AH910

Hall Current Sensor

Alfa Electronics Co.,Ltd

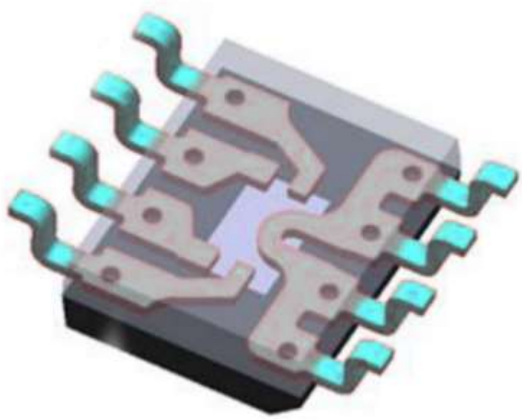
1. Product Introduction

AH910 is a high-performance Hall-effect current sensor that can measure alternating current (AC) or direct current (DC) more effectively. It can be widely used in industrial, consumer and communication equipment.

AH910 series internal integration of a high precision, low noise linear Hall circuit and a low impedance main current loop wire, when the sampling current flows through the main current loop, the magnetic field generated in the Hall circuit induction of the corresponding electrical signal, through the signal processing circuit output voltage signal, so that the product output is strictly proportional to the measured current value.

The linear Hall circuit is produced by advanced BCDMOS process, which includes high sensitivity Hall sensor, Hall signal pre-amplifier, high precision Hall temperature compensation unit, oscillator, dynamic offset elimination circuit and amplifier output module. In the absence of a magnetic field, the current sensor has a static output of 2.5V fixed voltage or 50%VCC. Under the condition of power supply voltage 5V, the static output of the sensor can change linearly with the magnetic field between 0.2 ~ 4.8V, and the linearity can reach 0.4%.

The dynamic offset elimination circuit integrated in AH910 makes the sensitivity of the sensor not affected by external pressure and IC package stress. The AH910 is available in a SOP8 package with an operating temperature range of -40 to 150 ° C, which is RoHS compliant.



2. Function

- Operating Voltage：4.5V～5.5V
- Static common mode output：2.5V or 50%V_{CC}
- Wide measurement range：5A/10A/20A 30A/40A/50A
- Isolation voltage：2500V
- High bandwidth：120kHz；
- Output response time：4μs（(typical value)；
- Stability in the working range：1.5%@25℃～150°C；1%@-40℃～25℃；
- Low noise analog signal path；
- Strong anti-interference ability；
- Strong resistance to mechanical stress, magnetic field parameters are not deviated by external

pressure;

- ESD(HBM):5kV;
- Operating temperature: -40℃～150℃;
- Passed RoHS certification: (EU) 2015/863

3. Application

- Inverter current detection
- Motor phase current detection (Motor control)
- Photovoltaic inverter
- Battery load detection system
- Current transformer
- Switching power supply
- Overload protector

4. Product packaging

Part No.	Sensitivity range	Packages	Packing
AH910-V-B-5	400mV/A	SOP8	100pcs/tube
AH910-V-B-5B	185mV/A	SOP8	100pcs/tube
AH910-V-B-10	200mV/A	SOP8	100pcs/tube
AH910-V-B-20	100mV/A	SOP8	100pcs/tube
AH910-V-B-30	66.7mV/A	SOP8	100pcs/tube
AH910-V-B-40	50mV/A	SOP8	100pcs/tube
AH910-V-B-50	40mV/A	SOP8	100pcs/tube
AH910-F-B-5	400mV/A	SOP8	100pcs/tube
AH910-F-B-5B	185mV/A	SOP8	100pcs/tube
AH910-F-B-10	200mV/A	SOP8	100pcs/tube
AH910-F-B-20	100mV/A	SOP8	100pcs/tube
AH910-F-B-30	66.7mV/A	SOP8	100pcs/tube
AH910-F-B-40	50mV/A	SOP8	100pcs/tube
AH910-F-B-50	40mV/A	SOP8	100pcs/tube
AH910-F-U-5	800mV/A	SOP8	100pcs/tube
AH910-F-U-5B	370mV/A	SOP8	100pcs/tube
AH910-F-U-10	400mV/A	SOP8	100pcs/tube
AH910-F-U-20	200mV/A	SOP8	100pcs/tube
AH910-F-U-30	133.3mV/A	SOP8	100pcs/tube
AH910-F-U-40	100mV/A	SOP8	100pcs/tube
AH910-F-U-50	80mV/A	SOP8	100pcs/tube
Note: F-fixed 2.5V, V-1/2 VDD, B- Bidirectional , U- Unidirectional .			

