Integrated Hall High-Performance Linear Current Sensor

1.Introduction

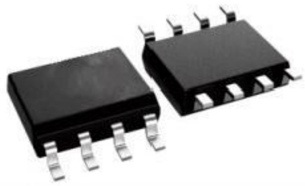
The ACS724 is a high-performance Hall effect current sensor that effectively measures both alternating (AC) and direct (DC) currents, making it suitable for a wide range of applications in industrial, consumer, and communication devices. The ACS724 series integrates a high-precision, low-noise linear Hall circuit and a low-resistance main current loop conductor. When the sampled current flows through the main current loop, the generated magnetic field induces a corresponding electrical signal in the Hall circuit, which is processed to output a voltage signal that is strictly proportional to the measured current.

The linear Hall circuit is produced using advanced BCDMOS technology, featuring a highly sensitive Hall sensor, Hall signal amplifier, high-precision temperature compensation unit, oscillator, dynamic offset cancellation circuit, and amplifier output module. In the absence of a magnetic field, the static output of the current sensor is 50% V. Under a supply voltage of 5V, the sensor's static output can linearly vary between 0.2 to 4.8V based on the magnetic field, with linearity reaching up to 0.4%.

The integrated dynamic offset cancellation circuit ensures that the sensor's sensitivity is unaffected by external pressure and IC packaging stress. The ACS724 is available in an SOP8 package and operates within a temperature range of -40 to 150°C, complying with RoHS standards.

2.Application

- Inverter current detection
- Motor phase current detection (motor control) for photovoltaic inverters
- Battery load detection system
- Current transformer
- Switch power supply
- Overload protection device



