AH950

Open loop high-precision linear current sensor

Alfa Electronics Co.,Ltd

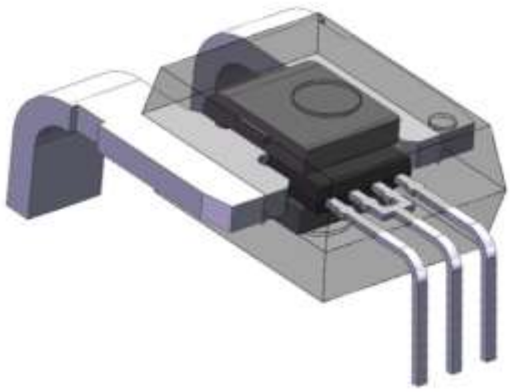
1. Product Introduction

AH950 series is an open-loop current sensor module based on the Hall effect principle, providing a more economical and accurate solution for AC or DC detection. It is widely used in industrial, commercial, and communication systems for AC or DC current detection. This product can be used for motor control, load detection and load management, power supply and DC-DC converter, Solar inverter, UPS, over-current protection, medium and low power inverter current detection and other applications.

The AH950 consists of a high-precision, low noise, low temperature drift linear Hall IC, magnetic core, and low insertion resistance (0.12m Ω) current conductor path (located near the mold surface). The applied current flowing through this conductor path generates a magnetic field, which the chip converts into a voltage signal output proportional to the input current.

The output voltage of AH950 is provided by the BCDMOS Hall IC with low offset and chopping stability. According to different current ranges, the output voltage is accurately calibrated internally in the factory. When the applied external current flows through the conduction path (from pin 4 to pin 5), the output of the chip has a positive slope (>VOQ). The typical internal resistance value of this conduction path is 120u Ω, which can achieve low energy consumption. The terminals (pins 4 and 5) of the conductive path are Galvanic isolation from the signal terminals (pins 1 to 3). This allows the AH950 current sensor module to be used in current detection applications without the need for other expensive isolation technologies.

All pins of the AH950 series are tin plated, and the packaging material does not contain lead, meeting RoHS standards.



2. Function

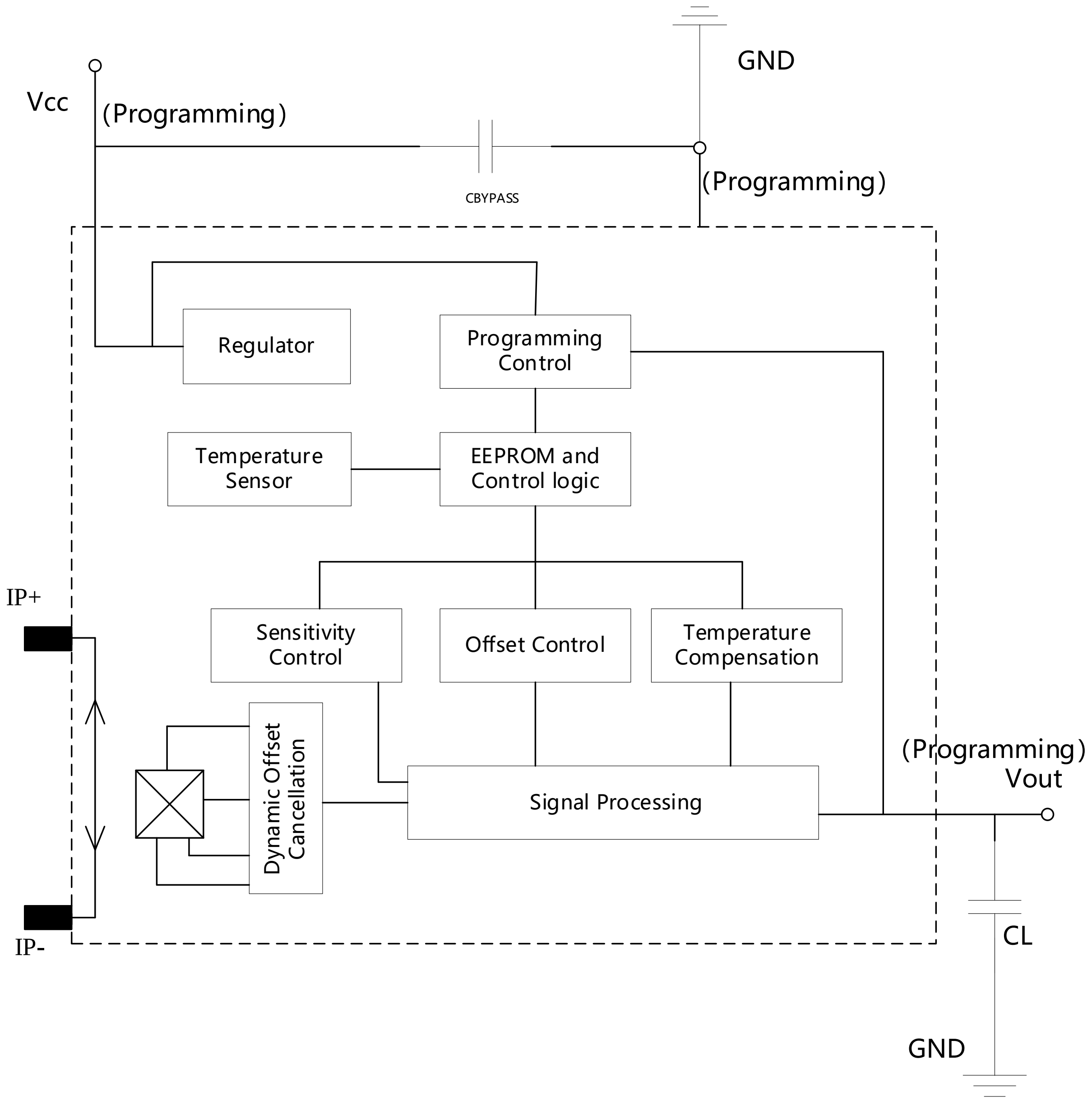
- Fast output Step response time: 4 μ S
- Single power supply: 4.5～5.5V
- 120kHz signal bandwidth
- Zero hysteresis
- Internal conductor resistance: 120 μ Ω
- Static common mode output：2.5V or 50%V_{cc}
- Extremely stable static output voltage
- Working temperature: -40 ℃~150 ℃

