SC4624: Fully integrated, hall-effect-based current sensor IC

1 Features

- Differential Hall sensing rejects common-mode fields and nearly zero magnetic hysteresis.
- 1 mΩ primary conductor resistance for low power loss and high inrush current withstand capability
- Industry-leading noise performance with greatly improved bandwidth through proprietary amplifier and filter design techniques
- High-bandwidth 120 kHz analog output for faster response times in control applications
- Patented integrated digital temperature compensation circuitry allows for near closed loop accuracy over
- 5V single power supply operation
- Non-ratio metric output with fixed VREF
- Power under-voltage protection and output short-circuit protection
- Small-footprint, low-profile SOIC8 package suitable for space-constrained applications

2 Applications

- Solar invertor
- DCDC
- Motor driver
- OBC of EV

3 Description

The SC4624 is a highly accurate and cost-effective current sensor IC suitable for AC/DC current sensing in a variety of industrial, automotive, commercial, and communications systems. It features a low-offset, linear Hall sensor circuit and a copper conduction path that generates a magnetic field when current flows through it. The integrated Hall IC senses this magnetic field and converts it into a proportional voltage output, which has a positive slope proportional to the current flowing through the primary copper conduction path. The device senses current differentially, rejecting common-mode fields and improving accuracy in magnetically noisy environments.

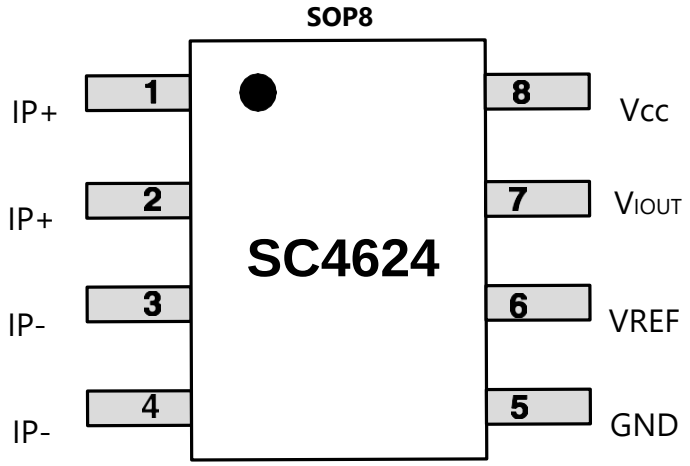
With its 1 mΩ internal resistance, the primary copper conduction path offers low power loss, and the small package size makes it ideal for space-constrained applications, such as motor control, load management, power supplies, and overcurrent fault protection.

Category

4 Revision history

Version	Modified date	Note
V1.0	3/8/2023	Original version
V1.1	16/10/2023	The load resistance value at the Ref terminal is updated
V1.2	26/10/2023	Sensitivity temperature drift specification updated
V1.3	21/11/2023	Revised sensitivity offset range and added lifetime drift concept
V1.4	24/4/2024	Updated package quantity of 4K per disc
V1.5	17/6/2024	Delete POR-related parameters & Updated UVLO and sensitivity temperature drift parameters

5 Device Information



Terminal		Type	Description
Name	Number		
IP+	1		Input of current carrier
IP+	2		Input of current carrier
IP-	3		Output of current carrier
IP-	4		Output of current carrier
GND	5	power	GND pin of chip
VREF	6	output	reference voltage output
V_{IOUT}	7	output	analog output
Vcc	8	power	supply voltage

6 Specifications

6.1 Absolute Maximum Ratings

Note: Stresses above those listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Characteristic	Symbol	Notes	Min.	Max.	Unit
Supply Voltage	V_{CC}		0	15	V
Reverse Supply Voltage	V_{RCC}		0	-0.5	V
Output Voltage	V_{IOUT}		0	15	V
Reverse Output Voltage	V_{RIOUT}		0	-0.5	V
Operating Ambient Temperature	T_A		-40	125	℃
Junction Temperature	T_J(max)		-55	165	℃
Storage Temperature	T_{Stg}		-65	170	℃

