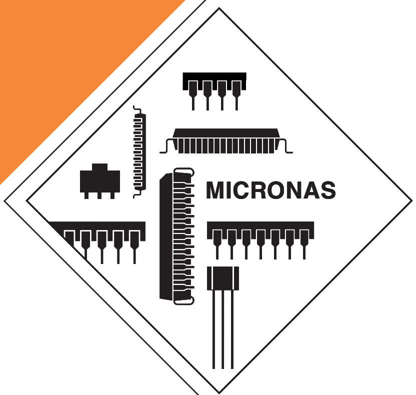

HAL501...506, 508, 509, HAL516...519, 523 Hall Effect Sensor Family

Edition Feb. 14, 2001
6251-485-2DS

MICRONAS

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Hall Effect Sensor Family
in CMOS technology

Release Notes: Revision bars indicate significant changes to the previous edition.

1. Introduction

The HAL5xx family consists of different Hall switches produced in CMOS technology. All 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 sensors of this family differ in the switching behavior and the switching points.

The active offset compensation leads to constant magnetic characteristics over 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 3.8 V to 24 V in the ambient temperature range from –40 °C up to 150 °C.

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

1.1. Features:

– switching offset compensation at typically 62 kHz

– operates from 3.8 V to 24 V supply voltage

– overvoltage protection at all pins

– reverse-voltage protection at V_{DD}-pin

– magnetic characteristics are robust against mechanical stress effects

– short-circuit protected open-drain output by thermal shut down

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

– constant 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 magnetic flux density values for the magnetic switching points, the temperature behavior of the magnetic switching points, and the mode of switching.

Type	Switching Behavior	Sensitivity	see Page
501	bipolar	very high	14
502	latching	high	16
503	latching	medium	18
504	unipolar	medium	20
505	latching	low	22
506	unipolar	high	24
508	unipolar	medium	26
509	unipolar	low	28
516	unipolar with inverted output	high	30
517	unipolar with inverted output	medium	32
518	unipolar with inverted output	medium	34
519	unipolar with inverted output (north polarity)	high	36
523	unipolar	low	38

Latching Sensors:

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.

Bipolar Switching Sensors:

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 state is not defined for all sensors if the magnetic field is removed again. Some sensors will change the output state and some sensors will not.

Unipolar Switching 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.

Unipolar Switching Sensors with Inverted Output:

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

Unipolar Switching Sensors with Inverted Output Sensitive to North Pole:

The output turns high with the magnetic north pole on the branded side of the package and turns low if the magnetic field is removed. The sensor does not respond to the magnetic south 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		
	A	**K**	**E**
HAL501	501A	501K	501E
HAL502	502A	502K	502E
HAL503	503A	503K	503E
HAL504	504A	504K	504E
HAL505	505A	505K	505E
HAL506	506A	506K	506E
HAL508	508A	508K	508E
HAL509	509A	509K	509E
HAL516	516A	516K	516E
HAL517	517A	517K	517E
HAL518	518A	518K	518E
HAL519	519A	519K	519E
HAL523	523A	523K	523E

1.3.1. Special Marking of Prototype Parts

Prototype parts are coded with an underscore beneath the temperature range letter on each IC. They may be used for lab experiments and design-ins but are not intended to be used for qualification tests or as production parts.

1.4. Operating Junction Temperature Range

A: T_J = –40 °C to +170 °C

K: T_J = –40 °C to +140 °C

E: T_J = –40 °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 5.1. on page 40.

1.5. Hall Sensor Package Codes

HAL XXXPA-T

- Temperature Range: A, K, or E
- Package: SF for SOT-89B
  UA for TO-92UA
- Type: 5xx

Example: **HAL 505UA-E**

→ Type: 505
→ 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

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

Components stored in the original packaging should provide a shelf life of at least 12 months, starting from the date code printed on the labels, even in environments as extreme as 40 °C and 90% relative humidity.

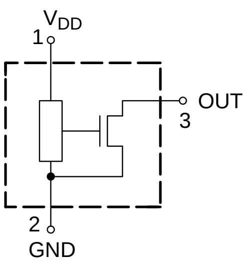

Fig. 1–1: Pin configuration

2. Functional Description

The HAL 5xx 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 open drain output switches to the appropriate state. 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 actual switching point. Subsequently, the open drain output switches to the appropriate state. The time from crossing the magnetic switching level to switching of output can vary between zero and $1/f_{osc}$.

Shunt protection devices clamp voltage peaks at the Output-Pin and 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 reverse protection diode is needed at the V_{DD}-Pin for reverse voltages ranging from 0 V to –15 V.

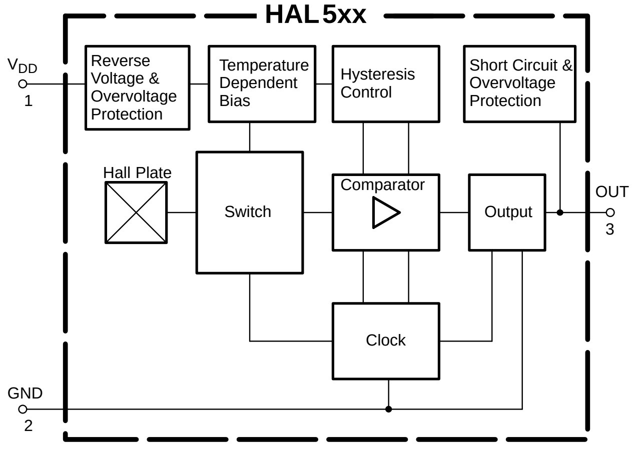

Fig. 2–1: HAL 5xx block diagram

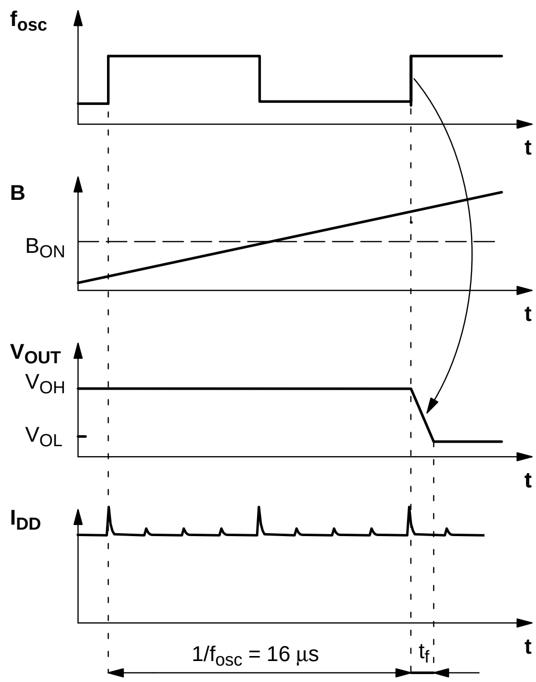

Fig. 2–2: Timing diagram

3. Specifications

3.1. Outline Dimensions

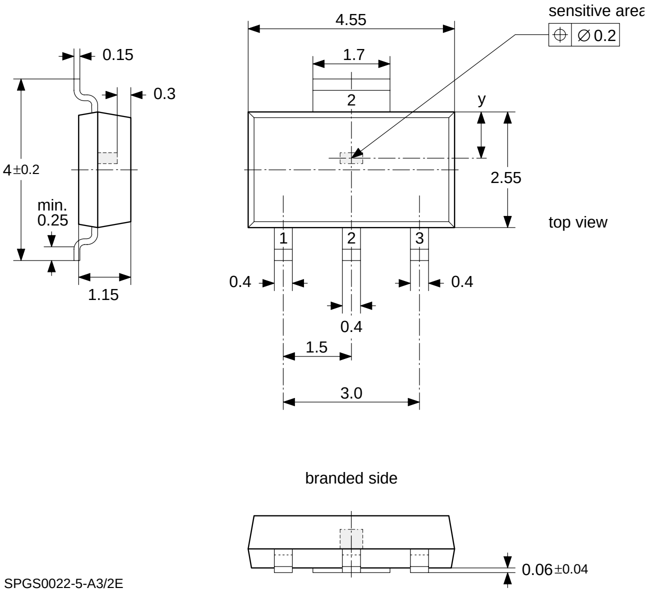

Fig. 3–1:
Plastic Small Outline Transistor Package
(SOT-89B)
Weight approximately 0.035 g
Dimensions in mm

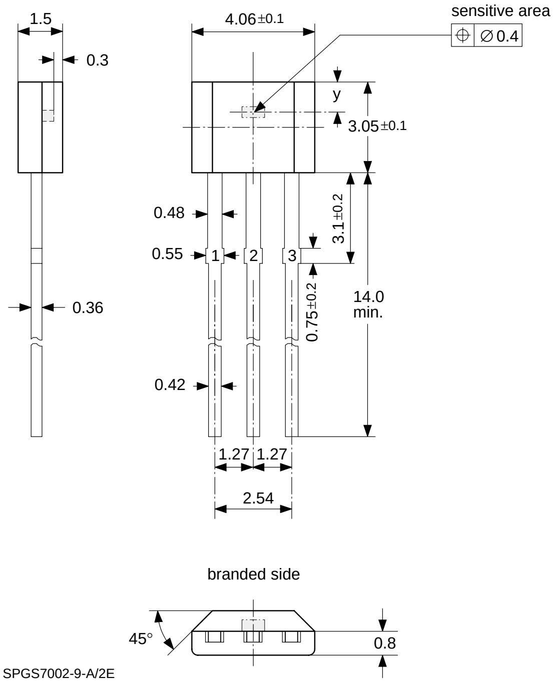

Fig. 3–2:
Plastic Transistor Single Outline Package
(TO-92UA)
Weight approximately 0.12 g
Dimensions in mm

3.2. Dimensions of Sensitive Area

0.25 mm x 0.12 mm

3.3. Positions of Sensitive Areas

	SOT-89B	TO-92UA
x	center of the package	center of the package
y	0.95 mm nominal	1.0 mm nominal

Note: For all package diagrams, a mechanical tolerance of ±0.05 mm applies to all dimensions where no tolerance is explicitly given.

An improvement of the TO-92UA package with reduced tolerances will be introduced end of 2001.

3.4. Absolute Maximum Ratings

Symbol	Parameter	Pin No.	Min.	Max.	Unit
V_{DD}	Supply Voltage	1	–15	28[1)]	V
$-V_P$	Test Voltage for Supply	1	–24[2)]	–	V
$-I_{DD}$	Reverse Supply Current	1	–	50[1)]	mA
I_{DDZ}	Supply Current through Protection Device	1	–200[3)]	200[3)]	mA
V_O	Output Voltage	3	–0.3	28[1)]	V
I_O	Continuous Output On Current	3	–	50[1)]	mA
I_{Omax}	Peak Output On Current	3	–	250[3)]	mA
I_{OZ}	Output Current through Protection Device	3	–200[3)]	200[3)]	mA
T_S	Storage Temperature Range[5)]		–65	150	°C
T_J	Junction Temperature Range		–40 –40	150 170[4)]	°C

1) as long as $T_J$max is not exceeded
2) with a 220 Ω series resistance at pin 1 corresponding to the test circuit on page 40
3) t<2 ms
4) t<1000h
5) Components stored in the original packaging should provide a shelf life of at least 12 months, starting from the date code printed on the labels, even in environments as extreme as 40 °C and 90% relative humidity.

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	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

3.6. Electrical Characteristics at T_J = –40 °C to +170 °C , V_{DD} = 3.8 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_{DD}	Supply Current	1	2.3	3	4.2	mA	T_J = 25 °C
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	3	–	130	280	mV	I_{OL} = 20 mA, T_J = 25 °C
V_{OL}	Output Voltage over Temperature Range	3	–	130	400	mV	I_{OL} = 20 mA
I_{OH}	Output Leakage Current	3	–	0.06	0.1	µA	Output switched off, T_J = 25 °C, V_{OH} = 3.8 to 24 V
I_{OH}	Output Leakage Current over Temperature Range	3	–	–	10	µA	Output switched off, $T_J \leq 150$ °C, V_{OH} = 3.8 to 24 V
f_{osc}	Internal Oscillator Chopper Frequency	–	49	62	–	kHz	T_J = 25 °C, V_{DD} = 4.5 V to 24 V
f_{osc}	Internal Oscillator Chopper Frequency over Temperature Range	–	38	62	–	kHz	
$t_{en(O)}$	Enable Time of Output after Setting of V_{DD}	1	–	30	70	µs	V_{DD} = 12 V [1)]
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	V_{DD} = 12 V, R_L = 820 Ohm, C_L = 20 pF
R_{thJSB} case 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. 3–3
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 HAL 50x, B > B_{OFF} + 2 mT or B < B_{ON} – 2 mT for HAL 51x

