ZHHXDZ 珠海海芯电子有限公司

www.haixindianzi.com

HX818-Shigh-performance, low-power instrument amplifier

The HX818-Sis a low-cost, high-precision instrument amplifier that requires only an external resistor to set the gain to 10,000. It comes in MSOP-8 and SOIC-8 packages with extremely low standby power consumption of just 1.3mA, making it ideal for battery-powered mobile devices.

This amplifier boasts excellent performance features, including a low nonlinearity of 0.8ppm and a maximum input offset voltage of 20µV, making it perfect for high-precision data acquisition systems. The HX818-Sis widely applicable in measuring instruments and sensor interfaces.

Additionally, the HX818-Soffers characteristics such as low noise, low input bias current, and low power consumption, excelling in medical applications like ECGs and blood pressure monitors. Its noise voltage is just 17nV/√Hz at 1kHz with a noise current characteristic of 0.45pA/√Hz, making it suitable for pre-amplification.

Furthermore, the HX818-Sis highly adaptable for multi-channel composite applications, showcasing its versatility and flexibility. Overall, the HX818-Sis a high-performance and user-friendly instrument amplifier that meets various demands for precision and low power consumption.

SOP-8

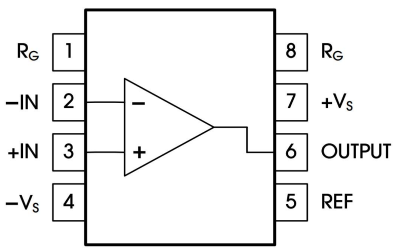
Features

- External resistor setting gain： 1 ~ 10000
- Wide supply voltage range： ±2V ~ ±19V
- Higher performance compared to 3-op amp instrumen tation amplifiers。
- Low power consumption, 1.3mA static current
- Adopting SOP-8 encapsulation
- Input offset voltage: maximum ± 20 μ V
- Input bias current: maximum 2.0nA
- Common mode rejection ratio (G=10): minimum 108dB
- low noise
  input noise voltage: 17nV/√Hz @
  1kHz 1.8µVPP (0.1Hz to 10Hz)
- AC performance: 2038kHz bandwidth (G=1)
- Operation temperature： –40°C to 125°C

Application

- Measuring instrument
- ECG and Medical Applications
- sensor interface
- Data Acquisition System
- industrial process control
- Batteries and Mobile Devices

Pin configuration and functions



Chip pin description

Pin	Name	Type	Function
1.8	RG	Analog Output	Connect a resistor between two RGs to set the gain
2	–IN	Analog Input	Negative signal input
3	+IN	Analog Input	Signal positive input
4	–VS	Power Supply	Negative power supply
5	REF	Analog Input	Output reference voltage input
6	OUTPUT	Analog Output	Output
7	+VS	Power Supply	Positive power supply

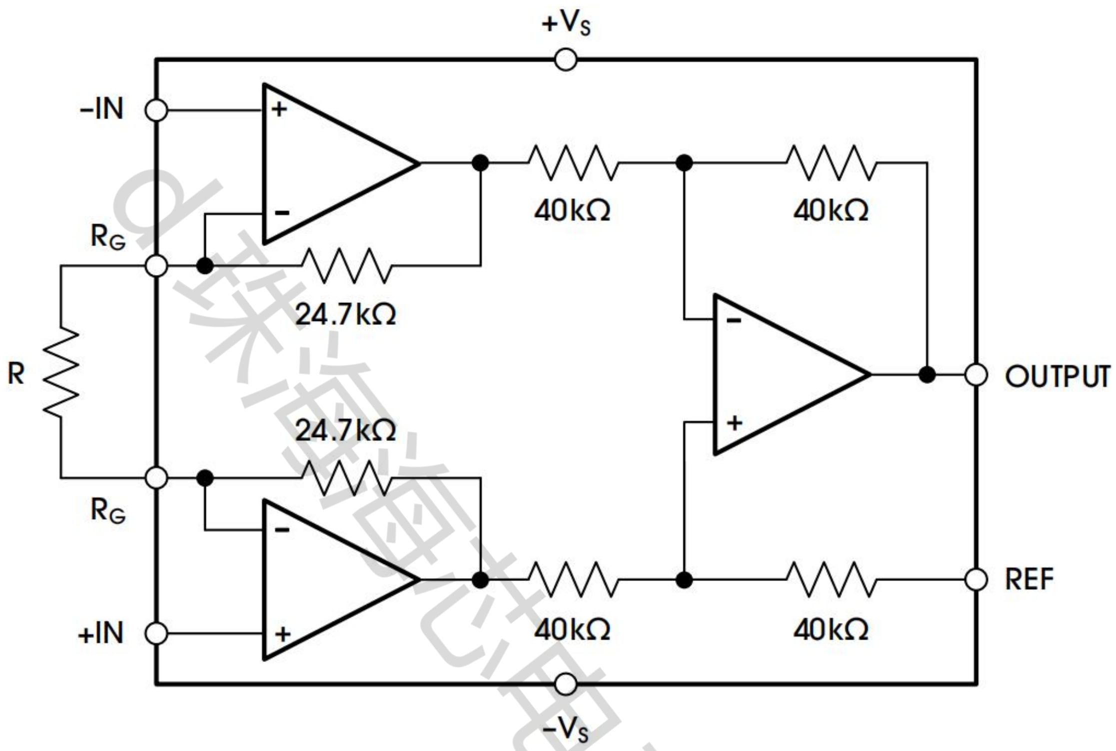


Table 1 Absolute maximum rated parameters				
Parameter	**Describe**	**Min**	**Max**	**Unit**
Voltage	Supply Voltage		±20	V
	INPUT VOLTAGE	−VS − 0.3	+VS + 0.3	V
Electric current	Any pin other than the power supply	−10	+10	mA
Output short circuit duration		Infinite		
Temperature	Operation temperature, TA	−40	125	°C
	Storage temperature, Tstg, Q	−65	150	
	Welding temperature，10s		300	

Note:

Exceeding the stress values listed in Table 1 may cause permanent damage to the device. These are only stress ratings and do not mean that the device can operate normally under any conditions other than those indicated in Table 3. Long term exposure to absolute maximum rated conditions may affect the reliability of the device.

Table 2 ESD Rating				
Parameter	**symbol**	**Describe**	**Price**	**Unit**
Electrostatic Discharge	V(ESD)	Human Body Model (HBM), according to ANSI/ESDA/JE DECJS-001[1]	±1500	V
		Charged Equipment Model (CDM), according to JEDEC specifications JESD22-C101[2]	±1000	

Note:

1.The JEDEC document JEP155 states that the 500V human body model (HBM) allows for safe manufacturing using standard electrostatic discharge (ESD) control processes.
2.The JEDEC document JEP157 states that the 250V Charged Device Model (CDM) allows for safe manufacturing using standard electrostatic discharge (ESD) control processes.

