

Data Sheet

Hardware

Documentation

HAL[®] 1xy Hall-Effect Switch IC Family

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2

Contents

Page	Section	Title
4	1.	Introduction
4	1.1.	Family Overview
5	1.2.	Marking Code
5	1.3.	Operating Junction Temperature Range
5	1.4.	Solderability and Welding
6	2.	Specifications
6	2.1.	Outline Dimensions
8	2.2.	Positions of Sensitive Areas
8	2.3.	Absolute Maximum Ratings
8	2.4.	Recommended Operating Conditions
9	2.5.	Characteristics
10	2.6.	Magnetic Characteristics Overview
11	3.	Application Notes
11	3.1.	Ambient Temperature
11	3.2.	Extended Operating Conditions
11	3.3.	Start-up Behavior
11	3.4.	EMC and ESD
12	4.	Data Sheet History

Hall-Effect Switch IC Family

Note: The HAL1xy family has been designed for commercial and industrial applications. It is not intended to be used in automotive or automotive-like applications.

1. Introduction

The HAL1xy Hall switch family is produced in CMOS technology. The sensors include a temperature-compensated Hall plate with active offset compensation, a comparator, and an open-drain output transistor. The comparator compares the actual magnetic flux through the Hall plate (Hall voltage) with the fixed reference values (switching points). Accordingly, the output transistor is switched on or off.

The active offset compensation leads to magnetic parameters which are robust against mechanical stress effects. In addition, the magnetic characteristics are constant in the full supply voltage and temperature range.

The HAL1xy family is available in the SMD-package SOT89B-3 and in the leaded version TO92UA-6.

1.1. Family Overview

This sensor family consists of sensors with a latching and unipolar output behavior.

Туре	Switching Behavior	Sensitivity	see Page
101	unipolar	low	10
102	latching	high	10
103	latching	medium	10
104	latching	low	10
106	unipolar	high	10
107	unipolar	low	10
108	unipolar	medium	10
109	unipolar	high	10

Unipolar Sensors:

The output turns low with the magnetic south pole on the branded side of the package and turns high if the magnetic field is removed. The sensor does not respond to the magnetic north pole on the branded side.

Latching Sensors:

The sensors have a latching behavior and require a magnetic north and south pole for correct functioning. The output turns low with the magnetic south pole on the branded side of the package and turns high with the magnetic north pole on the branded side. The output does not change if the magnetic field is removed. For changing the output state, the opposite magnetic field polarity must be applied.

4

1.2. Marking Code

All Hall sensors have a marking on the package surface (branded side). This marking includes the name of the sensor and the temperature range.

Туре	Temperate	ure Range
	I	С
HAL101	101I	101C
HAL102	1021	102C
HAL103	1031	103C
HAL104	104 1	104C
HAL106	1061	106C
HAL107	1071	107C
HAL108	1081	108C
HAL109	109I	109C

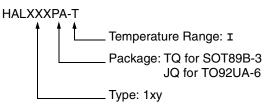
1.3. Operating Junction Temperature Range

The Hall sensors from Micronas are specified to the chip temperature (junction temperature $T_{\rm J}). \label{eq:temperature}$

I: $T_J = -20 \ ^{\circ}C \text{ to } +125 \ ^{\circ}C$

C: $T_J = 0 \circ C$ to +85 $\circ C$

Hall Sensor Package Codes



Example: HAL102JQ-I

- \rightarrow Type: 102
- \rightarrow Package: TO92UA-6
- \rightarrow Temperature Range: T_J = -20 °C to +125 °C

Hall sensors are available in a wide variety of packaging versions and quantities. For more detailed information, please refer to the brochure: "Hall Sensors. Ordering Codes, Packaging, Handling".

1.4. Solderability and Welding

Soldering

During soldering reflow processing and manual reworking, a component body temperature of 260 °C should not be exceeded.

Welding

Device terminals shall be compatible with laser and electrical welding. Please, note that the success of the welding process is subject to different welding parameters which will vary according to the welding technique used. A very close control of the welding parameters is absolutely necessary in order to reach satisfying results. Micronas, therefore, does not give any implied or express warranty as to the ability to weld the component.

