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MICRONAS

Hardware
Documentation

Data Sheet

HAL® 5xy

Hall-Effect Sensor Family

Edition April 15, 2010
DSH000020_004E

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Contents

Hall Effect Sensor Family
in CMOS technology

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

1. Introduction

The HAL 5xy 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 the SMD-package SOT89B-1 and in the leaded versions TO92UA-1 and TO92UA-2.

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 regarding 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 ISO 7637

1.2. Family Overview

The types differ according to the magnetic flux density values for the magnetic switching points and the temperature behavior of the magnetic switching points, and the mode of switching.

Type	Switching Behavior	Sensitivity	see Page
501	bipolar	very high	22
502	latching	high	24
503	latching	medium	26
504	unipolar	medium	28
505	latching	low	30
506	unipolar	high	32
507	unipolar	medium	34
508	unipolar	medium	36
509	unipolar	low	38
516	unipolar with inverted output	high	40
519	unipolar with inverted output (north polarity)	high	42
523	unipolar	low	44

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
HAL 501	501A	501K
HAL 502	502A	502K
HAL 503	503A	503K
HAL 504	504A	504K
HAL 505	505A	505K
HAL 506	506A	506K
HAL 507	507A	507K
HAL 508	508A	508K
HAL 509	509A	509K
HAL 516	516A	516K
HAL 519	519A	519K
HAL 523	523A	523K

1.4. Operating Junction Temperature Range

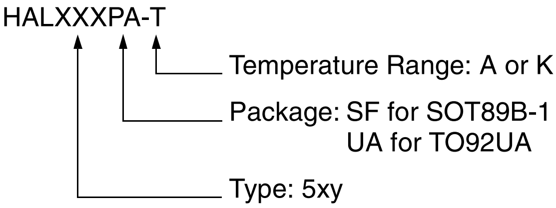
The Hall sensors from Micronas are specified to the chip temperature (junction temperature T_J).

A: T_J = –40 °C to +170 °C

K: T_J = –40 °C to +140 °C

Note: Due to the high power dissipation at high current consumption, there is a difference between the ambient temperature (T_A) and junction temperature. Please refer to Section 5.1. on page 46 for details.

1.5. Hall Sensor Package Codes



Example: **HAL505UA-K**

→ Type: 505
→ Package: TO92UA
→ Temperature Range: T_J = –40 °C to +140 °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 and Welding

Soldering

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

Welding

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

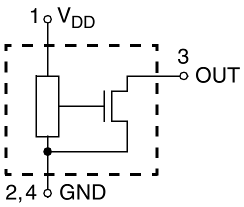


Fig. 1–1: Pin configuration

2. 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”. Thus, 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.

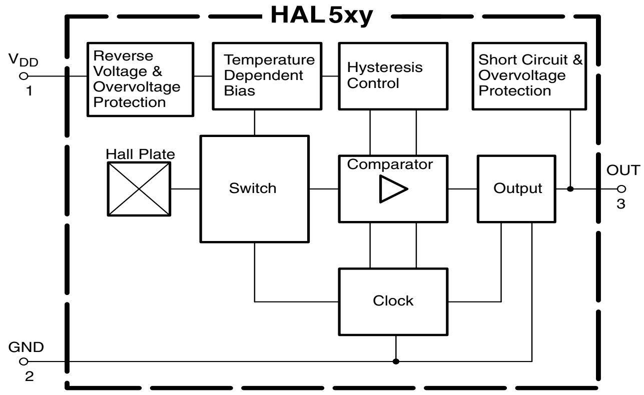


Fig. 2–1: HAL 5xx block diagram

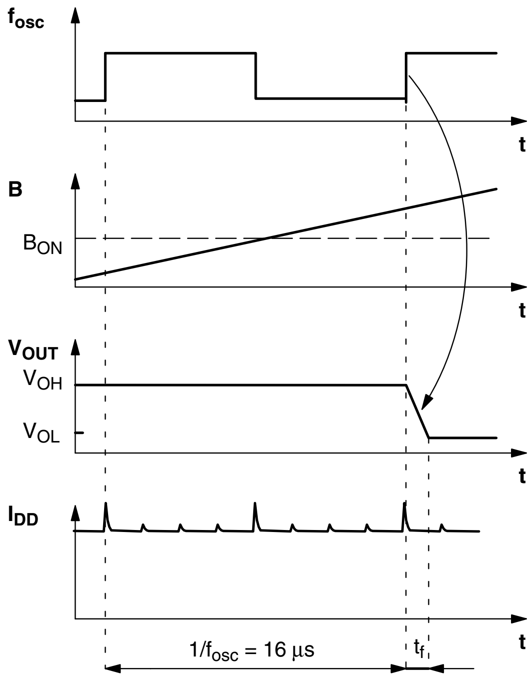
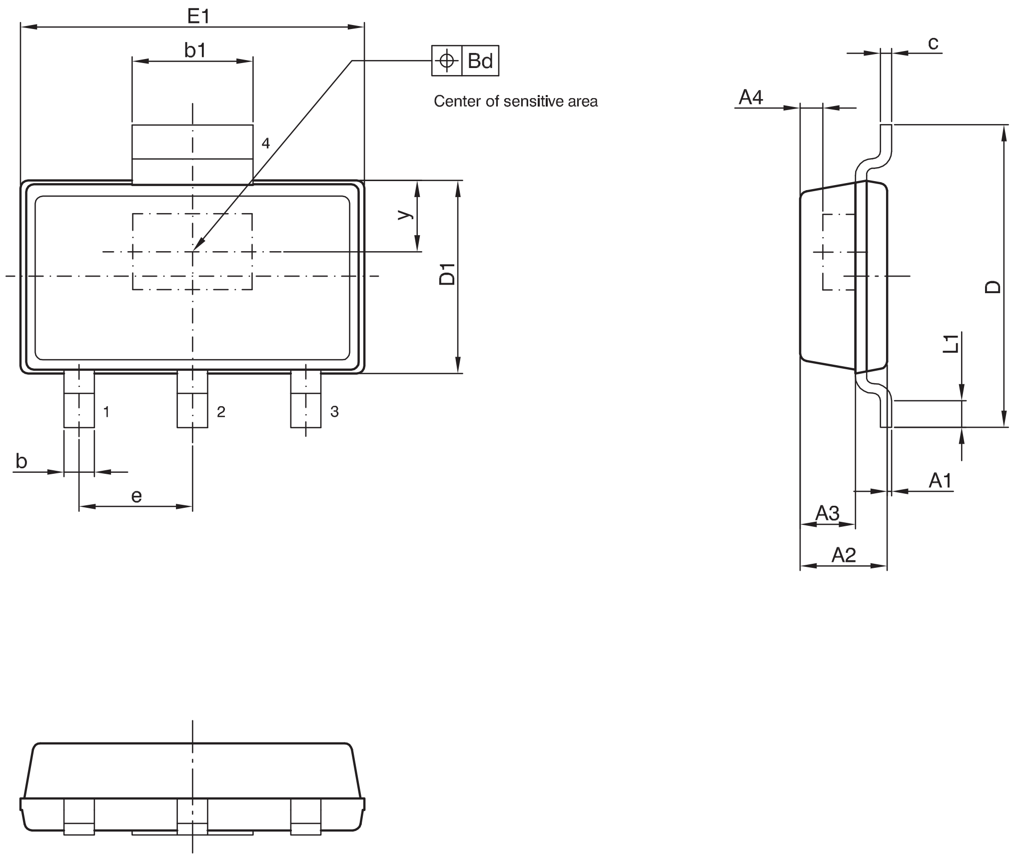


Fig. 2–2: Timing diagram

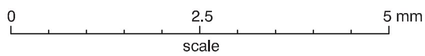
3. Specifications

3.1. Outline Dimensions



physical dimensions do not include moldflash.