- Wide measurement range：±50A，±100A，±150A，±200A
- Certification related to safety regulations：UL Ready
- dielectric strength：4800Vrms 1min
- Isolation Operating Voltage：680Vrms，990VDC or VPK
- Electrical clearance：5.2mm
- Creepage distance：7.2mm
- Packaging: CB-2-3 (PFF)

3.Application

UPS (Uninterruptible Power Supply)、 motor phase and rail current detection, DC power supply, overcurrent protection, medium and low power frequency converter current detection, charger and converter

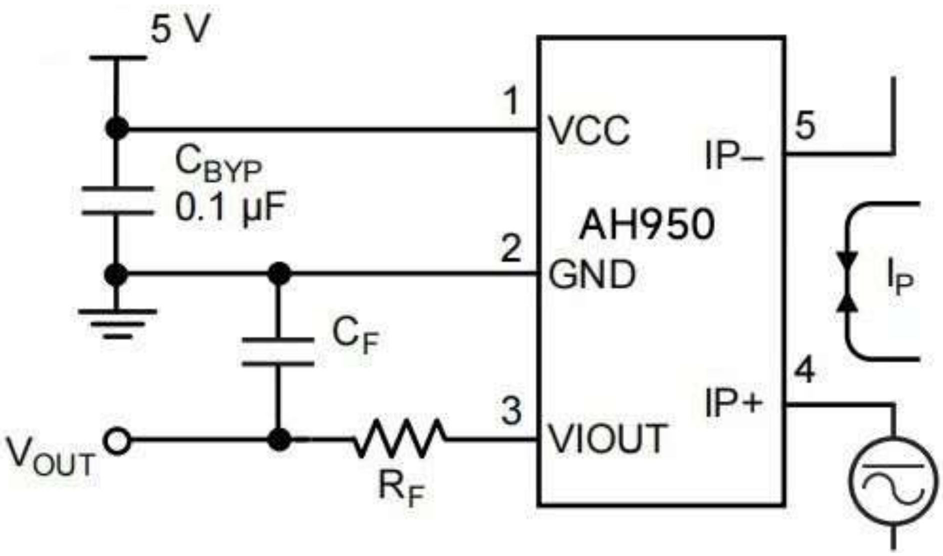
4. Functional Block Diagram

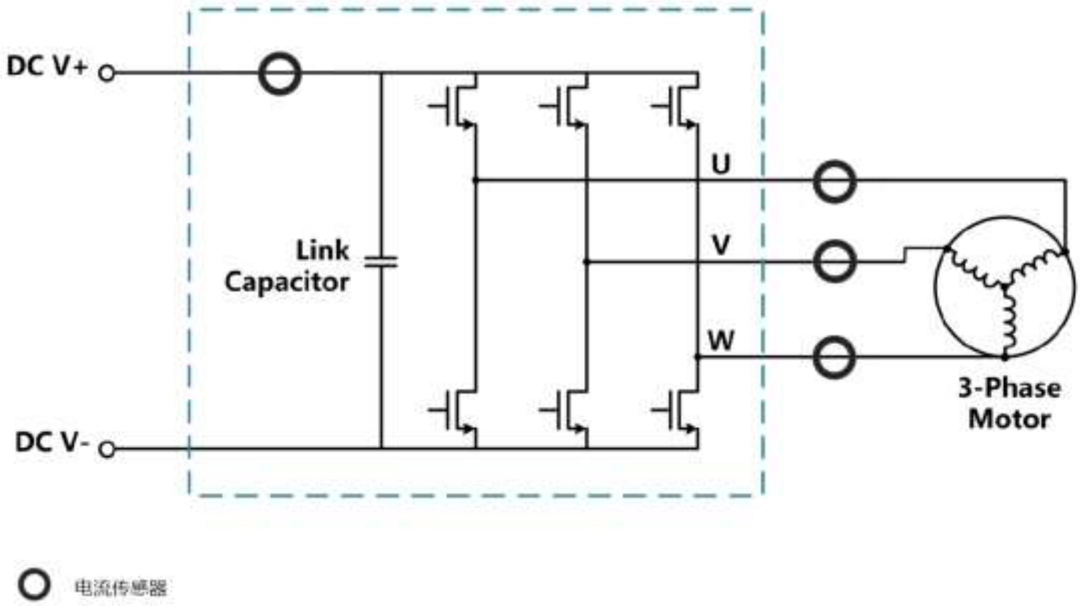


Content

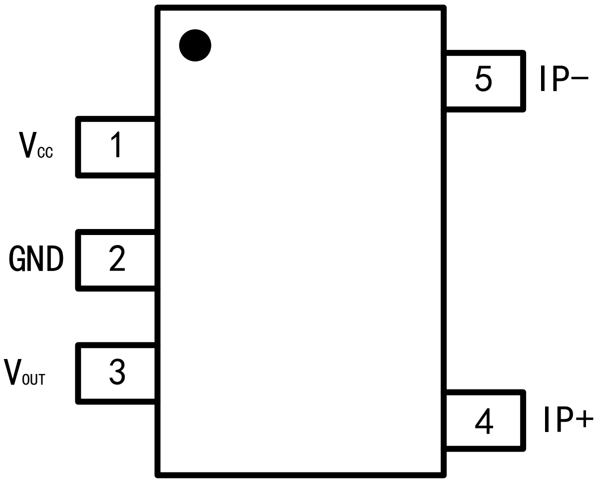
5.Application Circuit

Application 1: AH950 outputs an analog signal VOUT, which varies linearly with the bidirectional AC or DC primary sampling current IP within the specified range. CF is used to optimize noise management, and its value depends on the application.





