MICRONAS

Hardware
Documentation

Data Sheet

HAL® 525, HAL 526

Hall-Effect Switches

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DSH000144_003EN

Contents

Hall-Effect Switches

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

1. Introduction

The Hall switches HAL 525✝ and HAL 526 are produced in CMOS technology. These sensors include a temperature-compensated Hall plate with active offset compensation, a comparator, and an open-drain output transistor. The comparator compares the actual magnetic flux through the Hall plate (Hall voltage) with the fixed reference values (switching points). Accordingly, the output transistor is switched on or off.

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

This sensor is designed for industrial and automotive applications and operates with supply voltages from 3.8 V to 24 V in the ambient temperature range from –40 °C up to 125 °C.

The HAL 525✝ and HAL 526 are available in the SMD package SOT89B-1 and in the leaded versions TO92UA-1 and TO92UA-2.

1.1. Features

– operates from 3.8 V to 24 V supply voltage

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

– 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

– 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 window lifter, ignition timing, and revolution counting in extreme automotive and industrial environments

– EMC corresponding to ISO 7637

1.2. Switch Type

Type	Switching Behavior	Typical Temperature Coefficient	see Page
525✝	latching	–2000 ppm/K	19
526	latching	–2000 ppm/K	21

Note: ✝: HAL 525 is not available for new designs. Please use HAL 526 instead.

Latching Sensor:

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

1.3. 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	
	K	E
HAL 525✝	525K	–
HAL 526	526K	526E

1.4. Operating Junction Temperature Range (T_J)

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

K: T_J = –40 °C to +140 °C

E: T_J = –40 °C to +100 °C

The relationship between ambient temperature (T_A) and junction temperature is explained in Section 5.1. on page 23.

1.5. Hall Sensor Package Codes

HALXXXPA-T

- Temperature Range: K or E
- Package: SF for SOT89B-1
  UA for TO92UA
- Type: 526

Example: **HAL526UA-E**

→ Type: 526
→ Package: TO92UA
→ 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: “Hall Sensors: Ordering Codes, Packaging, Handling”.

1.6. Solderability and Welding

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.

1.7. Pin Connections

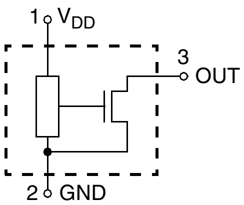


Fig. 1–1: Pin configuration

2. Functional Description

The Hall effect sensor is a monolithic integrated circuit that switches 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.

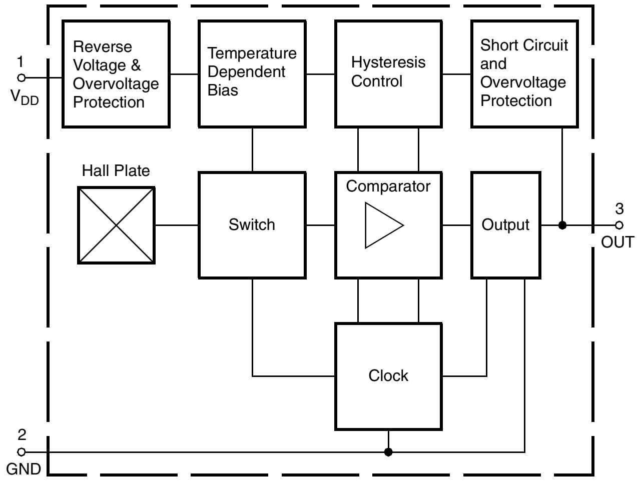


Fig. 2–1: HAL 525 and HAL 526 block diagram

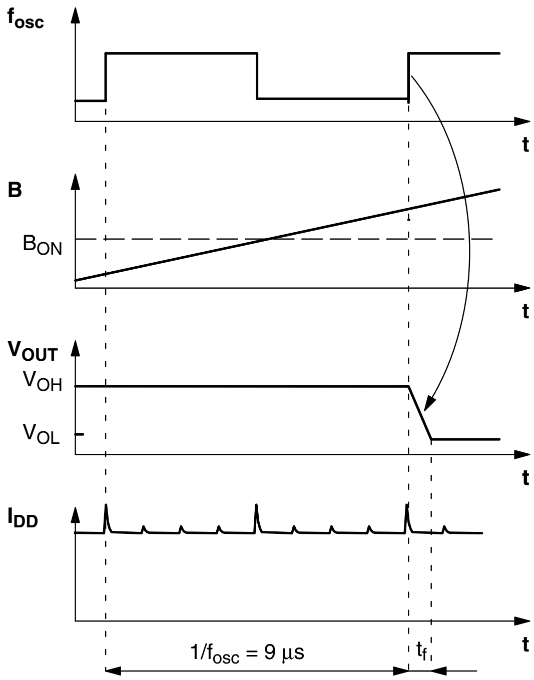
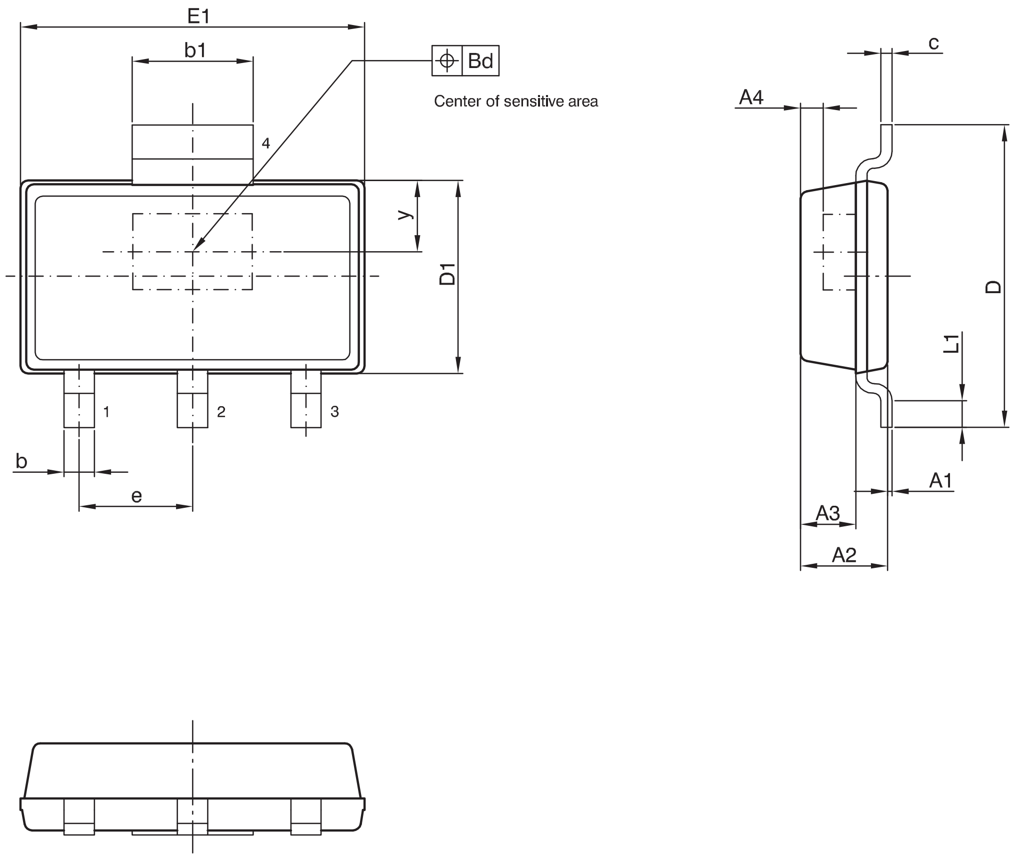


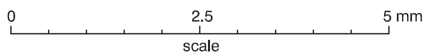
Fig. 2–2: Timing diagram of HAL 526

3. Specifications

3.1. Outline Dimensions



physical dimensions do not include moldflash.