A4, y= these dimensions are different for each sensor type and are specified in the data sheet.



UNIT	A1	A2	A3	b	b1	Bd	c	D	D1	e	E1	L1
mm	0.10 0.02	1.20 1.10	0.73	0.4	1.7	0.2	0.15	4.0	2.6 2.5	1.5	4.6 4.5	0.25 min.

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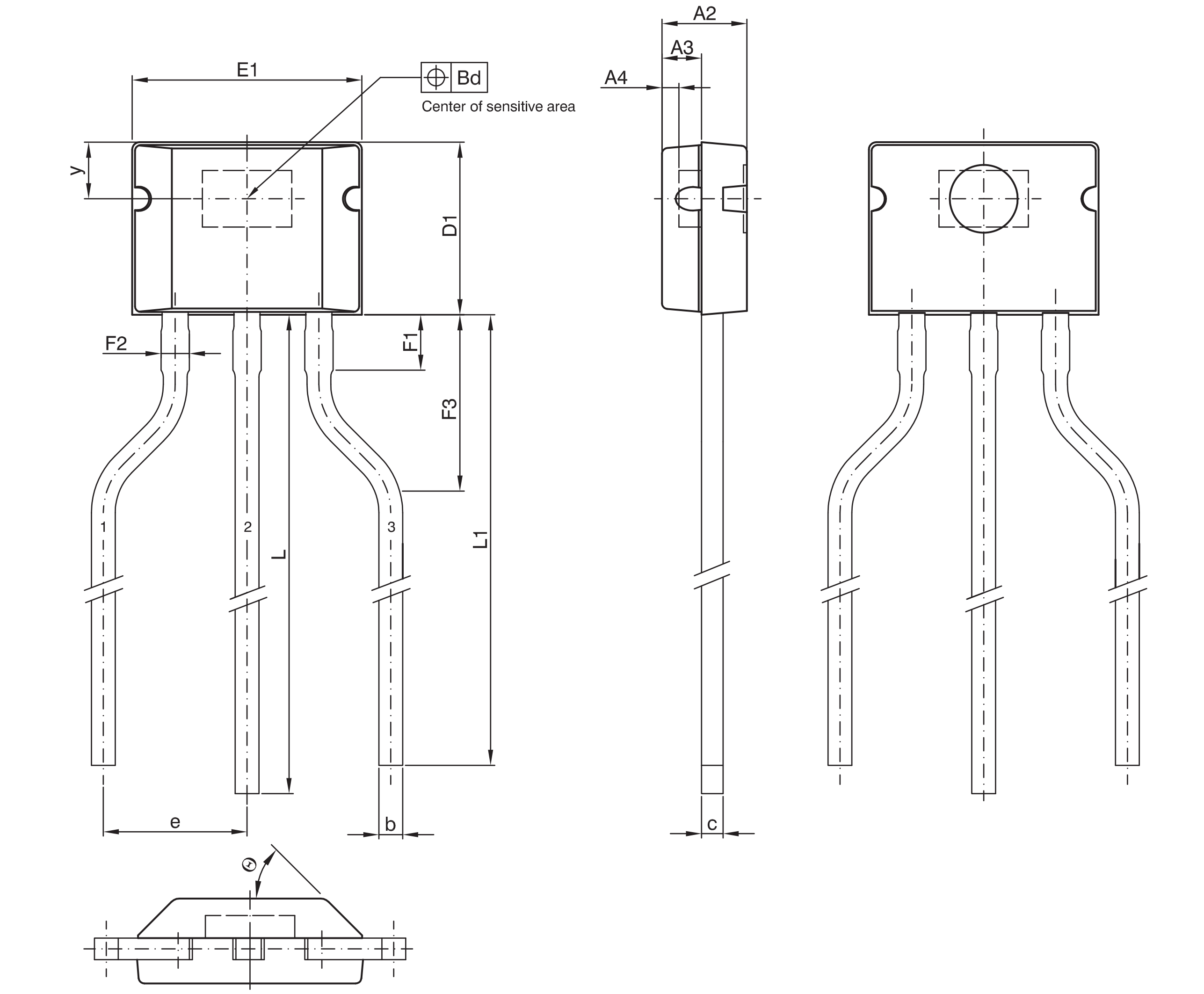
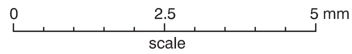
ISSUE	ITEM NO.				
-	-		07-07-02	06610.0001.4	ZG001010_Ver.03

Fig. 3–1:
SOT89B-1: Plastic **S**mall **O**utline **T**ransistor package, 4 leads
Ordering code: SF
Weight approximately 0.034 g



physical dimensions do not include moldflash.
solderability is guaranteed between end of pin and distance F1.
A4, y= these dimensions are different for each sensor type and is specified in the data sheet.
min/max of D1 are specified in the datasheet.



UNIT	A2	A3	b	Bd	c	D1	e	E1	F1	F2	F3	L	L1	Θ
mm	1.55 1.45	0.7	0.42	0.2	0.36	3.05	2.54	4.11 4.01	1.2 0.8	0.60 0.42	4.0 2.0	15.5 min	15.0 min	45°

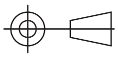
JEDEC STANDARD		ANSI	ISSUE DATE YY-MM-DD	DRAWING-NO.	ZG-NO.
ISSUE	ITEM NO.				
-	-		09-06-09	06616.0001.4	ZG001016_Ver.05