6.2 Isolation Specifications

SOP-8 PACKAGE SPECIFIC PERFORMANCE

Parameter	Symbol	Comments	Rating	Unit
SOP8 Package Isolation Characteristics				
Dielectric Surge Strength Test Voltage	V_{SURGE}	Tested ±5 pulses at 2/minute in compliance to IEC 61000-4-5 1.2 µs (rise) / 50 µs (width).	6000	V
Dielectric Strength Test Voltage	V_{ISO}	Agency type-tested for 60 seconds per UL standard 60950-1 (edition 2); production-tested at VISO for 1 second, in accordance with UL 60950-1 (edition 2).	2400	V_{RMS}
Working Voltage for Basic Isolation	V_{WVBI}	Maximum approved working voltage for basic (single) isolation according to UL 60950-1 (edition 2)	420	Vpk or VDC
			297	V_{RMS}
Clearance	Dcl	Minimum distance through air from IP leads to signal leads.	4.2	mm
Creepage	Dcr	Minimum distance along package body from IP leads to signal leads.	4.2	mm
Distance Through Insulation	DTI	Minimum internal distance through insulation		um
Comparative Tracking Index	CTI	Material Group II	400 to 599	V

6.3 General Electrical Specification

Valid through full operating temperature range, T_A = – 40°C to 125°C, C_{BYPASS} = 0.1 µF, and V_{CC} = 5 V, unless otherwise specified.

GENERAL ELECTRICAL CHARACTERISTICS						
POWER						
Supply Voltage	V_{CC}		4.50	5.0	5.50	V
Supply Current	I_{CC}	V_{CC}=5.0V,output open	11.50	14.0	16.00	mA
Power-on Time	t_{po}	CBYPASS=Open, CL=1nF, Sens= 2mV/G, B=400G	-	78.0	-	uS
UVLO voltage threshold	V_{UVLOH}	V_{DD} rising	-	3.8	-	V
	V_{UVLOL}	V_{DD} falling	-	3.2	-	V
Output stage						
Output Capacitance Load	C_L	Vout to GND	-	1.0	10.00	nF
Output Resistive Load	R_L	Vout to GND and Vout to Vcc	4.70	-	-	KΩ
VREF Resistive Load	Rref	Vref to GND and Vref to Vcc	100	-	-	KΩ
Rise Time	t_r	TA = 25°C, CL = 1nF	-	3.6	-	uS
Response Time	$t_{RESPONSE}$	TA = 25°C, CL = 1nF	3.00	3.7	-	uS
Output Slew Rate	SR	T_A = 25°C, C_L = 1nF	-	0.4	-	V/μs
Zero Current Output Voltage	$V_{IOUT(Q)}$	Bidirectional; IP = 0 A, TA = 25°C	2.48	2.5	2.52	V
Reference Output Voltage	Vref_init		2.48	2.5	2.52	V
Output saturation voltage	$V_{SAT(H)}$	$R_{L(DOWN)}$=10K to GND	4.70	-	-	V
	$V_{SAT(L)}$	$R_{L(UP)}$=10K to VDD	-	-	0.30	V
Input stage						
Primary Conductor Resistance	R_{IP}	TA=25℃	-	1.0	-	mΩ
Primary Conductor Inductance	L_{IP}	TA=25℃	-	2.0	-	nH
Rejection Ratio	CMFRR	Uniform external magnetic field	-	40.0	-	dB
Accuracy and Frequency						
Frequency Bandwidth	f	Small signal –3 dB; CL = 1 nF	-	120.0	-	kHZ
Noise	I_N	Input-referenced noise: CF = 4.7 nF, CL = 1 nF, BW = 18 kHz, TA = 25°C				mA(rms)
Nonlinearity	E_{LIN}	Over full range of IP	-1.00	±0.2	1.00	%
Symmetry	E_{SYM}	Over full range of IP	-1.00	±0.2	1.00	%

6.4 Performance Characteristics by Different Current Ranges

Valid through full operating temperature range, TA = – 40°C to 125°C, C_{BYPASS} = 0.1 μF, and VCC = 5V, unless otherwise specified

6.4.1 SC4624SP20B5 PERFORMANCE CHARACTERISTICS

Current-sensing Range	I_P		-20	-	20	A
Sensitivity	Sens	Over full range of IP, TA = 25°C	-	100	-	mV/A
Zero Current Output Voltage	$V_{IOUT(Q)}$	Bidirectional, IP = 0A, TA = 25°C	2.48	2.5	2.52	V
Total Output Error	E_{TOT}	IP =$I_{PR(max)}$, TA = 25°C to 150°C	-3	-	3	%
		IP =$I_{PR(max)}$, TA = -40°C to 25°C	-1	-	6.5	%
Sensitivity Error Lifetime Drift	Esens_drift		-5	-	5	%

6.4.2 SC4624SP30B5 PERFORMANCE CHARACTERISTICS

Current-sensing Range	I_P		-30	-	30	A
Sensitivity	Sens	Over full range of IP, TA = 25°C	-	66.6	-	mV/A
Zero Current Output Voltage	$V_{IOUT(Q)}$	Bidirectional, IP = 0A, TA = 25°C	2.48	2.5	2.52	V
Total Output Error	E_{TOT}	IP =$I_{PR(max)}$, TA = 25°C to 150°C	-3	-	3	%
		IP =$I_{PR(max)}$, TA = -40°C to 25°C	-1	-	6.5	%
Sensitivity Error Lifetime Drift	Esens_drift		-5	-	5	%