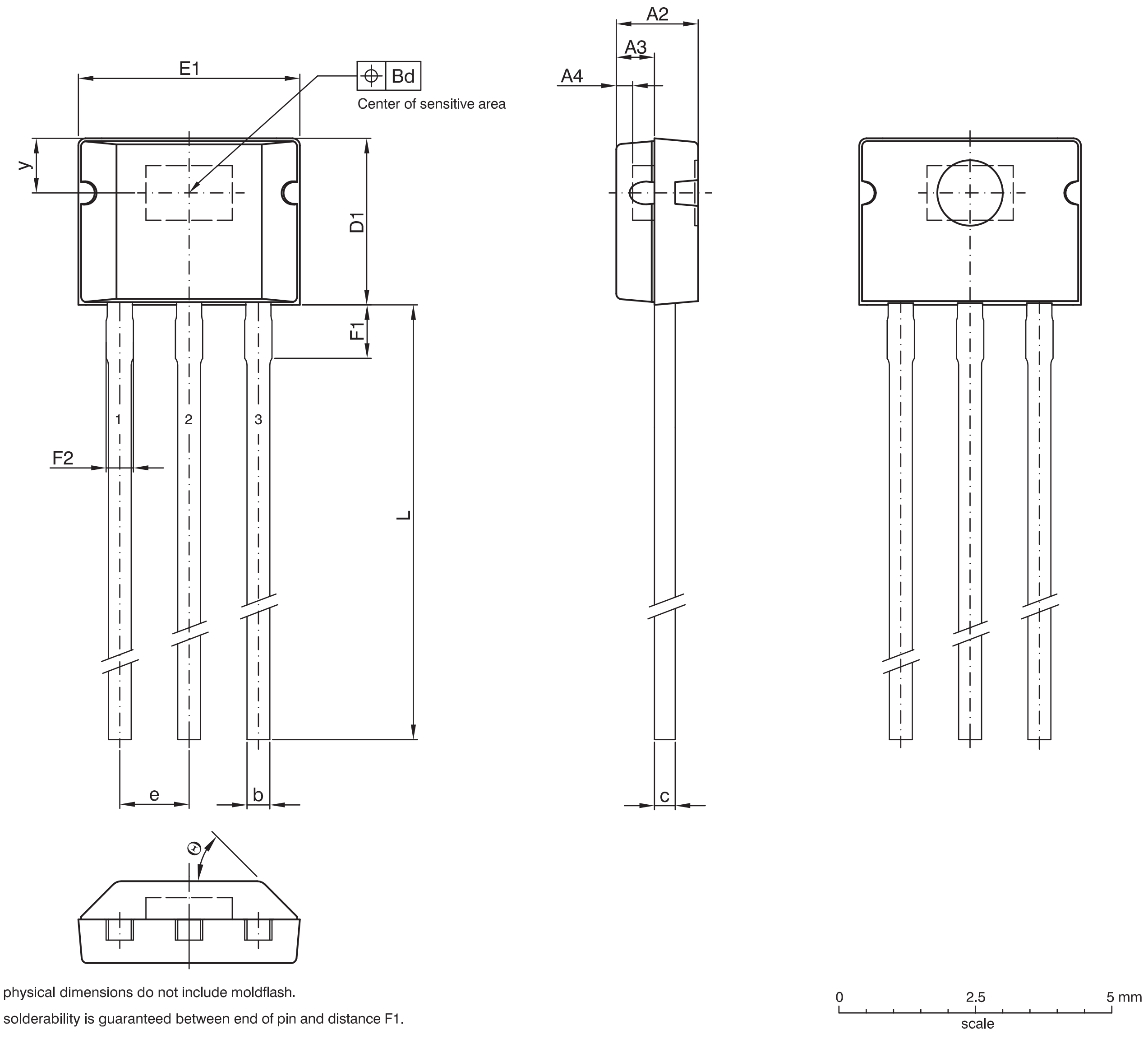


A4, y= these dimensions are different for each sensor type and are specified in the data sheet.

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.

JEDEC STANDARD		ANSI	ISSUE DATE YY-MM-DD	DRAWING-NO.	ZG-NO.
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.

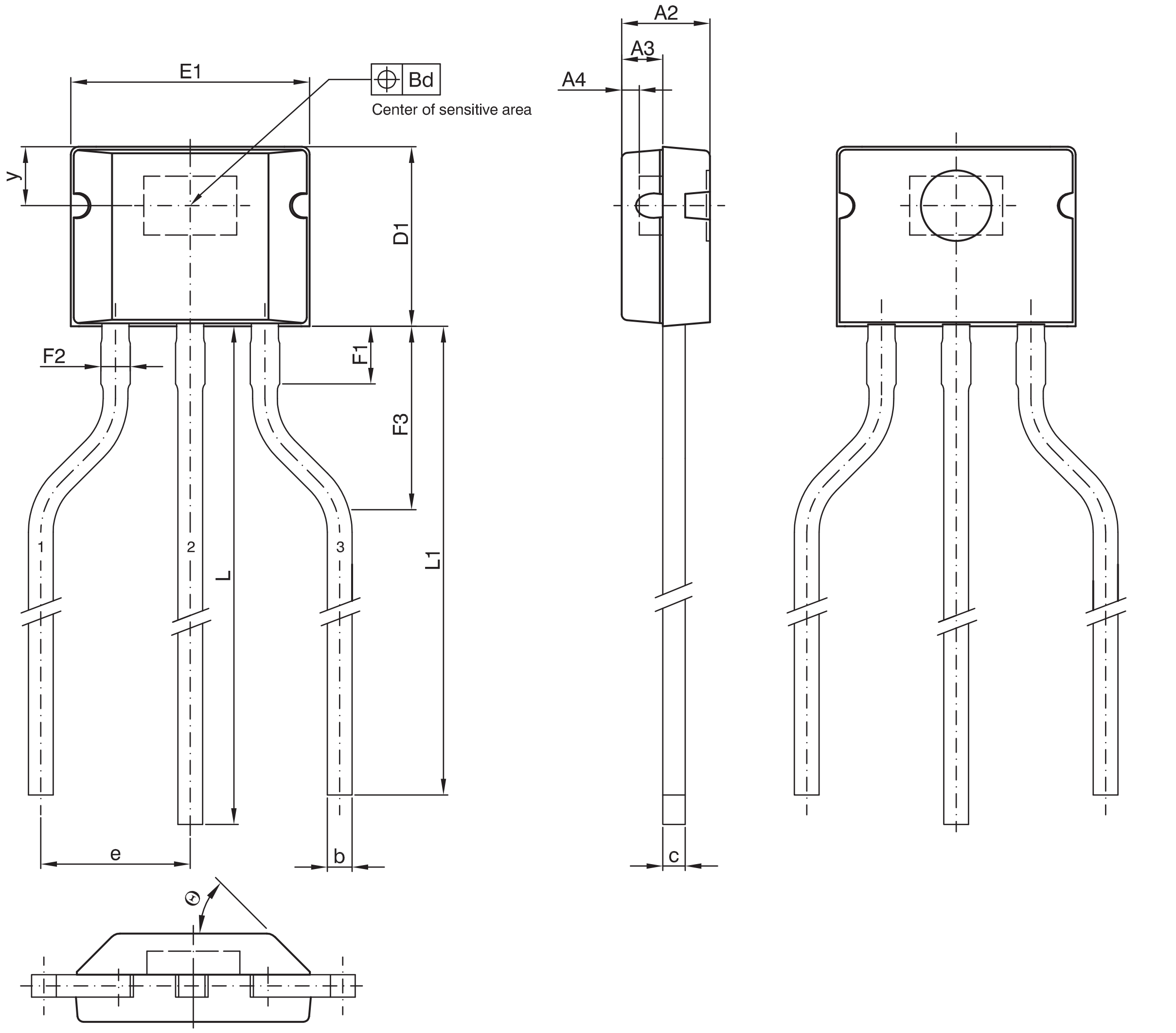
A4, y= these dimensions are different for each sensor type and is specified in the data sheet.

