

## Features

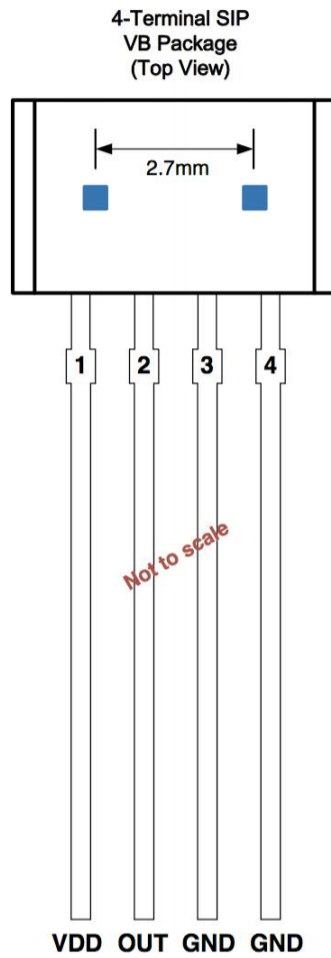
- Integrated filter capacitor
- South and North pole
- pre-induction possible
- Larger air gap
- 3.8 to 24V supply operating range
- Wide operating temperature range
- Output compatible with both TTL and CMOS logic families
- Over-voltage protection in all PINs
- Reverse-current protection in VDD PIN
- Output protection against electrical disturbances

## Description

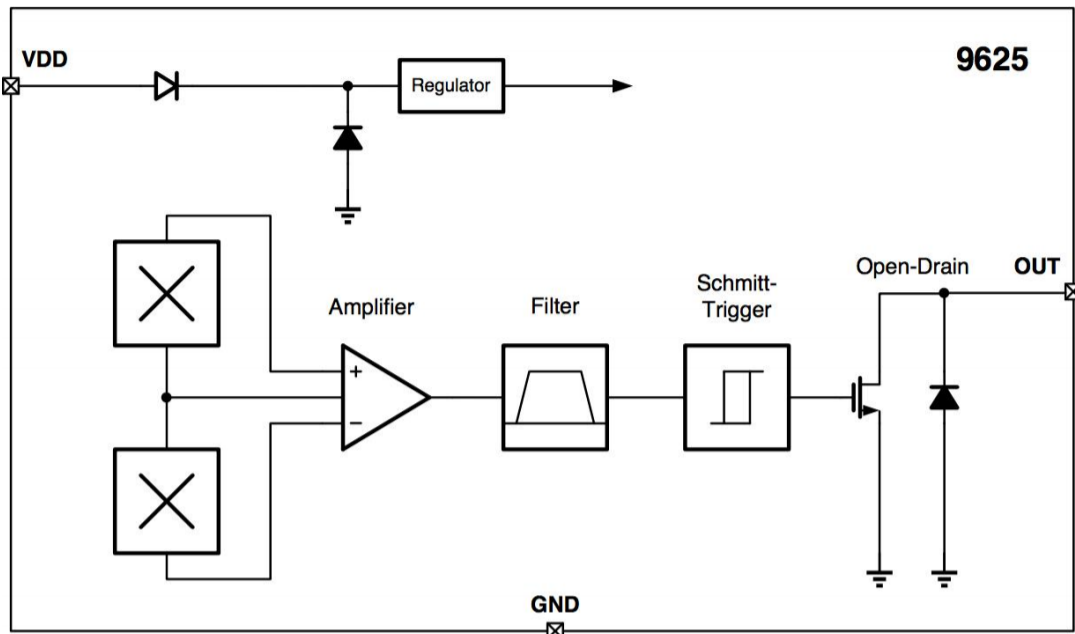
The differential Hall Effect sensor HL9625 provides a high sensitivity and a superior stability over temperature and symmetrical thresholds in order to achieve a stable duty cycle. The integrated circuit is response to changing differential magnetic fields created by rotating ring magnets and by ferrous targets when coupled with a magnet. The device is particularly suitable for rotational speed detection and timing applications of ferromagnetic toothed wheels, such as, anti-lock braking systems, transmissions, crankshafts, etc.

