HX810S

Hall Current Sensor

1.Product Introduction

HX810S is a single chip programmable Hall effect linear sensor produced using advanced BCD technology. It includes a high sensitivity Hall sensor, high-precision Hall temperature compensation unit, Hall signal preamplifier, oscillator, dynamic offset elimination circuit, and amplifier output module. It can provide customers with more effective AC/DC current detection solutions and is widely used in communication, industrial, and consumer electronic devices.

HX810S adopts overcurrent protection with high bandwidth dynamic offset cancellation technology. In the absence of a magnetic field, the static output can be selected as 50% V_{CC} or a fixed value of 2.5V. The internally integrated dynamic imbalance elimination circuit ensures that the sensitivity of the IC is not affected by external pressure and IC packaging stress.

The output voltage of HX810S is proportional to the applied magnetic field strength, and customers can program on the power pin to adjust the chip sensitivity and static (zero field) output voltage, thereby improving product performance in the final application.

HX810S has a static output voltage adjustable range of 2.5V ± 0.2V or 50% VCC, and an output sensitivity adjustable range of 1.8~30mV/Gs.

2. Function

- Single chip programmable
- Accuracy (typical value): ± 1mV@25 ℃
- High linearity：±0.1%@25℃；
- High bandwidth：65kHz；
- Output response time：4μs（typical value）；
- Stability within the working range：1.5%@25℃～150℃；1%@-40℃～25℃；
- V_{OUT} fixed 2.5V output；
- V_{REF} fixed output 2.5V；
- Low noise analog signal path；
- Strong anti-interference ability；
- Strong resistance to mechanical stress, and the magnetic field parameters are not offset 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）；
- Solar inverter；
- Battery load detection system;
- Current transformer；
- Switching power supply；
- Overload protection device；

4. Products packaging

Part No.	Sensitivity range	Packages	Packing
HX810S-A	1.66～3.65mV/Gs	TO94	1000pcs/ bag
HX810S -B	3.65～7.32mV/Gs	TO94	1000pcs/ bag
HX810S -C	7.32～14.82mV/Gs	TO94	1000pcs/ bag
HX810S -D	14.82～29.3mV/Gs	TO94	1000pcs/ bag