6. Pin information



Pin	Name	Functions
1	V_{CC}	power supply
2	GND	ground
3	V_{OUT}	Analog output signal
4	IP+	Terminals for sampling current
5	IP−	Terminals for sampling current

7.Naming conventions

Part No.	AH950	F	−	B	−	50
	①	②		③		④

①Series name

②Output mode

Model	Output model
F	Fixed 2.5V
V	Proportional output

③电流极性

Model	Current polarity
B	Bidirectional current
U	Unidirectional current

④Input current range

Model	Input current range
50	Full scale detection range: 50A
100	Full scale detection range： 100A
150	Full scale detection range： 150A
200	Full scale detection range： 200A

8.Packing information

Part	Zero current output （V）		Operating Voltage （V）	current range （A）	sensitivity （mV/A）	temperature range （℃）	package
AH950-F-B-50	-	2. 5	4. 5～5. 5	±50	40	-40～150	40pcs/tube
AH950-F-B-100	-	2. 5		±100	20		
AH950-F-B-150	-	2. 5		±150	13. 3		
AH950-F-B-200	-	2. 5		±200	10		
AH950-V-B-50	50%V_{cc}	-		±50	40		
AH950-V-B-100	50%V_{cc}	-		±100	20		
AH950-V-B-150	50%V_{cc}	-		±150	13. 3		
AH950-V-B-200	50%V_{cc}	-		±200	10		
AH950-F-U-50	-	0. 5		50	80		
AH950-F-U-100	-	0. 5		100	40		
AH950-F-U-150	-	0. 5		150	26. 7		
AH950-F-U-200	-	0. 5		200	20		
Note：F-fixed 2.5V，V-1/2 VDD，B- Bidirectional ，U- Unidirectional							

9. Limit parameter

Symbols	Parameters	Min	Max	Units
V_{CC}	Power supply voltage	–	6	V
V_{OUT}	Output voltage	–	V_{CC}+0.5	V
I_{OUT}(source)	Output current source	–	80	mA
I_{OUT}(sink)	Output current sink	–	40	mA
T_A	Working environment temperature	-40	150	℃
T_S	Storage temperature	-65	170	℃
T_J	Maximum junction temperature	–	165	℃
Endurance	EEPROM	200	–	cycle
Transient impulse current at the current sampling end	IP1pulse100ms		100	A

Note: If the chip is under extreme parameters, it may cause unstable chip functionality, and prolonged exposure to this environment may damage the chip

9. 1 Isolation characteristics

Symbols	Parameters	Test conditions	Rating	Units
VISO	dielectric strength	Test 60 seconds	4800	Vrms
VWFSI	Isolation operating Voltage	Single isolation	990	VDC or Vpk
I_{OUT}(source)	Output current source		680	Vrms
DCL	Electrical clearance	Minimum air distance from input terminal to output terminal	5.2	mm
DCR	creepage	The shortest distance from the input terminal to the output terminal along the plastic packaging body	7.2	mm

9.2ESD Parameters

Symbols		Enforcement standards	Max	Units
V_{ESD}	HBM	JEDECJS-001-2017	5	kV

9.3 flow capacity

Symbols	Parameters	Test conditions	Rating	Units
IP_{OC}		T_A=25˚C, duration 1 second, duty cycle 1%	1200	A
		T_A=85˚C, duration 1 second, duty cycle 1%	900	A
		T_A=150˚C, duration 1 second, duty cycle 1%	600	A

9.4Electrical parameters

Symbols	Parameters	Test conditions	Min	Typ	Max	Units
V_{CC}	Operating voltage	–	4.5	5	5.5	V
I_{CC}	Operating current	T_A=25°C, output no load	9	11.18	13	mA
BW	Built-in bandwidth	Small signal: –3dB, C_L=1nF, TA=25°C	–	120	–	kHz
TPO	Power-on time	T_A=25°C, C_L=1nF, sensitivity 2mV/G, constant magnetic field: 400Gs	–	100	–	us
TTC	Temperature compensation for power-on time	T_A=150˚C, C_L=1nF, sensitivity 2mV/G, constant magnetic field: 400Gs	–	300	–	us
VUVLOH	Undervoltage-lockout threshold	T_A=25°C, the voltage rises and the device starts working		4.1		V
VUVLOL		T_A=25°C, the voltage drops and the device stops working		3.8		V
VPORH	Reset voltage	T_A=25°C, V_{CC} rising	–	4.1	–	V
VPORL		T_A=25°C, V_{CC} goes down	–	3.8	–	V
tPORR	Power-on reset release time	T_A=25°C, V_{CC} rising	–	10	–	us
I_{SCLP}	Output current source	–	–	80	–	mA
I_{SCLN}	Output current sink	–	–	40	–	mA
V_{OL}	Analog output saturated low level	R_L>=4.7KΩ	–	0.5	–	V
V_{OH}	Analog output saturated high level	R_L>=4.7KΩ	V_{CC}–0.3	–	4.97	V