Content

5. Naming conventions

Part No. | AH910 | F | - | B | - | 5 |

① ② ③ ④

①Series name

②Output mode

Model	Output model
F	Fixed 2.5V
V	Proportional output

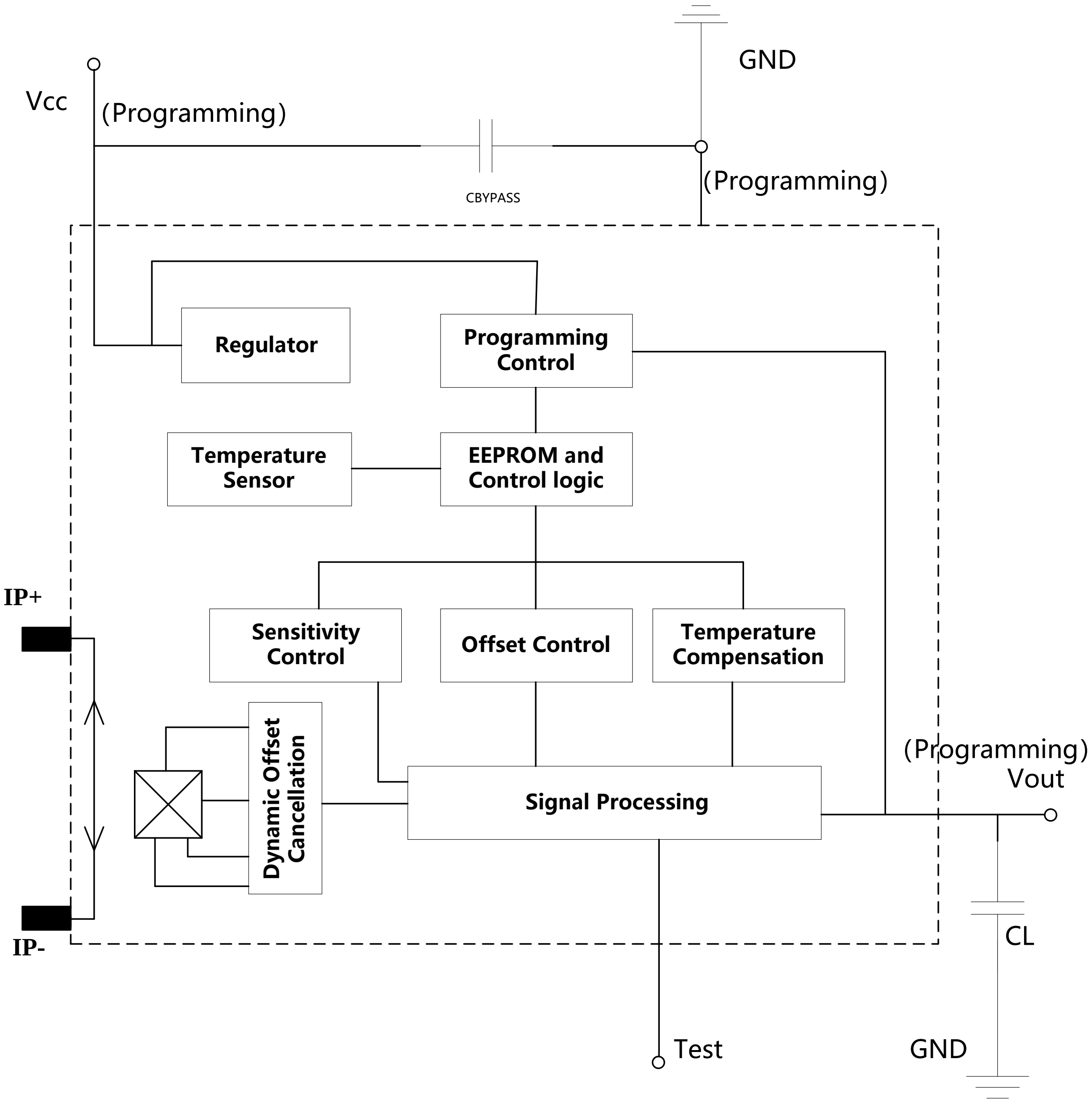
③ Current polarity

Model	Current polarity
B	Bidirectional current
U	Unidirectional current

④Input current range

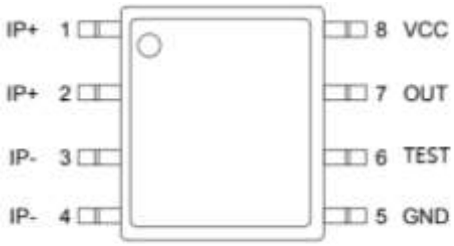
Model	Input current range
5	Full scale detection range: 5A
5B	Full scale detection range： 10.8A
10	Full scale detection range： 10A
20	Full scale detection range： 20A
30	Full scale detection range： 30A
40	Full scale detection range： 40A
50	Full scale detection range： 50A

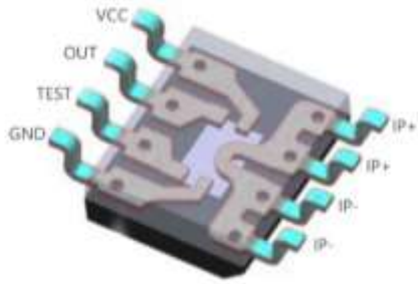
6. Functional Block Diagram



7. Pin information

Name	Number	Functions	Name	Number	Functions
IP+	1	Current input positive end	GND	5	Ground/program pins
IP+	2	Current input positive end	TEST	6	Factory test/hang
IP-	3	Current input negative end	OUT	7	Signal output/program pins
IP-	4	urrent input negative end	VCC	8	Power supply/programming pins





8. Electromagnetic characteristics

8.1 limit parameter

Exceeding the limit parameters during use can lead to unstable chip functionality, and prolonged exposure to this environment can damage the chip.

