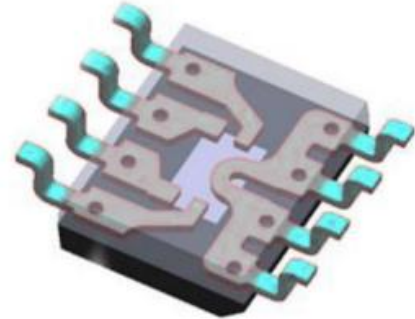


## AC/DC Open Loop Hall Current Sensor IC CYHCS91X

The CYHCS91X is a high performance single-ended linear current sensor that can effectively measure AC or DC currents in a wide range of industrial, consumer and communication applications.

The CYHCS91X series incorporates a high precision, low noise linear Hall circuit and a low impedance main current loop lead. When the input current flows through the main current circuit, the resulting magnetic field induces a corresponding electrical signal on the Hall IC, which is then output as a voltage signal through the signal processing circuit, making the sensor output signal proportional to the measured current value.

The linear Hall circuit is manufactured using the advanced BCDMOS process and comprises a high sensitivity Hall sensor, Hall signal preamplifier, high accuracy Hall temperature compensation unit, oscillator, dynamic detuning circuit and amplifier output module. In the absence of a magnetic field, the static output of the current sensor is 2.5V fixed or 50%  $V_{CC}$ . With a supply voltage of 5V, the sensor output can vary linearly with the magnetic field from 0.2 to 4.8V with a linearity of up to 0.4%



The CYHCS91X has an integrated dynamic detuning circuit that makes the sensitivity of the sensor unaffected by external pressure and stress on the IC package. The CYHCS91X is available in a SOP8 package with an operating temperature range of -40 to 125°C and is RoHS compliant.

### Features

- Static output bias voltage of 2.5V or 50% VCC
- Measurement range 10A / 20A / 30A / 40A
- Isolation voltage 1200VDC
- High frequency bandwidth: 100kHz
- Output response time: 4 $\mu$ s (typical)
- Temperature range -40°C to 125°C
- Stability over operating range: 1.6% @25°C~125°C, 2.5% @ -40°C~25°C
- Low noise analog signal; high immunity to interference
- High resistance to mechanical stress, magnetic field parameters are not shifted by external pressure,
- ESD (HBM) 5kV
- ROHS approved: (EU) 2015 / 863

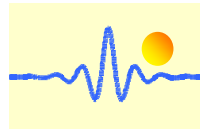
### Applications

- Electric Vehicles
- Inverter current detection
- Motor phase current detection (motor control)
- Photovoltaic inverters
- Battery load detection systems
- Current transformers
- Switching power supplies
- Overload protection devices
- Inverter speed control equipment
- Uninterruptible Power Supplies (UPS)
- Electrolytic and plating equipment
- Various power supplies

### Absolute maximum rating

Supply voltage $V_{CC}$	6V
Output voltage $V_{OUT}$	$V_{CC} - 0.25V$
Output source current, $I_{OUT}$	80mA
Output sink current, $I_{OUT}$	40mA
Operating temperature range, $T_A$	-40°C ~ +125°C
Storage temperature range, $T_S$	-55°C ~ +165°C
Maximum junction temperature, $T_J$	165°C
Transient inrush current at the current input	100A (IP 1Pulse 100ms)

Exceeding the limit parameters during use may cause the IC to function unstably and may damage the chip if left in this environment for a long period of time.



## Static protection

Human Body Model (HBM) testing according to: Standard EIA/JESD22-A114-B HBM

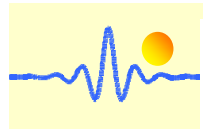
Parameter	Symbol	Standard	Min	max	Unit
Human model HBM electrostatic stress voltage	V <sub>ESD</sub>	JEDEC JS-001-2017	-5000	5000	V

