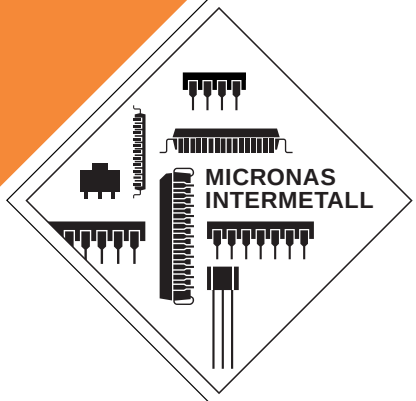

HAL114
Unipolar Hall Switch IC

Edition June 10, 1998
6251-456-1DS

MICRONAS
INTERMETALL

Unipolar Hall Switch IC
in CMOS technology

Introduction

The HAL114 is a Hall switch produced in CMOS technology. The sensor includes a temperature-compensated Hall plate, a Schmitt trigger, and an open-drain output transistor (see Fig. 2).

The HAL114 has a unipolar behavior: The output turns low with a magnetic south pole on the branded side of the package (see figures 3 and 4). The output turns high if the magnetic field is removed. The output signal remains high if the magnetic north pole approaches the branded side of the package.

The sensor is designed for industrial and automotive applications and operates with supply voltages from 4.5 V to 24 V in the ambient temperature range from –40°C up to 150 °C.

The HAL114 is available in a SMD-package (SOT-89A) and in a leaded version (TO-92UA).

Features:

– operates from 4.5 V to 24 V supply voltage

– overvoltage protection

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

– short-circuit protected open-drain output by thermal shutdown

– operates with magnetic fields from DC to 20 kHz

– stable magnetic switching points over a wide supply voltage range

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

– ideal sensor for contactless switches and speed measurement in hostile automotive and industrial environments

Specifications

– switching type: unipolar

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

– output turns high if magnetic field is removed

Marking Code

Type	Temperature Range		
	A	E	C
HAL114SO, HAL114UA	114A	114E	114C

Operating Junction Temperature Range (T_J)

A: T_J = –40 °C to +170 °C

E: T_J = –40 °C to +100 °C

C: T_J = 0 °C to +100 °C

The relationship between ambient temperature (T_A) and junction temperature (T_J) is explained on page 8.

Hall Sensor Package Codes

HAL XXXPA-T

Temperature Range: A, E, or C
Package: SO for SOT-89A,
UA for TO-92UA
Type: 114

Example: **HAL114UA-E**

→ Type: 114
→ 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”.

Solderability

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

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

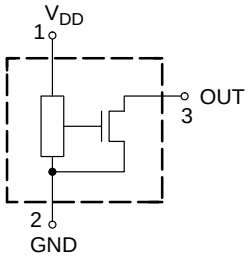

Fig. 1: Pin configuration

Functional Description

The HAL114 is a CMOS integrated circuit with a switching output in response to magnetic fields. It processes the “Hall Voltage” internally: The Hall Voltage is proportional to the magnetic flux component Bz orthogonal to an integrated Hall Plate, in case an electric current is imposed to the plate. The HAL114 compares the Hall Voltage with a predefined threshold and generates the output signal dependent of the direction of the magnetic field. A special circuit compensates for the temperature dependent effects of the IC, as well as the external magnet. A built-in hysteresis eliminates possible oscillations of the output signal adjacent to its switching point so that “output bouncing” is avoided. The output is short-circuit protected by limiting high currents and by sensing excess temperature. 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 values ranging from 0 V to –15 V.

