MICRONAS

Hardware
Documentation

Data Sheet

HAL® 156y

Hall-Effect Switches with Current Interface (2-wire) in SOT23 package

ASIL ready

Edition June 28, 2016
DSH000180_002EN

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Contents, continued

Hall-Effect Switches with Current Interface (2-wire) in SOT23 package

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

1. Introduction

The HAL 156y Hall-switch family members produced in CMOS technology as 2-wire devices with current interface include a temperature-compensated Hall plate with active offset compensation, a comparator, and a current source.

The comparator compares the actual magnetic flux through the Hall plate (Hall voltage) with the fixed reference values (switching points). Accordingly the current source is switched on or off.

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 sensor is designed for industrial and automotive applications and operates with supply voltages from 3 V to 24 V in the junction temperature range from –40 °C up to 170 °C.

HAL 156y is available in a JEDEC TO236-compliant SMD-package 3-lead SOT23.

1.1. Features of HAL 156y

– SOT23-3L JEDEC TO236-compliant package
– ISO 26262 compliant as ASIL A ready device
– Current interface
– Operates from 3 V to 24 V supply voltage
– Overvoltage protection capability up to 40 V
– Reverse-voltage protected VSUP-pin (–18 V)
– High ESD performance up to ±8 kV (HBM)
– Thermal shutdown
– Sample frequency of 500 kHz, 2 µs output refresh time
– Operates with static and dynamic magnetic fields up to 12 kHz
– High resistance to mechanical stress by active offset compensation
– Constant switching points over a wide supply voltage and temperature range
– Wide junction temperature range from –40 °C to 170 °C
– Built-in temperature coefficient
– Optimized for applications in extreme automotive and industrial environments
– Qualified according to AEC-Q100 test standard for automotive electronics industry to provide high-quality performance
– Robust EMC performance, corresponding to different standards, such as ISO 7637, ISO 16750, IEC 61967, ISO 11452, and ISO 62132

2. Ordering Information

A Micronas device is available in a variety of delivery forms. They are distinguished by a specific ordering code:

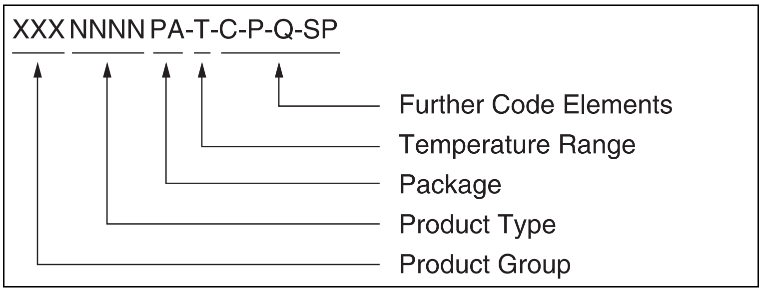


Fig. 2–1: Ordering Code Principle

For a detailed information, please refer to the brochure: “Hall Sensors: Ordering Codes, Packaging, Handling”.

2.1. Device-Specific Ordering Codes

HAL 156y is available in the following package and temperature range.

Table 2–1: Available packages

Package Code (PA)	Package Type
SU	SOT23

Table 2–2: Available temperature ranges

Temperature Code (T)	Temperature Range
A	T_J = –40 °C to +170 °C

The relationship between ambient temperature (T_A) and junction temperature (T_J) is explained in **Section 5.2. on page 31.**

For available variants for Configuration (C), Packaging (P), Quantity (Q), and Special Procedure (SP) please contact Micronas.

Table 2–3: Available ordering codes and corresponding package marking

Available Ordering Codes	Package Marking
HAL1562SU-A-[C-P-Q-SP]	1562
HAL1563SU-A-[C-P-Q-SP]	1563
HAL1564SU-A-[C-P-Q-SP]	1564
HAL1565SU-A-[C-P-Q-SP]	1565
HAL1566SU-A-[C-P-Q-SP]	1566

3. Functional Description of HAL 156y

The HAL 156y 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. If the magnetic field exceeds the threshold levels, the current source is switched to the appropriate state.

The built-in hysteresis eliminates oscillation and provides switching behavior without bouncing.

Offsets caused by mechanical stress are compensated by using the “switching offset compensation technique”.

A diode on the supply line is not required thanks to the built-in reverse voltage protection.

The current source is forced to a safe, error current level (I_{SUP}), in any of the following fault conditions: overtemperature, undervoltage and functional safety related diagnoses (see Section 3.1.).

The device is able to withstand a maximum supply voltage of 24 V for unlimited time and features overvoltage capability (40 V load dump).