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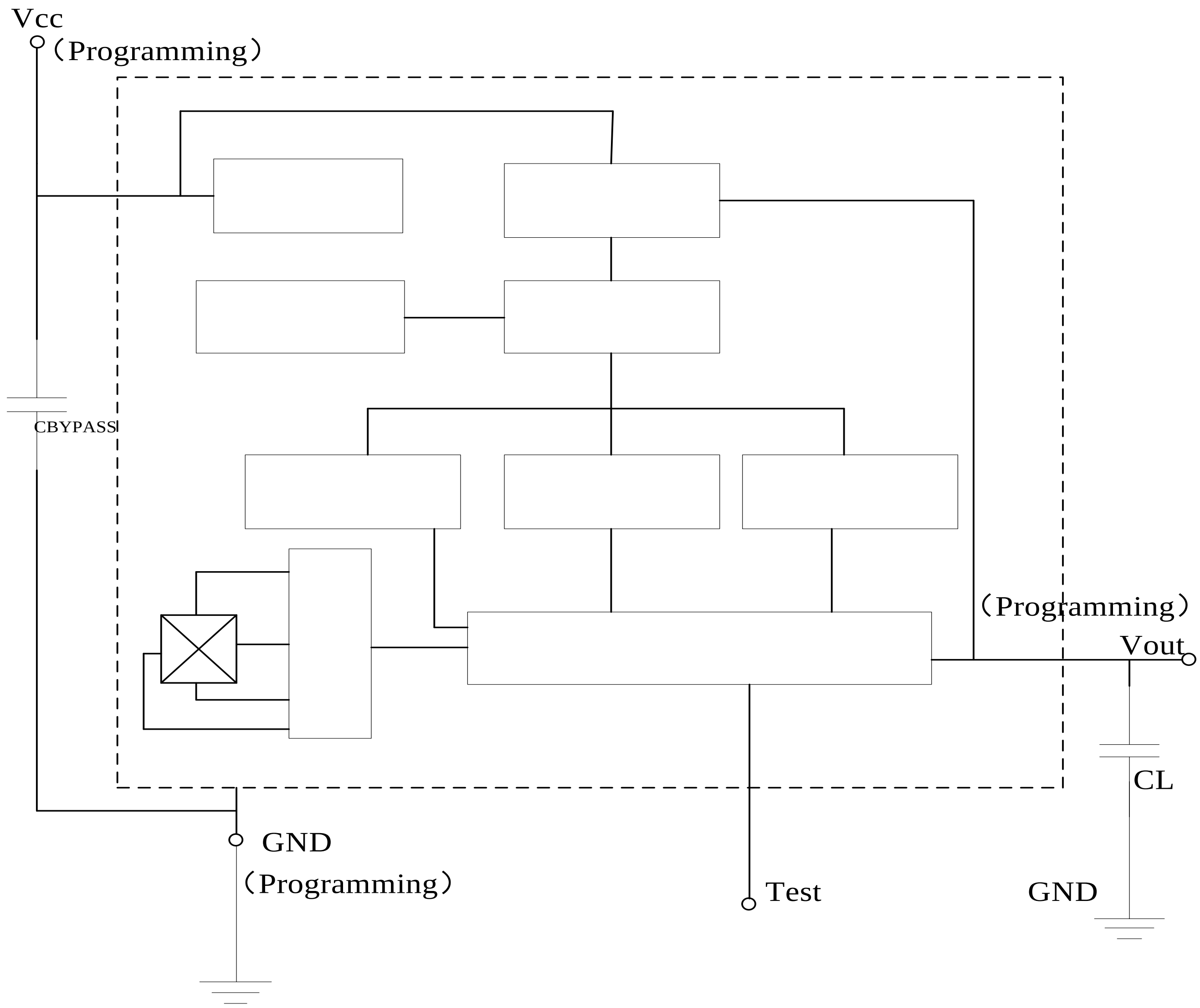
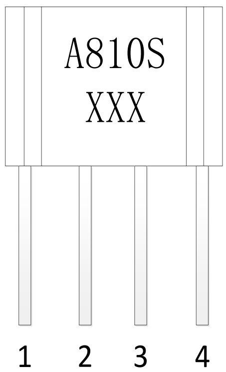
5. Functional Block Diagram