Table 3 Recommended operating conditions

Parameter	Describe	Min	Rating	Max	Unit
Working voltage range	Dual power supply	±2.25	±18	±19	V
	Single Power Supply	4.5	36	38	V
Specify temperature range		−40		125	°C

Table 4 Thermal Information

Parameter	Symbol	SOP-8	Unit
Thermal resistance from node to environment	RθJA	90.6	°C/W
Thermal resistance from node to board	RθJB	47.6	°C/W
Characterization parameters from node to top	ψJT	3.6	°C/W
Characterization parameters from nodes to boards	ψJB	47	°C/W
Thermal resistance from node to shell (top)	RθJC(top)	35	°C/W

Table 5 [Calculation] Typical electrical characteristics at 25 ° C, VS=± 18V, and RL=2k Ω to GND, unless otherwise specified

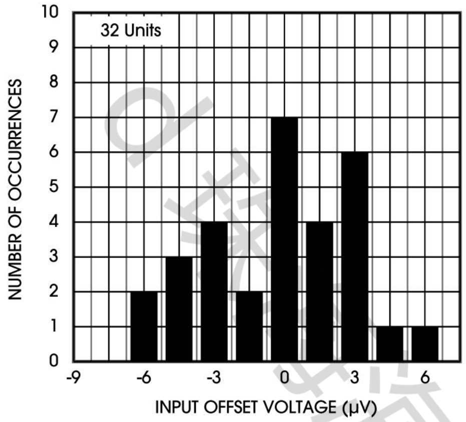
Parameter	Condition	Min	Typ	Max	Unit
Gain					
Gain range	G=1+(49.4kΩ/RG)	1		10K	
Gain error[1]	VOUT=±10V,G=1		0.2	0.2	%
	VOUT=±10V,G=10		0.3	0.4	%
	VOUT=±10V,G=100		0.3	0.7	%
	VOUT=±10V,G=1000		0.3	0.5	%
Nonlinearity	VOUT=−10Vto+10V,G=1,RL=10kΩ		0.8		ppm
	VOUT=−10Vto+10V,G=10,RL=10kΩ		8		ppm
	VOUT=−10Vto+10V,G=100,RL=10kΩ		15		ppm
	VOUT=−10Vto+10V,G=1000,RL=10kΩ		30		ppm
The relationship between gain and temperature	G=1[5]		0.15	0.4	ppm/°C
	Gain>1[1,5]		9	32	ppm/°C
Voltage offset[2]					
Input Offset，VOSI	VS=±18V		±4	±20	μV
	VS=±2Vto±19V,overheat[5]			±45	μV
	VS=±2Vto±19V,Average thermal time constant TC[5]		±0.1		μV/°C
Output offset，VOSO	VS=±18V		±130	±300	μV
	VS=±2Vto±19V,overheat[5]			±450	μV
	VS=±2Vto±19V,Average thermal time constant TC[5]		±0.4		μV/°C
The relationship between offset and input and power supply (PSR)	VS=±2Vto±20V,G=1	104	111		dB
	VS=±2Vto±20V,G=1,overheat[5]	100			dB
	VS=±2Vto±20V,G=10	123	131		dB
	VS=±2Vto±20V,G=10,overheat[5]	120			dB
	VS=±2Vto±20V,G=100	130	147		dB
	VS=±2Vto±20V,G=100,overheat[5]	130			dB
	VS=±2Vto±20V,G=1000	130	156		dB
	VS=±2Vto±20V,G=1000,overheat[5]	130			dB
Input Current					
Input Bias Current		0.6	2	nA	0.6

	overheat[5]		10	nA	
input offset current		0.1	1	nA	0.1
	overheat[5]		4.0	nA	
Input					
Input impedance	Finite difference				GΩ_pF
	Common mode		34||5		
Input Voltage[3]	V_S=±2Vto±19V	−V_S+0.1	34||6	+V_S−2	V
CMRR					
CMRR	V_{CM}=(−V_S+0.1V)to(+V_S−2V),G=1	88	148		dB
	V_{CM}=(−V_S+0.1V)to(+V_S−2V),G=1,overheat[5]	83			dB
	V_{CM}=(−V_S+0.1V)to(+V_S−2V),G=10	108	161		dB
	V_{CM}=(−V_S+0.1V)to(+V_S−2V),G=10,overheat[5]	103			dB
	V_{CM}=(−V_S+0.1V)to(+V_S−2V),G=100	129	163		dB
	V_{CM}=(−V_S+0.1V)to(+V_S−2V),G=100,overheat[5]	123			dB
	V_{CM}=(−V_S+0.1V)to(+V_S−2V),G=1000	143	163		dB
	V_{CM}=(−V_S+0.1V)to(+V_S−2V),G=1000,overheat	136			dB
Output	R_L = 10kΩ, V_S = ±2V to ±19V, overheat[5]	−V_S+0.2		+V_S−0.3	V
	Overheat		±19		mA
Dynamic response					
Small signal -3dB bandwidth	G = 1		2038		kHz
	G = 10		417		kHz
	G = 100		53		kHz
	G = 1000		4		kHz
Slew Rate	G = 1, 10V step		2		V/μs
	G = 100, 10V step		1		V/μs
Noise					
Voltage noise，1 kHz[4]	Input, voltage noise，e_{ni}		17		nV/√Hz
	Output, voltage noise，e_{no}		63		nV/√Hz
RTI，0.1Hz to10Hz	G = 1		1.8		μV_{PP}
	G = 100		0.4		μV_{PP}
Current noise	f = 1kHz		450		fA/√Hz
Reference input					
R_{IN}			80		kΩ
Voltage range		−VS		+V_S	V
Reference gain to output			10	41	μV/V
power supply					
Scope of work		±2		±19	V
Static current	V_S =±2V to ±19V		1.3	1.5	mA
Overheat				1.6	mA
Temperature range					
For the specified performance		-40		+125	°C

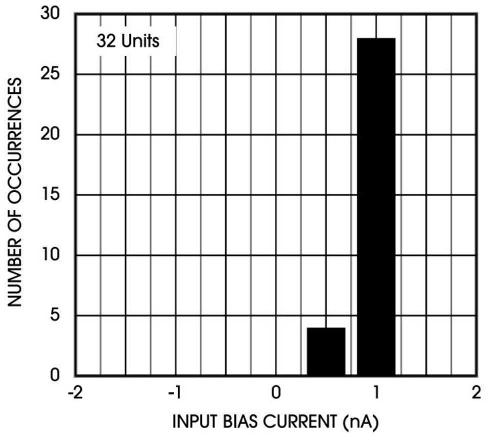
Notes

1. Excluding the influence of external resistance RG
2. Total RTI error=VOSI+VOSO/G
3. One input is grounded. G=1。
4. Total RTI noise=√ e2ni+(eno/G) 2
5. All equipment shall undergo 100% production testing at TA=+25 ° C. All temperaturelimits are guaranteed through bench test batches.