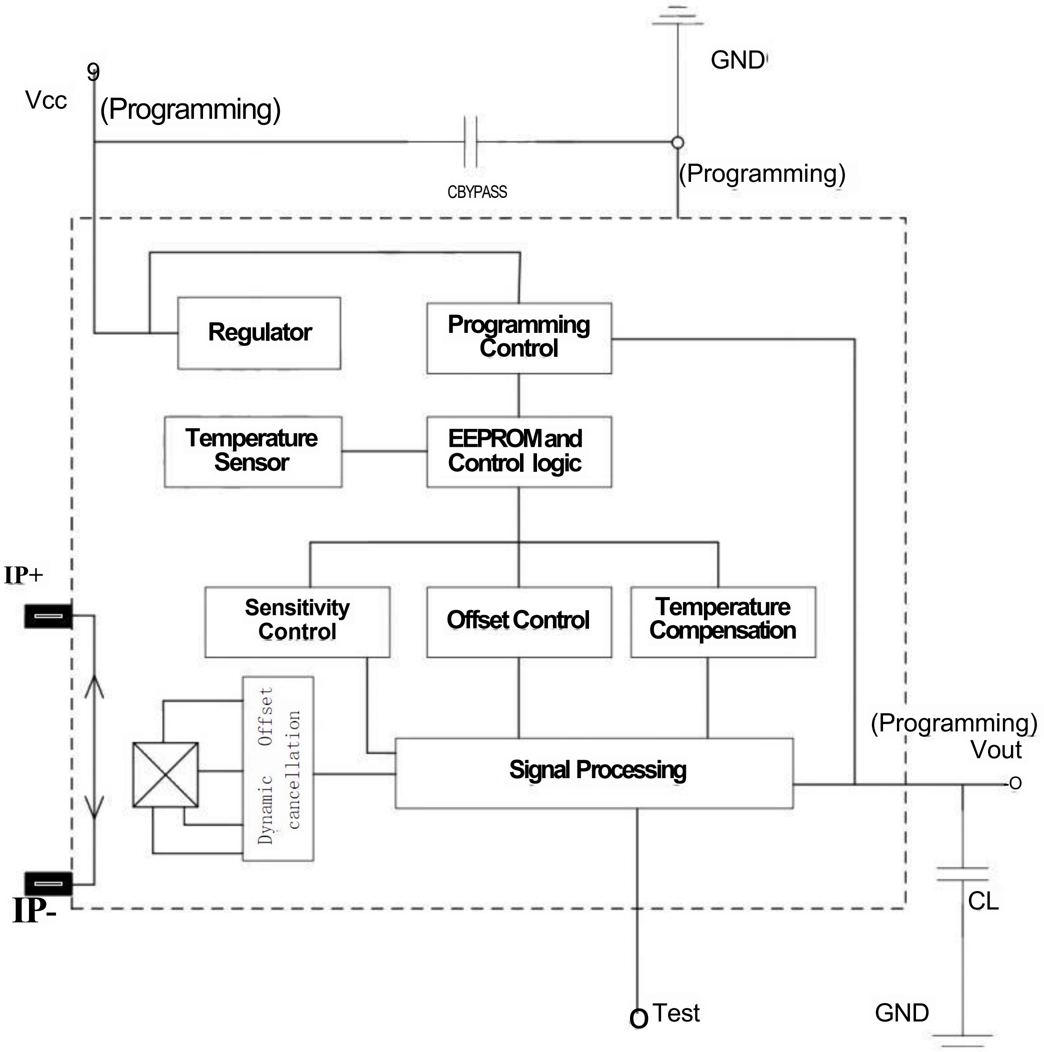
3.Product Functions

- Operating voltage: 4.5V – 5.5V
- Static common-mode output point: 50% Vc
- Wide measurement range: 5A/10A/20A/30A/50A
- Isolation voltage: 2500V
- High bandwidth: 120kHz
- Output response time: 4μs (typical);
- Stability within operating range: 1.5% @ 25℃~150℃; 1% @ -40℃~25℃;
- Low noise analog signal path; strong anti-interference capability;
- High resistance to mechanical stress; magnetic field parameters not affected by external pressure;
- ESD (HBM): 5kV;
- Operating temperature: -40℃~150℃;
- RoHS certified: (EU) 2015/863.

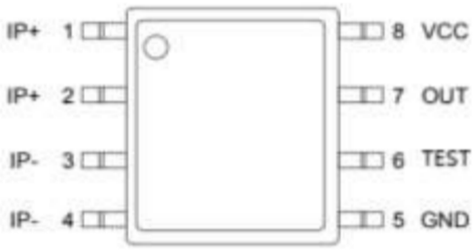
4.Product Package

Model	Sensitivity	Package	Product Packaging
ACS724LLCTR-05AB-T	400mV/A	SOP-8	Tape and reel, 3000 per reel.
ACS724LLCTR-10AU-T	400mV/A	SOP-8	Tape and reel, 3000 per reel.
ACS724LLCTR-10AB-T	200mV/A	SOP-8	Tape and reel, 3000 per reel.
ACS724LLCTR-20AB-T	100mV/A	SOP-8	Tape and reel, 3000 per reel.
ACS724LLCTR-20AU-T	200mV/A	SOP-8	Tape and reel, 3000 per reel.
ACS724LLCTR-30AB-T	66.7mV/A	SOP-8	Tape and reel, 3000 per reel.
ACS724LLCTR-30AU-T	133.3mV/A	SOP-8	Tape and reel, 3000 per reel.
ACS724LLCTR-50AB-T	40mV/A	SOP-8	Tape and reel, 3000 per reel.
Note: 1/2 VDD, AB - bidirectional, AU - unidirectional.			

5.Functions Picture



6.Pin information



Name	Number	Function	Name	Number	Function
IP+	1	Current input positive terminal	GND	5	Ground / Programming pin
IP+	2	Current input positive terminal	TEST	6	Factory test / NC (not connected)
IP-	3	Current input negative terminal	OUT	7	Signal output / Programming pin
IP-	4	Current input negative terminal	VCC	8	Power supply / Programming pin

7.Electromagnetic characteristics

7.1Limit parameters

Exceeding limit parameters during use can lead to unstable chip functionality, and prolonged exposure to such conditions may damage the chip.

Symbol	Parameter	Min	Min	Min
V_{CC}	Power Supply Voltage	—	6	V
V_{OUT}	Output Voltage	—	Vcc-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	170	℃
T_J	Maximum Junction Temperature		165	℃
Endurance	EEPROM Programming Cycle Count	200		cycle
Current Sensing Terminal Transient	IP1pulse100ms		100	A

7.2ESD Parameter

Symbol		Implementation Standard	Max	Unit
V_{ESP}	Human body discharge model	JEDECJS-001-2017	5	kV