C_L	Output load capacitor	V_{OUT} to GND	–	0.5	1	nF
R_L	Output load resistance	V_{OUT} to GND		10	–	KΩ
		V_{OUT} to V_{CC}		10		KΩ
R_{OUT}	Output resistance	–		9		Ω
t_R	Rise time	T_A=25˚C, constant magnetic field 400Gs, C_L=1nF, sensitivity 2mV/Gs	–	5.5	–	us
TPD	Transmission delay	T_A=25˚C, constant magnetic field 400Gs, C_L=1nF, sensitivity 2mV/Gs	–	4.5	–	us
TRESP	Response time	T_A=25˚C, constant magnetic field 400Gs, C_L=1nF, sensitivity 2mV/Gs	–	4	5	us
VN	Noise	T_A=25˚C, C_L=1nF, sensitivity 2mV/Gs, BWf=Bwi	–	14.1	–	mVp-p
RP	Main current end resistor			1.5	1.8	mΩ
Elin	Linear error	T_A=25˚C, C_L=1nF, sensitivity 2mV/Gs, BWf=Bwi	–	0.4		%
Voq	Static working point	T_A=25˚C, C_L=1nF, sensitivity 2mV/Gs, BWf=Bwi	2.485	2.500	2.515	V

AH950-F-B-50

Parameters	Symbols	Conditions	Min	Typ	Max	Units
External current range	IP		-50		50	A
Sensitivity	Sens	Full scale application of IP for 5ms, T_A=25 ℃		40		mV/A
Output	VOQ			50%V_{CC}or2.5		V
Noise	$V_{NOISE(PP)}$	T_A=25 ℃, 10nF capacitor from V_{OUT} to GND		12		mV
Nonlinear	ELIN	Within the full range IP range, the IP has been applied for 5ms	-1		1	%
Zero current output error	VOE(TA)	IP=0A, T_A=25˚C		±7		mV
	VOE(TOP)HT	IP=0A, TOP=25˚C～150˚C		±15		mV
	VOE(TOP)LT	IP=0A, TOP=－40˚C～25˚C		±18		mV

Sensitivity error	ESEN(TA)	IP=±50A, T_A=25˚C		±1.2		%
	ESEN(TOP)HT	IP=±50A,TOP=25°C～150°C		±2.3		%
	ESEN(TPO)LT	IP=±50A,TOP=–40°C～25°C		±2.3		%
accuracy	ETOT(HT)	IP application time within the full range IP range 5ms, TOP=25˚C～150˚C		±2.5		%
	ETOT(LT)	IP application time within the full range IP range 5ms, TOP=-40˚C～25˚C		±2.5		%

AH950-F-B-100

Parameters	Symbols	Conditions	Min	Typ	Max	Units
Primary current sampling	IP		-100		100	A
Sensitivity	SensTA	Full scale application of IP for 5ms, T_A=25 ℃		20		mV/A
Output	VOQ			50%V_{CC} or 2.5		V
Noise	$V_{NOISE(PP)}$	T_A=25 ℃, 10nF capacitor from V_{OUT} to GND		8		mV
Nonlinear	ELIN	Within the full range IP range, the IP has been applied for 5ms	-1.25		1.25	%
Zero current output error	VOE(TA)	IP=0A, T_A=25˚C		±5		mV
	VOE(TOP)HT	IP=0A, TOP=25˚C～150˚C		±20		mV
	VOE(TOP)LT	IP=0A, TOP=－40˚C～25˚C		±20		mV
Sensitivity error	ESEN(TA)	IP=±100A, T_A=25˚C		±1.2		%
	ESEN(TOP)HT	IP=±100A,TOP=25°C～150°C		±2.3		%
	ESEN(TPO)LT	IP=±100A,TOP=–40°C～25°C		±2.3		%
accuracy	ETOT(HT)	IP application time within the full range IP range 5ms, TOP=25˚C～150˚C		±2.5		%
	ETOT(LT)	IP application time within the full range IP range 5ms, TOP=-40˚C～25˚C		±2.5		%

AH950-F-B-150

Parameters	Symbols	Conditions	Min	Typ	Max	Units
Primary current sampling	IP		-150		150	A
Sensitivity	Sens	Full scale application of IP for 5ms, T_A=25 ℃		13.3		mV/A
Noise	$V_{NOISE(PP)}$	T_A=25 ℃, 10nF capacitor from V_{OUT} to GND		6		mV
Nonlinear	ELIN	Within the full range IP range, the IP has been applied for 5ms	-1		1	%
Zero current output error	VOE(TA)	IP=0A, T_A=25˚C		±5		mV
	VOE(TOP)HT	IP=0A, TOP=25˚C～150˚C		±20		mV
	VOE(TOP)LT	IP=0A, TOP=－40˚C～25˚C		±20		mV
Sensitivity error	ESEN(TA)	IP=±150A, T_A=25˚C		±1.2		%
	ESEN(TOP)HT	IP=±150A,TOP=25℃～150℃		±2.3		%
	ESEN(TPO)LT	IP=±150A,TOP=-40℃～25℃		±2.3		%
accuracy	ETOT(HT)	IP application time within the full range IP range 5ms, TOP=25˚C～150˚C		±2.5		%
	ETOT(LT)	IP application time within the full range IP range 5ms, TOP=-40˚C～25˚C		±2.5		%

AH950-F-B-200

Parameters	Symbols	Conditions	Min	Typ	Max	Units
External current range	IP		-200		200	A
Sensitivity	Sens	Full scale application of IP for 5ms, T_A=25 ℃		10		mV/A
Noise	$V_{NOISE(PP)}$	T_A=25 ℃, 10nF capacitor from V_{OUT} to GND		3		mV
Nonlinear	ELIN	Within the full range IP range, the IP has been applied for 5ms	-1		1	%
Zero current output error	VOE(TA)	IP=0A, T_A=25˚C		±5		mV
	VOE(TOP)HT	IP=0A, TOP=25˚C～150˚C		±20		mV