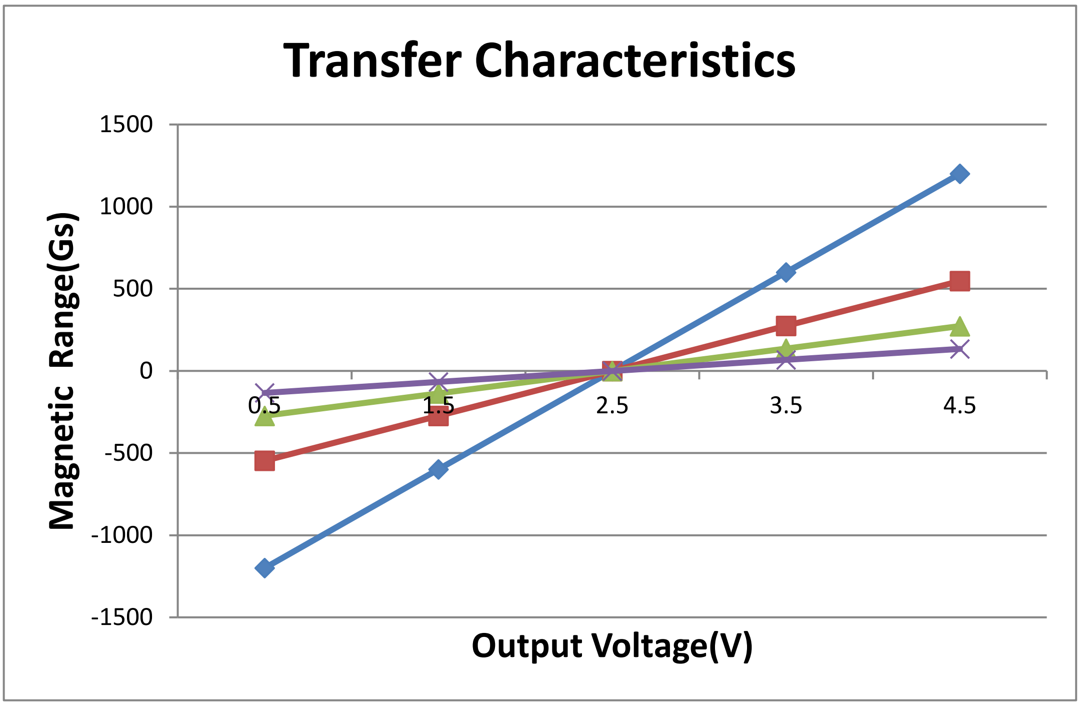


6. Pin information

No.	Name	Describe
1	V_{CC}	Power supply/programming pins
2	V_{OUT}	simulate output/ programming pins
3	TEST	Programming test pin/output 2.5V reference
4	GND	Grounding/programming pins

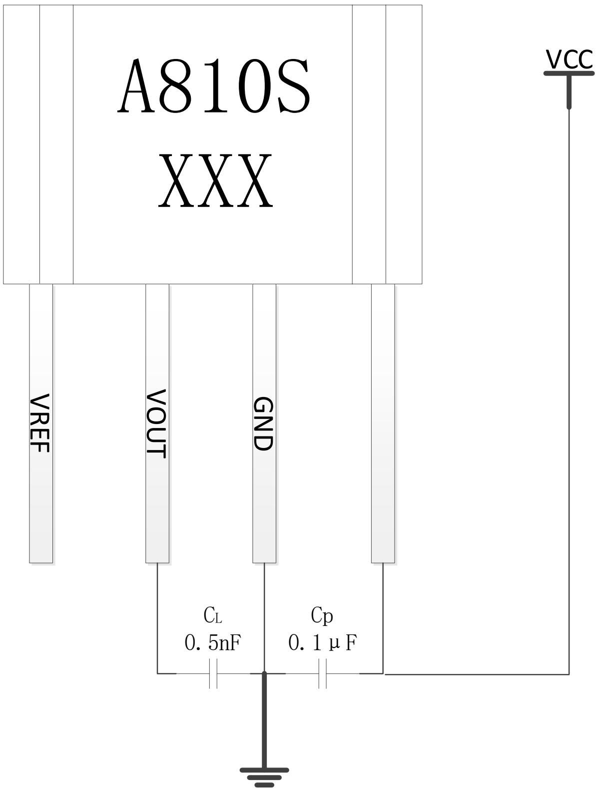


7. Output characteristics



8. Typical Application Circuit

HX810 typical application circuit, C_L filter capacitor, C_P bypass capacitor



9. Electromagnetic characteristics

9.1 limit parameter

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

Symbol	Parameters	Min	Max	Unit
V_{CC}	Power supply current	-	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	operating ambient temperature	-40	150	℃
T_S	storage temperature	-65	175	℃
T_J	maximum junction temperature	-	170	℃
Endurance	EEPROM	200	-	cycle

9.2ESD ratings

Symbol	Describe	Executive standcards	Max	Unit
V_{ESD}	HBM	JEDEC JS-001-2017	5	kV

9.3Electrical Parameters

Symbol	Parameters	Test condition	Min	Typ	Max	Unit
V_{CC}	Power supply current	-	4.5	5	5.5	V
I_{CC}	Power supply current	T_A=25℃，Output unloaded	9	11.4	13	mA
BW	Built in bandwidth	Small signal：–3dB，C_L=1nF，T_A=25℃	-	120	-	kHz
V_{REF}	Reference output	–	2. 48	2. 5	2. 52	V
TPO	TPO	T_A=25℃，C_L=1nF，sensitivity 2mV/G，constant magnetic field：400Gs	-	100	-	us
TTC	TTC	T_A=150℃，C_L=1nF，sensitivity 2mV/G，constant magnetic field：400Gs	-	300	-	us
VUVLOH	Undervoltage-	T_A=25℃，The voltage rises		4.1		V