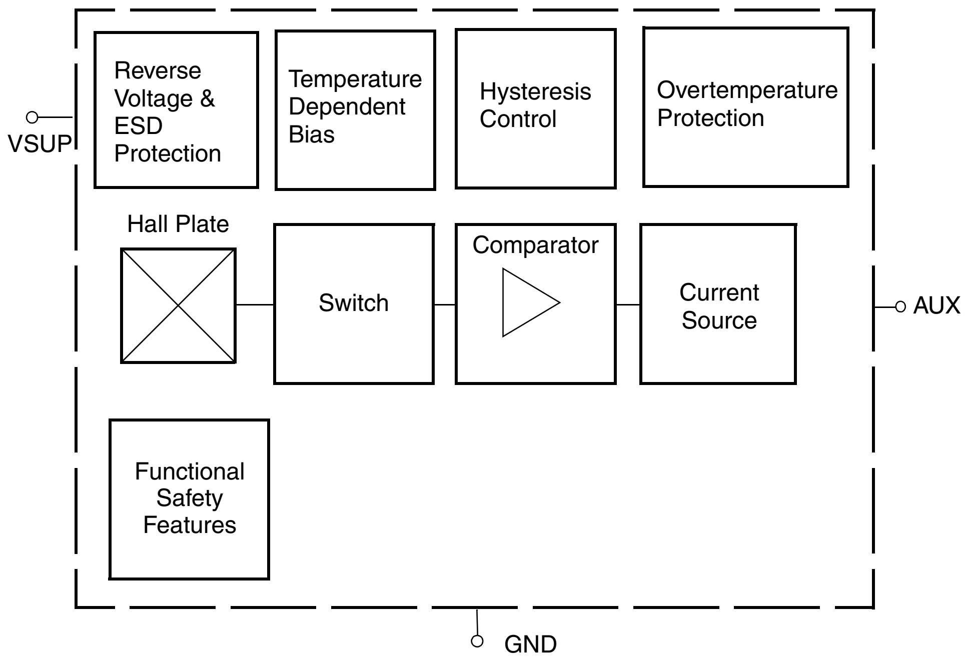


Fig. 3–1: HAL 156y block diagram

3.1. Functional Safety According to ISO 26262

The HAL 156y is ISO 26262 compliant as an ASIL A ready device.

Magnetic and switching performance is defined as hardware safety requirement.

The safe state is defined as error current level and is specified in Section 4.9. on page 17.

3.1.1. Diagnostic Features

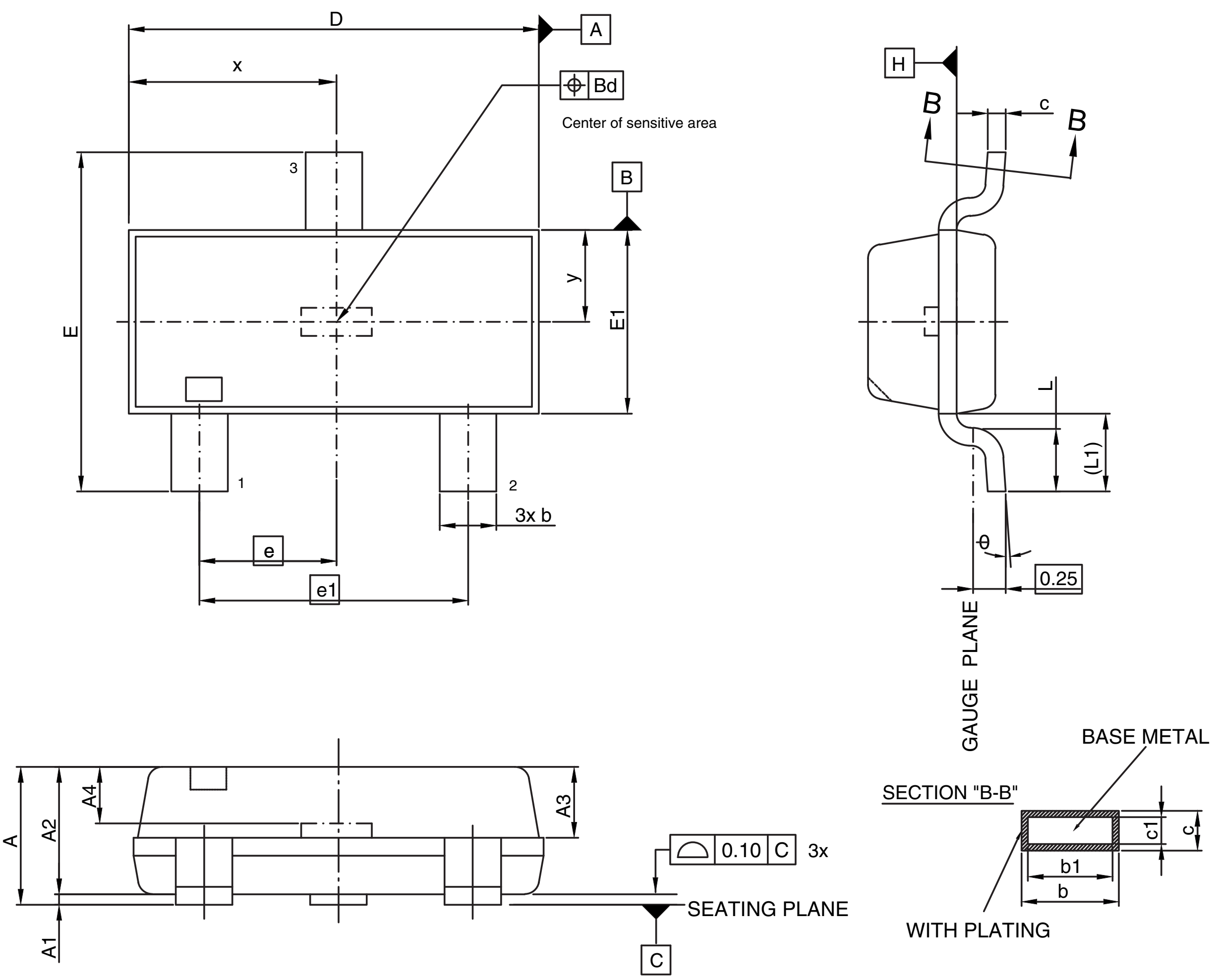
Internal states are monitored and in an error condition flagged as error current:

- Internal voltage regulator: under and overvoltage detection
- Monitoring of internal bias and current levels
- Monitoring of the internal reference voltage
- Monitoring of the Hall plate voltage

Note For further documentation regarding functional safety please contact Micronas.

4. Specifications

4.1. Outline Dimensions



physical dimensions do not include moldflash.