## Electric parameters

Parameters	Symbol	Test conditions	min	Typ.	Max.	unit
Supply voltage	V <sub>CC</sub>	operation	4.5	5.0	5.5	V
Supply current	I <sub>CC</sub>	T <sub>A</sub> =25°C, no load on output	9.18	11.18	13.18	mA
Built-in band width (-3dB)	BW	Small signal: -3dB, C <sub>L</sub> =1nF, T <sub>A</sub> =25°C	-	65	-	kHz
Power-up time	T <sub>PO</sub>	T <sub>A</sub> =25°C, C <sub>L</sub> =1nF, sensitivity: 2mV/G, constant mag. field: 400Gs		100		µs
Temperature compensated power-up time	T <sub>TC</sub>	T <sub>A</sub> =125°C, C <sub>L</sub> =1nF, sensitivity: 2mV/G, constant mag. field: 400Gs		300		µs
Undervoltage lockout threshold (T <sub>A</sub> =25°C)	V <sub>UVLOH</sub>	voltage rises, IC starts to operate	-	4.1	-	V
	V <sub>UVLOL</sub>	voltage drops, IC stops	-	3.8	-	V
Reset voltage	V <sub>PORH</sub>	T <sub>A</sub> =25°C, V <sub>CC</sub> rises	-	4.1	-	V
	V <sub>PORL</sub>	T <sub>A</sub> =25°C, V <sub>CC</sub> drops	-	3.8	-	V
Power-on reset release time	T <sub>PORR</sub>	T <sub>A</sub> =25°C, V <sub>CC</sub> rises		10		µs
Max. current (source)	I <sub>SCLP</sub>			80		mA
Maximum current (sink)	I <sub>SCLN</sub>			40		mA
Analog output saturation low	V <sub>OL</sub>	R <sub>L</sub> >=4.7kΩ		0.5		V
Analog output saturation high	V <sub>OH</sub>	R <sub>L</sub> >=4.7kΩ	-	V <sub>CC</sub>	-	V
Output load capacitance	C <sub>L</sub>	V <sub>OUT</sub> to GND	-	0.5	1	nF
Output load resistance	R <sub>L</sub>	V <sub>OUT</sub> to GND		10		kΩ
		V <sub>OUT</sub> to V <sub>CC</sub>		10		kΩ
Output resistance	R <sub>OUT</sub>			9		Ω
Rise time	T <sub>R</sub>	T <sub>A</sub> =25°C, C <sub>L</sub> =1nF, sensitivity: 2mV/G, constant mag. field: 400Gs		5.5		µs
Transfer delay time	T <sub>PD</sub>			4.5		µs
Response time	T <sub>RESP</sub>			4	5	µs
Noise	V <sub>N</sub>	T <sub>A</sub> =25°C, C <sub>L</sub> =1nF, sensitivity: 2mV/G , B <sub>Wf</sub> = B <sub>wi</sub>		14.1		mVp-p
Resistance of current input Terminals	R <sub>P</sub>			1.5	1.8	mΩ
Linearity error	E <sub>lin</sub>	T <sub>A</sub> =25°C, C <sub>L</sub> =1nF, sensitivity: 2mV/G , B <sub>Wf</sub> = B <sub>wi</sub>		0.4		%
Static operating point	V <sub>OS</sub>		2.48	2.500	2.515	V

## Measuring range

parameter	symbol	Part no.	Min.	typ	Max.	unit
Measuring range	I <sub>P</sub>	CYHCS911	-10		10	A
		CYHCS912	-20		20	A
		CYHCS913	-30		30	A
		CYHCS914	-40		40	A



## Accuracy parameters

### CYHCS911

parameter	symbol	Test conditions	Min.	typ	Max.	unit
Current measuring range	$I_P$		-10		10	A
Sensitivity	Sens	Full current range	190	200	210	mV/A
Output noise	$V_{NOISE(PP)}$		-	50	-	mV
Temperature coefficient of offset output	$\Delta V_{OUT(Q)}$		-	0.26	-	%
Temperature coefficient of sensitivity	$\Delta Sens$			0.054		%/°C
Total measuring error	$E_{TOT}$		-3.0		3.0	%

### CYHCS912

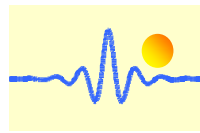
parameter	symbol	Test conditions	Min.	typ	Max.	unit
Current measuring range	$I_P$		-20		20	A
Sensitivity	Sens	Full current range	90	100	110	mV/A
Output noise	$V_{NOISE(PP)}$		-	30	-	mV
Temperature coefficient of offset output	$\Delta V_{OUT(Q)}$		-	0.26	-	%
Temperature coefficient of sensitivity	$\Delta Sens$			0.054		%/°C
Total measuring error	$E_{TOT}$		-3.0		3.0	%