The device is packaged in a 4-pin plastic SIP. It is lead (Pb) free, with 100% matte tin plated leadframe

## Terminal Configuration and Functions



## Functional Block Diagram



## Functional Description

The Differential Hall Sensor IC detects the motion and position of ferromagnetic and permanent magnet structures by measuring the differential flux density of the magnetic field. Changes in field strength at the device face, which are induced by a moving target, are sensed by the two integrated Hall transducers. The transducers generate signals that are differentially amplified by on-chip electronics. This differential design provides immunity to radial vibration within the operating air gap range of the HL9625, by rejection of the common mode signal. Steady-state magnet and system offsets are eliminated using an on-chip differential band-pass filter. This filter also provides relative immunity to interference from electromagnetic sources.

The device utilizes advanced temperature compensation for the band-pass filter, sensitivity, and Schmitt trigger switch-points to guarantee optimal operation over a wide range of air gaps and temperatures even at lower frequency.

The HL9625 can be exploited to detect toothed wheel rotation in a rough environment. Jolts against the toothed wheel and ripple have no influence on

the output signal. Furthermore, the device can be operated in a two-wire as well as in a three wire-configuration.

## Absolute Maximum Ratings

Parameter	Symbol	Limit Values		Units
		Min.	Max.	
Power supply voltage	$V_{DD}$	-30	30	V
Power supply current	$I_{DD}$	-10	25	mA
Output terminal voltage	$V_{OUT}$	-0.5	30	V
Output terminal current sink	$I_{SINK}$	0	40	mA
Operating ambient temperature	$T_A$	-40	150	°C
Maximum junction temperature	$T_J$	-55	165	°C
Storage temperature	$T_{STG}$	-65	175	°C

*Note: Stresses above those listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

## ESD Protection

*Human Body Model (HBM) tests according to: standard EIA/JESD22-A114-B HBM*

Parameter	Symbol	Limit Values		Units
		Min.	Max.	
ESD-Protection	$V_{ESD}$	-4	4	KV

## Operating Characteristics

over operating free-air temperature range ( $V_{DD}=12V$ , unless otherwise noted)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
$V_{DD}$	Operating voltage	$T_J < T_{J(max)}$	3.8	--	24	V
$I_{DD}$	Operating supply current	$V_{DD}=3.8$ to 24 V	2.5	3.8	4.5	mA
$V_{Qsat}$	Output saturation voltage	$I_Q=20mA$ , $T_A=25^\circ C$	--	150	--	mV
$I_{QL}$	Output leakage current	$V_{DD} < 24V$	--	--	10	$\mu A$
$V_{DZ}$	Overvoltage protection at VDD terminal	$I_{DD} = 10mA$	30	35	40	V
$V_{OZ}$	Overvoltage protection at OUT terminal	$V_Q = High$ $I_Q = 1mA$	30	35	40	V
OCP <sup>1</sup>	Over current protection	$T_A=25^\circ C$	40	--	--	mA
$t_{po}$ <sup>2</sup>	Power-on time	$V_{DD}>3.8V$	--	3.8	9	mS
$t_{settle}$ <sup>3</sup>	Settling time	$V_{DD}>3.8V$ , $f=1kHz$	0	--	50	mS
$t_{response}$ <sup>4</sup>	Response time	$V_{DD}>3.8V$ , $f=1kHz$	3.8	--	59	mS
$t_r$ <sup>5</sup>	Output rise time	$R1=1Kohm$ $C_Q=20pF$	--	--	0.2	$\mu S$
$t_f$	Output fall time	$R1=1Kohm$ $C_Q=20pF$	--	--	0.2	$\mu S$
$f_{cu}$	Upper corner frequency	-3dB, single pole	20	--	--	kHz
$f_{cl}$	Lower corner frequency	-3dB, single pole	--	--	10	Hz
<b>Magnetic Characteristics</b>						
$B_{Back}$	Pre-induction		-500	--	500	mT
$B_{Diff}$ <sup>6</sup>	Differential fields	$f=1kHz$	-100	--	100	mT
$B_{OP}$	Output on switch point	$f=1kHz$ , $B_{Diff}=5mT$	--	--	0	mT
$B_{RP}$	Output off switch point	$f=1kHz$ , $B_{Diff}=5mT$	0	--	--	mT
$B_{HYS}$	Hysteresis	$f=1kHz$ , $B_{Diff}=5mT$	0.4	1.2	2.0	mT
$\Delta B_M$	Center of switch points	$(B_{OP} + B_{RP}) / 2$	-2.0	0	+2.0	mT

