MICRONAS

Hardware Documentation

Data Sheet

HAL® 1xy

Hall-Effect Switch IC Family

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DSH000150_001EN

Contents

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.

Type	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.

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.

Type	Temperature Range	
	I	C
HAL 101	101I	101C
HAL 102	102I	102C
HAL 103	103I	103C
HAL 104	104I	104C
HAL 106	106I	106C
HAL 107	107I	107C
HAL 108	108I	108C
HAL 109	109I	109C

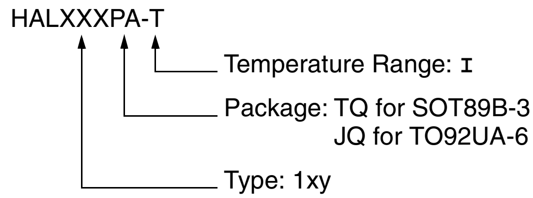
1.3. Operating Junction Temperature Range

The Hall sensors from Micronas are specified to the chip temperature (junction temperature T_J).

I: T_J = –20 °C to +125 °C

C: T_J = 0 °C to +85 °C

Hall Sensor Package Codes



Example: **HAL102JQ-I**

→ Type: 102
→ Package: TO92UA-6
→ 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.

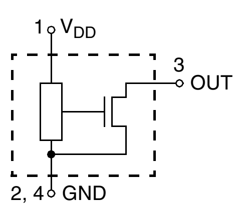
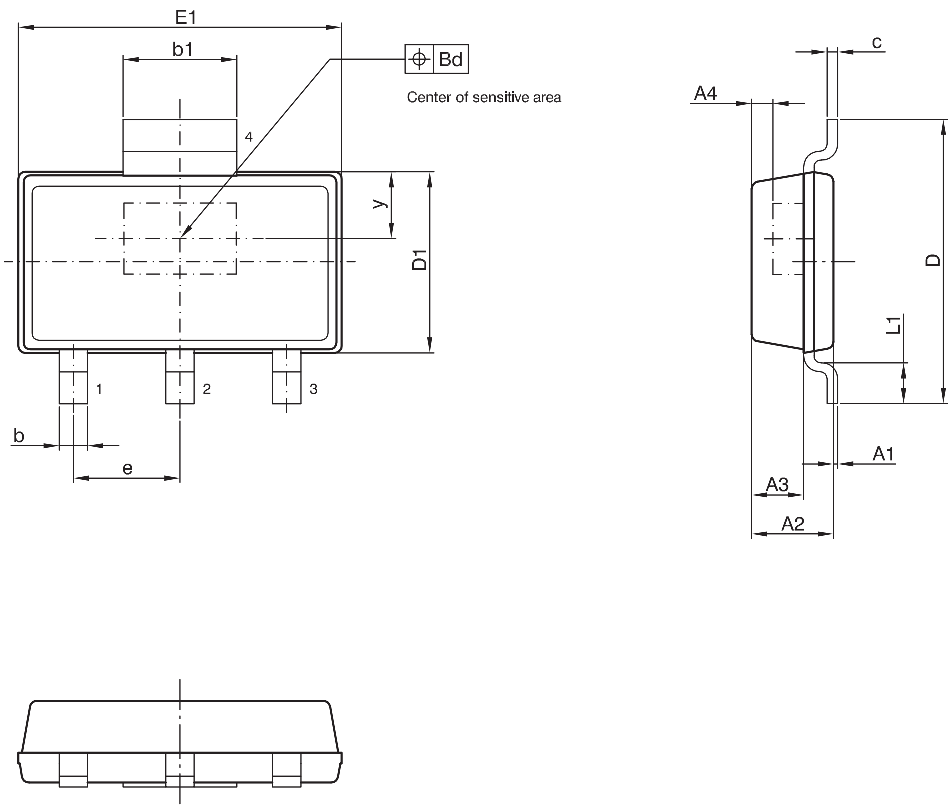


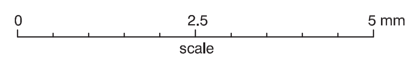
Fig. 1–1: Pin configuration

2. Specifications

2.1. Outline Dimensions



A4, y= this dimension is different for each sensor type and is specified in the data sheet.
physical dimensions do not include mold flash



UNIT	A1	A2	A3	b	b1	Bd	c	D	D1	e	E1	L1
mm	0.10 0.02	1.20 1.10	0.73	0.4	1.7	0.3	0.15	4.0	2.6 2.5	1.5	4.6 4.5	0.25 min.