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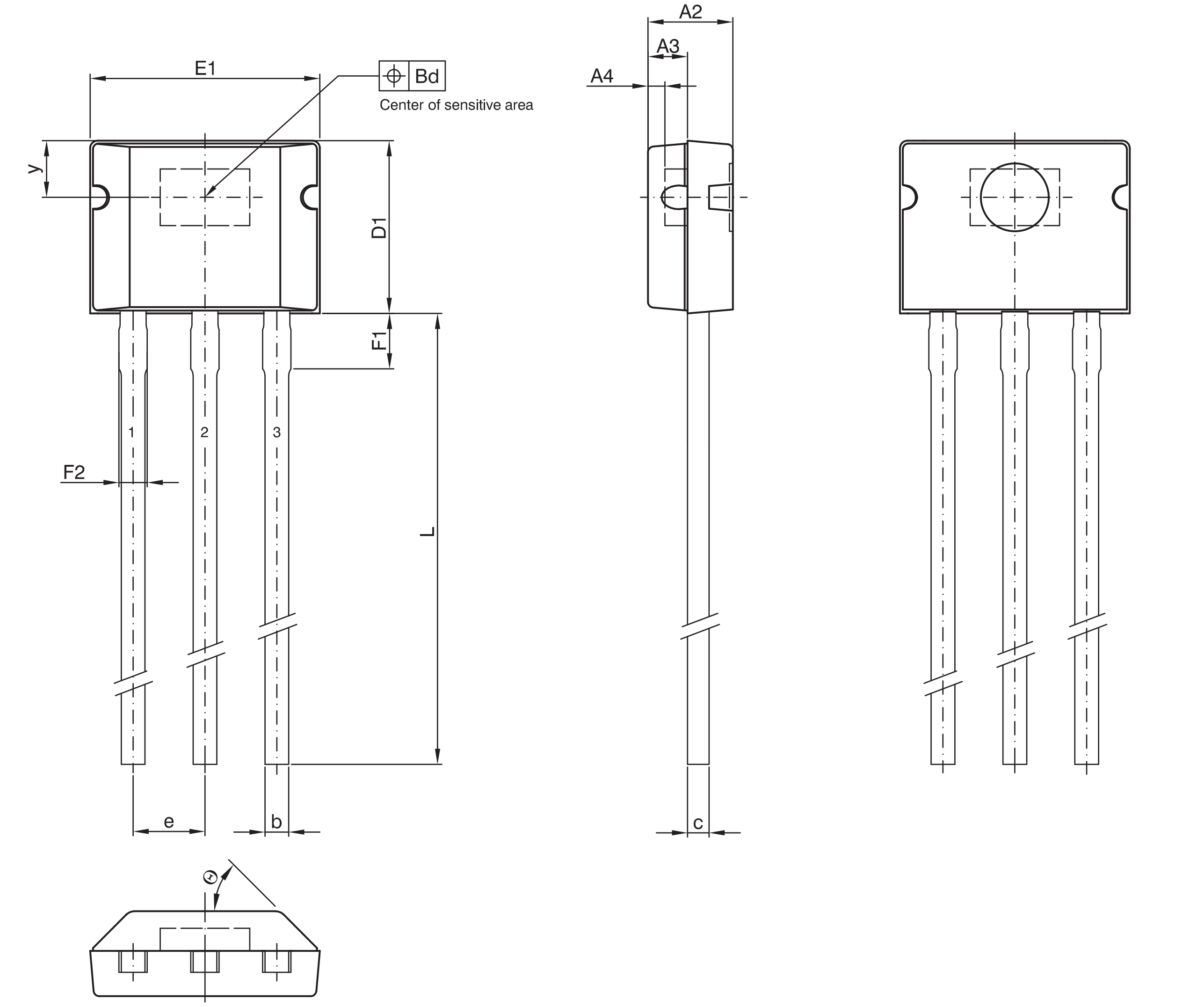
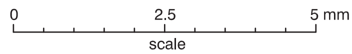
Fig. 3–2:
TO92UA-1: Plastic Transistor Standard UA package, 3 leads, spread
Weight approximately 0.106 g



physical dimensions do not include moldflash.
solderability is guaranteed between end of pin and distance F1.
A4, y= these dimensions are different for each sensor type and is specified in the data sheet.
min/max of D1 are specified in the datasheet.



UNIT	A2	A3	b	Bd	c	D1	e	E1	F1	F2	L	Θ
mm	1.55 1.45	0.7	0.42	0.2	0.36	3.05	1.27	4.11 4.01	1.2 0.8	0.60 0.42	15.5 min	45°

JEDEC STANDARD		ANSI	ISSUE DATE YY-MM-DD	DRAWING-NO.	ZG-NO.
ISSUE	ITEM NO.				
-	-		09-06-05	06612.0001.4	ZG001012_Ver.06

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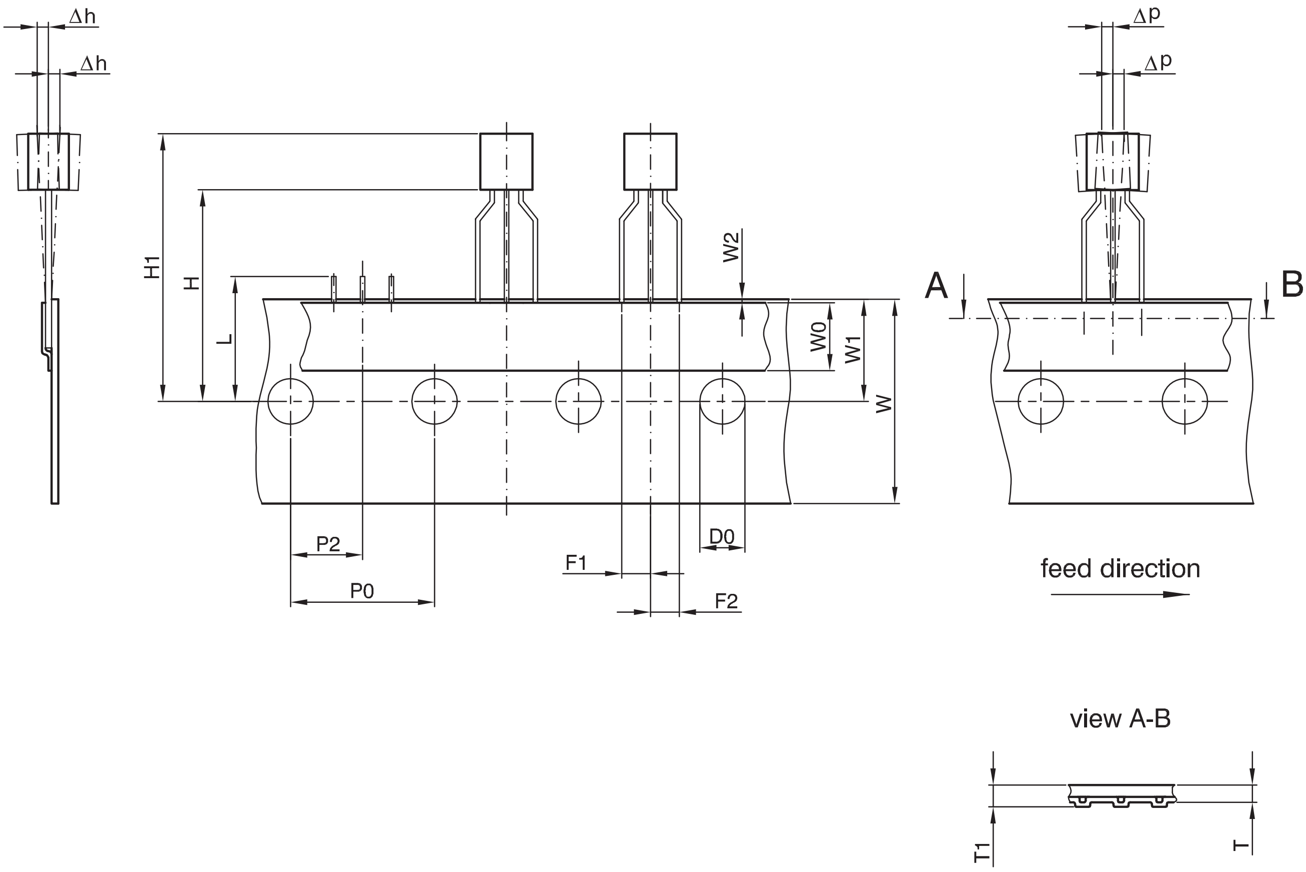
Fig. 3–3:
TO92UA-2: Plastic Transistor Standard UA package, 3 leads, not spread
Weight approximately 0.106 g



all dimensions in mm
other dimensions see drawing of bulk
max. allowed tolerance over 20 hole spacings ±1.0
H1 = this dimension is different for each sensor type and is specified in the data sheet