	lockout threshold	and the device begins to operate				
VUVLOL		T_A=25℃, The voltage drops and the device stops operating		3.8		V
VPORH	Reset voltage	T_A=25℃, V_{CC} rises	-	4.1	-	V
VPORL		T_A=25℃, V_{CC} drops	-	3.8	-	V
tPORR	Power on reset release time	T_A=25℃, V_{CC} rises	-	10	-	us
I_{SCLP}	Maximum current source	-	-	80	-	mA
I_{SCLN}	Maximum current sink	-	-	40	-	mA
V_{OL}	Analog output saturation low level	R_L>=4.7kΩ	-	0.5	-	V
V_{OH}	Analog output saturation high level	R_L>=4.7kΩ	V_{CC}-0.3	-	4.7	V
C_L	Output load capacitance	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℃, constant magnetic field 400Gs, C_L=1nF, sensitivity 2mV/Gs	-	5.5	-	μs
TPD	transmission delay	T_A=25℃, constant magnetic field 400Gs, C_L=1nF, sensitivity 2mV/Gs	-	4.5	-	μs
TRESP	response time	T_A=25℃, constant magnetic field 400Gs, C_L=1nF, sensitivity 2mV/Gs	-	4	5	μs
VN	noise	T_A=25℃, C_L=1nF, sensitivity 2mV/Gs,BWf=Bwi	-	14.1	-	mVp-p

9.4 Precision parameters

Symbol	Parameters	Test condition	Min	Typ	Max	Unit
LinERR	Linear sensitivity		-0.1	<±0.05	0.1	%

	error					
SymERR	symmetry sensitivity error		-0.1	<±0.05	0.1	
ERAT_VOQ	Static voltage output error	V_{CC}=4.5 to 5.5V, T_A=25℃	-	0.4	-	%
ΔSNST_PKG	Sensitivity drift (caused by packaging)	T_A=25℃, Temperature cycling 25℃ to 150℃ and back to 25℃	-	±1.25	-	%

9.5 programming parameters

Symbol	Parameters	Test condition	Min	Typ	Max	Unit
VOUT(Q)_init	Initially programmed static voltage output	T_A=25℃,V_{CC}=5V	-	2.5	-	V
VOQ_PR	Static voltage output programming range	T_A=25℃,V_{CC}=5V	2.3	-	2.7	V
VOQ_STEP	Average static voltage output step value	T_A=25℃,V_{CC}=5V	-	2.38	-	mV
EVOQ_STEP	Static voltage output programming resolution	T_A=25℃,V_{CC}=5V	-	±0.5×EVOQ_STEP	-	mV
SENS_INIT	Initial non programming sensitivity for each gear position	SENS_COARSE=001 ,T_A=25℃	-	2.5	-	mV/Gs
		SENS_COARSE=000 ,T_A=25℃	-	5	-	mV/Gs
		SENS_COARSE=111 ,T_A=25℃	-	10	-	mV/Gs
		SENS_COARSE=110 ,T_A=25℃	-	20	-	mV/Gs
SENS_PR	Sensitivity programming gear	SENS_COARSE=001 ,T_A=25℃	1.80		3.65	mV/Gs
		SENS_COARSE=000 ,T_A=25℃	3.65		7.32	mV/Gs
		SENS_COARSE=111 ,T_A=25℃	7.32		14.82	mV/Gs
		SENS_COARSE=110 ,T_A=25℃	14.82		30.00	mV/Gs
Sens_fine_s	Average fine	SENS_COARSE=001		7.5		µV/Gs

tep	sensitivity step value	,T_A=25℃				
		SENS_COARSE=000 ,T_A=25℃		15		µV/Gs
		SENS_COARSE=111 ,T_A=25℃		30		µV/Gs
		SENS_COARSE=110 ,T_A=25℃		60		µV/Gs

