MICRONAS INTERMETALL

HAL556, HAL560, HAL566 Two-Wire Hall Effect Sensor Family

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MICRONAS INTERMETALL

Contents

Two-wire Hall Effect Sensor Family
in CMOS technology

1. Introduction

This sensor family consists of different two-wire Hall switches produced in CMOS technology. All sensors change the current consumption depending on the external magnetic field and require only two wires between sensor and evaluation circuit. The sensors of this family differ in the magnetic switching behavior and switching points.

The sensors include a temperature-compensated Hall plate with active offset compensation, a comparator, and a current source. The comparator compares the actual magnetic flux through the Hall plate (Hall voltage) with the fixed reference values (switching points). Accordingly, the current source is switched on (high current consumption) or off (low current consumption).

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

The sensors are designed for industrial and automotive applications and operate with supply voltages from 4 V to 24 V in the junction temperature range from –40 °C up to 100 °C.

All sensors are available in two SMD-packages (SOT-89A and SOT-89B) and in a leaded version (TO-92UA).

1.1. Features:

– current output for two-wire applications

– switching offset compensation at typically 145 kHz

– operates from 4 V to 24 V supply voltage

– overvoltage and reverse-voltage protection

– magnetic characteristics are robust against mechanical stress effects

– operates with static magnetic fields and dynamic magnetic fields up to 10 kHz

– constant magnetic switching points over a wide supply voltage range

– the decrease of magnetic flux density caused by rising temperature in the sensor system is compensated by a built-in negative temperature coefficient of the magnetic characteristics

– ideal sensor for applications in extreme automotive and industrial environments

– EMC corresponding to DIN 40839

1.2. Family Overview

The types differ according to the mode of switching and the magnetic switching points.

Type	Switching Behavior	Sensitivity	see Page
556	unipolar	very high	12
560	unipolar inverted	low	14
566	unipolar inverted	very high	16

Unipolar Switching Sensors:

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

Unipolar Inverted Switching Sensors:

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

1.3. 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	
	E	C
HAL556	556E	556C
HAL560	560E	560C
HAL566	566E	566C

1.4. Operating Junction Temperature Range

E: T_J = –40 °C to +100 °C

C: T_J = 0 °C to +100 °C

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

The relationship between ambient temperature (T_A) and junction temperature is explained in section 5.4. on page 19.

1.5. Hall Sensor Package Codes

HALXXXPA-T

- Temperature Range: E or C
- Package: SF for SOT-89B
  SO for SOT-89A
  UA for TO-92UA
- Type: 556, 560, or 566

Example: **HAL556UA-E**

→ Type: 556
→ Package: TO-92UA
→ Temperature Range: T_J = –40 °C to +100 °C

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

1.6. Solderability

all packages: according to IEC68-2-58

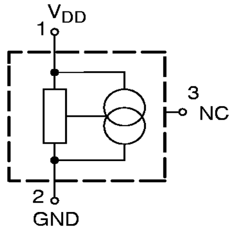

Fig. 1–1: Pin configuration

2. Functional Description

The HAL55x, HAL56x two-wire sensors are monolithic integrated circuits which switch in response to magnetic fields. If a magnetic field with flux lines perpendicular to the sensitive area is applied to the sensor, the biased Hall plate forces a Hall voltage proportional to this field. The Hall voltage is compared with the actual threshold level in the comparator. The temperature-dependent bias increases the supply voltage of the Hall plates and adjusts the switching points to the decreasing induction of magnets at higher temperatures.

If the magnetic field exceeds the threshold levels, the current source switches to the appropriate state. In the low current consumption state, the current source is switched off and the current consumption is caused only by the current through the Hall sensor. In the high current consumption state, the current source is switched on and the current consumption is caused by the current through the Hall sensor and the current source. The built-in hysteresis eliminates oscillation and provides switching behavior of output without bouncing.

Magnetic offset caused by mechanical stress is compensated for by using the "switching offset compensation technique". Therefore, an internal oscillator provides a two-phase clock. The Hall voltage is sampled at the end of the first phase. At the end of the second phase, both sampled and actual Hall voltages are averaged and compared with the switching points. Subsequently, the current consumption switches to the appropriate state. The amount of time elapsed from crossing the magnetic switching level to switching of the current level can vary between zero and $1/f_{osc}$.

Shunt protection devices clamp voltage peaks at the V_{DD}-pin together with external series resistors. Reverse current is limited at the V_{DD}-pin by an internal series resistor up to –15 V. No external protection diode is needed for reverse voltages ranging from 0 V to –15 V.

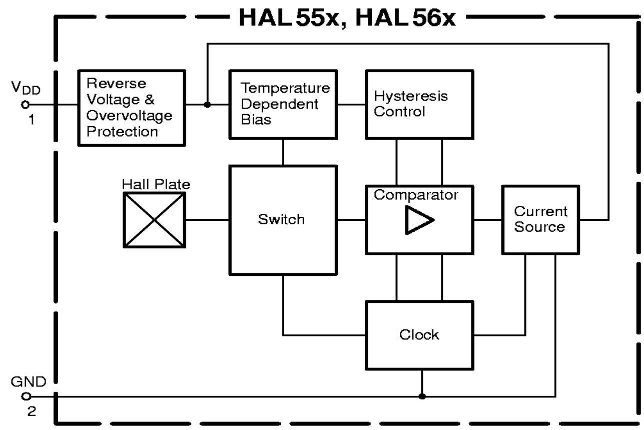

Fig. 2–1: HAL55x, HAL56x block diagram

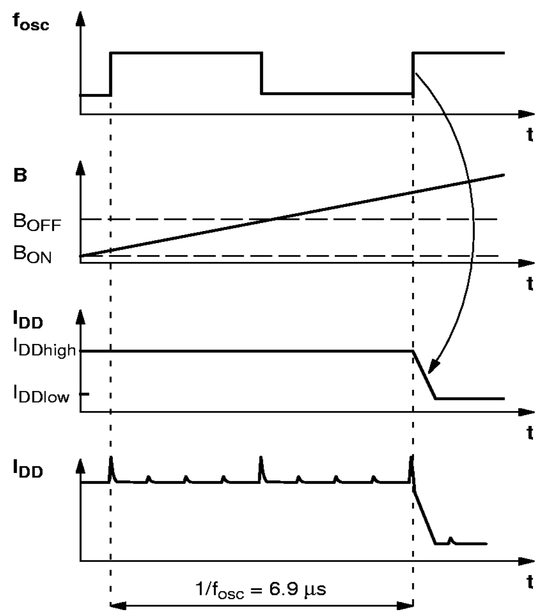

Fig. 2–2: Timing diagram (example: HAL56x)

