

### **Rail Current Measurement IC**



### **General Description**

The FP130A 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**

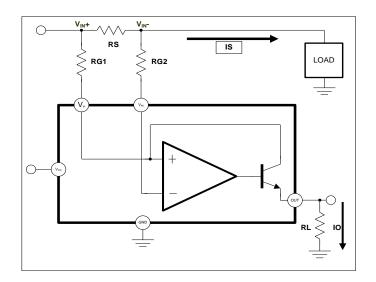
Battery Charger

> High Side Rail Current Detector

> SPS (Adaptor)

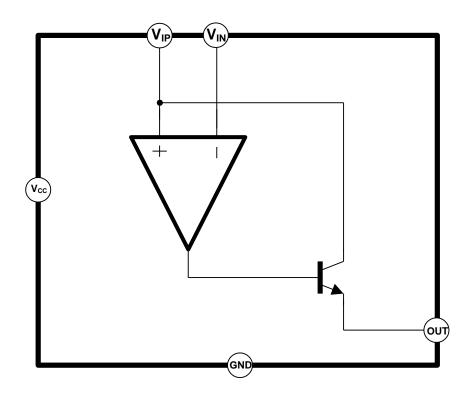
Current Sense Networking System

## **Typical Application Circuit**



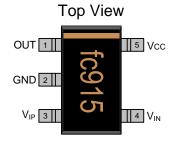


# **Function Block Diagram**



# **Pin Descriptions**

#### **SOT23-5L**

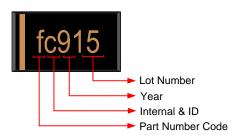


Name	No.	1/0	Description	
OUT	1	0	Current Detect Output	
GND	2	Р	IC Ground	
V <sub>IP</sub>	3	I	Positive Input of Differential OPA	
V <sub>IN</sub>	4	I	Negative Input of Differential OPA	
Vcc	5	Р	IC Power Supply	



## **IC Date Code Identification**

#### SOT23-5L



Lot Number: Wafer lot number's last two digits

For Example: 132386TB → 86

Year: Production year's last digit

Internal ID: Internal Identification Code

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



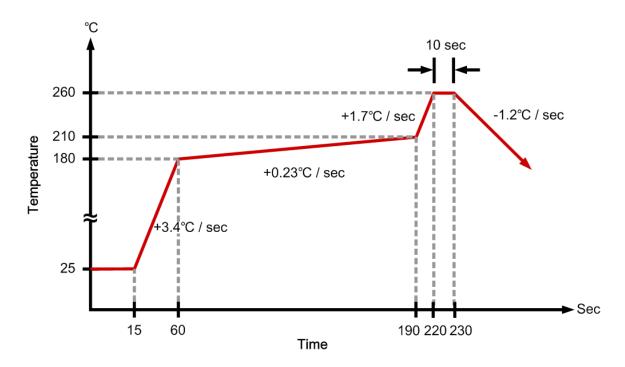
**Ordering Information** 

Part Number	Operating Temperature	Package	MOQ	Description	
FP130AKR-LF	-20°C ~ +125°C	SOT23-5L	2500EA	Tape & Reel	

**Absolute Maximum Ratings** 

Absolute Maximum Natings						
Parameter	Symbol	Conditions	Min.	Тур.	Max.	Unit
Supply Voltage	V <sub>cc</sub>		-0.3		28	V
Common Mode Inputs Voltage	Vi		-0.3		28	V
Differential Inputs Voltage (V <sub>IP</sub> – V <sub>IN</sub> )			-30		1.5	V
OUT Voltage			-0.3		28	V
Operating Temperature			-20		+125	°C
Storage Temperature			-55		+150	°C
Junction Temperature	TJ				+150	°C
Allowable Power Dissipation		T <sub>A</sub> =25°C			220	mW
Junction to Ambient Thermal Resistance	θја				+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.	Тур.	Max.	Unit
Supply Voltage	V <sub>cc</sub>		2.7		28	٧
Operating Temperature			-20		+125	°C