7.3Electrical parameters

Symbol	Parameter	Test Conditions	Min	Typical	Max	Unit
V_{cc}	Working voltage	—	4.5	5	5.5	V
I_{cc}	Working current	TA=25℃,Output no load	9	11.18	13	mA
BW	Built-in bandwidth	Smallsignal:-3dB, C=1nF,TA=25℃	—	120	—	KHz
TP0	Power-on time	TA=25℃,C=1nF,Sensitivity 2mV/G,Constant magnetic field：400Gs	—	100	—	us
TTC	Temperature compensation power-on time	TA=150℃,CL=1nF,Sensitivity 2mV/G,Constant magnetic field：400Gs	—	300	—	us
VUVLOH	Undervoltage lockout threshold	TA=25℃,The voltage rises		4.1		V
VUVLOL		TA=25℃,The voltage drops and the device stops working		3.8		V
VPORH	Reset voltage	TA=25℃,Vcc Rise		4.1		V
VPORL		TA=25℃,Vcc Decline	—	3.8	—	V
tPORR	Power-on reset release time	TA=25℃,Vcc Rise	—	10	—	us
I_{SCLP}	Maximum current source	—	—	80	—	mA
I_{SCLN}	Maximum current sink	—	—	40	—	mA
V_{OL}	Analog output saturation low level	RL>=4.7KQ	—	0.5	—	V
V_{OH}	Analog output saturation high level	RL>=4.7KQ	Vcc-0.3	—	4.97	V
C_L	Output load capacitance	VourtoGND	—	0.5	1	nF
R_L	Output load resistance	VourtoGND		10	—	KQ
		VourtoVcc		10		KQ
R_{OUT}	Output resistance			9		Q
t_R	Rise time	TA=25℃,Constant magnetic field 400Gs, CL=1nF,Sensitivity 2mV/Gs	—	5.5		us
TPD	Transmission delay	TA=25℃,Constant magnetic field 400Gs, C=1nF,Sensitivity2mV/Gs	—	4.5	—	us
TRESP	Response time	TA=25℃,Constant magnetic field 400Gs, C=1nF,Sensitivity 2mV/Gs	—	4	5	us
VN	Noise	TA=25℃,C=1nF,Sensitivity 2mV/Gs,BWf=Bwi	—	14.1	—	mVp-p
RP	Main current terminal resistance			1.5	1.8	mΩ
Elin	Linearity error	TA=25℃,C=1nF,Sensitivity 2mV/Gs,BWf=Bwi	—	0.4		%

V_{oq}	Static working point	TA=25℃,C=1nF,Sensitivity 2mV/Gs,BWf=Bwi	2.485	2.5	2.515	V

7.4Accuracy parameters

ACS724LLCTR-05A

Parameter	Symbol	Conditions	Min	Typical	Max	Unit
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	△$V_{OUT(Q)}$			0.26		mV/℃
Sensitivity Temperature Coefficient	△ Sens	TA=150℃,TA=-40℃, Relative to 25℃		0		%/℃

ACS724LLCTR-10A

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Current range	IP		-10		10	A
Sensitivity	Sens	Full current range	195	200	205	mV/A
Output noise	$V_{NOISE(PP)}$			50		mV
Zero current output temperature coefficient	△$V_{OUT(Q)}$			0.26		mV/℃
Sensitivity temperature coefficient	△Sens	TA=150℃,TA=-40℃, Relative to 25℃		0		%/℃
Total output error	ETOT		-3		3	%

ACS724LLCTR-20A

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
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	△$V_{OUT(Q)}$			0.26		mV/℃
Sensitivity temperature coefficient	△Sens	TA=150℃,TA=-40℃, Relative to 25℃		0		%/℃
Total output error	ETOT		-3		3	%

ACS724LLCTR-30A

Parameter	Symbol	Conditions	Min	Typ	Max	c
Current range	IP		-30		30	A
Sensitivity	Sens	Full current range	64	66.6	69	mV/A
Output noise	$V_{NOISE(PP)}$			20		mV
Zero current output temperature coefficient	$\triangle V_{OUT(Q)}$			0.26		mV/℃
Sensitivity temperature coefficient	△Sens	TA=150℃,TA=-40℃, Relative to 25℃		0		%/℃
Total output error	ETOT		-3		3	%

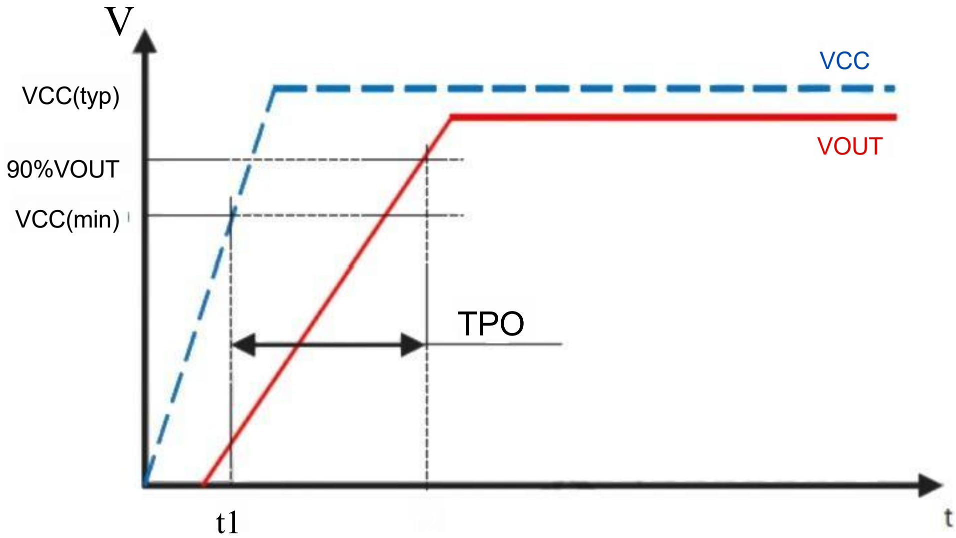
ACS724LLCTR-50A

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Current range	IP		-50		50	A
Sensitivity	Sens	Full current range	37	40	43	mV/A
Output noise	$V_{NOISE(PP)}$			11		mV
Zero current output temperature coefficient	$\triangle V_{OUT(Q)}$			0.26		mV/℃
Sensitivity temperature coefficient	△Sens	TA=150℃,TA=-40℃, Relative to 25℃		0		%/℃
Total output error	ETOT		-3		3	%