3. Specifications

3.1. Outline Dimensions

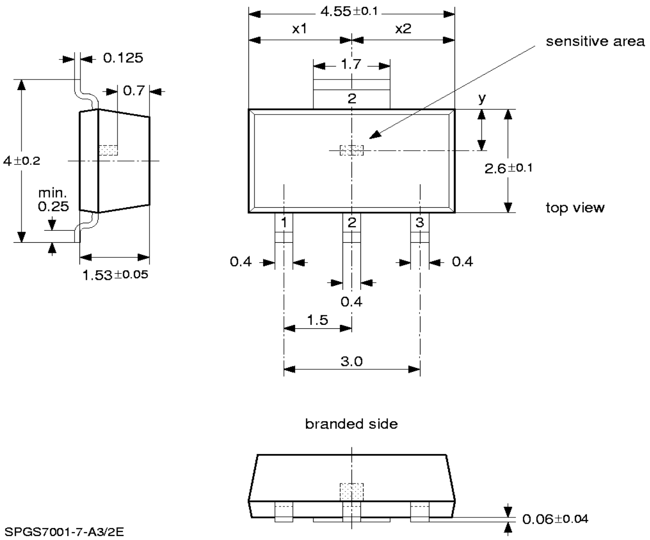

Fig. 3–1:
Plastic Small Outline Transistor Package
(SOT-89A)
Weight approximately 0.04 g
Dimensions in mm

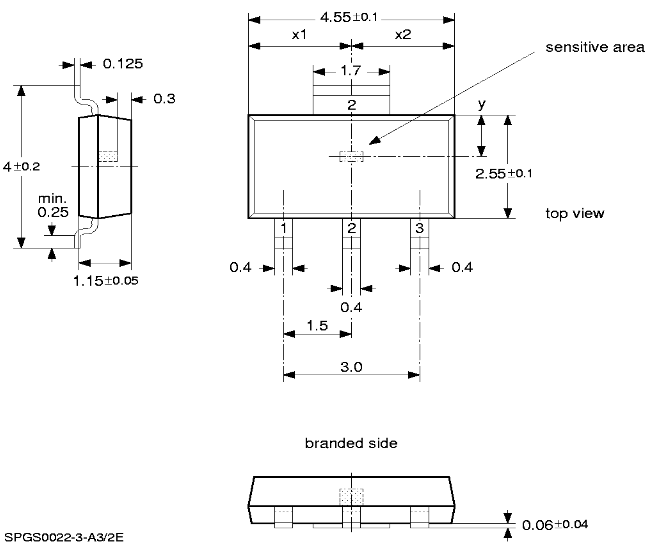

Fig. 3–2:
Plastic Small Outline Transistor Package
(SOT-89B)
Weight approximately 0.035 g
Dimensions in mm

Note: This package will be introduced in 1999. Samples are available. Contact the sales offices for high volume delivery.

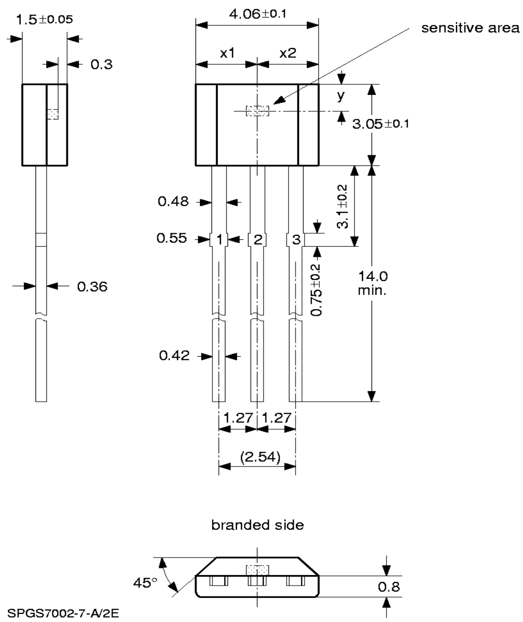

Fig. 3–3:
Plastic Transistor Single Outline Package
(TO-92UA)
Weight approximately 0.12 g
Dimensions in mm

For all package diagrams, a mechanical tolerance of ±50 µm applies to all dimensions where no tolerance is explicitly given.

3.2. Dimensions of Sensitive Area

0.25 mm x 0.12 mm

3.3. Positions of Sensitive Areas

SOT-89A	SOT-89B	TO-92UA
$\lvert x_2 - x_1 \rvert / 2 < 0.2$ mm		
y = 0.88 mm ± 0.2 mm	y = 0.85 mm ± 0.2 mm	y = 0.9 mm ± 0.2 mm

3.4. Absolute Maximum Ratings

Symbol	Parameter	Pin No.	Min.	Max.	Unit
V_{DD}	Supply Voltage	1	–15[1)]	28[2)]	V
I_{DDZ}	Supply Current through Protection Device	1	–50[2)] –200[3)]	50[2)] 200[3)]	mA mA
T_S	Storage Temperature Range		–65	150	°C
T_J	Junction Temperature Range		–40	150	°C

1) –18 V with a 100 Ω series resistor at pin 1 (–16 V with 30 Ω series resistor) as long as T_{Jmax} is not exceeded.
2) as long as T_{Jmax} is not exceeded
3) $t<2$ ms

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 or any other conditions beyond those indicated in the “Recommended Operating Conditions/Characteristics” of this specification is not implied. Exposure to absolute maximum ratings conditions for extended periods may affect device reliability.