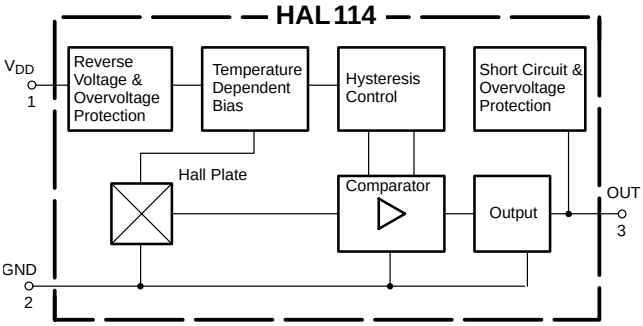

Fig. 2: HAL114 block diagram

Dimensions of Sensitive Area

0.4 mm x 0.2 mm

Positions of Sensitive Area

SOT-89A	TO-92UA
x = 0 ± 0.2	x = 0 ± 0.2
y = 0.98 ± 0.2	y = 1.0 ± 0.2

x is referenced to the center of the package

Outline Dimensions

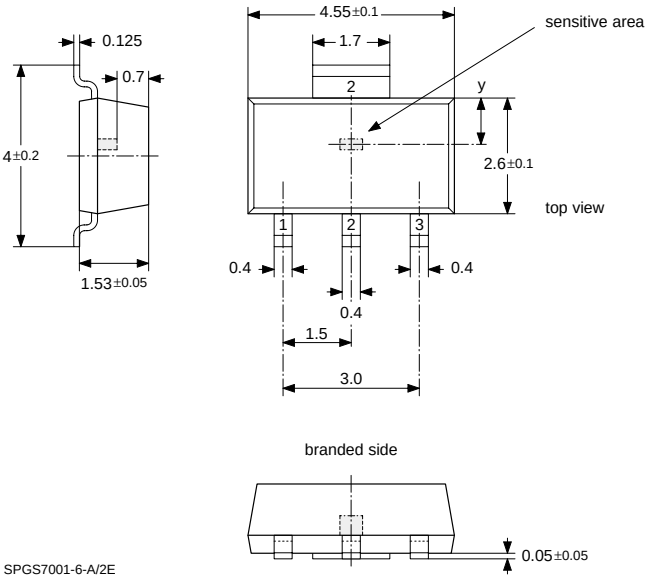

Fig. 3:
Plastic Small Outline Transistor Package
(SOT-89A)
Weight approximately 0.04 g
Dimensions in mm

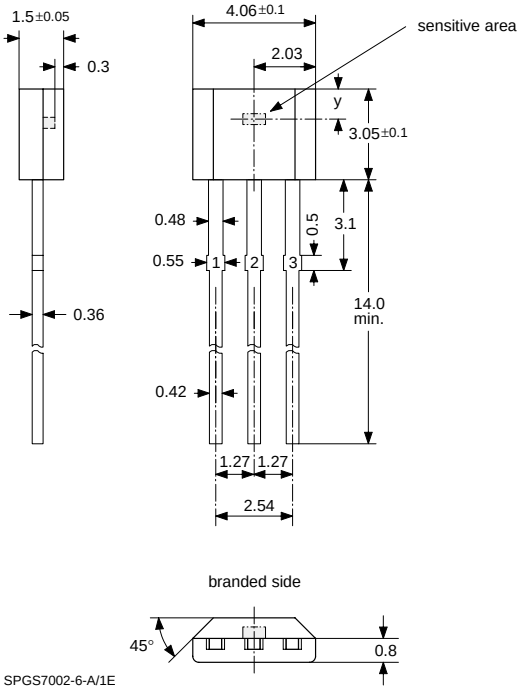

Fig. 4:
Plastic Transistor Single Outline Package
(TO-92UA)
Weight approximately 0.12 g
Dimensions in mm

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	–200[3)]	200[3)]	mA
V_O	Output Voltage	3	–0.3	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	–200[3)]	200[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
R_V	Series Resistor	1	–	–	270	Ω

Electrical Characteristics at T_J = –40 °C to +170 °C , V_{DD} = 4.5 V to 24 V, as not otherwise specified in Test Conditions
Typical Characteristics for T_J = 25 °C and V_{DD} = 12 V

Symbol	Parameter	Pin No.	Min.	Typ.	Max.	Unit	Test Conditions
V_{OL}	Output Voltage over Temperature Range	3	–	120	400	mV	I_{OL} = 12.5 mA
V_{OL}	Output Voltage over Temperature Range	3	–	190	500	mV	I_{OL} = 20 mA
I_{OH}	Output Leakage Current	3	–	–	1	µA	B < B_{off}, V_{OH} = 24 V, T_J = 25 °C