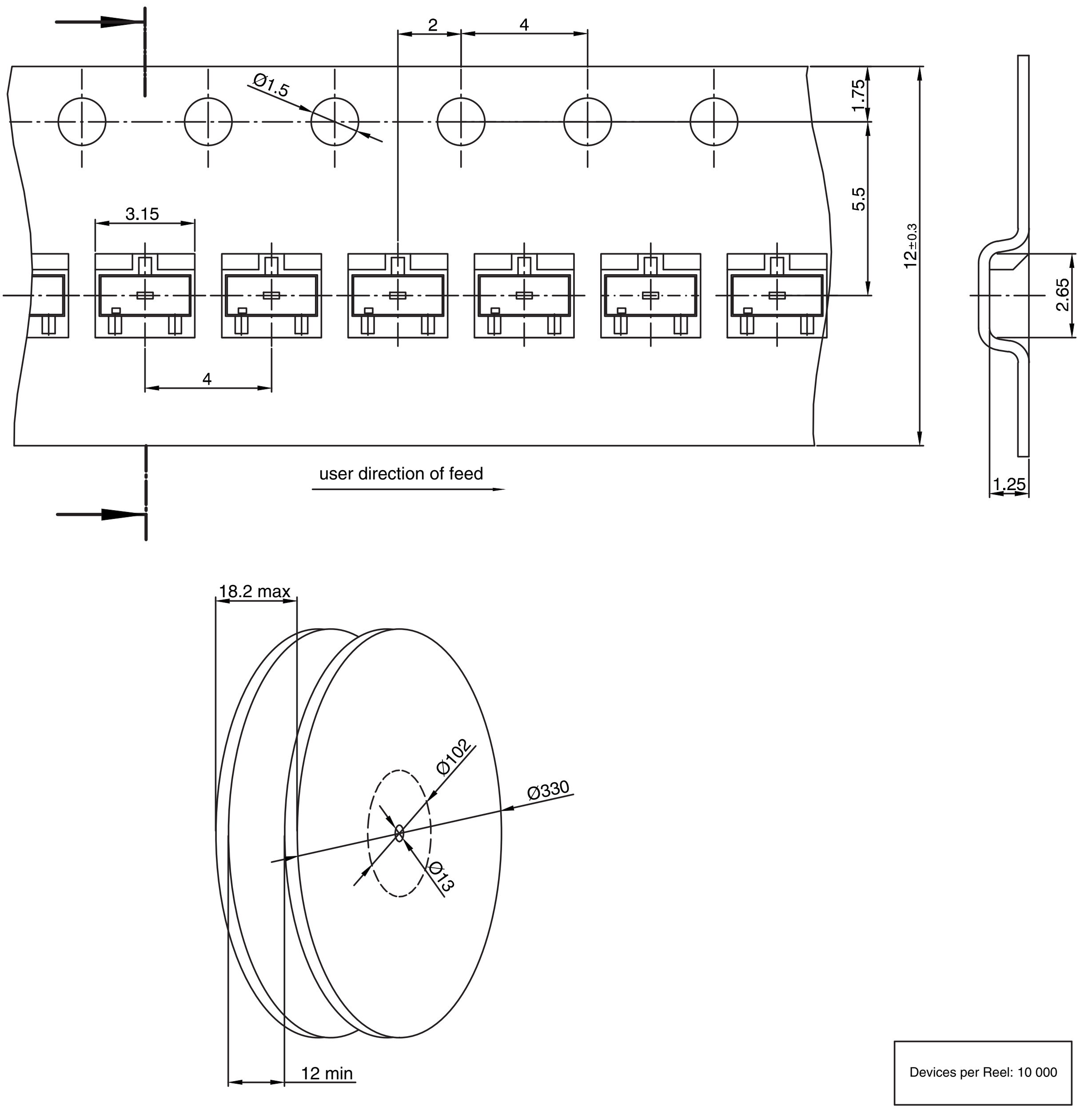
0 1.25 2.5mm
scale

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

UNIT	A	A1	A2	A3	b	b1	c	c1	D	E	E1	e	e1	L	L1	θ
mm	1.10 max.	0.05 0.10	0.88 1.02	0.5	0.3 0.48	0.3 0.45	0.1 0.18	0.1 0.15	2.8 3.0	2.1 2.5	1.2 1.4	0.95	1.9	0.4 0.6	0.55	0° 8°

JEDEC STANDARD		ANSI	ISSUE DATE YY-MM-DD	DRAWING-NO.	ZG-NO.
ISSUE	ITEM NO.				
-	TO-236		13-05-10	06902.0001.4	ZG001101_Ver.01

Fig. 4–1:
SOT23: Plastic **S**mall **O**utline **T**ransistor package, 3 leads
Ordering code: SU
Weight approximately is 0.01094 g



IEC STANDARD		ANSI	ISSUE DATE YY-MM-DD	DRAWING-NO.	ZG-NO.
ISSUE	ITEM NO.				
4th	60286-3		15-09-23	06839.0001.4	ZG002042_001_01

Fig. 4–2:
SOT23: Tape & Reel Finishing

4.2. Soldering, Welding and Assembly

Information related to solderability, welding, assembly, and second-level packaging is included in the document “Guidelines for the Assembly of Micronas Packages”.
It is available on the Micronas website (http://www.micronas.com/en/service-center/downloads) or on the service portal (http://service.micronas.com).

4.2.1. SOT23 Footprint for Reflow and Wave Soldering

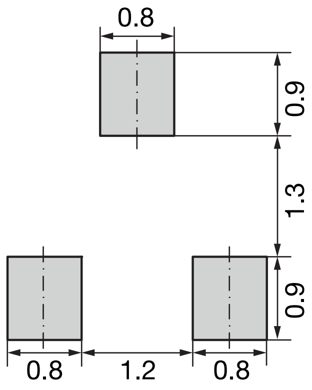


Fig. 4–3: SOT23 footprint for reflow soldering

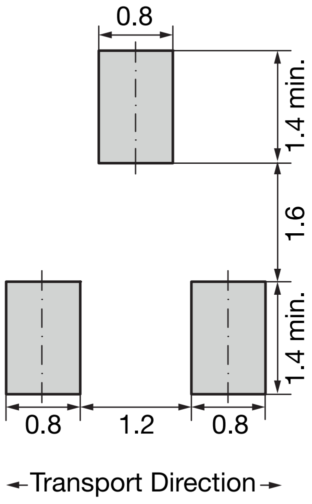


Fig. 4–4: SOT23 footprint for wave soldering

All dimensions mm.