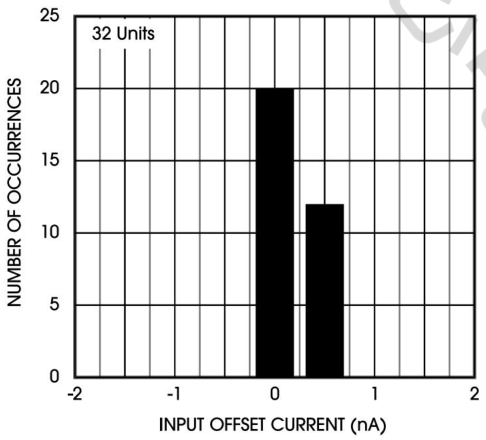
typical characteristics TA=25°C，VS=±18V，RL=2kΩ，Unless otherwise specified。



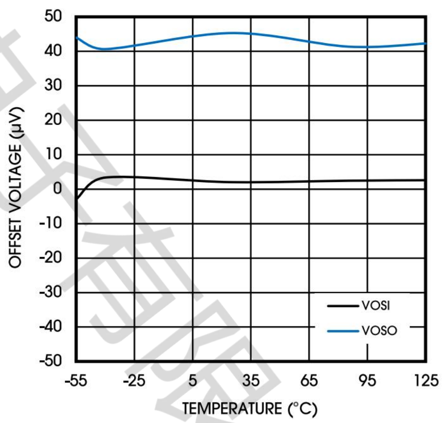
Typical distribution of input offset voltage



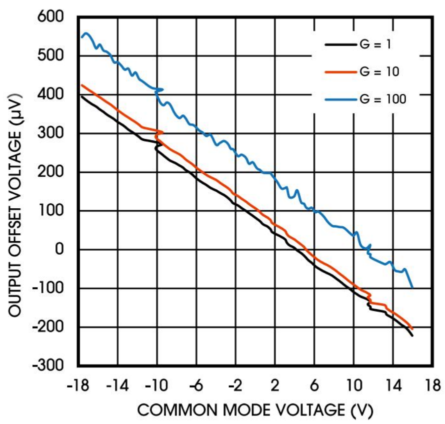
Typical distribution of input bias current



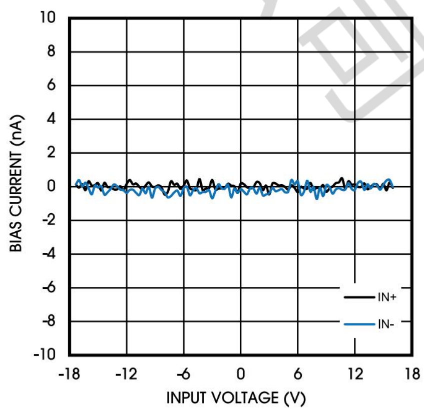
Typical distribution of input offset current



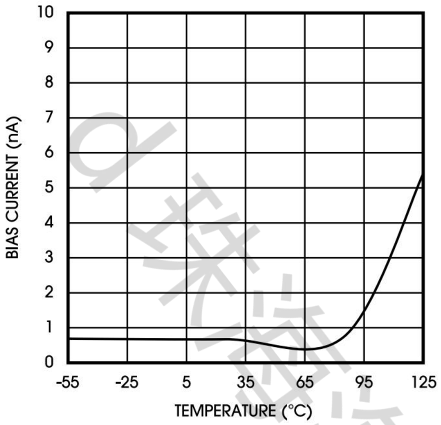
Input offset voltage and temperature



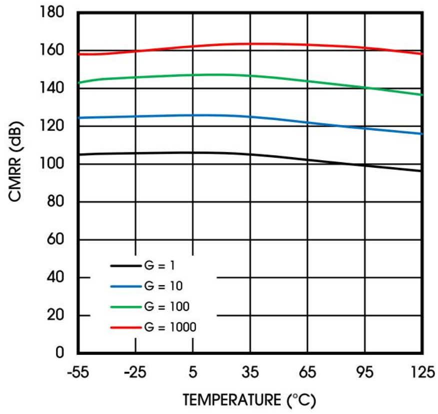
Input offset voltage and common mode voltage



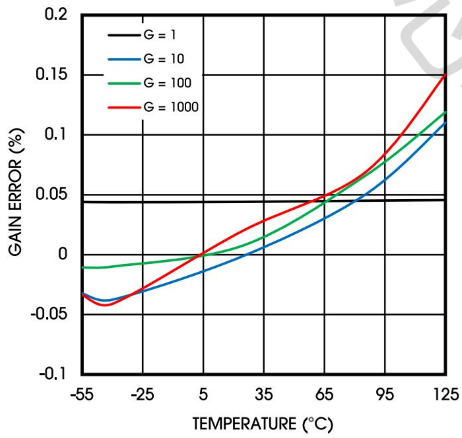
Input bias current and common mode voltage（25°C）