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	˚C
T_S	Storage temperature	–65	170	˚C
T_J	Maximum junction temperature	–	165	˚C
Endurance	EEPROM	200	–	cycle
Transient impulse current at the current sampling end	IP1pulse100ms		100	A

8.2ESD Parameters

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

8.3Electrical 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℃，output no load	9	11.18	13	mA
BW	Built-in bandwidth	Small signal：–3dB，C_L=1nF，T_A=25℃	–	120	–	kHz
TPO	Power-on time	T_A=25℃，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℃，the voltage rises and the device starts working		4.1		V
VUVLOL		T_A=25℃，the voltage drops and the device stops working		3.8		V
VPORH	Reset voltage	T_A=25℃，V_{CC} rising	–	4.1	–	V
VPORL		T_A=25℃，V_{CC} goes down	–	3.8	–	V
tPORR	Power-on reset release time	T_A=25℃，V_{CC} rising	–	10	–	us
I_{SCLP}	Maximum current source	–	–	80	–	mA
I_{SCLN}	Maximum 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

8.4Precision Parameters

AH910-F-B-05A

Parameters	Symbols	Conditions	Min	Typ	Max	Units
Current range	IP			±5		A
Sensitivity	Sens	Full current range	385	400	415	mV/A
Output noise	$V_{NOISE(PP)}$			56		mV
Zero current output temperature coefficient	$\Delta V_{OUT(Q)}$			0.26		mV/°C
Temperature coefficient of sensitivity	ΔSens	T_A=150°C, T_A=-40°C, relative to 25°C		0		%/°C
Total output error	ETOT		-3.0		3.0	%

AH910-F-B-05B

Parameters	Symbols	Conditions	Min	Typ	Max	Units
Current range	IP			±5		A
Sensitivity	Sens	Full current range	180	185	190	mV/A
Output noise	VNOISE(PP)			46		mV
Zero current output temperature coefficient	ΔVOUT(Q)			0.26		mV/°C
Temperature coefficient of sensitivity	ΔSens	T_A=150°C, T_A=-40°C, relative to 25°C		0		%/°C

Total output error	ETOT		-3.0		3.0	%

AH910-F-B-10

Parameters	Symbols	Conditions	Min	Typ	Max	Units
Current range	IP		-10		10	A
Sensitivity	Sens	Full current range	195	200	205	mV/A
Output noise	VNOISE(PP)			50		mV
Zero current output temperature coefficient	ΔVOUT(Q)			0.26		mV/°C
Temperature coefficient of sensitivity	ΔSens	T_A=150°C, T_A=-40°C, relative to 25°C		0		%/°C
Total output error	ETOT		-3.0		3.0	%

AH910-F-B-20

Parameters	Symbols	Conditions	Min	Typ	Max	Units
Current range	IP		-20		20	A
Sensitivity	Sens	Full current range	96	100	104	mV/A
Output noise	VNOISE(PP)			30		mV
Zero current output temperature coefficient	ΔVOUT(Q)			0.26		mV/°C
Temperature coefficient of sensitivity	ΔSens	T_A=150°C, T_A=-40°C, relative to 25°C		0		%/°C
Total output error	ETOT		-3.0		3.0	%

AH910-F-B-30

Parameters	Symbols	Conditions	Min	Typ	Max	Units
Current range	IP		-30		30	A
Sensitivity	Sens	Full current range	64	66.6	69	mV/A
Output noise	VNOISE(PP)			20		mV
Zero current output temperature coefficient	ΔVOUT(Q)			0.26		mV/°C
Temperature coefficient of	ΔSens	T_A=150°C, T_A=-40°C,		0		%/°C

sensitivity		relative to 25°C				
Total output error	ETOT		-3.0		3.0	%

AH910-F-B-40

Parameters	Symbols	Conditions	Min	Typ	Max	Units
Current range	IP		-40		40	A
Sensitivity	Sens	Full current range	47	50	53	mV/A
Output noise	VNOISE(PP)			15		mV
Zero current output temperature coefficient	ΔVOUT(Q)			0.26		mV/°C
Temperature coefficient of sensitivity	ΔSens	T_A=150°C, T_A=-40°C, relative to 25°C		0		%/°C
Total output error	ETOT		-3.0		3.0	%

AH910-F-B-50

Parameters	Symbols	Conditions	Min	Typ	Max	Units
Current range	IP		-50		50	A
Sensitivity	Sens	Full current range	37	40	43	mV/A
Output noise	VNOISE(PP)			11		mV
Zero current output temperature coefficient	ΔVOUT(Q)			0.26		mV/°C
Temperature coefficient of sensitivity	ΔSens	T_A=150°C, T_A=-40°C, relative to 25°C		0		%/°C
Total output error	ETOT		-3.0		3.0	%

9. Characteristic definition

9.1 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.