Electrical Characteristics, continued

Symbol	Parameter	Pin No.	Min.	Typ.	Max.	Unit	Test Conditions
I_{OH}	Output Leakage Current over Temperature Range	3	–	–	10	µA	$B < B_{off}$ V_{OH} = 24 V, T_J < 150 °C
I_{DD}	Supply Current	1	6	8.2	11	mA	T_J = 25 °C
I_{DD}	Supply Current over Temperature Range	1	3.9	8.2	12	mA	
$t_{en(O)}$	Enable Time of Output after Setting of V_{DD}	3	–	6	10	µs	V_{DD} = 12 V
t_r	Output Rise Time	3	–	85	400	ns	V_{DD} = 12 V, RL = 820 Ohm, CL = 20 pF
t_f	Output Fall Time	3	–	60	400	ns	V_{DD} = 12 V, RL = 820 Ohm, CL = 20 pF
R_{thJSB} case SOT-89A	Thermal Resistance Junction to Substrate Backside		–	150	200	K/W	Fiberglass Substrate pad size see Fig. 6
R_{thJA} case TO-92UA	Thermal Resistance Junction to Soldering Point		–	150	200	K/W	Leads at ambient temperature at a distance of 2 mm from case

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}	7.5	21.5	36.0	7.0	21.3	34.0	6.3	19.6	31.5	6.0	19.2	31.0	mT
Off point B_{OFF}	4.3	17.4	33.2	4.0	17.6	31.2	3.6	16.1	28.9	3.6	15.8	28.8	mT
Hysteresis B_{HYS}	2.8	4.1	5.0	2.8	3.7	4.5	2.6	3.5	4.0	2.2	3.4	4.0	mT