<sup>1</sup>  $I_{OUT}$  does not change state when  $I_{OUT}=OCP$

<sup>2</sup> Time required to initialize device.

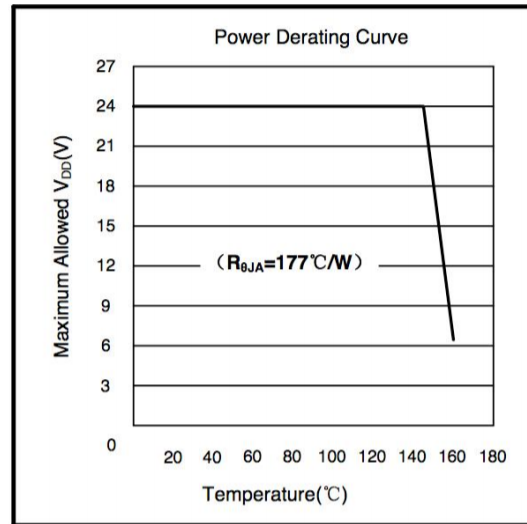
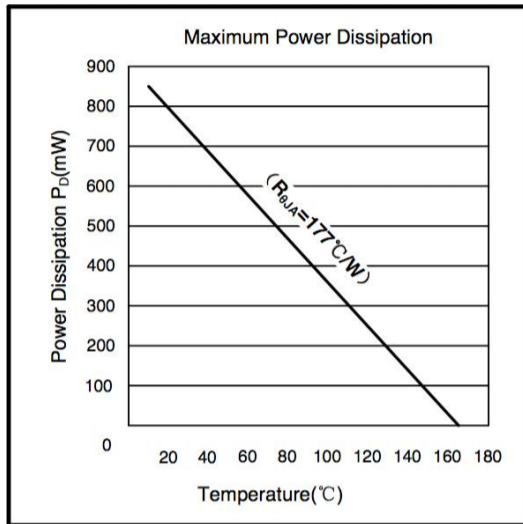
<sup>3</sup> Time required for the output switch points to be within specification.

<sup>4</sup> Equal to  $t_{po} + t_{settle}$

<sup>5</sup> Output Rise Time will be dominated by the RC time constant.

## Thermal Characteristics

Symbol	Parameter	Test Conditions	Rating	Units
$R_{\theta JA}$	Package thermal resistance	Single-layer PCB, with copper limited to solder pads	177	$^{\circ}\text{C}/\text{W}$



## Power Derating Description

The device must be operated below the maximum junction temperature of the device,  $T_{J(max)}$ . Under certain combinations of peak condition, reliable operation may require derating supplied power or improving the heat dissipation properties of the application.

The package Thermal Resistance,  $R_{\theta JA}$ , is figure of merit summarizing the ability of the application and device to dissipate heat from the junction, through all paths to the ambient air. Its primary component is a Effective Thermal Conductivity,  $K$ , of the printed circuit board, including adjacent devices and traces. Radiation from the die through the device case,  $R_{\theta JC}$ , is relatively small component of  $R_{\theta JA}$ . Ambient air temperature,  $T_A$ , and air motion are significant external factors, damped by over molding.

The effect of varying power levels (Power Dissipation,  $P_D$ ), can be estimated.