### CYHCS913

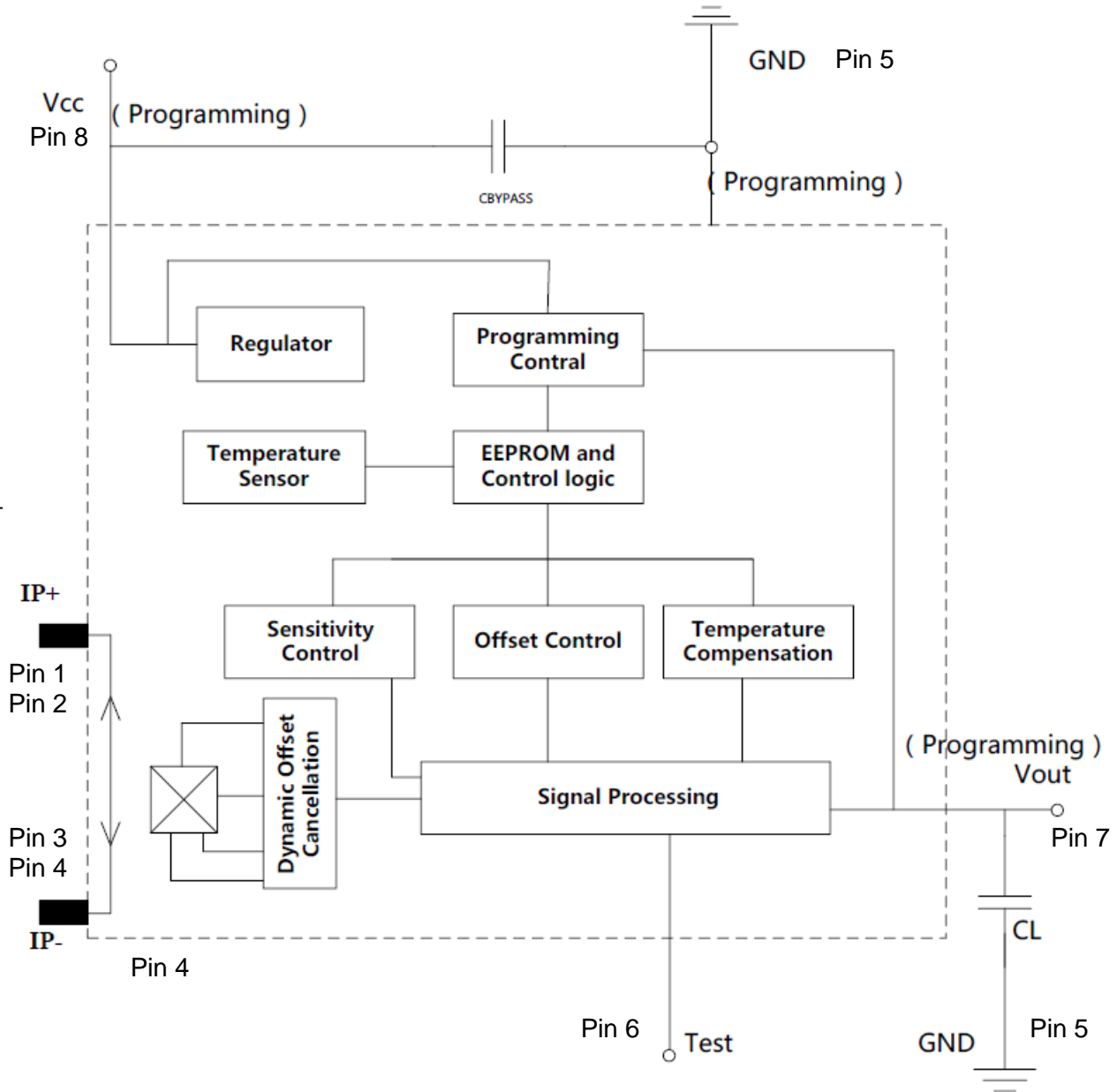
parameter	symbol	Test conditions	Min.	typ	Max.	unit
Current measuring range	$I_P$		-30		30	A
Sensitivity	Sens	Full current range	60	66.6	72	mV/A
Output noise	$V_{NOISE(PP)}$		-	20	-	mV
Temperature coefficient of offset output	$\Delta V_{OUT(Q)}$		-	0.26	-	%
Temperature coefficient of sensitivity	$\Delta Sens$			0.054		%/°C
Total measuring error	$E_{TOT}$		-3.0		3.0	%