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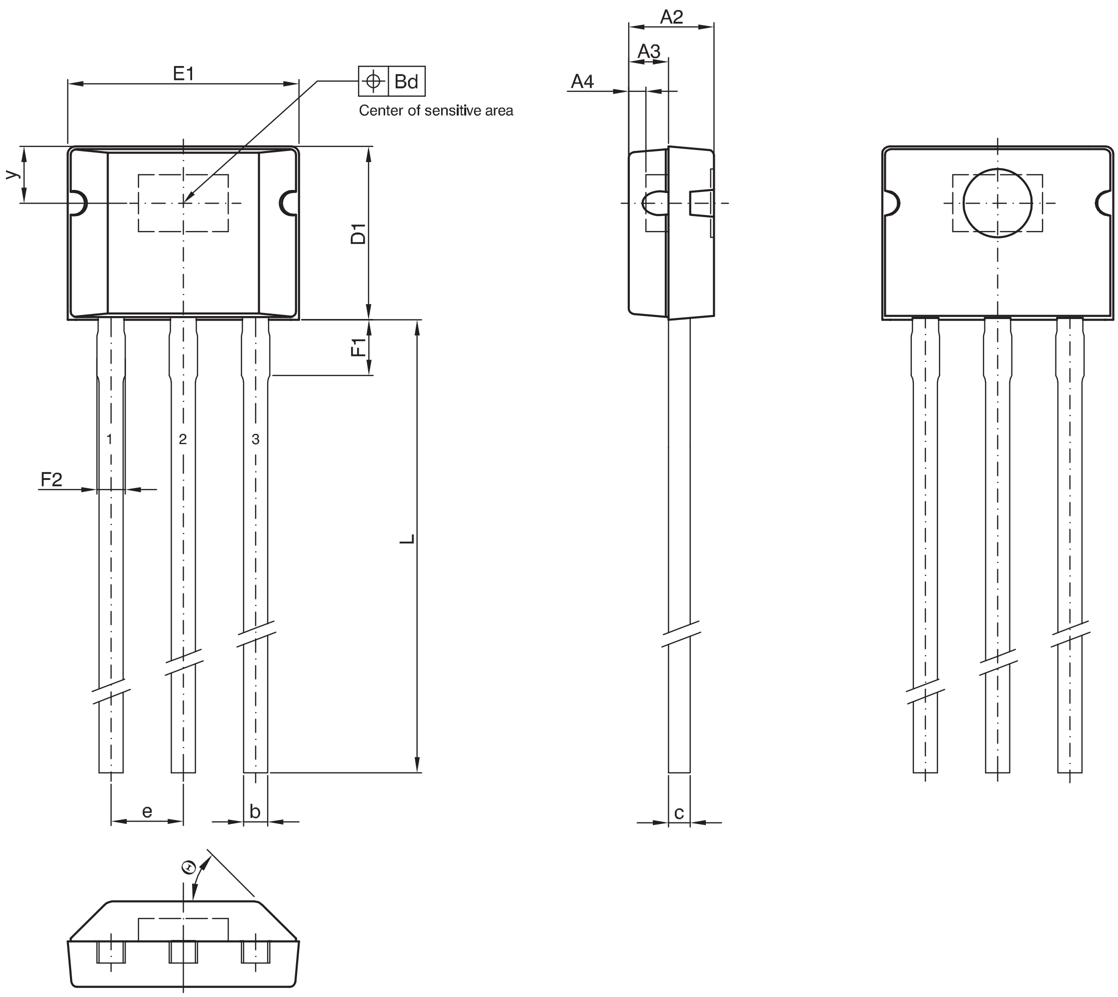
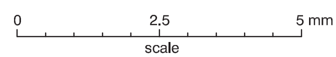
Fig. 2–1:
SOT89B-3: Plastic **S**mall **O**utline **T**ransistor package, 4 leads, with one sensitive area
Weight approximately 0.034 g.



solderability is guaranteed between end of pin and distance F1.

y= this dimension is different for each sensor type and is specified in the data sheet.

physical dimensions do not include mold flash.



UNIT	A2	A3	A4	b	Bd	c	D1	e	E1	F1	F2	L	Θ
mm	1.55 1.45	0.7	0.3	0.43	0.3	0.36	3.1 3.0	1.27	4.11 4.01	1.2 0.8	0.60 0.42	15.5 min	45°

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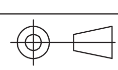
-	-		07-05-30	06666.0001.4	ZG001066_Ver.03

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
y	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.