UNIT	D0	F1	F2	H	Δh	L	P0	P2	Δp	T	T1	W	W0	W1	W2
mm	4.0	2.74 2.34	2.74 2.34	20.0 18.0	±1.0	11.0 max	13.2 12.2	7.05 5.65	±1.0	0.5	0.9	18.0	6.0	9.0	0.3

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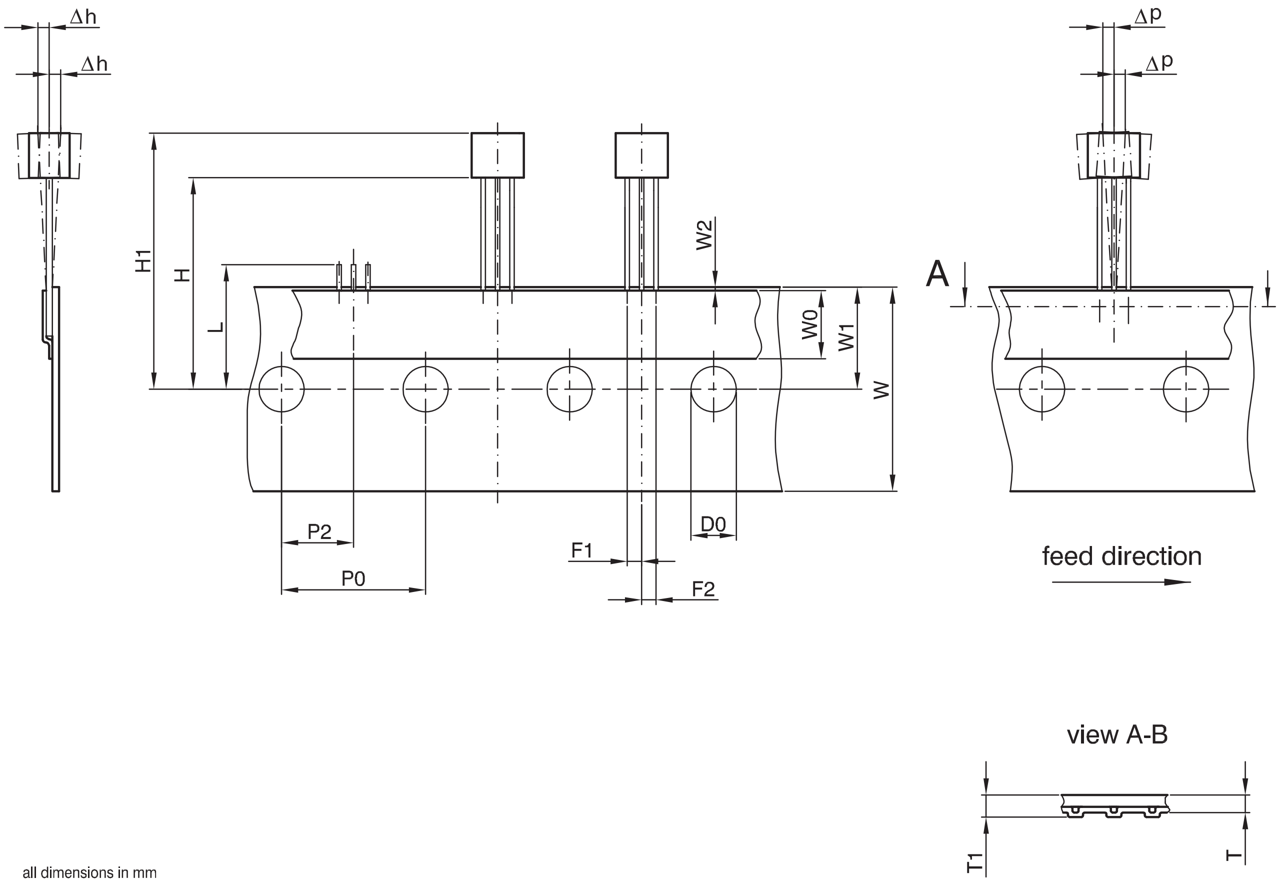
ISSUE	ITEM NO.				
-	ICE 60286-2		07-01-18	06632.0001.4	ZG001032_Ver.04

Fig. 3–4:
TO92UA-1: Dimensions ammopack inline, spread



all dimensions in mm
other dimensions see drawing of bulk
max. allowed tolerance over 20 hole spacings ±1.0
H1= this dimension is different for each sensor type and is specified in the data sheet

UNIT	D0	F1	F2	H	Δh	L	P0	P2	Δp	T	T1	W	W0	W1	W2
mm	4.0	1.47 1.07	1.47 1.07	20.0 18.0	±1.0	11.0 max	13.2 12.2	7.05 5.65	±1.0	0.5	0.9	18.0	6.0	9.0	0.3

JEDEC STANDARD		ANSI	ISSUE DATE YY-MM-DD	DRAWING-NO.	ZG-NO.
ISSUE	ITEM NO.				
-	ICE 60286-2		07-01-18	06631.0001.4	ZG001031_Ver.03

Fig. 3–5:
TO92UA-2: Dimensions ammopack inline, not spread

3.2. Dimensions of Sensitive Area

0.25 mm × 0.12 mm

3.3. Positions of Sensitive Areas

	SOT89B-1	TO92UA-1/-2
y	0.95 mm nominal	1.0 mm nominal
A4	0.3 mm nominal	0.3 mm nominal
D1	see drawing	3.05 mm +/- 0.05 mm
H1	not applicable	min. 21 mm max. 23.1 mm

3.4. Absolute Maximum Ratings

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

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

All voltages listed are referenced to ground (GND).

Symbol	Parameter	Pin No.	Min.	Max.	Unit
V_{DD}	Supply Voltage	1	–15	28[1)]	V
V_O	Output Voltage	3	–0.3	28[1)]	V
I_O	Continuous Output On Current	3	–	50[1)]	mA
T_J	Junction Temperature Range		–40	170[2)]	°C

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

3.4.1. Storage and Shelf Life

The permissible storage time (shelf life) of the sensors is unlimited, provided the sensors are stored at a maximum of 30 °C and a maximum of 85% relative humidity. At these conditions, no Dry Pack is required.

Solderability is guaranteed for one year from the date code on the package.

3.5. Recommended Operating Conditions

Functional operation of the device beyond those indicated in the “Recommended Operating Conditions” of this specification is not implied, may result in unpredictable behavior of the device and may reduce reliability and lifetime.

All voltages listed are referenced to ground (GND).