8. Feature Definition

8.1Power-on time——TPO

When the power supply rises to the operating voltage, the chip requires a limited time to power its internal components before responding to the input magnetic field. Power-up time: the time taken for the power supply to reach the minimum operating voltage Vcm is t1; under the applied magnetic field, the time taken for the output to reach 90% of its stable value is t2. The difference between these two times is the power-up time.



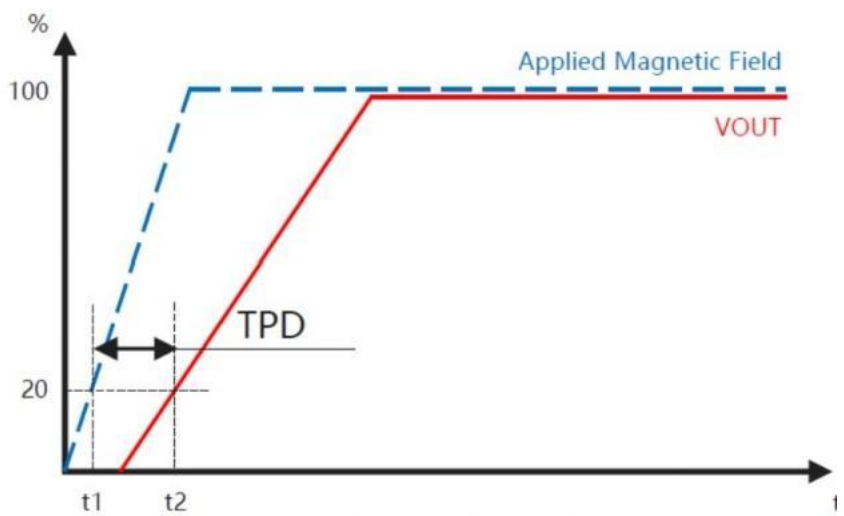
Picture 1: Power-on time definition

8.2Temperature adjustment power-on time——TTC

After power-up, a temperature adjustment time is required before effective temperature compensation output is achieved.

8.3Transmission delay——TPD

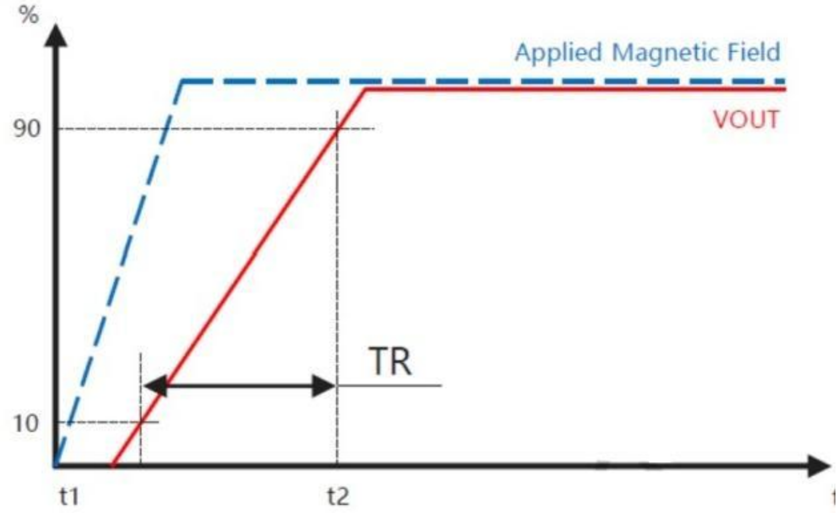
The time difference between when the external magnetic field reaches 20% of the final value and when the output reaches 20% of the final value.