All voltages listed are referenced to ground (GND).

Symbol	Parameter	Pin Name	Min.	Max.	Unit
V_{DD}	Supply Voltage	1	–15	28[1)]	V
V_O	Output Voltage	3	–0.3	28[1)]	V
I_O	Continuous Output On Current	3	–	50[1)]	mA
T_J	Junction Temperature Range		–40	140[2)]	°C

1) as long as $T_J$max is not exceeded
2) t < 1000 h

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	
V_O	Output Voltage (output switched off)	3	0	24	V	

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.

Symbol	Parameter	Pin No.	Min.	Typ.	Max.	Unit	Conditions
I_{DD}	Supply Current over Temperature Range	1	1.6	3	5.2	mA	
V_{DDZ}	Overvoltage Protection at Supply	1	–	28.5	32	V	I_{DD} = 25 mA, T_J = 25 °C, t = 20 ms
V_{OZ}	Overvoltage Protection at Output	3	–	28	32	V	I_{OH} = 25 mA, T_J = 25 °C, t = 20 ms
V_{OL}	Output Voltage over Temperature Range	3	–	130	400	mV	I_{OL} = 20 mA
I_{OH}	Output Leakage Current over Temperature Range	3	–	–	10	µA	Output switched off, T_J ≤150 °C, V_{OH} = 3.8 to 24 V
f_{osc}	Internal Oscillator Chopper Frequency over Temperature Range	–	–	62	–	kHz	HAL 10y, HAL 11y
			–	140	–	kHz	HAL 104
$t_{en(O)}$	Enable Time of Output after Setting of V_{DD}	1	–	35	–	µs	
t_r	Output Rise Time	3	–	75	400	ns	V_{DD} = 12 V, R_L = 820 Ohm, C_L = 20 pF
t_f	Output Fall Time	3	–	50	400	ns	
SOT89B Package							
	Thermal Resistance						Measured with a 1s0p board 30 mm x 10 mm x 1.5 mm, pad size (see Fig. 2–3)
R_{thja}	Junction to Ambient	–	–	–	212	K/W	
R_{thjc}	Junction to Case	–	–	–	73	K/W	
TO92UA Package							
	Thermal Resistance						Measured with a 1s0p board
R_{thja}	Junction to Ambient	–	–	–	225	K/W	
R_{thjc}	Junction to Case	–	–	–	63	K/W	

1) V_{DD} = 12 V, B > B_{ON} + 2 mT or B < B_{OFF} – 2 mT

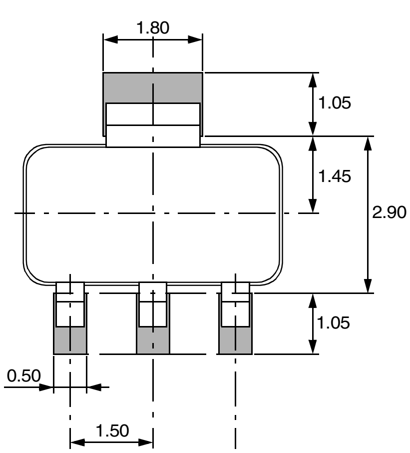


Fig. 2–3: Recommended footprint SOT89B-3, Dimensions in mm
All dimensions are for reference only. The pad size may vary depending on the requirements of the soldering process.

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	On point B_{ON}			Off point B_{OFF}			Hysteresis B_{HYS}			Unit
Switching Type	T_J	**Min.**	**Typ.**	**Max.**	**Min.**	**Typ.**	**Max.**	**Min.**	**Typ.**	**Max.**	
HAL 101	–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
HAL 102	–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
HAL 103	–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
HAL 104	–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
HAL 106	–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
HAL 107	–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
HAL 108	–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
HAL 109	–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.

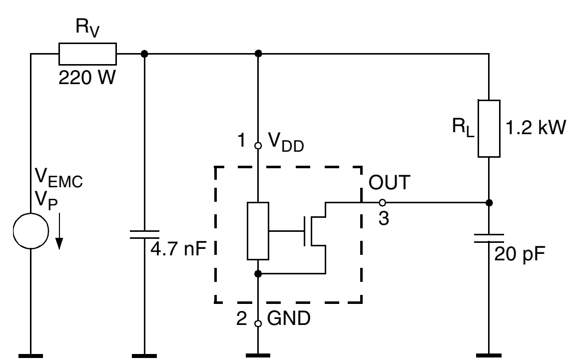


Fig. 3–1: Test circuit for EMC investigations

4. Data Sheet History

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

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