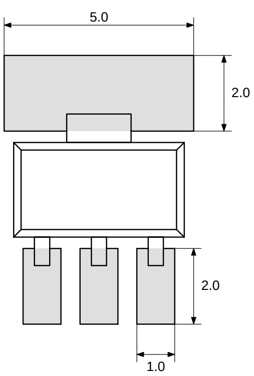

Fig. 3–3: Recommended pad size SOT-89B
Dimensions in mm

3.7. Magnetic Characteristics Overview at T_J = –40 °C to +170 °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 Switching type	Parameter T_J	On point B_{ON}			Off point B_{OFF}			Hysteresis B_{HYS}			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
HAL 501	–40 °C	–0.8	0.6	2.5	–2.5	–0.8	0.8	0.5	1.4	2	mT
bipolar	25 °C	–0.5	0.5	2.3	–2.3	–0.7	0.5	0.5	1.2	1.9	mT
	170 °C	–1.5	0.7	3	–2.5	–0.2	2	0.4	0.9	1.8	mT
HAL 502	–40 °C	1	2.8	5	–5	–2.8	–1	4.5	5.6	7.2	mT
latching	25 °C	1	2.6	4.5	–4.5	–2.6	–1	4.5	5.2	7	mT
	170 °C	0.9	2.3	4.3	–4.3	–2.3	–0.9	3.5	4.6	6.8	mT
HAL 503	–40 °C	6.4	8.6	10.8	–10.8	–8.6	–6.4	14.6	17.2	20.6	mT
latching	25 °C	6	8	10	–10	–8	–6	13.6	16	18	mT
	170 °C	4	6.4	8.9	–8.9	–6	–4	11	12.4	16	mT
HAL 504	–40 °C	10.3	13	15.7	5.3	7.5	9.6	4.4	5.5	6.5	mT
unipolar	25 °C	9.5	12	14.5	5	7	9	4	5	6.5	mT
	170 °C	8.5	10.2	13.7	4.2	5.9	8.5	3.2	4.3	6.4	mT
HAL 505	–40 °C	11.8	15	18.3	–18.3	–15	–11.8	26	30	34	mT
latching	25 °C	11	13.5	17	–17	–13.5	–11	24	27	32	mT
	170 °C	9.4	11.7	16.1	–16.1	–11.7	–9.4	20	23.4	31.3	mT
HAL 506	–40 °C	4.3	5.9	7.7	2.1	3.8	5.4	1.6	2.1	2.8	mT
unipolar	25 °C	3.8	5.5	7.2	2	3.5	5	1.5	2	2.7	mT
	170 °C	3.2	4.6	6.8	1.7	3	5.2	0.9	1.6	2.6	mT
HAL 508	–40 °C	15.5	19	21.9	14	16.7	20	1.6	2.3	2.8	mT
unipolar	25 °C	15	18	20.7	13.5	16	19	1.5	2	2.7	mT
	170 °C	12.7	15.3	20	11.4	13.6	18.3	1	1.7	2.6	mT
HAL 509	–40 °C	23.1	27.4	31.1	19.9	23.8	27.2	2.9	3.6	3.9	mT
unipolar	25 °C	23.1	26.8	30.4	19.9	23.2	26.6	2.8	3.5	3.9	mT
	170 °C	21.3	25.4	28.9	18.3	22.1	25.3	2.5	3.3	3.8	mT
HAL 516	–40 °C	2.1	3.8	5.4	4.3	5.9	7.7	1.6	2.1	2.8	mT
unipolar	25 °C	2	3.5	5	3.8	5.5	7.2	1.5	2	2.7	mT
inverted	170 °C	1.7	3	5.2	3.2	4.6	6.8	0.9	1.6	2.6	mT
HAL 517	–40 °C	14	17.1	21.5	15.5	19.6	22.5	1.6	2.5	3	mT
unipolar	25 °C	13.5	16.2	19	15	18.3	20.7	1.5	2.1	2.7	mT
inverted	170 °C	9	12.3	18	10.5	13.7	20	0.8	1.4	2.4	mT
HAL 518	–40 °C	14	16.7	20	15.5	19	22	1.5	2.3	3	mT
unipolar	25 °C	13.5	16	19	15	18	20.7	1.4	2	2.8	mT
inverted	170 °C	11	13.6	18.3	12.2	15.3	20	0.8	1.7	2.6	mT

Note: For detailed descriptions of the individual types, see pages 14 and following.

Magnetic Characteristics Overview, continued

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 519	–40 °C	–5.4	–3.8	–2.1	–7.7	–5.9	–4.3	1.6	2.1	2.8	mT
unipolar	25 °C	–5	–3.6	–2	–7.2	–5.5	–3.8	1.5	1.9	2.7	mT
inverted	170 °C	–5.2	–3.0	–1.5	–6.8	–4.6	–2.8	0.9	1.6	2.6	mT
HAL 523	–40 °C	28	34.5	42	18	24	30	7	10.5	14	mT
unipolar	25 °C	28	34.5	42	18	24	30	7	10.5	14	mT
	170 °C	28	34.5	42	18	24	30	7	10.5	14	mT

Note: For detailed descriptions of the individual types, see pages 14 and following.