Picture 2: Transmission Delay Definition

8.4Rise time——TR

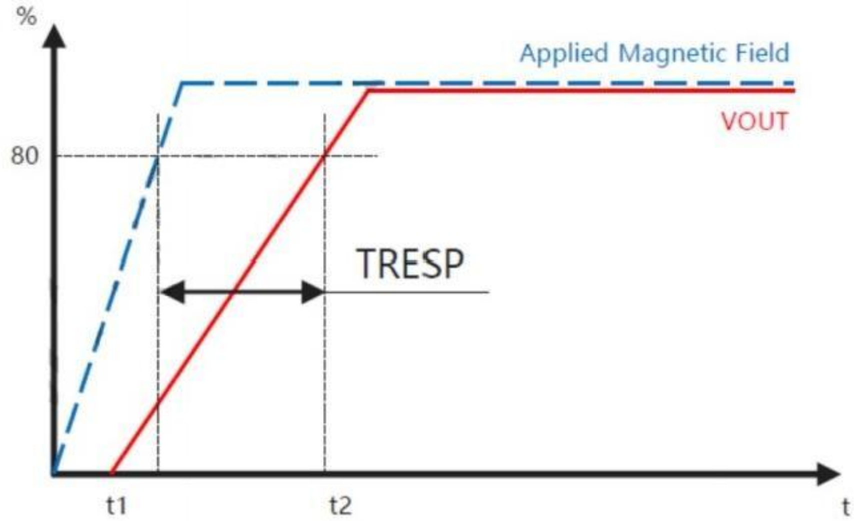
The time difference between the chip output level rising from 10% to 90%.



Picture 3: Rise Time Definition

8.5Response time——TRESP

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



Picture 3:Response time definition

8.6Quiescent voltage output——VOQ

The chip output when the chip power supply voltage and ambient temperature are within the operating range and the measured current is 0.

Note: Long-term operation at the maximum rating may affect the reliability of the device, and exceeding the maximum rating may damage the device.

8.7Quiescent voltage output error——VOE

The difference between the actual output voltage of the sensor and the ideal output voltage supply when the measured current value 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 the output mode proportional to the power supply, the static voltage output error is the difference between the actual output error and V.c/2.

8.8Sensitivity——Sens

Sensitivity indicates the change in sensor output for every 1A change in the measured current, in units of mV/A. The calculation method is to pass the positive full-scale current and the negative full-scale current, and the difference in the sensor output voltage at two points is divided by the difference between the positive full-scale current and the negative full-scale current, which is the sensitivity of the sensor. The specific calculation formula is as follows:

SENS=(Vout(IPma0)-Vout(Inma0))/(IPma0-Inma0)

IPma0 and Inma0 at here are positive full-scale current and negative full-scale current respectively, Vout(IPma0) and Vout(Inma0) are the analog output voltage of the sensor when the positive full-scale current and negative full-scale current are respectively.

8.9Global error range——ETOT

This error value represents the maximum error of the sensor under various environments. It is equal to the absolute value of the measurement error in each temperature range within 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)

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

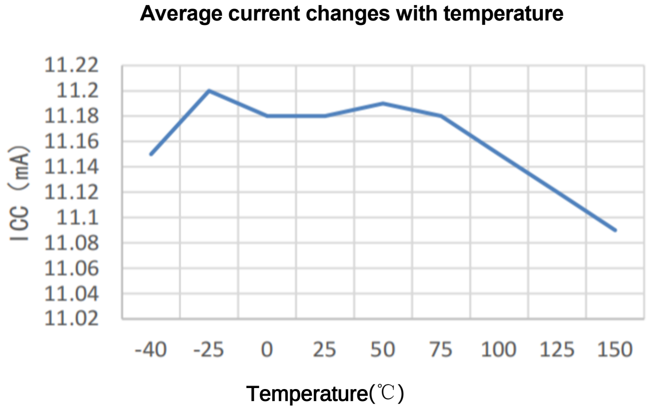
8.10Nonlinearity error——ELIN

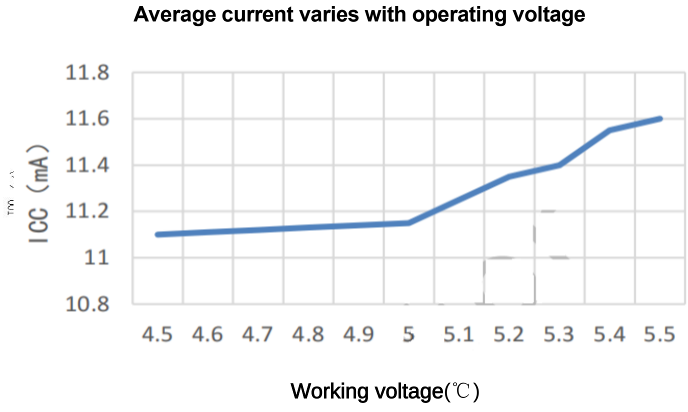
Since the sensor is a non-ideal device, its output voltage and measured current are not completely linear in practical applications. After least squares linear fitting, the maximum output error of the sensor divided by the dynamic range of the sensor is the linear error of the sensor.

