AiP8199
Zero-Drift, Bi-directional Current Sense Amplifier

Product Specification

Specification Revision History:

Version	Date	Description
2022-03-A0	2022-03	New
2023-10-A1	2023-10	Correct parameter
2023-12-A2	2023-12	Modify the supply voltage in the absolute maximum ratings
2023-12-A3	2023-12	Modify the part number
2024-05-A4	2024-05	Modify the content

Contents

1、General Description

AiP8199 series are zero-drift, bidirectional current- sensing amplifiers, which can be powered from 2.7V to 30V， and sense the voltage drop across the detection resistor at common-mode voltages from -0.2 V to 30V. The AiP8199 devices are mainly used in high and low side current detection, battery charging and power management system. This series of circuits have three fixed gains to choose from: 50V/V, 100V/V, 200V/V. These devices adopt zero drift architecture and have low offset. Under typical conditions, the power supply current consumed by AiP8199 series is 110μA.

Features:

- Input offset voltage: ±200uV (maximum)
- Input common-mode voltage range: -0.2V to 30V
- Power voltage: 2.7V to 30V
- Precision and zero drift characteristics:
  ±1% gain error (maximum, full temperature)
  0.5μV/℃ offset drift max.
  Maximum gain drift of 10ppm/℃.
- Output voltage gain:
  50V/V (AiP8199A1)
  100V/V (AiP8199A2)
  200V/V (AiP8199A3)
- Power supply current: 110uA (typical)
- Rail to rail output
- Temperature range: -40℃ to 125℃
- Package information: SOT363
- ESD level: 4KV- HBM

Ordering Information:

Reel packing specifications:

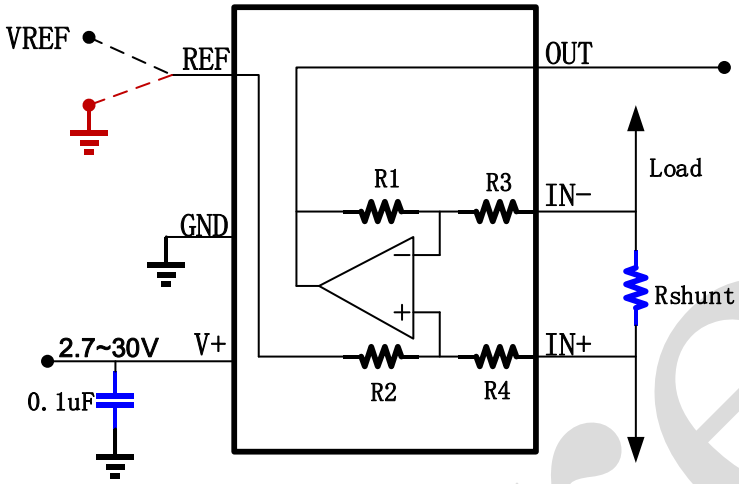
Part number	Packaging form	Marking code	Reel quantity	Boxed reel quantity	Notes
AiP8199A1GC363.TR	SOT363	FAXX	3000 PCS/reel	30000 PCS/box	Dimensions of plastic enclosure: 2.1mm×1.3mm Pin spacing: 0.65mm
AiP8199A2GC363.TR	SOT363	FCXX	3000 PCS/reel	30000 PCS/box	Dimensions of plastic enclosure: 2.1mm×1.3mm Pin spacing: 0.65mm
AiP8199A3GC363.TR	SOT363	FDXX	3000 PCS/reel	30000 PCS/box	Dimensions of plastic enclosure: 2.1mm×1.3mm Pin spacing: 0.65mm

Note 1：“XX” is a variable content, indicating the year and serial number of the packaging batch.

Note 2：If the physical information is inconsistent with the ordering information, please refer to the actual product.