4.3. Pin Connections (from Top Side, example HAL 1564) and Short Descriptions

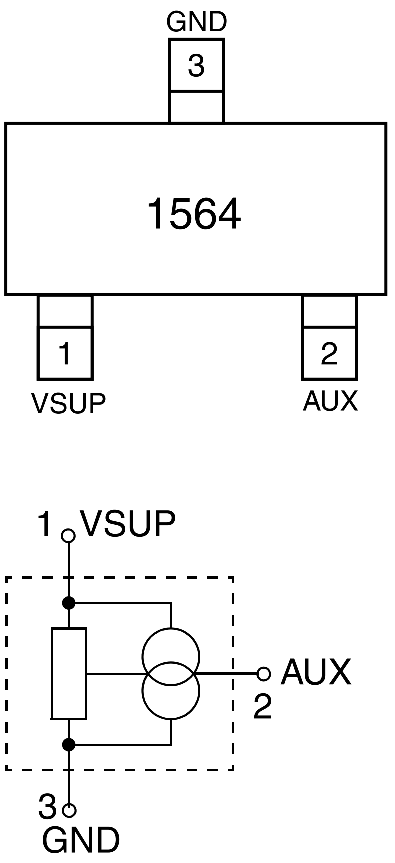


Fig. 4–5: Pin configuration

Table 4–1: Pin assignment.

Pin number	Name	Function
1	VSUP	Supply and output
2	AUX[1)]	Functional test pin
3	GND	Ground

1) connection to ground is recommended

4.4. Dimension and Position of Sensitive Area

Parameter	Min.	Typ.	Max.	Unit
Dimension of sensitive area		100 x 100		μm^2
A4 (denotes the distance of die to top package surface in Z-direction)	0.24	0.27	0.37	mm
x (denotes the nominal distance of the center of the Bd circle to the package border in x-direction)		1.45		mm
y (denotes the nominal distance of the center of the Bd circle to the package border in y-direction)		0.65		mm
Bd (denotes the diameter of the circuit in which the center of the sensitive area is located)	–	–	0.23	mm

4.5. 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	Conditions
T_J	Junction temperature range A	–	–40	190	°C	t < 96 h[1)]
V_{SUP}	Supply voltage	1	–18	28	V	t < 96 h[1)]
			–	32	V	t < 5 min[1)]
			–	40	V	t < 10 x 400 ms “Load-Dump”[1)] with series resistor R_V > 100 Ω.
1) No cumulative stress						

4.6. ESD and Latch-up

Symbol	Parameter	Min.	Max.	Unit
I_{latch}	Maximum latch-up free current at any pin (measurement according to AEC Q100-004), class 1	–100	100	mA
V_{HBM} [1)]	Human body model (according to AEC Q100-002)	–8	8	kV
V_{HBM} [2)]	Human body model (according to AEC Q100-002)	–6	6	kV
V_{CDM}	Charged device model (according to AEC Q100-011)	–1	1	kV
V_{SYSTEM_LEVEL}	Unpowered Gun Test (150 pF/330 Ω or 330 pF/2 kΩ) according to ISO 10605-2008[1)3)4)]	–15	15	kV

1) VSUP-pin and GND-pin

2) AUX-pin

3) only valid with ESD System Level Application Circuit (see Fig. 5–2 on page 30)

4) Based on 3-wire HAL 150y test results

4.7. Storage and Shelf Life

Information related to storage conditions of Micronas sensors is included in the document “Guidelines for the Assembly of Micronas Packages”. It gives recommendations linked to moisture sensitivity level and long-term storage.
It is available on the Micronas website (http://www.micronas.com/en/service-center/downloads) or on the service portal (http://service.micronas.com).

4.8. 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.	Typ.	Max.	Unit	Conditions
V_{SUP}	Supply voltage	1	3		24	V	
$\Delta V_{SUP} / \Delta t$	Power-down slope [1]	1	–	–	0.1	V/µs	V_{SUP} below 3.0 V
	Power-up slope [2]		0.1	–	–		V_{SUP} below 3.5 V $R_V + R_L < 100\ \Omega$ (see Fig. 5–1 on page 29)
T_J	Junction temperature range A[3]	–	–40		170 150 125	°C	t < 1000 h[4] t < 2500 h[4] t < 8000 h[4]

1) This parameter is relevant for ISO26262 applications: In order to ensure the defined output state (I_{SUP}) during power-up in the range below the recommended supply voltage, the preceding power-down slope is required to be slower than the maximum $\Delta V_{SUP} / \Delta t$ value.

2) In order to ensure the output state I_{SUP} during power-up, the minimum power-up slope is required. At slower power-up slopes, the sensor may toggle between I_{SUP} and the corresponding switching current I_{SUPlo} or I_{SUPhi} due to the undervoltage detection and the voltage drop at the series resistors R_L and R_V.

3) Depends on the temperature profile of the application. Please contact Micronas for life time calculations.