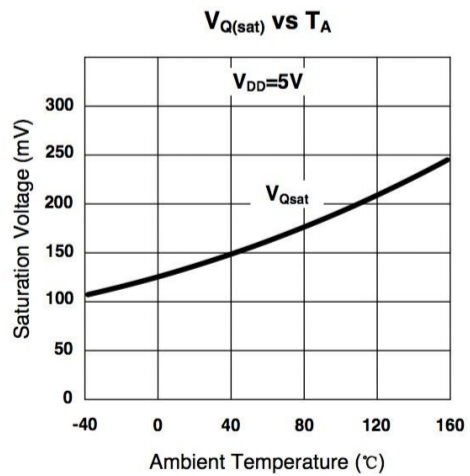
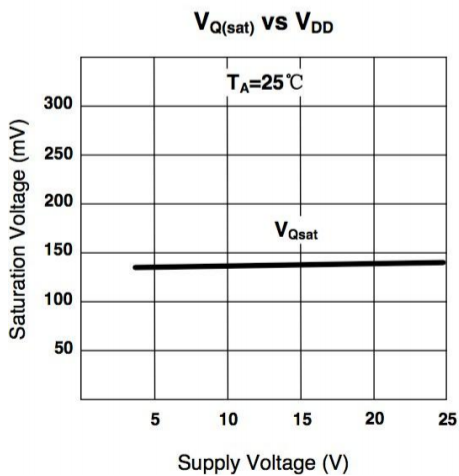
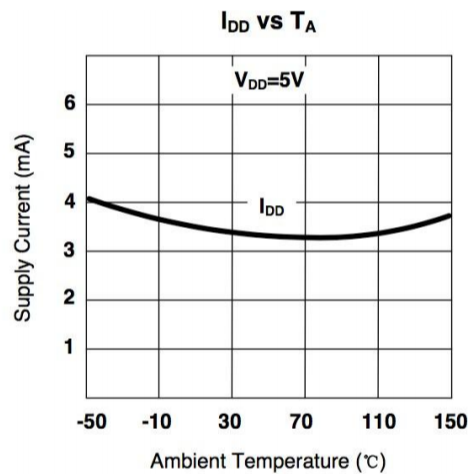
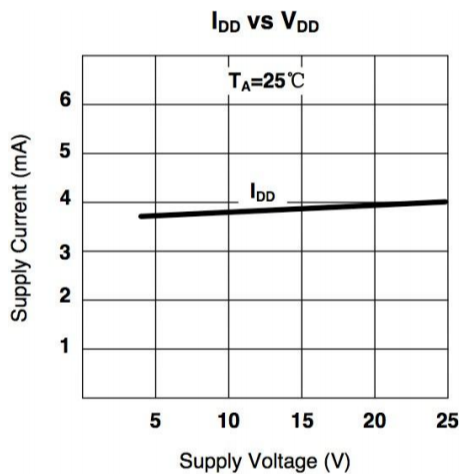
The following formulas represent the fundamental relationships used to estimate  $T_J$ , at  $P_D$ .

$$P_D = V_{DD} \times I_{DD} \quad (1) \quad \Delta T = P_D \times R_{\theta JA} \quad (2) \quad T_J = T_A + \Delta T \quad (3)$$

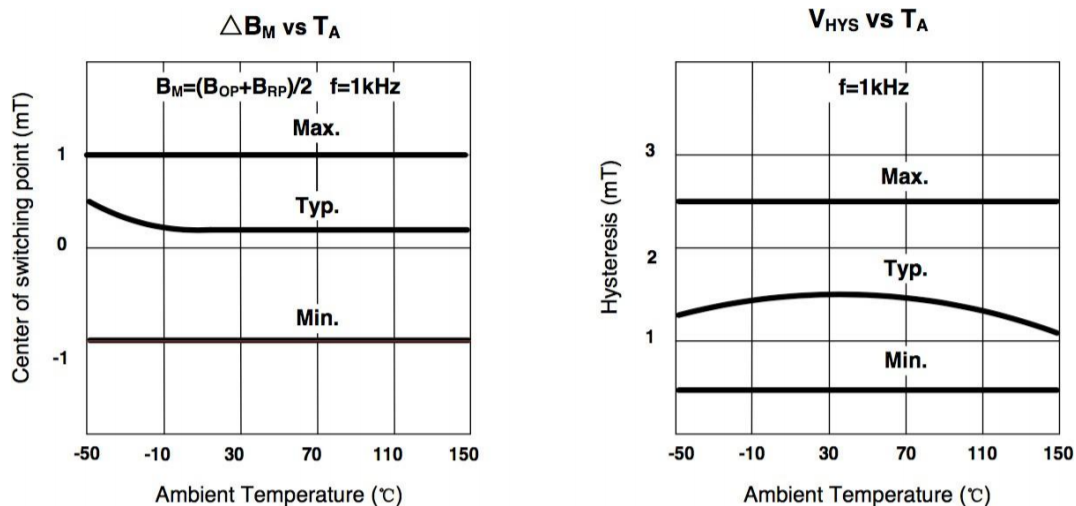
For example  $T_A = 25^\circ \text{C}$ ,  $V_{DD} = 12\text{V}$ ,  $I_{DD} = 3.5\text{mA}$ ,  $R_{\theta JA} = 177^\circ \text{C/W}$ .  $P_D = V_{DD} \times I_{DD} = 12\text{V} \times 3.5\text{mA} = 42\text{mW}$