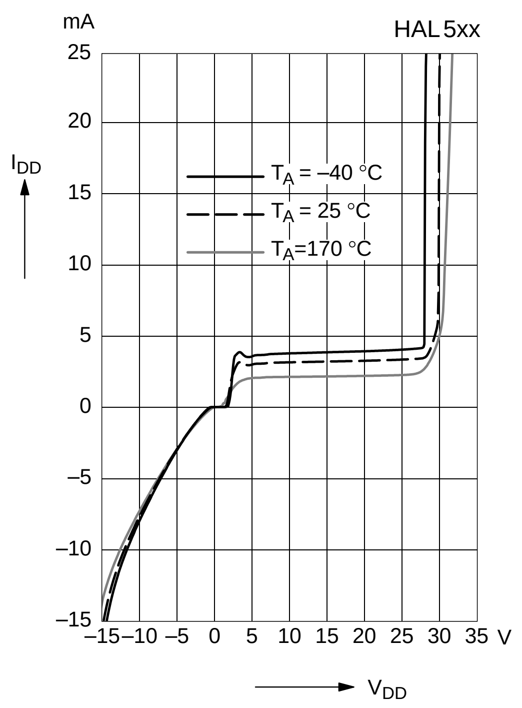

Fig. 3–4: Typical supply current versus supply voltage

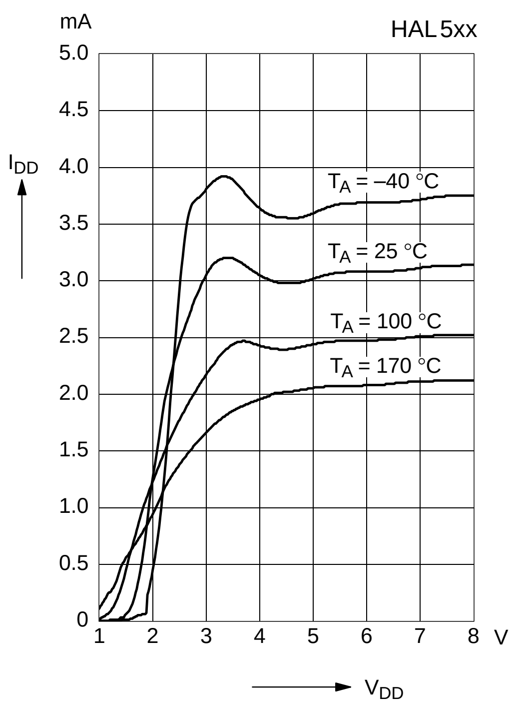

Fig. 3–5: Typical supply current versus supply voltage

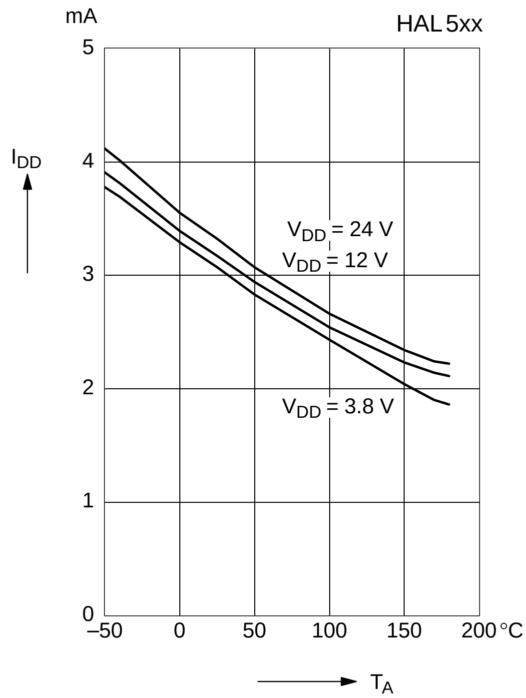

Fig. 3–6: Typical supply current versus ambient temperature

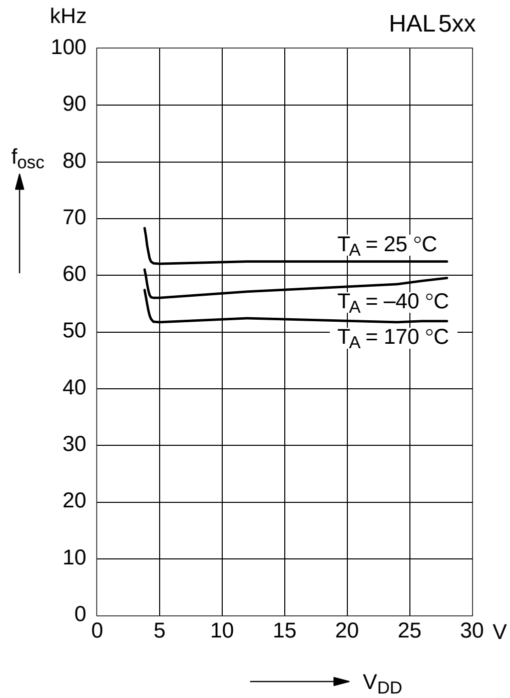

Fig. 3–8: Typ. Internal chopper frequency versus supply voltage

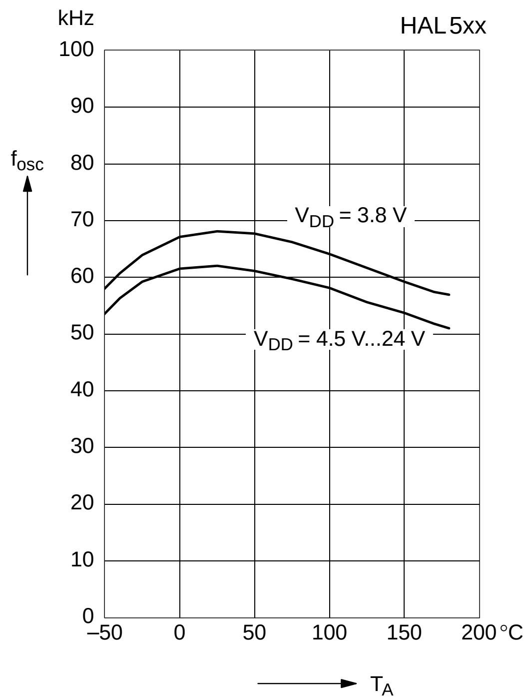

Fig. 3–7: Typ. internal chopper frequency versus ambient temperature

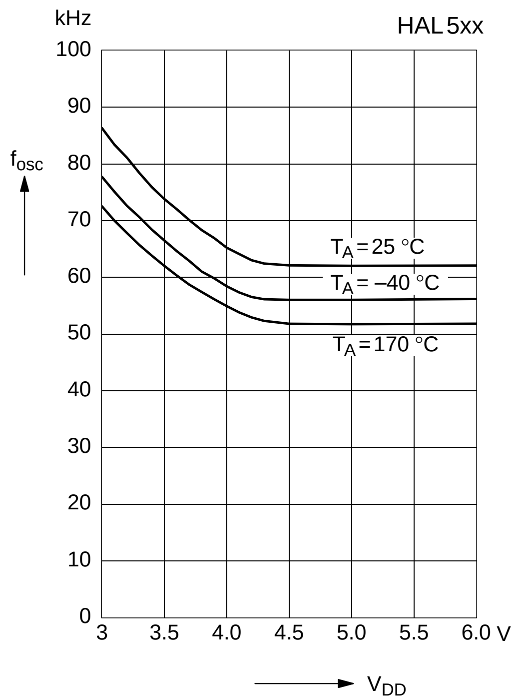

Fig. 3–9: Typ. internal chopper frequency versus supply voltage

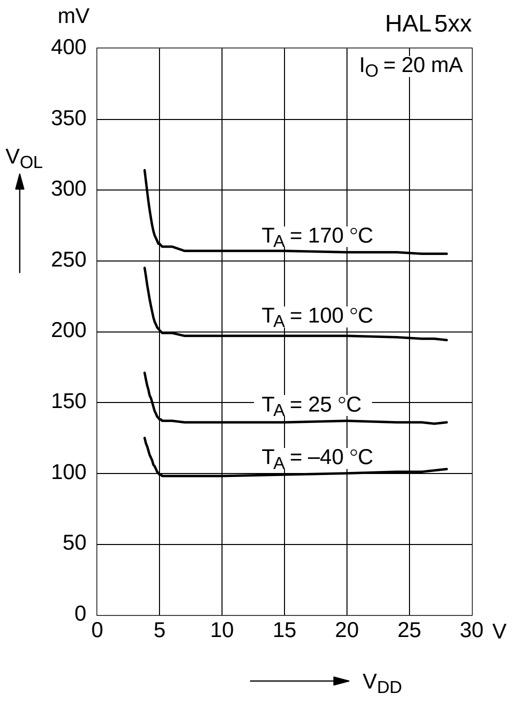

Fig. 3–10: Typical output low voltage versus supply voltage

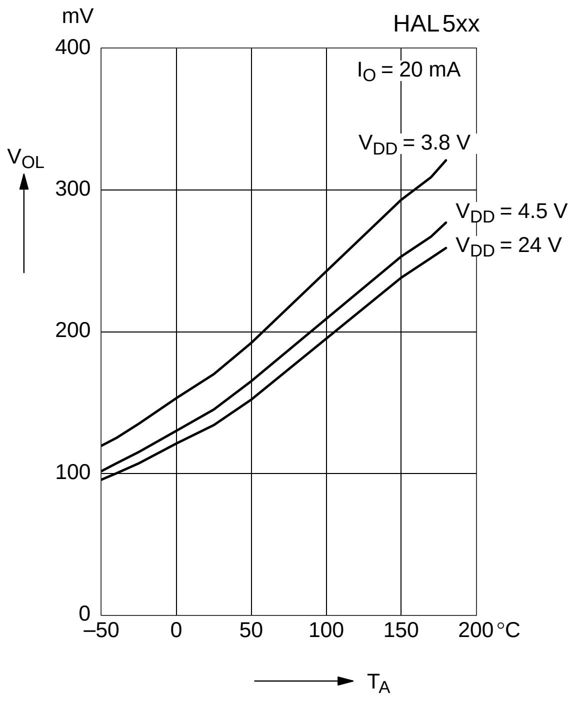

Fig. 3–12: Typical output low voltage versus ambient temperature

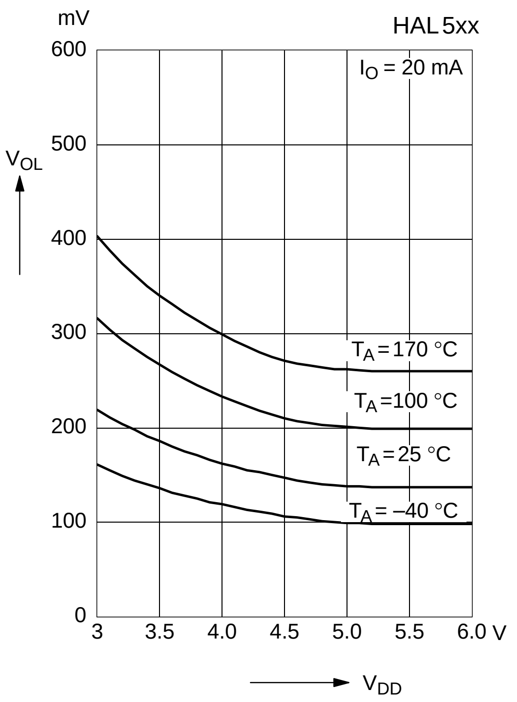

Fig. 3–11: Typical output low voltage versus supply voltage

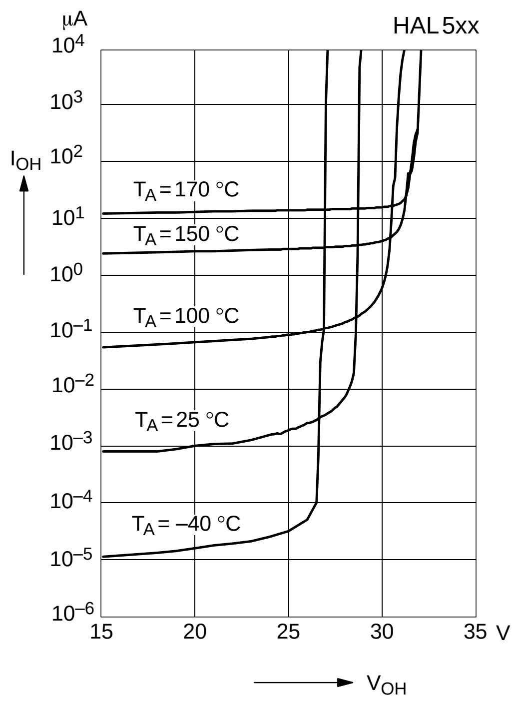

Fig. 3–13: Typical output high current versus output voltage

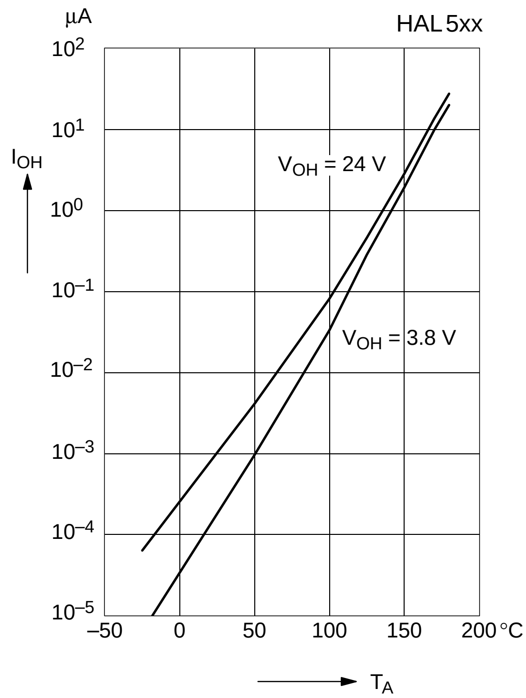

Fig. 3–14: Typical output leakage current versus ambient temperature

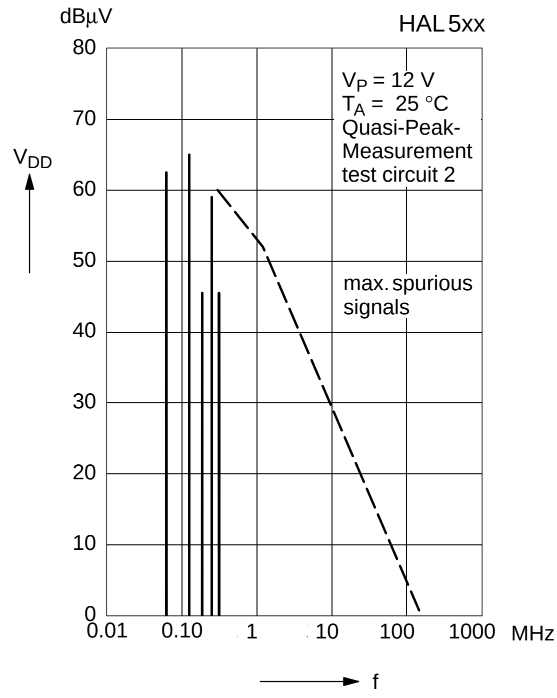

Fig. 3–16: Typ. spectrum at supply voltage

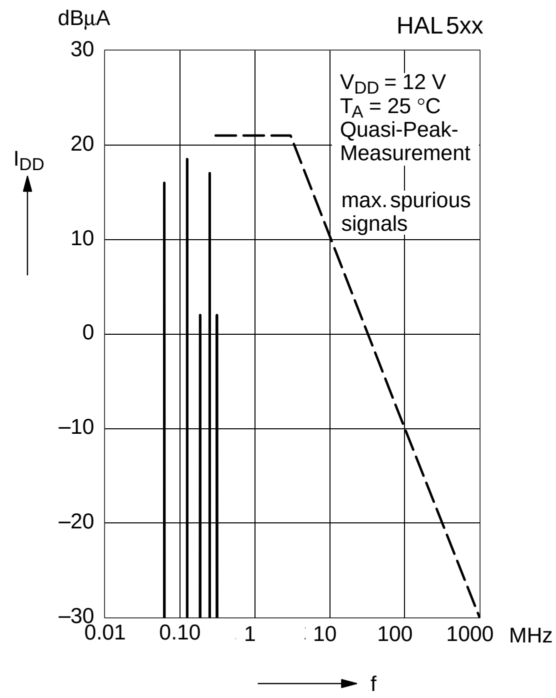

Fig. 3–15: Typ. spectrum of supply current

4. Type Description

4.1. HAL 501

The HAL 501 is the most sensitive sensor of this family with bipolar switching behavior (see Fig. 4–1).

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 state is not defined for all sensors if the magnetic field is removed again. Some sensors will change the output state and some sensors will not.

For correct functioning in the application, the sensor requires both magnetic polarities (north and south) on the branded side of the package.

Magnetic Features:

– switching type: bipolar

– very high sensitivity

– typical B_{ON}: 0.5 mT at room temperature

– typical B_{OFF}: –0.7 mT at room temperature

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

Applications

The HAL 501 is the optimal sensor for all applications with alternating magnetic signals and weak magnetic amplitude at the sensor position such as:

– applications with large airgap or weak magnets,

– rotating speed measurement,

– CAM shaft sensors, and

– magnetic encoders.

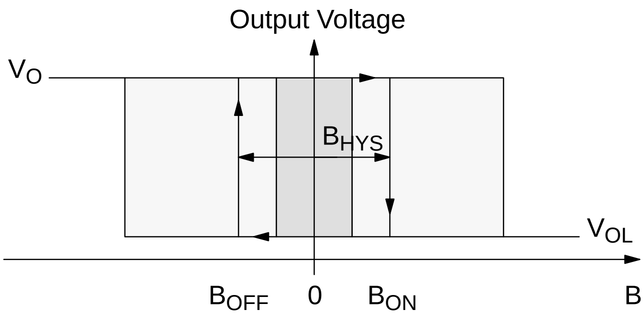

Fig. 4–1: Definition of magnetic switching points for the HAL 501

Magnetic Characteristics at T_J = –40 °C to +170 °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.

Parameter	On point B_{ON}			Off point B_{OFF}			Hysteresis B_{HYS}			Magnetic Offset B_{OFFSET}			Unit
T_J	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
–40 °C	–0.8	0.6	2.5	–2.5	–0.8	0.8	0.5	1.4	2		–0.1		mT
25 °C	–0.5	0.5	2.3	–2.3	–0.7	0.5	0.5	1.2	1.9	–1.4	–0.1	1.4	mT
100 °C	–0.9	0.5	2.5	–2.5	–0.6	0.9	0.5	1.1	1.8		0		mT
140 °C	–1.2	0.6	2.8	–2.5	–0.5	1.3	0.5	1.1	1.8		0		mT
170 °C	–1.5	0.7	3	–2.5	–0.2	2	0.4	0.9	1.8		0.2		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 $B_{OFFSET} = (B_{ON} + B_{OFF}) / 2$

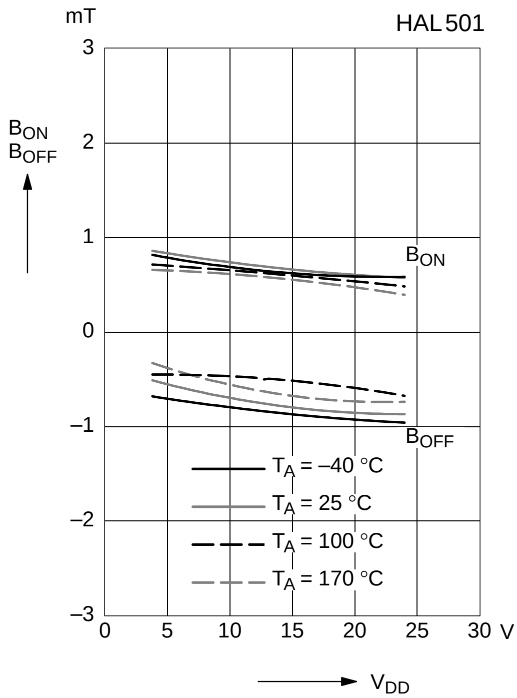

Fig. 4–2: Typ. magnetic switching points versus supply voltage

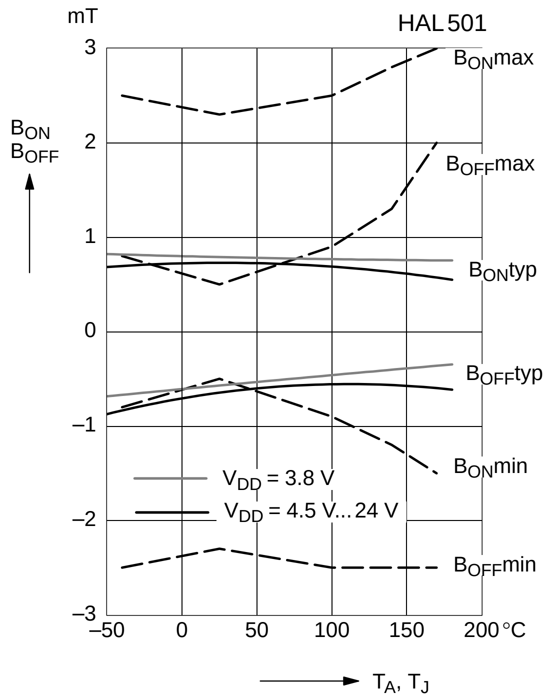

Fig. 4–4: Magnetic switching points versus temperature

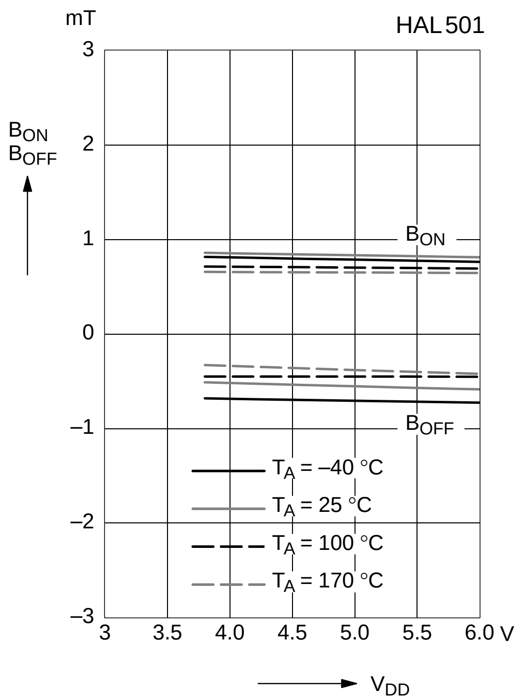

Fig. 4–3: Typ. magnetic switching points versus supply voltage

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 502

The HAL 502 is the most sensitive latching sensor of this family (see Fig. 4–5).

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.

For correct functioning in the application, the sensor requires both magnetic polarities (north and south) on the branded side of the package.

Magnetic Features:

- switching type: latching
- high sensitivity
- typical B_{ON}: 2.6 mT at room temperature
- typical B_{OFF}: –2.6 mT at room temperature
- operates with static magnetic fields and dynamic magnetic fields up to 10 kHz
- typical temperature coefficient of magnetic switching points is –1000 ppm/K

Applications

The HAL 502 is the optimal sensor for all applications with alternating magnetic signals and weak magnetic amplitude at the sensor position such as:

- applications with large airgap or weak magnets,
- rotating speed measurement,
- commutation of brushless DC motors,
- CAM shaft sensors, and
- magnetic encoders.

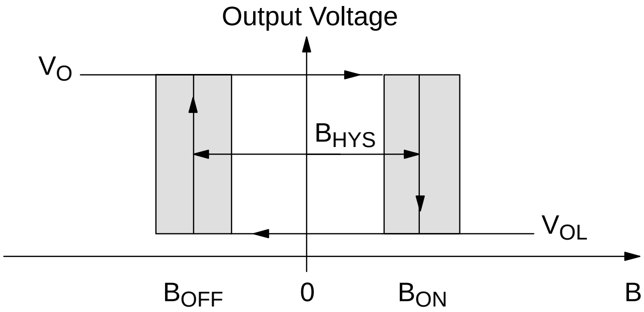

Fig. 4–5: Definition of magnetic switching points for the HAL 502

Magnetic Characteristics at T_J = –40 °C to +170 °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.