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. Characteristics

at T_J = –40 °C to +170 °C, V_{DD} = 3.8 V to 24 V,

at Recommended Operation Conditions if not otherwise specified in the column “Conditions”. Typical Characteristics for T_J = 25 °C and V_{DD} = 12 V

Symbol	Parameter	Pin No.	Min.	Typ.	Max.	Unit	Conditions
I_{DD}	Supply Current	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 ≤150 °C, V_{OH} = 3.8 to 24 V
f_{osc}	Internal Oscillator Chopper Frequency	–	–	62	–	kHz	
$t_{en(O)}$	Enable Time of Output after Setting of V_{DD}	1	–	50	–	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	
R_{thJSB} case SOT89B-1	Thermal Resistance Junction to Substrate Backside	–	–	150	200	K/W	Fiberglass Substrate 30 mm x 10 mm x 1.5 mm, pad size see Fig. 3–6
R_{thJA} case TO92UA-1, TO92UA-2	Thermal Resistance Junction to Soldering Point	–	–	150	200	K/W	

[1] B > B_{ON} + 2 mT or B < B_{OFF} – 2 mT for HAL50x, B > B_{OFF} + 2 mT or B < B_{ON} – 2 mT for HAL51x

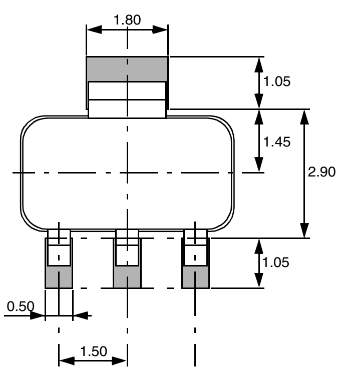


Fig. 3–6: Recommended pad size SOT89B-1
Dimensions in mm

3.7. Magnetic Characteristics Overview

at TJ = –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	Parameter	On point B_{ON}			Off point B_{OFF}			Hysteresis B_{HYS}			Unit
Switching Type	T_J	**Min.**	**Typ.**	**Max.**	**Min.**	**Typ.**	**Max.**	**Min.**	**Typ.**	**Max.**	
HAL 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 507	–40 °C	15.5	19.6	22.5	14.0	17.1	21.5	1.6	2.5	5.2	mT
unipolar	25 °C	15.0	18.3	20.7	13.5	16.2	19.0	1.5	2.1	2.7	mT
	170 °C	10.5	13.7	20.0	9.0	12.3	18.0	0.8	1.4	2.4	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

Note: For detailed descriptions of the individual types, see pages 22 and following.

Magnetic Characteristics Overview, continued

Sensor Switching Type	Parameter T_J	On point$_{ON}$ Min.	Typ.	Max.	Off point$_{OFF}$ 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 22 and following

