High Precision Current sensor with Common Mode Magnetic Field suppression Up to 5000V$_{RMS}$ Isolation

1. Features

- High bandwidth and fast response time
- 400kHz bandwidth with 1.2us response time
- High-precision current measurement:
  - Sensitivity error: ±2.5% from -40°C to 125°C
  - Non-linearity: ±1% Max
  - Symmetry: ±1% Max
- Differential Hall sets can immune stray field
- Adjustable fast overcurrent fault output with 1us typical response time
- Fixed output with VREF
- Two versions respectively support 3.3V & 5V applications
- Supports bidirectional and unidirectional output mode
- Supports proportional and fixed output modes
- High isolation level that meets UL standards
- Withstand isolation voltage (VISO):5000Vrms
- Maximum surge isolation withstand voltage (VIOSM): 10kV
- Creepage distance/Clearance distance: 8mm
- Support self-test and a variety of diagnostic functions: OVP, OTP, OCD, broken wire, etc.
- Working temperature: -40°C ~ 125°C
- Primary internal resistance: 0.27mΩ(SOW10), 0.85mΩ(SOW16)
- Wide body SOW10, SOW16 package

2. Applications

- Solar inverter
- Industrial power
- Motor driver
- OBC/DCDC/PTC Heater

3. Description

The SC4671 current sensor is a cost-effective isolated current sensing solution in the industrial and automotive applications. The device consists of a precise, low-offset, linear Hall sensor circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which is sensed by the integrated Hall IC and converted into a proportional voltage. The current is sensed differentially in order to reject common-mode fields, improving accuracy in magnetically noisy environments. SOW16 is for 50A~100A, SOW10 is for 100A~120A and size-limit applications.

The OCD interface provides a fast output signal in case a current exceeds the threshold set by VOC pin or pre-set in SOW16 and SOW10 part.

The package construction provides high isolation by magnetically coupling the field generated by the current in the conductor to the monolithic Hall sensor IC which has no physical connection to the integrated current conductor. The SOW16 and SOW10 package is optimized for lower noise with 5000VRMS dielectric withstand voltage.

SOW16 conductor resistance is 0.85mΩ, SOW10 conductor resistance is 0.27mΩ.