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	1	2.8	5	–5	–2.8	–1	4.5	5.6	7.2		0		mT
25 °C	1	2.6	4.5	–4.5	–2.6	–1	4.5	5.2	7	–1.5	0	1.5	mT
100 °C	0.95	2.5	4.4	–4.4	–2.5	–0.95	4	5	6.8		0		mT
140 °C	0.9	2.4	4.3	–4.3	–2.4	–0.9	3.7	4.8	6.8		0		mT
170 °C	0.9	2.3	4.3	–4.3	–2.3	–0.9	3.5	4.6	6.8		0		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 $B_{OFFSET} = (B_{ON} + B_{OFF}) / 2$

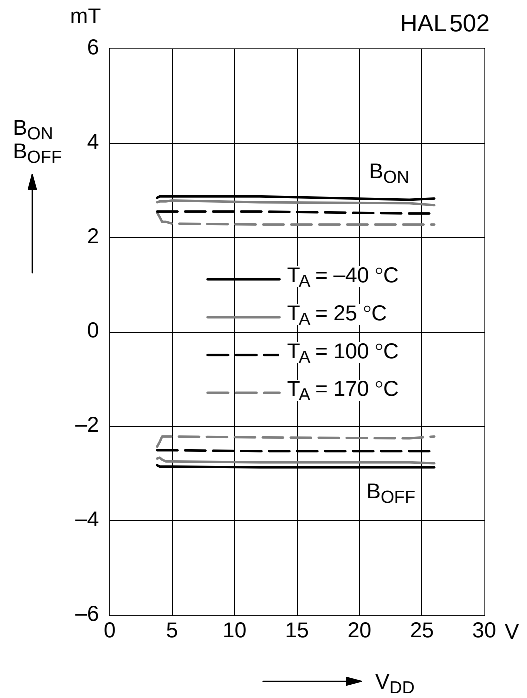

Fig. 4–6: Typ. magnetic switching points versus supply voltage

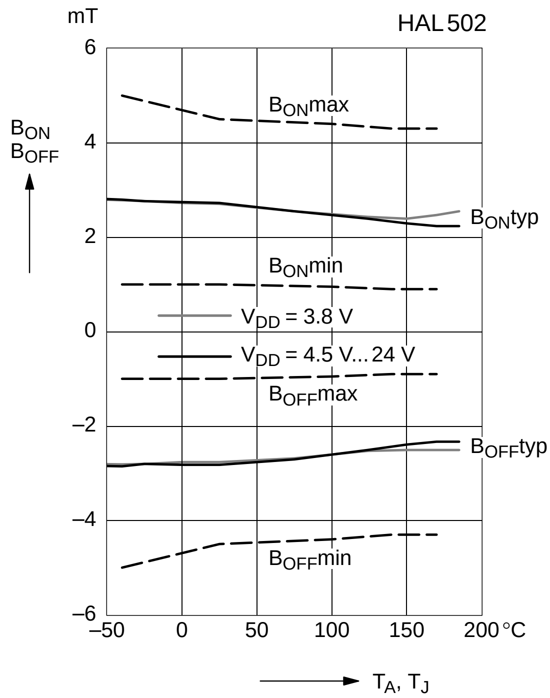

Fig. 4–8: Magnetic switching points versus temperature

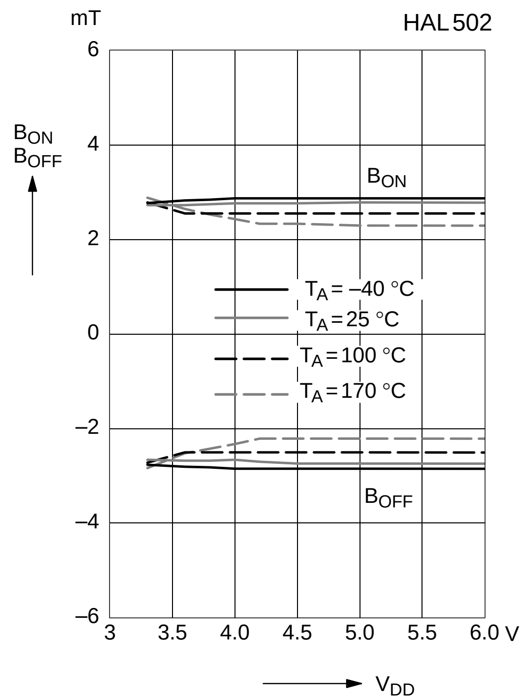

Fig. 4–7: Typ. magnetic switching points versus supply voltage

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 503

The HAL 503 is a latching sensor (see Fig. 4–9).

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.

For correct functioning in the application, the sensor requires both magnetic polarities (north and south) on the branded side of the package.

Magnetic Features:

– switching type: latching
– medium sensitivity
– typical B_{ON}: 7.6 mT at room temperature
– typical B_{OFF}: –7.6 mT at room temperature
– operates with static magnetic fields and dynamic magnetic fields up to 10 kHz
– typical temperature coefficient of magnetic switching points is –1000 ppm/K

Applications

The HAL 503 is the optimal sensor for applications with alternating magnetic signals such as:

– multipole magnet applications,
– rotating speed measurement,
– commutation of brushless DC motors, and
– window lifter.

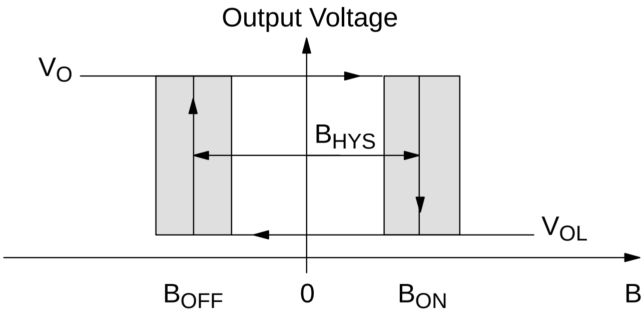

Fig. 4–9: Definition of magnetic switching points for the HAL 503

Magnetic Characteristics at T_J = –40 °C to +170 °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.

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	6.4	8.4	10.8	–10.8	–8.6	–6.4	14.6	17	20.6		–0.1		mT
25 °C	6	7.6	10	–10	–7.6	–6	13.6	15.2	18	–1.5	0	1.5	mT
100 °C	4.8	7.1	9.5	–9.5	–6.9	–4.8	12.3	14	17		0.1		mT
140 °C	4.4	6.7	9.2	–9.2	–6.4	–4.4	11.5	13.1	16.5		0.1		mT
170 °C	4	6.4	8.9	–8.9	–6	–4	11	12.4	16		0.2		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 $B_{OFFSET} = (B_{ON} + B_{OFF}) / 2$

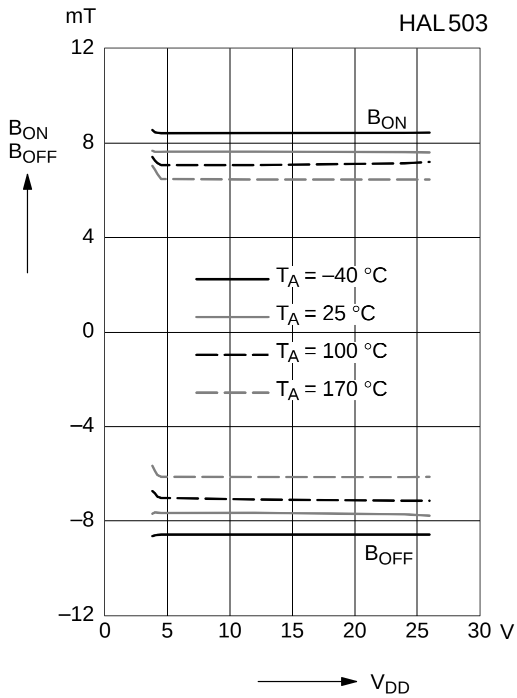

Fig. 4–10: Typ. magnetic switching points versus supply voltage

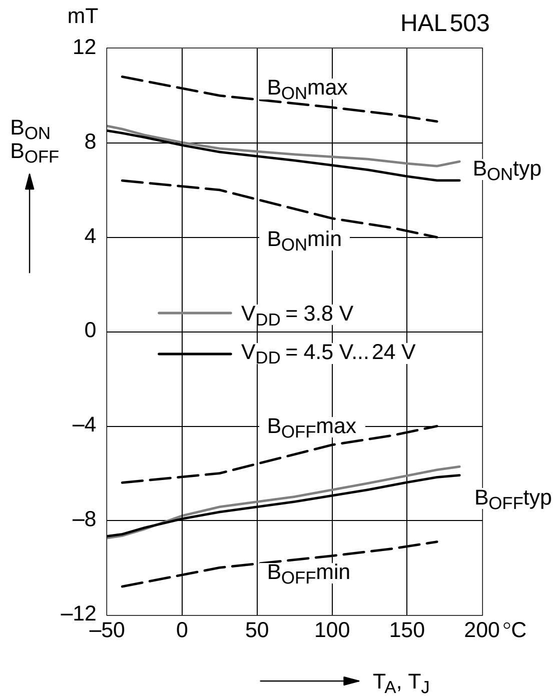

Fig. 4–12: Magnetic switching points versus temperature

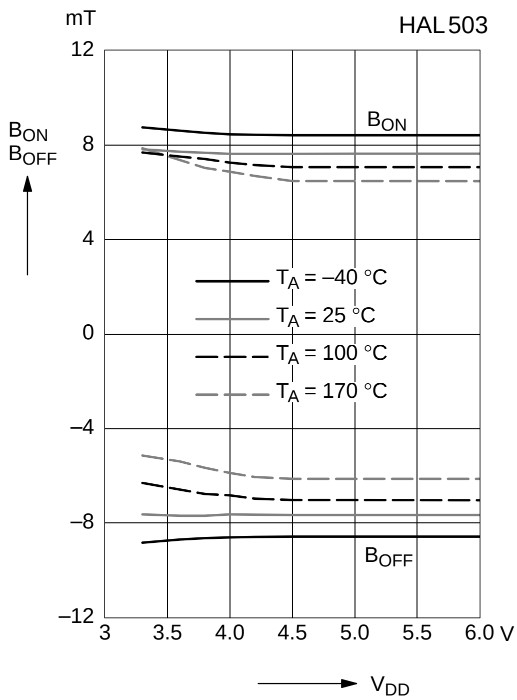

Fig. 4–11: Typ. magnetic switching points versus supply voltage

Note: In the diagram “Magnetic switching points versus ambient 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.

4.4. HAL 504

The HAL 504 is a unipolar switching sensor (see Fig. 4–13).

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.

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

– medium sensitivity

– typical B_{ON}: 12 mT at room temperature

– typical B_{OFF}: 7 mT at room temperature

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

– typical temperature coefficient of magnetic switching points is –1000 ppm/K

Applications

The HAL 504 is the optimal sensor for applications with one magnetic polarity such as:

– solid state switches,

– contactless solution to replace micro switches,

– position and end-point detection, and

– rotating speed measurement.

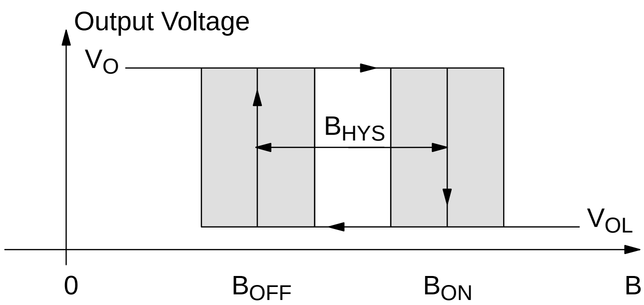

Fig. 4–13: Definition of magnetic switching points for the HAL 504

Magnetic Characteristics at T_J = –40 °C to +170 °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.

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	10.3	13	15.7	5.3	7.5	9.6	4.4	5.5	6.5		10.2		mT
25 °C	9.5	12	14.5	5	7	9	4	5	6.5	7.2	9.5	11.8	mT
100 °C	9	11.1	14.1	4.6	6.4	8.7	3.6	4.7	6.4		8.8		mT
140 °C	8.7	10.6	13.9	4.4	6.1	8.6	3.4	4.5	6.4		8.4		mT
170 °C	8.5	10.2	13.7	4.2	5.9	8.5	3.2	4.3	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 $B_{OFFSET} = (B_{ON} + B_{OFF}) / 2$

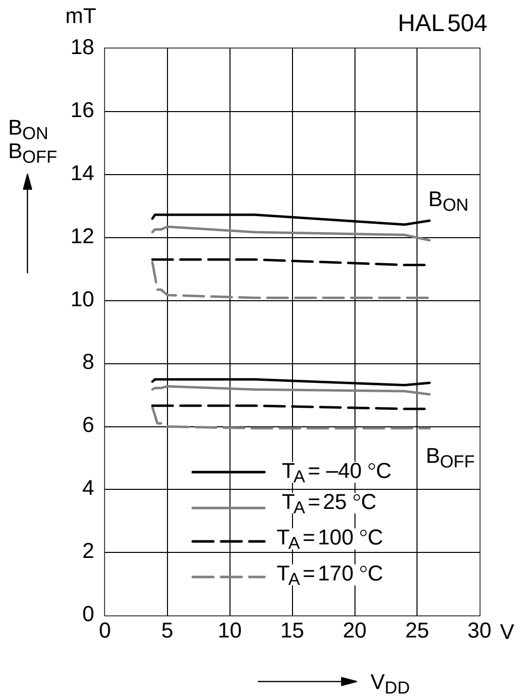

Fig. 4–14: Typ. magnetic switching points versus supply voltage

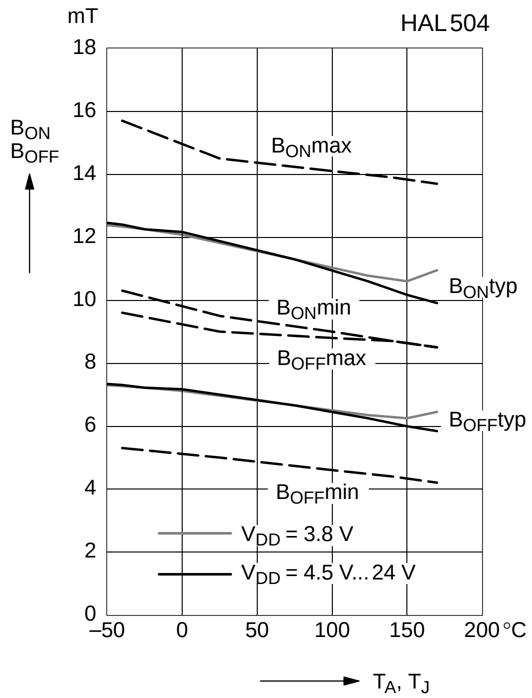

Fig. 4–16: Magnetic switching points versus temperature

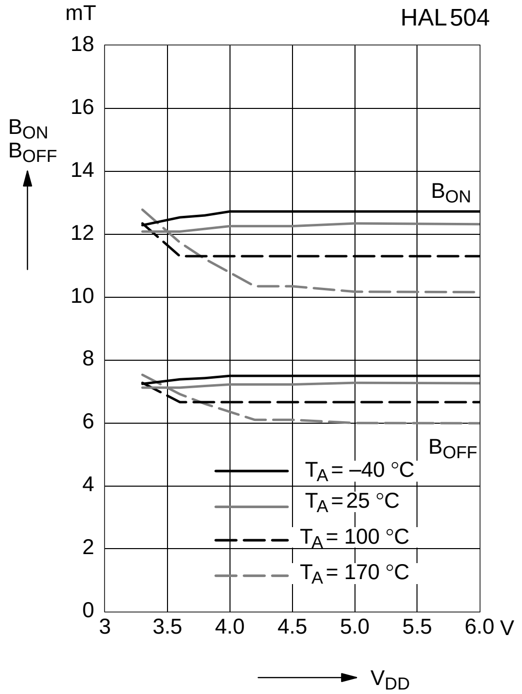

Fig. 4–15: Typ. magnetic switching points versus supply voltage

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.