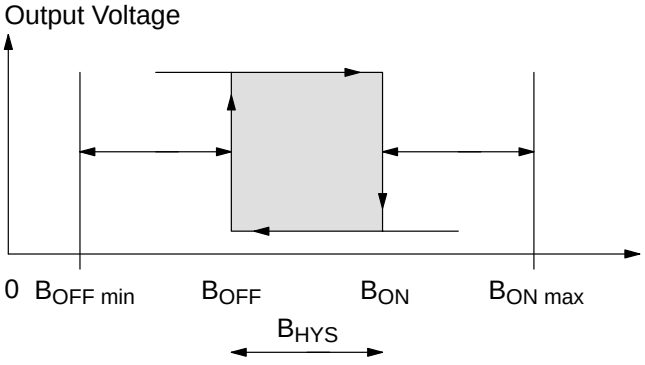

Fig. 5: Definition of switching points and hysteresis

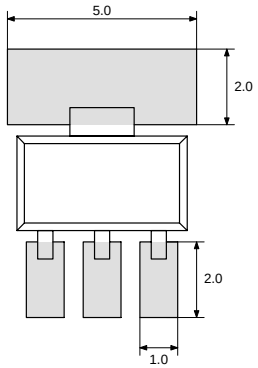

Fig. 6: Recommended pad size SOT-89A
Dimensions in mm

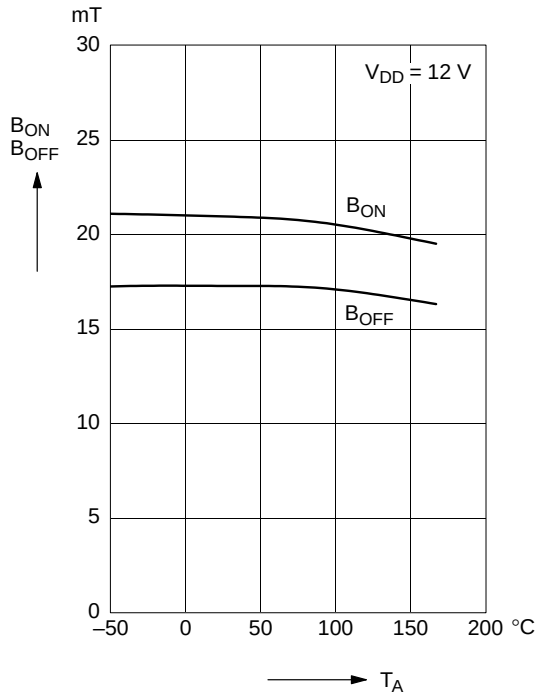

Fig. 7: Typical magnetic switching points versus temperature

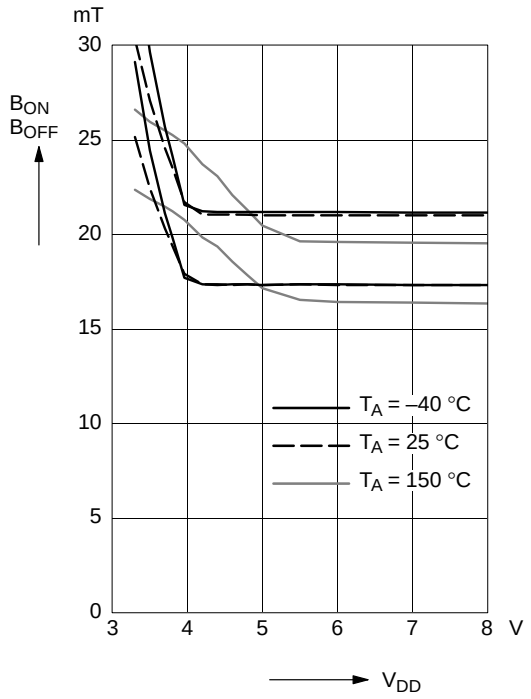

Fig. 9: Typical magnetic switching points versus supply voltage

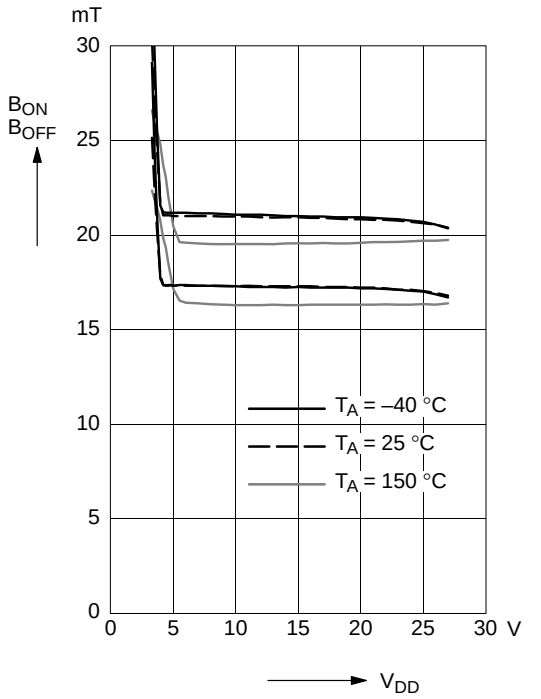

Fig. 8: Typical magnetic switching points versus supply voltage

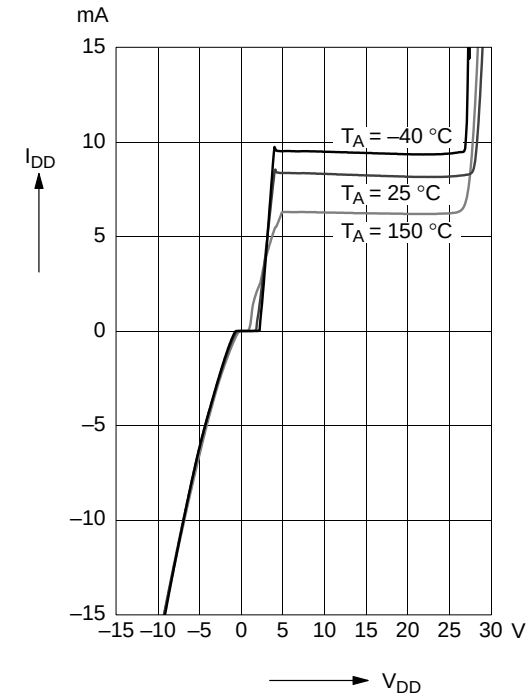

Fig. 10: Typical supply current versus supply voltage