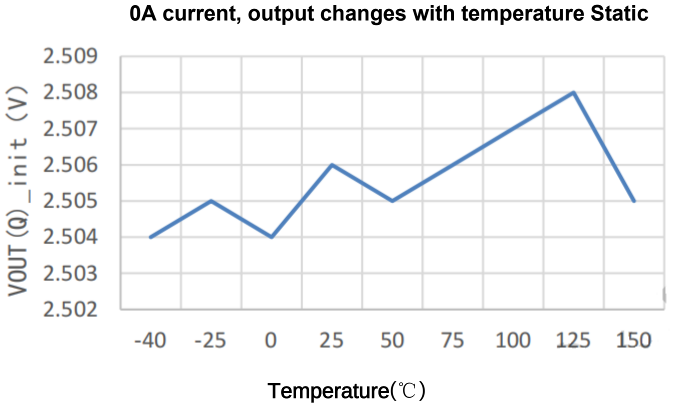
ELIN(IP)=△Vout/(Vout(IPma0)-Voq)

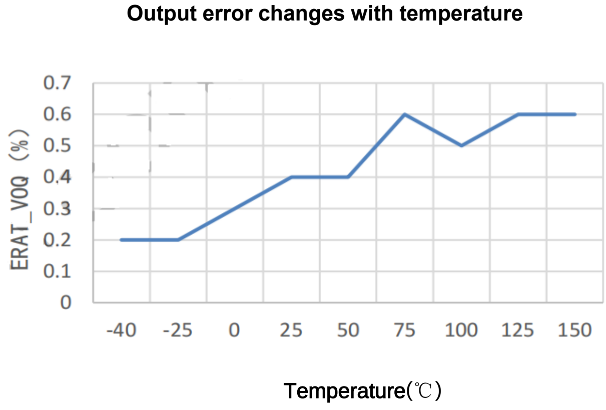
△Voutis the maximum linear error within the sensor measurement range.