3.5. Recommended Operating Conditions

Symbol	Parameter	Pin No.	Min.	Max.	Unit
V_{DD}	Supply Voltage	1	4	24	V
t_{on}	Supply Time for pulsed mode		30	–	µs
T_A	Ambient Temperature		–40	85[1)]	°C

Pulsed mode of supply voltage is recommended for operation at high ambient temperatures to keep junction temperature low (see also section 5.4. on page 19).
1) with pulsed mode of supply, $t_{on}/t_{off} \leq 1/6$ and $t_{on} \leq 1$ ms

3.6. Electrical Characteristics at T_J = –40 °C to +100 °C , V_{DD} = 4 V to 24 V, as not otherwise specified in Conditions
Typical Characteristics for T_J = 25 °C and V_{DD} = 12 V

Symbol	Parameter	Pin No.	Min.	Typ.	Max.	Unit	Conditions
I_{DDlow}	Low Current Consumption over Temperature Range	1	2	3.3	5	mA	
I_{DDhigh}	High Current Consumption over Temperature Range	1	12	14.3	17	mA	
V_{DDZ}	Overvoltage Protection at Supply	1	–	28.5	32	V	I_{DD} = 25 mA, T_J = 25 °C, t = 20 ms
f_{osc}	Internal Oscillator Chopper Frequency	–	90	145	–	kHz	T_J = 25 °C
f_{osc}	Internal Oscillator Chopper Frequency over Temperature Range	–	75	145	–	kHz	
$t_{en(O)}$	Enable Time of Output after Setting of V_{DD}	1		20	30	µs	1)
t_r	Output Rise Time	1		0.4	1.6	µs	V_{DD} = 12 V, R_s = 30 Ω
t_f	Output Fall Time	1		0.4	1.6	µs	V_{DD} = 12 V, R_s = 30 Ω
R_{thJSB} case SOT-89A SOT-89B	Thermal Resistance Junction to Substrate Backside	–	–	150	200	K/W	Fiberglass Substrate 30 mm x 10 mm x 1.5mm, pad size see Fig. 3–4
R_{thJA} case TO-92UA	Thermal Resistance Junction to Soldering Point	–	–	150	200	K/W	

1) B > B_{ON} + 2 mT or B < B_{OFF} – 2 mT for HAL55x, B > B_{OFF} + 2 mT or B < B_{ON} – 2 mT for HAL56x

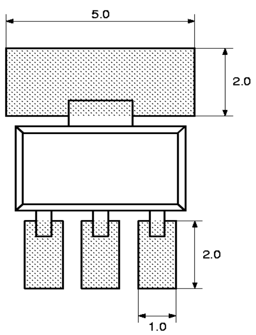

Fig. 3–4: Recommended pad size SOT-89x
Dimensions in mm

3.7. Magnetic Characteristics Overview at T_J = –40 °C to +100 °C, V_{DD} = 4 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 Switching Type	Parameter T_J	On point B_{ON} Min.	Typ.	Max.	Off point B_{OFF} Min.	Typ.	Max.	Hysteresis B_{HYS} Min.	Typ.	Max.	Unit
HAL 556	–40 °C	3.4	6.3	7.7	2.1	4.2	5.9	0.8	2.1	2.8	mT
unipolar	25 °C	3.4	6	7.4	2	4	5.7	0.5	2	2.7	mT
	100 °C	3.2	5.7	7.2	1.9	3.8	5.7	0.3	1.9	2.6	mT
HAL 560	–40 °C	41	46.5	52	45	53.5	59.5	4	7	10	mT
unipolar	25 °C	41	45.6	52	45	51.7	59.5	3	6.1	9	mT
inverted	100 °C	41	44.3	52	45	49.5	59.5	2	5.2	8	mT
HAL 566	–40 °C	2.1	4.1	5.9	3.4	6.1	7.7	0.8	2	2.8	mT
unipolar	25 °C	2	4	5.7	3.4	5.9	7.2	0.5	1.9	2.7	mT
inverted	100 °C	1.85	3.8	5.7	3.25	5.6	7	0.3	1.8	2.6	mT

Note: For detailed descriptions of the individual types, see pages 12 and following.

