ADVANCE INFORMATION

HAL628, HAL638 Hall Effect Sensor ICs

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6251-424-1AI

MICRONAS
INTERMETALL

Hall Effect Sensor IC
in CMOS technology

Common Features:

– switching offset compensation

– operates from 4.5 V to 24 V supply voltage

– overvoltage and reverse-voltage protection

– extremely robust against mechanical stress

– short-circuit protected open-drain output

– operates with magnetic fields from DC to 15 kHz

– on-chip temperature compensation circuitry minimizes shifts in on and off points and hysteresis over temperature and supply voltage

– ideal sensor for ignition timing, anti-lock brake systems and revolution counting in extreme automotive and industrial environments

– EMC corresponding to DIN 40839

Specifications

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.

HAL 628

– switching type: unipolar

– output turns low with magnetic south pole on branded side of package

– output turns high if magnetic field is removed

– delay time 25 µs

HAL 638

– switching type: unipolar

– output turns high with magnetic south pole on branded side of package

– output turns low if magnetic field is removed

– delay time 25 µs

Marking Code

Type	Temperature Range		
	A	**E**	**C**
HAL 628UA, HAL628S	628A	628E	628C
HAL 638UA, HAL638S	638A	638E	638C

Operating Junction Temperature Range

A: T_J = –40 °C to +170 °C

E: T_J = –40 °C to +100 °C

C: T_J = 0 °C to +100 °C

Designation of Hall Sensors

HAL XXXPP-T

- Temperature Range: A, E, or C
- Package: UA for TO-92UA, S for SOT-89A
- Type: 628, 638

Example: **HAL 628UA-E**

→ Type: 628
→ Package: TO-92UA
→ Temperature Range: T_J = –40 °C to +100 °C

Solderability

– Package SOT-89A: according to IEC68-2-58

– Package TO-92UA: according to IEC68-2-20

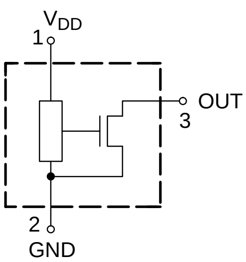


Fig. 1: Pin configuration

Functional Description

This Hall effect sensor is realized in CMOS technology. It includes the following:

– internal voltage regulator

– Hall voltage bias generator

– circuits for offset compensation

– oscillator

– filter

– comparator

– threshold generator

– logical parts

– n-channel open drain output

– protection devices

The regulators allow use of the Hall effect sensor over a wide range of 4.5 V to 24 V. 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.

The voltage which appears between both Hall plates of the Hall probes is influenced by offset voltage caused by mechanical stress. This offset voltage is compensated for by using the switching offset compensation technique. Therefore, an internal oscillator provides a clock. The switched Hall voltage is amplified and filtered by the internal chopper stabilized filter.

The comparator with internal hysteresis compares the filter output voltage with the actual switching point. Subsequently, the open drain output switches to the appropriate state.

The output transistor is switched on when the magnetic field becomes larger than the operating point B_{ON}. It remains in this state as long as the magnetic field does not fall below the release point B_{OFF}. If the magnetic field falls below B_{OFF}, the transistor is switched off until the magnetic field once again exceeds B_{ON} (HAL638: opposite polarities).

According to the principle of the circuit, there is a continuous delay time from crossing the magnetic switch level to switching of output. Thereby, time jitter is suppressed in switching of output.

The output is short circuit protected by limiting high currents and by sensing overtemperature. Shunt protection devices clamp voltage peaks at the V_{DD} pin and Output pin together with external series resistors. Reverse current is limited at the V_{DD} pin by an internal series resistor up to –15 V.