Fig.1 SOW16(Left)&SOW10(Right)Package Outline

CONTENTS

4. Terminal Configuration

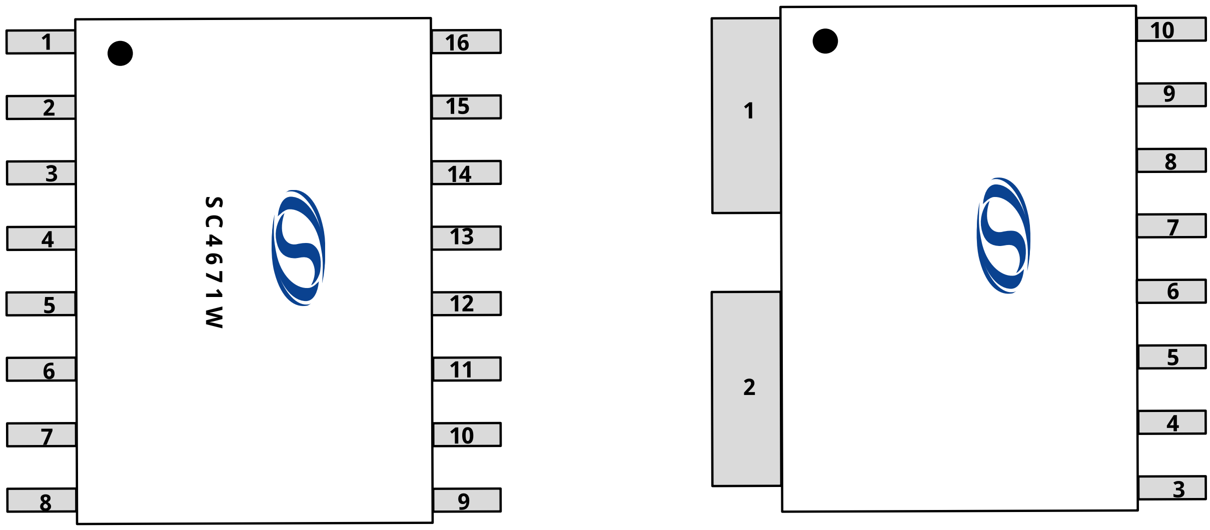


Fig. 2: Terminal Configuration

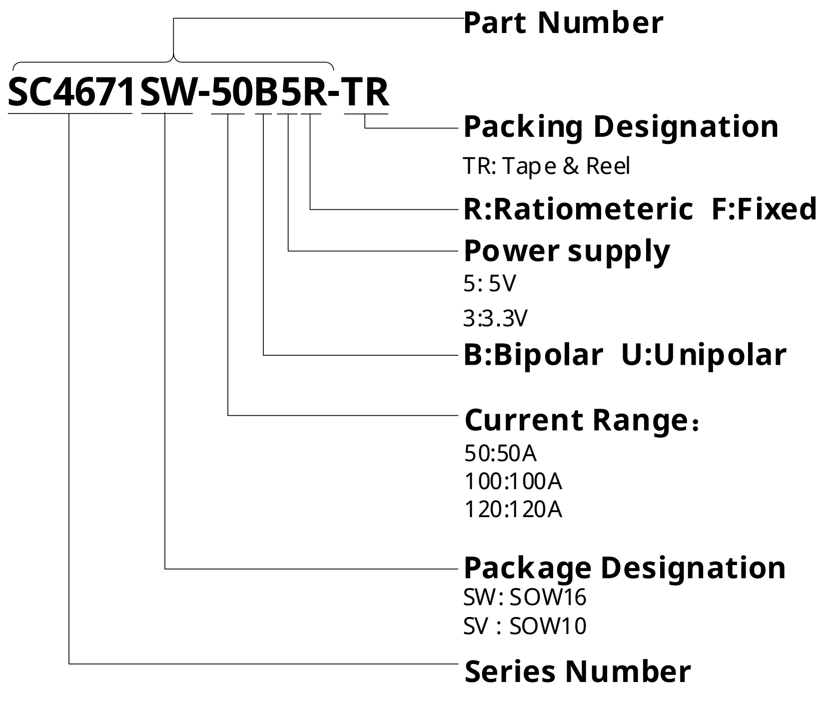
Terminal			Type	Description
Name	SOW16	SOW10		
	Number			
IP+	1、2、3、4	1	I	Input of current
IP-	5、6、7、8	2	I	Output of current
OCD	9	3	O	Overcurrent fault, open-drain
VDD	10	4	P	supply voltage
VOC	11	5	I	Overcurrent fault operation point input
VOUT	12	6	O	analog output
VREF	13	7	O	VREF
NC	14、16	8、10		No connected
GND	15	9	G	GND pin

5. Ordering Information

Order Information	Primary Current(A)	Power Supply(V)	Sensitivity (mV/A)	Zero Current Output Voltage(V)	Package	Packing
SC4671SW-50B5R-TR	±50	5	40	2.5	SOW16	1000pcs per Reel
SC4671SW-100B5R-TR	±100	5	20	2.5	SOW16	1000pcs per Reel
SC4671SV-100B5R-TR	±100	5	20	2.5	SOW10	1000pcs per Reel

Note:
If you have 3.3V supply, unidirectional output or other application need, please contact Semiment engineer. The SC4671W supports multiple power supply and output modes.

Ordering Information Format:



6. Absolute Maximum Ratings

Symbol	Parameter	Test Conditions	Min.	Max.	Unit
V_{DD_abs1}	Positive Supply Voltage (DC)	V_{DD}=0 to 10V	-	6.5	V
V_{DDR_abs}	Negative Supply Voltage	V_{DD}=0 to -1.0V	-	-0.2	V
V_{OUT_abs}	Positive V_{OUT} Voltage	V_{OUT}=0 to 10V	-	V_{DD}+0.2	V
V_{OUTR_abs}	Negative V_{OUT} Voltage	V_{DD}=0 to -1.0V	-	-0.3	V
T_A	Operating Temperature Range		-40	125	℃
T_{STG}	Storage Temperature Range		-55	165	℃
T_J(max)	Maximum Junction Temperature		-	165	℃

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.

7. ESD Protection

Symbol	Ratings	Value	Units
Electrostatic Discharge	Human body model (HBM), per AEC-Q100-002-RevD •All pins	±8	kV
	Charged device model (CDM), per AEC-Q100-011-RevB •All pins	±2	V

8. Isolation Characteristics

Symbol	Parameter	Test Conditions	Typ	Unit
V_{SURGE}	Dielectric Surge Strength Test Voltage	Tested ±5 pulses at 2/minute in compliance to IEC 61000-4-5 1.2μs (rise) / 50μs (width).	10000	V
V_{ISO}	Dielectric Strength Test Voltage	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).	5000	VRMS
VWVBI	Working Voltage for Basic Isolation	Maximum approved working voltage for basic (single) isolation according to UL 60950-1 (edition 2)	1097	VPK or VDC
			1550	V_{RMS}
DCL	Clearance	Minimum distance through air from IP leads to signal leads.	8	mm
DCR	Creepage	Minimum distance along package body from IP leads to signal leads.	8	mm
CTI	Comparative Tracking Index	Material Group II	>=600	V