4) No cumulative stress

4.9. Characteristics

at T_J = –40 °C to +170 °C, V_{SUP} = 3 V to 24 V,
at Recommended Operating Conditions if not otherwise specified in the column “Conditions”.
Typical Characteristics for T_J = 25 °C and V_{SUP} = 12 V

Symbol	Parameter	Pin No.	Min.	Typ.	Max.	Unit	Conditions
Supply							
I_{SUPlo}	Low supply current 1	1	2.5		5	mA	valid for: HAL 1564 and HAL 1565
I_{SUPlo}	Low supply current 2	1	5		7	mA	valid for: HAL 1562, HAL 1563, and HAL 1566
I_{SUP}	Error current	1	0.8		2.2	mA	
I_{SUPhi}	High supply current	1	12		17	mA	
I_{SUPR}	Reverse current	1			0.6	mA	for V_{SUP} = –18 V
Port Output							
B_{noise}	Effective noise of magnetic switching points (RMS)[2)]	–		72		µT	For square wave signal with 12 kHz
t_j	Output jitter (RMS)[1)]	–		±0.58	±0.72	µs	For square wave signal with 1 kHz. Jitter is evenly distributed between –1 µs and +1 µs
t_d	Delay time[2) 3)]	–		16	21	µs	
t_{samp}	Output refresh period[2)]	–	1.6	2.2	3.0	µs	
t_{en}	Enable time of output after settling of V_{SUP}	–		50	60	µs	V_{SUP} = 12 V B > B_{on} + 2 mT or B < B_{off} – 2 mT

Symbol	Parameter	Pin No.	Min.	Typ.	Max.	Unit	Conditions
Package							
R_{thja}	Thermal Resistance junction to air	–	–	–	300	K/W	Measured with a 1s0p board
		–	–	–	250	K/W	Measured with a 1s1p board
		–	–	–	210	K/W	Measured with a 2s2p board
R_{thjc}	Thermal Resistance junction to case	–	–	–	30	K/W	Measured with a 1s0p board
		–	–	–	50	K/W	Measured with a 1s1p board
		–	–	–	40	K/W	Measured with a 2s2p board

1) Not tested, characterized only
2) Guaranteed by design
3) Systematic delay between magnetic threshold reached and output switching

4.10. HAL 1562 Magnetic Characteristics

The HAL 1562 Hall-latch provides medium sensitivity (see Fig. 4–6).

The output turns to low current consumption (I_{SUPlo}) with the magnetic north pole on the top side of the package and turns to high current consumption (I_{SUPhi}) with the magnetic south pole on the top 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 top side of the package.

Magnetic Features:

– switching type: latching

– medium sensitivity

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

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

– operates with static magnetic fields and dynamic magnetic fields up to 12 kHz

– typical temperature coefficient of magnetic switching points is 0 ppm/K

Applications

The HAL 1562 is the optimal sensor for applications with alternating magnetic fields, such as:

– seat position detection
– break-by-wire
– electric sunroof
– window lifter

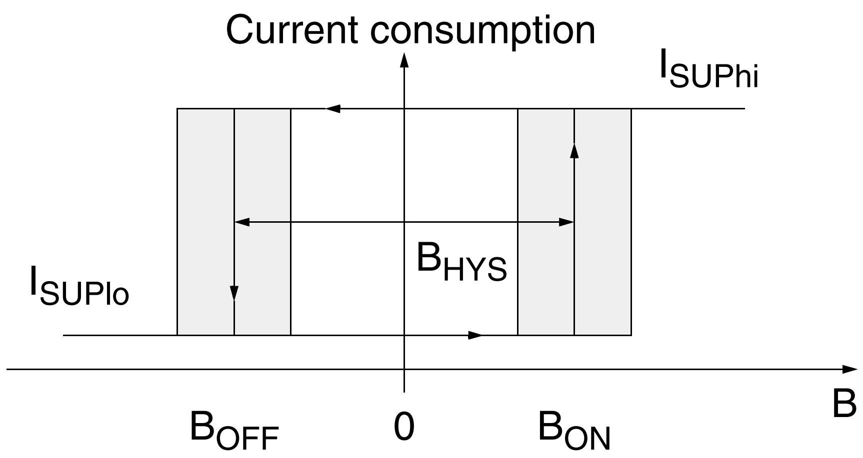


Fig. 4–6: Definition of magnetic switching points for the HAL 1562

Magnetic Characteristics at T_J = –40 °C to +170 °C, V_{DD} = 3 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 top side of the package.

Parameter	**On point B_{ON}**			**Off point B_{OFF}**			**Hysteresis B_{HYS}**			**Unit**
T_J	**Min.**	**Typ.**	**Max.**	**Min.**	**Typ.**	**Max.**	**Min.**	**Typ.**	**Max.**	
–40 °C	7	12	17	–17	–12	–7	–	24	–	mT
25 °C	7	12	17	–17	–12	–7	–	24	–	mT
170 °C	7	12	17	–17	–12	–7	–	24	–	mT

The hysteresis is the difference between the switching points $|B_{HYS} = B_{ON} - B_{OFF}|$

Note Regarding switching points, temperature coefficients, and B-field switching frequency, customized derivatives via mask option are possible. For more information contact Micronas.

4.11. HAL 1563 Magnetic Characteristics

The unipolar inverted HAL 1563 Hall-switch provides high sensitivity (see Fig. 4–7).

The sensor turns to low current consumption (I_{SUPlo}) with the magnetic south pole on the top side of the package and turns to high current consumption (I_{SUPhi}) if the magnetic field is removed. It does not response to the magnetic north pole on the top side of the package.

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

Magnetic Features:

– switching type: unipolar inverted

– high sensitivity

– typical B_{ON}: 7.6 mT at room temperature

– typical B_{OFF}: 9.4 mT at room temperature

– operates with static magnetic fields and dynamic magnetic fields up to 12 kHz

– typical temperature coefficient of magnetic switching points is 0 ppm/K

Applications

The HAL 1563 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 air gap or weak magnets

– brake pedal position detection (brake light switch)