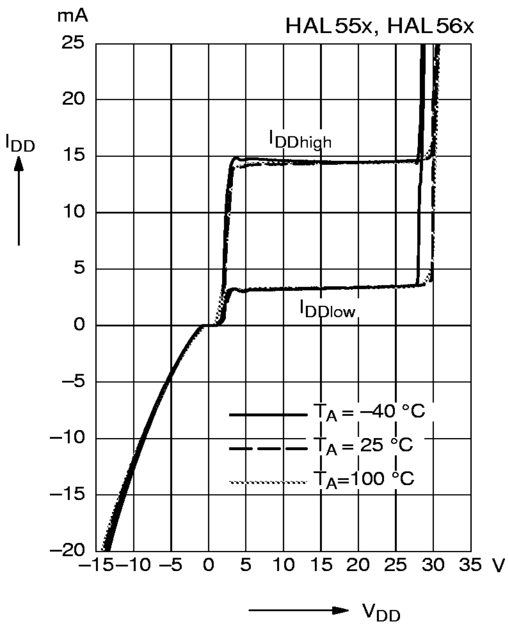

Fig. 3–5: Typical current consumption versus supply voltage

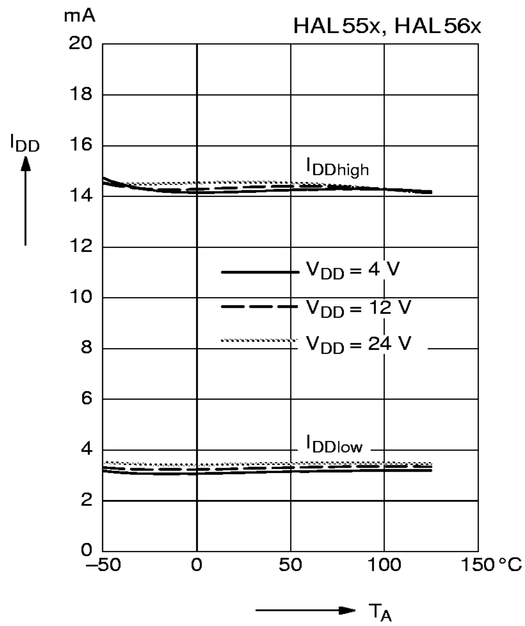

Fig. 3–7: Typical current consumption versus ambient temperature

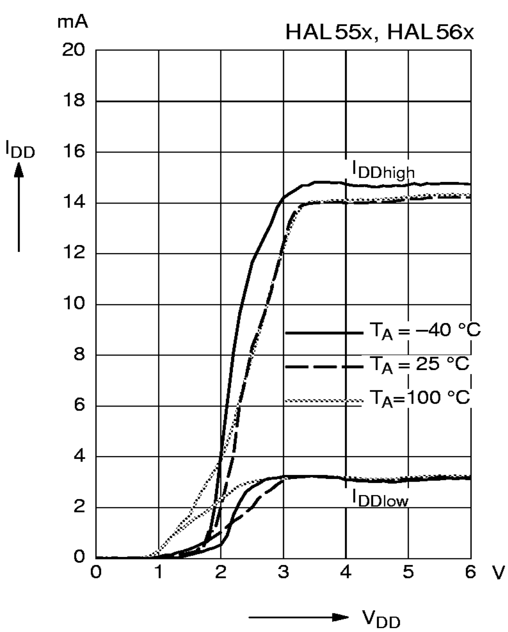

Fig. 3–6: Typical current consumption versus supply voltage

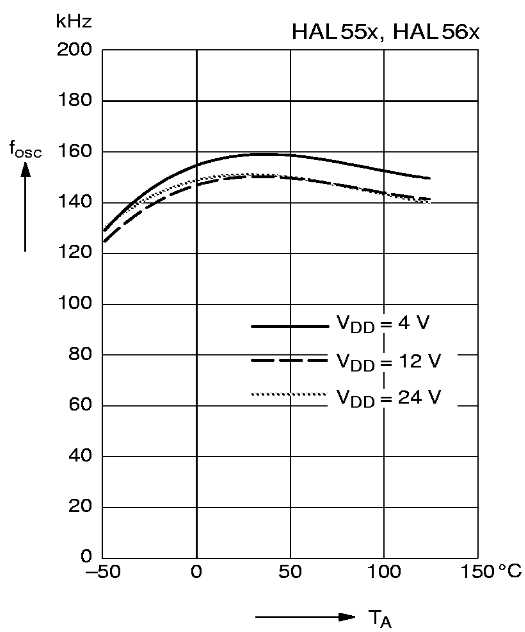

Fig. 3–8: Typ. internal chopper frequency versus ambient temperature

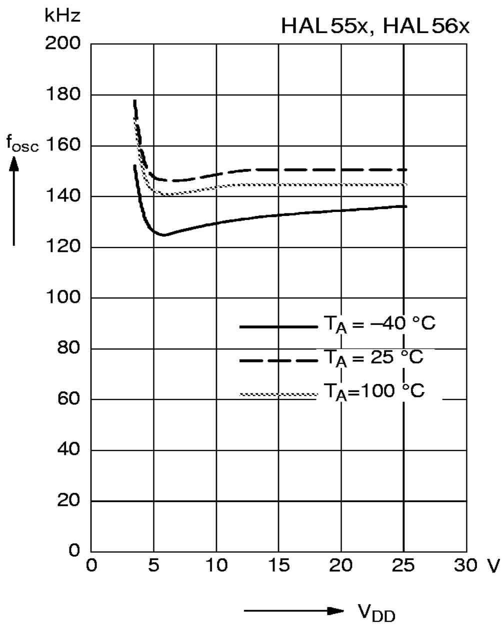

Fig. 3–9: Typ. internal chopper frequency versus supply voltage

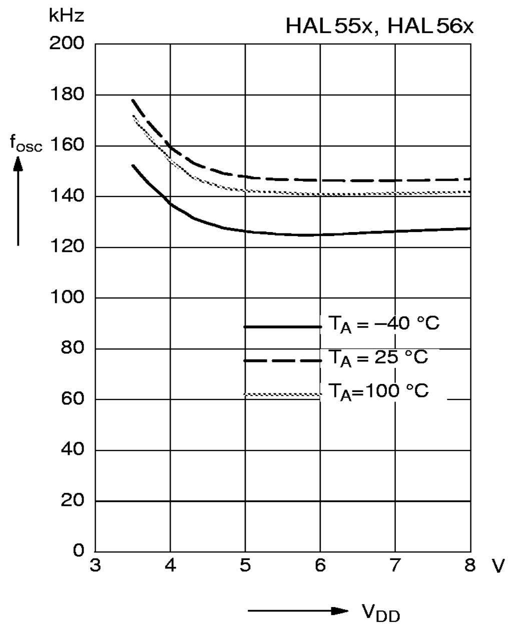

Fig. 3–10: Typ. internal chopper frequency versus supply voltage

4. Type Description

4.1. HAL 556

The HAL 556 is a very sensitive unipolar switching sensor (see Fig. 4–1).

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

For correct functioning in the application, the sensor requires only the magnetic south pole on the branded side of the package.

In the HAL 55x, HAL 56x two-wire sensor family, the HAL 566 is a sensor with the same magnetic characteristics but with an inverted output characteristic.