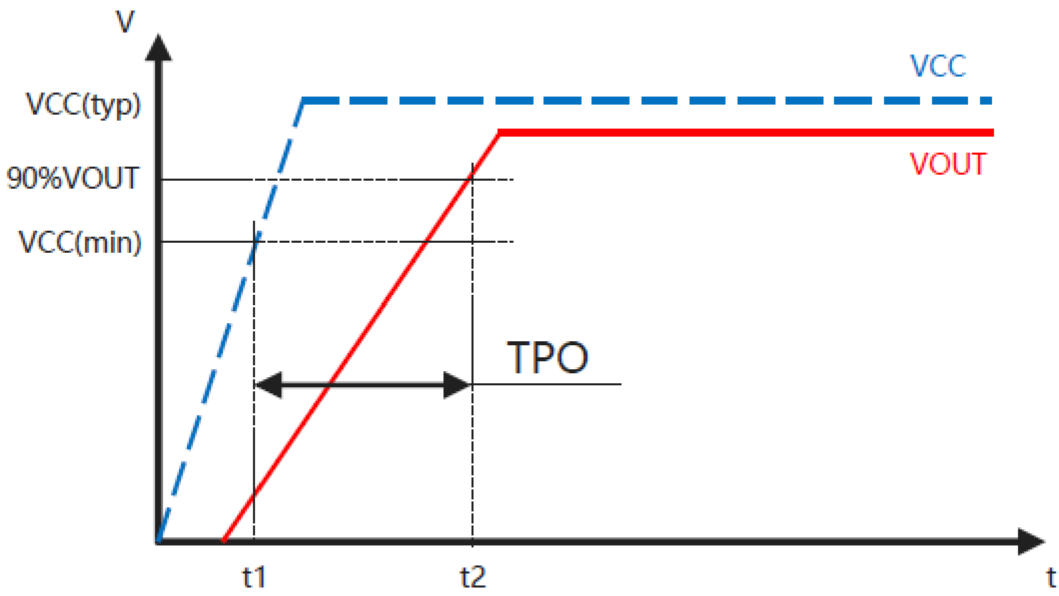


Figure 1: Power-on time definition

9.2 TTC

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

9.3 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.

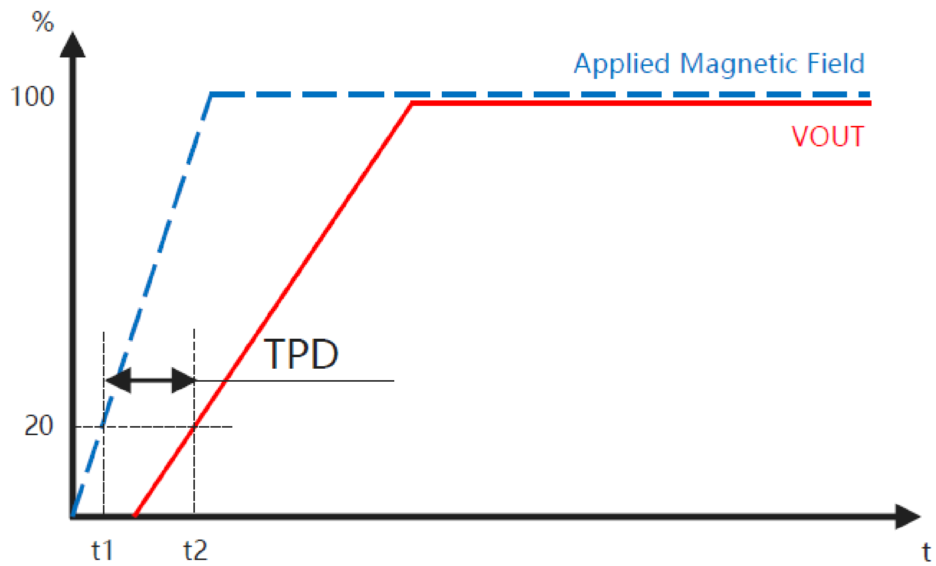


Figure 2: Transmission delay definition

9.4 TR

The time difference between the chip output level rising from 10% to 90%, both TR and TRESP are negatively affected from eddy currents if used to ground the conductive plane.

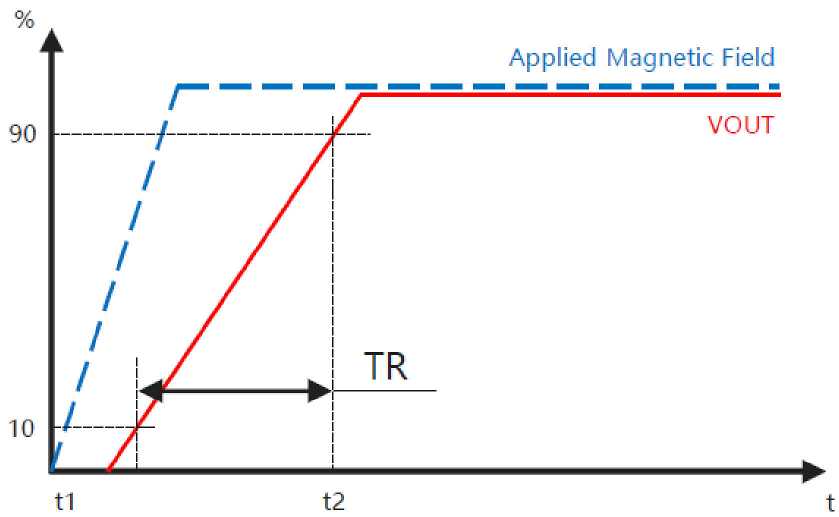


Figure 3: Rise time definition

9.5 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%.

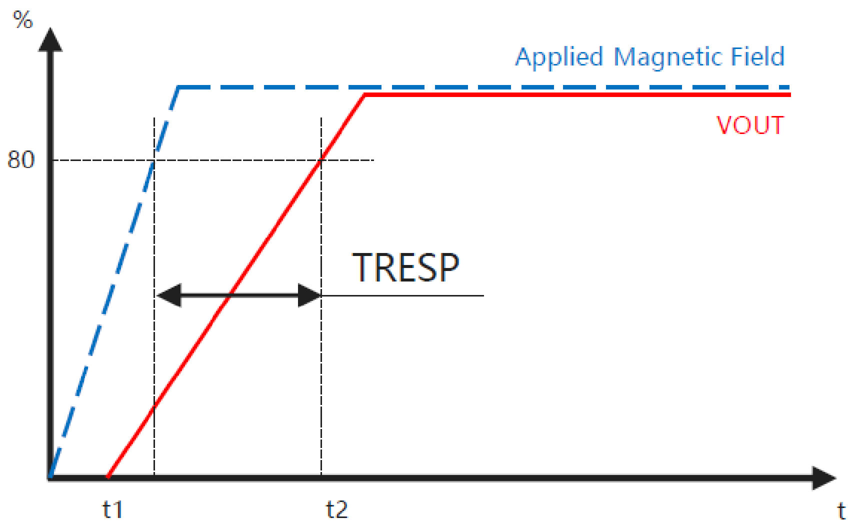


Figure 4: Response time definition

9.6 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.