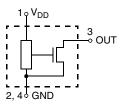


Fig. 1–1: Pin configuration

HAL1xy

2. Specifications

2.1. Outline Dimensions

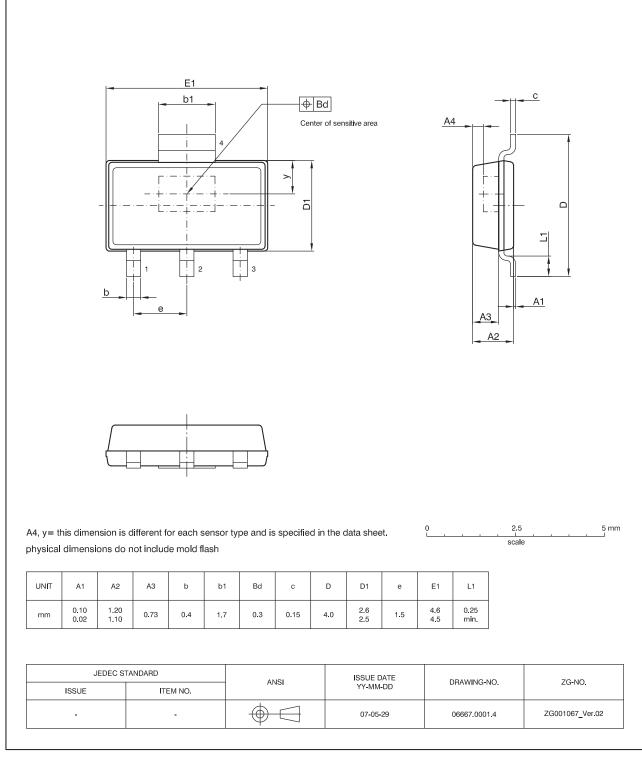


Fig. 2–1:

SOT89B-3: Plastic Small Outline Transistor package, 4 leads, with one sensitive area Weight approximately 0.034 g.

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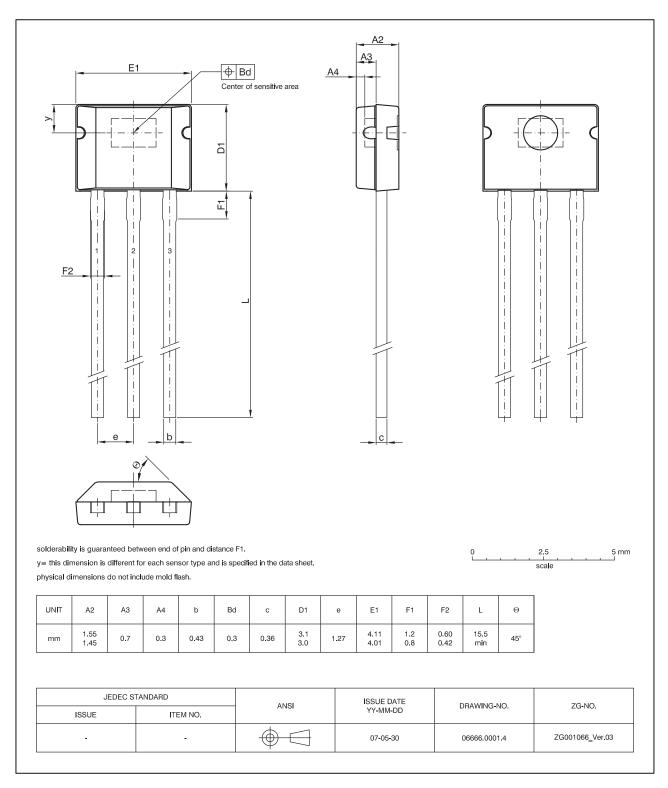


Fig. 2–2:

TO92UA-6: Plastic Transistor Standard UA package, 3 leads Weight approximately 0.106 g

2.2. Positions of Sensitive Areas

	SOT89B-3	TO92UA-6			
у	0.95 mm nominal	1.08 mm nominal			
A4	0.33 mm nominal	0.30 mm nominal			

2.3. Absolute Maximum Ratings

Stresses beyond those listed in the "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only. Functional operation of the device at these conditions is not implied. Exposure to absolute maximum rating conditions for extended periods will affect device reliability.

This device contains circuitry to protect the inputs and outputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than absolute maximum-rated voltages to this high-impedance circuit.

Symbol	Parameter	Pin Name	Min.	Max.	Unit
V _{DD}	Supply Voltage	1	–15	28 ¹⁾	V
Vo	Output Voltage	3	-0.3	28 ¹⁾	V
I _O	Continuous Output On Current	3	_	50 ¹⁾	mA
Т _Ј	Junction Temperature Range		-40	140 ²⁾	°C
¹⁾ as long as ⁻ ²⁾ t < 1000 h	T _J max is not exceeded	•	·		

All voltages listed are referenced to ground (GND).