$$\Delta T = P_D \times R_{\theta JA} = 42\text{mW} \times 177^\circ \text{C/W} = 7.5^\circ \text{C} \quad T_J = T_A + \Delta T = 25^\circ \text{C} + 7.5^\circ \text{C} = 32.5^\circ \text{C}$$

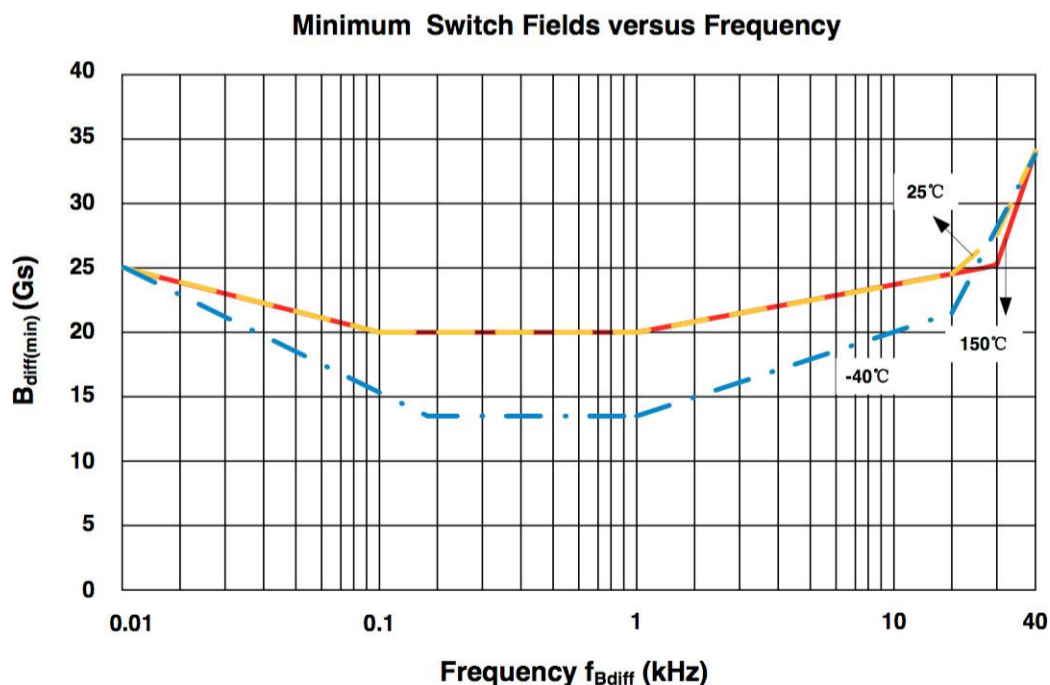
## Empirical Result



## Empirical Result (continued)

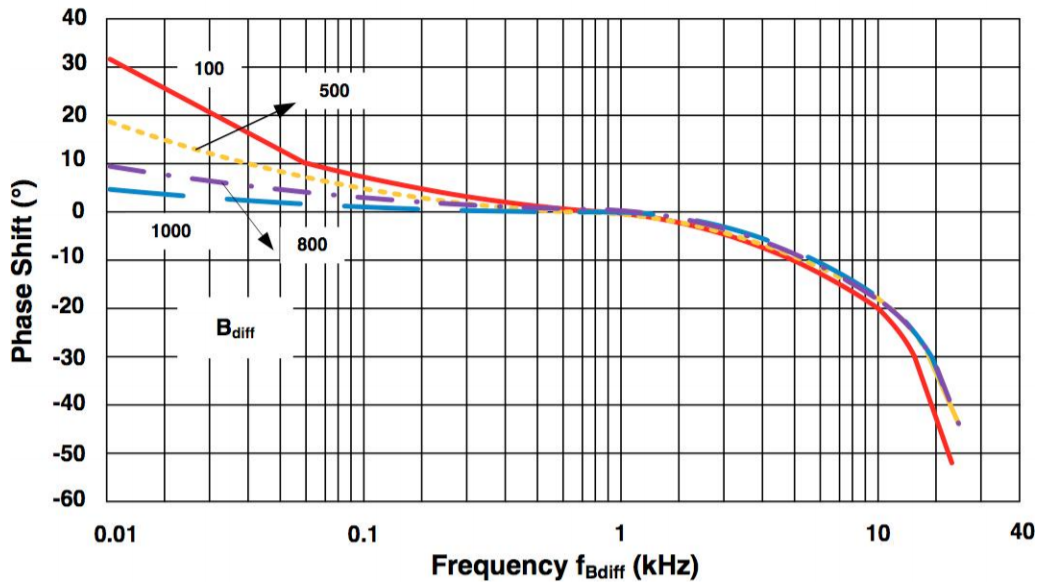


## Simulation Result





**Typical Phase Shift versus Frequency**

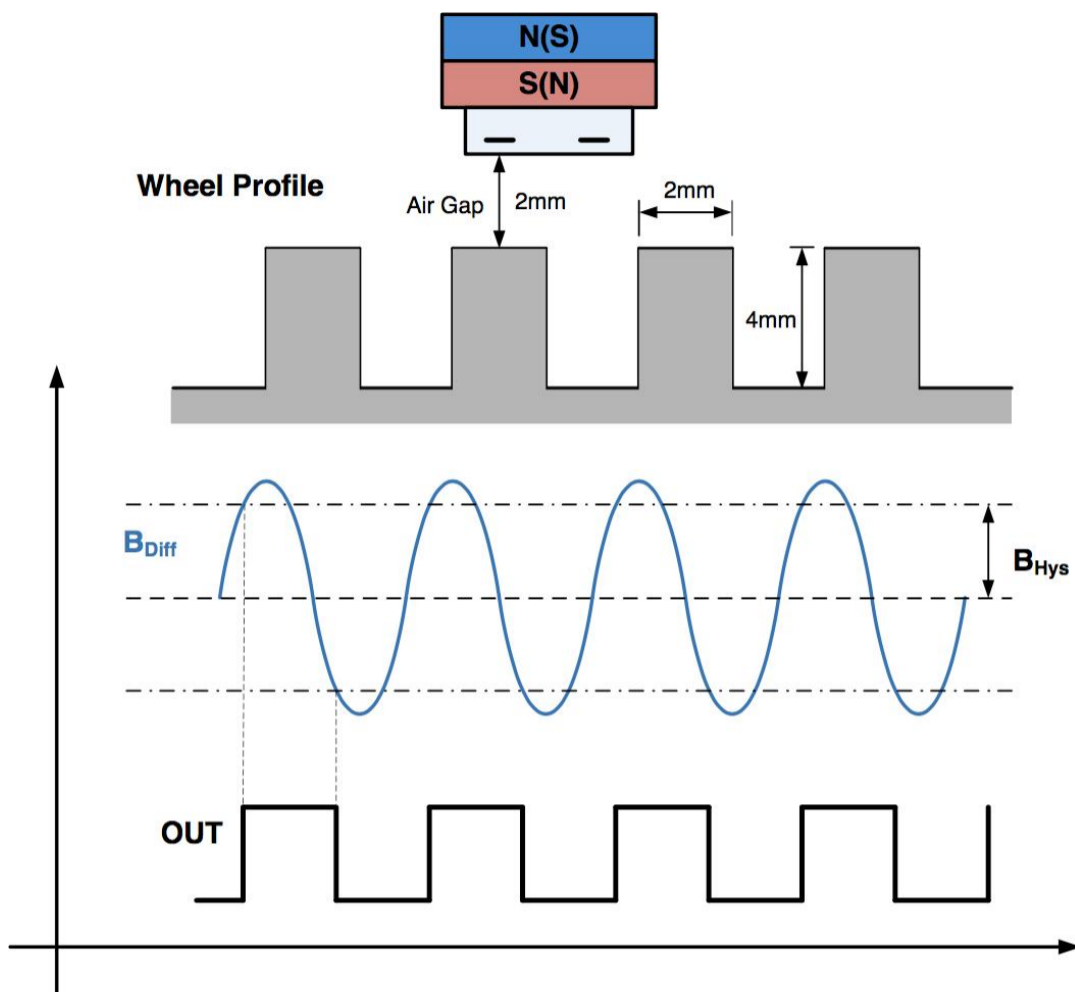