9. Specifications

9.1 General Electrical Specification

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{DD}	Supply Voltage	5V device only	4.5	5	5.5	V
I_{DD}	Supply Current	No load on V_{OUT} or V_{REF}; V_{DD} = 5V	-	9	-	mA
C_{BYPASS}	Supply Bypass Capacitor	V_{DD} to GND recommended	0.1	-	-	μF
R_{VREF}	Reference Resistive Load	V_{REF} to GND, V_{REF} to V_{DD}	1	-	100	KΩ
C_{VREF}	Reference Capacitive Load	V_{REF} to GND	-	-	6	nF
T_{PO}	Power-On Delay	V_{DD}=0V to 5V, Time from V_{DD}=90% to V_{OUT}=90%	-	77	-	us
$V_{POR(H)}$	Power-On Reset Voltage	V_{DD}=0V to 5.5V	-	2.9	-	V
$V_{POR(L)}$		V_{DD}=5.5V to 0V	-	2.6	-	V
U_{VLOH}	Under-voltage Protection	V_{DD}=0V to 5.5V	-	4.1	4.3	V
U_{VLOL}		V_{DD}=5V to 0V	-	3.25	-	V
V_{OVPH}	Overvoltage Protection (OVP) Threshold	V_{DD} rising	-	6.4	-	V
V_{OVPH}		V_{DD} rising	-	5.9	-	V
Td $_{OVD(E)}$	OVP Delay Time	Time from V_{DD} rising ≥ $V_{OVP(EN)}$ until OVP asserts		54	-	us
Td $_{OVD(D)}$		Time from V_{DD} falling ≤ $V_{OVP(DIS)}$ until OVP clears		7.6		us
I_{OUT}	V_{OUT} Load Current	V_{DD} =4.5V--5.5V, V_{OU}T=0.5V--4.5V, I $_{load}$=-10--10mA	-	9	-	mA
R_{OUT}	V_{OUT} Output Resistance	V_{OUT}=VQ, I $_{load}$=5mA	-	11	-	Ω
I_{LEAK}	Output Leakage Current	High Impedance Mode	-	6	20	uA
R $_{Load\ L}$	Output Load Resistance	V_{OUT} to GND, RL=10k to 1k, B=+BMAX	1	-	10	kΩ
R $_{Load\ H}$		V_{OUT} to V_{DD}, RL=10k to 1k, B=-BMAX	1	-	10	kΩ
Clamp _lo	Clamped Output Voltage (EE_Clamp level=1)	B=-BMAX, RL=5k to V_{DD} EE_CL=enable	-	5	-	%V_{DD}
Clamp _hi		B=+BMAX, RL=5k to GND EE_CL=enable	-	95	-	%V_{DD}
Clamp _lo		B=-BMAX, RL=5k to V_{DD} EE_CL=enable	-	7.5	-	%V_{DD}
Clamp _hi		B=+BMAX, RL=5k to GND EE_CL=enable	-	92.5	-	%V_{DD}
CLACC	Clamped Output Accuracy	B=+BMAX, RL=5k to GND EECL=enable	-	-	1	%V_{DD}
V_{OOR}	Output Operating Range	5 V linear operating range	0.5		4.5	V
R_{IP}	SV, TA=25℃		-	0.27	-	mΩ
	SW, TA=25℃		-	0.85	-	mΩ
Fc	Chopping Frequency		-	2	-	MHz
T_{rr}	Refresh rate	Guaranteed by design	0.8	1	2	us

9.2 Electrical Characteristics

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

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
VSAT(H)	Saturation voltage	RL = 10kΩ to GND	Vcc-0.25	-	-	V
VSAT(L)		RL = 10kΩ to V_{DD}	-	-	0.15	V
VOOR	Output Range	5V linear operation range	0.5	-	4.5	V
IOUT	Output Drive		5	-	-	mA
t_r	Rise Time	TA = 25°C, CL = 6nF	-	3	-	us
t_{pd}	Propagation Delay	TA = 25°C, CL = 6nF	-	2	-	us
$t_{RESPONSE}$	Response Time	TA = 25°C, CL = 6nF	-	3.6	-	us
f	Frequency Bandwidth	Small signal −3 dB; CL = 6nF	-	-	400	kHZ
IND	Noise Density	Input-referenced noise density; TA = 25°C, CL = 6nF; V_{DD} = 5V @ >1kHz	-	1000	-	μA/√Hz
E_{LIN}	Nonlinearity	Over full range of Ip	-1	-	1	%
E_{SYM}	Symmetry	Over full range of Ip	-1	-	1	%
R_{pu}	Fault pull up Resistance		4.7	-	-	kΩ
Ift	Overcurrent threshold		50		300	%IP
Ihys	Overcurrent hysteresis	Ta=25℃, IP 50A, threshold=100%		10		%IP
Tre	Overcurrent response time	4.7k pull up		1.2		us
VOC	Overcurrent accuracy			±6		%IP
PSRR	Power supply rejection ratio	T_A=25°C, DC to 1kHz, 100 mV pk-pk ripple around V_{DD}= $V_{DD(typ)}$, Ip = 0A	-	-50	-	dB
CMFR	Common-mode magnetic field rejection ratio		-	＞40	-	dB

10. Performance Characteristics

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

10.1 SC4671SW50F5R PERFORMANCE CHARACTERISTICS

SC4671SW50F5R PERFORMANCE CHARACTERISTICS						
Symbol	**Parameter**	**Test Conditions**	**Min.**	**Typ.**	**Max.**	**Unit**
I_P	Optimized Accuracy Range		-50	-	50	A
Sens	Sensitivity	Over full range of IP, T_A = 25°C	-	40	-	mV/A
$V_{IOUT(Q)}$	Zero Current Output Voltage	Bidirectional, IP = 0A, T_A = 25°C	-	2.5	-	V
VRE	Reference Voltage Error	$V_{REF\ actual}$ – $V_{REF\ ideal}$, T_A = –40°C to 125°C	-10	-	10	mV
VOE	Offset Error	$V_{IOUT(Q)}$-V_{REF}, T_A = –40°C to 125°C, Ip=0A	-15	-	15	mV
E_{SENS}	Sensitivity Error	IP =IPR(max), T_A = 25°C to 125°C	-2.5	-	2.5	%
		IP =IPR(max), TA = -40°C to 25°C	-2.5	-	2.5	%
E_{TOTAL}	Total output error	IP =IPR(max), TA = 25°C to 125°C	-3.5	-	3.5	%
		IP =IPR(max), TA = -40°C to 25°C	-3.5	-	3.5	%