– seat belt presents detection

– seat position detection,

– break fluid level switch

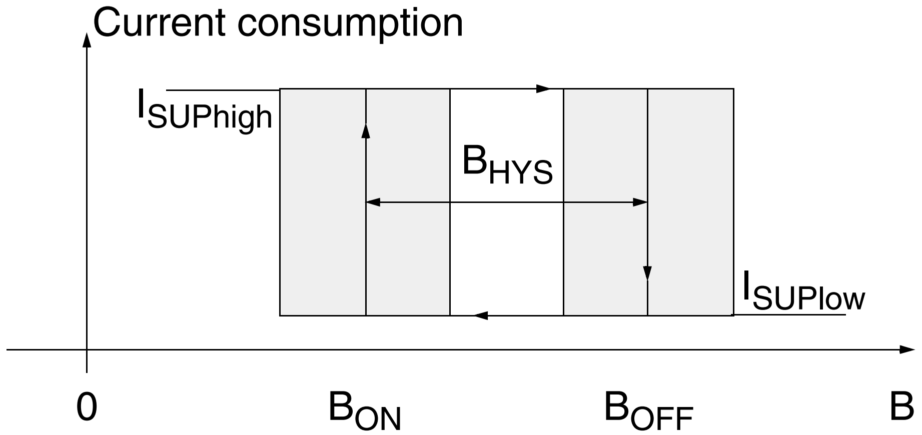


Fig. 4–7: Definition of magnetic switching points for the HAL 1563

Magnetic Characteristics at T_J = –40 °C to +170 °C, V_{DD} = 3 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 top side of the package.

Parameter	**On point B_{ON}**			**Off point B_{OFF}**			**Hysteresis B_{HYS}**			**Unit**
T_J	**Min.**	**Typ.**	**Max.**	**Min.**	**Typ.**	**Max.**	**Min.**	**Typ.**	**Max.**	
–40 °C	5.5	7.6	10.5	7.0	9.4	12	–	1.8	–	mT
25 °C	5.8	7.6	10.0	7.0	9.4	11.5	–	1.8	–	mT
170 °C	5.5	7.6	10.5	7.0	9.4	12	–	1.8	–	mT

The hysteresis is the difference between the switching points $|B_{HYS} = B_{ON} - B_{OFF}|$

Note Regarding switching points, temperature coefficients, and B-field switching frequency, customized derivatives via mask option are possible. For more information contact Micronas.

4.12. HAL 1564 Magnetic Characteristics

The unipolar inverted HAL 1564 Hall-switch provides high sensitivity (see Fig. 4–8).

The sensor turns to low current consumption (I_{SUPlo}) with the magnetic south pole on the top side of the package and turns to high current consumption (I_{SUPhi}) if the magnetic field is removed. It does not response to the magnetic north pole on the top side of the package.

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

Magnetic Features:

– switching type: unipolar inverted
– high sensitivity
– typical B_{ON}: 4.1 mT at room temperature
– typical B_{OFF}: 6.0 mT at room temperature
– operates with static magnetic fields and dynamic magnetic fields up to 12 kHz
– typical temperature coefficient of magnetic switching points is –1000 ppm/K

Applications

The HAL 1564 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 air gap or weak magnets
– brake pedal position detection (brake light switch)
– seat belt presents detection
– seat position detection
– break fluid level switch

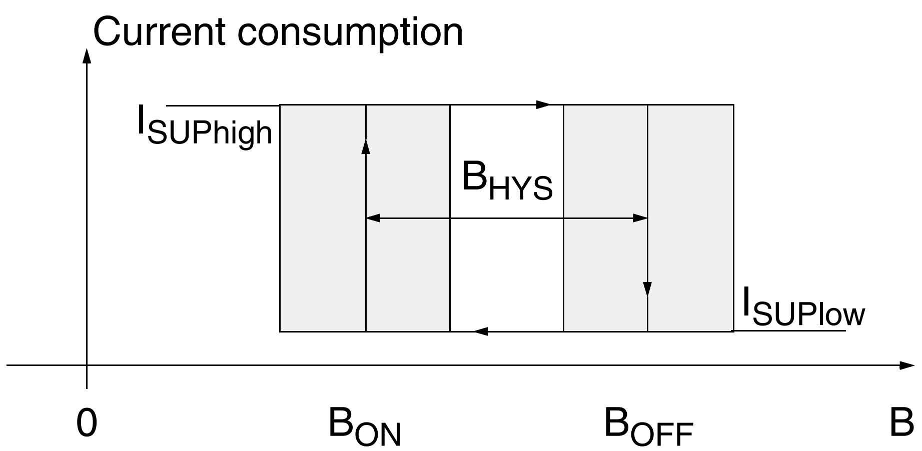


Fig. 4–8: Definition of magnetic switching points for the HAL 1564

Magnetic Characteristics at T_J = –40 °C to +170 °C, V_{DD} = 3 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 top side of the package.

Parameter	On point B_{ON}			Off point B_{OFF}			Hysteresis B_{HYS}			Unit
T_J	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
–40 °C	3.2	4.5	6.7	5.0	6.4	8.5	–	1.9	–	mT
25 °C	2.9	4.1	6.1	4.3	6.0	7.7	–	1.9	–	mT
170 °C	2.4	4.0	6.4	3.7	5.6	7.7	–	1.6	–	mT

The hysteresis is the difference between the switching points $|B_{HYS} = B_{ON} - B_{OFF}|$

Note Regarding switching points, temperature coefficients, and B-field switching frequency, customized derivatives via mask option are possible. For more information contact Micronas.

4.13. HAL 1565 Magnetic Characteristics

The unipolar HAL 1565 is a high-sensitive unipolar switching sensor (see Fig. 4–9).

The sensor turns to high current consumption (I_{SUPhi}) with the magnetic south pole on the top side of the package and turns to low current consumption (I_{SUPlo}) if the magnetic field is removed. It does not response to the magnetic north pole on the top side of the package.