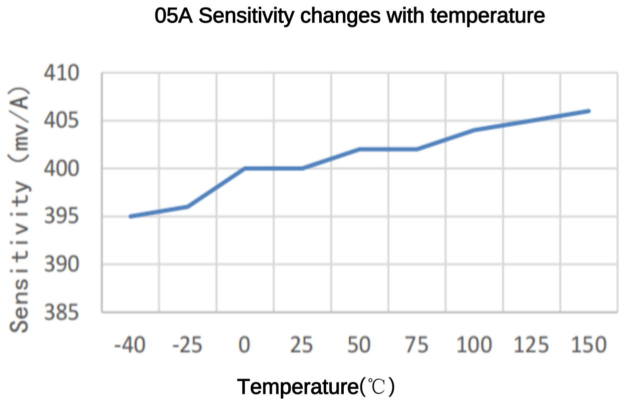
9.Characteristic curves

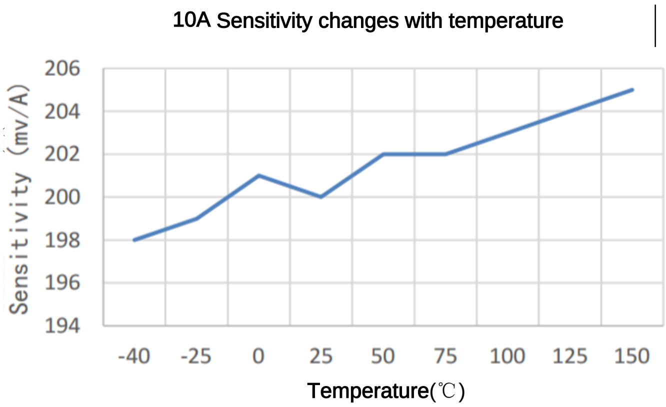




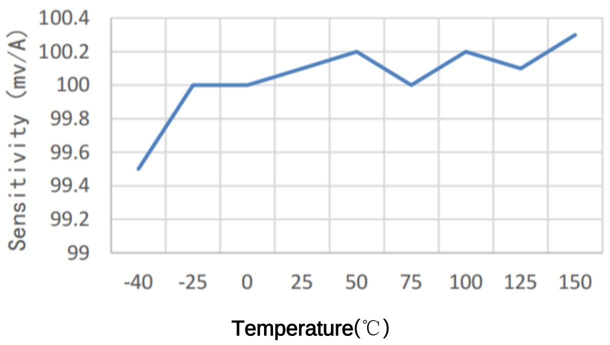




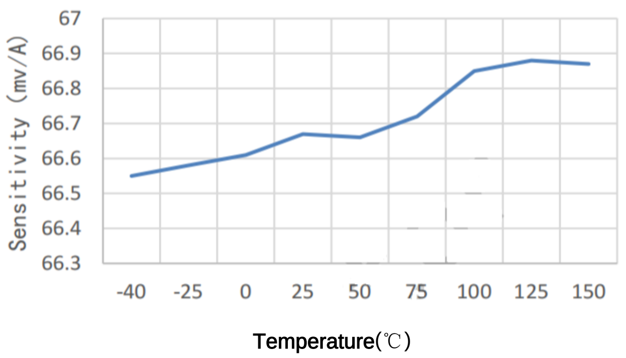




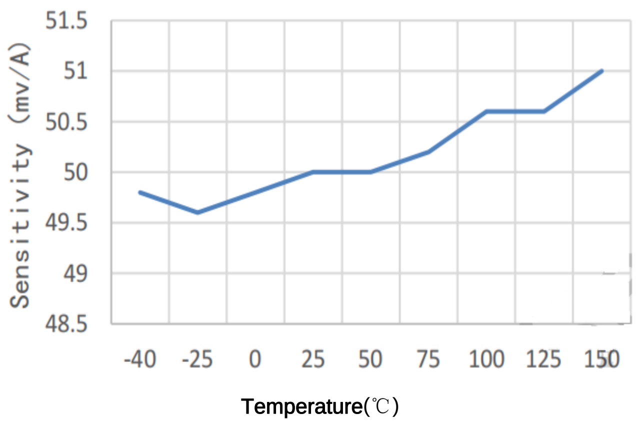
20A Sensitivity changes with temperature



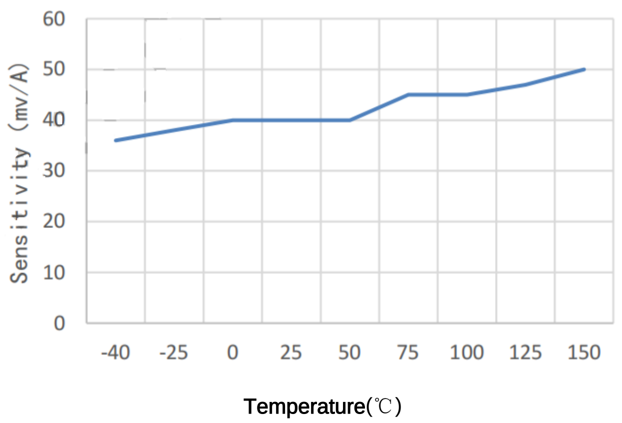
30A Sensitivity changes with temperature