10.2 SC4671SW100F5R PERFORMANCE CHARACTERISTICS

SC4671SW100F5R PERFORMANCE CHARACTERISTICS						
Symbol	**Parameter**	**Test Conditions**	**Min.**	**Typ.**	**Max.**	**Unit**
I_P	Optimized Accuracy Range		-100	-	100	A
Sens	Sensitivity	Over full range of IP, T_A = 25°C		20		mV/A
VIOUT(Q)	Zero Current Output Voltage	Bidirectional, IP = 0A, T_A = 25°C		2.5		V
VRE	Reference Voltage Error	V $_{REF\ actual}$ – V $_{REF\ ideal}$, T_A = –40°C to 125°C	-10	-	10	mV
VOE	Offset Error	$V_{IOUT(Q)}$-V_{REF}, T_A = –40°C to 125°C, Ip=0A	-15	-	15	mV
E_{TOT}	Sensitivity Error	IP =IPR (max), T_A = 25°C to 125°C	-2.5	-	2.5	%
		IP =IPR (max), T_A = -40°C to 25°C	-2.5	-	2.5	%
E_{TOTAL}	Total output error	IP =IPR (max), T_A = 25°C to 125°C	-3.5	-	3.5	%
		IP =IPR (max), T_A = -40°C to 25°C	-3.5	-	3.5	%

10.3 SC4671SV100F5R PERFORMANCE CHARACTERISTICS

SC4671SV100F5R PERFORMANCE CHARACTERISTICS						
Symbol	**Parameter**	**Test Conditions**	**Min.**	**Typ.**	**Max.**	**Unit**
I_P	Optimized Accuracy Range		-100	-	100	A
Sens	Sensitivity	Over full range of IP, T_A = 25°C		20		mV/A
VIOUT(Q)	Zero Current Output Voltage	Bidirectional, IP = 0A, T_A = 25°C		2.5		V
VRE	Reference Voltage Error	$V_{REF\ actual} - V_{REF\ ideal}$, T_A = −40°C to 125°C	-10	-	10	mV
VOE	Offset Error	$V_{IOUT(Q)}$-V_{REF}, T_A = −40°C to 125°C, Ip=0A	-15	-	15	mV
E_{TOT}	Sensitivity Error	IP =IPR (max), T_A = 25°C to 125°C	-2.5	-	2.5	%
		IP =IPR (max), T_A = -40°C to 25°C	-2.5	-	2.5	%
E_{TOTAL}	Total output error	IP =IPR (max), T_A = 25°C to 125°C	-3.5	-	3.5	%
		IP =IPR (max), T_A = -40°C to 25°C	-3.5	-	3.5	%

11. Functional Description

11.1 Overview

The SC4671W series current sensors can accurately measure the AC/DC current while minimizing the overall measurement cost. The current sensor based on the Hall principle can be widely used in all current monitoring scenarios of consumer, industrial and automotive applications. Comparing with current transformers, SC4671W series could help customers to reduce PCB size with its extreme compact size. Comparing with the solution of shunt resistor + isolated amplifier, SC4671W series only need low side power supply, eliminating the complexity of high side power supply design.