min/max of D1 are specified in the datasheet.

UNIT	A2	A3	b	Bd	c	D1	e	E1	F1	F2	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

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



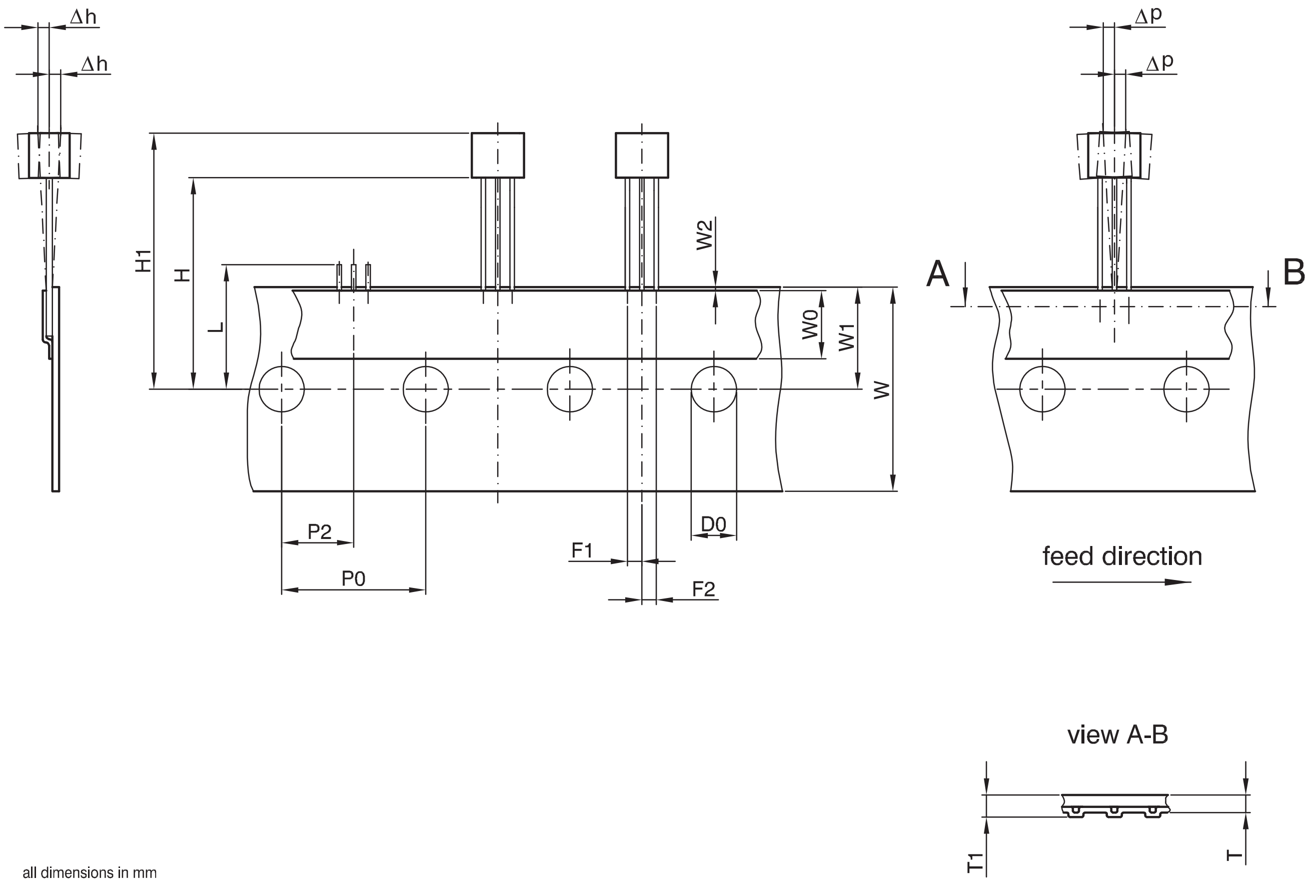
physical dimensions do not include moldflash.
solderability is guaranteed between end of pin and distance F1.
A4, y= these dimensions are different for each sensor type and is specified in the data sheet.
min/max of D1 are specified in the datasheet.