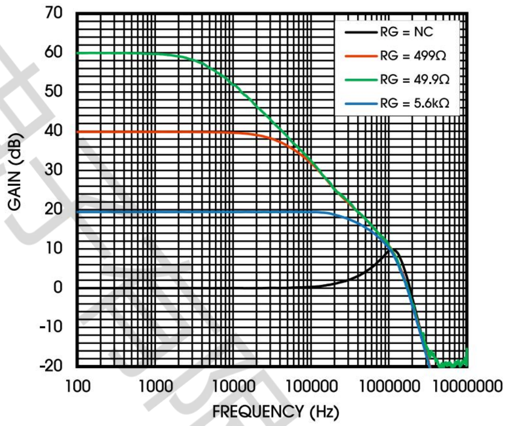
Bias current and temperature



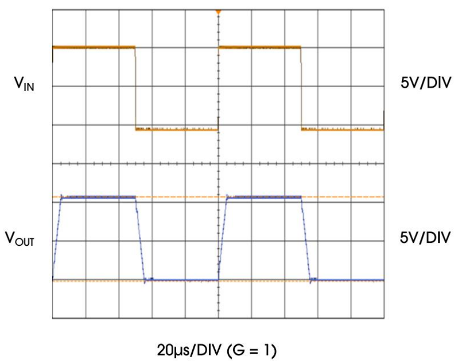
CMRR and Temperature



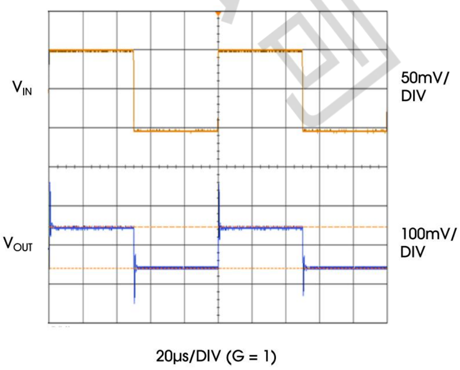
Gain and temperature



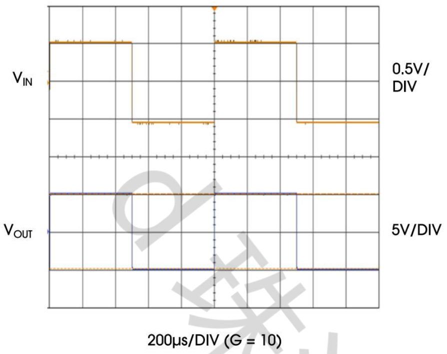
Gain and frequency



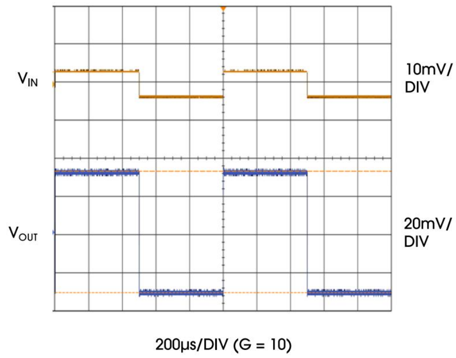
Big signal response (G = 1)



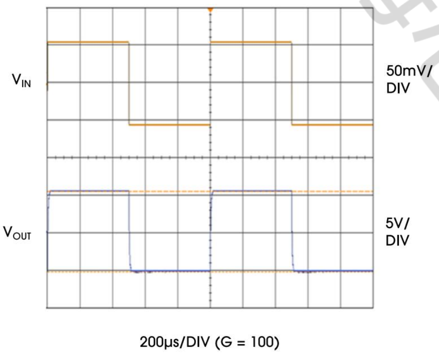
Small signal response(G = 1)



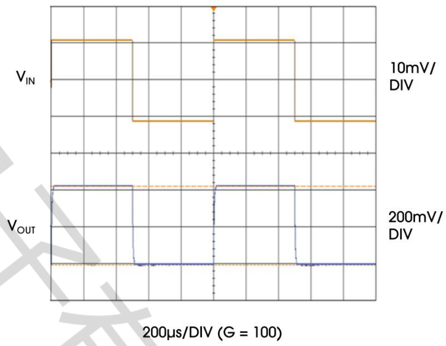
Big signal response (G = 10)



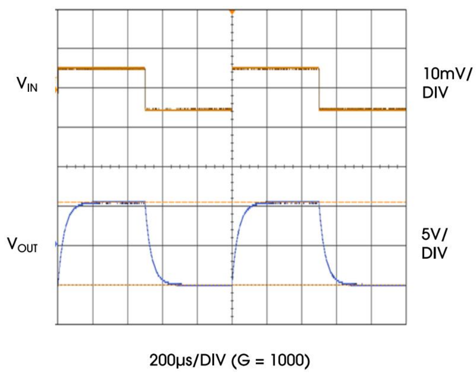
Small signal response (G = 10)



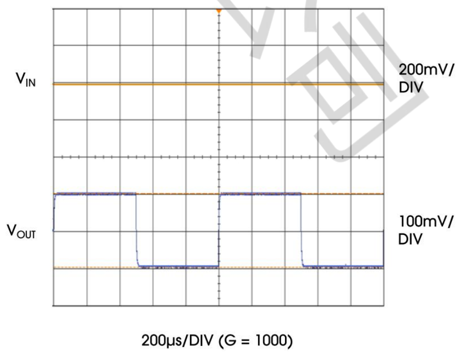
Big signal response (G = 100)



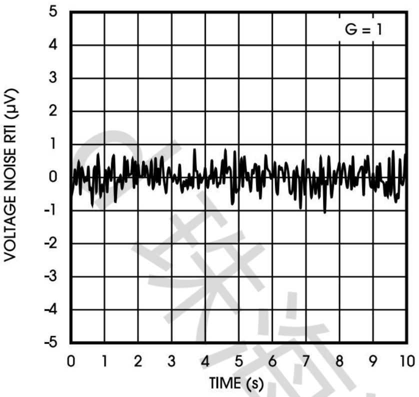
Small signal response (G = 100)



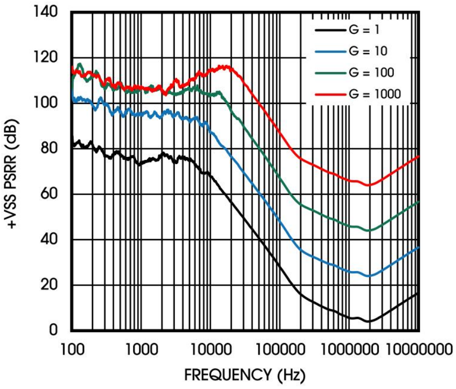
Big signal response (G = 1000)



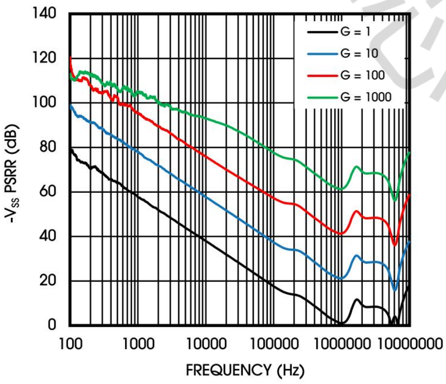
Small signal responseG = 1000)