40A Sensitivity changes with temperature

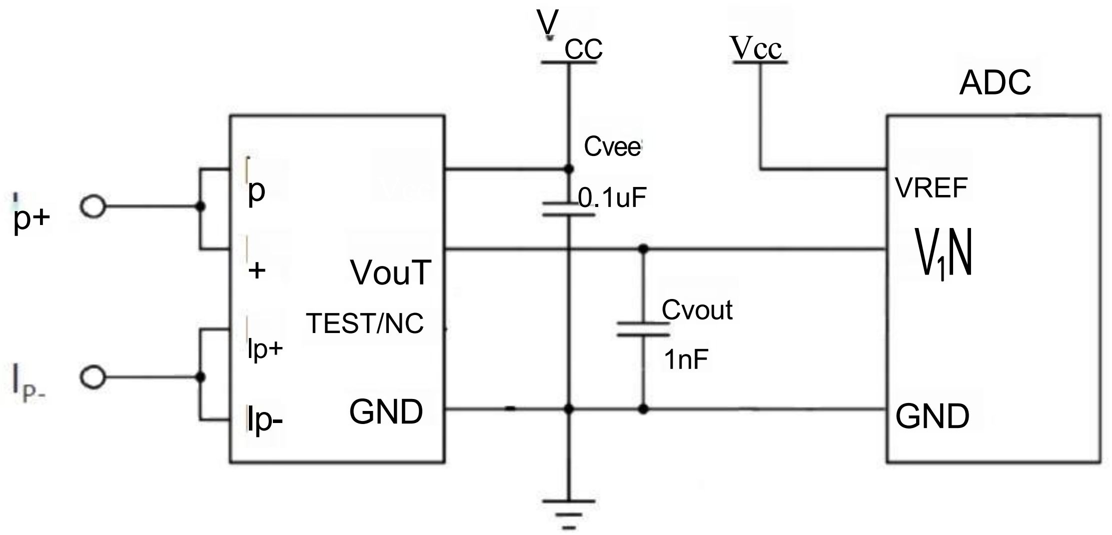


50A Sensitivity changes with temperature

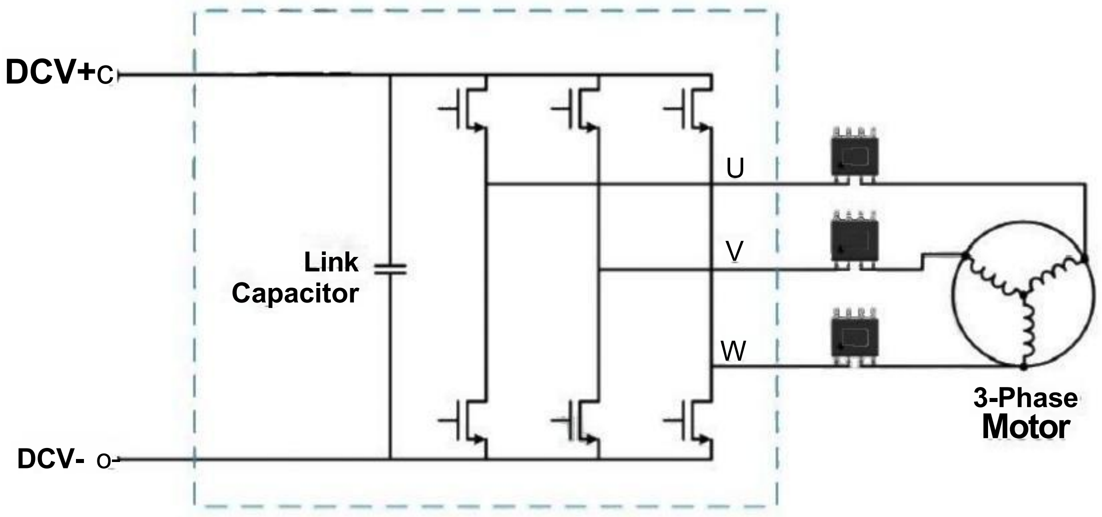


10.Typical application circuit

The typical application circuit of ACS724 includes a filter capacitor C between Vc and ground, and an optional filter capacitor Co between the output and ground. At the input end of the measured current, pins 1 and 2 are short-circuited together as the input end of the measured current, and pins 3 and 4 are short-circuited together as the output end of the measured current. The analog output signal of the sensor is completely proportional to the measured AC and DC current.

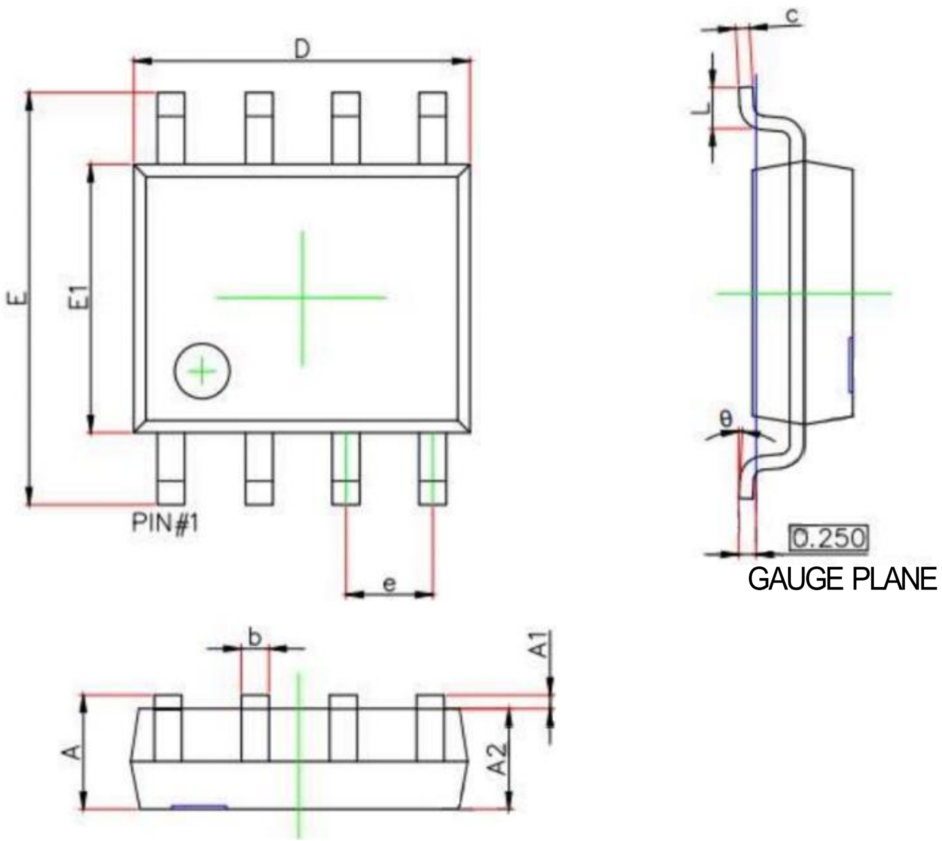


Typical application circuit



3-phase motor control application circuit

11. Packaging information



Symbol	Dimensions (mm)		Dimensions (inches)	
	Minimum	Maximum	Minimum	Maximum
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.Precautions

Hall is a sensitive device. During use and storage, electrostatic protection measures should be taken. During installation and use, the mechanical stress applied to the device housing and leads should be minimized. It is recommended that the welding temperature does not exceed 350°C and the duration does not exceed 5 seconds.

To ensure the safety and stability of the Hall chip, it is not recommended to use it beyond the parameter range for a long time.