4.5. HAL 505

The HAL 505 is a latching sensor (see Fig. 4–17).

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.

For correct functioning in the application, the sensor requires both magnetic polarities (north and south) on the branded side of the package.

Magnetic Features:

– switching type: latching

– low sensitivity

– typical B_{ON}: 13.5 mT at room temperature

– typical B_{OFF}: –13.5 mT at room temperature

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

– typical temperature coefficient of magnetic switching points is –1000 ppm/K

Applications

The HAL 505 is the optimal sensor for applications with alternating magnetic signals such as:

– multipole magnet applications,

– rotating speed measurement,

– commutation of brushless DC motors, and

– window lifter.

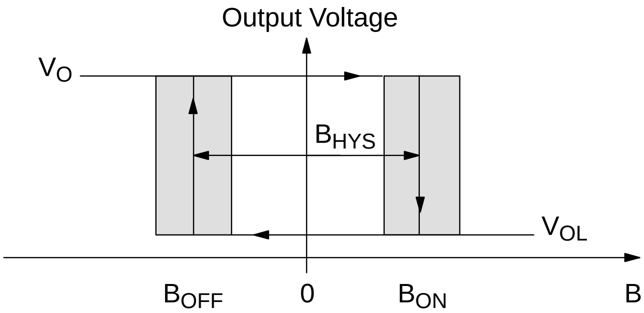

Fig. 4–17: Definition of magnetic switching points for the HAL 505

Magnetic Characteristics at T_J = –40 °C to +170 °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.

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	11.8	15	18.3	–18.3	–15	–11.8	26	30	34		0		mT
25 °C	11	13.5	17	–17	–13.5	–11	24	27	32	–1.5	0	1.5	mT
100 °C	10.2	12.4	16.6	–16.6	–12.4	–10.2	22	24.8	31.3		0		mT
140 °C	9.7	12	16.3	–16.3	–12	–9.7	21	24.2	31.3		0		mT
170 °C	9.4	11.7	16.1	–16.1	–11.7	–9.4	20	23.4	31.3		0		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 $B_{OFFSET} = (B_{ON} + B_{OFF}) / 2$

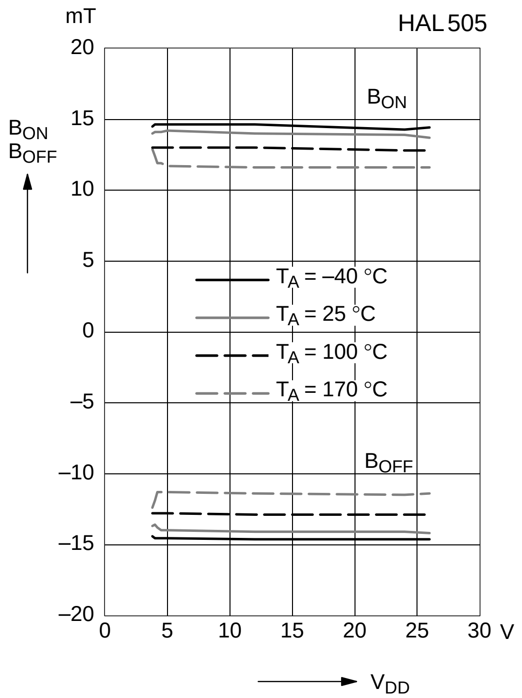

Fig. 4–18: Typ. magnetic switching points versus supply voltage

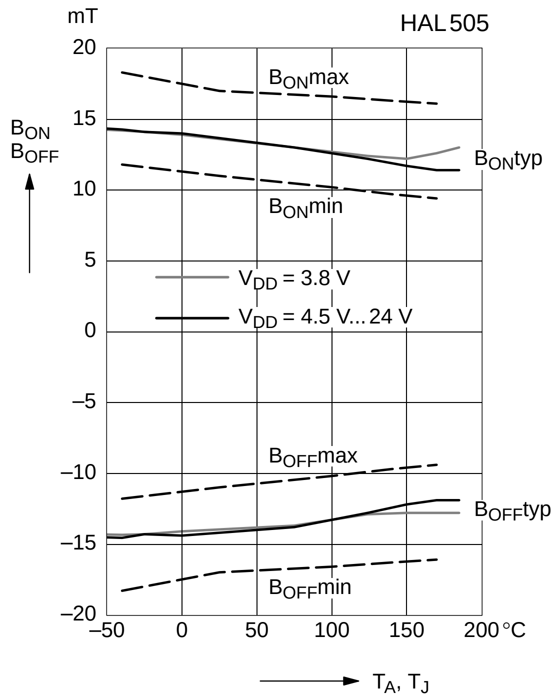

Fig. 4–20: Magnetic switching points versus temperature

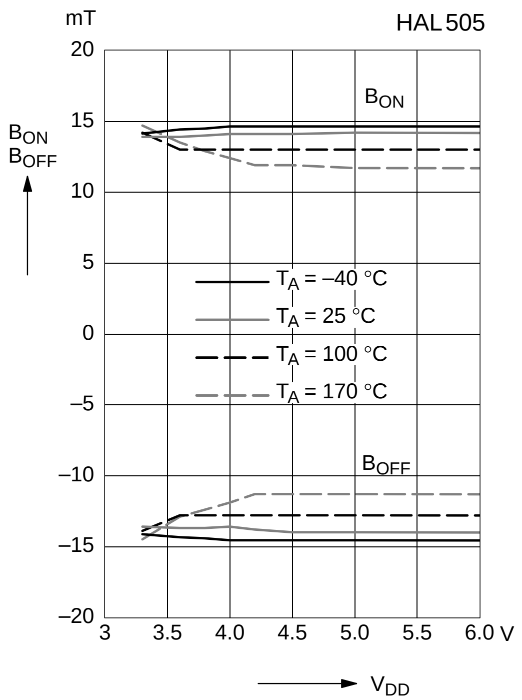

Fig. 4–19: Typ. magnetic switching points versus supply voltage

Note: In the diagram “Magnetic switching points versus ambient 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.

4.6. HAL 506

The HAL 506 is the most sensitive unipolar switching sensor of this family (see Fig. 4–21).

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.

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

In the HAL 5xx family, the HAL 516 is a sensor with the same magnetic characteristics but with an inverted output characteristic.

Magnetic Features:

– switching type: unipolar

– high sensitivity

– typical B_{ON}: 5.5 mT at room temperature

– typical B_{OFF}: 3.5 mT at room temperature

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

– typical temperature coefficient of magnetic switching points is –1000 ppm/K

Applications

The HAL 506 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 solution to replace micro switches,

– position and end point detection, and

– rotating speed measurement.

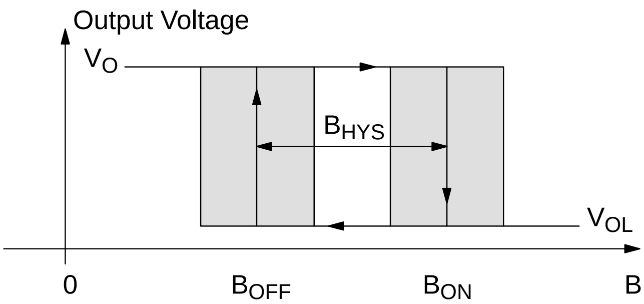

Fig. 4–21: Definition of magnetic switching points for the HAL 506

Magnetic Characteristics at T_J = –40 °C to +170 °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.

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	4.3	5.9	7.7	2.1	3.8	5.4	1.6	2.1	2.8		4.8		mT
25 °C	3.8	5.5	7.2	2	3.5	5	1.5	2	2.7	3.8	4.5	6.2	mT
100 °C	3.6	5.1	7	1.9	3.3	4.9	1.2	1.8	2.6		4.2		mT
140 °C	3.4	4.8	6.9	1.8	3.1	5.1	1	1.7	2.6		4		mT
170 °C	3.2	4.6	6.8	1.7	3	5.2	0.9	1.6	2.6		3.8		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 $B_{OFFSET} = (B_{ON} + B_{OFF}) / 2$

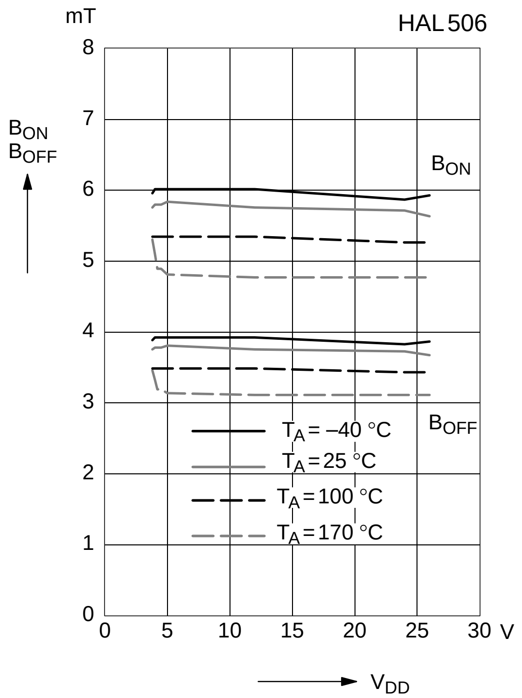

Fig. 4–22: Typ. magnetic switching points versus supply voltage

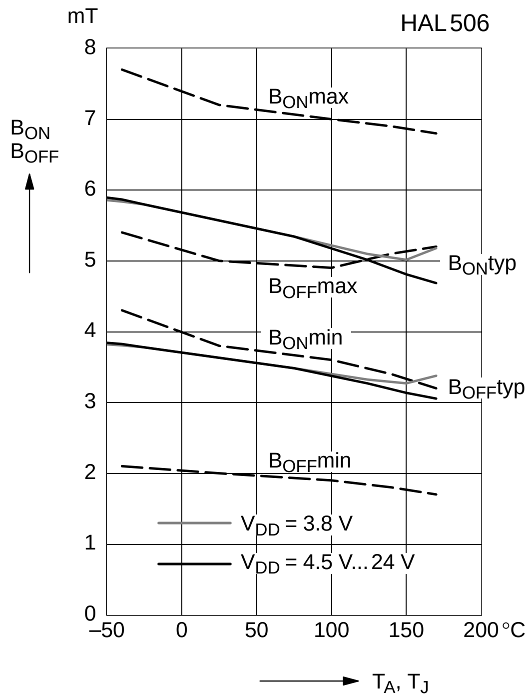

Fig. 4–24: Magnetic switching points versus temperature

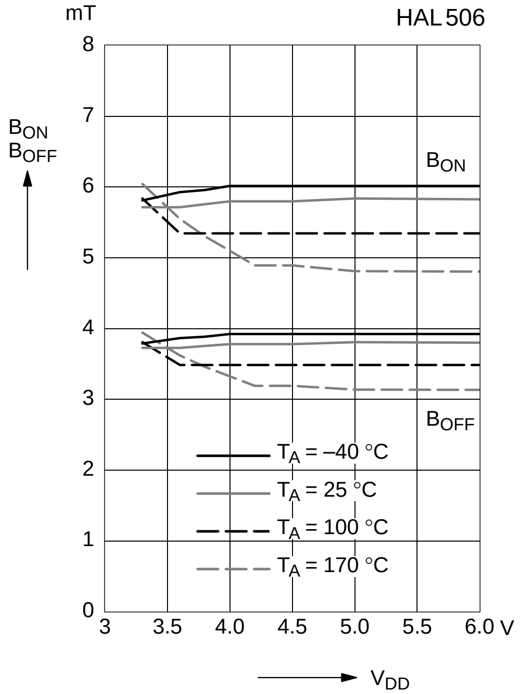

Fig. 4–23: Typ. magnetic switching points versus supply voltage

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.

4.7. HAL508

The HAL508 is a unipolar switching sensor (see Fig. 4–25).

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.

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

In the HAL5xx family, the HAL518 is a sensor with the same magnetic characteristics but with an inverted output characteristic.

Magnetic Features:

- switching type: unipolar
- medium sensitivity
- typical B_{ON}: 18 mT at room temperature
- typical B_{OFF}: 16 mT at room temperature
- operates with static magnetic fields and dynamic magnetic fields up to 10 kHz
- typical temperature coefficient of magnetic switching points is –1000 ppm/K

Applications

The HAL508 is the optimal sensor for applications with one magnetic polarity such as:

- solid state switches,
- contactless solution to replace micro switches,
- position and end point detection, and
- rotating speed measurement.