2.4. Recommended Operating Conditions

Functional operation of the device beyond those indicated in the "Recommended Operating Conditions/Characteristics" is not implied and may result in unpredictable behavior, reduce reliability and lifetime of the device.

All voltages listed are referenced to ground (GND).

Symbol	Parameter	Pin Name	Min.	Max.	Unit	Comment
V _{DD}	Supply Voltage	1	3.8	24	V	
I _O	Continuous Output on Current	3	0	20	mA	
Vo	Output Voltage (output switched off)	3	0	24	V	

8

2.5. Characteristics

at T_J = -20 °C to +125 °C, V_{DD} = 3.8 V to 24 V, GND = 0 V at Recommended Operation Conditions if not otherwise specified in the column "Conditions". Typical Characteristics for T_J = 25 °C and V_{DD} = 12 V.

Parameter	Pin No.	Min.	Тур.	Max.	Unit	Conditions
Supply Current over Temperature Range	1	1.6	3	5.2	mA	
Overvoltage Protection at Supply	1	-	28.5	32	V	$I_{DD} = 25 \text{ mA}, T_{J} = 25 \text{ °C}, t = 20 \text{ ms}$
Overvoltage Protection at Output	3	-	28	32	V	$I_{OH} = 25 \text{ mA}, T_J = 25 \text{ °C}, t = 20 \text{ ms}$
Output Voltage over Temperature Range	3	-	130	400	mV	I _{OL} = 20 mA
Output Leakage Current over Temperature Range	3	-	-	10	μΑ	Output switched off, T _J \leq 150 °C, V _{OH} = 3.8 to 24 V
Internal Oscillator Chopper	_	-	62	-	kHz	HAL10y, HAL11y
Frequency over Temperature Range		-	140	-	kHz	HAL104
Enable Time of Output after Setting of V _{DD}	1	-	35	-	μs	
Output Rise Time	3	-	75	400	ns	$V_{DD} = 12 V,$
Output Fall Time	3	-	50	400	ns	$R_{L} = 820 \text{ Ohm},$ $C_{L} = 20 \text{ pF}$
ckage	ł	!	-	-		
Thermal Resistance Junction to Ambient Junction to Case	_			212 73	K/W K/W	Measured with a 1s0p board 30 mm x 10 mm x 1.5 mm, pad size (see Fig. 2–3)
ckage						
Thermal Resistance Junction to Ambient	_	-	_	225 63	K/W K/W	Measured with a 1s0p board
	Supply Current over Temperature Range Overvoltage Protection at Supply Overvoltage Protection at Output Output Voltage over Temperature Range Output Leakage Current over Temperature Range Internal Oscillator Chopper Frequency over Temperature Range Enable Time of Output after Setting of V _{DD} Output Fall Time Output Fall Time Ckage Thermal Resistance Junction to Case Thermal Resistance Thermal Resistance	Supply Current over Temperature Range 1 Overvoltage Protection at Supply 1 Overvoltage Protection at Output 3 Output Voltage over Temperature Range 3 Output Voltage over Temperature Range 3 Output Leakage Current over Temperature Range 3 Internal Oscillator Chopper Frequency over Temperature Range - Enable Time of Output after Setting of V _{DD} 1 Output Fall Time 3 Output Fall Time 3 Enable Time I Resistance Junction to Ambient - Junction to Case - Ckage - Thermal Resistance - Junction to Rase -	Supply Current over Temperature Range 1 1.6 Overvoltage Protection at Supply 1 - Overvoltage Protection at Output 3 - Overvoltage Protection at Output 3 - Output Voltage over Temperature Range 3 - Output Voltage over Temperature Range 3 - Output Leakage Current over Temperature Range 3 - Internal Oscillator Chopper Frequency over Temperature Range - - Internal Oscillator Chopper Frequency over Temperature Range 1 - Output Rise Time of Output after Setting of V _{DD} 1 - Output Fall Time 3 - - Output Fall Time 3 - - Thermal Resistance Junction to Ambient - - - ckage - - - -	