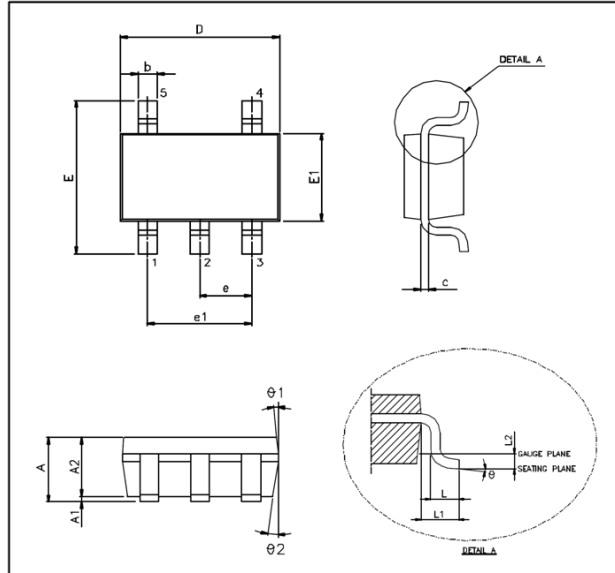


**Figure 3 Comparator Detection Circuit**

Figure 3 shows a detection circuit using 1.25V reference regulator and comparator. At initial, the non-inverting input of the comparator which is connected to the 1.25V regulator is higher than inverting input. The comparator's output signal is high. Once the IC output voltage is higher than 1.25V, the comparator's output will change to low.

## Package Outline

### SOT23-5L



UNIT: mm

Symbols	Min. (mm)	Max.(mm)
A	1.050	1.350
A1	0.050	0.150
A2	1.000	1.200
b	0.250	0.500
c	0.080	0.200
D	2.700	3.000
E	2.600	3.000
E1	1.500	1.700
e	0.950 BSC	
e1	1.900 BSC	
L	0.300	0.550
L1	0.600 REF	
L2	0.250 BSC	
$\theta^\circ$	0°	10°
$\theta1^\circ$	3°	7°
$\theta2^\circ$	6°	10°

#### Note:

1. Package dimensions are in compliance with JEDEC outline: MO-178 AA.
2. Dimension "D" does not include molding flash, protrusions or gate burrs.
3. Dimension "E1" does not include inter-lead flash or protrusions.