	VOE(TOP)LT	IP=0A, TOP=－40˚C～25˚C		±20		mV
Sensitivity error	ESEN(TA)	IP=±200A, T_A=25˚C		±1.2		%
	ESEN(TOP)HT	IP=±200A,TOP=25°C～150°C		±2.3		%
	ESEN(TPO)LT	IP=±200A,TOP=—40°C～25°C		±2.3		%
accuracy	ETOT(HT)	IP application time within the full range IP range 5ms, TOP=25˚C～150˚C		±2.5		%
	ETOT(LT)	IP application time within the full range IP range 5ms, TOP=-40˚C～25˚C		±2.5		%

10. Characteristic definition

Sensitivity: The sensitivity indicates the change value of the sensor output for every 1A change in the measured current, in mV/A. The calculation method is to input the forward full range current and the negative full range current, and the sensitivity of the sensor is determined by dividing the difference in output voltage of the sensor at 2 points by the difference in forward full range current and negative full range current. The specific calculation formula is as follows:

SENS=(VOUTIPmax) - OUT (Inmax)/(IPmax Inmax)

Noise (V_{NOISE}): It is generated by thermal noise and Shot noise observed in Hall elements. The noise (mV)/sensitivity (mV/A) can obtain the minimum current that the device can analyze.

Ratio change of static voltage output (%):

$$\Delta V_{IOUTQ(\Delta V)} = \frac{V_{IOUTQ(V_{CC})} / V_{IOUTQ(5V)}}{V_{CC} / 5\ \mathrm{V}} \times 100\%$$

Sensitivity ratio change (%):

$$\Delta \mathrm{Sens}_{(\Delta V)} = \frac{\mathrm{Sens}_{(V_{CC})} / \mathrm{Sens}_{(5V)}}{V_{CC} / 5\ \mathrm{V}} \times 100\%$$

Static Output Voltage (V_{OUT}): The output value of the device when the initial current is zero. The changes in V_{OUT} can be attributed to the resolution of static voltage tuning, hysteresis, and thermal drift in linear ICs.

Accuracy (E_{TOT}): The maximum deviation between the actual output and its ideal value, also known as accuracy.

ETOT is divided into four areas:

- 0A at 25 ℃: The accuracy of zero current at 25 ℃ is not affected by temperature
- 0A exceeds Δ Temperature: The accuracy of zero current, including the impact of temperature.
- Half range current at 25 ℃: The accuracy at half range current at 25 ℃ is not affected by temperature.
- Exceeding Δ Half range current of temperature: The accuracy of half range current, including temperature influence.

10.1 TPO

When the power supply rises to the operating voltage, the chip needs a limited time to power its internal components before it can react to the input magnetic field.

Power-on time: the time it takes for the power supply to reach the minimum working voltage VCCMIN is t1; In the case of an external magnetic field, the time it takes for the output to reach 90% of the stable value t2, the difference between the two is the power-on time.

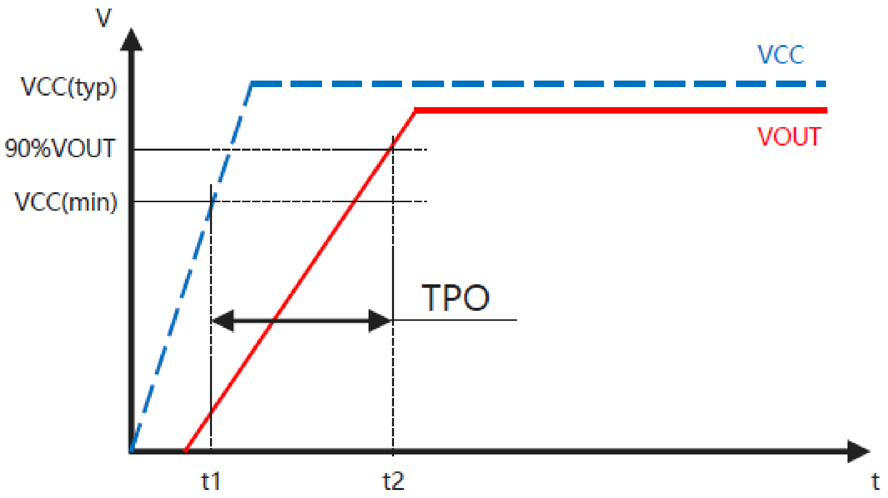


Figure 1: Power-on time definition

10.2 TTC

After power-on, temperature tune-up time is required before effective temperature compensation output.

10.3 TPD

The time difference between when the external magnetic field reaches 20% of the final value and when the output reaches 20% of the final value.

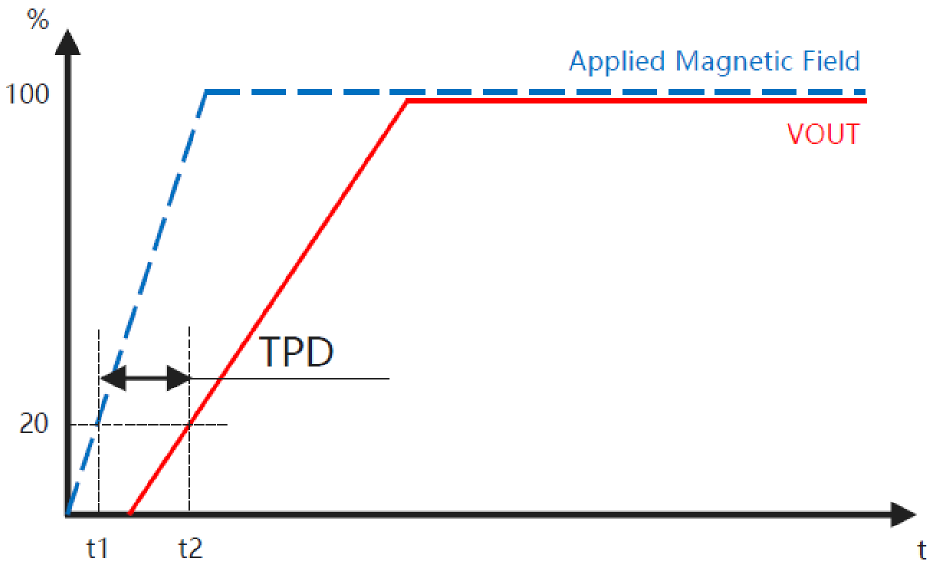


Figure 2: Transmission delay definition

10.4 TR

The time difference between the chip output level rising from 10% to 90%.