### **DC Electrical Characteristics**

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

Parameter	Symbol	Conditions	Min.	Тур.	Max.	Unit
Full Scale Sense Voltage	V <sub>SENSE</sub>	V <sub>SENSE</sub> =V <sub>IN</sub> <sup>+</sup> - V <sub>IN</sub> <sup>-</sup>		100	500	mV
Common-Mode Input Voltage	V <sub>CM</sub>		2.7		28	V
Common-Mode Rejection	CMRR	V <sub>IN</sub> <sup>+</sup> =2.7V to 28V, V <sub>SENSE</sub> =50mV	100	120		dB
Input Offset Voltage vs temp	V <sub>OFFSET(TA)</sub>	T <sub>MIN</sub> to T <sub>MAX</sub>		4		μV / °C
Input Offset Voltage vs V <sub>CC</sub>	V <sub>OFFSET(VCC)</sub>	V <sub>CC</sub> =2.7V to 28V, V <sub>SENSE</sub> =50mV		2.5	10	μV/V
Input Bias Current	I <sub>BIAS</sub>	$V_{IP}, V_{IN}$		2		μΑ
Non-linearity Error	NLE	V <sub>SENSE</sub> =10mV to 150mV			±1	%
Output Voltage	V <sub>OUT</sub>	$V_{SENSE}$ =50mV, RG1=RG2=1K $\Omega$ , RL=25K $\Omega$	1.225		1.275	V
Total Output Error	TOE	V <sub>SENSE</sub> =100mV			±2	%
Output Impedance	R <sub>OUT</sub>			1  5		GΩ  pF
Voltage Swing to V <sub>CC</sub>	V <sub>SCC</sub>			V <sub>CC</sub> -0.8		V
Voltage Swing to V <sub>CM</sub>	V <sub>SCM</sub>			V <sub>CM</sub> -0.5		V
Bandwidth	BW	R <sub>OUT</sub> =125KΩ		32		kHz
Settling Time	Ts	5V Step, R <sub>OUT</sub> =125KΩ		30		μS
Output Current	lout	$V_{CC}=V_{IN}^{+}=20V$ , $V_{SENSE}=1V$ , RG1=RG2=1K $\Omega$ , RL=15K $\Omega$	350			μA
Total Output-Current Noise	I <sub>NOISE</sub>	BW=100KHz		3		nA
Operating Voltage Range	V <sub>CC</sub>		2.7		28	V
Quiescent Current	I <sub>CC</sub>	V <sub>SENSE</sub> =0, Vcc=28V		400		μA

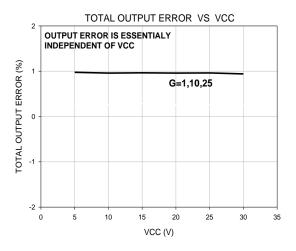
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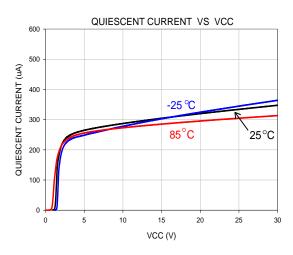
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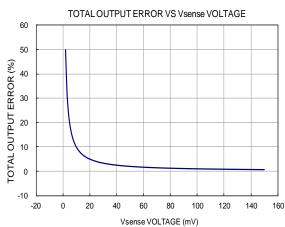


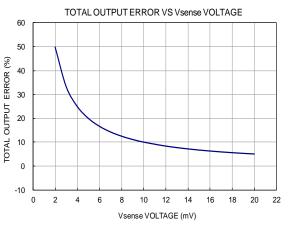
## **Typical Operating Characteristics**