2、Block Diagram And Pin Description

2.1、Block Diagram



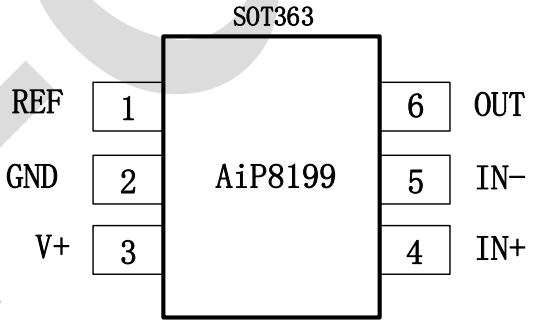
AiP8199 Block Diagram

AiP8199 Type List

Porduct	Gain	R1, R2	R3, R4
AiP8199A1	50	1M	20K
AiP8199A2	100	1M	10K
AiP8199A3	200	1M	5K

$$OUT = \frac{R_1}{R_3}(I_{load} * R_{shunt}) + REF$$

2.2、Pin Configurations



AiP8199 Pin Configurations

2.3、Pin Description

Pin	Symbol	IO	Description
1	REF	I	Reference voltage, set the common-mode voltage of OUT. When using a single power supply, the REF configuration is V+/2. When the positive and negative power supplies are used, REF is grounded.
2	GND	GND	Negative power supply. When a single power supply is used, it is grounded.
3	V+	Power	Positive power supply. A 0.1uF bypass capacitor needs to be connected between it and GND, which is as close to the pin as possible.
4	IN+	I	Co-directional input terminal
5	IN-	I	Reverse input terminal
6	OUT	O	Output voltage

3、Electrical Parameter

3.1、Absolute Maximum Ratings

(T_{amb}=25℃, unless otherwise specified)

Characteristic	Symbol	Conditions	Min.	Max.	Unit
Supply Voltage	V_S	-	-	32	V
Input Voltage	V_{IN+},V_{IN-}	V_{IN+}-V_{IN-}	-5	5	V
		(V_{IN+}+V_{IN-})/2	GND-0.2	30	V
Input Current	I_{IN+}, I_{IN-}	-	-	5	mA
Ambient Temperature	T_A	-	-	-40 to +125	℃
Storage Temperature	T_{stg}	-	-	-65 to +150	℃
ESD Level	HBM	-	-	±4	kV

3.2、Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Common-Mode Input Voltage	V_{CM}	-0.2	12	30	V
Supply Voltage	Vs	2.7	5	30	V
Ambient Temperature	T_A	-40	25	125	℃

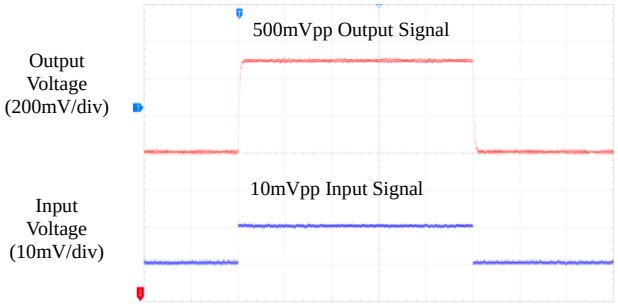
3.3、Electrical Characteristics

(T_{amb}=25℃, V_{SENSE}=V_{IN+} – $V_{IN–}$, V_S=5V, V_{IN+}=12V, V_{REF}=V_S/2, unless otherwise specified)

Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Input						
Input offset Voltage	V_{OS}	V_{SENSE}=0mV	-	±60	±200	μV
Input Offset Voltage Temperature Drift	V_{OS} TC	V_{SENSE}=0mV, -40~125℃	-	0.1	0.5	μV/℃
Common-Mode Input Range	V_{CM}	-40~125℃	-0.2	-	30	V
Common-Mode Rejection Ratio	CMRR	V_{IN+}=5~26V, V_{SENSE}=0mV, -40~125℃	95	110	-	dB
Input Bias Current	I_B	V_{SENSE}=0mV	-	35	-	μA
Input Offset Current	I_{OS}	V_{SENSE}=0mV	-	0.4	-	μA
Power Supply Rejection Ratio	PSRR	V_S=+2.7~18V, V_{IN+}=18V, V_{SENSE}=0mV	-	±3	±10	μV/V
NOISE RTI (Referred to Input)						
Input Voltage Noise Density	e_n	f =1 kHz	-	40	-	nV / √ Hz
Output						
Gain	G	AiP8199A1	-	50	-	V/V
		AiP8199A2	-	100	-	
		AiP8199A3	-	200	-	
Gain Error	E_G	V_{SENSE}=-5~5mV, -40~125℃	-	±0.1%	±1%	-
Gain Error Temperature Drift	E_G TC	-40~125℃	-	3	10	ppm/℃
Maximum Capacitor Load	C_{LOAD}	No oscillation	-	1	-	nF
Output Swing from Power Rail	V_{OH}	R_{LOAD}=10kΩ~REF, -40~125℃	-	0.02	0.05	V
Output Swing from Ground Rail	V_{OL}	R_{LOAD}=10kΩ~REF, -40~125℃	-	0.01	0.05	V
Frequency Response						
Bandwidth	BW	C_{LOAD}=10pF，AiP8199A1	-	50	-	kHz
		C_{LOAD}=10pF，AiP8199A2	-	30	-	
		C_{LOAD}=10pF，AiP8199A3	-	20	-	
Swing Rate	SR	-	-	0.45	-	V/μs
Power Supply						
Power Supply Voltage	V+	-	2.7	-	30	V
Quiescent Current	I_Q	VSENSE=0 mV	-	110	145	μA
Temperature Range						
Operating Temperature		T_A	-40	-	125	℃

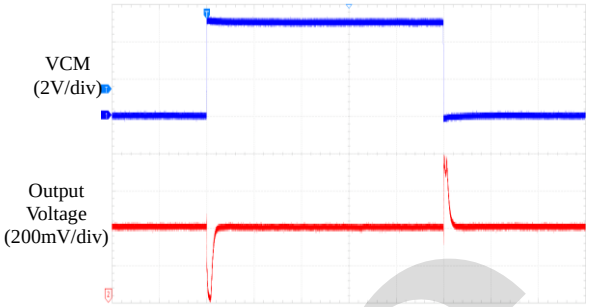
3.4、Typical Parameter Characteristics

AiP8199A1 characteristics, test conditions: T_A=25℃，V_S=5V，V_{IN+}=12V，V_{REF}= V_S/2 except for special instructions.



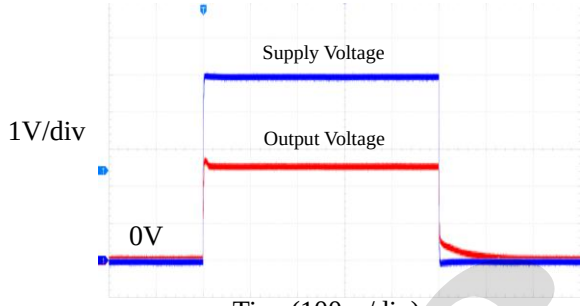
Time(100us/div)

Input Step Response



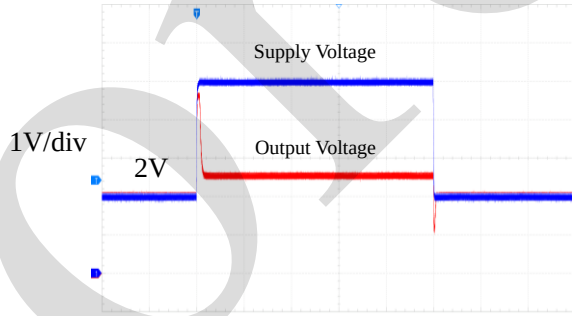
Time(50us/div)

Input Common-Mode Response



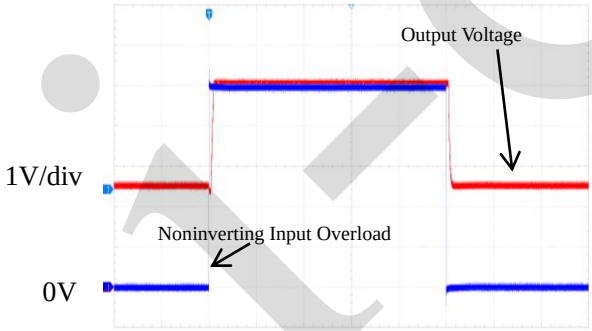
Time(100us/div)

