## Description

The differential Hall Effect sensor JYM16929 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

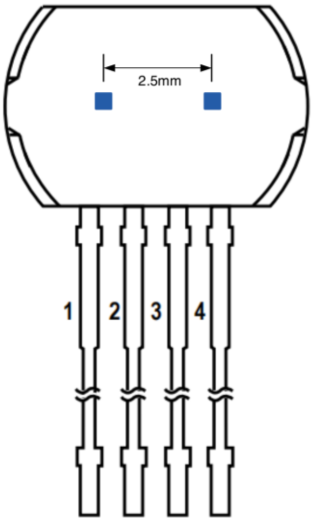
## Features

- Integrated filter capacitor
- Digital output signal
- Larger air gap
- 3.8 to 24V supply operating range
- Wide operating temperature range
- South and North pole pre-induction possible
- 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

## Order Information

| Part Number | Packing | Mounting | Ambient,$T_A$ | Marking |
|---|---|---|---|---|
| JYM16929 | Tube,50 pieces/Tube | 4-pin SIP | -40°C to150°C | 9600G |

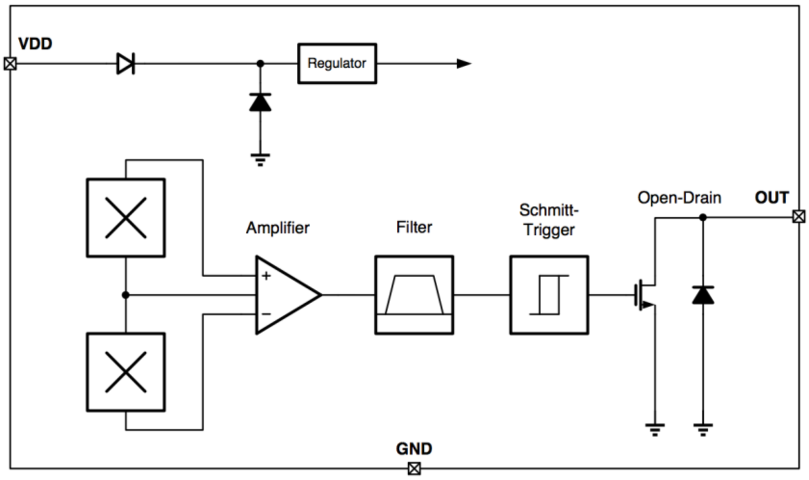
## Pinout Diagram



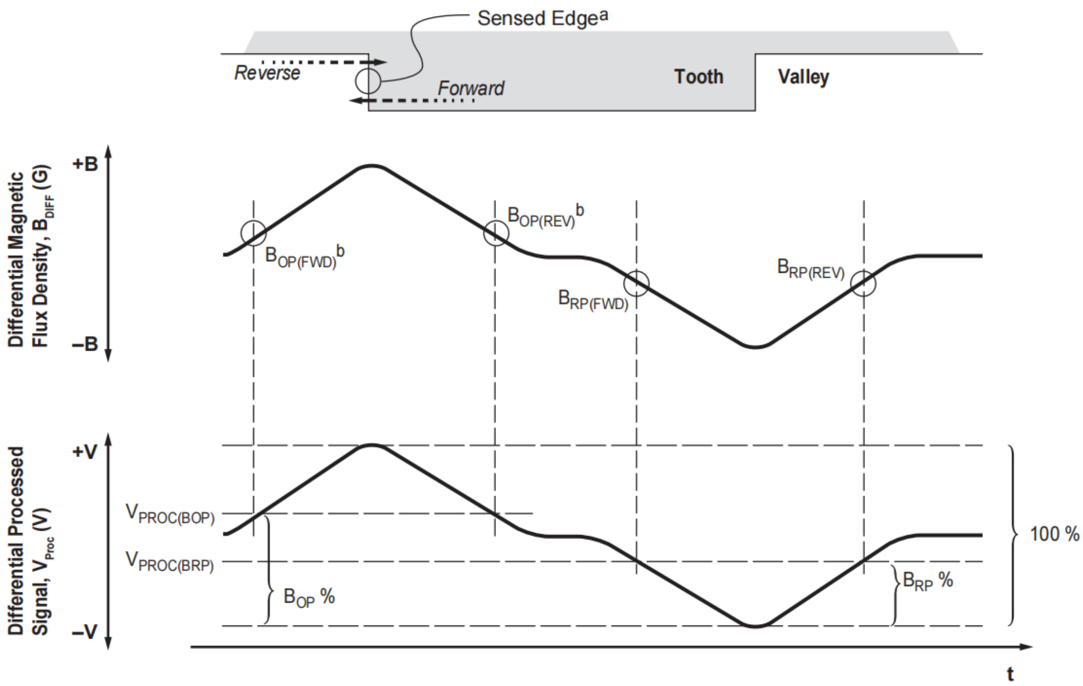

## Terminal List

| Terminal | | Type | Description |
|---|---|---|---|
| **Name** | **Number** | | |
| VDD | 1 | Supply voltage | 3.8V ~ 24 V power supply |
| OUTA | 2 | Output | Open-drain output required a pull-up resistor |
| GND | 3 | Ground | Ground terminal |
| GND | 4 | Ground | Ground terminal |

# Functional Block Diagram



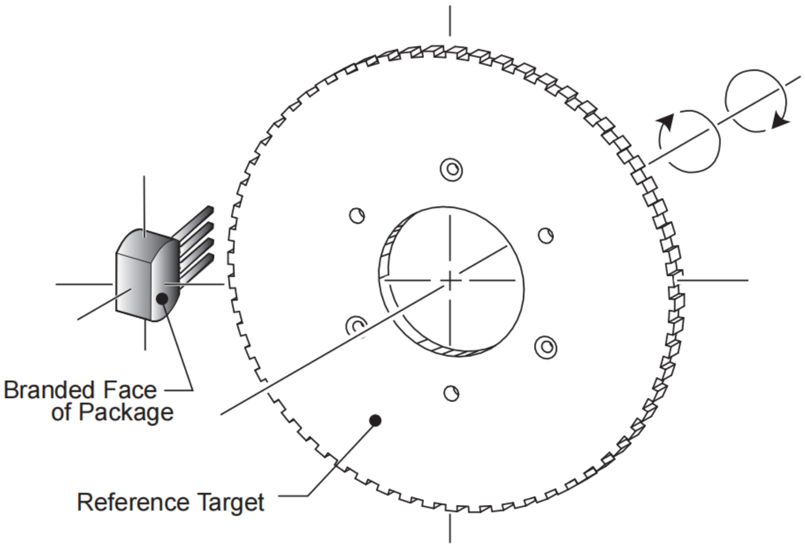

## Definitions of Terms for Switch Points

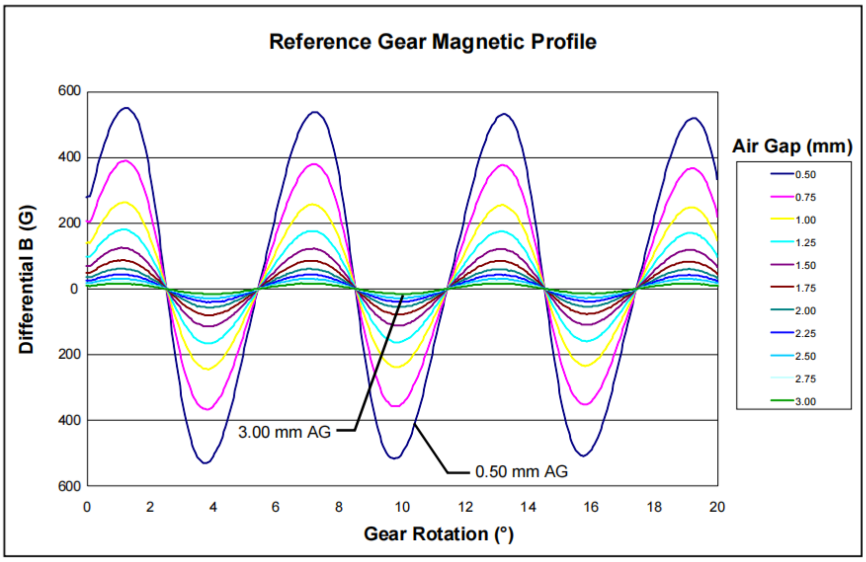



aSensed Edge: leading (rising) mechanical edge in forward rotation, trailing (falling) mechanical edge in reverse rotation

bBOP(FWD) triggers the output transition during forward rotation, and BOP(REV) triggers the output transition during reverse rotation

## Reference Target Characteristics



# Functional Description

## Hall Technology

The JYM16929 contains a single-chip differential Hall-effect sensor IC, a samarium cobalt pellet, and a flat ferrous pole piece (con-centrator). As shown in figure 1, the Hall IC supports two Hall elements, which sense the magnetic profile of the ferrous gear target simultaneously, but at different points (spaced at a 2.2 mm pitch), generating a differential internal analog voltage, VPROC, that is processed for precise switching of the digital output signal. The Hall IC is self-calibrating and also possesses a tempera ture compensated amplifier and offset cancellation circuitry. Its voltage regulator provides supply noise rejection throughout the operating voltage range. Changes in temperature do not greatly affect this device due to the stable amplifier design and the offset compensation circuitry. The Hall transducers and signal process ing electronics are integrated on the same silicon substrate, using a proprietary BiCMOS process.