9.6 factory-programmed static voltage output temperature coefficient

Symbol	Parameters	Test condition	Min	Typ	Max	Unit
ΔSensTC	Sensitivity drift of each temperature range	T_A=25℃ to 150℃	-2.5		2.5	%
		T_A=–40℃ to 25℃	-3		3	%
SENS_TC_STEP	Average sensitivity temperature compensation step value		-	0.23	-	%
ΔVOQ_TC	Static voltage output drift in different temperature ranges	T_A=150℃,T_A=–40℃,calculated relative to 25℃	-	0	-	mV/℃
StepQVOTC	Average static voltage output temperature compensation step value		-	3.6	-	mV

9.7 programmed lock bits

EELOCK_BIT	EEPROM		-	1	-	Bit

10. Characteristic definition

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.

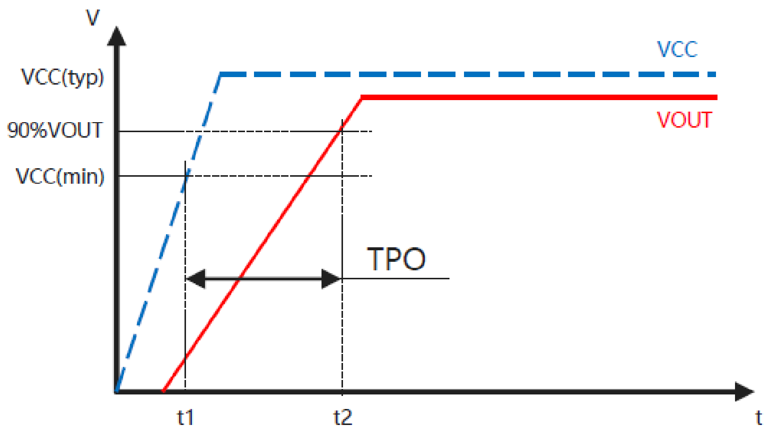


Figure 1: Power-on time definition

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.

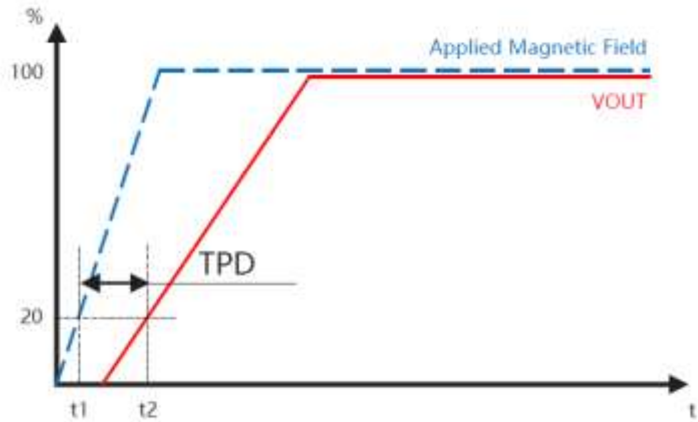


Figure 2: Transmission delay definition

10.4 TR

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

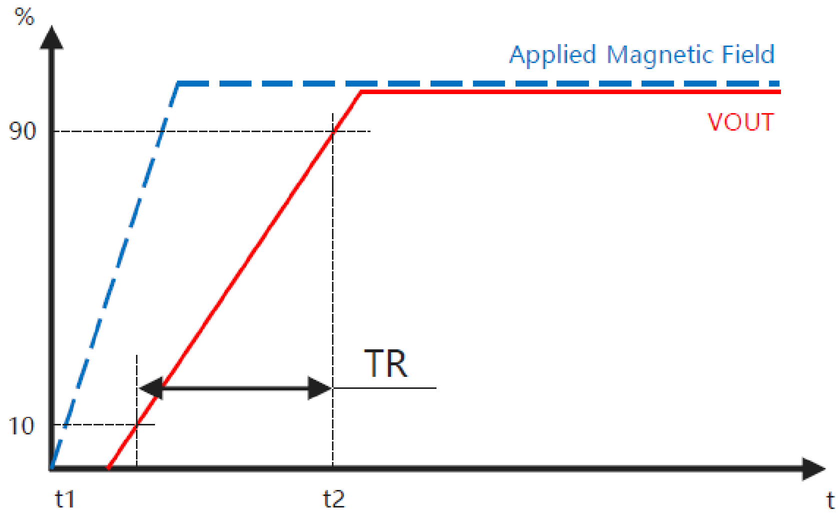


Figure 3: Rise time definition

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%. If the conductive plane grounding is used, both TR and TRESP will be negatively affected by eddy currents.