Start-up Response



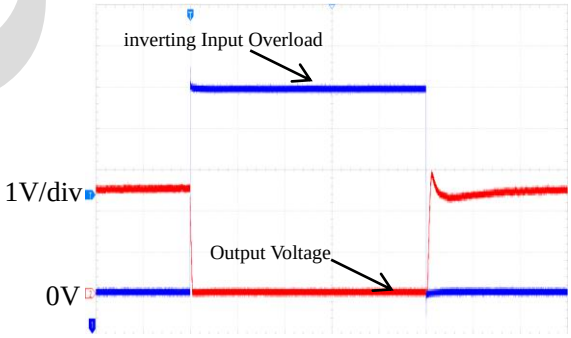
Time(100us/div)

Brownout Recovery Response



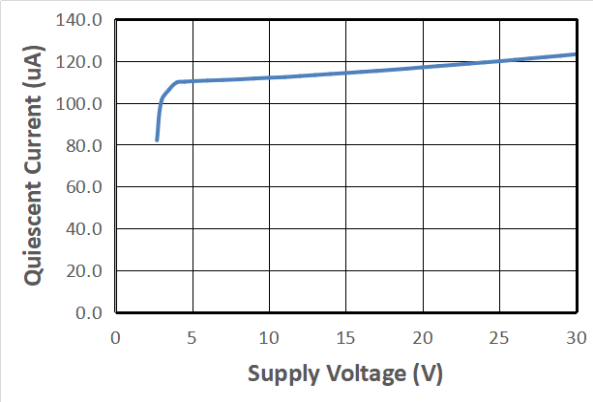
Time(100us/div)

Non-inverting Differential Input Overload Recovery

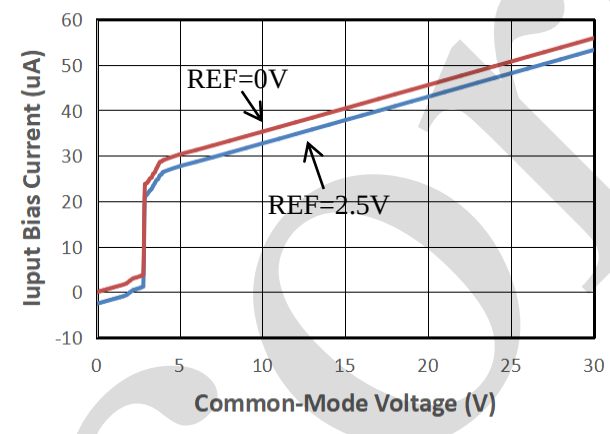


Time(100us/div)

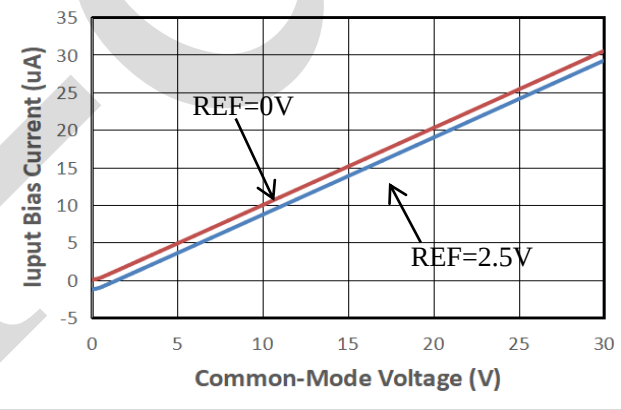
Inverting Differential Input Overload Recovery