### CYHCS914

parameter	symbol	Test conditions	Min.	typ	Max.	unit
Current measuring range	$I_P$		-40		40	A
Sensitivity	Sens	Full current range	45	50	55	mV/A
Output noise	$V_{NOISE(PP)}$		-	15	-	mV
Temperature coefficient of offset output	$\Delta V_{OUT(Q)}$		-	0.26	-	%
Temperature coefficient of sensitivity	$\Delta Sens$			0.054		%/°C
Total measuring error	$E_{TOT}$		-3.0		3.0	%

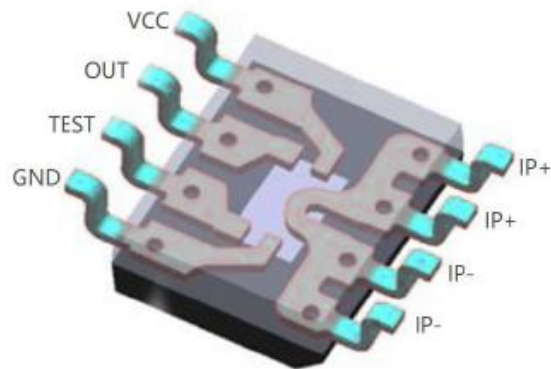
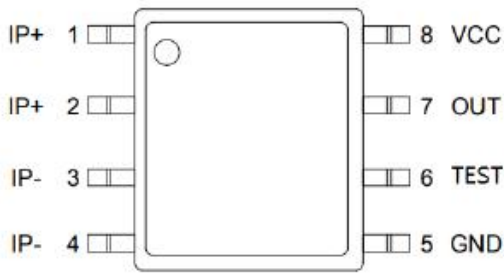
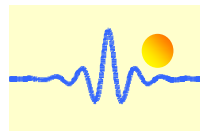


## Functional diagram



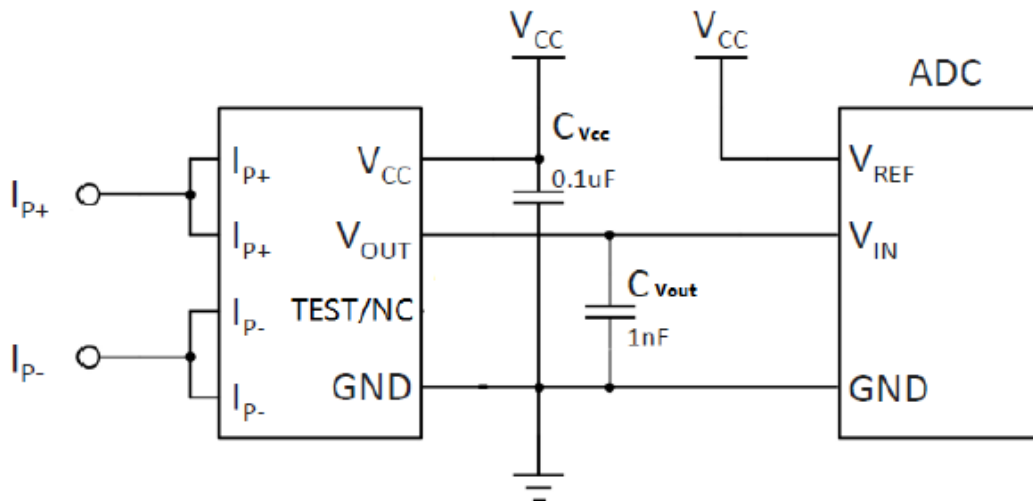
## Pin arrangement

Pin	No.	Function	Pin	No.	Function
IP +	1	Positive current input	GND	5	Ground / Programming pin
IP +	2	Positive current input	TEST	6	Factory test / NC
IP -	3	Negative current input	OUT	7	Signal Out / Programming pin
IP -	4	Negative current input	VCC	8	Power supply / programming pin