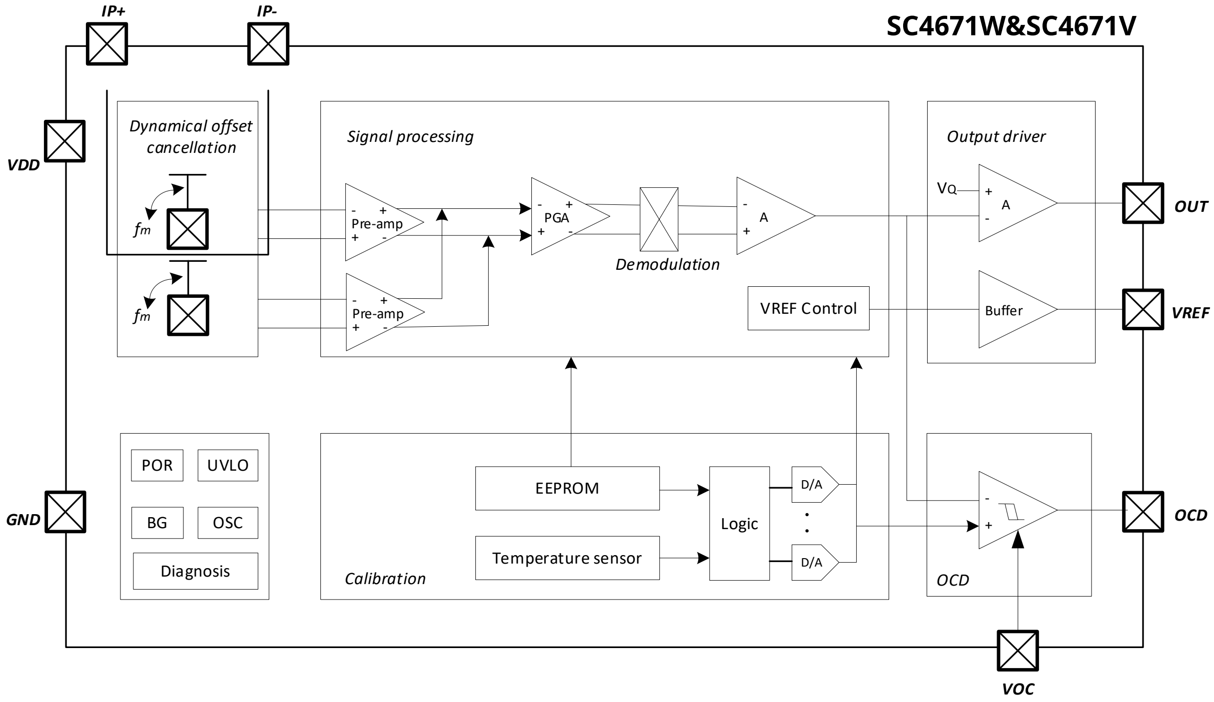


Fig. 3: Function Block Diagram

11.2 Power-on Reset Operation

The descriptions in this section assume: temperature = 25°C, with the labeled test conditions. The provided graphs in this section show V_{OUT} moving with V_{DD}. The voltage of V_{OUT} during a high-impedance state will be most consistent with a known load (RL, CL).

11.3 Power-on Time

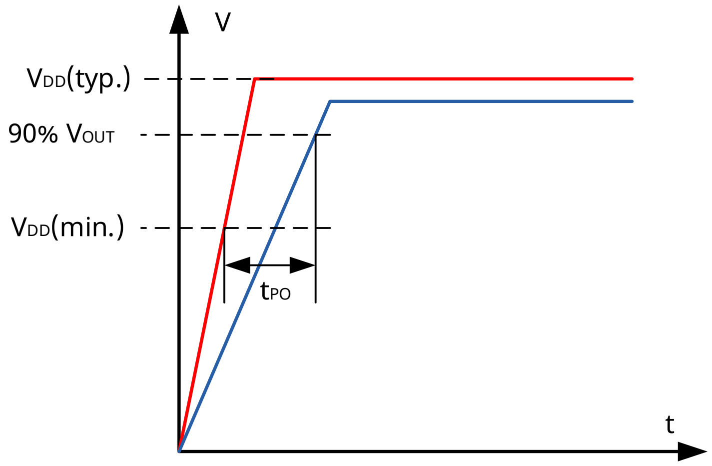


Fig. 4: Power-on time

11.4 Response Time

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.

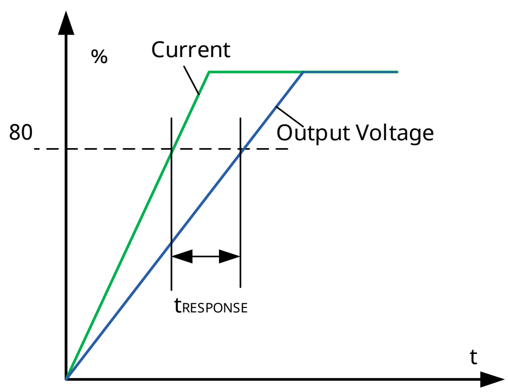


Fig. 5: Response time

11.5 Transfer Function

The ideal first-order transfer function of the SC4671 is given by Equation 1, where the output voltage V_{OUT} is a linear function of input current IP. The accuracy of the device is quantified both by the error terms in the transfer function parameters, as well as by nonidealities that introduce additional error terms not in the simplified linear model.

$$V_{OUT} = (I_P \times Sens) + V_{REF}$$

- V_{OUT} is the output voltage.
- IP is the isolated input current.
- Sens is the sensitivity of the SC4671.
- V_{REF} is the zero current reference output voltage.

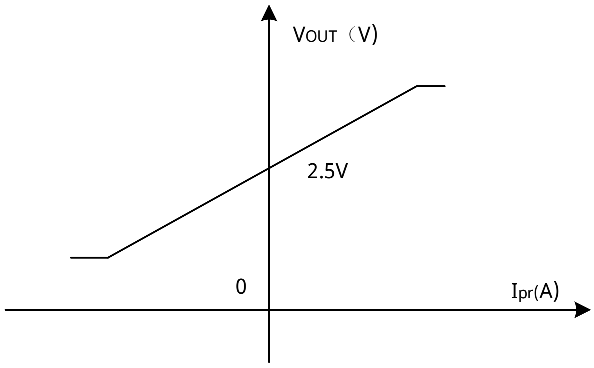


Fig. 6: Sensitivity

11.6 Overcurrent Fault(OCD)

As the output swings, if the sensed current exceeds its comparator threshold, the overcurrent fault pin triggers with an active low flag. This is internally compared with either the factory-programmed thresholds or the VOC voltage when V_{voc} > 0.1V. This flag trips symmetrically for the positive and negative OCD operating point.

The implementation for the OCD circuitry is accurate over temperature and does not require further temperature compensation because it is dependent on the Sens and V_{OFF} parameters that are factory trimmed flat over temperature.