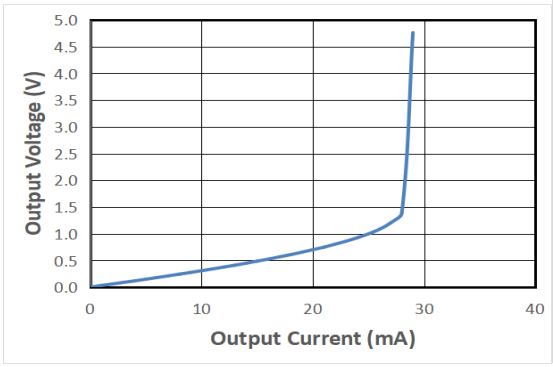
Quiescent Current vs Supply Voltage



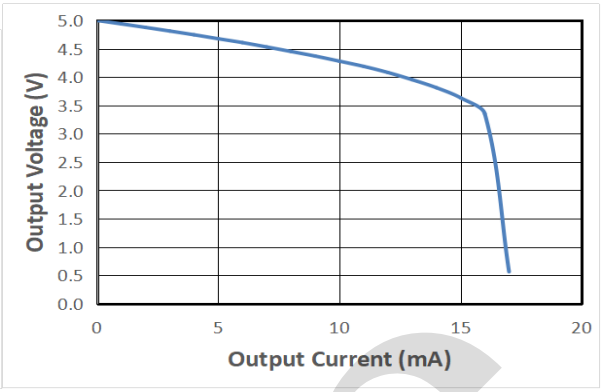
Input Bias Current vs Common-Mode Voltage (V+=5V)



Input Bias Current vs Common-Mode Voltage (V+=0V)