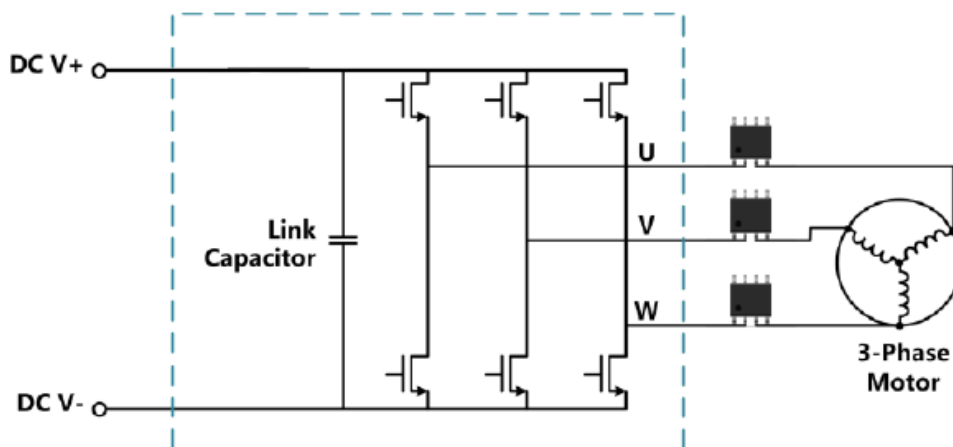


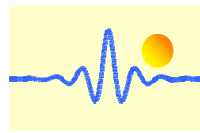
### Typical application circuit

The typical application circuit of the sensor CYHCS91X consists of a filter capacitor  $C_{V_{CC}}$  between  $V_{CC}$  and ground, and an optional filter capacitor  $C_{V_{out}}$  between the output and ground. At the input of the measured current, pin 1 and pin 2 are shorted together as the positive input of the measured current, pin 3 and pin 4 are shorted together as the negative input of the measured current, and the analogue output signal of the sensor is fully proportional to the measured AC/DC current.



### Application circuit of a 3-phase motor controller



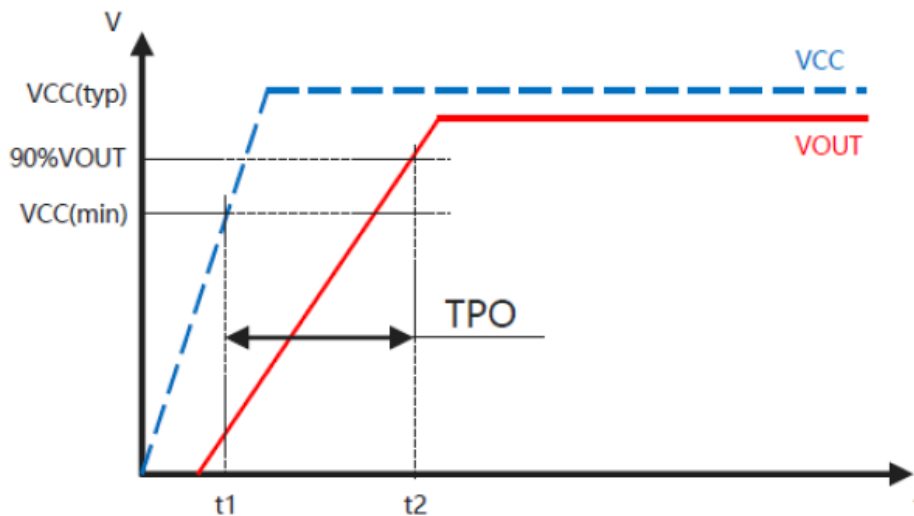


## Parameter Definitions

### Power on Time - TPO

When the power supply rises to the operating voltage, the IC needs a limited time to power up the internal components before responding to the input current.

Power-up time: the time taken for the power supply to reach the minimum operating voltage  $V_{CC_{MIN}}$  is  $t_1$ ; in the case of an applied current under test, the time taken for the output to reach 90% of its stable value  $t_2$ . The difference between the two times is the power-up time.