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 frequence.

The JYM16929 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.

## Target Profiling During Operation

An operating device is capable of providing digital information that is representative of the mechanical features of a rotating gear.

The waveform diagram in figure 3 presents the automatic transla tion of the mechanical profile,through the magnetic profile that it induces, to the digital output signal of the JYM16929. No additional optimization is needed and minimal processing circuitry is required. This ease of use reduces design time and incremental assembly costs for most applications.

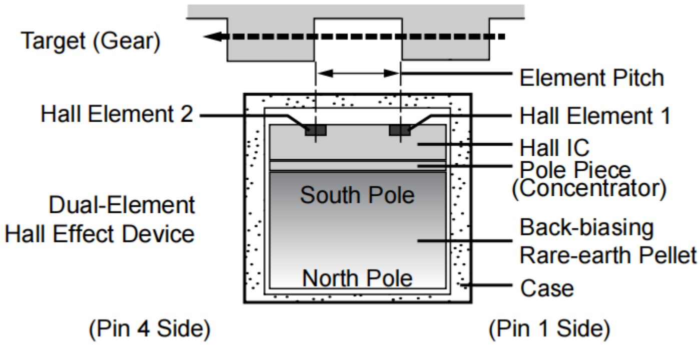



Figure 1. Relative motion of the target is detected by the dual Hallelements mounted on the Hall IC.

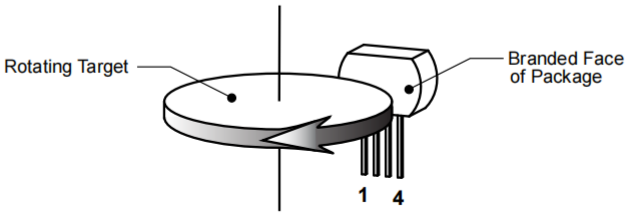



Figure 2. This left-to-right (pin 1 to pin 4) direction of target rotation resultsin a high output state when a tooth of the target gear is nearest thepackage face (see figure 3). A right-to-left (pin 4 to pin 1) rotation invertsthe output signal polarity.