0 2.5 5 mm
scale

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

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

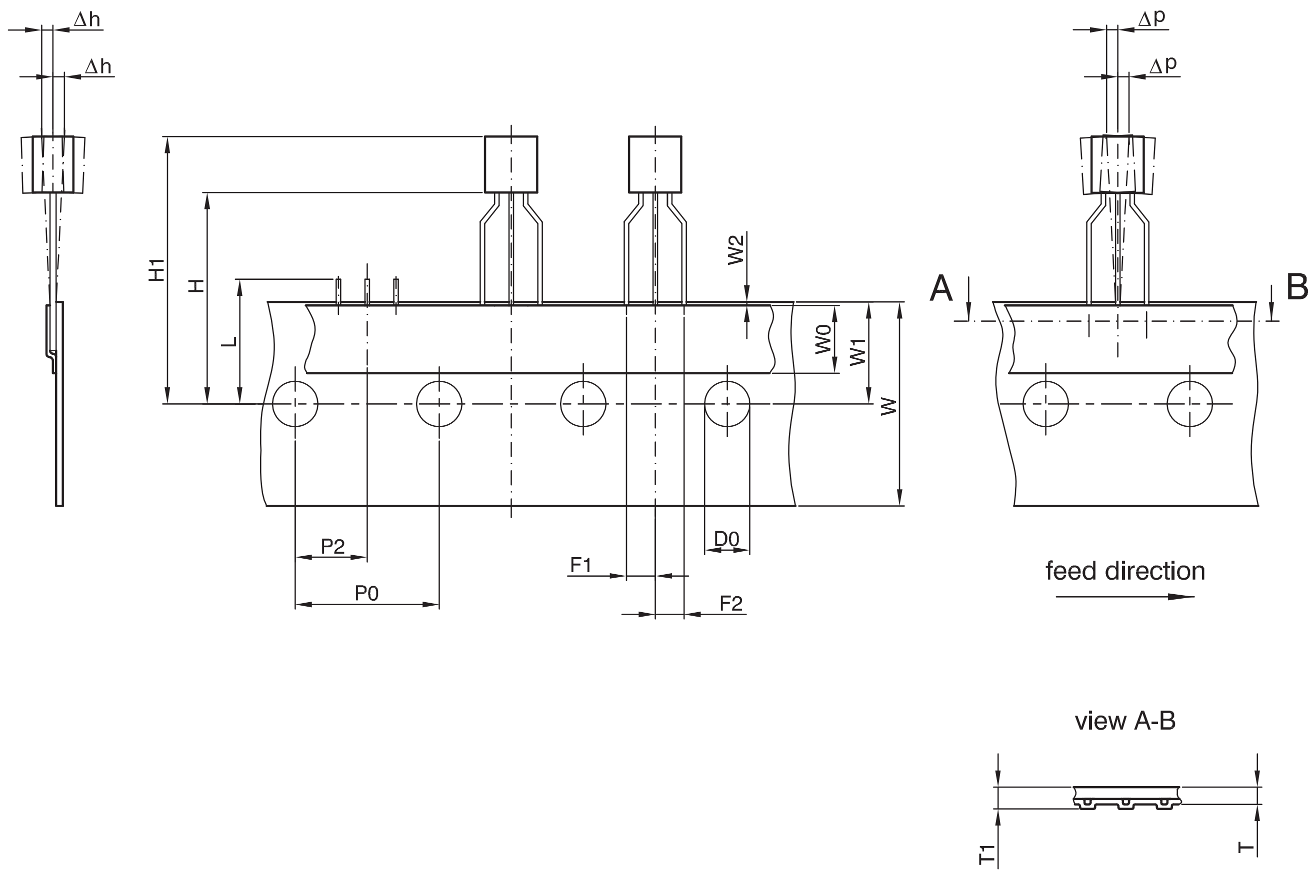


all dimensions in mm
other dimensions see drawing of bulk
max. allowed tolerance over 20 hole spacings ±1.0
H1= this dimension is different for each sensor type and is specified in the data sheet

UNIT	D0	F1	F2	H	Δh	L	P0	P2	Δp	T	T1	W	W0	W1	W2
mm	4.0	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. 3–4:
TO92-2: Dimensions ammopack inline, not 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	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

JEDEC STANDARD		ANSI	ISSUE DATE YY-MM-DD	DRAWING-NO.	ZG-NO.
ISSUE	ITEM NO.				
-	ICE 60286-2		07-01-18	06632.0001.4	ZG001032_Ver.04

Fig. 3–5:
TO92UA-1: Dimensions ammopack inline, 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 –40	150 170[2)]	°C
[1)] as long as $T_J$max is not exceeded [2)] t < 1000h					

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 +140 °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	Test Conditions
I_{DD}	Supply Current over Temperature Range	1	1.6	3	5.2	mA	
V_{DDZ}	Overvoltage Protection at Supply	1	–	28.5	32	V	I_{DD} = 25 mA, T_J = 25 °C, t = 20 ms
V_{OZ}	Overvoltage Protection at Output	3	–	28	32	V	I_{OH} = 25 mA, T_J = 25 °C, t = 20 ms
V_{OL}	Output Voltage	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 24V
f_{osc}	Internal Oscillator Chopper Frequency over Temperature Range	–	73 100	115 150	– –	kHz kHz	HAL 525 HAL 526
$t_{en(O)}$	Enable Time of Output after Setting of V_{DD}	1	–	30	70	µs	V_{DD} = 12 V B > B_{ON} + 2 mT or B < B_{OFF} – 2 mT
t_r	Output Rise Time	3	–	75	400	ns	V_{DD} = 12 V, R_L = 820 Ω, C_L = 20 pF
t_f	Output Fall Time	3	–	50	400	ns	
SOT89B Package							
 R_{thja} R_{thjc} R_{thjs}	Thermal Resistance Junction to Ambient Junction to Case Junction to Solder Point	 – – –	 – – –	 – – –	 209 1) 56 1) 82 2)	 K/W K/W K/W	30 mm x 10 mm x 1.5 mm, pad size (see Fig. 3–6)
TO92UA Package							
 R_{thja} R_{thjc} R_{thjs}	Thermal Resistance Junction to Ambient Junction to Case Junction to Solder Point	 – – –	 – – –	 – – –	 246 1) 70 1) 127 2)	 K/W K/W K/W	

1) Measured with a 1s0p board
2) Measured with a 1s1p board

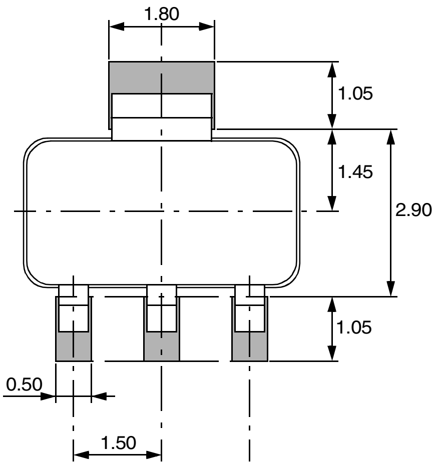


Fig. 3–6: Recommended pad size SOT89B-1
Dimensions in mm

3.7. Magnetic Characteristics Overview

at T_J = –40 °C to +140 °C, V_{DD} = 3.8 V to 24 V
Typical Characteristics for T_J = 25 °C and 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 525	–40 °C	11.8	15.8	19.2	–19.2	–15.8	–11.8	27.4	31.6	35.8	mT
latching	25 °C	11	14	17	–17	–14	–11	24	28	32	mT
	140 °C	6.5	10	14	–14	–10	–6.5	16	20	26	mT
HAL 526	–40 °C	11.8	15.8	19.2	–19.2	–15.8	–11.8	27.4	31.6	35.8	mT
latching	25 °C	11	14	17	–17	–14	–11	24	28	32	mT
	140 °C	6.5	10	14	–14	–10	–6.5	16	20	26	mT

Note: For detailed descriptions of the individual types, see pages 19 and following.