9.7 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 $V_{CC}/2$.

9.8 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:

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

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.

9.9 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::

$$\mathrm{ETOT(IP)} = \mathrm{Ma0(Vout - Vout\_idea)/(Vout(IPma0) - Voq)}$$

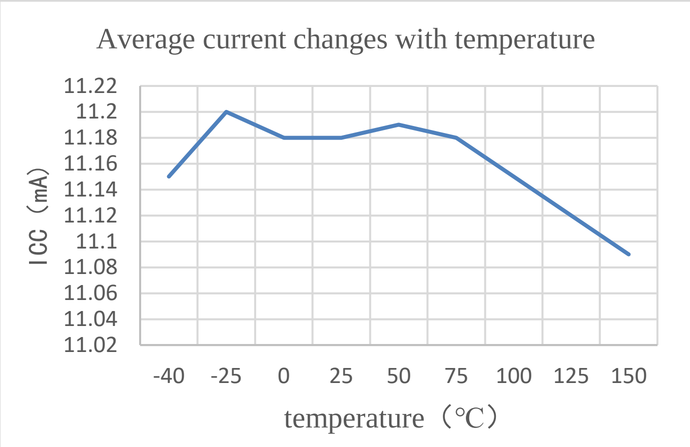
Ma0(Vout - Vout_idea) represents the maximum error within the measurement range, and (Vout(IPma0)-Voq) represents the maximum output dynamic range of the sensor.

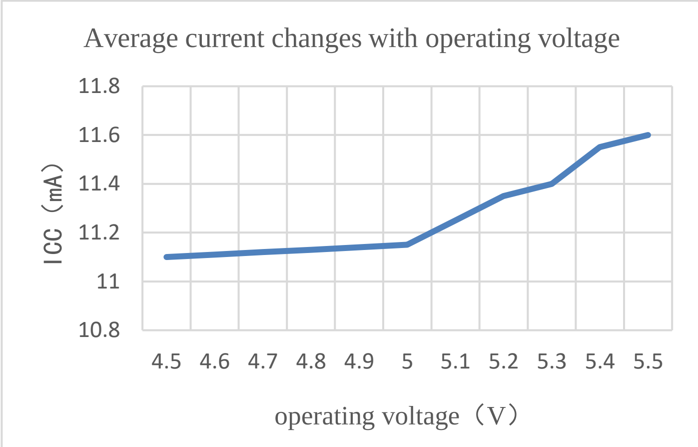
9.10 ELIN

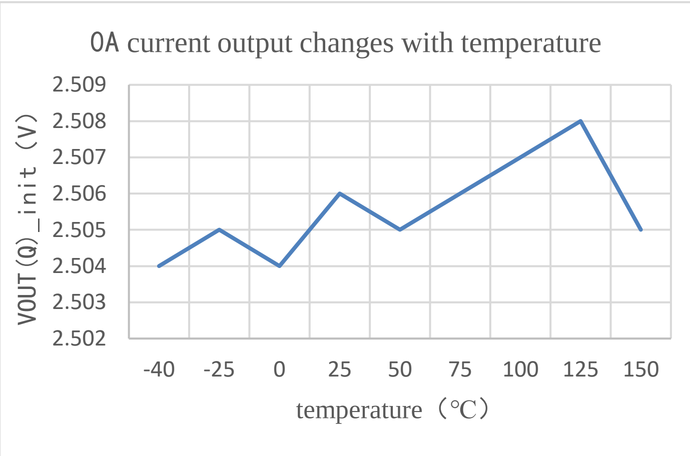
Due to the fact that the sensor is a non ideal device, its output voltage and measured current are not completely linear in practical applications. After linear fitting using the least squares method, the maximum output error of the sensor is divided by the dynamic range of the sensor, which is the linear error of the sensor, ELIN（IP）=ΔVout/(Vout(IPmaO)-Voq)

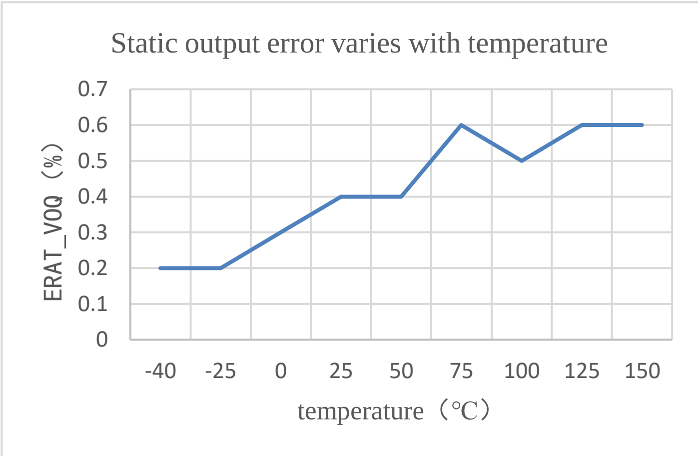
ΔVout is the maximum linear error in the measurement range of the sensor.