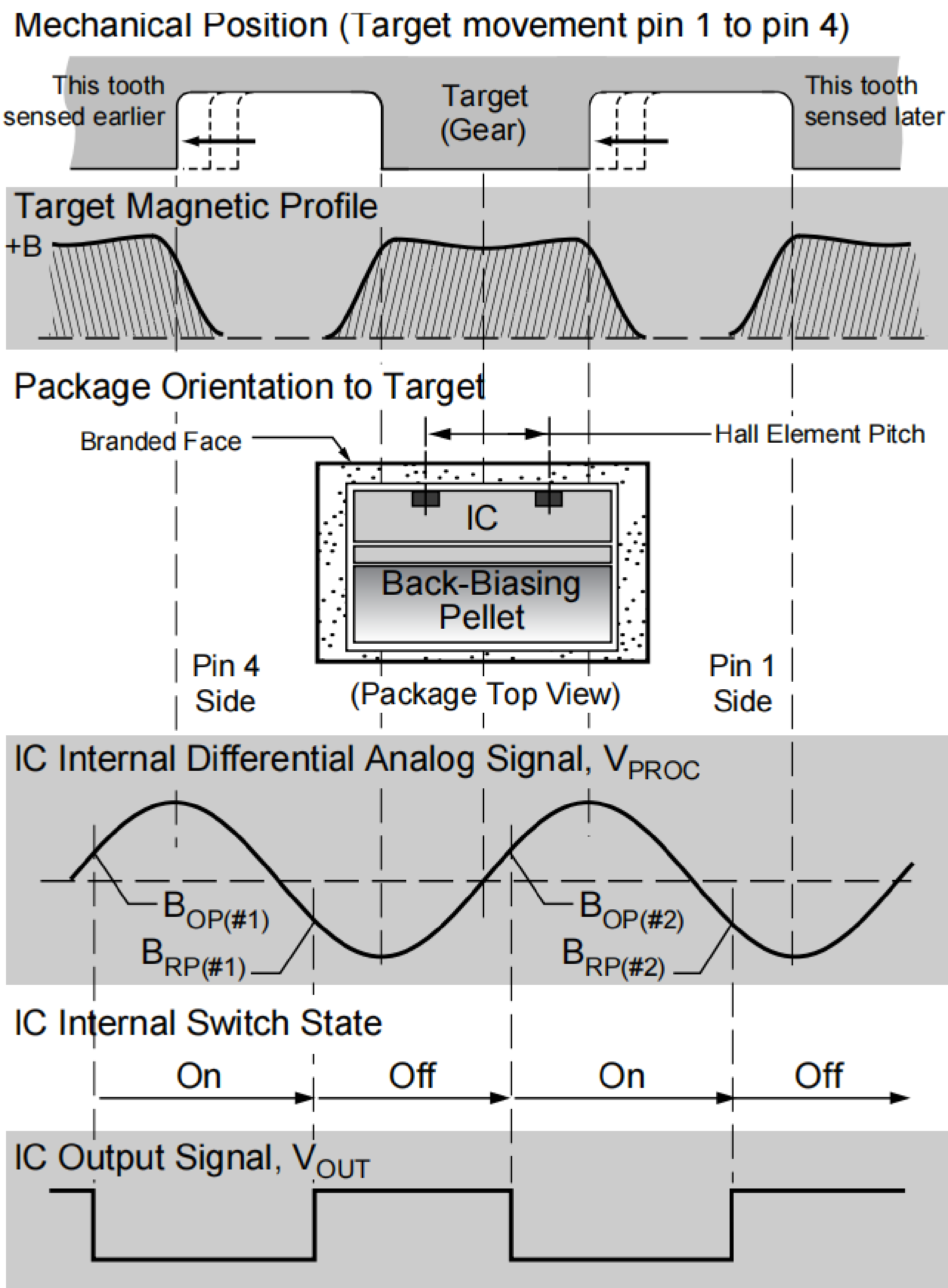



Figure 3. The magnetic profile reflects the geometry of the target, allowing the JYM16929 to present an accurate digital output response.

## 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 | ℃ |
| Maximum junction temperature | $T_J$ | -55 | 165 | ℃ |
| Storage temperature | $T_{STG}$ | -65 | 175 | ℃ |

*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 |

## Thermal Characteristics

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

## Operating Characteristics

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

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

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| **Electrical parameters** | | | | | | |
| $V_{DD}$ | 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℃ | -- | 150 | -- | mV |
| $I_{QL}$ | Output leakage current | $V_{DD}$ < 24V | -- | -- | 10 | μA |
| $V_{DZ}$ | 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[1] | Over current protection | $T_A$=25℃ | 40 | -- | -- | mA |
| $t_{po}$[2] | Power-on time | $V_{DD}$>3.8V | -- | 3.8 | 9 | mS |
| $t_{settle}$[3] | Settling time | $V_{DD}$>3.8V, f=1kHz | 0 | -- | 50 | mS |
| $t_{response}$[4] | Response time | $V_{DD}$>3.8V, f=1kHz | 3.8 | -- | 59 | mS |
| $t_r$[5] | Output rise time | R1=1Kohm $C_Q$=20pF | -- | -- | 0.2 | μS |
| $t_f$ | Output fall time | R1=1Kohm $C_Q$=20pF | -- | -- | 0.2 | μS |
| $f_{cu}$ | Upper corner frequency | -3dB, single pole | -- | 20 | -- | kHz |
| $f_{cl}$ | Lower corner frequency | -3dB, single pole | -- | 5 | -- | Hz |
| **Magnetic Characteristics** | | | | | | |
| $B_{Back}$ | Pre-induction | | -50 | -- | 500 | mT |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | 0 | | | |
| $B_{Diff}$[6] | Differential fields | f=1kHz | -10<br>0 | -- | 100 | mT |
| $B_{OP}$ | Output on switch point | f=1kHz, $B_{Diff}$ increasing | 0.3 | 0.4<br>5 | 0.6 | mT |
| $B_{RP}$ | Output off switch point | f=1kHz, $B_{Diff}$ decreasing | -0.<br>3 | -0.4<br>5 | -0.6 | mT |
| $B_{HYS}$ | Hysteresis | f=1kHz, $B_{Diff}$=5mT | 0.6 | 0.9 | 1.2 | mT |
| △$B_M$ | Center of switch points | ( $B_{OP}$ + $B_{RP}$ ) / 2 | -0.<br>3 | 0 | 0.3 | mT |