Magnetic Features:

– switching type: unipolar

– very high sensitivity

– typical B_{ON}: 6 mT at room temperature

– typical B_{OFF}: 4 mT at room temperature

– operates with static magnetic fields and dynamic magnetic fields up to 10 kHz

Applications

The HAL 556 is the optimal sensor for all applications with one magnetic polarity and weak magnetic amplitude at the sensor position such as:

– applications with large airgap or weak magnets,

– solid state switches,

– contactless solutions to replace micro switches,

– position and end point detection, and

– rotating speed measurement.

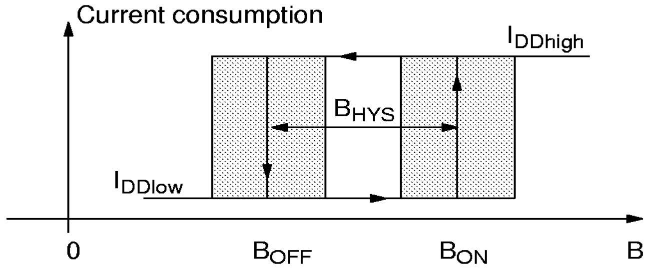

Fig. 4–1: Definition of magnetic switching points for the HAL 556

Magnetic Characteristics at T_J = –40 °C to +100 °C, V_{DD} = 4 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.

Parameter	On point B_{ON}			Off point B_{OFF}			Hysteresis B_{HYS}			Magnetic Offset			Unit
T_J	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
–40 °C	3.4	6.3	7.7	2.1	4.2	5.9	0.8	2.1	2.8		5.2		mT
25 °C	3.4	6	7.4	2	4	5.7	0.5	2	2.7	3	5	6.2	mT
100 °C	3.2	5.7	7.2	1.9	3.8	5.7	0.3	1.9	2.6		4.8		mT

The hysteresis is the difference between the switching points $B_{HYS} = B_{ON} - B_{OFF}$
The magnetic offset is the mean value of the switching points $B_{OFFSET} = (B_{ON} + B_{OFF}) / 2$

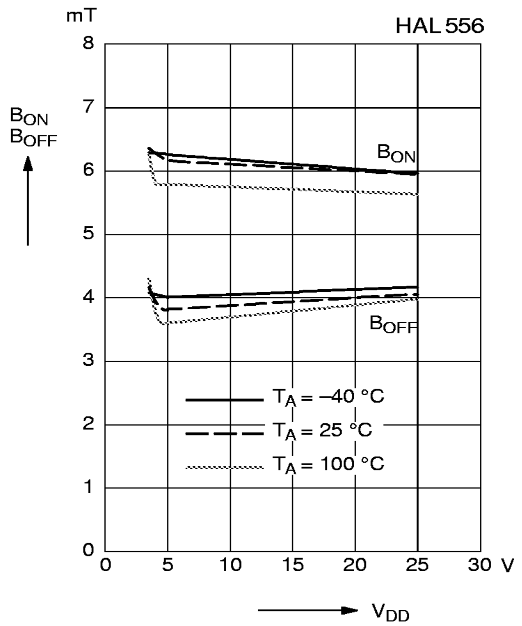

Fig. 4–2: Typ. magnetic switching points versus supply voltage

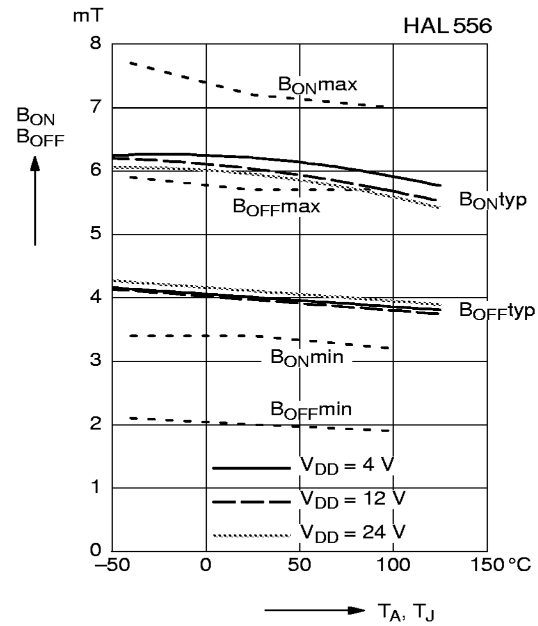

Fig. 4–4: Magnetic switching points versus temperature

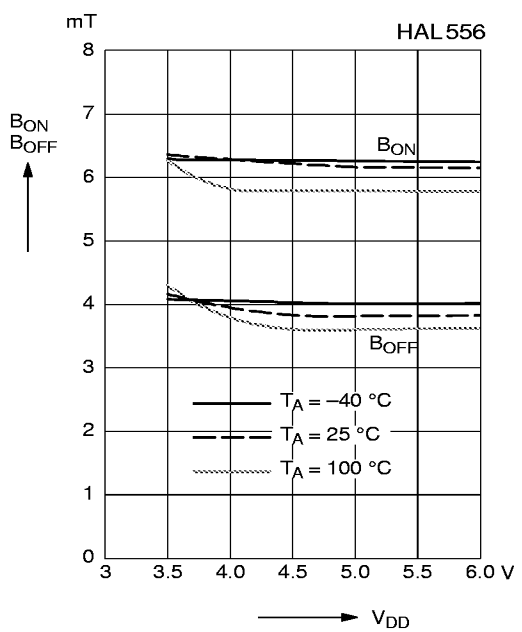

Fig. 4–3: Typ. magnetic switching points versus supply voltage

Note: In the diagram “Magnetic switching points versus temperature” the curves for B_{ON}min, B_{ON}max, B_{OFF}min, and B_{OFF}max refer to junction temperature, whereas typical curves refer to ambient temperature.