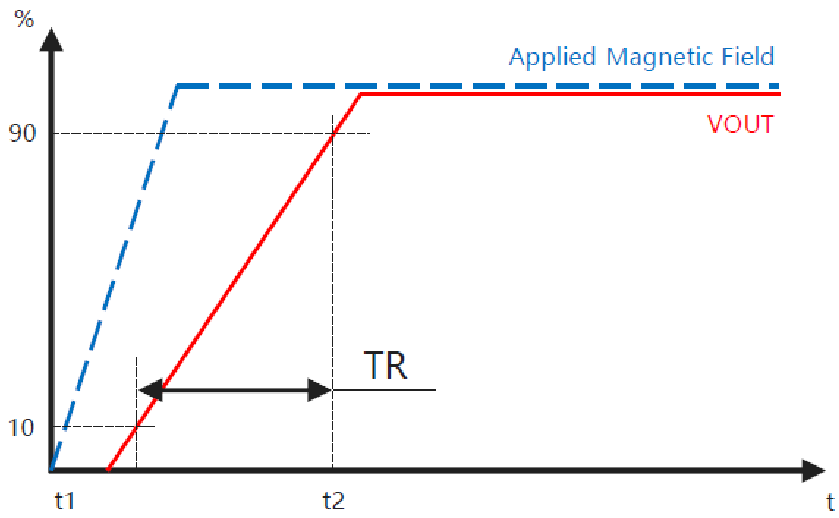


Figure 3: Rise time definition

10.5 TRESP

The time difference when the external magnetic field applied by the chip reaches 80% of the final value and the corresponding output value also reaches 80%.

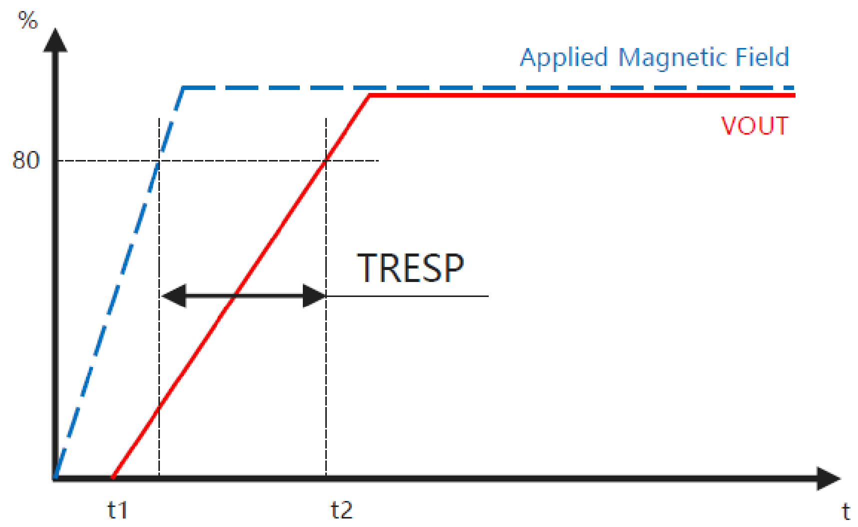


Figure 4: Response time definition

10.6 VOQ

The hall sensor supply voltage and ambient temperature in working range, magnetic field for 0Gs, chip output. Attention: Working at the maximum rated value for a long time may affect the reliability of the device, and exceeding the maximum rated value may damage the device.

10.7 VOE

The difference between the actual output voltage of the sensor and the ideal output voltage supply when the magnetic field is zero. When the output voltage is fixed, the static voltage output error is the difference between the actual output error and the 2.5V voltage. In output mode proportional to the supply, the static voltage output error is the difference between the actual output error and $V_{CC}/2$.

10.8 Sens

Sensitivity indicates the change in the sensor output in mV/Gs for every 1 Gauss change in the magnetic field generated by the current being measured. The calculation method is as follows: the south magnetic field and the north magnetic field are respectively entered, and the difference of the sensor output voltage at 2 points is divided by the difference of the south magnetic field and the north magnetic field, that is, the sensitivity of the sensor. The specific calculation formula is as follows:

$$\text{SENS} = (\text{Vout}(\text{IPma0}) - \text{Vout}(\text{Inma0}))/(\text{IPma0} - \text{Inma0})$$

IPma0 and Inma0 represent the forward full range current and the negative full range current, respectively. Vout (IPma0) and Vout (Inma0) represent the analog output voltage of the sensor at the forward full range current and the negative full range current, respectively.

10.9 ETOT

This error value represents the maximum error of the sensor in various environments, and is equal to the absolute value of the measurement error in each temperature range over the full current measurement range, divided by the maximum output dynamic range of the sensor. It can be expressed as follows::

ETOT(IP)=Ma0(Vout - Vout_idea)/(Vout(IPma0)-Voq)

Ma0(Vout - Vout_idea) represents the maximum error within the measurement range, and (Vout(IPma0)-Voq) represents the maximum output dynamic range of the sensor.