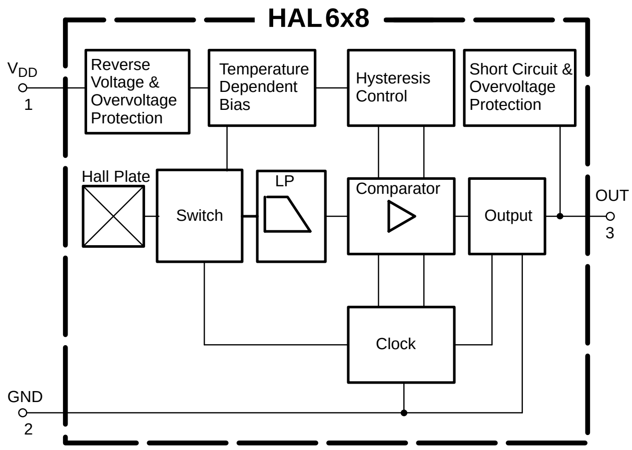


Fig. 2: HAL 6x8 block diagram

Outline Dimensions

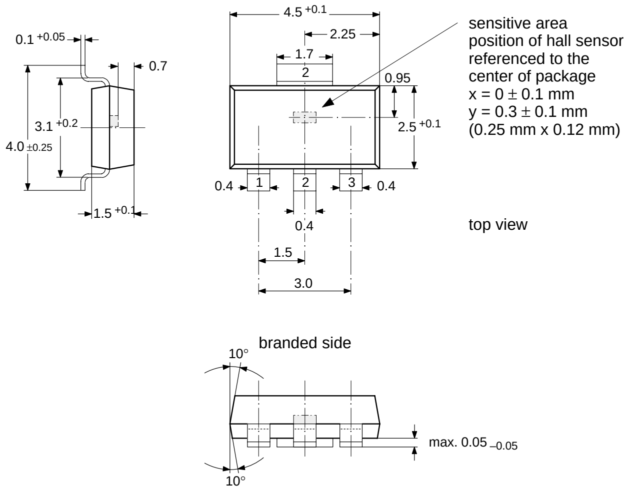


Fig. 3:
Plastic Small Outline Transistor Package
(SOT-89A)
Weight approximately 0.04 g
Dimensions in mm

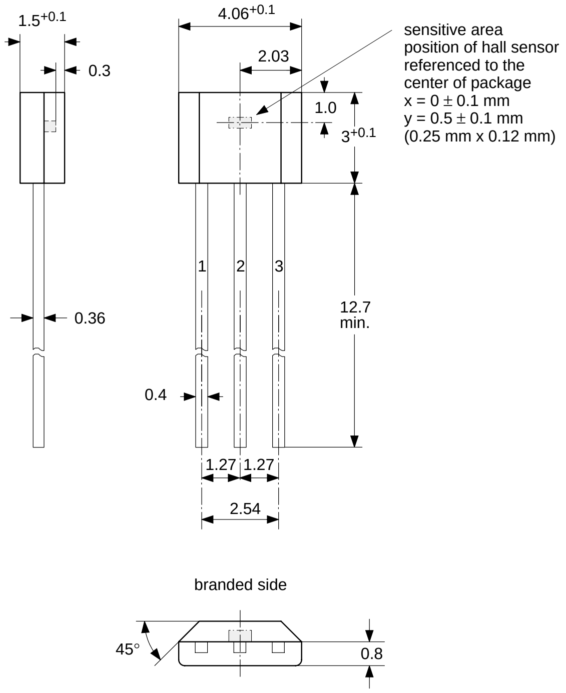


Fig. 4:
Plastic Transistor Single Outline Package
(TO-92UA)
Weight approximately 0.12 g
Dimensions in mm

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	–300[3)]	300[3)]	mA
V_{OH}	Output High Voltage	3	–	28[1)]	V
I_O	Continuous Output On Current	3	–	30	mA
I_{Omax}	Peak Output On Current	3	–	250[3)]	mA
I_{OZ}	Output Current through Protection Device	3	–300[3)]	300[3)]	mA
T_S	Storage Temperature Range		–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 test circuit 1
3) t<2 ms
4) t<1000h

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.