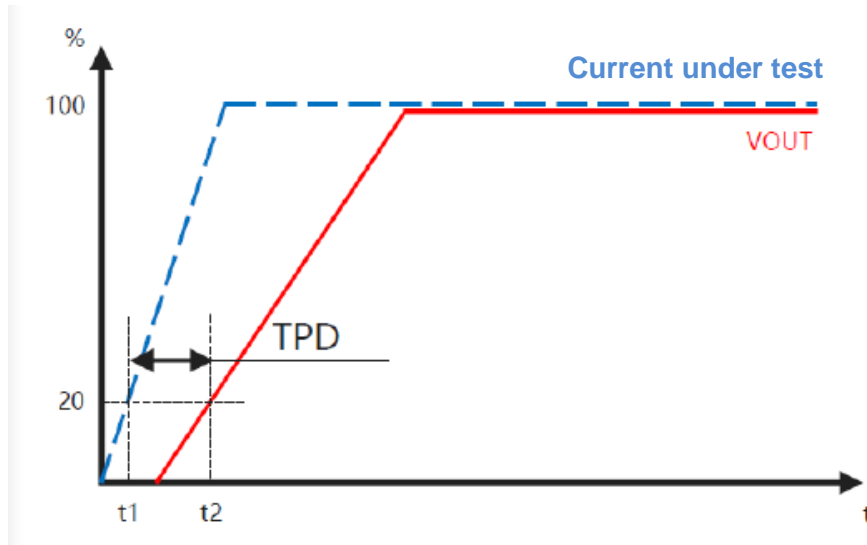


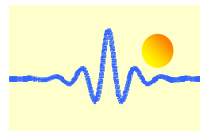
### Temperature trimmed power-up time - TTC

After power-up, temperature trim time is required before a valid temperature compensation output is available.

### Transmission delay - TPD

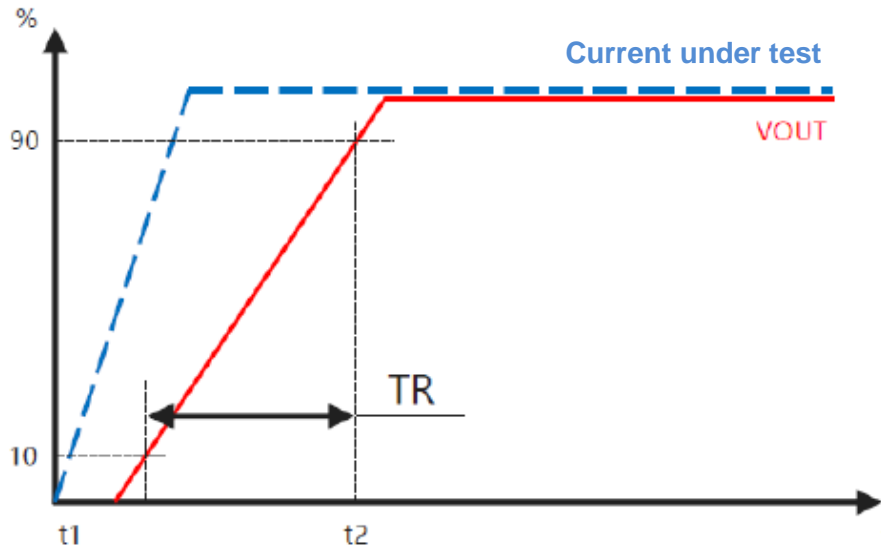
It is the time difference between when the current under test reaches 20% of its final value and when the output reaches 20% of its final value.