4.2. HAL 560

The HAL 560 is a low sensitive unipolar switching sensor with an inverted output (see Fig. 4–5).

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

For correct functioning in the application, the sensor requires only the magnetic south pole on the branded side of the package.

Magnetic Features:

– switching type: unipolar inverted
– low sensitivity
– typical B_{ON}: 45.6 mT at room temperature
– typical B_{OFF}: 51.7 mT at room temperature
– operates with static magnetic fields and dynamic magnetic fields up to 10 kHz

Applications

The HAL 560 is the optimal sensor for all applications with one magnetic polarity and strong magnetic amplitude at the sensor position where an inverted output signal is required such as:

– applications with strong magnets,
– solid state switches,
– contactless solutions to replace micro switches,
– position and end point detection, and
– rotating speed measurement.

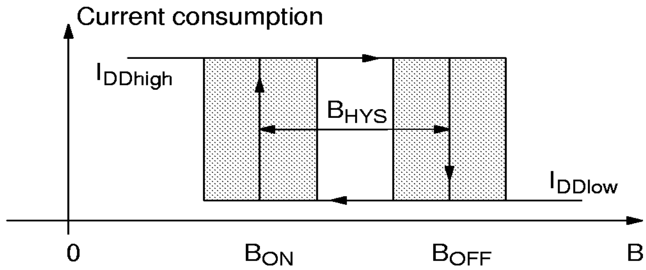

Fig. 4–5: Definition of magnetic switching points for the HAL 560

Magnetic Characteristics at T_J = –40 °C to +100 °C, V_{DD} = 4 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.

Parameter	On point B_{ON}			Off point B_{OFF}			Hysteresis B_{HYS}			Magnetic Offset			Unit
T_J	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
–40 °C	41	46.5	52	45	53.5	59.5	4	7	10		50		mT
25 °C	41	45.6	52	45	51.7	59.5	3	6.1	9		48.6		mT
100 °C	41	44.3	52	45	49.5	59.5	2	5.2	8		46.9		mT

The hysteresis is the difference between the switching points $B_{HYS} = B_{OFF} - B_{ON}$
The magnetic offset is the mean value of the switching points $B_{OFFSET} = (B_{ON} + B_{OFF}) / 2$

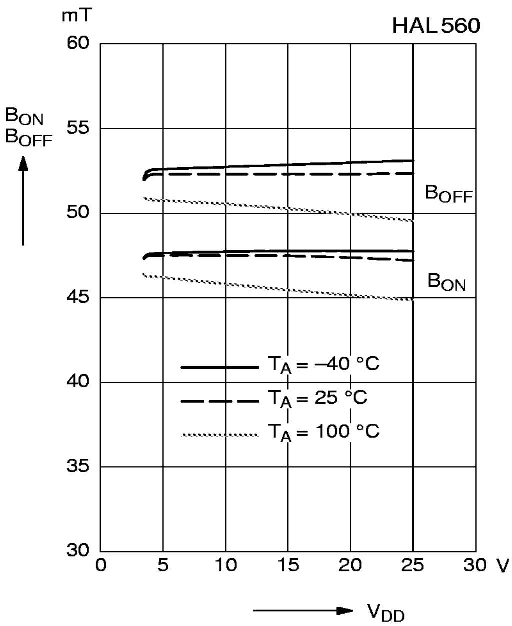

Fig. 4–6: Typ. magnetic switching points versus supply voltage

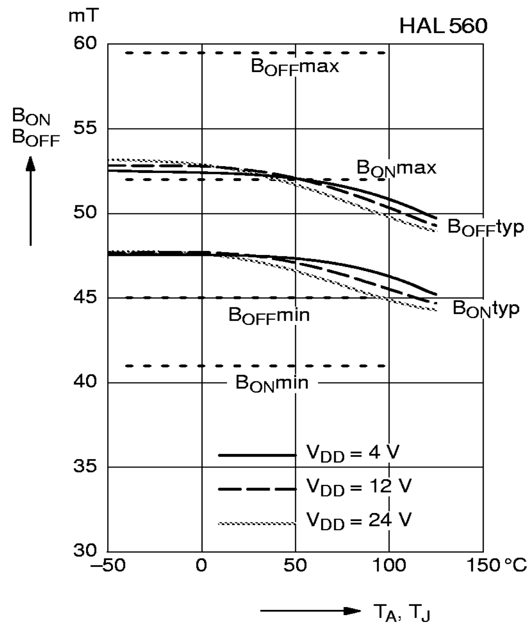

Fig. 4–8: Magnetic switching points versus temperature

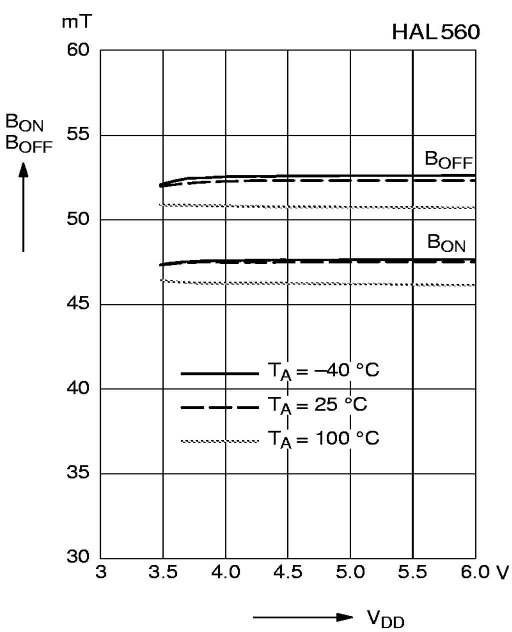

Fig. 4–7: Typ. magnetic switching points versus supply voltage

Note: In the diagram "Magnetic switching points versus temperature" the curves for B_{ON}min, B_{ON}max, B_{OFF}min, and B_{OFF}max refer to junction temperature, whereas typical curves refer to ambient temperature.