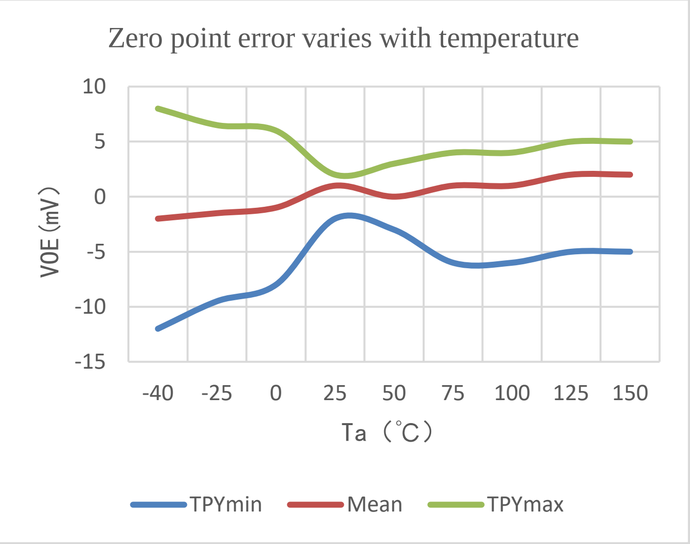
10.10 ELIN

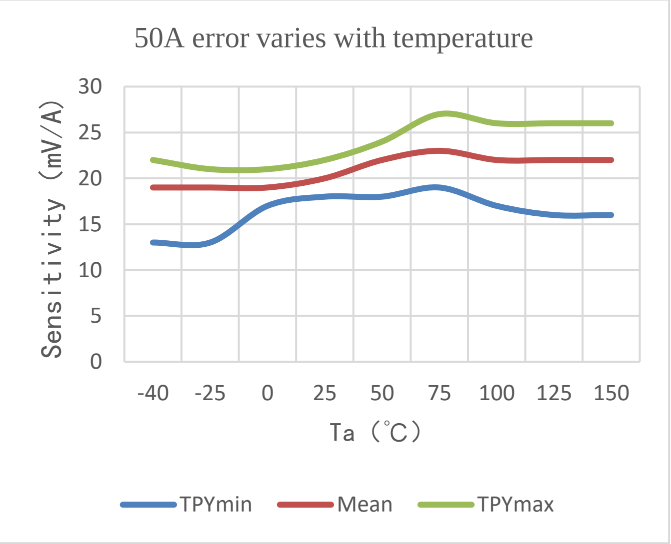
Due to the fact that the sensor is a non ideal device, its output voltage and measured current are not completely linear in practical applications. After linear fitting using the least squares method, the maximum output error of the sensor is divided by the dynamic range of the sensor, which is the linear error of the sensor,

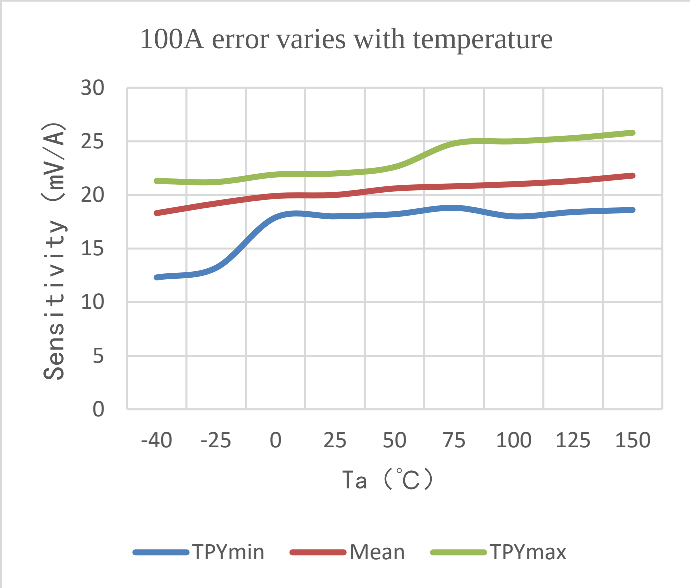
ELIN (IP) =ΔVout/(Vout(IPma0)-Voq)

ΔVout is the maximum linear error in the measurement range of the sensor.