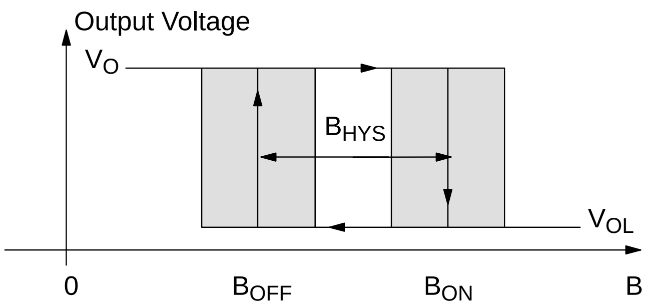

Fig. 4–25: Definition of magnetic switching points for the HAL508

Magnetic Characteristics at T_J = –40 °C to +170 °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.

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	15.5	19	21.9	14	16.7	20	1.6	2.3	2.8		17.8		mT
25 °C	15	18	20.7	13.5	16	19	1.5	2	2.7	14	17	20	mT
100 °C	13.9	16.6	20.4	12.5	14.8	18.7	1.2	1.8	2.6		15.7		mT
140 °C	13.2	15.8	20.2	11.9	14.1	18.5	1.1	1.7	2.6		15		mT
170 °C	12.7	15.3	20	11.4	13.6	18.3	1	1.7	2.6		14.4		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 $B_{OFFSET} = (B_{ON} + B_{OFF}) / 2$

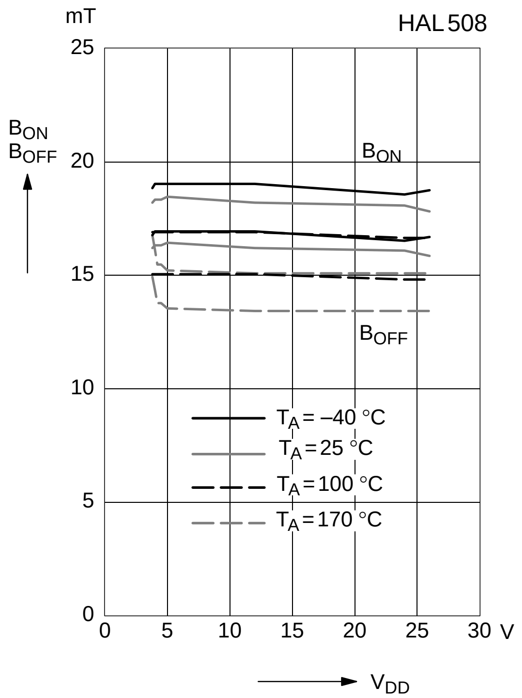

Fig. 4–26: Typ. magnetic switching points versus supply voltage

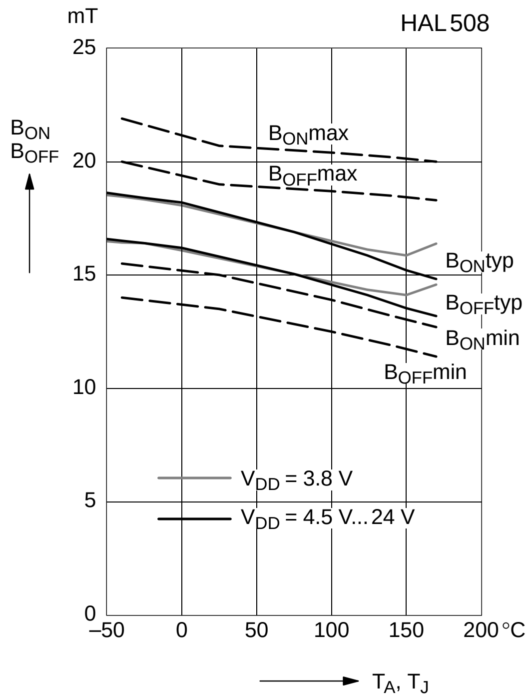

Fig. 4–28: Magnetic switching points versus temperature

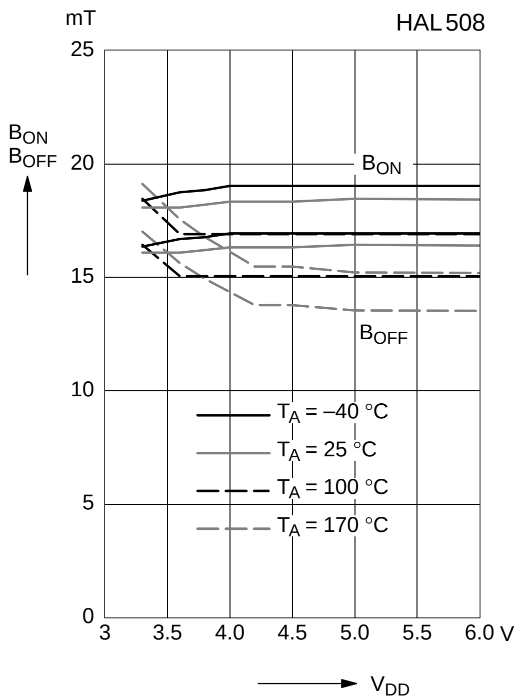

Fig. 4–27: Typ. magnetic switching points versus supply voltage

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.

4.8. HAL 509

The HAL 509 is a unipolar switching sensor (see Fig. 4–29).

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.

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

– low sensitivity

– typical B_{ON}: 26.8 mT at room temperature

– typical B_{OFF}: 23.2 mT at room temperature

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

– typical temperature coefficient of magnetic switching points is –300 ppm/K

Applications

The HAL 509 is the optimal sensor for applications with one magnetic polarity and strong magnetic fields at the sensor position such as:

– solid state switches,

– contactless solution to replace micro switches,

– position and end point detection, and

– rotating speed measurement.

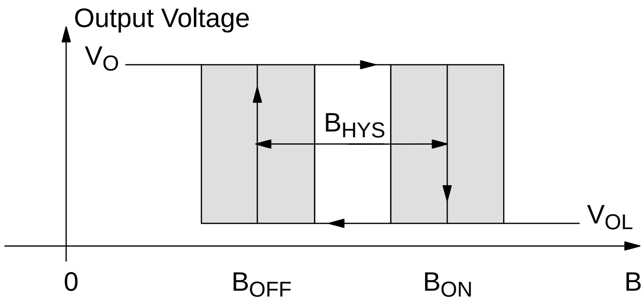

Fig. 4–29: Definition of magnetic switching points for the HAL 509

Magnetic Characteristics at T_J = –40 °C to +170 °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.

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	23.1	27.4	31.1	19.9	23.8	27.2	2.9	3.6	3.9		25.6		mT
25 °C	23.1	26.8	30.4	19.9	23.2	26.6	2.8	3.5	3.9	21.5	25	28.5	mT
100 °C	22.2	26.1	29.7	19.1	22.7	25.9	2.7	3.4	3.8		24.4		mT
140 °C	21.7	25.7	29.2	18.6	22.4	25.6	2.6	3.3	3.8		24		mT
170 °C	21.3	25.4	28.9	18.3	22.1	25.3	2.5	3.3	3.8		23.7		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 $B_{OFFSET} = (B_{ON} + B_{OFF}) / 2$

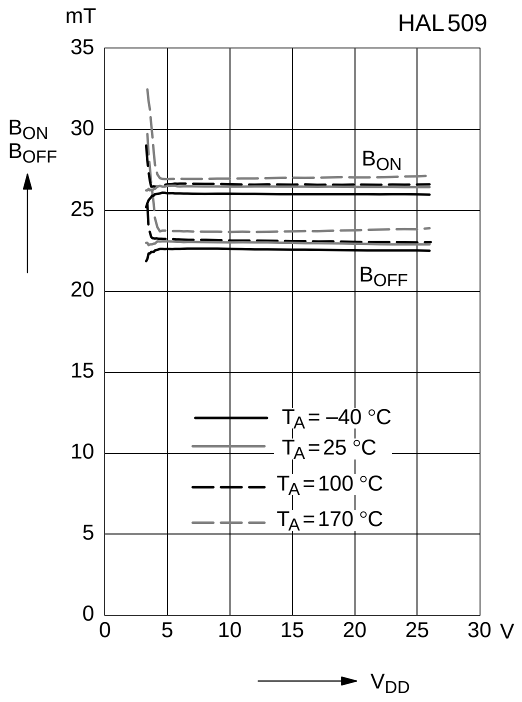

Fig. 4–30: Typ. magnetic switching points versus supply voltage

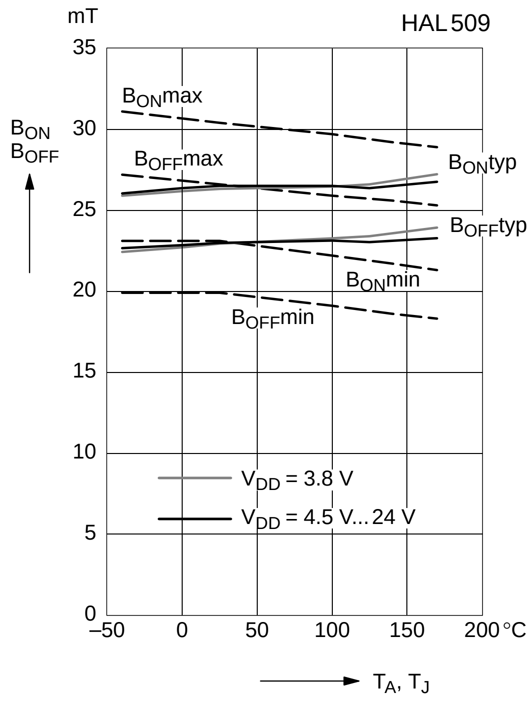

Fig. 4–32: Magnetic switching points versus temperature

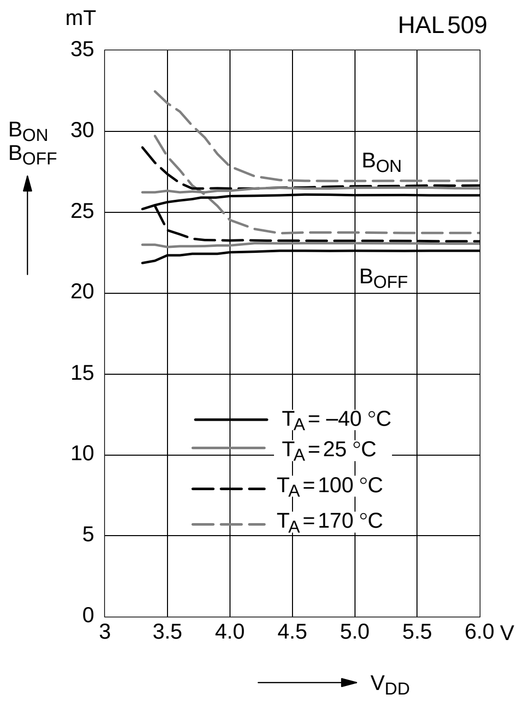

Fig. 4–31: Typ. magnetic switching points versus supply voltage

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.

4.9. HAL516

The HAL516 is the most sensitive unipolar switching sensor with an inverted output of this family (see Fig. 4–33).

The output turns high with the magnetic south pole on the branded side of the package and turns low 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 HAL5xx family, the HAL506 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}: 3.5 mT at room temperature

– typical B_{OFF}: 5.5 mT at room temperature

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

– typical temperature coefficient of magnetic switching points is –1000 ppm/K

Applications

The HAL516 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 solution to replace micro switches,

– position and end point detection, and

– rotating speed measurement.

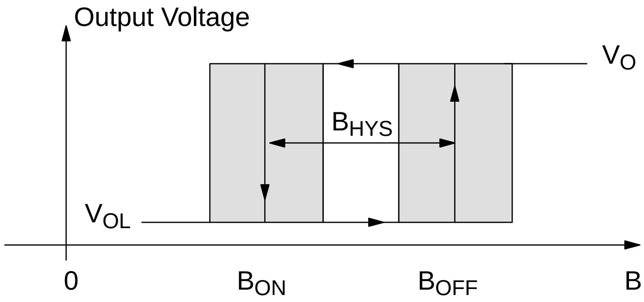

Fig. 4–33: Definition of magnetic switching points for the HAL516

Magnetic Characteristics at T_J = –40 °C to +170 °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.

Parameter T_J	On point B_{ON}			Off point B_{OFF}			Hysteresis B_{HYS}			Magnetic Offset			Unit
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
–40 °C	2.1	3.8	5.4	4.3	5.9	7.7	1.6	2.1	2.8		4.8		mT
25 °C	2	3.5	5	3.8	5.5	7.2	1.5	2	2.7	3.8	4.5	6.2	mT
100 °C	1.9	3.3	4.9	3.6	5.1	7	1.2	1.8	2.6		4.2		mT
140 °C	1.8	3.1	5.1	3.4	4.8	6.9	1	1.7	2.6		4		mT
170 °C	1.7	3	5.2	3.2	4.6	6.8	0.9	1.6	2.6		3.8		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 $B_{OFFSET} = (B_{ON} + B_{OFF}) / 2$