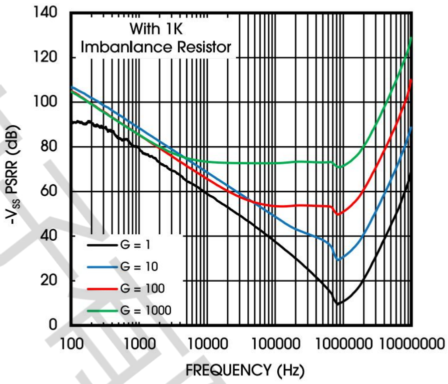
0.1Hz to10Hz



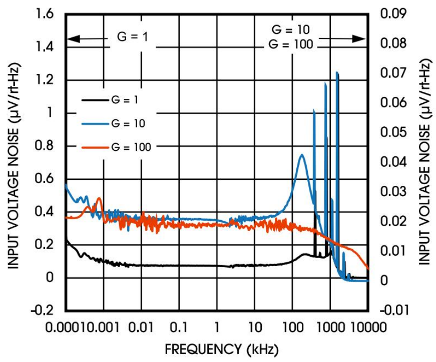
Positive PSR and frequency



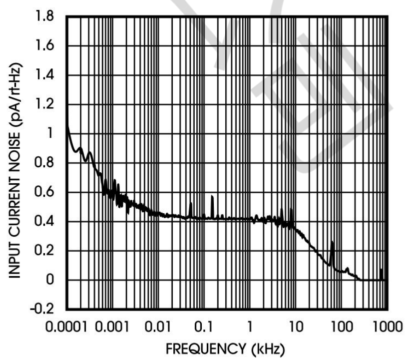
Negative PSR and frequency



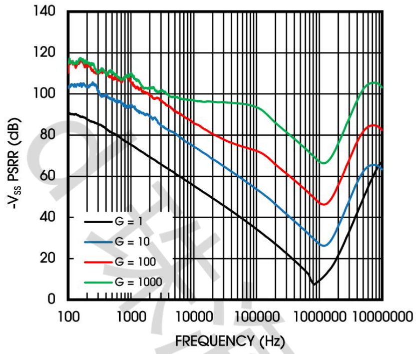
Unbalanced CMRR and frequency



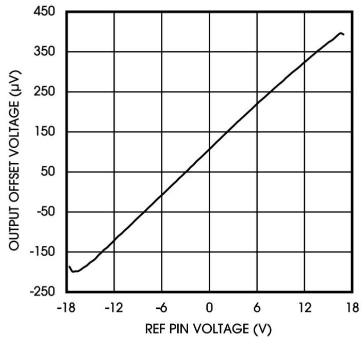
Input voltage noise density



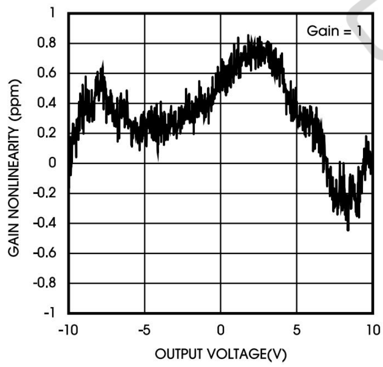
Input current noise density



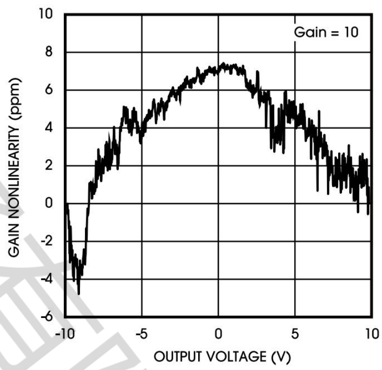
CMRR and frequency



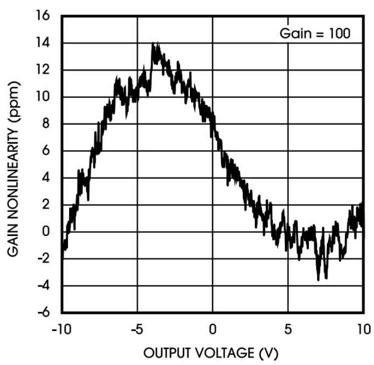
Reference voltage and output offset voltage



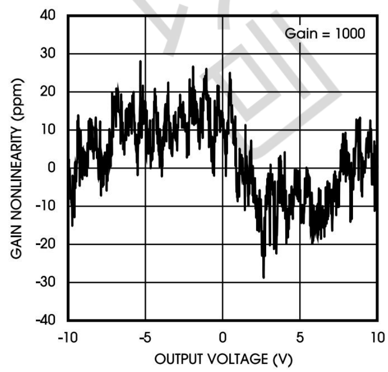
Gain nonlinearity（G=1）



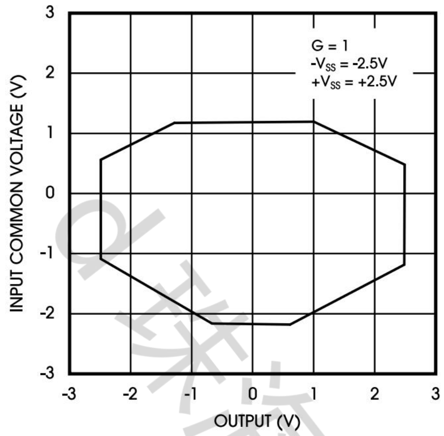
Gain nonlinearity（G=10）



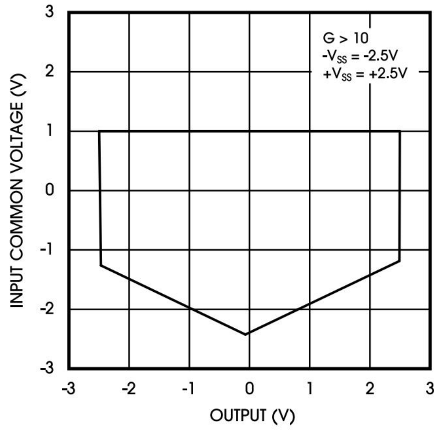
Gain nonlinearity (G=100)



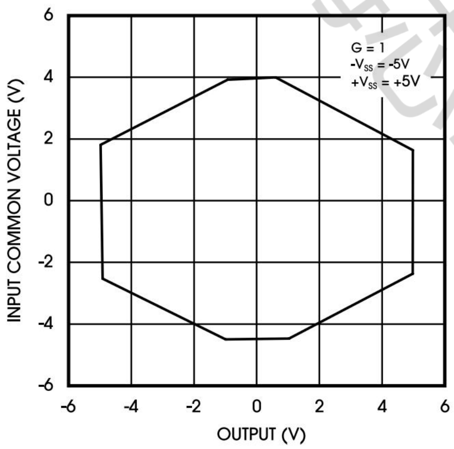
Gain nonlinearity（G=1000）



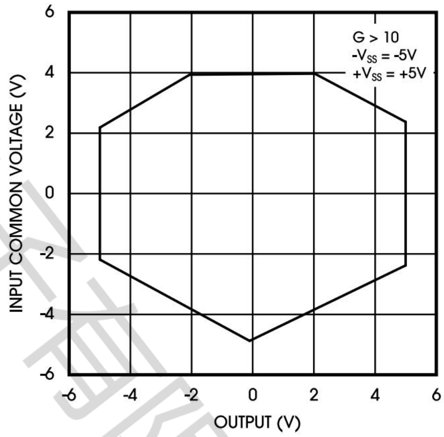
Input common mode range and output voltage，G = 1（5V)