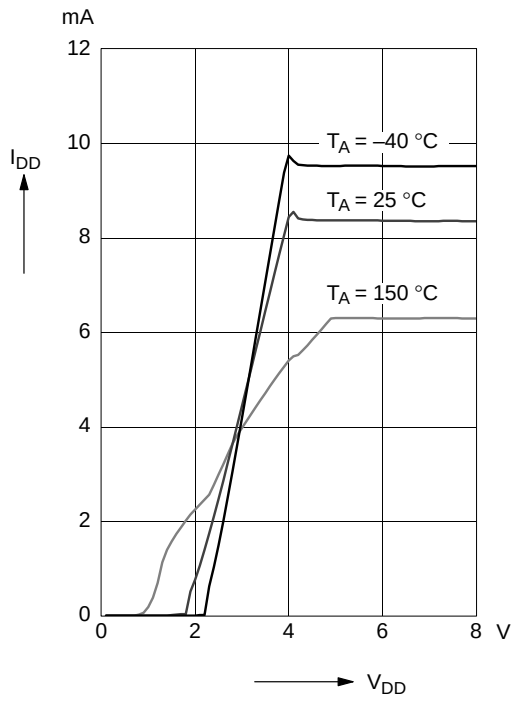

Fig. 11: Typical supply current versus supply voltage

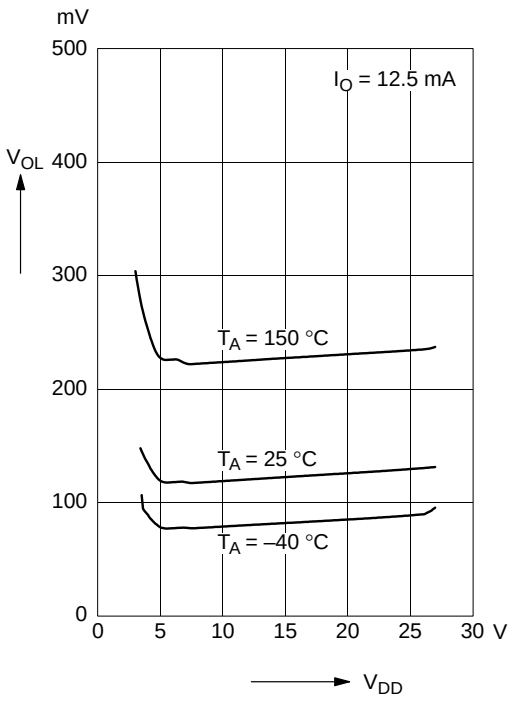

Fig. 13: Typical output low voltage versus supply voltage

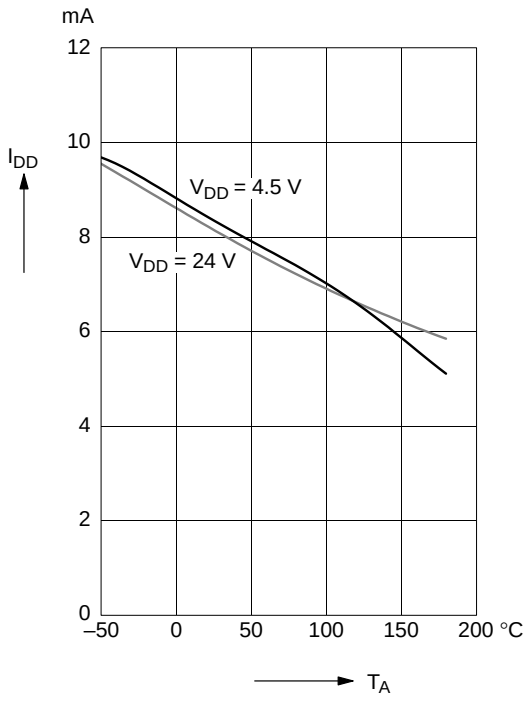

Fig. 12: Typical supply current versus temperature

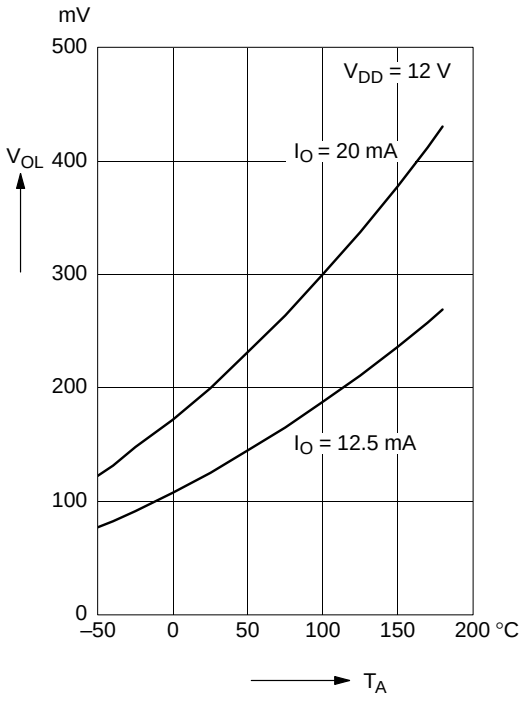

Fig. 14: Typical output low voltage versus temperature

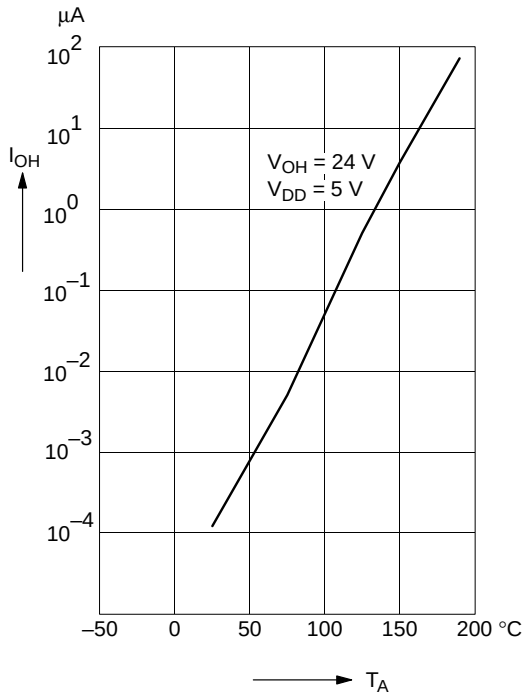

Fig. 15: Typical output leakage current versus temperature

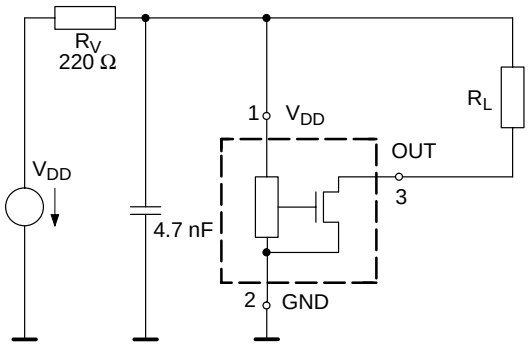

Fig. 16: Recommended application circuit

Application Note

For electromagnetic immunity, it is recommended to apply a 330 pF minimum capacitor between V_{DD} (pin 1) and Ground (pin 2).

For applications requiring robustness to conducted disturbances (transients), a 220 Ω series resistor to pin 1 and a 4.7 nF capacitor between V_{DD} (pin1) and Ground (pin 2) 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.

Data Sheet History

1. Final data sheet: “HAL114 Unipolar Hall Switch IC”, June 10, 1998, 6251-456-1DS. First release of the final data sheet.

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