11.7 Voltage Overcurrent PIN(VOC)

The fault trip points can be set using the VOC pin as the direct analog input for the fault trip point, for bidirectional devices, the VOC pin voltage can be set using resistor dividers from V_{REF}. The fault performance is valid when V_{VOC} is within the VOC operating voltage range or < 0.1V, If voltage is beyond the defined valid performance region, the device responds with varied results. For a 5V bidirectional device: If the VOC pin is set to 0.5V, the minimum trip point, $I_{FAULT(MIN)}$ is selected; if the VOC pin is set to 1.75V, the maximum trip point, $I_{FAULT(max)}$ is selected, as defined in the Performance Characteristic table, All voltages between 0.5 and 1.75V for the 5V option, and between 0.33 and 1.321V for the 3.3V option, can be used to linearly select a trip point between the minimum and maximum levels. When Voc < 0.1V, the internal EEPROM fault level is used.

The resulting equation for the fault is:

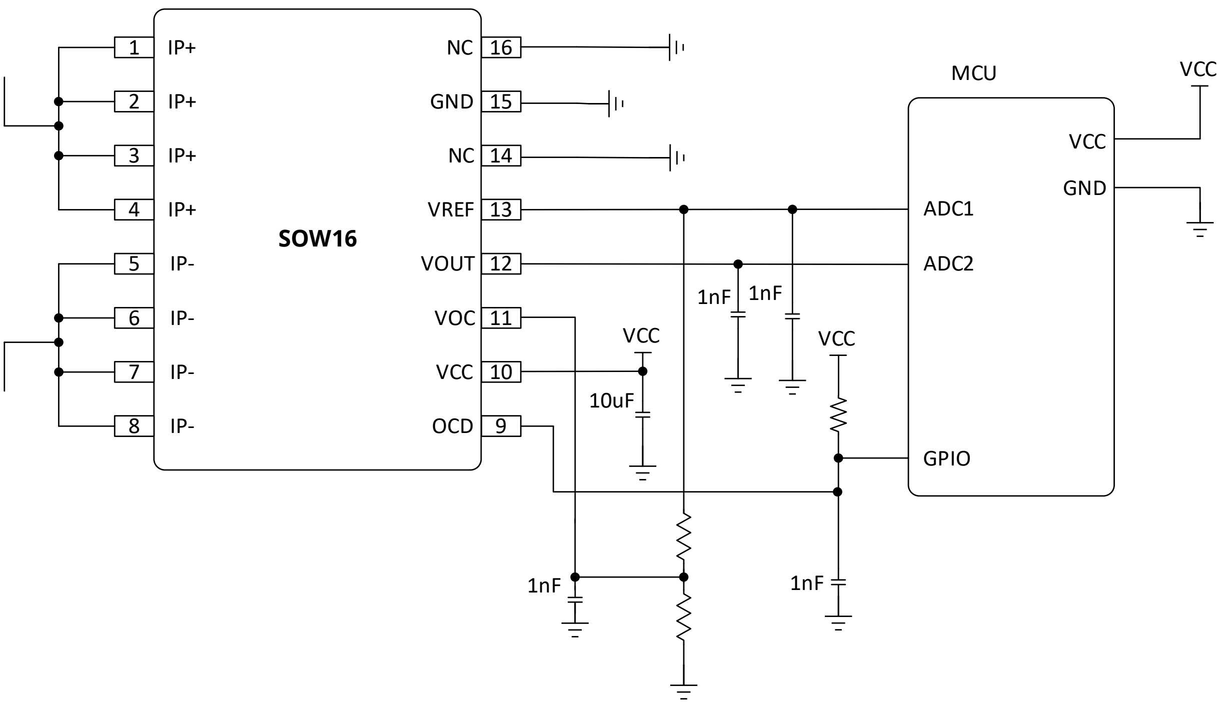
$$OCF_{\%FS}[\%] = \frac{V_{OC(VCC)}[V]}{2} * 100[\%] * 0.45$$

$$I_{OCF}[A] = OCF_{\%FS}[\%] * I_{PR}[A]$$

Table 1: $V_{oc(cc)}$ Thresholds and Corresponding Percentage of the Full-Scale Output for Bidirectional and Unidirectional Operational Modes

VOC(3.3V)(V)	VOC(5V)(V)	Fault Operation Point %FS	
		Bidirectional	Unidirectional
<0.1		100%(factory default)	50%(factory default)
0.330	0.250	20%	10%
0.466	0.500	33%	16.5%
0.661	0.750	46%	23%
0.826	1.000	59%	29.5%
0.991	1.250	72%	36%
1.156	1.500	85%	42.5%