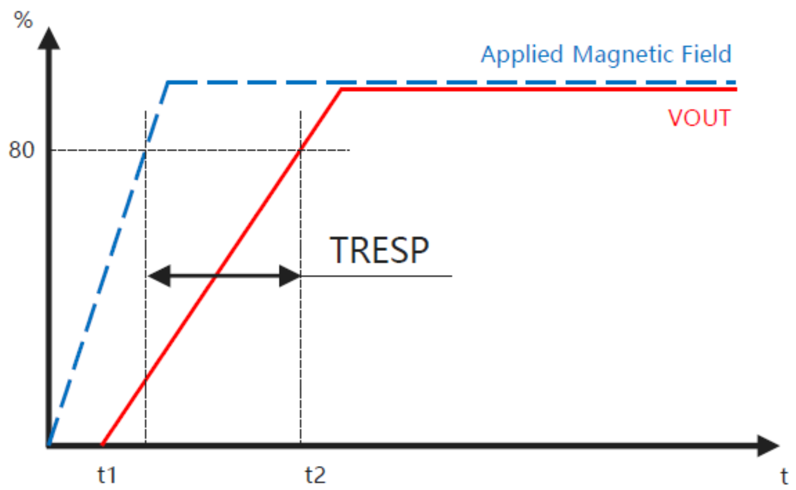


Figure 4: Response time definition

10.6 VOQ

The hall sensor supply voltage and ambient temperature in working range, magnetic field for 0Gs, chip output.

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:

$$\mathrm{SENS} = (\mathrm{Vout(GSmax)} - \mathrm{Vout(GNmax)})/(\mathrm{GSmax} - \mathrm{GNmax})$$

GSmax and GNmax are the south magnetic field and the north magnetic field respectively, and Vout(GSmax) and Vout(GNmax) are the analog output voltage of the sensor when it is moving towards the south magnetic field and the north magnetic field respectively.

10.9 ETOT

This error value represents the maximum error of the sensor in various environments, which is equal to the absolute value of the measurement error in each temperature range in the whole measurement range, divided by the maximum output dynamic range of the sensor. The details can be expressed as follows:

$$\mathrm{ETOT(IP)} = \mathrm{Max}(V_{OUT} - V_{OUT}\_\mathrm{idea})/(V_{OUT}(\mathrm{IPmax}) - \mathrm{Voq})$$