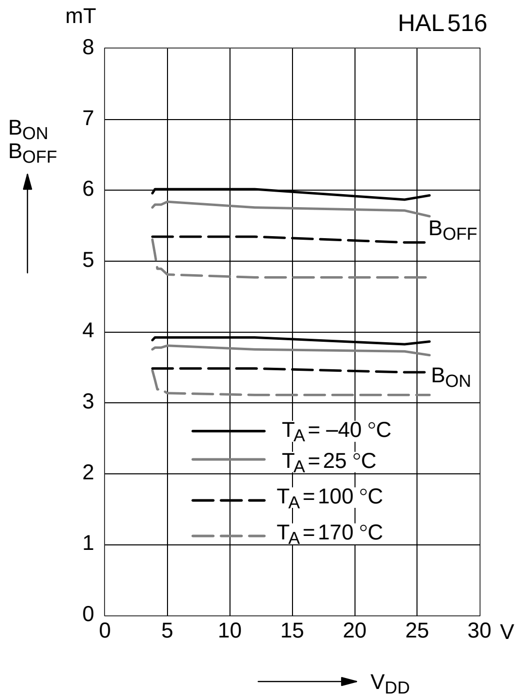

Fig. 4–34: Typ. magnetic switching points versus supply voltage

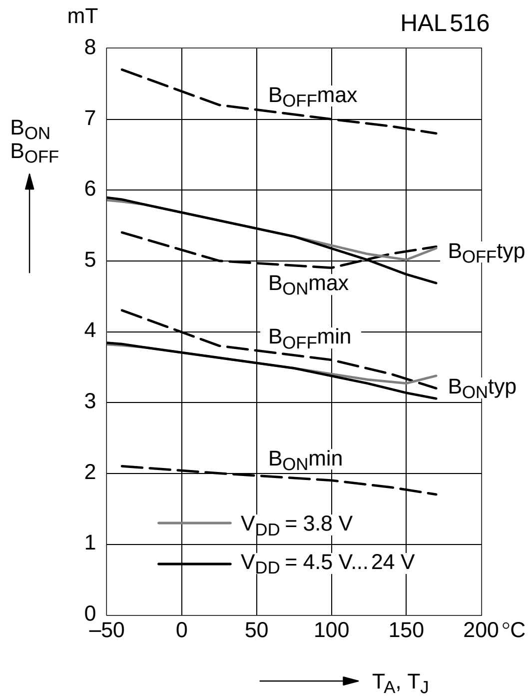

Fig. 4–36: Magnetic switching points versus temperature

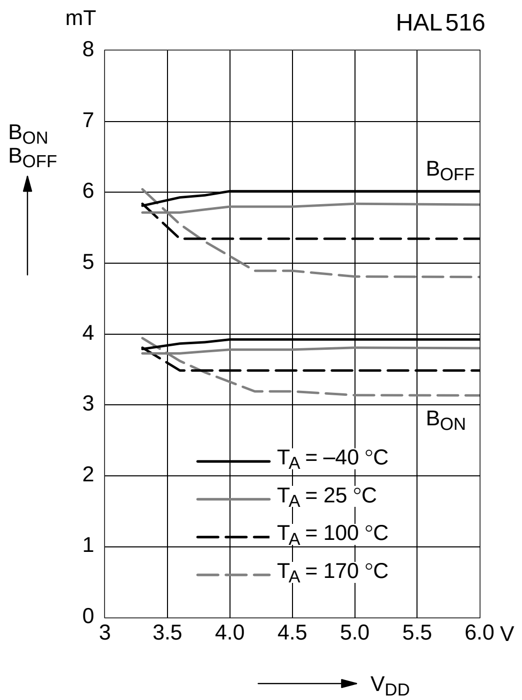

Fig. 4–35: Typ. magnetic switching points versus supply voltage

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.

4.10. HAL 517

The HAL 517 is a unipolar switching sensor with inverted output (see Fig. 4–37).

The output turns high with the magnetic south pole on the branded side of the package and turns low 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

– medium sensitivity

– typical on point is 16.2 mT at room temperature

– typical off point is 18.3 mT at room temperature

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

– typical temperature coefficient of magnetic switching points is –1700 ppm/K

Applications

The HAL 517 is the optimal sensor for applications with one magnetic polarity where an inverted output signal is required such as:

– solid state switches,

– contactless solution to replace micro switches,

– position and end point detection, and

– rotating speed measurement.

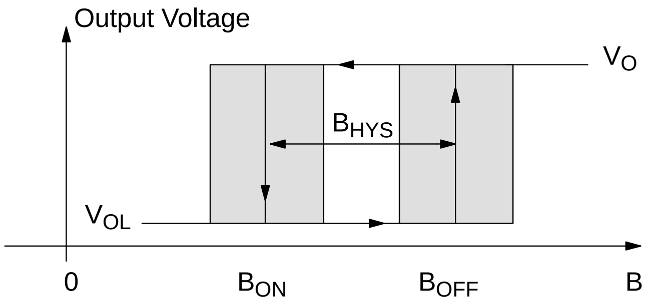

Fig. 4–37: Definition of magnetic switching points for the HAL 517

Magnetic Characteristics at T_J = –40 °C to +170 °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.

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	14	17.1	21.5	15.5	19.6	22.5	1.6	2.5	3		18.3		mT
25 °C	13.5	16.2	19	15	18.3	20.7	1.5	2.1	2.7	14	17.2	20	mT
100 °C	11	14.3	18.5	12.8	16.1	20.4	1.2	1.8	2.6		15.2		mT
140 °C	10	13.2	18.2	11.5	14.8	20.2	1	1.6	2.6		14		mT
170 °C	9	12.3	18	10.5	13.7	20	0.8	1.4	2.4		13		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 $B_{OFFSET} = (B_{ON} + B_{OFF}) / 2$

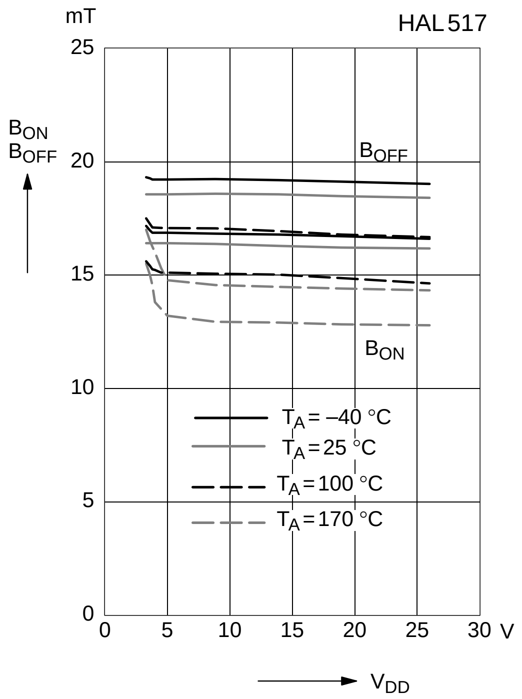

Fig. 4–38: Typ. magnetic switching points versus supply voltage

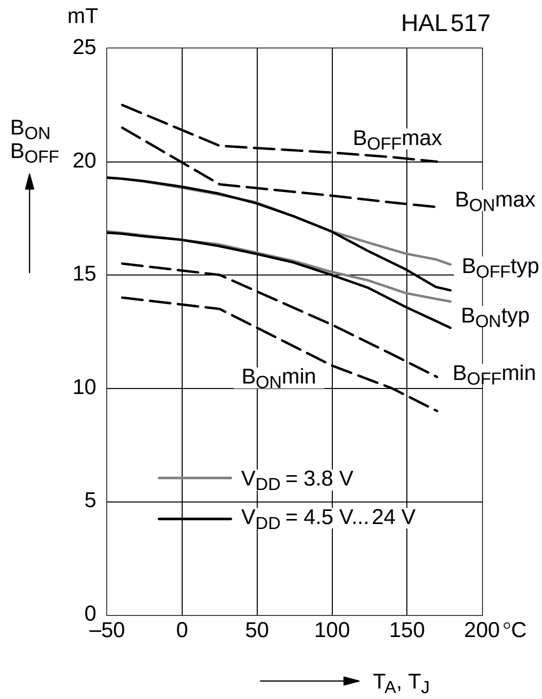

Fig. 4–40: Magnetic switching points versus temperature

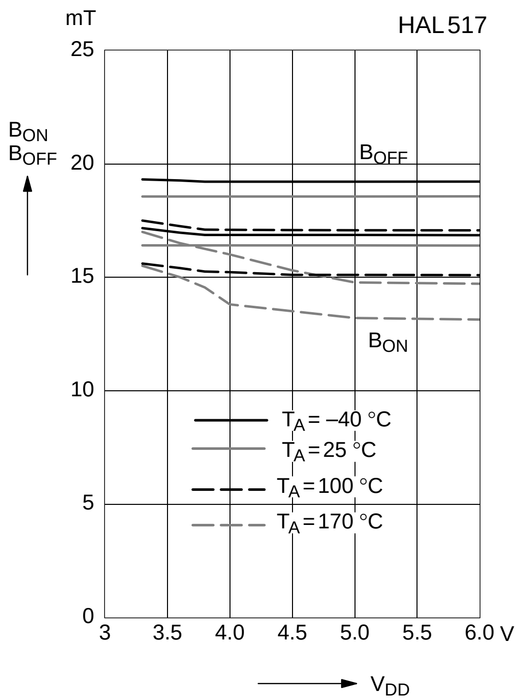

Fig. 4–39: Typ. magnetic switching points versus supply voltage

Note: In the diagram “Magnetic switching points versus ambient 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.

4.11. HAL 518

The HAL 518 is a unipolar switching sensor with inverted output (see Fig. 4–41).

The output turns high with the magnetic south pole on the branded side of the package and turns low 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 5xx family, the HAL 508 is a sensor with the same magnetic characteristics but with a normal output characteristic.

Magnetic Features:

- switching type: unipolar inverted
- medium sensitivity
- typical B_{ON}: 16 mT at room temperature
- typical B_{OFF}: 18 mT at room temperature
- operates with static magnetic fields and dynamic magnetic fields up to 10 kHz
- typical temperature coefficient of magnetic switching points is –1000 ppm/K

Applications

The HAL 518 is the optimal sensor for applications with one magnetic polarity where an inverted output signal is required such as:

- solid state switches,
- contactless solution to replace micro switches,
- position and end point detection, and
- rotating speed measurement.

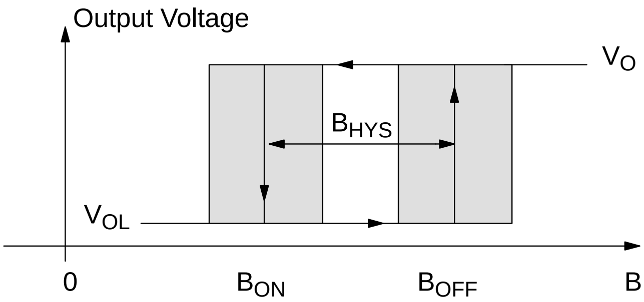

Fig. 4–41: Definition of magnetic switching points for the HAL 518

Magnetic Characteristics at T_J = –40 °C to +170 °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.

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	14	16.7	20	15.5	19	22	1.5	2.3	3		17.8		mT
25 °C	13.5	16	19	15	18	20.7	1.4	2	2.8	14	17	20	mT
100 °C	12.5	14.8	18.7	13.9	16.6	20.4	1	1.8	2.7		15.7		mT
140 °C	11.7	14.1	18.5	13	15.8	20.2	0.9	1.7	2.7		15		mT
170 °C	11	13.6	18.3	12.2	15.3	20	0.8	1.7	2.6		14.4		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 $B_{OFFSET} = (B_{ON} + B_{OFF}) / 2$

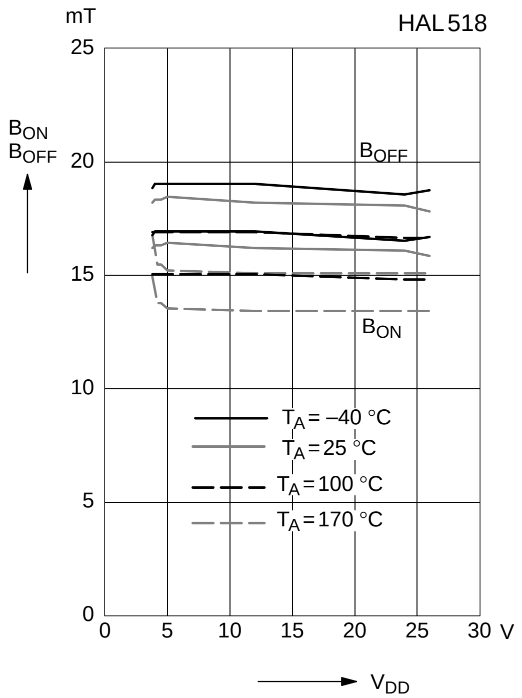

Fig. 4–42: Typ. magnetic switching points versus supply voltage

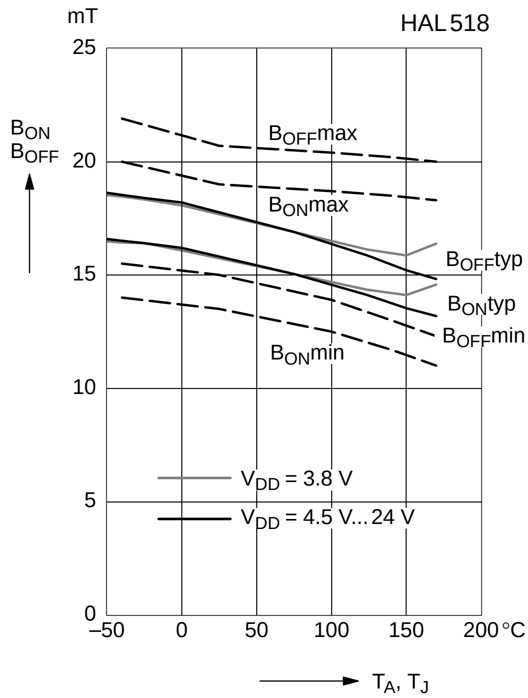

Fig. 4–44: Magnetic switching points versus temperature

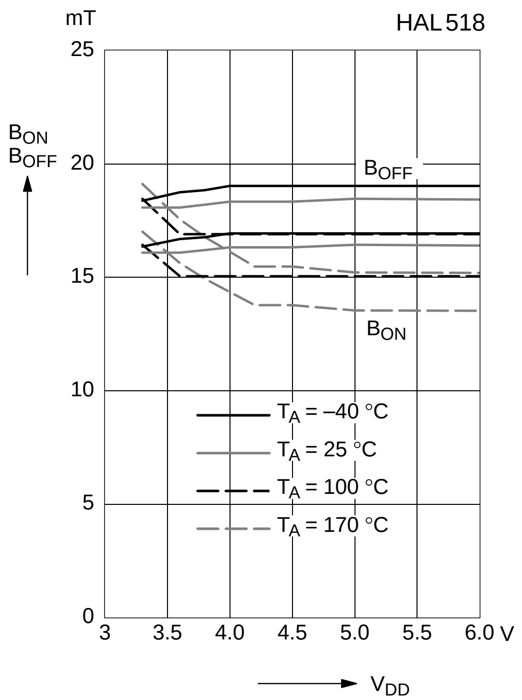

Fig. 4–43: Typ. magnetic switching points versus supply voltage

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.