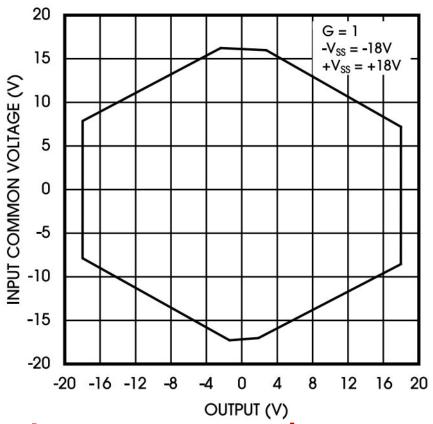
Input common mode range and output voltage，G > 10 (5V)



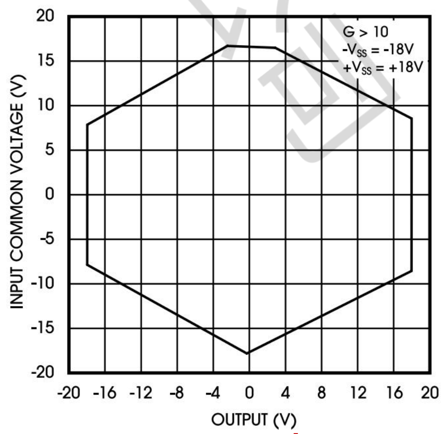
Input common mode range and output voltage, G=1 (10V)



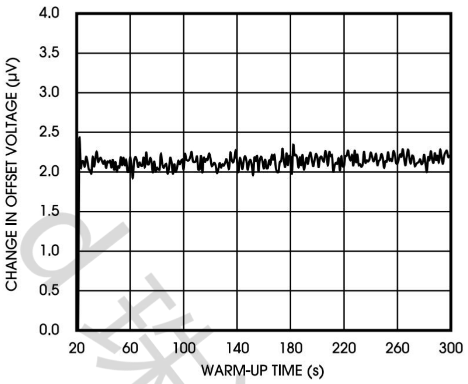
Input common mode range and output voltage, G > 10 (10V)



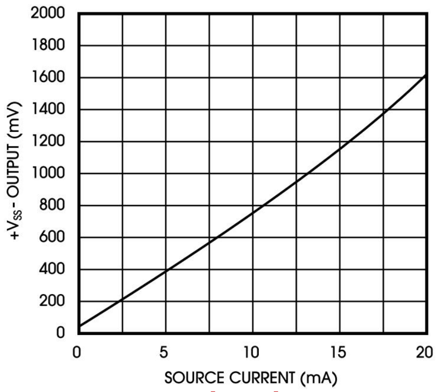
Input common mode range and output voltage, G=1 (36V)



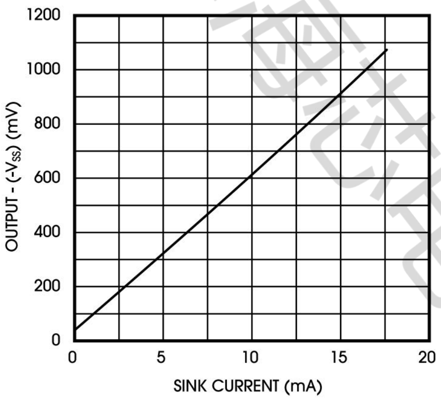
Input common mode range and output voltage, G>10 (36V)



Heating time



VOH Compared to the source current



VOL Current in the sink

Detailed description

Overview

HX818-Sis a single-chip instrument amplifier improved by the classic three operational amplifier method. Its absolute value fine-tuning function allows users to accurately set the gain with just one resistor. The single-chip structure and fine-tuning technology ensure tight matching and tracking of circuit components, thereby ensuring the inherent excellent performance of the circuit.

The absolute values of internal gain resistors R1 and R2 have been adjusted to 24.7k Ω, which allows users to precisely program the gain by using a single external resistor. This design not only simplifies the process of gain adjustment, but also improves the accuracy of adjustment, making HX818-San efficient and easy-to-use instrument amplifier.

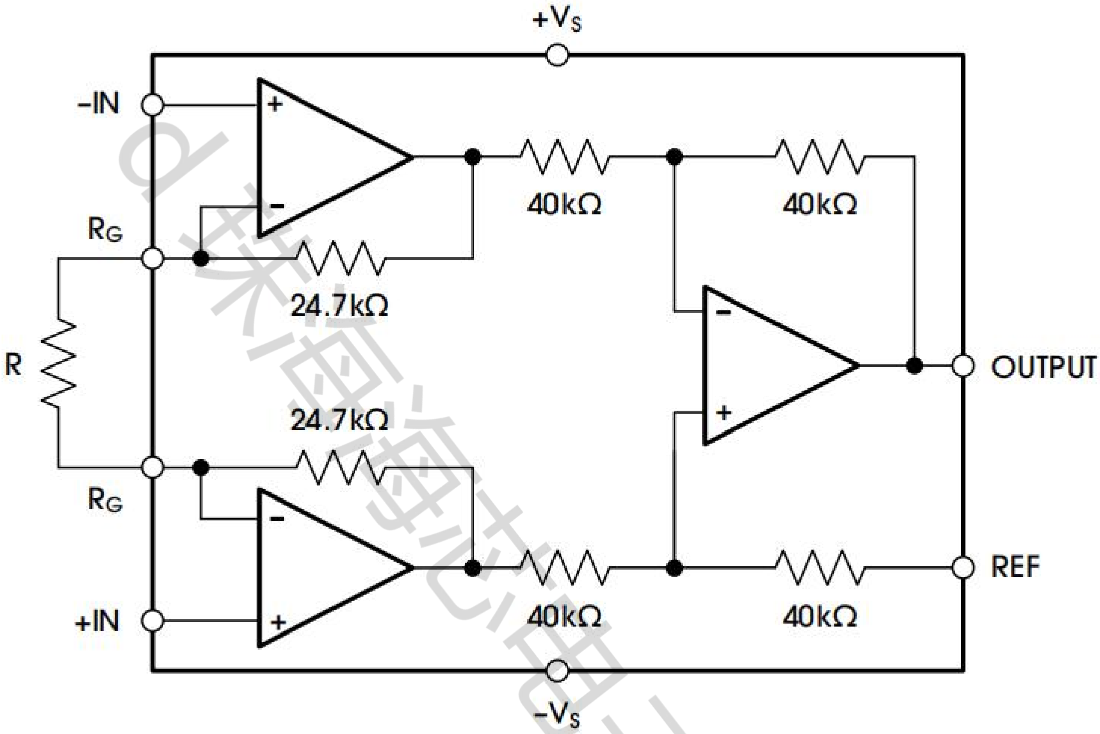
The gain equation is:

$$G = \frac{49.4k\Omega}{R_G} + 1$$

$$R_G = \frac{49.4k\Omega}{G - 1}$$

As a reference for the single ended output of the REF pin, it can be connected to ground or a low resistance source.