6.4.3 SC4624SP50B5 PERFORMANCE CHARACTERISTICS

Current-sensing Range	I_P		-50	-	50	A
Sensitivity	Sens	Over full range of IP, TA = 25°C	-	40	-	mV/A
Zero Current Output Voltage	$V_{IOUT(Q)}$	Bidirectional, IP = 0A, TA = 25°C	2.48	2.5	2.52	V
Total Output Error	E_{TOT}	IP =$I_{PR(max)}$, TA = 25°C to 150°C	-3		3	%
		IP =$I_{PR(max)}$, TA = -40°C to 25°C	-1	-	6.5	%
Sensitivity Error Lifetime Drift	Esens_drift		-5	-	5	%

6.5 Detailed Functional Description

6.5.1 Overview

The SC4624 series current sensors are based on the Hall principle and can accurately measure AC/DC current while minimizing measurement costs. These sensors find extensive use in various current monitoring applications, including consumer, industrial, and automotive scenarios. Compared to current transformers, the SC4624 series offers a compact size, which can significantly reduce PCB size. In comparison to shunt resistor + isolated amplifier solutions, the SC4624 series only requires low-side power supply, eliminating the complexity of high-side power supply design.

The internal conductor of the SC4624 generates a magnetic field proportional to the current value, according to Maxwell's equations. The sensor converts this magnetic field value into a voltage output, ensuring a high level of accuracy. Moreover, the sensor has an ultra-small resistor value, ensuring little influence on thermal power consumption.

6.5.2 Quiescent Output Voltage (V_{OUTQ})

The Quiescent Output Voltage of the SC4624 indicates the output voltage of the IC when there is no magnetic field. Although the theoretical output voltage of the SC4624 is 2.5V, factors such as offset voltage, sensitivity, packaging stress, and temperature coefficient may cause the actual Quiescent Output Voltage to deviate from the theoretical figure. During factory testing, the actual Quiescent Voltage is modified to be within ±5mV of the theoretical value. The Quiescent Output Voltage is also influenced by the temperature coefficient, which means that as the temperature changes, the Quiescent Output Voltage will also change (this effect is more noticeable when sensitivity is higher). The SC4624 is equipped with temperature sensors that can modify the temperature coefficient of the Quiescent Output Voltage.

6.5.3 POWER-UP Time (t_{PO})

Power-Up time is a term used to define the time required for the output voltage of a sensor to reach 90% of its target value after the supply voltage reaches 4.5V, at a specific magnetic field strength. This time difference is measured and expressed in micro seconds. The Power-Up time is an important parameter to consider when using magnetic sensors, especially in applications where a quick response is required. The accuracy of the Power-Up time measurement is crucial to ensure reliable and precise operation of the sensor in various conditions.

6.5.4 Response Time ($t_{RESPONSE}$)

Response time is a term used to define the time difference between the moment when the magnetic field reaches 80% of its target value and the moment when the output voltage of the IC reaches 80% of its target value. This difference is measured and expressed in micro seconds. The Response time is related to the sensitivity of the IC and the size of the output load capacitance. It is an important parameter to consider when using magnetic sensors, especially in applications where a quick response is required. The accuracy of the Response time measurement is crucial to ensure reliable and precise operation of the sensor in various conditions.