## Gear Tooth Sensing

In the case of ferromagnetic toothed wheel application the IC has to be biased by the South or North pole of a permanent magnet which should cover both Hall probes

The maximum air gap depends on

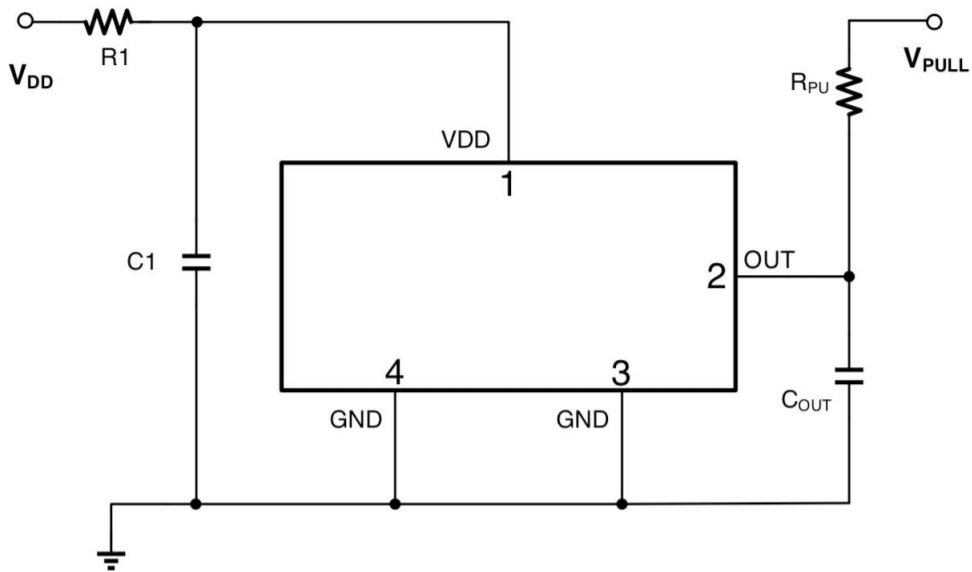
1. - the magnetic field strength (magnet used; pre-induction), and
2. - the toothed wheel that is used (dimensions, material, etc.)



### Recommended Application

The HL9600G contains an on-chip voltage regulator and can operate over a wide supply voltage range. In applications that operate the device from an unregulated power supply, transient protection must be added externally. For applications using a regulated line, EMI/RFI protection may still be required.