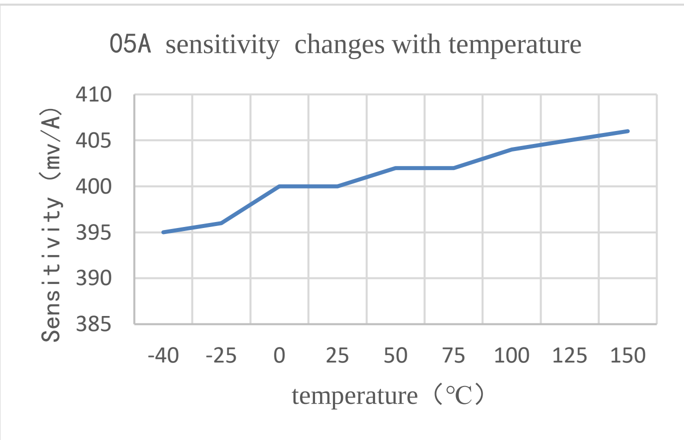
10. Characteristic Performance

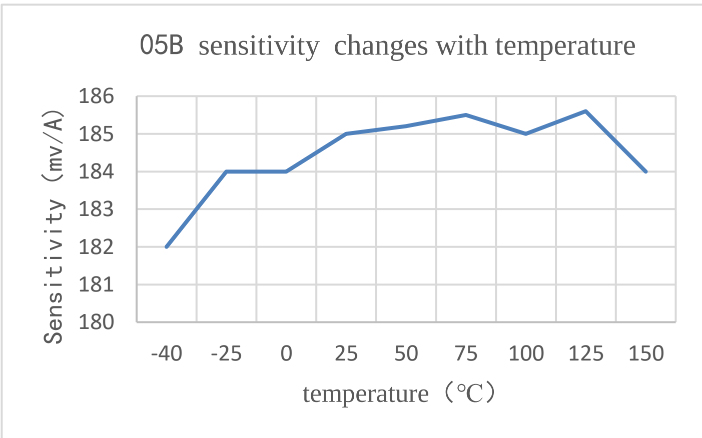


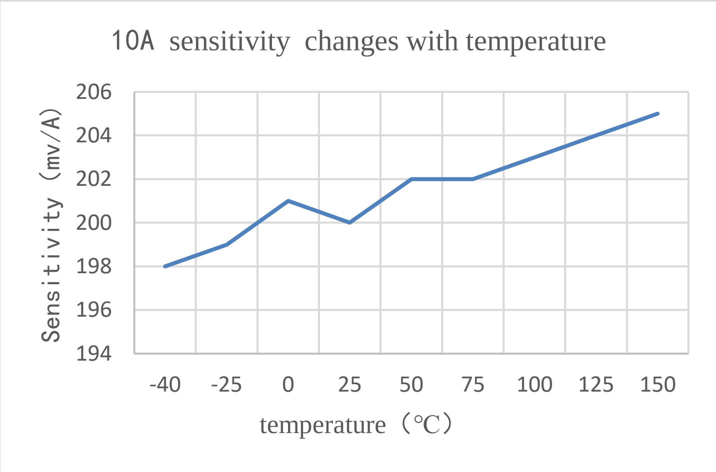




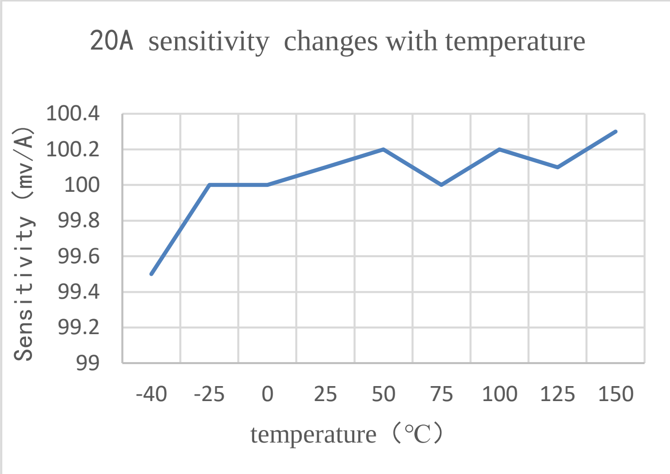




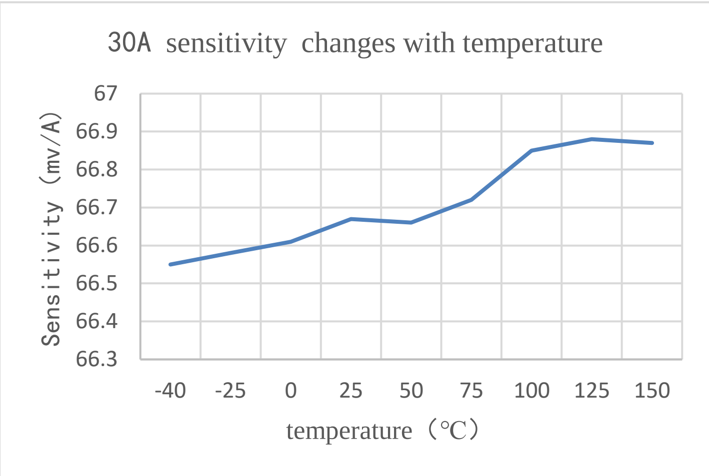




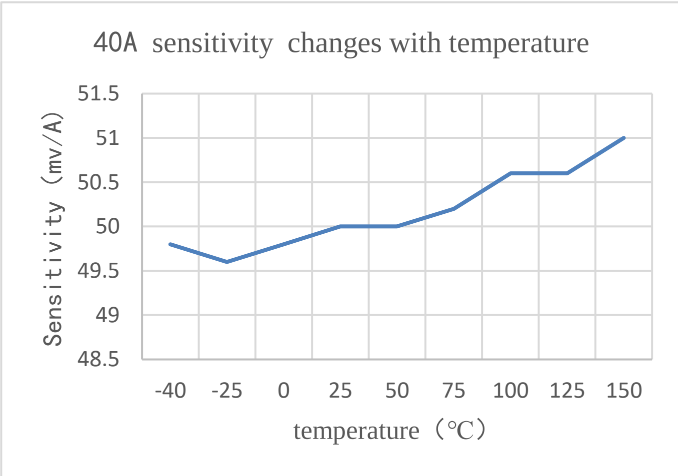
10A sensitivity changes with temperature
Sensitivity (mv/A)
206
204
202
200
198
196
194
-40 -25 0 25 50 75 100 125 150
temperature (℃)



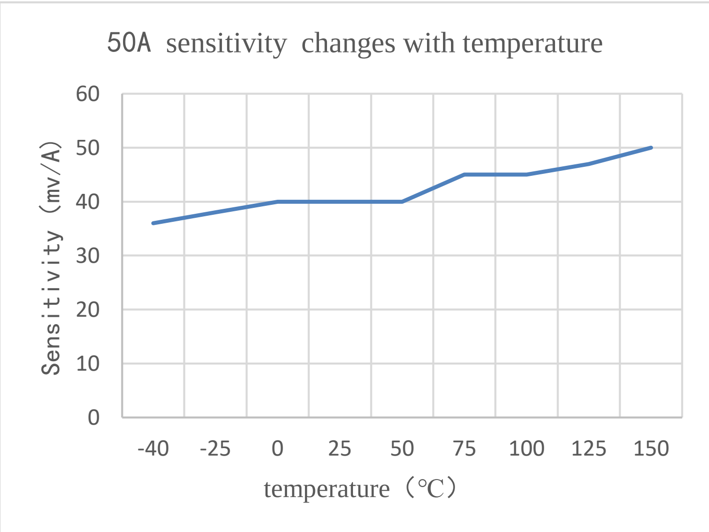