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

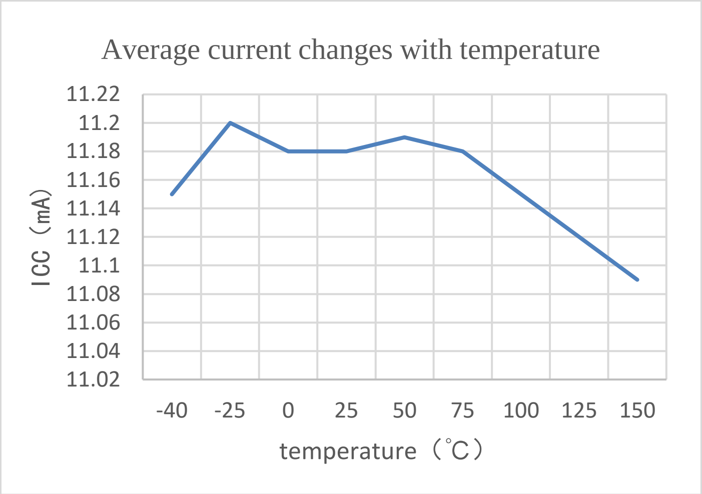
10.10 ELIN

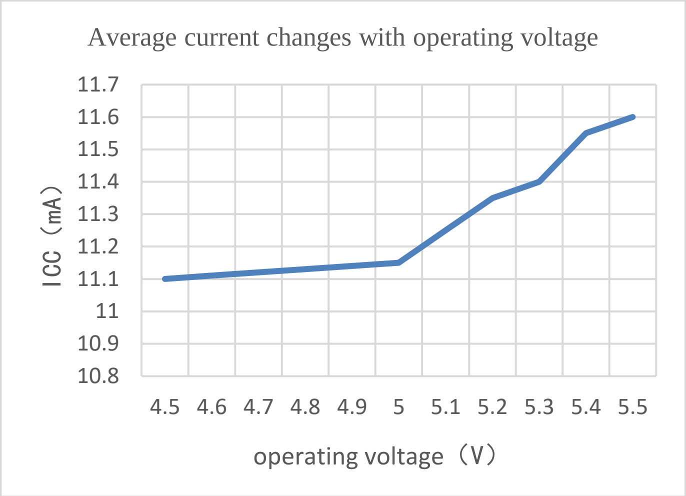
Because the sensor is not ideal, the output voltage of the sensor and the measured magnetic field are not completely linear in practical application. After linear fitting by least square method, the maximum output error of the sensor divided by the dynamic range of the sensor is the linear error of the sensor.

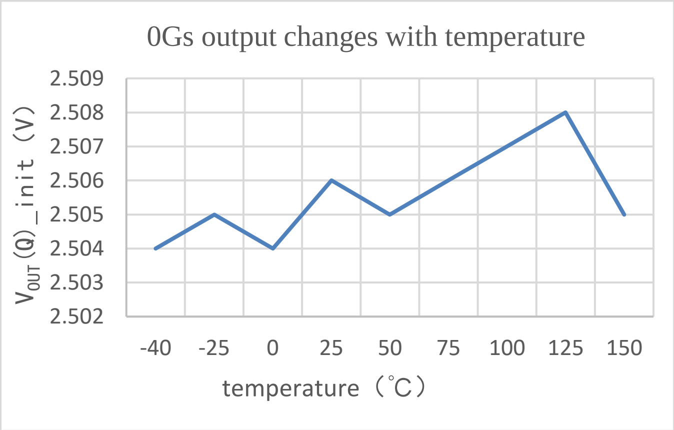
$$\mathrm{ELIN(IP)} = \Delta \mathrm{Vout}/(\mathrm{Vout(IPmax)} - \mathrm{Voq})$$

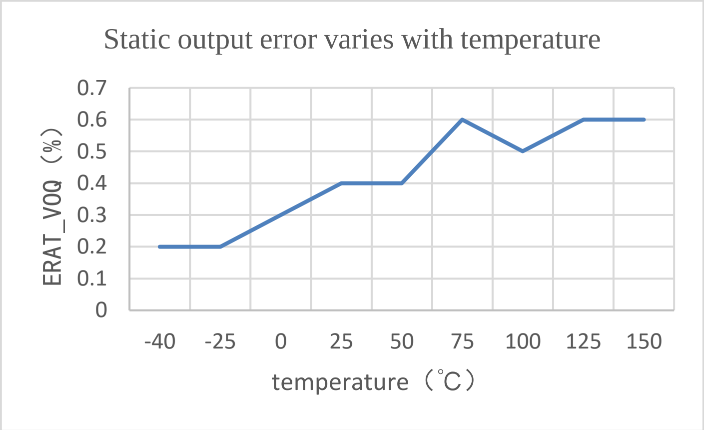
ΔVout is the maximum linear error in the measurement range of the sensor.