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

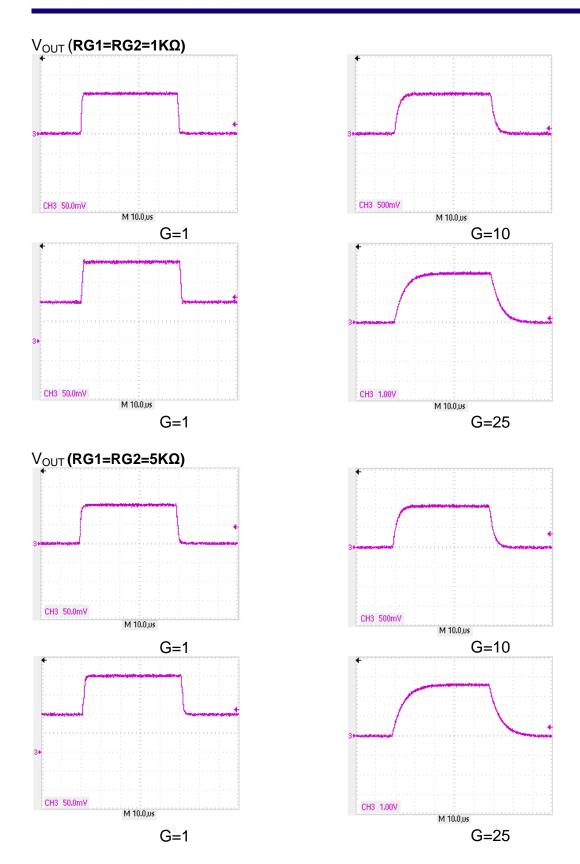














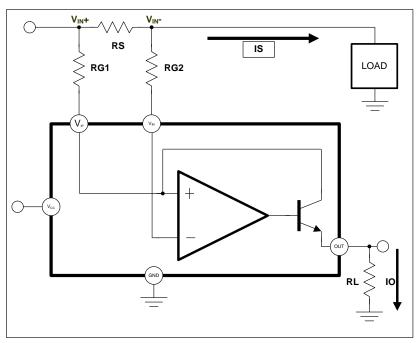
### **Function Description**

Figure 1 shows the FP130A 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 FP130A transfer function is:

$$I_{O} = \frac{V_{IN}^{+} - V_{IN}^{-}}{RG1}$$
 ----- (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:

$$V_{OUT} = G \times I_S \times R_S$$
 ---- (2)  
 $G = R_L / RG1$  ---- (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 FP130A 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 FP130A output.
- 3. The voltage difference between VIP and VIN is under 20mV, the output error is bigger (see page6). It isn't recommended to design in this condition. The output error also increases when the Gain is increased.

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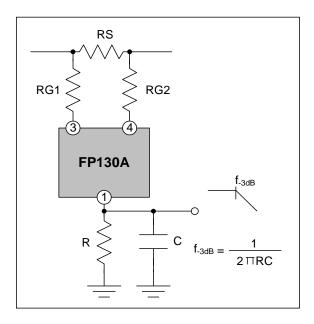
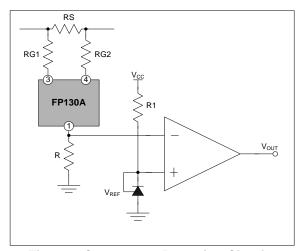


Figure 2 shows a simple method to delay the converting time. When a transient voltage happens at sense resistor ( $R_S$ ), the IC would change sourcing current ( $I_O$ ) to the output and generate a voltage change at the output. The RC circuit will delay a time during output change.

Figure 2 Output R-C Delay Circuit



**Figure 3 Comparator Detection Circuit** 

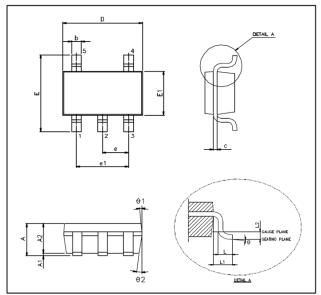
Figure 3 shows a detection circuit using 1.25V reference regulator and comparator.

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)		
А	1.050	1.350		
A1	0.050	0.150		
A2	1.000	1.200		
b	0.250	0.500		
С	0.080	0.200		
D	2.700	3.000		
Е	2.600	3.000		
E1	1.500	1.700		
е	0.950 BSC			
e1	1.900 BSC			
L	0.300	0.550		
L1	0.600 REF			
L2	0.250 BSC			
θ°	0°	10°		
θ1°	3°	7°		
θ2°	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.

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