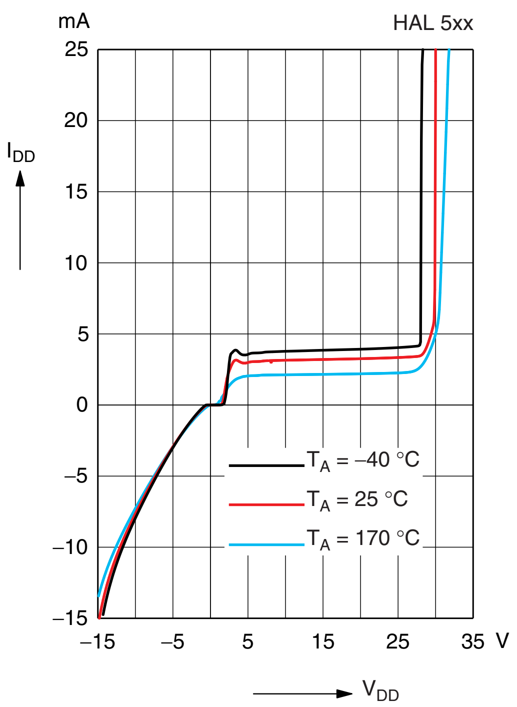


Fig. 3–7: Typical supply current versus supply voltage

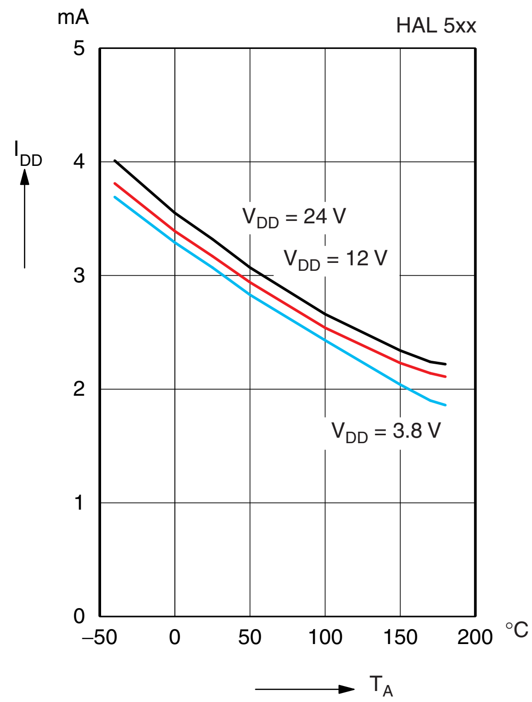


Fig. 3–9: Typical supply current versus ambient temperature

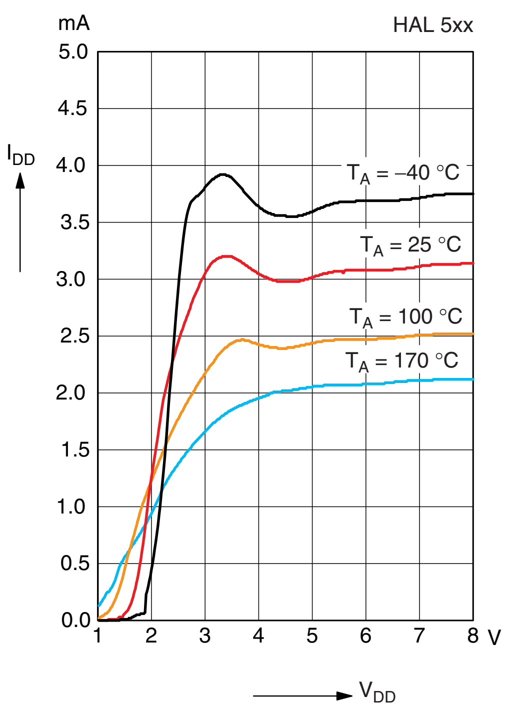


Fig. 3–8: Typical supply current versus supply voltage

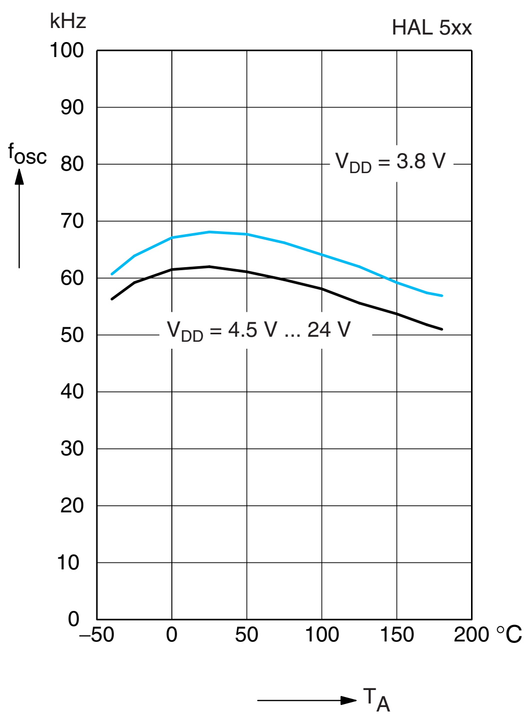


Fig. 3–10: Typ. internal chopper frequency versus ambient temperature

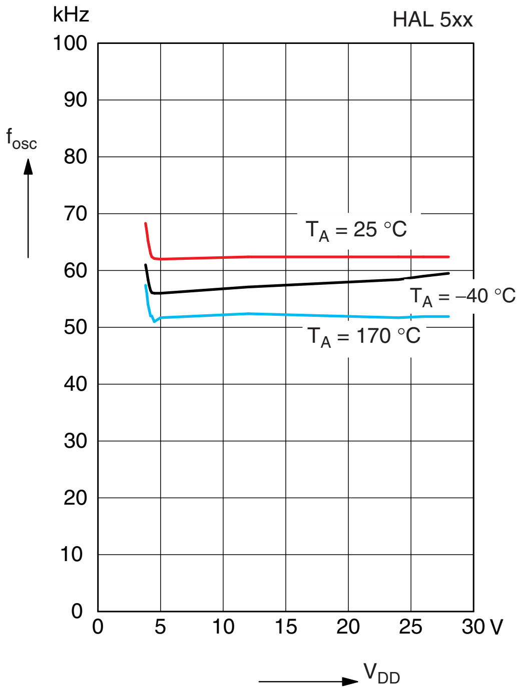


Fig. 3–11: Typ. internal chopper frequency versus supply voltage

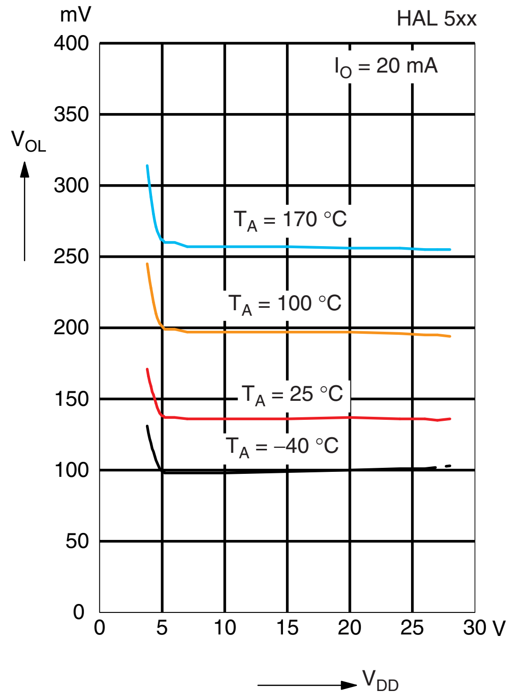


Fig. 3–13: Typical output low voltage versus supply voltage

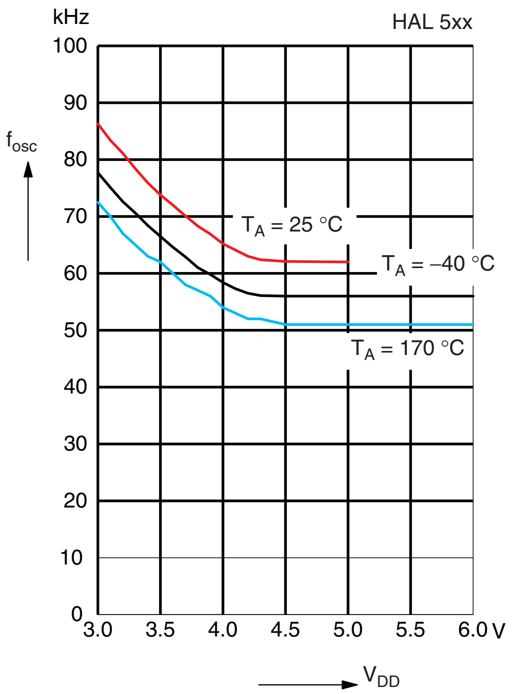


Fig. 3–12: Typ. internal chopper frequency versus supply voltage

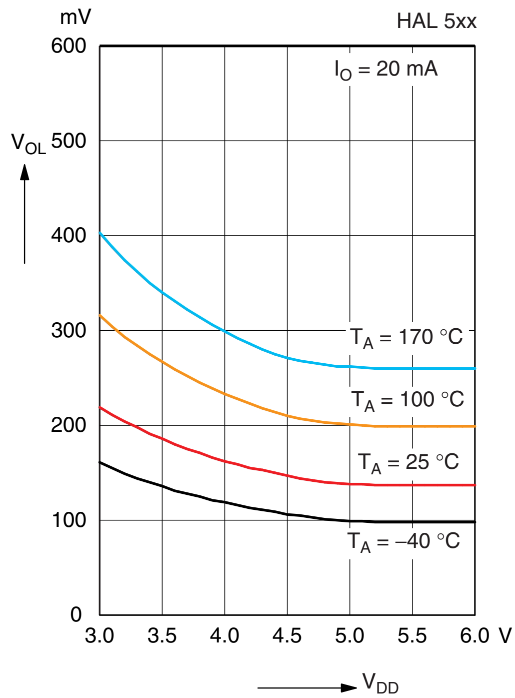


Fig. 3–14: Typical output low voltage versus supply voltage

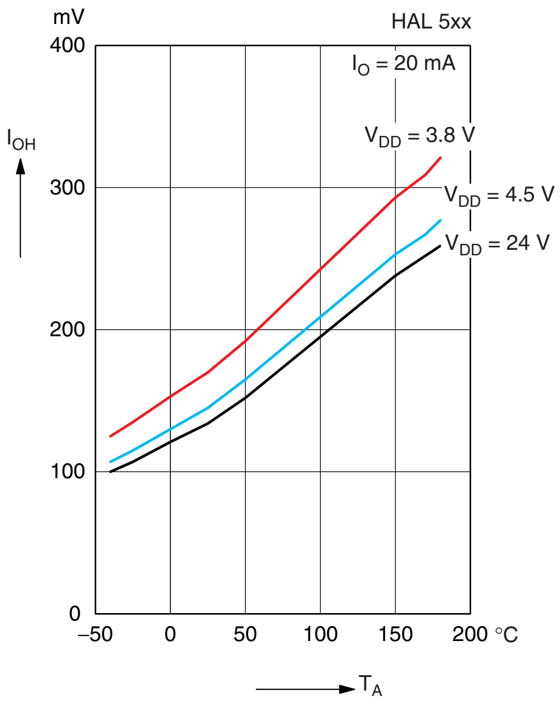


Fig. 3–15: Typ. output low voltage versus ambient temperature