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

Magnetic Features:

– switching type: unipolar

– high sensitivity

– typical B_{ON}: 6 mT at room temperature

– typical B_{OFF}: 4.1 mT at room temperature

– operates with static magnetic fields and dynamic magnetic fields up to 12 kHz

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

Applications

The HAL 1565 is the optimal sensor for all applications with one magnetic polarity and weak magnetic amplitude at the sensor position, such as:

– seat belt presents detection

– flow measurement

– door lock

– roof top open/close

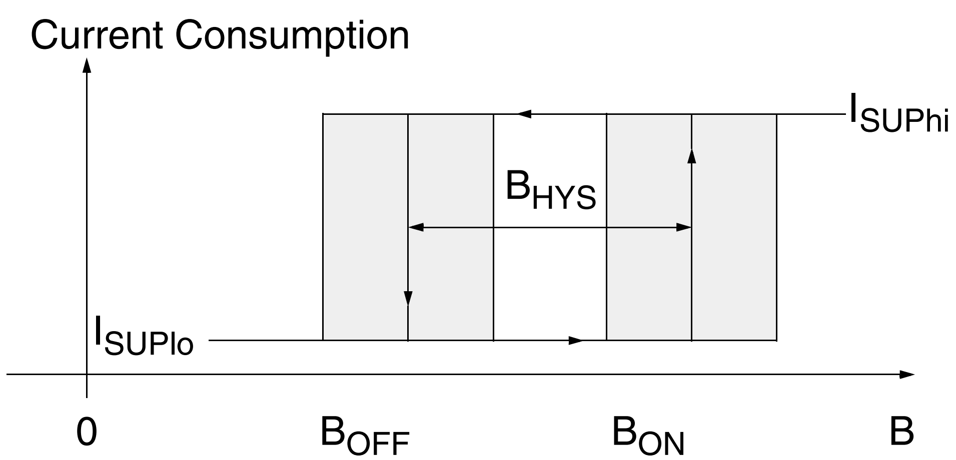


Fig. 4–9: Definition of magnetic switching points for the HAL 1565

Magnetic Characteristics at T_J = –40 °C to +170 °C, V_{DD} = 3 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 top side of the package.

Parameter	**On point B_{ON}**			**Off point B_{OFF}**			**Hysteresis B_{HYS}**			**Unit**
T_J	**Min.**	**Typ.**	**Max.**	**Min.**	**Typ.**	**Max.**	**Min.**	**Typ.**	**Max.**	
–40 °C	5.0	6.4	8.5	3.2	4.5	6.7	–	1.9	–	mT
25 °C	4.3	6.0	7.7	2.9	4.1	6.1	–	1.9	–	mT
170 °C	3.7	5.6	7.7	2.4	4.0	6.4	–	1.9	–	mT

The hysteresis is the difference between the switching points $|B_{HYS} = B_{ON} - B_{OFF}|$

Note Regarding switching points, temperature coefficients, and B-field switching frequency, customized derivatives via mask option are possible. For more information contact Micronas.

4.14. HAL 1566 Magnetic Characteristics

The unipolar HAL 1566 is a high-sensitive unipolar switching sensor (see Fig. 4–10).

The sensor turns to high current consumption (I_{SUPhi}) with the magnetic south pole on the top side of the package and turns to low current consumption (I_{SUPlo}) if the magnetic field is removed. It does not response to the magnetic north pole on the top side of the package.

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

Magnetic Features:

– switching type: unipolar

– high sensitivity

– typical B_{ON}: 9.4 mT at room temperature

– typical B_{OFF}: 7.6 mT at room temperature

– operates with static magnetic fields and dynamic magnetic fields up to 12 kHz

– typical temperature coefficient of magnetic switching points is 0 ppm/K

Applications

The HAL 1566 is the optimal sensor for all applications with one magnetic polarity and weak magnetic amplitude at the sensor position, such as:

– seat belt presents detection

– seat position

– electric sun roof

– gear shift lever

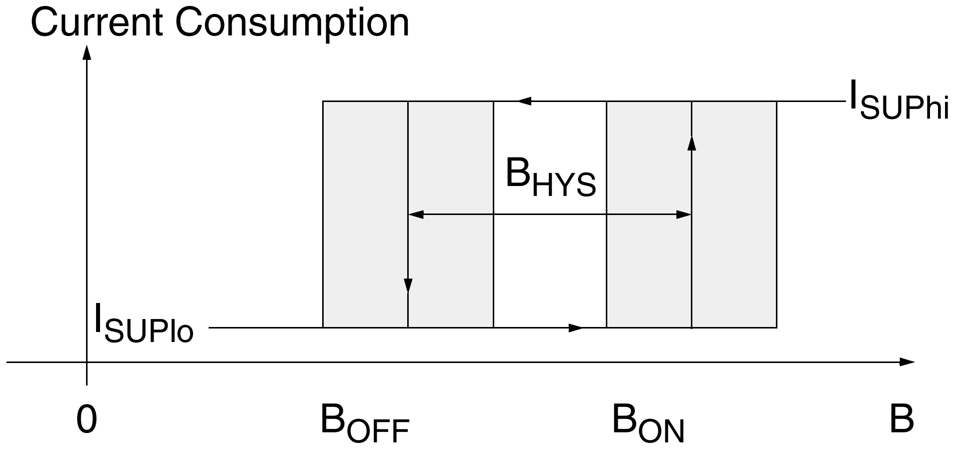


Fig. 4–10: Definition of magnetic switching points for the HAL 1566

Magnetic Characteristics at T_J = –40 °C to +170 °C, V_{DD} = 3 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 top side of the package.

Parameter	On point B_{ON}			Off point B_{OFF}			Hysteresis B_{HYS}			Unit
T_J	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
–40 °C	7	9.4	12	5.5	7.6	10.5	–	1.8	–	mT
25 °C	7.3	9.4	11.5	5.8	7.6	10	–	1.8	–	mT
170 °C	7	9.4	12	5.5	7.6	10.5	–	1.8	–	mT

The hysteresis is the difference between the switching points $|B_{HYS} = B_{ON} - B_{OFF}|$

Note Regarding switching points, temperature coefficients, and B-field switching frequency, customized derivatives via mask option are possible. For more information contact Micronas.