Recommended Operating Conditions

Symbol	Parameter	Pin No.	Min.	Typ.	Max.	Unit
V_{DD}	Supply Voltage	1	4.5	–	24	V
I_O	Continuous Output On Current	3	0	–	20	mA

Electrical Characteristics at T_J = –40 °C to +170 °C , V_{DD} = 4.5 V to 24 V, as not otherwise specified
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	1	3.6	4.5	5.4	mA	T_J = 25 °C
I_{DD}	Supply Current over Temperature Range	1	2.2	4.5	7.2	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	180	mV	I_{OL} = 20 mA, T_J = 25 °C, V_{DD} = 4.5 V to 24 V
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	B< B_{OFF}, T_J = 25 °C, V_{OH} = 4.5 to 24 V
I_{OH}	Output Leakage Current over Temperature Range	3	–	–	10	µA	B< B_{OFF}, T_J ≤ 150 °C, V_{OH} = 4.5 to 24 V
f_{osc}	Internal Oscillator Chopper Frequency	–	280	340	400	kHz	T_J = 25 °C, V_{DD} = 4.5 V to 24 V
f_{osc}	Internal Oscillator Chopper Frequency over Temperature Range	–	245	340	430	kHz	V_{DD} = 4.5 V to 24 V
t_d	Delay Time between Switching Threshold ΔB and Edge of Output over Temperature Range	–		25		µs	T_J = 25 °C, $B_{overshoot}$ =4 mT V_{DD} = 4.5 V to 24 V
t_d	Delay Time between Switching Threshold ΔB and Output Edge	–		25		µs	V_{DD} = 4.5 V to 24 V, $B_{overshoot}$ = 4 mT
$t_{en(O)}$	Enable Time of Output after Setting of V_{DD}	3	–	18	30	µs	V_{DD} = 12 V
t_r	Output Rise Time	3	–	75	400	ns	V_{DD} = 12 V, RL = 820 Ohm, C_L = 20 pF
t_f	Output Fall Time	3	–	50	400	ns	V_{DD} = 12 V, RL = 820 Ohm, C_L = 20 pF
R_{thJSB} case SOT-89A	Thermal Resistance Junction to Substrate Backside	–	–	150	200	K/W	Fiberglass Substrate 30 mm x 10 mm x 1.5mm, pad size see Fig. 7
R_{thJS} case TO-92UA	Thermal Resistance Junction to Soldering Point	–	–	150	200	K/W	

Magnetic Characteristics at T_J = –40 °C to +170 °C, V_{DD} = 4.5 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	–40 °C			25 °C			100 °C			170 °C			Unit
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
On point B_{ON}													
HAL628	14	18.6	20.5	13.5	18.1	20.5	12.5	17.5	20.5	12.5	16.8	20.5	mT
HAL638	12.5	16.2	20	12.5	15.9	19	12.5	15.7	18.7	11.4	15.4	18.3	mT
Off point B_{OFF}													
HAL628	12.5	16.2	20	12.5	15.9	19	12.5	15.7	18.7	11.4	15.4	18.3	mT
HAL638	14	18.6	20.5	13.5	18.1	20.5	12.5	17.5	20.5	12.5	16.8	20.5	mT
Hysteresis B_{HYS}													
HAL628	1	2.4	3	1	2.2	3	1	1.8	3	1	1.4	3	mT
HAL638	1	2.4	3	1	2.2	3	1	1.8	3	1	1.4	3	mT
Magnetic Offset (B_{ON} + B_{OFF})/2													
HAL628	–	17.4	–	14	17	20	–	16.6	–	–	16.1	–	mT
HAL638	–	17.4	–	14	17	20	–	16.6	–	–	16.1	–	mT

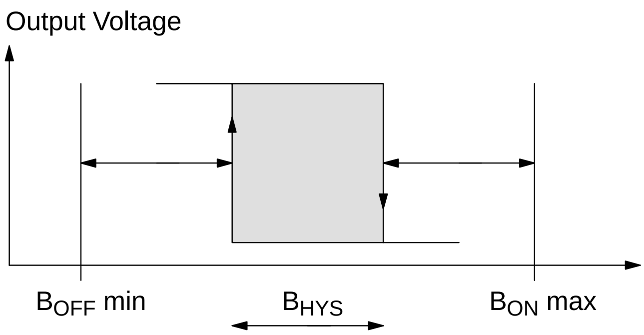


Fig. 5: Definition of magnetic switching points and hysteresis for HAL628.