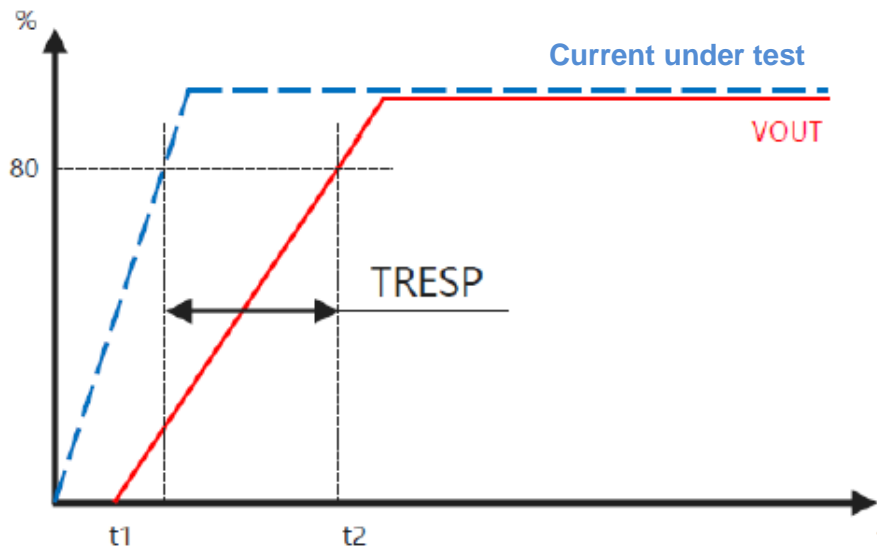
## Rise time - TR

The time difference between the rising times of the IC output level from 10% to 90%, TR is negatively affected by eddy currents if a conductive plane ground is used.



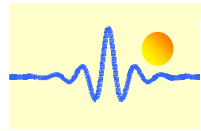
## Response time – TRESP

It is the time difference when the current under test input to the IC reaches 80% of its final value and the corresponding output value the IC reaches 80%. The TRESP is negatively affected by eddy currents if a conductive plane ground is used.



## Static voltage output - VOQ

It is the output voltage of the IC at a zero current under test when both the supply voltage and the surrounding temperature are within the operating range.



## Static Voltage Output Error - VOE

It is the difference between the actual output voltage of the sensor and the ideal output voltage when the current under test is zero. At a fixed output voltage, the static voltage output error is the difference between the actual output voltage and the 2.5V voltage. In output mode proportional to the supply voltage, the static voltage output error is the difference between the actual output voltage and  $VCC/2$ .

## Sensitivity - Sens

The sensitivity indicates the change in the sensor output in mV/A for every 1 Ampere change in the current under test.

It is defined by dividing the difference between the two output voltages of the sensor by the difference between positive and negative full-scale currents. The sensitivity of the sensor is calculated as follows:

$$SENS = (V_{out}(I_{Pmax}) - V_{out}(I_{Nmax})) / (I_{Pmax} - I_{Nmax})$$

Where  $I_{Pmax}$  and  $I_{Nmax}$  are positive full-scale current and negative full-scale current, respectively,  $V_{out}(I_{Pmax})$  and  $V_{out}(I_{Nmax})$  are the analog output voltages of the sensor for the positive full-scale current and negative full-scale current, respectively.

## Error Range - ETOT

This error value represents the maximum error of the sensor in various environments. This value is equal to the absolute value of the measuring error in each temperature range over the full measuring range, divided by the maximum dynamic range of the sensor output. This can be expressed as follows:

$$ETOT(IP) = \text{Max}(V_{out} - V_{out\_idea}) / (V_{out}(IP_{max}) - V_{oq})$$

Where  $\text{Max}(V_{out} - V_{out\_idea})$  represents the maximum error within the measuring range, and  $(V_{out}(IP_{max}) - V_{oq})$  represents the maximum output dynamic range of the sensor.

## Nonlinearity error – ELIN

Due to various factors affecting the operation of the sensor, the output voltage of the sensor is in practice not completely linear to the current under test. After least squares linear fitting, the maximum deviation between the sensor output voltage and the linear fitted line divided by the dynamic range of the sensor is defined as the linearity error of the sensor:

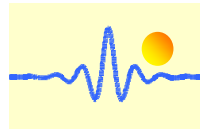
$$ELIN(IP) = \Delta V_{out} / (V_{out}(IP_{max}) - V_{oq})$$

Where,  $\Delta V_{out}$  is the maximum absolute linear deviation in the measuring range of the sensor.