5. Application Notes

5.1. Application Circuits

For applications with disturbances on the supply line or radiated disturbances, a series resistor R_V and a capacitor C_P both placed close to the sensor are recommended (see Fig. 5–1). In this case, the maximum R_L can be calculated as:

$$R_{Lmax} = \frac{V_{BATTmin} - V_{SUPmin}}{I_{SUPhimax}} - R_V$$

For example: R_V =100 Ω and C_P = 47 nF

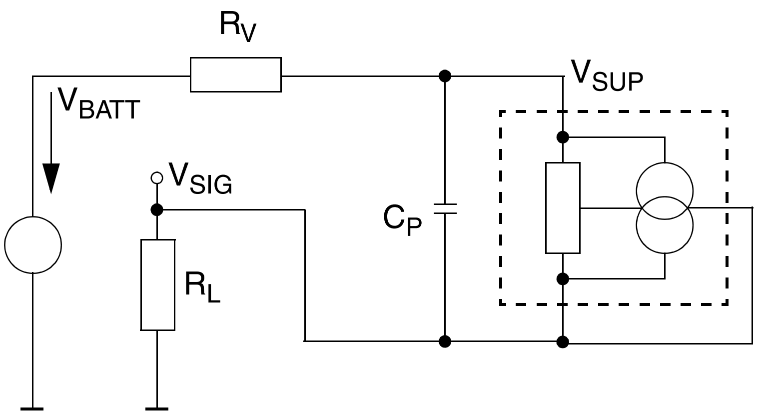


Fig. 5–1: Example application circuit

5.1.1. ESD System Level Application Circuit (ISO10605-2008)

For an ESD system level application circuit according to ISO10605-2008 a 100 nF capacitor at VSUP is necessary.

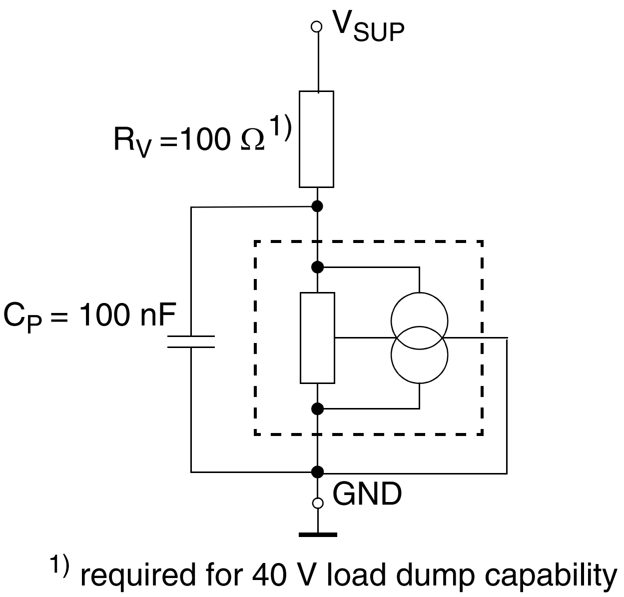


Fig. 5–2: Application circuit with external resistor

5.2. 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).

$$T_J = T_A + \Delta T$$

Under static conditions and continuous operation, the following equation applies:

$$\Delta T = \left[\left(I_{SUPhi} \times \frac{t_{high}}{t_{period}}\right) + \left(I_{SUPlo} \times t\frac{t_{low}}{t_{period}}\right)\right] \times V_{SUP} \times R_{thja}$$

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

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

For typical values, use the typical parameters. For worst case calculation, use the max. parameters according to the application conditions.

Example calculation for ΔT with I_{SUPhi}=17 mA (t_{high}=20%), I_{SUPlo}=7 mA (t_{low}=80%), V_{SUP}=5 V, R_{th}=300 K/W

$$\Delta T = [(0.017\text{ A} \times 0.2) + (0.007\text{ A} \times 0.8)] \times 5\text{ V} \times 300\text{ K/W} = 13.5\text{ K}$$

$$T_{Amax} = 170\text{ °C} - 13.5\text{ °C} = 156.5\text{ °C}$$

For 2-wire devices self-heating can be critical due to the range of I_{SUPhi}. The junction temperature can be reduced with pulsed supply voltage. For supply times (t_{on}) of e.g. 120 μs, the following equation can be used:

$$\Delta T = I_{SUPhi} \times V_{SUP} \times R_{thja} \times \frac{t_{on}}{t_{off} + t_{on}}$$

5.3. Start-Up Behavior

The sensors have an initialization time (enable time t_{en}) after applying the supply voltage. The parameter t_{en} is specified in the Electrical Characteristics (see page 17).

During the initialization time, the output state is defined as error current.

After t_{en}, the current consumption will be high if the applied magnetic field B is above B_{ON}. The current consumption will be low if B is below B_{OFF}. In case of sensors with an inverted switching behavior the current consumption will be low if $B > B_{OFF}$ and high if $B < B_{ON}$.

Note For non-inverted ICs and magnetic fields between B_{OFF} and B_{ON} after applying V_{SUP} , the current consumption will be low (I_{SUPlo}). For inverted ICs, the current consumption will be high (I_{SUPhi}).

For further information see Application Notes for HAL 15xy.

5.4. EMC and ESD

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

Special application arrangements were evaluated to pass EMC tests according to different standards, such as ISO 7637, ISO 16750, IEC 61967, ISO 11452 and ISO 62132.

6. Data Sheet History

1. Data Sheet: “HAL 156y, Hall-Effect Switch in SOT23 package”, June 15, 2016; DSH000180_001EN. First release of the Data Sheet.
2. Data Sheet: “HAL 156y, Hall-Effect Switch in SOT23 package”, June 28, 2016; DSH000180_002EN. Second release of the Data Sheet.

   Major change: SOT23 footprint added

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