Supply Current over Temperature Range11.63Overvoltage Protection at Supply1-28.5Overvoltage Protection at Output3-28Output Voltage over Temperature Range3-130Output Voltage over Temperature Range3Output Leakage Current over Temperature Range3Internal Oscillator Chopper Frequency over Temperature Range-62Internal Oscillator Chopper Frequency over Temperature Range1-35Output Rise Time of Output after Setting of VDD3-75Output Fall Time3-5050CkageThermal Resistance Junction to AmbientJunction to CaseThermal ResistanceThermal Resistance <td>Supply Current over Temperature Range11.635.2Overvoltage Protection at Supply1-28.532Overvoltage Protection at Output3-2832Overvoltage Protection at Output3-2832Output Voltage over Temperature Range3-130400Output Leakage Current over Temperature Range3-10Internal Oscillator Chopper Frequency over Temperature Range-62-Internal Oscillator Chopper Frequency over Temperature Range-62-Output Rise Time of Output after Setting of VDD1-35-Output Fall Time3-50400Output Fall Time3-50400Cutput Fall Time21273Charge212Thermal Resistance Junction to Ambient Junction to CaseThermal Resistance212Thermal Resistance73Charge73</td> <td>SubmitHarmonHarmonHarmonHarmonHarmonHarmonHarmonSupply Current over Temperature Range11.635.2mAOvervoltage Protection at Supply1-28.532VOvervoltage Protection at Output3-2832VOutput Voltage over Temperature Range3-130400mVOutput Leakage Current over Temperature Range3-10μAInternal Oscillator Chopper Frequency over Temperature Range-62-kHzInternal Oscillator Chopper Frequency over Temperature Range-62-kHzInternal Oscillator Chopper Frequency over Temperature Range-50400nsOutput Rise Time of Output after Setting of V_{DD}1-50400nsOutput Rise Time3-50400nssOutput Fall Time3212K/WMurciton to Ambient Junction to Case212K/WThermal Resistance Junction to Case212K/WThermal Resistance212K/WThermal Resistance1K/WThermal Resistance1-Thermal Resistance212K/W</td>	Supply Current over Temperature Range11.635.2Overvoltage Protection at Supply1-28.532Overvoltage Protection at Output3-2832Overvoltage Protection at Output3-2832Output Voltage over Temperature Range3-130400Output Leakage Current over Temperature Range3-10Internal Oscillator Chopper Frequency over Temperature Range-62-Internal Oscillator Chopper Frequency over Temperature Range-62-Output Rise Time of Output after Setting of VDD1-35-Output Fall Time3-50400Output Fall Time3-50400Cutput Fall Time21273Charge212Thermal Resistance Junction to Ambient Junction to CaseThermal Resistance212Thermal Resistance73Charge73	SubmitHarmonHarmonHarmonHarmonHarmonHarmonHarmonSupply Current over Temperature Range11.635.2mAOvervoltage Protection at Supply1-28.532VOvervoltage Protection at Output3-2832VOutput Voltage over Temperature Range3-130400mVOutput Leakage Current over Temperature Range3-10 μ AInternal Oscillator Chopper Frequency over Temperature Range-62-kHzInternal Oscillator Chopper Frequency over Temperature Range-62-kHzInternal Oscillator Chopper Frequency over Temperature Range-50400nsOutput Rise Time of Output after Setting of V _{DD} 1-50400nsOutput Rise Time3-50400nssOutput Fall Time3212K/WMurciton to Ambient Junction to Case212K/WThermal Resistance Junction to Case212K/WThermal Resistance212K/WThermal Resistance1K/WThermal Resistance1-Thermal Resistance212K/W