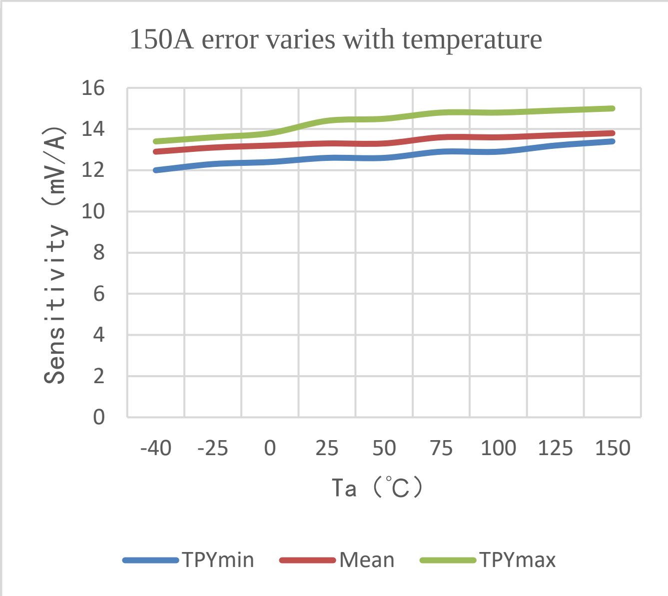
11. Characteristic Performance



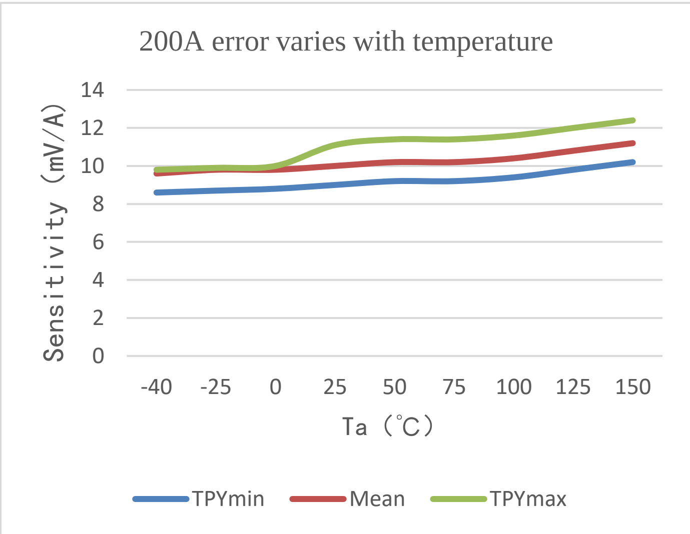




100A error varies with temperature
Sensitivity（mV/A)
30
25
20
15
10
5
0
-40
-25
0
25
50
75
100
125
150
Ta（℃）
TPYmin
Mean
TPYmax

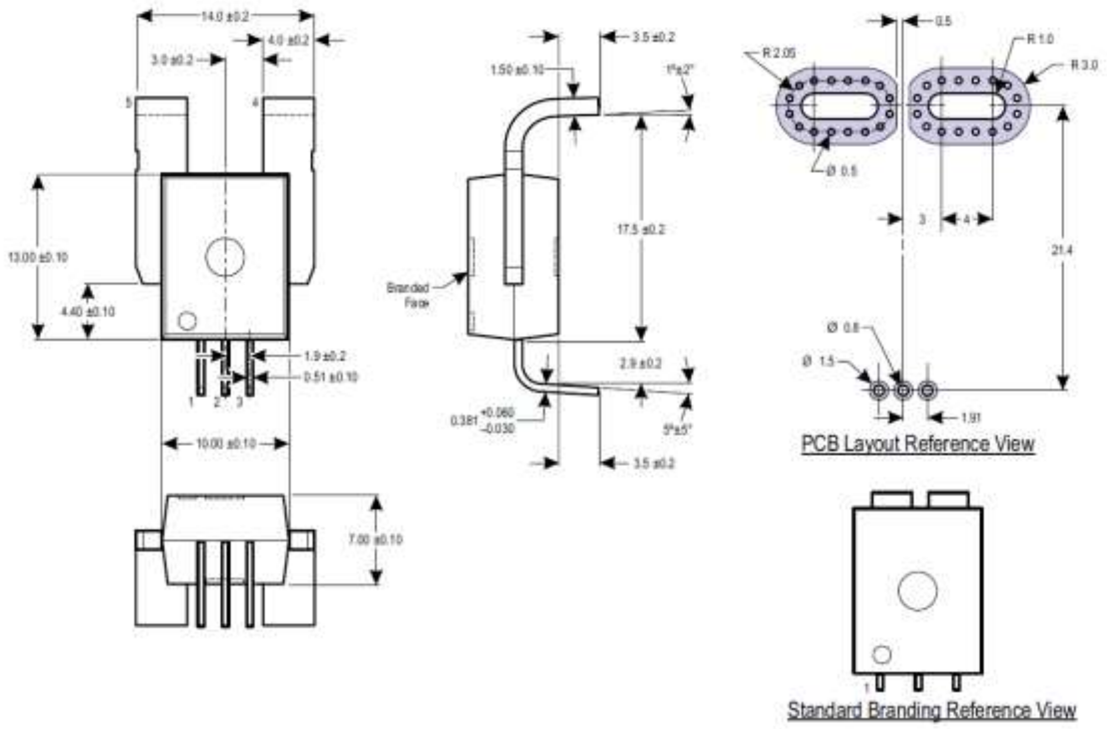


150A error varies with temperature
Sensitivity（mV/A)
16
14
12
10
8
6
4
2
0
-40
-25
0
25
50
75
100
125
150
Ta（℃）
TPYmin
Mean
TPYmax



200A error varies with temperature
Sensitivity（mV/A)
14
12
10
8
6
4
2
0
-40
-25
0
25
50
75
100
125
150
Ta（℃）
TPYmin
Mean
TPYmax

12. Package Material Information



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1. 420	1. 620	0. 056	0. 064
A1	0. 77TYP		0. 03TYP	
b	0. 350	0. 560	0. 0137	0. 022
b1	0. 42TYP		0. 0165TYP	
D	3. 9000	4. 100	0. 154	0. 161
E	2. 900	3. 100	0. 114	0. 122
e	1. 27TYP		0. 050TYP	
e1	2. 54TYP		0. 1TYP	
L	15. 500	16. 200	0. 610	0. 638
θ	45°TYP		45°TYP	

13. Notes

- Hall chips are sensitive devices, and electrostatic protection measures should be taken during use, installation, and storage.
- During installation and use, mechanical stress applied to the device casing and leads should be minimized as much as possible.
- It is recommended that the welding temperature should not exceed 350 ℃ and the duration should not exceed 5 seconds.
- To ensure the safety and stability of Hall chips, it is not recommended to use them beyond the parameter range for a long time.

14. Historical Version

No.	Time	Describe
1	September 6th, 2022	Update Characteristic Performance
2	December 22th, 2022	Update static voltage output error range
3	February 9th, 2023	Update IC limit of operate temperature and storage temperature
4	April 10th, 2023	Version update to V1.2