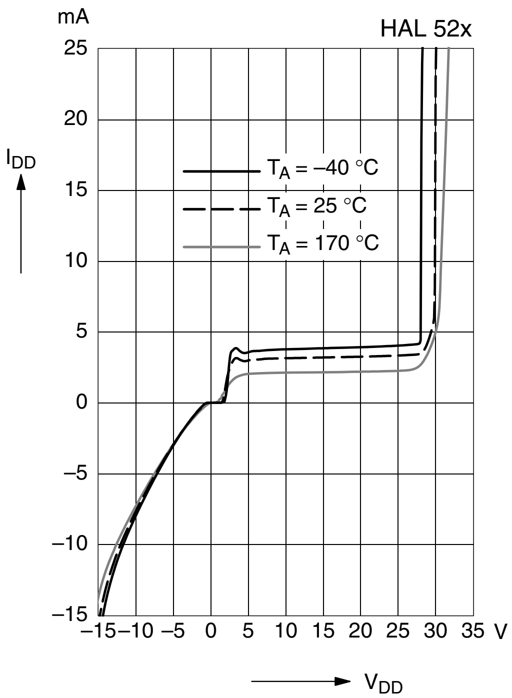


Fig. 3–7: Typical supply current versus supply voltage

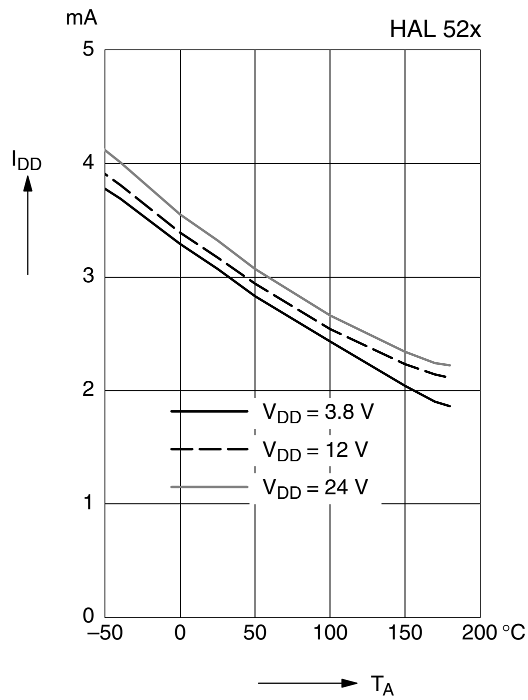


Fig. 3–9: Typical supply current versus ambient temperature

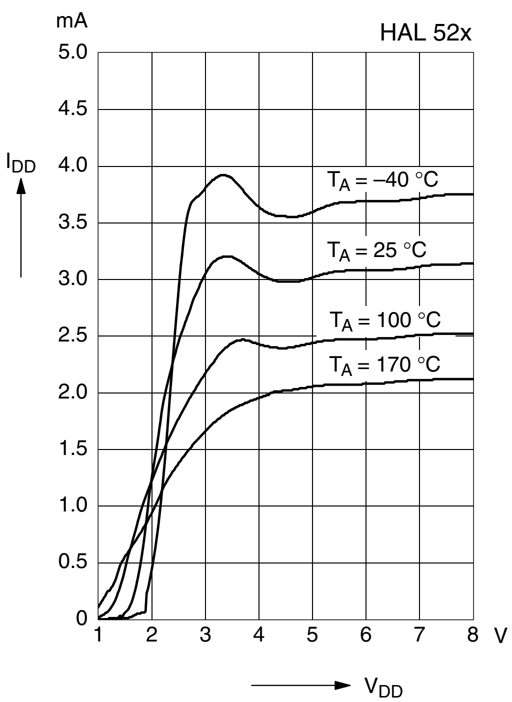


Fig. 3–8: Typical supply current versus supply voltage

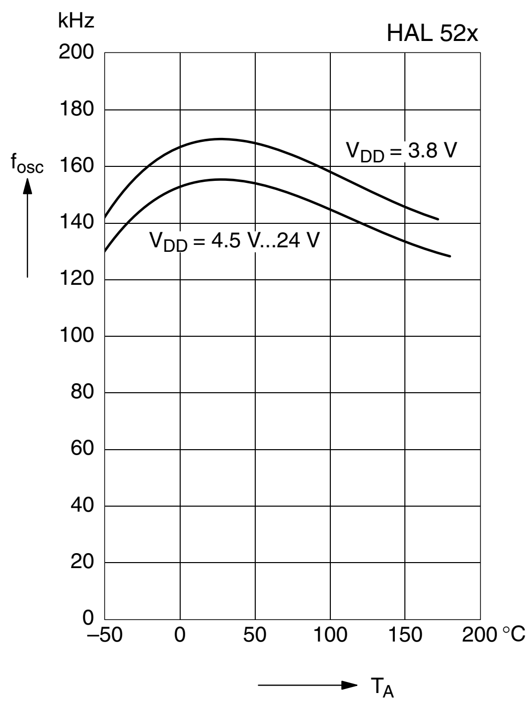


Fig. 3–10: Typ. internal chopper frequency versus ambient temperature

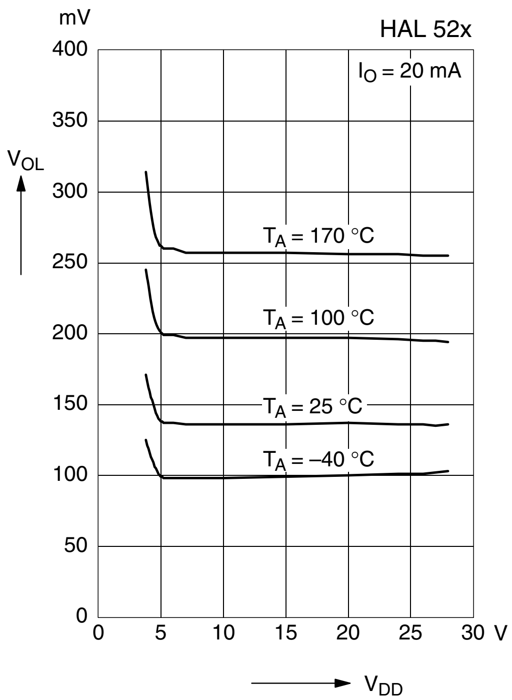


Fig. 3–11: Typical output low voltage versus supply voltage

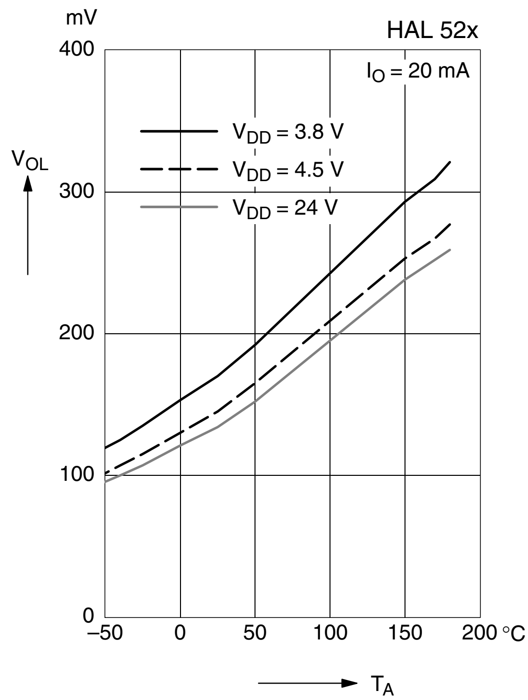


Fig. 3–13: Typical output low voltage versus ambient temperature

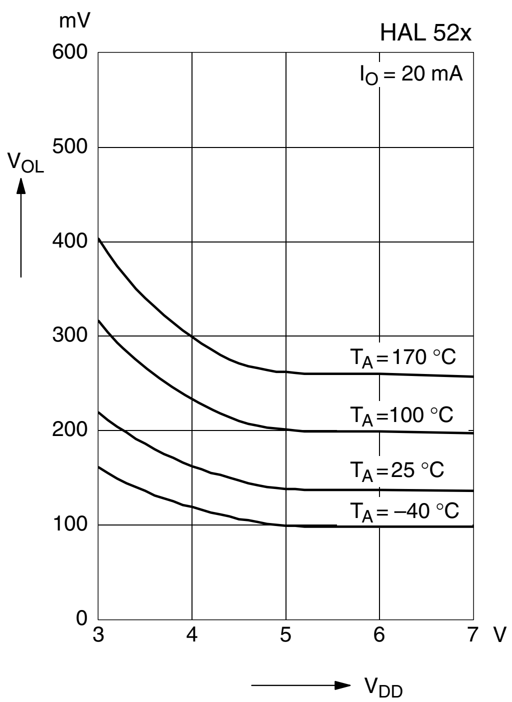


Fig. 3–12: Typical output low voltage versus supply voltage

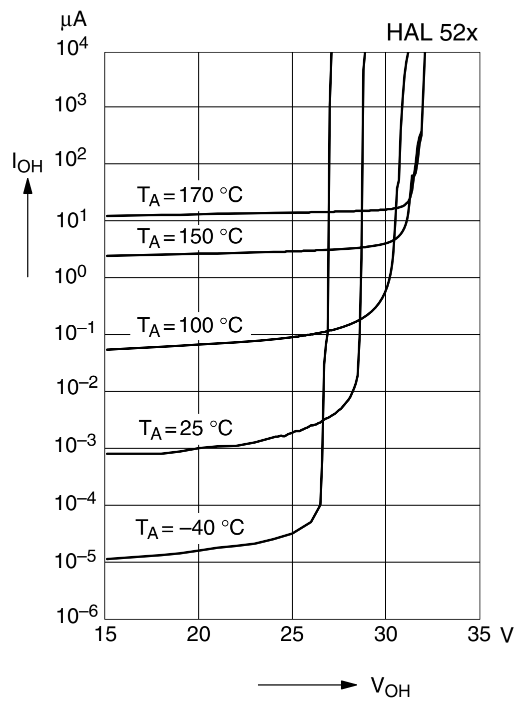


Fig. 3–14: Typ. output high current versus output voltage