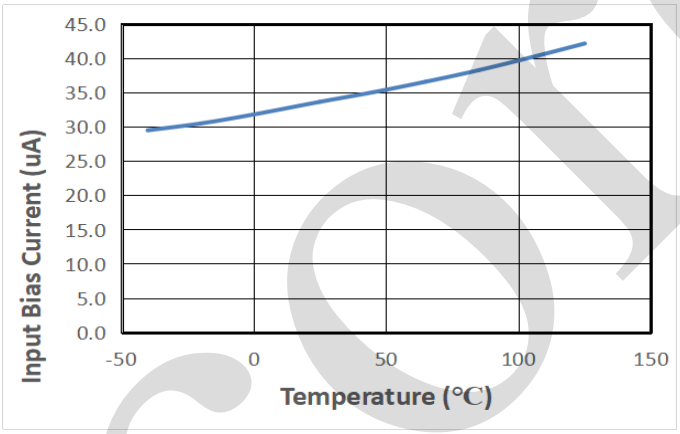


Low-Level Driving Ability

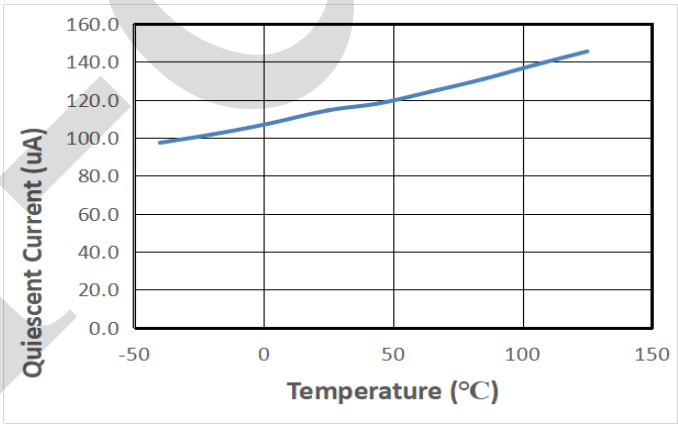


High-Level Driving Ability

Output Voltage Swing vs Output Current



Input Bias Current vs Temperature

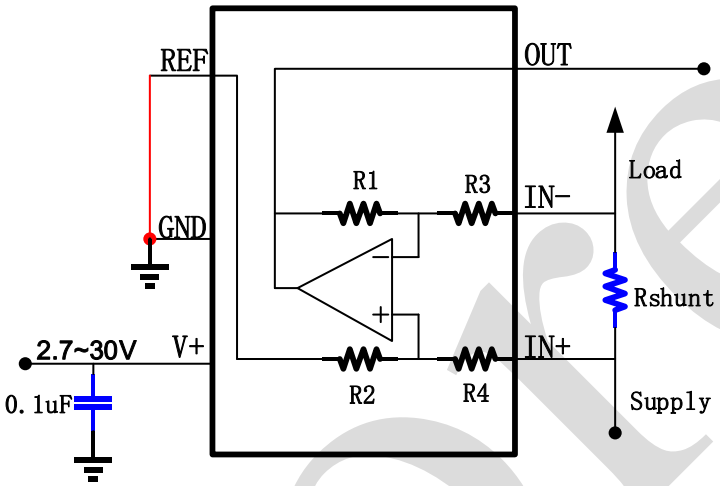


Quiescent Current vs Temperature

4、Typical Application

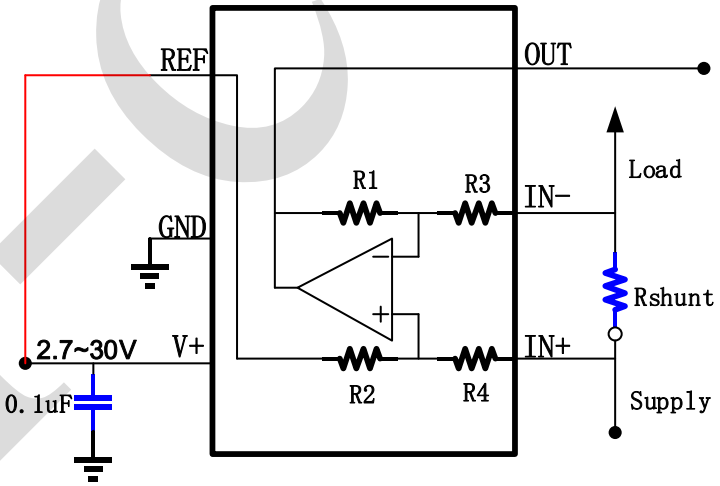
Configuring VREF port of the AiP8199 series can realize unidirectional (positive or negative) and bidirectional (positive and negative) detection of the current to be measured.

When the negative power supply GND voltage is used to drive the REF terminal, the forward current to be measured can be detected in the range of (50 mV~V+-50mV) output voltage, and the output voltage increases linearly with the increase of the current to be measured.



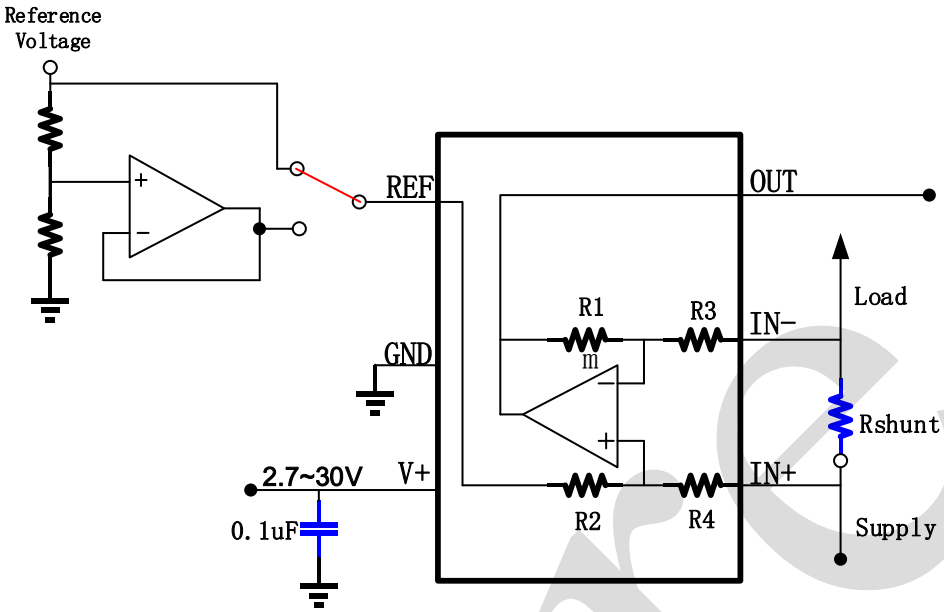
Positive Current Detection

When the REF terminal is driven by positive power supply V+ voltage, the negative current to be measured can be detected in the range of (50mV~V+-50mV) output voltage, and the output voltage decreases linearly with the increase of the current to be measured.