12. Typical Application



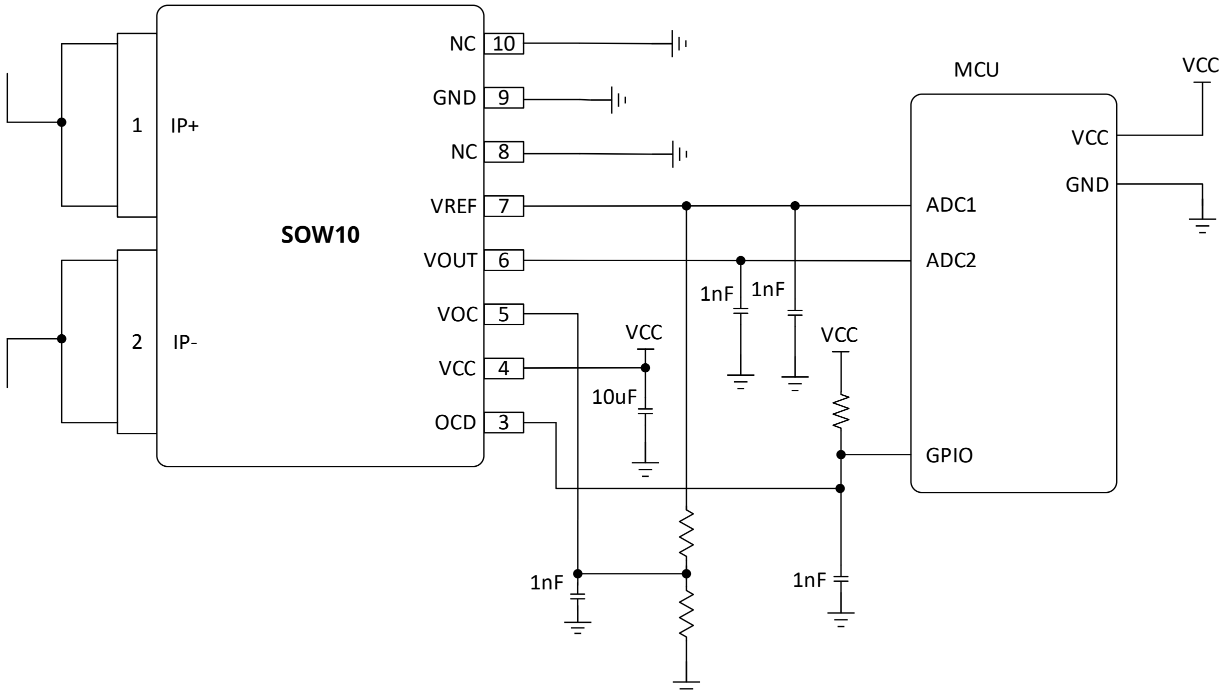
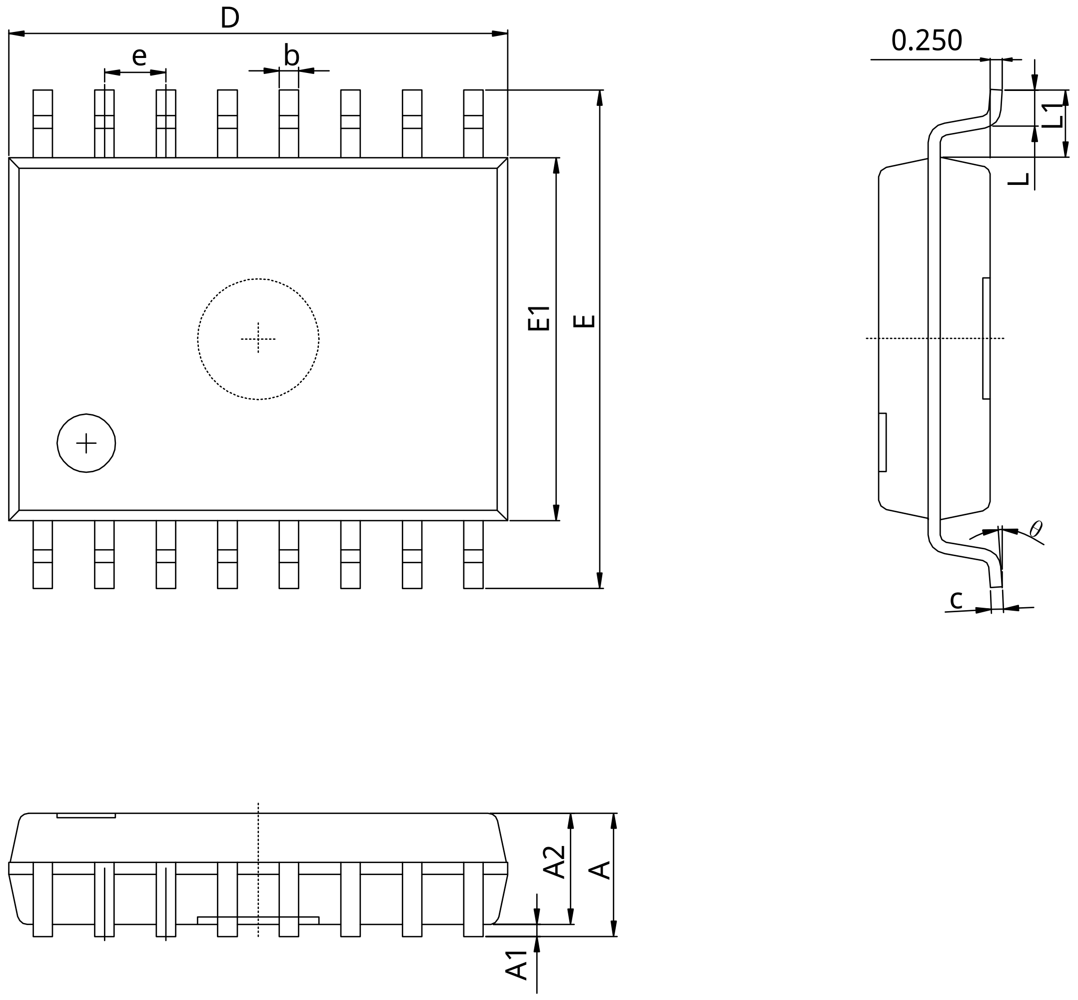