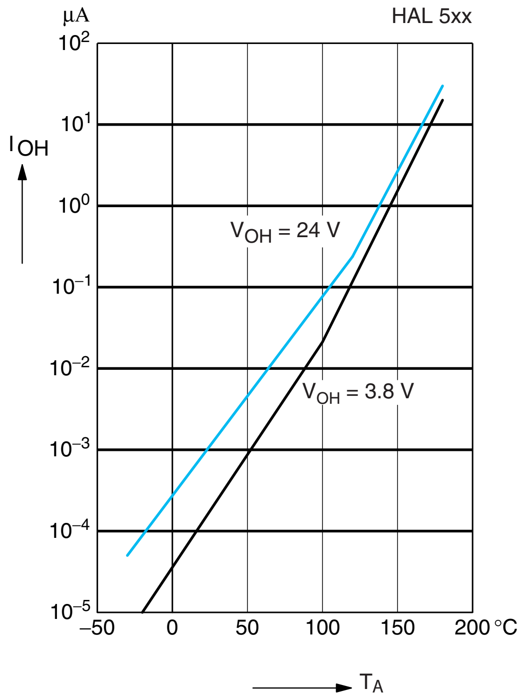


Fig. 3–17: Typ. output leakage current versus ambient temperature

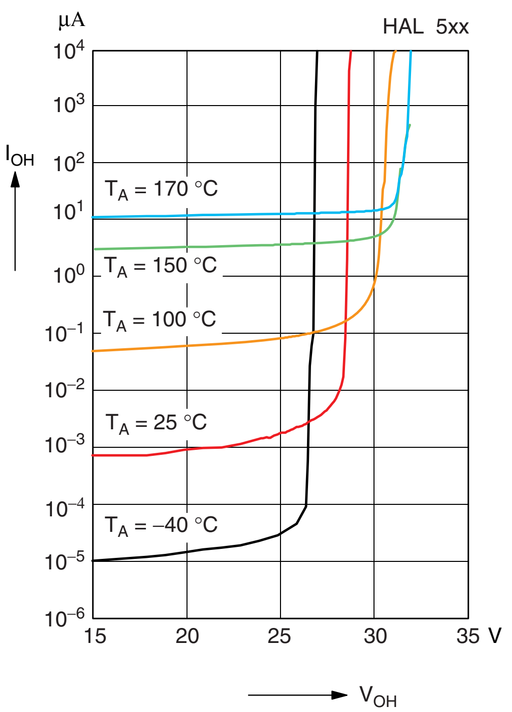


Fig. 3–16: Typ. output high current versus output voltage

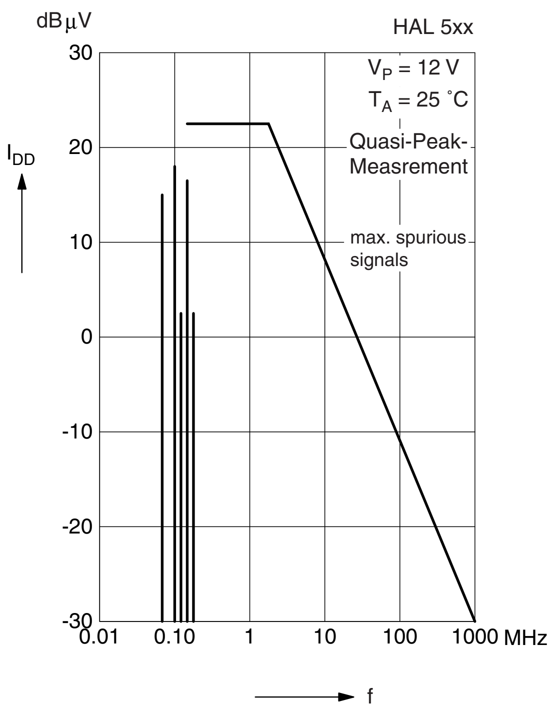


Fig. 3–18: Typ. spectrum of supply current

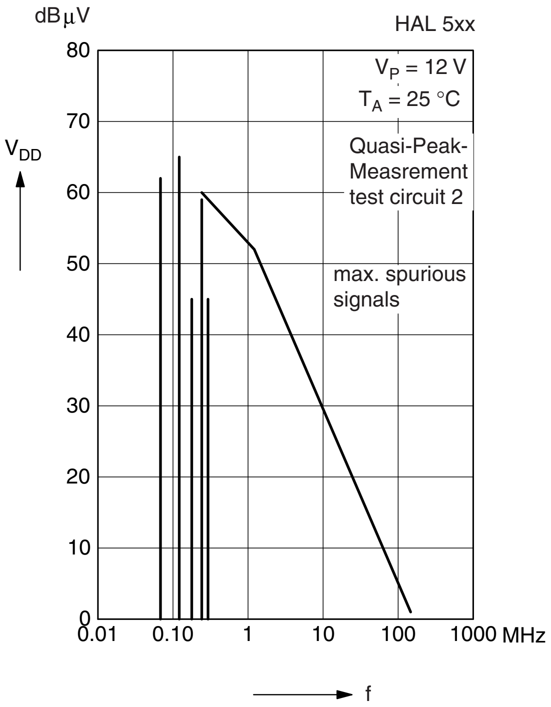


Fig. 3–19: Typ. spectrum of supply current

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 applications with alternating magnetic signals and weak magnetic amplitude at the sensor position such as:

– applications with large air gap or weak magnets,

– rotating speed measurement,

– commutation of brushless DC motors, and

– CAM shaft sensors, and

– magnetic encoders.

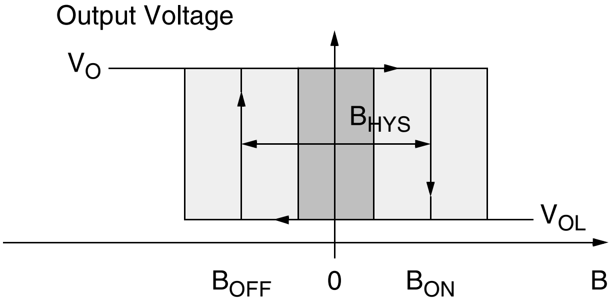


Fig. 4–1: Definition of magnetic switching points for HAL 501

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
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 $B_{OFFSET} = (B_{ON} + B_{OFF}) / 2$