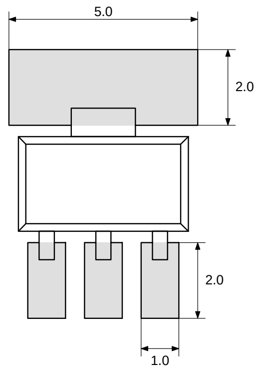


Fig. 7: Recommended pad size SOT-89A
Dimensions in mm

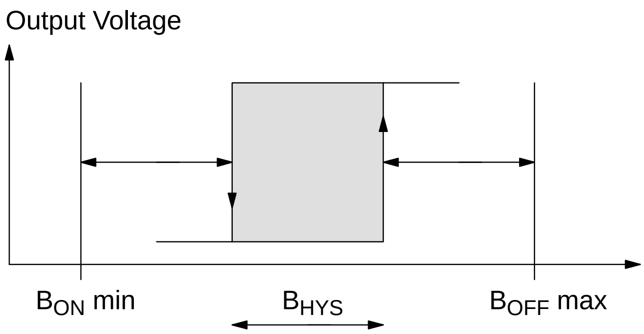
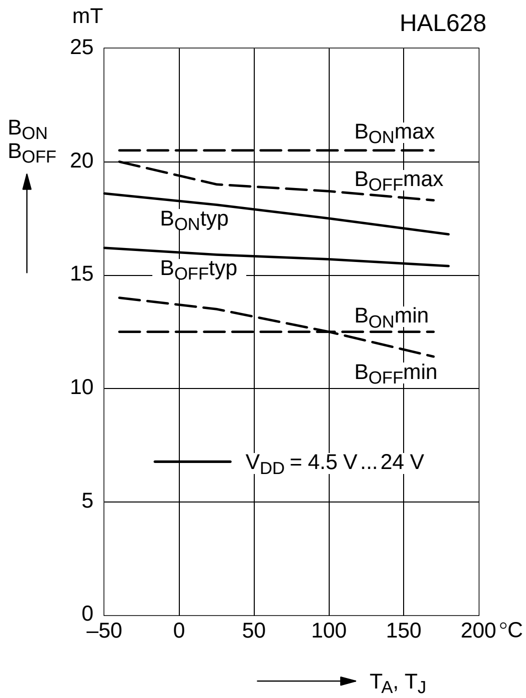


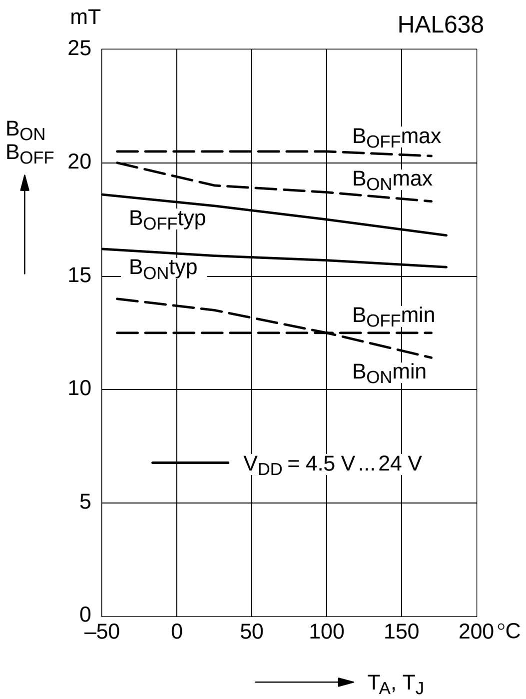
Fig. 6: Definition of magnetic switching points and hysteresis for HAL638.

Note: In the following diagrams "Magnetic switch points versus ambient temperature" on pages 8 and 9, 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.