Fig. 7: Typical Application Circuit

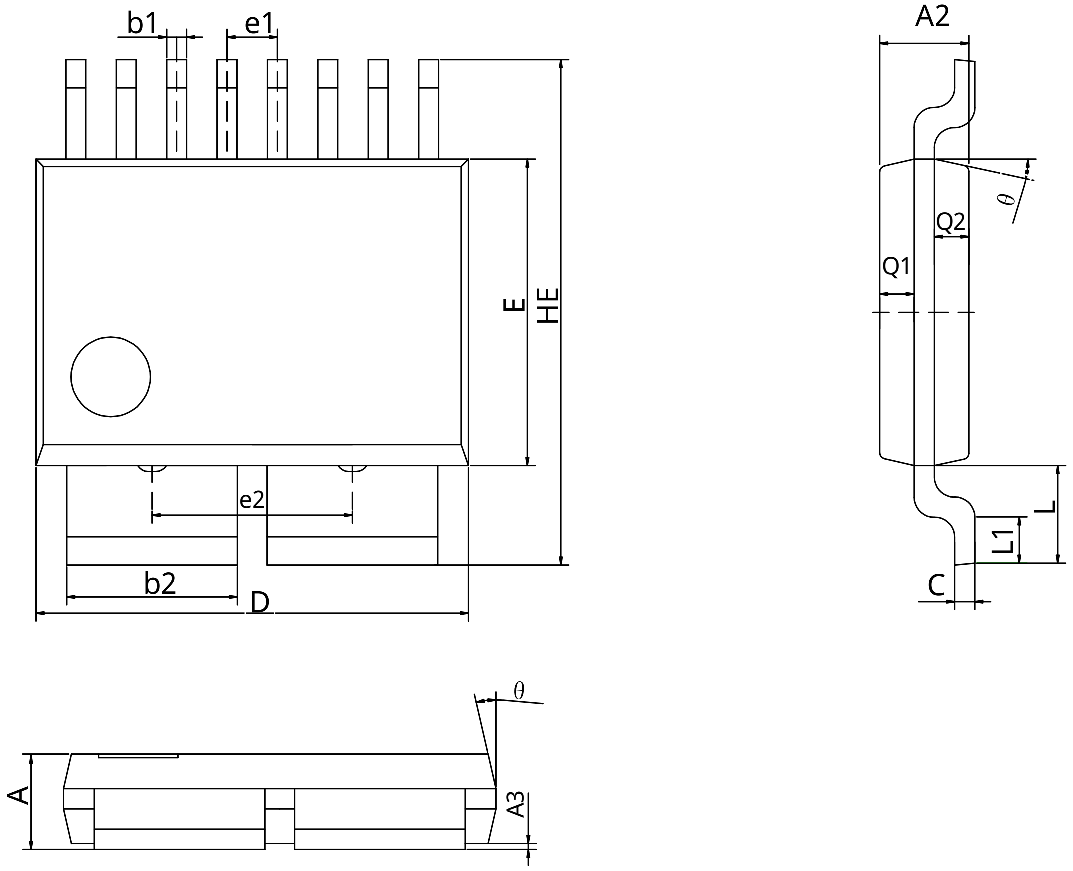
13. Package Information

13.1 SOW16 POD



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	-	2.650	-	0.104
A1	0.100	0.300	0.004	0.012
A2	2.250	2.350	0.089	0.093
b	0.350	0.430	0.014	0.017
c	0.240	29.000	0.009	0.011
D	10.200	10.400	0.402	0.409
E	10.100	10.500	0.398	0.413
E1	7.400	7.600	0.291	0.299
e	1.270(BSC)		0.050(BSC)	
L	0.550	0.850	0.022	0.033
L1	1.400(REF)		0.060(REF)	
θ	0°	8°	0°	8°

13.2 SOW10 POD



Symbol	Dimensions In Millimeters		
	Min.	TYP	Max.
A	2.35	2.45	2.55
A2	2.18	2.25	2.32
A3	0.10	0.20	0.30
b1	0.45	0.50	0.55
b2	4.25	4.30	4.35
c	0.508(REF)		
D	10.80	10.90	11.00
E	7.60	7.70	7.80
HE	12.50	12.70	12.90
Q1	0.85	0.87	0.90
Q2	0.85	0.87	0.90
e1	1.27(BSC)		
e2	5.09(BSC)		
L	2.50(BSC)		
L1	0.40	1.20	2.00
θ	0°		13°

14. Revision History

Revision	Date	Description
Rev0.1	2024-06-07	Preliminary datasheet
Rev1.0	2024-11-27	Release
Rev1.1	2025-03-26	Modify the order information
Rev1.2	2025-05-12	Update POD