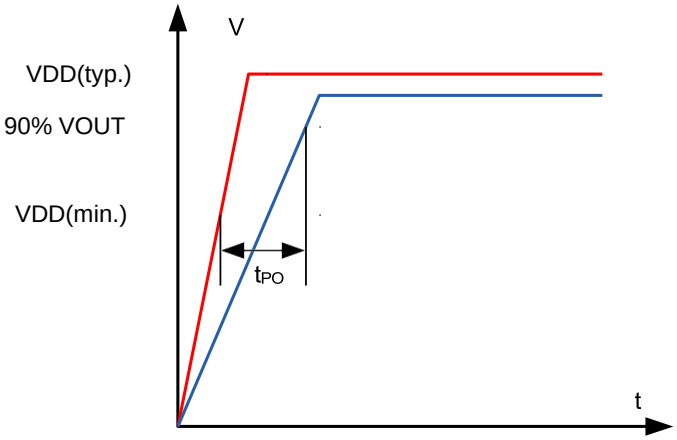


Figure 1. Power-On Time

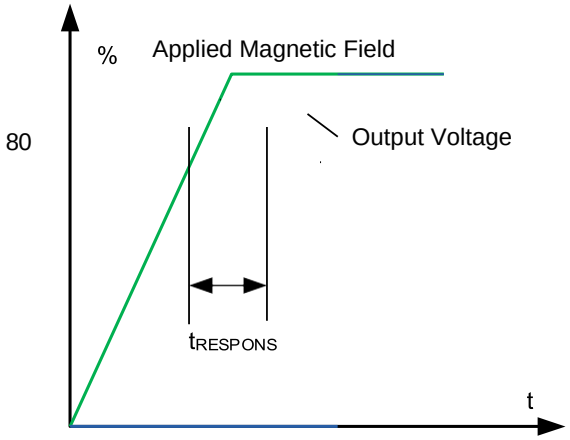
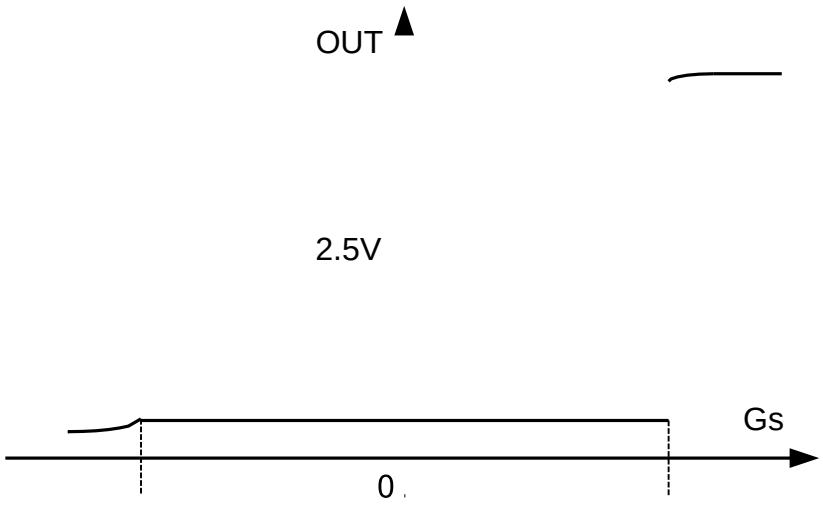


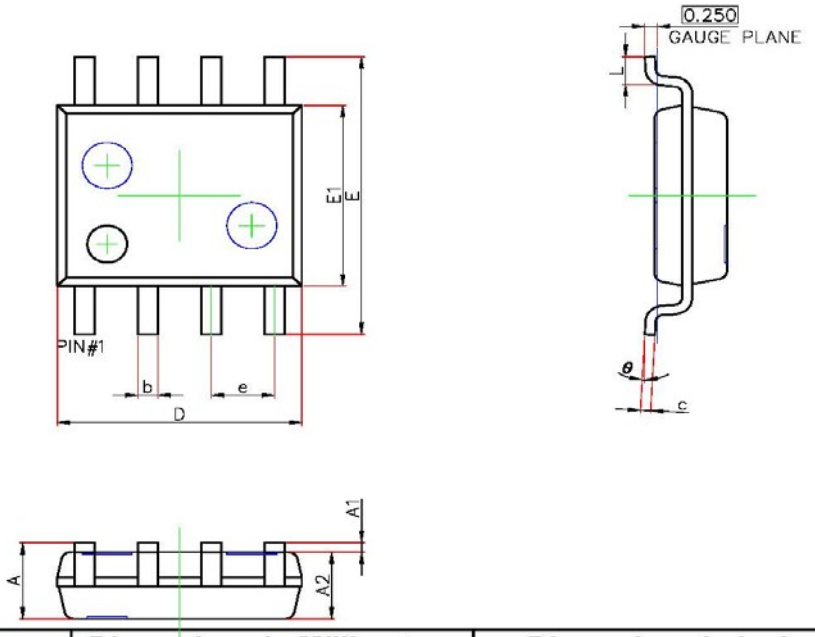
Figure 2. Response Time

6.5.5 Transfer function



7 Mechanical, Packaging and Orderable Information

7.1 Packaging information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.450	1.750	0.057	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	4.700	5.100	0.185	0.201
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

7.2 Orderable Information

Part Number	IPR (A)	Sens (Typ) at V_{CC} = 5 V (mV/A)	TA (°C)	Packing
SC4624SP20B5	±20	100	–40 to 150	4000pcs per Reel
SC4624SP30B5	±30	66	–40 to 150	4000pcs per Reel
SC4624SP50B5	±50	40	–40 to 150	4000pcs per Reel