20A sensitivity changes with temperature
Sensitivity (mv/A)
100.4
100.2
100
99.8
99.6
99.4
99.2
99
-40 -25 0 25 50 75 100 125 150
temperature (℃)



30A sensitivity changes with temperature
Sensitivity (mv/A)
67
66.9
66.8
66.7
66.6
66.5
66.4
66.3
-40 -25 0 25 50 75 100 125 150
temperature (℃)

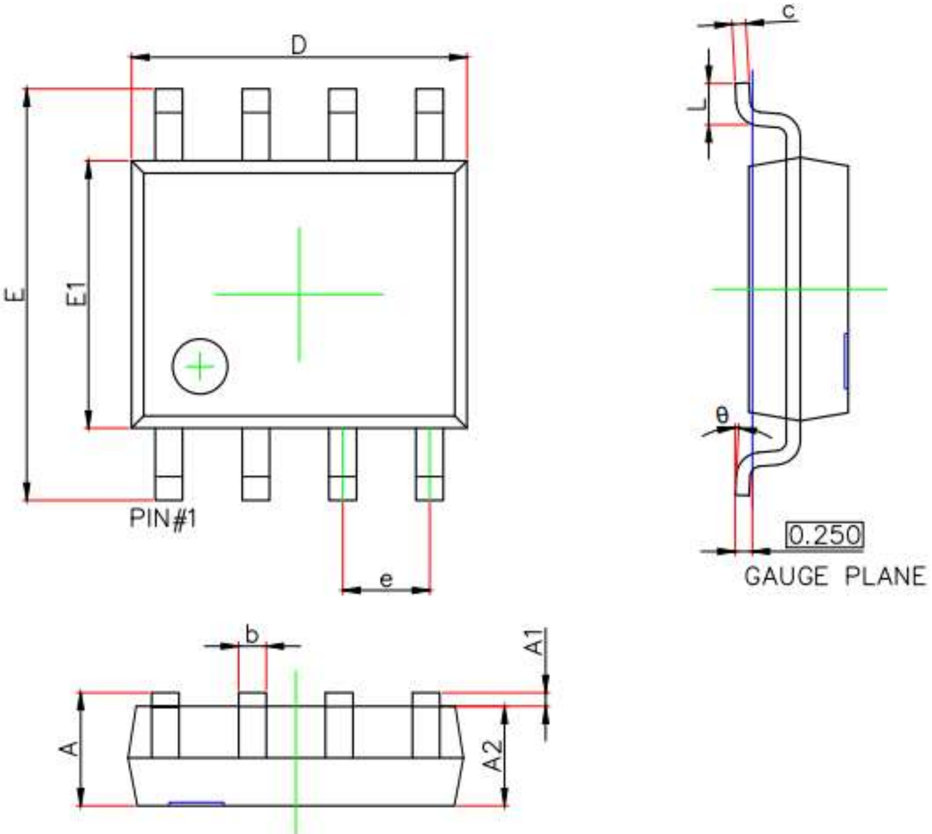


40A sensitivity changes with temperature
Sensitivity (mv/A)
51.5
51
50.5
50
49.5
49
48.5
-40 -25 0 25 50 75 100 125 150
temperature (℃)