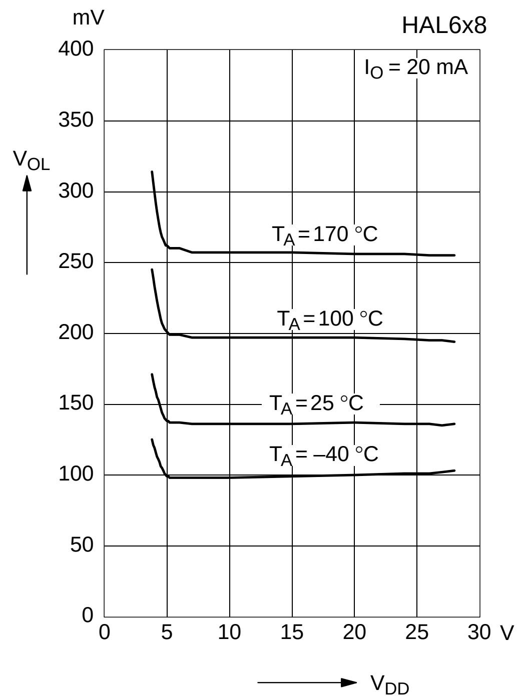
Magnetic switch points versus temperature



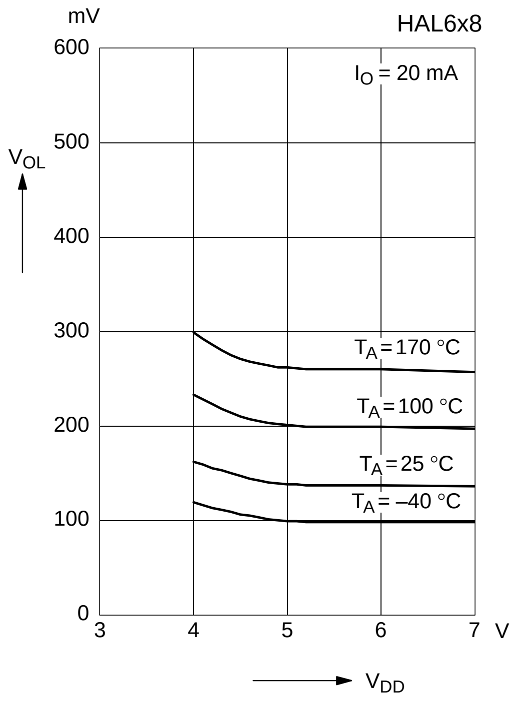
Magnetic switch points versus temperature



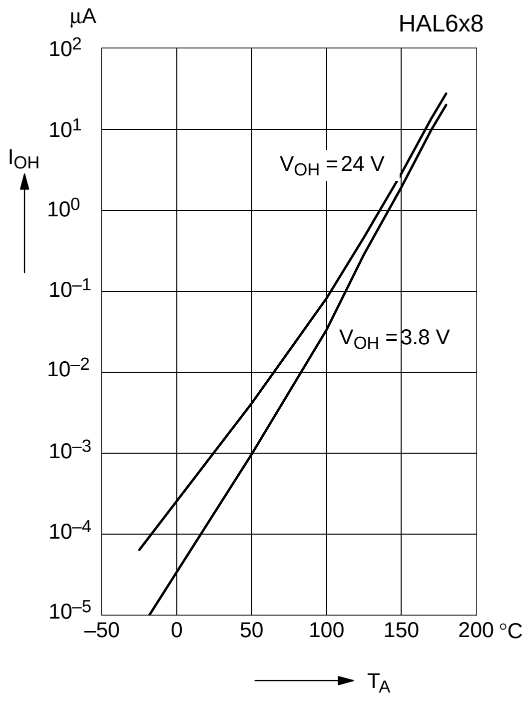
Output low voltage versus supply voltage



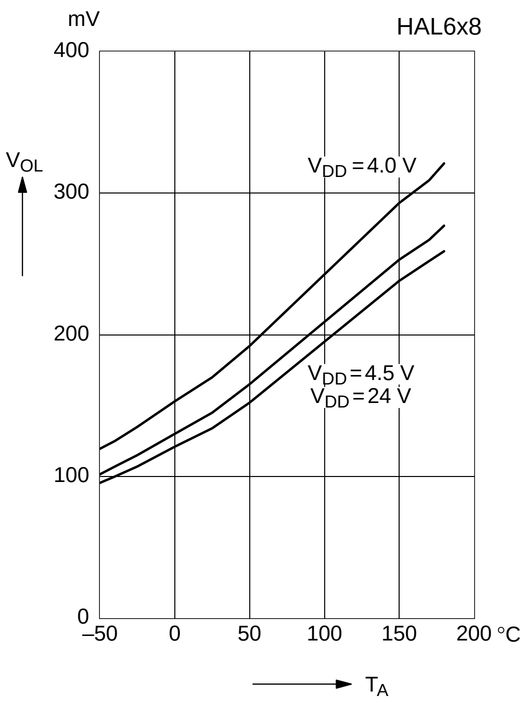
Output low voltage versus supply voltage