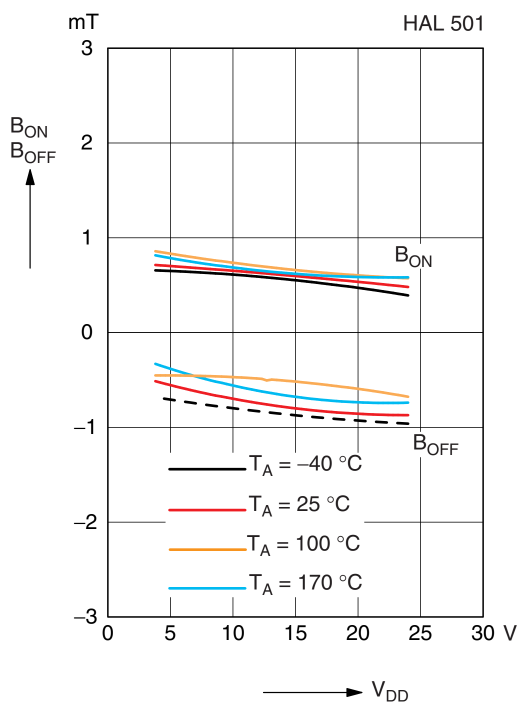


Fig. 4–2: Typ. magnetic switching points versus supply voltage

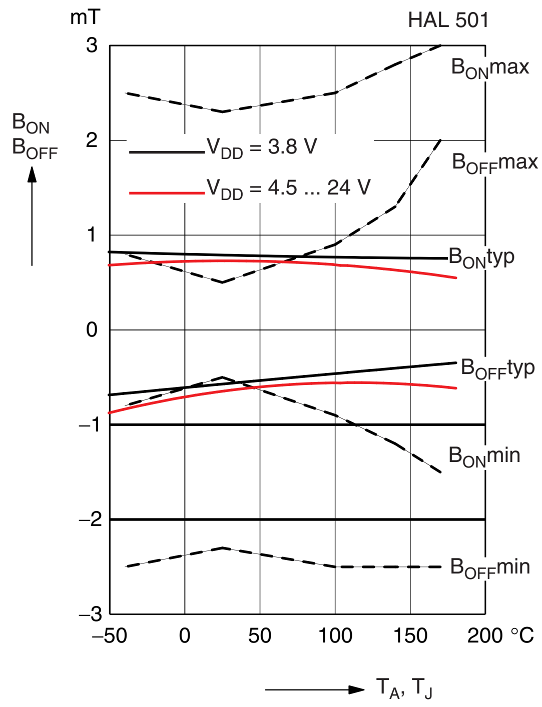


Fig. 4–4: Magnetic switching points versus temperature

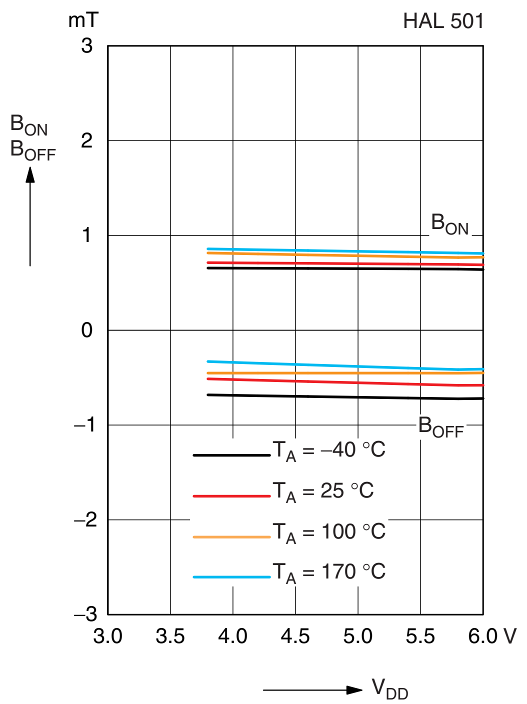


Fig. 4–3: Typ. Magnetic switching points versus supply voltage

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 BON: 2.6 mT at room temperature
- typical BOFF: −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 air gap or weak magnets,
- rotating speed measurement,
- commutation of brushless DC motors,
- CAM shaft sensors, and
- magnetic encoders.

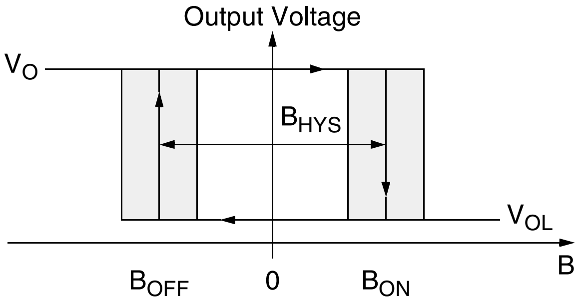


Fig. 4–5: Definition of magnetic switching points for the HAL 502

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
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 $B_{OFFSET} = (B_{ON} + B_{OFF}) / 2$

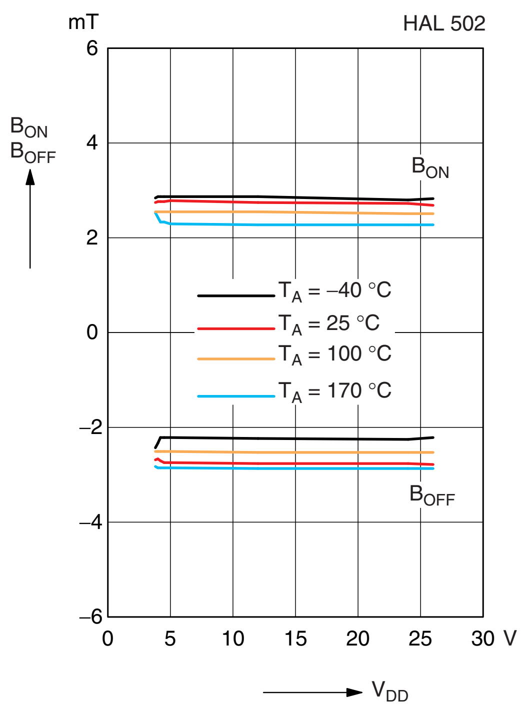


Fig. 4–6: Typ. magnetic switching points versus supply voltage

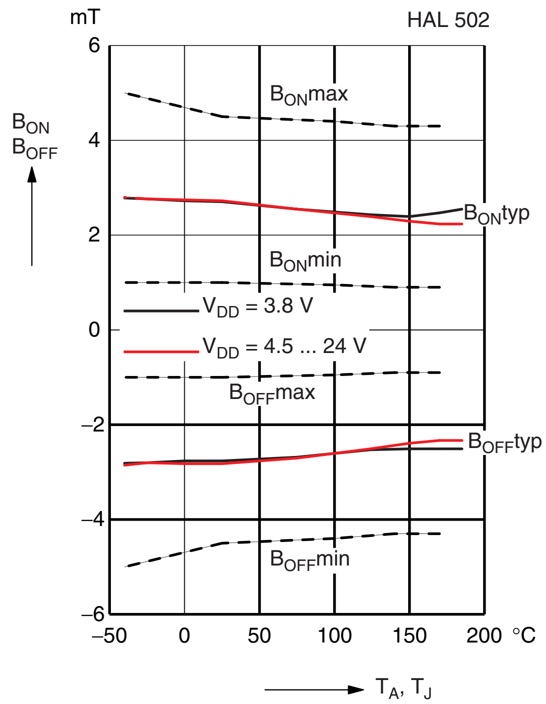


Fig. 4–8: Magnetic switching points versus temperature

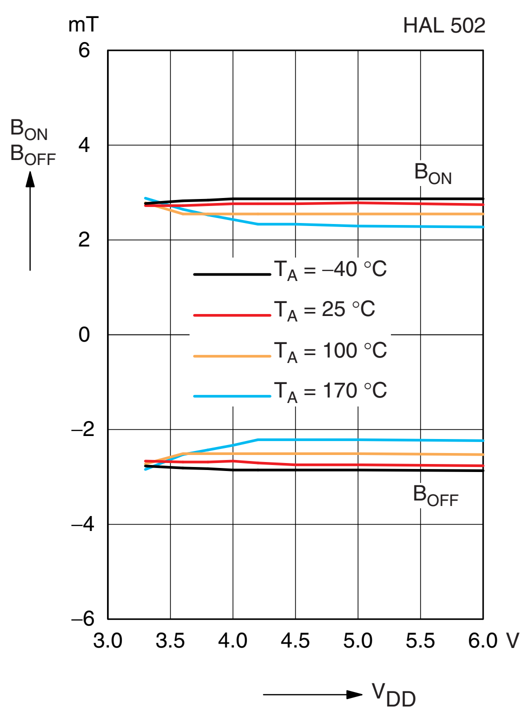


Fig. 4–7: Typ. magnetic switching points versus supply voltage

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.