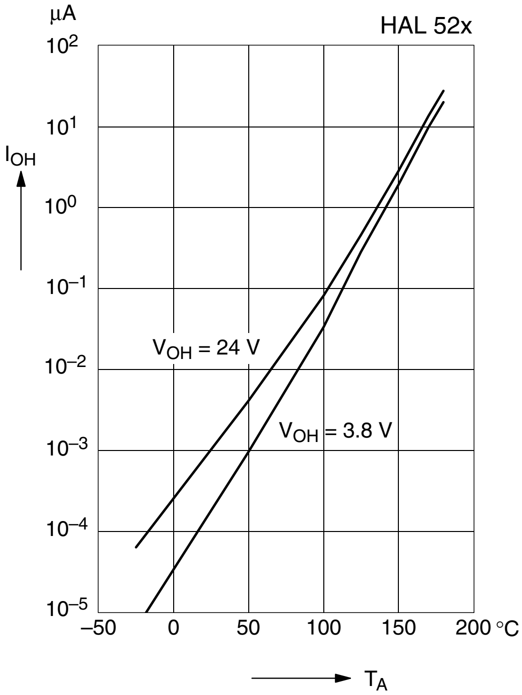


Fig. 3–15: Typical output leakage current versus ambient temperature

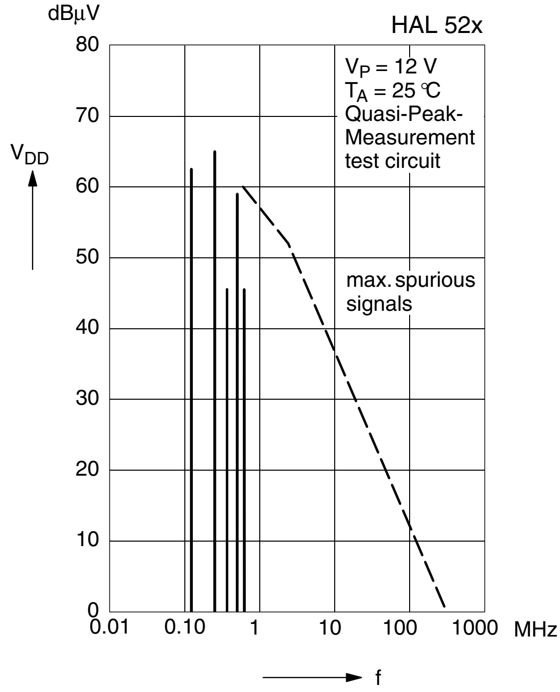


Fig. 3–17: Typ. spectrum of supply voltage

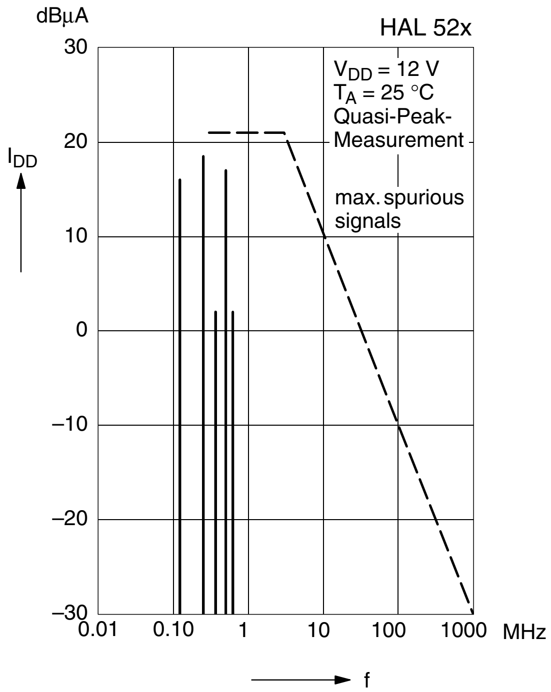


Fig. 3–16: Typ. spectrum of supply current

4. Type Description

4.1. HAL 525✝

The HAL 525✝ is a latching sensor (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 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}: 14 mT at room temperature

– typical B_{OFF}: –14 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 –2000 ppm/K

Applications

The HAL 525✝ is an optimal sensor for applications with alternating magnetic signals such as:

– multipole magnet applications,

– rotating speed measurement,

– commutation of brushless DC motors, and

– window lifter.