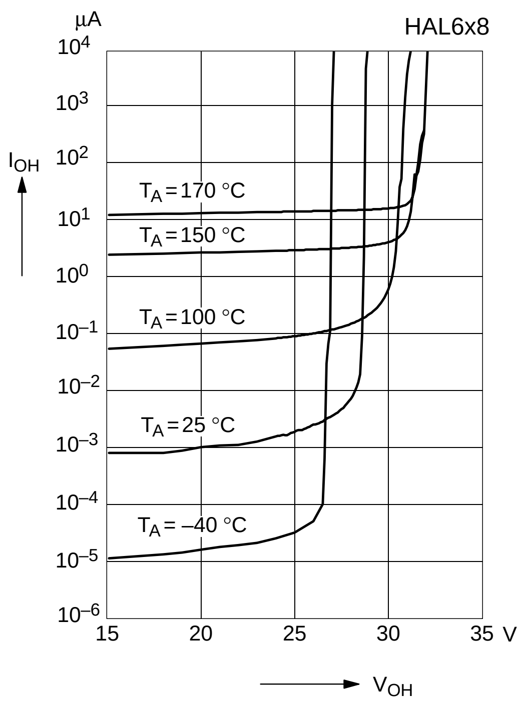
Output leakage current versus ambient temperature