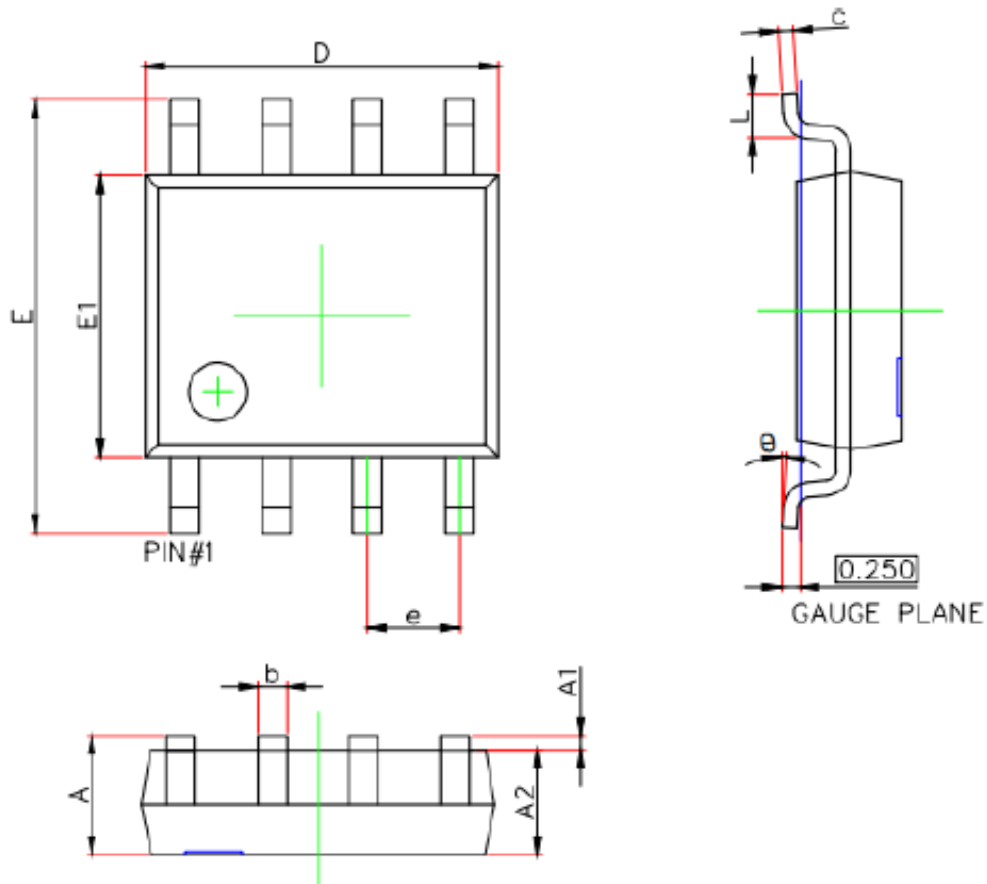
## Ordering Information

Part number	Sensitivity range	package	packing	Operating temperature range
CYHCS911	200mV/A	SOP8	100pcs/tube	-40°C ~ 125°C
CYHCS912	100mV/A	SOP8	100pcs/tube	-40°C ~ 125°C
CYHCS913	66.7mV/A	SOP8	100pcs/tube	-40°C ~ 125°C
CYHCS914	50.0mV/A	SOP8	100pcs/tube	-40°C ~ 125°C

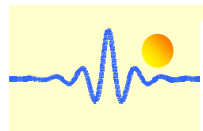




## Package Information



symbol	dimensions(mm)		dimensions (inches)	
	Min.	Max.	Min.	Max.
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
A2	1.35	1.55	0.053	0.061
b	0.33	0.51	0.013	0.020
c	0.17	0.25	0.007	0.010
D	4.80	5.00	0.189	0.197
e	1.27(BSC)		0.050(BSC)	
E	5.80	6.20	0.228	0.244
E1	3.80	4.00	0.150	0.157
L	0.40	1.27	0.016	0.050
θ	0°	8°	0°	8°



---

## Notes

- Hall chips are sensitive devices, so special care should be taken to protect them from static electricity during use and storage.
- The mechanical stress applied to the device housing and leads should be minimized during soldering and use.
- It is recommended that the soldering temperature does not exceed 350°C and the duration does not exceed 5 seconds.
- To ensure the safety and stability of Hall ICs, long-term use outside the parameter range is not recommended.

Copyright© 2022, ChenYang Technologies GmbH & Co. KG

(This material is published on October 25, 2022, last revision on October 25, 2022)

All rights reserved. No part of this data sheet may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the copyright holder.

## Author and Contact Info:

Dr.-Ing. habil. Jigou Liu  
ChenYang Technologies GmbH & Co. KG  
Markt Schwabener Str. 8  
85464 Finsing,  
Germany  
Tel. +49-8121-2574102,  
Fax: +49-8121-2574101  
Email: jigou.liu@chenyang-ism.com