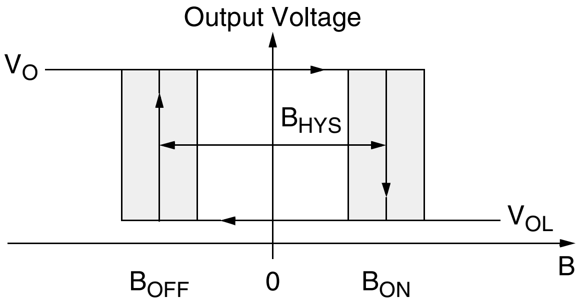


Fig. 4–1: Definition of magnetic switching points for the HAL 525✝

Note: ✝:HAL 525 is not available for new designs. Please use HAL 526 instead.

Magnetic Characteristics at T_J = –40 °C to +140 °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	15.8	19.2	–19.2	–15.8	–11.8	27.4	31.6	35.8		0		mT
25 °C	11	14	17	–17	–14	–11	24	28	32	–2	0	2	mT
100 °C	8	11	15.5	–15.5	–11	–8	18.5	22	28.7		0		mT
140 °C	6.5	10	14	–14	–10	–6.5	16	20	26		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 $B_{OFFSET} = (B_{ON} + B_{OFF}) / 2$

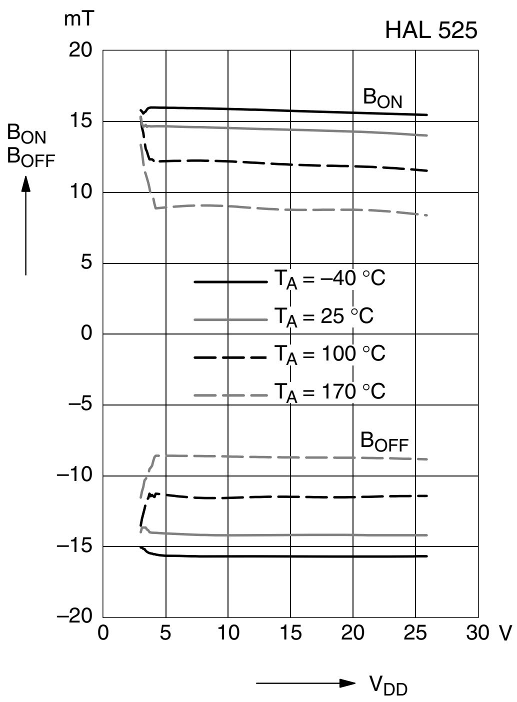


Fig. 4–2: Typ. magnetic switching points versus supply voltage

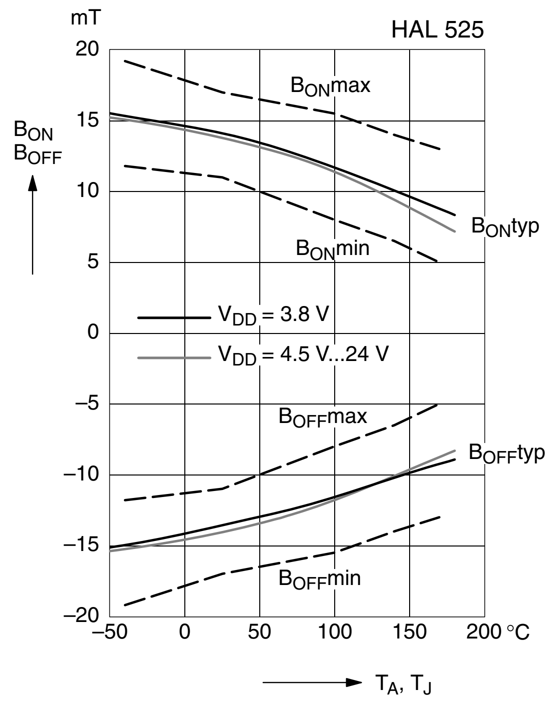


Fig. 4–4: Magnetic switching points versus temperature

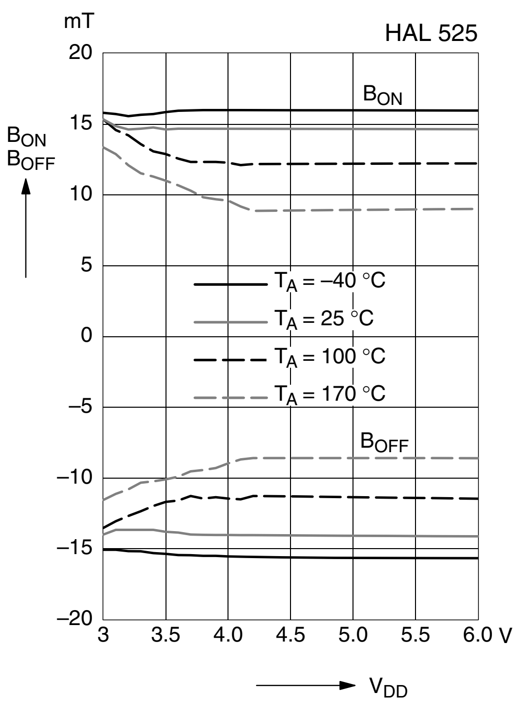


Fig. 4–3: Typ. magnetic switching points versus supply voltage

Note: In the diagram “Magnetic switching points versus 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.

4.2. HAL 526

The HAL 526 is a latching sensor (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
– low sensitivity
– typical B_{ON}: 14 mT at room temperature
– typical B_{OFF}: –14 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 –2000 ppm/K

Applications

The HAL 526 is an optimal sensor for applications with alternating magnetic signals such as:

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

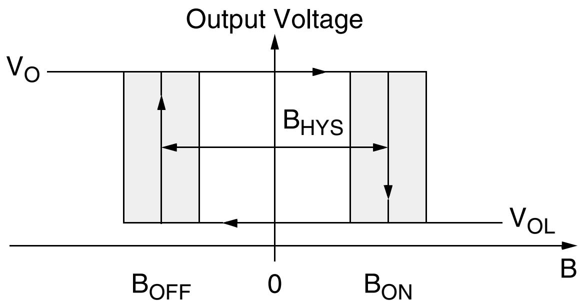


Fig. 4–5: Definition of magnetic switching points for the HAL 526

Magnetic Characteristics at T_J = –40 °C to +140 °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	15.8	19.2	–19.2	–15.8	–11.8	27.4	31.6	35.8		0		mT
25 °C	11	14	17	–17	–14	–11	24	28	32	–2	0	2	mT
100 °C	8	11	15.5	–15.5	–11	–8	18.5	22	28.7		0		mT
140 °C	6.5	10	14	–14	–10	–6.5	16	20	26		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 $B_{OFFSET} = (B_{ON} + B_{OFF}) / 2$