50A sensitivity changes with temperature
Sensitivity (mv/A)
60
50
40
30
20
10
0
-40 -25 0 25 50 75 100 125 150
temperature (℃)

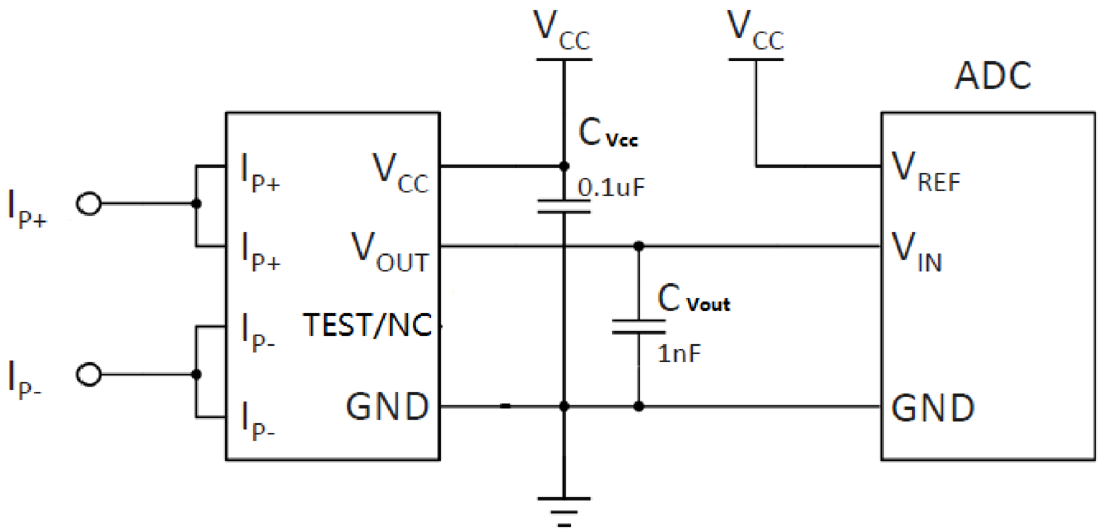
11. Package Material Information



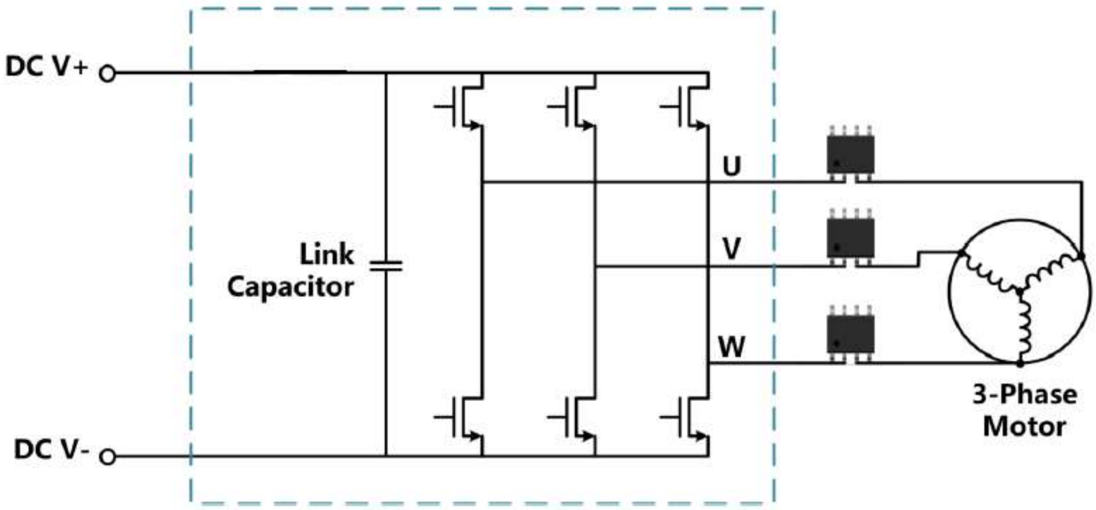
Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1. 350	1. 750	0. 530	0. 069
A1	0. 100	0. 250	0. 004	0. 010
A2	1. 350	1. 550	0. 053	0. 061
b	0. 330	0. 510	0. 013	0. 020
c	0. 170	0. 250	0. 007	0. 010
D	4. 800	5. 000	0. 189	0. 197
e	1. 270（BSC）		0. 050（BSC）	
E	5. 800	6. 200	0. 228	0. 224
E1	3. 800	4. 000	0. 150	0. 157
L	0. 400	1. 270	0. 016	0. 050
θ	0°	8°	0°	8°

12. Typical application circuit

The typical application circuit of AH910 includes a filtering capacitor C_{VCC} between V_{CC} and ground, as well as an optional filtering capacitor C_{VOUT} between output and ground. At the input end of the measured current, pin 1 and pin 2 are short circuited together, serving as the input end of the measured current. Pin 3 and pin 4 are short circuited together, serving as the output end of the measured current. The analog output signal of the sensor is completely proportional to the measured AC/DC current.



Typical application circuit



3-phase motor control application circuit

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