4.3. HAL 566

The HAL 566 is a very sensitive unipolar switching sensor with an inverted output (see Fig. 4–9).

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

For correct functioning in the application, the sensor requires only the magnetic south pole on the branded side of the package.

In the HAL 55x, HAL 56x two-wire sensor family, the HAL 556 is a sensor with the same magnetic characteristics but with a normal output characteristic.

Magnetic Features:

– switching type: unipolar inverted
– high sensitivity
– typical B_{ON}: 4 mT at room temperature
– typical B_{OFF}: 5.9 mT at room temperature
– operates with static magnetic fields and dynamic magnetic fields up to 10 kHz

Applications

The HAL 566 is the optimal sensor for all applications with one magnetic polarity and weak magnetic amplitude at the sensor position where an inverted output signal is required such as:

– applications with large airgap or weak magnets,
– solid state switches,
– contactless solutions to replace micro switches,
– position and end point detection, and
– rotating speed measurement.

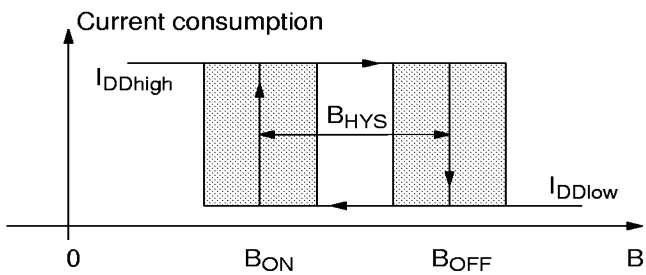

Fig. 4–9: Definition of magnetic switching points for the HAL 566

Magnetic Characteristics at T_J = –40 °C to +100 °C, V_{DD} = 4 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.

Parameter	On point B_{ON}			Off point B_{OFF}			Hysteresis B_{HYS}			Magnetic Offset			Unit
T_J	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
–40 °C	2.1	4.1	5.9	3.4	6.1	7.7	0.8	2	2.8		5.1		mT
25 °C	2	4	5.7	3.4	5.9	7.2	0.5	1.9	2.7	3	5	6.2	mT
100 °C	1.85	3.8	5.7	3.25	5.6	7	0.3	1.8	2.6		4.7		mT

The hysteresis is the difference between the switching points $B_{HYS} = B_{OFF} - B_{ON}$
The magnetic offset is the mean value of the switching points $B_{OFFSET} = (B_{ON} + B_{OFF}) / 2$

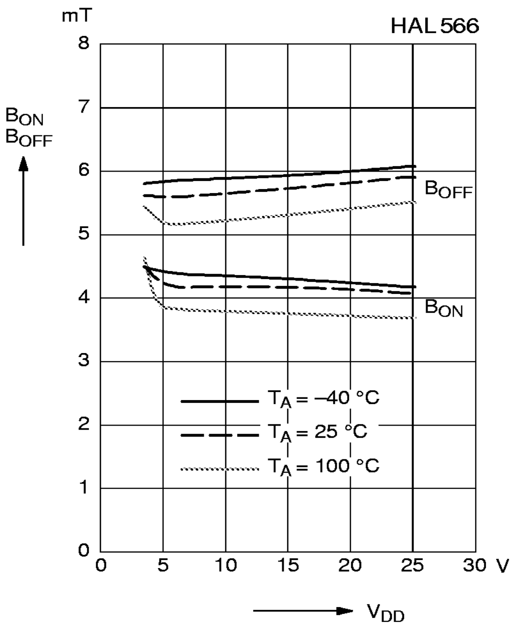

Fig. 4–10: Typ. magnetic switching points versus supply voltage

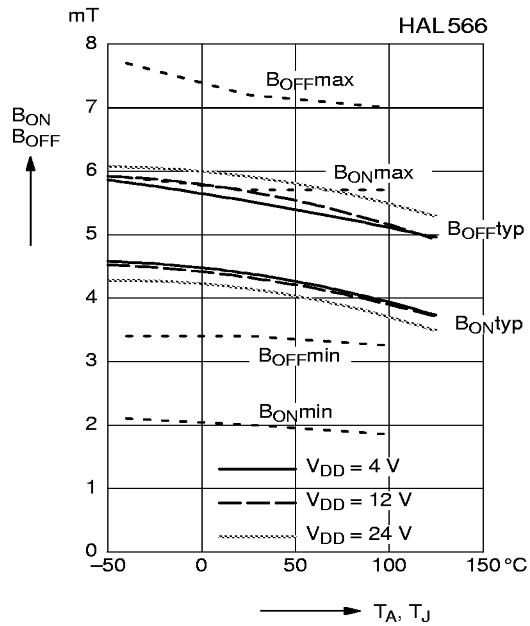

Fig. 4–12: Magnetic switching points versus temperature

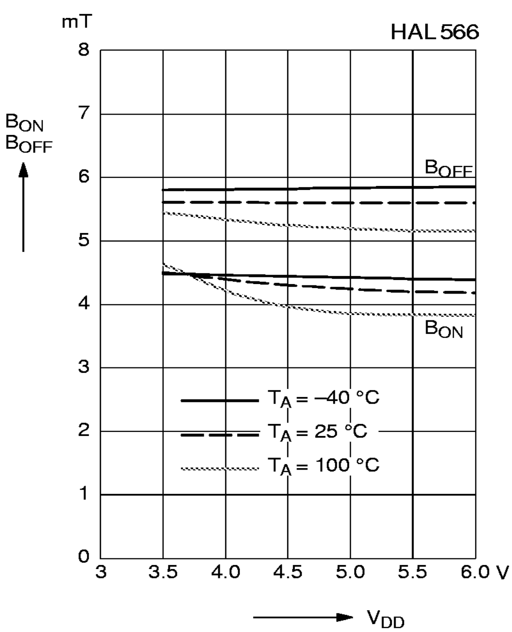

Fig. 4–11: Typ. magnetic switching points versus supply voltage

Note: In the diagram "Magnetic switching points versus temperature" the curves for B_{ON}min, B_{ON}max, B_{OFF}min, and B_{OFF}max refer to junction temperature, whereas typical curves refer to ambient temperature.