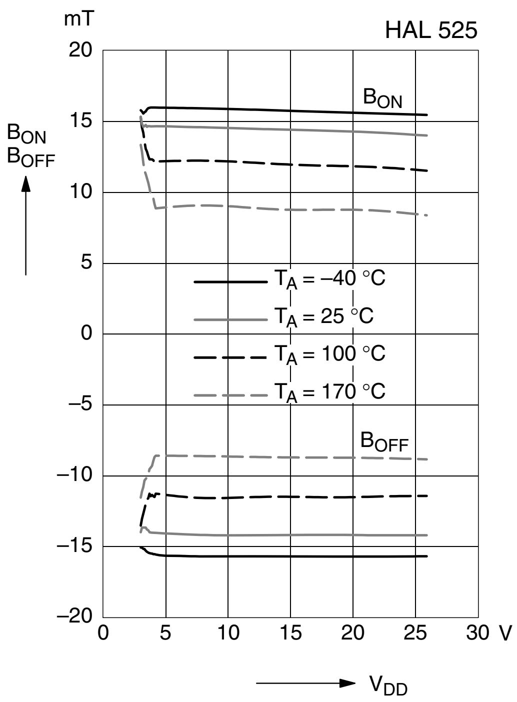


Fig. 4–6: Typ. magnetic switching points versus supply voltage

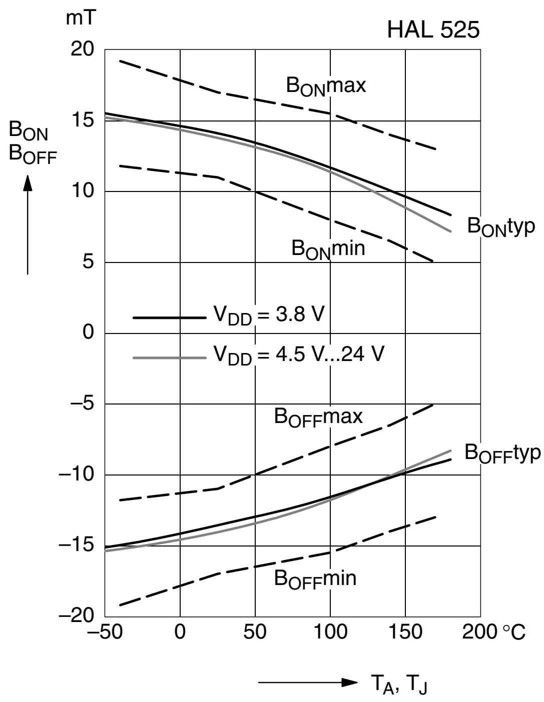


Fig. 4–8: Magnetic switching points versus temperature

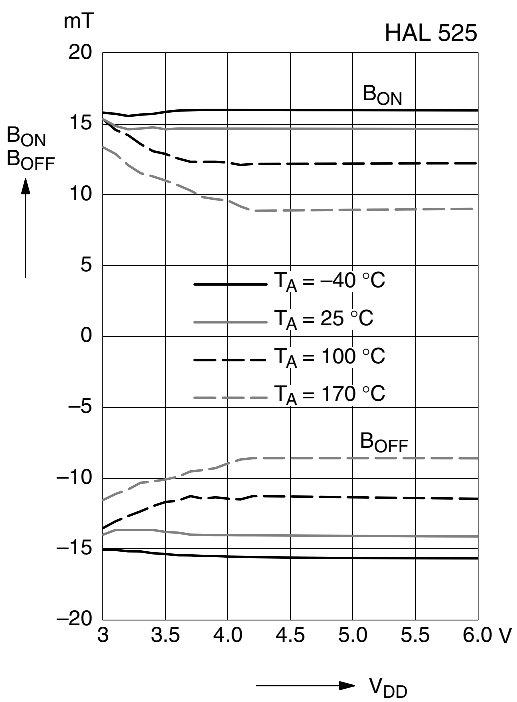


Fig. 4–7: Typ. magnetic switching points versus supply voltage

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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.

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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 and continuous operation, the following equation applies:

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

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

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

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

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

5.2. Extended Operating Conditions

All sensors fulfill the electrical and magnetic characteristics when operated within the Recommended Operating Conditions (see page 13).

Supply Voltage Below 3.8 V

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

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

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 Characteristics (see page 14).

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

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

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 Fig. 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 ISO 7637.

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

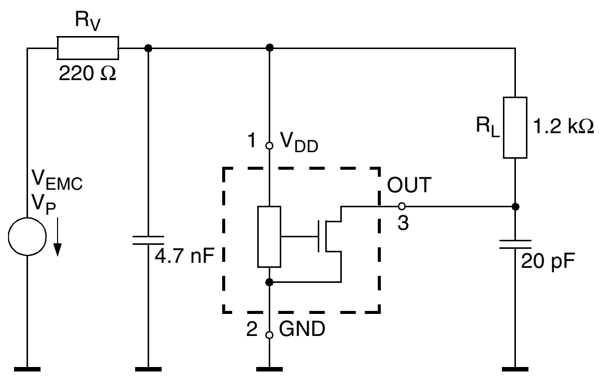

Fig. 5–1: Test circuit for EMC investigations

6. Data Sheet History

1. Final data sheet: “HAL 525 Hall Effect Sensor IC”, April 23, 1997, 6251-465-1DS. First release of the final data sheet.

2. Final data sheet: “HAL 525 Hall Effect Sensor IC”, March 10, 1999, 6251-465-2DS. Second release of the final data sheet. Major changes:

– additional package SOT-89B

– outline dimensions for SOT-89A and TO-92UA changed

– electrical characteristics changed

– section 4.2.: Extended Operating Conditions added

– section 4.3.: Start-up Behavior added

3. Final data sheet: “HAL 525, HAL 535 Hall Effect Sensor Family”, Aug. 30, 2000, 6251-465-3DS. Third release of the final data sheet. Major changes:

– new sensor HAL 535 added

– outline dimensions for SOT-89B: reduced tolerances

– SMD package SOT-89A removed

– temperature range “C” removed

4. Data Sheet: “HAL 525, HAL 535 Hall Effect Sensor Family”, Aug. 8, 2002, 6251-465-4DS. Fourth release of the data sheet. Major changes:

– outline dimensions for TO-92UA changed

– temperature range “A” removed

5. Data Sheet: “HAL 525, HAL 526, HAL 535 Hall Effect Sensor Family”, Oct. 22, 2002, 6251-465-5DS. Fifth release of the data sheet. Major changes:

– new sensor HAL 526 added

6. Data Sheet: “HAL 526, HAL 535 Hall Effect Sensor Family”, March 31, 2004, 6251-465-6DS. Sixth release of the data sheet. Major changes:

– specification for HAL525 removed

– new package diagrams for SOT89B-1 and TO92UA-1

– package diagram for TO92UA-2 added

– ammopack diagrams for TO92UA-1/-2 added

7. Data Sheet: “HAL 526 Hall-Effect Switch”, Nov. 8, 2007, DSH000144_001EN. Seventh release of the data sheet. Major changes:

– specification for HAL 535 removed

– package diagrams for SOT89B-1, TO92UA-1, and TO92UA-2 updated

– ammopack diagrams for TO92UA-1/-2 updated

8. Data Sheet: “HAL 526 Hall-Effect Switches”, Feb. 6, 2009, DSH000144_002EN. Eighth release of the data sheet. Major changes:

– Section 1.6. “Solderability and Welding” updated

9. Data Sheet: “HAL 525, HAL 526 Hall-Effect Switches”, Nov. 30, 2009, DSH000144_003EN. Ninth release of the data sheet. Major changes:

– HAL 525 added

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