Negative Current Detection

When the voltage of (V+-GND)/2 drives the REF terminal, the positive or negative current to be measured can be detected within the output voltage range of (50 mV~V+-50mV)/2. When the forward current is detected, the output voltage increases linearly with the increase of the current to be measured. When the negative current is detected, the output voltage decreases linearly with the increase of the current to be detected.



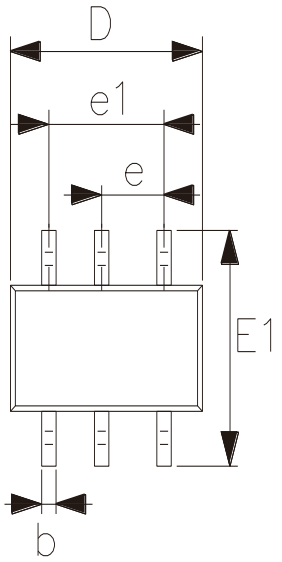
Bidirectional Current Detection

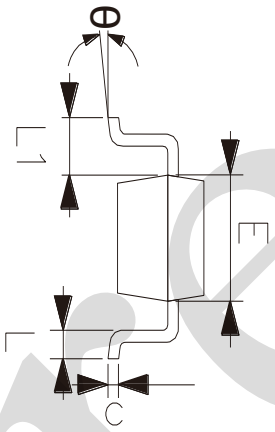
In the application of bidirectional current detection, if the REF port is driven by an external reference power supply through a resistor divider, it is necessary to add a voltage buffer after the divider resistor to drive the REF port.

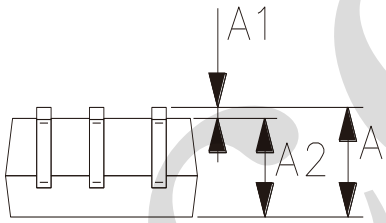
In the basic connection of the above AiP8199 application, the input pins IN+ and IN- should be directly connected with the detection resistor as closely as possible to minimize any resistance in series with the detection resistor. In order to ensure the stability, it is necessary to use the power supply bypass capacitor, and the recommended capacitor value is 100nF, and the bypass capacitor is close to the V+ pin of the device.

5、Package Information

5.1、SOT363







2023/12/A	Dimensions In Millimeters	
Symbol	Min.	Max.
A	0.90	1.10
A1	0.00	0.10
A2	0.90	1.00
b	0.15	0.35
c	0.11	0.175
D	2.00	2.20
E1	2.15	2.45
E	1.15	1.35
e	0.65	
e1	1.20	1.40
L	0.26	0.46
L1	0.525	
θ	0°	8°

6、Statements And Notes

6.1、The name and content of Hazardous substances or Elements in the product

Part name	Hazardous substances or Elements									
	Lead and lead compounds	Mercury and mercury compounds	Cadmium and cadmium compounds	Hexavalent chromium compounds	Polybrominated biphenyls	Polybrominated biphenyl ethers	Dibutyl phthalate	Butylbenzyl phthalate	Di-2-ethylhexyl phthalate	Diisobutyl phthalate
Lead frame	○	○	○	○	○	○	○	○	○	○
Plastic resin	○	○	○	○	○	○	○	○	○	○
Chip	○	○	○	○	○	○	○	○	○	○
The lead	○	○	○	○	○	○	○	○	○	○
Plastic sheet installed	○	○	○	○	○	○	○	○	○	○
explanation	○：Indicates that the content of hazardous substances or elements in the detection limit of the following the SJ/T11363-2006 standard. ×：Indicates that the content of hazardous substances or elements exceeding the SJ/T11363-2006 Standard limit requirements.									

6.2、Notes

We recommend you to read this chapter carefully before using this product.

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