5. Application Notes

5.1. Application Circuit

Figure 5–1 shows a very simple application with a two-wire sensor. The current consumption can be detected by measuring the voltage over R_L. For correct functioning of the sensor, the supply voltage for the sensor must be above 4 V. With the maximum current consumption of 17 mA, the maximum R_L can be calculated as:

$$R_{Lmax} = \frac{V_{SUPmin} - 4V}{17\ mA}$$

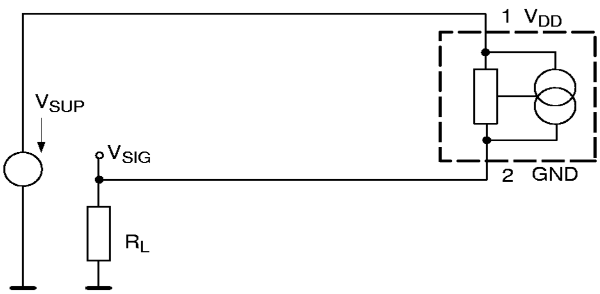

Fig. 5–1: Application Circuit 1

For applications with disturbances on the supply line or radiated disturbances, a series resistor R_V ranging from 10 Ω to 30 Ω and a capacitor both placed close to the sensor are recommended (see figure 5–2). In this case, the maximum R_L can be calculated as:

$$R_{Lmax} = \frac{V_{SUPmin} - 4V}{17\ mA} - R_V$$

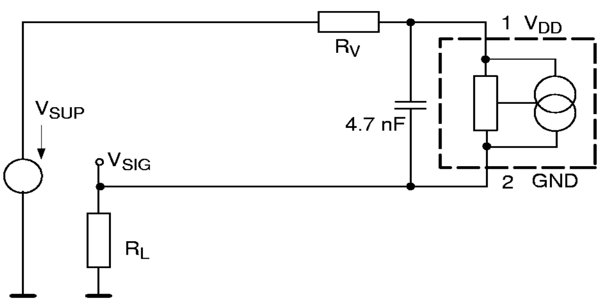

Fig. 5–2: Application Circuit 2

5.2. Extended Operating Conditions

All sensors fulfill the electrical and magnetic characteristics when operated within the Recommended Operating Conditions (see page 7).

Typically, the sensors operate with supply voltages above 3 V. However, below 4 V, the current consumption and the magnetic characteristics may be outside the specification.

Note: The functionality of the sensor below 4 V is not tested routinely. For special test conditions, please contact MICRONAS.

5.3. 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 the Electrical Characteristics (see page 8). During the initialization time, the current consumption is not defined and can toggle between low and high.

HAL 556:

After $t_{en(O)}$, the current consumption will be high if the applied magnetic field B is above B_{ON}. The current consumption will be low if B is below B_{OFF}.

HAL 560, HAL 566:

In case of sensors with an inverted switching behavior, the current consumption will be low if $B > B_{OFF}$ and high if $B < B_{ON}$.

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

5.4. 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 is valid:

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

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

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

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.

Due to the range of I_{DDhigh}, self-heating can be critical. The junction temperature can be reduced with pulsed supply voltage. For supply times (t_{on}) ranging from 30 µs to 1 ms, the following equation can be used:

$$\Delta T = I_{DD} * V_{DD} * R_{th} * \frac{t_{on}}{t_{off} + t_{on}}$$

5.5. EMC

The EMC performance has been tested in a lab environment with EMC optimized printed circuit board layouts. The results in the following tables show that function classes A and C could be reached in these investigations. Depending on customer circuit designs and layouts, EMC results obtained in those applications may be different from the ones obtained in the MICRONAS lab investigations.

Test Circuits for Electromagnetic Compatibility
Test pulses V_{EMC} corresponding to DIN 40839.

Note: The international standard ISO 7637 is similar to the product standard DIN 40839.

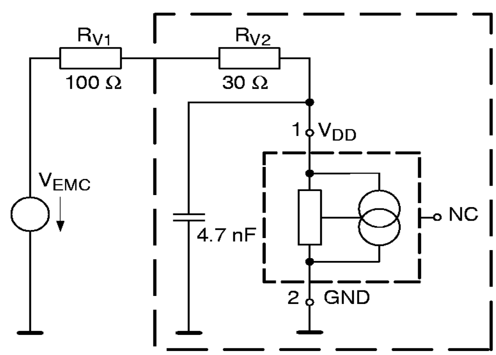

Fig. 5–3: EMC test circuit

Interferences conducted along supply lines in 12 V onboard systems

Product standard: DIN 40839 part 1

Test-Pulse	Severity Level	U_s in V	Pulses/ Time	Function Class	Remarks
1	IV	–100	5000	C	5 s pulse interval
2	IV	100	5000	C	0.5 s pulse interval
3a	IV	–150	1 h	A	
3b	IV	100	1h	A	
4	IV	–7	5	C	
5	II[1)]	46.5	10	C	10 s pulse interval

[1)] Function class C at severity level IV (86.5 V) can be obtained when changing R_{V1} to 270 Ω.

Electrical transient transmission by capacitive and inductive coupling via lines other than the supply lines

Product standard: DIN 40839 part 3

Test-Pulse	Severity Level	U_s in V	Pulses/ Time	Function Class	Remarks
1	IV	–30	500	A	5 s pulse interval
2	IV	30	500	A	0.5 s pulse interval
3a	IV	–60	10 min	A	
3b	IV	40	10 min	A	

6. Data Sheet History

1. Final data sheet: “HAL556, HAL560, HAL566, Two-Wire Hall Effect Sensor Family, April 6, 1999, 6251-425-1DS. First release of the final data sheet.

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