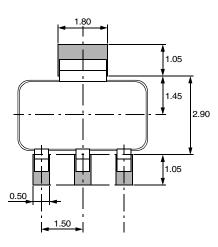


Fig. 2–3: Recommended footprint SOT89B-3, Dimensions in mm All dimensions are for reference only. The pad size may vary depending on the requirements of the soldering process.

2.6. Magnetic Characteristics Overview

at $T_J = -20$ °C to +125 °C, $V_{DD} = 3.8$ V to 24 V, Typical Characteristics for $V_{DD} = 12$ V. Magnetic flux density values of switching points. Positive flux density values refer to the magnetic south pole at the branded side of the package.

Sensor	Parameter	0	On point B _{ON} Off p			ff point B _C)FF	Hy	steresis B	HYS	Unit
Switching Type	TJ	Min.	Тур.	Max.	Min.	Тур.	Max.	Min.	Тур.	Max.	
HAL101	–20 °C	28	33	42	18	23	30	-	10.0	-	mT
unipolar	25 °C	28	34	42	18	24	30	-	10.0	-	mT
	125 °C	26	32	42	17.5	22	30	-	10.0	-	mT
HAL102	−20 °C	0.5	2.8	6.5	-6.5	-2.8	-0.5	-	5.6	_	mT
latching	25 °C	0.5	2.6	6	-6	-2.6	-0.5	-	5.2	_	mT
	125 °C	0.1	2.4	5.5	-5.5	-2.4	-0.1	-	4.8	-	mT
HAL103	–20 °C	5.5	8.4	12.5	-12.5	-8.6	-5.5	-	17	-	mT
latching	25 °C	5	7.6	11.5	-11.5	-7.6	-5	-	15.2	-	mT
	125 °C	3.5	6.7	11.0	-11.0	-6.4	-3.5	-	13.1	-	mT
HAL104	–20 °C	10.5	15.8	21.5	-21.5	-15.8	-10.5	-	31.6	-	mT
latching	25 °C	10	14	18.5	-18.5	-14	-10	-	28	-	mT
	125 °C	6.0	10	15.5	-15.5	-10	-6.0	-	20	-	mT
HAL106	−20 °C	8.8	12.5	18.0	4.5	7.0	11.0	-	5.5	-	mT
unipolar	25 °C	8.1	12.0	16.5	4.2	6.5	10.4	-	5.5	-	mT
	125 °C	7.4	10.0	16.0	3.4	6.0	9.9	-	4.0	-	mT
HAL107	–20 °C	19.6	27.5	35.8	16.9	23.0	31.3	-	4.5	-	mT
unipolar	25 °C	19.6	26.5	35.0	16.9	22.5	30.6	-	4.0	-	mT
	125 °C	18.4	26.0	33.6	15.8	22.0	29.4	-	4.0	-	mT
HAL108	–20 °C	13.1	17.5	25.0	11.9	15.7	23.0	-	1.8	-	mT
unipolar	25 °C	12.7	17.0	23.8	11.4	15.0	21.9	-	2.0	-	mT
	125 °C	10.8	14.6	23.0	9.7	13.0	21.0	-	1.6	-	mT
HAL109	–20 °C	2.3	8.1	12.0	1.8	5.9	11.5	-	2.2	-	mT
unipolar	25 °C	2.3	7.9	12.0	1.8	5.7	11.5	-	2.2	-	mT
	125 °C	2.3	7.7	12.0	1.8	5.7	11.5	-	2.0	-	mT

3. Application Notes

3.1. Ambient Temperature

Due to the internal power dissipation, the temperature on the silicon chip (junction temperature T_J) is higher than the temperature outside the package (ambient temperature T_A).

$$T_J = T_A + \Delta T$$

At static conditions and continuous operation, the following equation applies:

$$\Delta T = I_{DD} \times V_{DD} \times R_{th}$$

If $I_{OUT} > I_{DD}$, please contact Micronas application support for detailed instructions on calculating ambient temperature.

For typical values, use the typical parameters. For worst case calculation, use the max. parameters for I_{DD} and R_{th} , and the max. value for V_{DD} from the application.

For all sensors, the junction temperature range T_{J} is specified. The maximum ambient temperature T_{Amax} can be calculated as:

$$T_{Amax} = T_{Jmax} - \Delta T$$

3.2. Extended Operating Conditions

All sensors fulfill the electrical and magnetic characteristics when operated within the Recommended Operating Conditions (see page 8).

Supply Voltage Below 3.8 V

Typically, the sensors operate with supply voltages above 3 V, however, below 3.8 V some characteristics may be outside the specification.

Note: The functionality of the sensor below 3.8 V is not tested. For special test conditions, please contact Micronas.

3.3. Start-up Behavior

Due to the active offset compensation, the sensors have an initialization time (enable time $t_{en(O)}$) after applying the supply voltage. The parameter $t_{en(O)}$ is specified in Section 2.5.: Characteristics on page 9.

During the initialization time, the output state is not defined and the output can toggle. After $t_{en(O)}$, the output will be low if the applied magnetic field B is above B_{ON} . The output will be high if B is below B_{OFF} .

For magnetic fields between B_{OFF} and B_{ON} , the output state of the HAL sensor after applying V_{DD} will be either low or high. In order to achieve a well-defined output state, the applied magnetic field must be above B_{ONmax} , respectively, below B_{OFFmin} .

3.4. EMC and ESD

For applications with disturbances on the supply line or radiated disturbances, a series resistor and a capacitor are recommended (see Fig. 3–1). The series resistor and the capacitor should be placed as closely as possible to the HAL sensor.

Please contact Micronas for the detailed investigation reports with the EMC and ESD results.

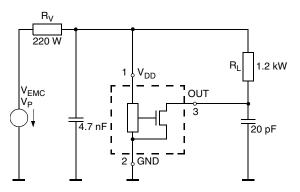


Fig. 3–1: Test circuit for EMC investigations

4. Data Sheet History

1. Data Sheet: "HAL1xy Hall-Effect Switch IC Family", April 8, 2009, DSH000150_001EN. First release of the data sheet.