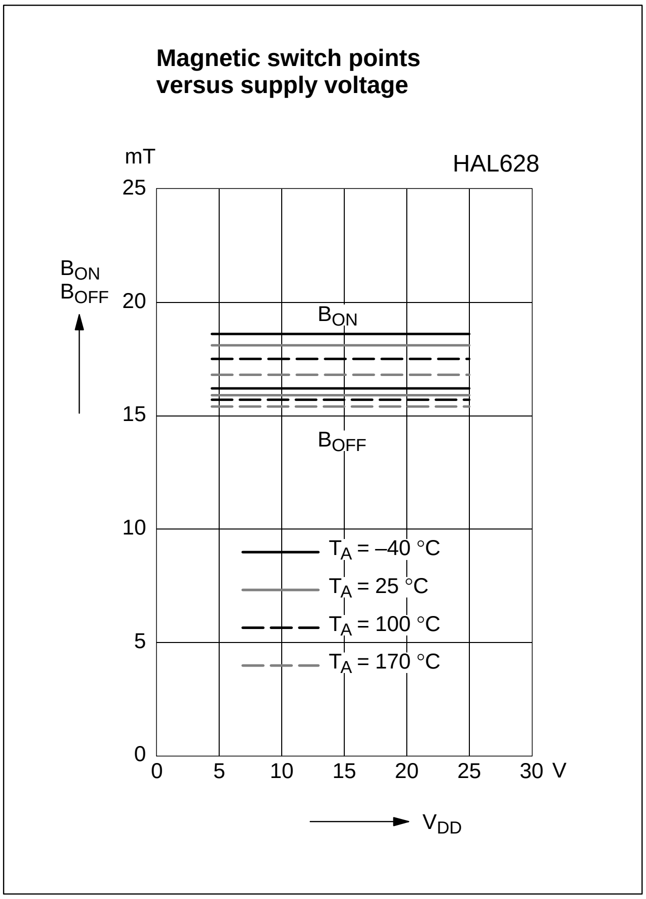


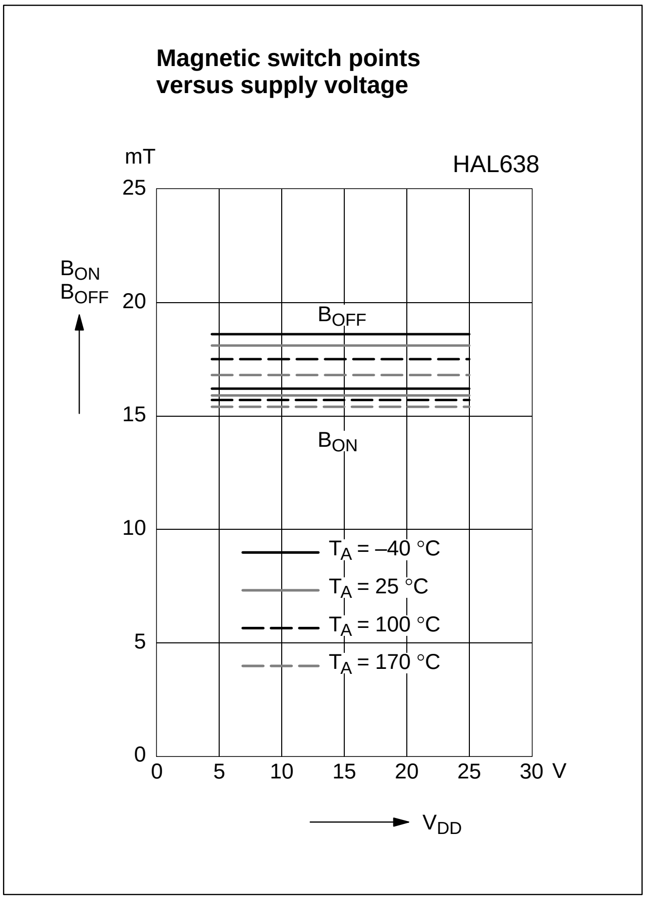
Output low voltage versus ambient temperature



Output high current versus output voltage







Application Note

For electromagnetic immunity, it is recommended to apply a 4.7 nF capacitor between V_{DD} (pin 1) and Ground (pin 2).

For automotive applications, a 220 Ω series resistor to pin 1 is recommended.

The series resistor and the capacitor should be placed as close as possible to the IC.

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 equations are valid:

– for SOT-89A: $\Delta T = I_{DD} * V_{DD} * R_{thJSB}$

– for TO-92UA: $\Delta T = I_{DD} * V_{DD} * R_{thJA}$

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.

Test Circuits for Electromagnetic Compatibility

Test pulses V_{EMC} corresponding to DIN 40839.

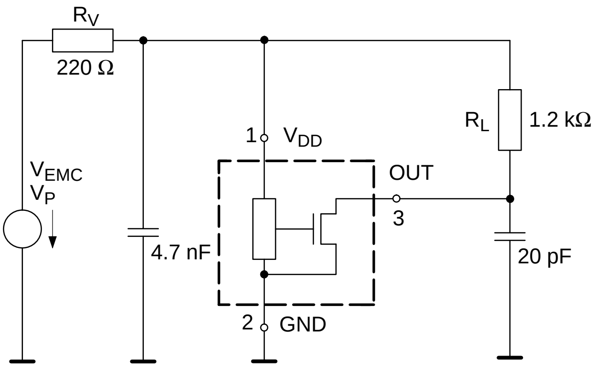


Fig. 8: Test circuit 2: test procedure for class A

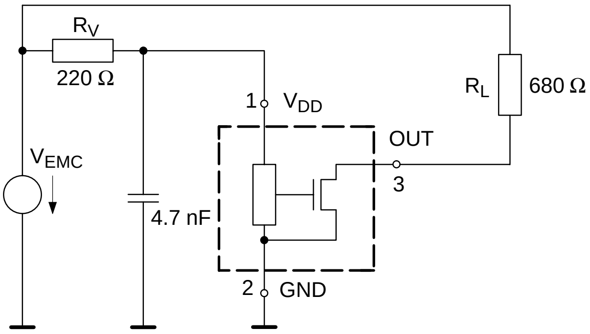


Fig. 9: Test circuit 1: test procedure for class C

Data Sheet History

1. Advance Information: “HAL 628, HAL 638 Hall Effect Sensor ICs”, May 5, 1997, 6251-424-1AI. First release of the advance information.

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