11. Characteristic Performance





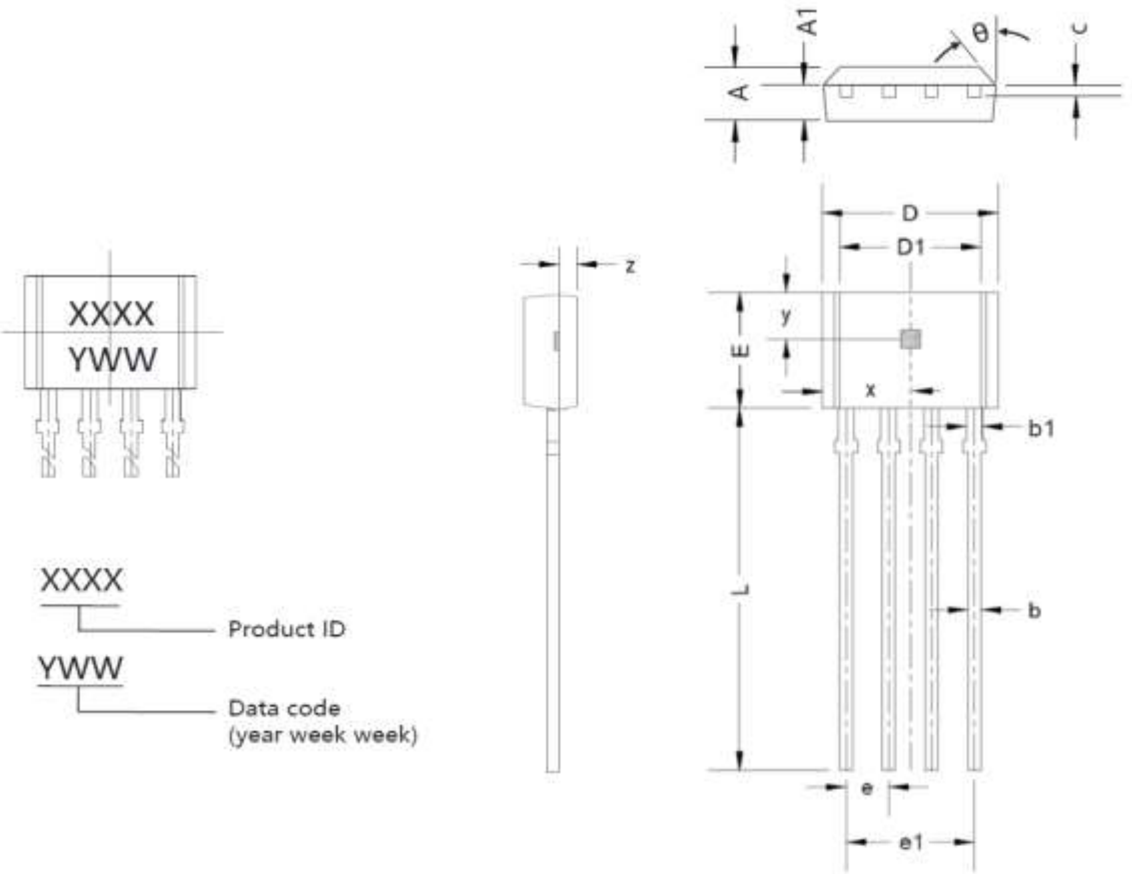




12. Ordering information

No.	Packages	Packing	temperature range
HX810S-A	TO94	1000/ bag	-40℃～150℃
HX810S-B	TO94	1000/ bag	-40℃～150℃
HX810S-C	TO94	1000/ bag	-40℃～150℃
HX810S-D	TO94	1000/ bag	-40℃～150℃

13. Package Material Information



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.400	1.800	0.055	0.071
A1	0.700	0.900	0.028	0.035
b	0.360	0.500	0.014	0.020
b1	0.380	0.550	0.015	0.022
c	0.360	0.510	0.014	0.020

D	4.980	5.280	0.196	0.208
D1	3.780	4.080	0.149	0.161
E	3.450	3.750	0.136	0.148
e	1.270(BSC)		0.050(BSC)	
e1	3.710	3.910	0.146	0.154
L	14.900	15.300	0.587	0.602
x	2.565(BSC)		0.101(BSC)	
y	1.170(BSC)		0.046(BSC)	
z	0.500(BSC)		0.020(BSC)	
θ	45°		45°	

14. 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 °C 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.

15. 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