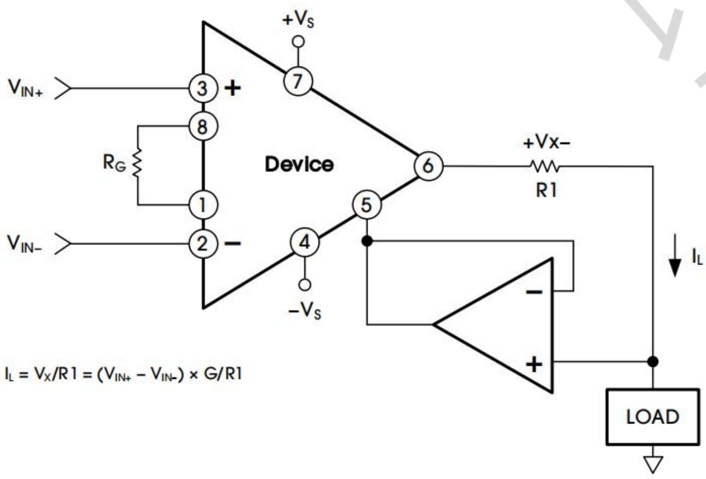
Functional module block diagram



characterization

Precision V-I converter

The HX818-S, paired with an op amp and two resistors, creates a high-precision current source. The op amp buffers the reference terminals, ensuring a strong CMR. Voltage VX from the HX818-Sappears across resistor R1, converting it to current. After deducting the op amp's input bias current, the resulting current powers the load, ensuring accurate output. This design boosts accuracy, stability, and reliability.



Precision Voltage-Current Converter

Gain selection

The gain of HX818-S is programmed through an RG resistor, or more precisely, set through any impedance connected between pins 1 and 8. The original design intention of HX818-S is to use resistors with an accuracy between 0.1% and 1% to provide precise gain. Table 9 lists the RG values required to achieve various gains. It is worth noting that when the gain G is 1, the RG pin does not need to be connected (i.e. RG=∞). For any gain, the value of RG can be calculated using the following formula:

$$R_G = \frac{49.4k\Omega}{G - 1}$$

In order to minimize gain errors and avoid high parasitic resistance in series with RG; To minimize gain drift, RG should have a lower TC - below 10ppm/° C for optimal performance.

Required value of gain resistor			
RG's 1% standard table value (Ω)	Calculate gain	RG's 0.1% standard table value (Ω)	Calculate gain
49.9k	1.990	49.3k	2.002
12.4k	4.984	12.4k	4.984
5.49k	9.998	5.49k	9.998
2.61k	19.93	2.61k	19.93
1.00k	50.40	1.01k	49.91
499	100.0	499	100.0
249	199.4	249	199.4
100	495.0	98.8	501.0
49.9	991.0	49.3	1,003.0

Input and output offset voltage

The low error of HX818-S mainly comes from two aspects: input error and output error. When the reference input is used, the output error will be divided by the gain G. In fact, at high gain, input error will dominate; At low gain, the output error is more significant. The total VOS calculation method for a given gain is as foll ows:

Total Error RTI = Input Error + (Output Error / G)

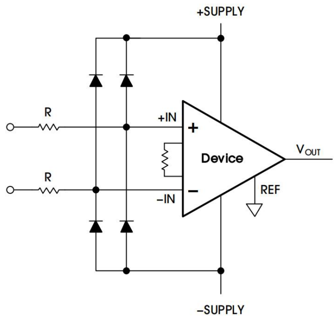
Total Error RTO = (Input Error × G) + Output Error

Reference terminal

The reference terminal potential is the reference for zero output voltage, especially when the load does not share precise grounding with other system components. It provides us with a direct and effective method f or injecting precise offsets into the output. To ensure optimal common mode rejection ratio (CMR), we sho uld strive to maintain parasitic resistance at the lowest possible level.

Input protection

For input voltages beyond the power supply range, it is recommended to connect a protective resistor in series at each input terminal to limit the current to within 10mA. These resistors can be the same as those used in RFI filters. However, it should be noted that high resistance values may have adverse effects on the noise and AC common mode rejection ratio (CMRR) performance of the system. To reduce the required protection resistance value, it is possible to consider installing a low leakage diode at the input end. This design helps to protect the circuit while maintaining stable system performance.



Diode protection when voltage exceeds the supply range

Rfi

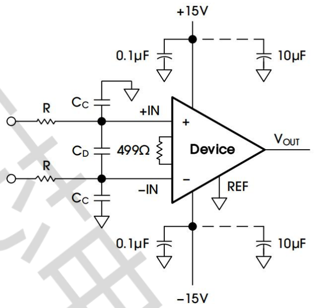
All instrumentation amplifiers rectify small out of band signals, which may result in small DC voltage offsets, manifested as interference. To filter high-frequency signals, a low-pass R-C network can be placed at the input of the instrumentation amplifier. This configuration is shown in Figure 44. This filter restricts the input signal through the following relationship.

$$FilterFreq_{DIFF} = \frac{1}{2\pi R(2C_D + C_C)}$$

$$FilterFreq_{CM} = \frac{1}{2\pi RC_C}$$

Note：CD ≥ 10CC.

CD impacts the difference signal, while CC affects the common mode signal. HX818-S's CMRR is sensitive to R and CC mismatches. To maintain CMRR's bandwidth, CC should be at least ten times smaller than CD. As CD/CC ratio rises, CC mismatch effects diminish.

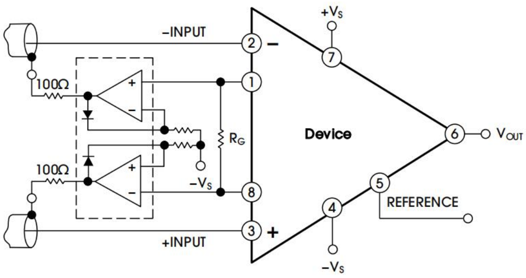


Circuit for attenuating radio frequency interference

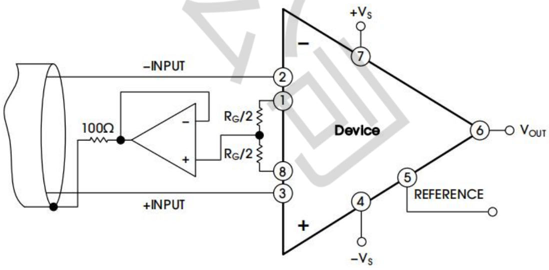
Common-mode rejection

The HX818-Sinstrument amplifier provides high common mode rejection ratio (CMR), which is used to measure the degree of change in output voltage when two inputs change equally. These specifications are typically provided for a wide range of input voltage variations and specific source imbalance situations.