4.12. HAL 519

The HAL 519 is a very sensitive unipolar switching sensor with an inverted output sensitive only to the magnetic north polarity. (see Fig. 4–45).

The output turns high with the magnetic north pole on the branded side of the package and turns low if the magnetic field is removed. The sensor does not respond to the magnetic south pole on the branded side, the output remains low. For correct functioning in the application, the sensor requires only the magnetic north pole on the branded side of the package.

Magnetic Features:

- switching type: unipolar inverted, north sensitive
- high sensitivity
- typical B_{ON}: –3.5 mT at room temperature
- typical B_{OFF}: –5.5 mT at room temperature
- operates with static magnetic fields and dynamic magnetic fields up to 10 kHz
- typical temperature coefficient of magnetic switching points is –1000 ppm/K

Applications

The HAL 519 is the optimal sensor for all applications with the north magnetic polarity and weak magnetic amplitude at the sensor position where an inverted output signal is required such as:

- solid state switches,
- contactless solution to replace micro switches,
- position and end point detection, and
- rotating speed measurement.

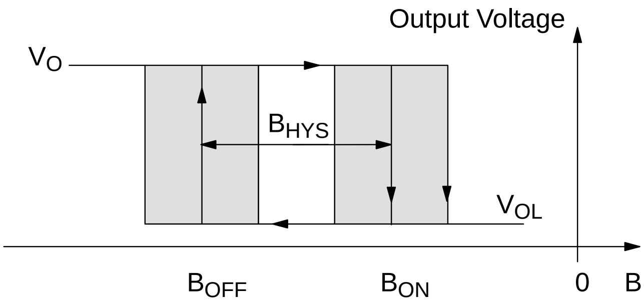

Fig. 4–45: Definition of magnetic switching points for the HAL 519

Magnetic Characteristics at T_J = –40 °C to +170 °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.

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	–5.4	–3.8	–2.1	–7.7	–5.9	–4.3	1.6	2.1	2.8		–4.8		mT
25 °C	–5	–3.6	–2	–7.2	–5.5	–3.8	1.5	1.9	2.7	–6.2	–4.5	–3.8	mT
100 °C	–4.9	–3.3	–1.9	–6.7	–5	–3.4	1.2	1.7	2.6		–4.2		mT
140 °C	–5.1	–3.1	–1.7	–6.8	–4.8	–3.1	1	1.7	2.6		–4		mT
170 °C	–5.2	–3	–1.5	–6.8	–4.6	–2.8	0.9	1.6	2.6		–3.8		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 $B_{OFFSET} = (B_{ON} + B_{OFF}) / 2$

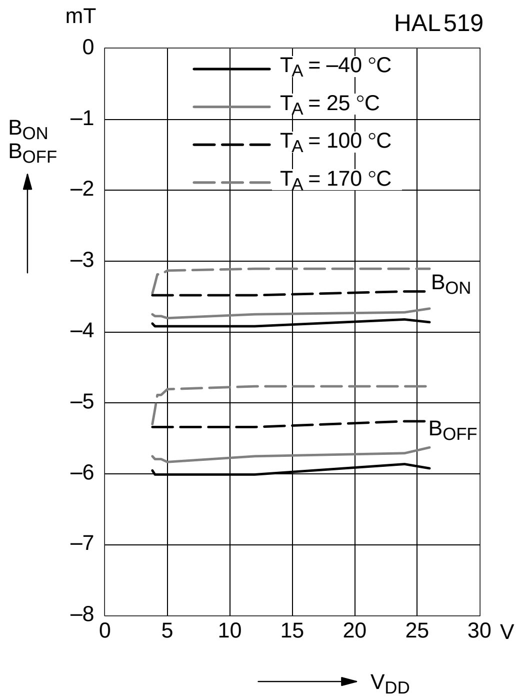

Fig. 4–46: Typ. magnetic switching points versus supply voltage

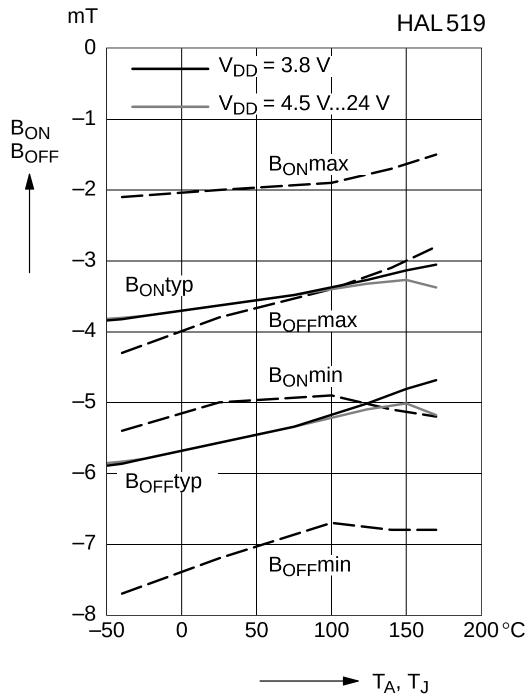

Fig. 4–48: Magnetic switching points versus temperature

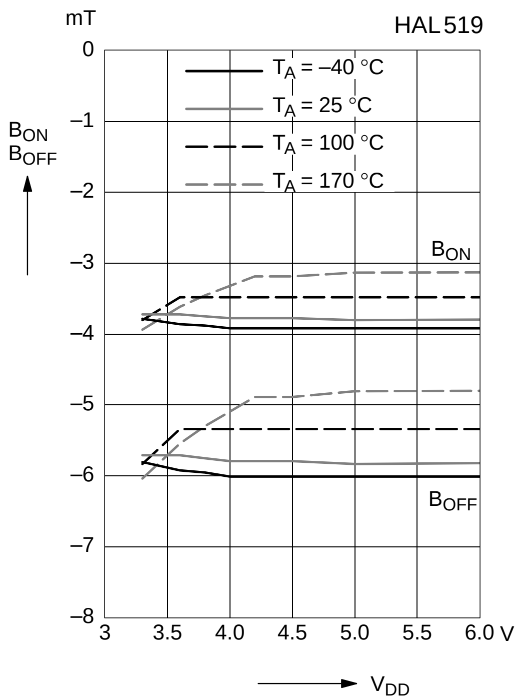

Fig. 4–47: Typ. magnetic switching points versus supply voltage

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.

4.13. HAL 523

The HAL 523 is the least sensitive unipolar switching sensor of this family (see Fig. 4–49).

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.

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
- low sensitivity
- typical B_{ON}: 34.5 mT at room temperature
- typical B_{OFF}: 24 mT at room temperature
- operates with static magnetic fields and dynamic magnetic fields up to 10 kHz

Applications

The HAL 523 is the optimal sensor for applications with one magnetic polarity and strong magnetic fields at the sensor position such as:

- solid state switches,
- contactless solution to replace micro switches,
- position and end point detection, and
- rotating speed measurement.

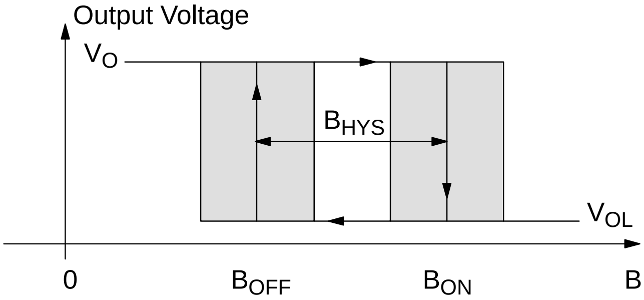

Fig. 4–49: Definition of magnetic switching points for the HAL 523

Magnetic Characteristics at T_J = –40 °C to +170 °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.

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	28	34.5	42	18	24	30	7	10.5	14		29.3		mT
25 °C	28	34.5	42	18	24	30	7	10.5	14		29.3		mT
100 °C	28	34.5	42	18	24	30	7	10.5	14		29.3		mT
140 °C	28	34.5	42	18	24	30	7	10.5	14		29.3		mT
170 °C	28	34.5	42	18	24	30	7	10.5	14		29.3		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 $B_{OFFSET} = (B_{ON} + B_{OFF}) / 2$

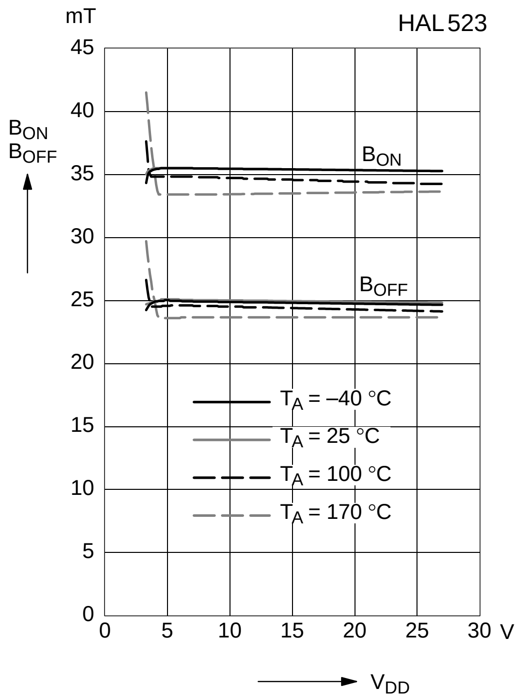

Fig. 4–50: Typ. magnetic switching points versus supply voltage

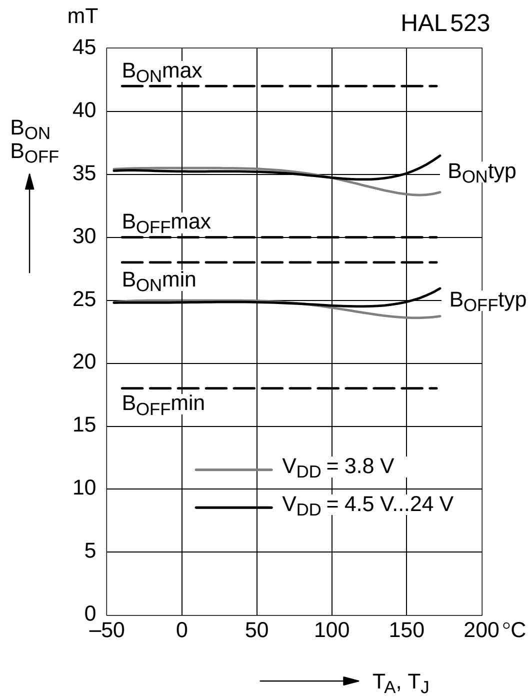

Fig. 4–52: Magnetic switching points versus temperature

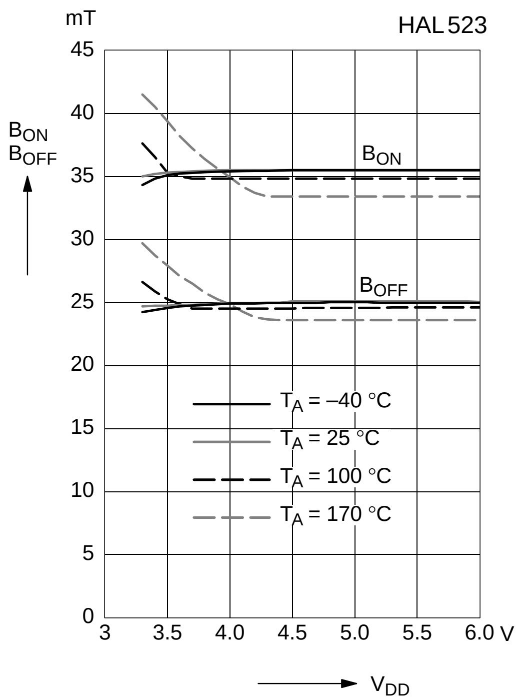

Fig. 4–51: Typ. magnetic switching points versus supply voltage

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. 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, the following equation is valid:

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

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:

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

5.2. Extended Operating Conditions

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

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 has not been tested. 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 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}. In case of sensors with an inverted switching behavior (HAL 516 ... HAL 519), the output state will be high if $B > B_{OFF}$ and low if $B < B_{ON}$.

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}.

5.4. EMC and ESD

For applications with disturbances on the supply line or radiated disturbances, a series resistor and a capacitor are recommended (see figures 5–1). The series resistor and the capacitor should be placed as closely as possible to the HAL sensor.

Applications with this arrangement passed the EMC tests according to the product standards DIN 40839.

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

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

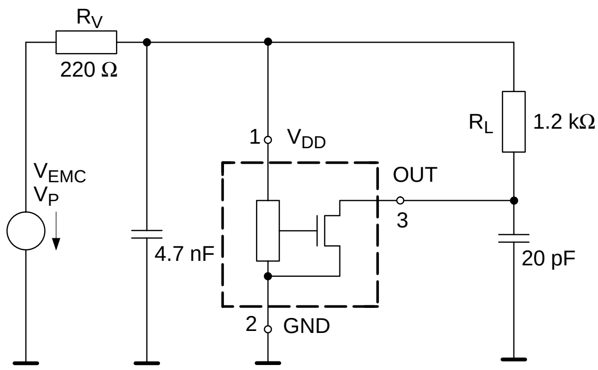

Fig. 5–1: Test circuit for EMC investigations

6. Data Sheet History

1. Final data sheet: "HAL 501...506, 508, 509, 516... 518, Hall Effect Sensor Family, Aug. 11, 1999, 6251-485-1DS. First release of the final data sheet. Major changes to the previous edition "HAL501 ... HAL506, HAL 508", Hall Effect Sensor ICs, May 5, 1997, 6251-405-1DS:

- additional types: HAL509, HAL516 ... HAL518
- additional package SOT-89B
- additional temperature range "K"
- outline dimensions for SOT-89A and TO-92UA changed
- absolute maximum ratings changed
- electrical characteristics changed
- magnetic characteristics for HAL 501, HAL 503, HAL 506, and HAL 509 changed

2. Final data sheet: "HAL 501...506, 508, 509, 516... 519, 523, Hall Effect Sensor Family", Feb. 14, 2001, 6251-485-2DS. Second release of the final data sheet. Major changes:

- additional types: HAL519, HAL523
- phased-out package SOT-89A removed
- temperature range "C" removed
- outline dimensions for SOT-89B: reduced tolerances

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