**Three-wire-application**



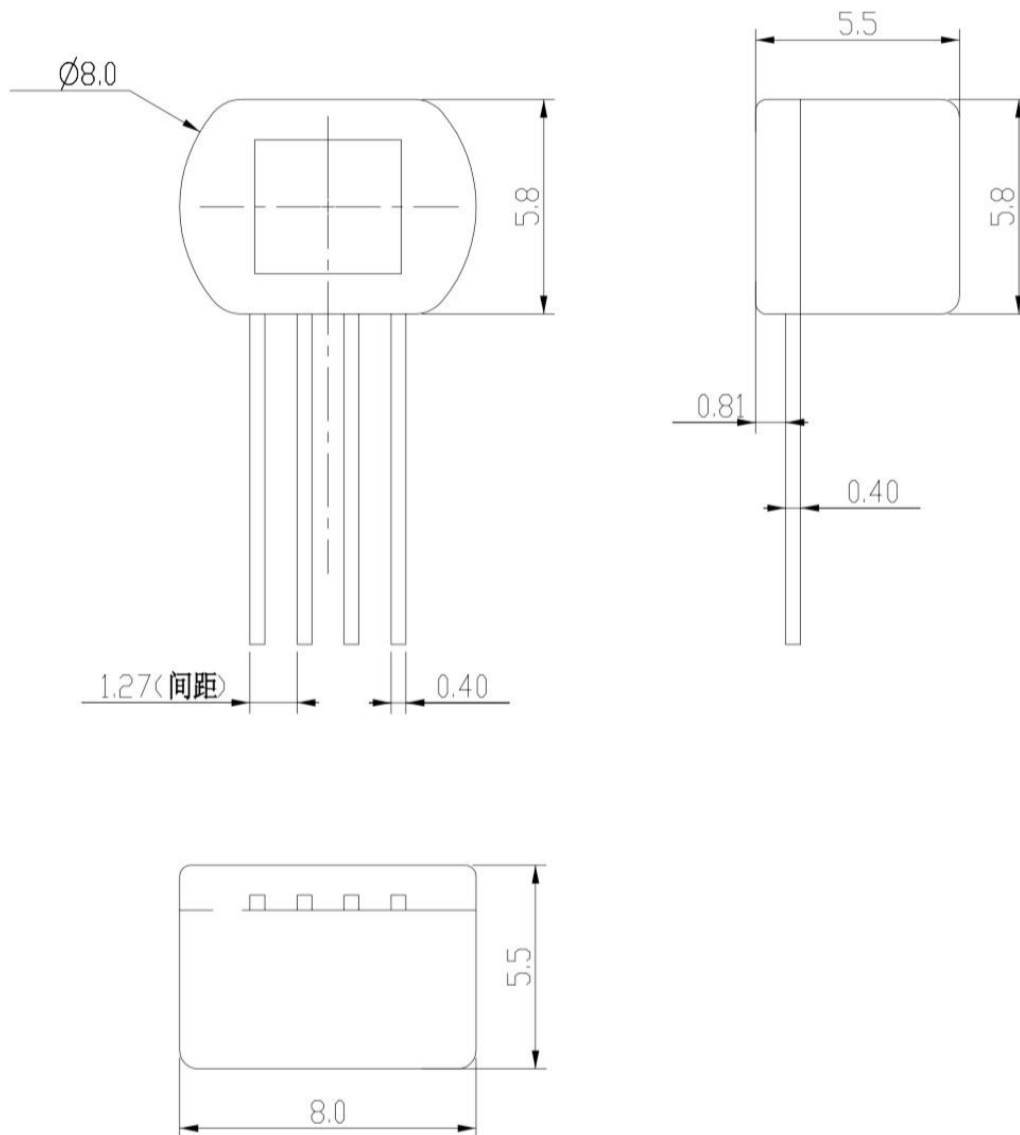
Component	Value	Units
R <sub>PU</sub>	1.2	kΩ
R1	200	Ω
C1	0.1	μF
C <sub>OUT</sub>	1.0	nF

1. Pull-up resistor not required for protection but for normal operation

2. R1 is for improved CI performance

3. C<sub>OUT</sub> is for improved BCI performance

## Package Designator



### Notes:

1. Exact body and lead configuration at vendor's option within limits shown.

2. Height does not include mold gate flash.

Where no tolerance is specified, dimension is nominal.