In order to achieve the best common mode rejection ratio, the reference terminal should be connected to a low impedance point and the capacitance and resistance differences between the two inputs should be minimized as much as possible. In many applications, shielded cables are used to minimize noise. To achieve the best common mode rejection ratio across the entire frequency range, it is necessary to drive the shielding layer correctly. Figures 45 and 46 show active data protection configurations that enhance AC common mode rejection by "bootstrap" the capacitance of the input cable shielding layer, thereby minimizing capacitance mismatch between inputs.



Common mode shielded driver



Common mode shielded driver

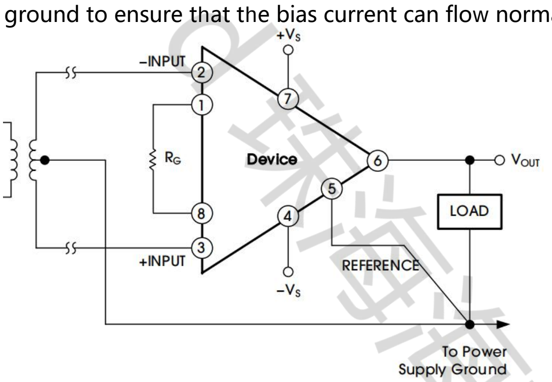
Common mode input range

The linear input voltage range of the HX818-Sis typically about 2V below the positive power supply and 0.1V above the negative power supply. An increase in differential input voltage leads to a corresponding rise in output voltage. However, this linear range is constrained by the amplifier's output swing, making it closely tied to the overall amplifier output and influenced by power supply voltage.

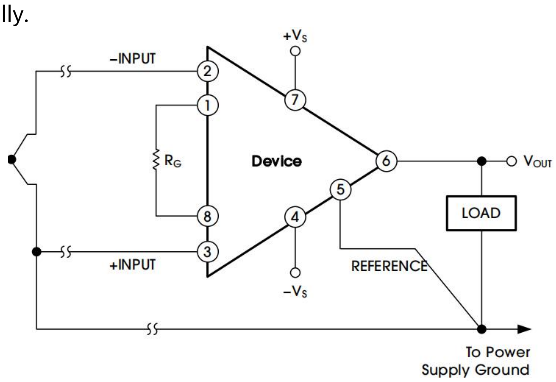
Additionally, input overload can produce seemingly normal output voltages. For instance, if an overload causes both input amplifiers to hit their positive output limits, the measured differential voltage will approach zero. In such cases, even with overloaded inputs, the output stage will tend toward 0V.

Grounding circuit for input bias current

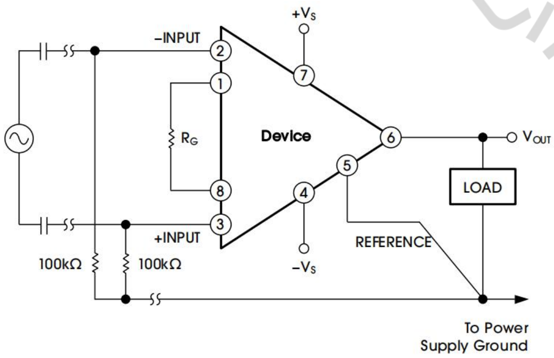
The input bias current is the necessary current for the normal operation of the amplifier input transistor. These currents require a direct return path. Therefore, when amplifying a "floating" input source (such as a transformer or AC coupling source), it is necessary to ensure that there is a DC path between each input and ground to ensure that the bias current can flow normally.



The bias current grounding circuit when the transformer is coupled to the input



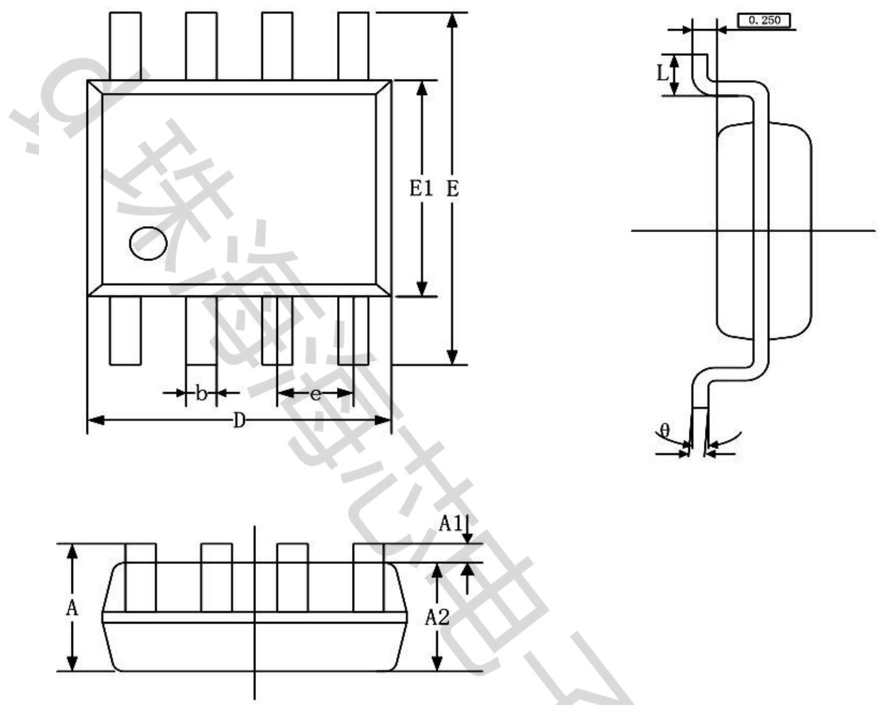
Grounding circuit for bias current during thermocouple input



Bias current ground loop in AC coupled input

Packaging specifications

SOP-8 (Package Outline Dimensions)



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A			1.10
A1	0.05		0.15
A2	0.75	0.85	0.95
A3	0.30	0.35	0.40
b	0.28		0.36
b1	0.27	0.30	0.33
c	0.15		0.19
c1	0.14	0.15	0.16
D	2.90	3.00	3.10
E	4.70	4.90	5.10
E1	2.90	3.00	3.10
e	0.65BSC		
L	0.40		0.70
L1	0.95REF		
θ	0		8。

Part Number	Package Type	package	quantity
HX620-S	SOP-8	Taping	2500