[1] *$I_{OUT}$ does not change state when $I_{OUT}$=OCP*

. [2] *Time required to initialize device.*

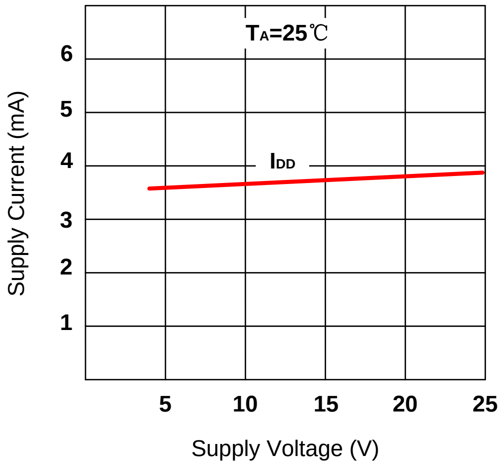
[3] *Time required for the output switch points to be within specification.*

[4] *Equal to $t_{po}$ + $t_{settle}$*

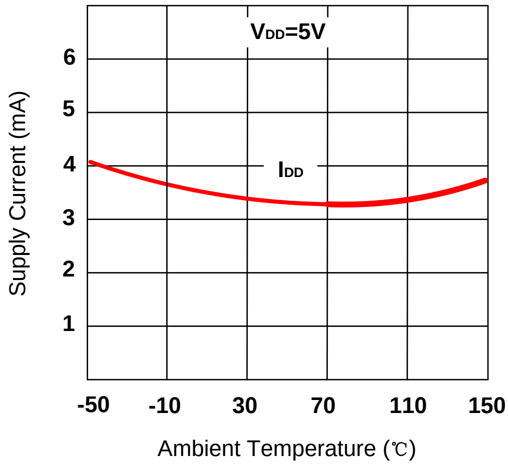
. [5] *Output Rise Time will be dominated by the RC time constant.*

## TYPICAL CHARACTERISTICS

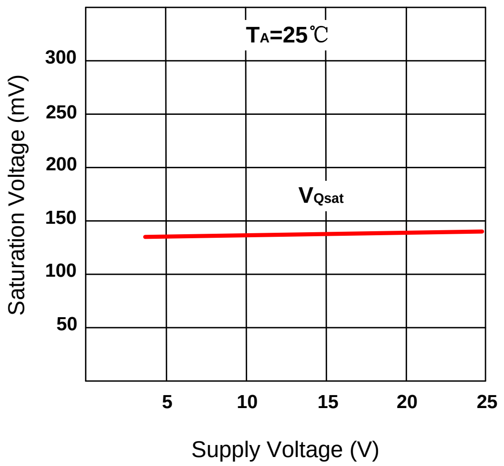
$I_{DD}$ vs $V_{DD}$



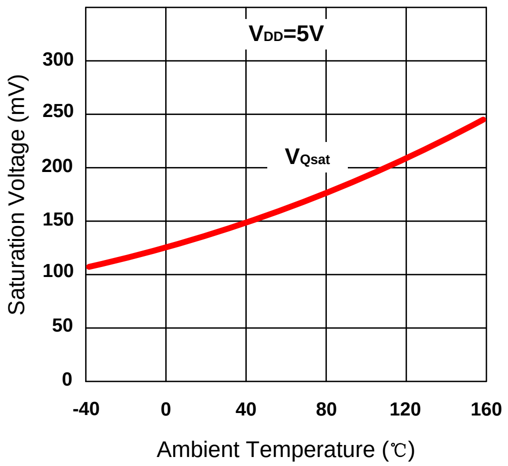

$I_{DD}$ vs $T_A$

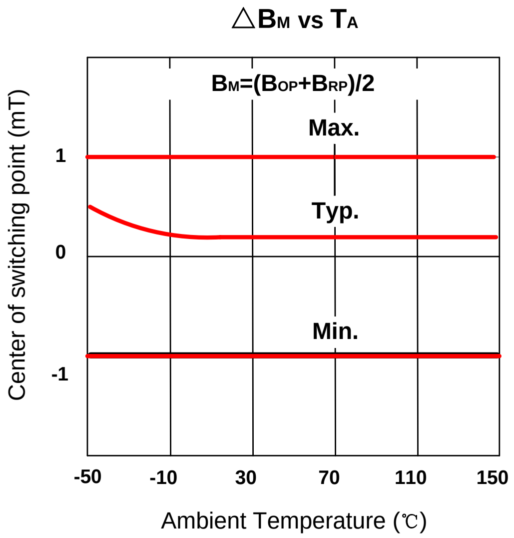


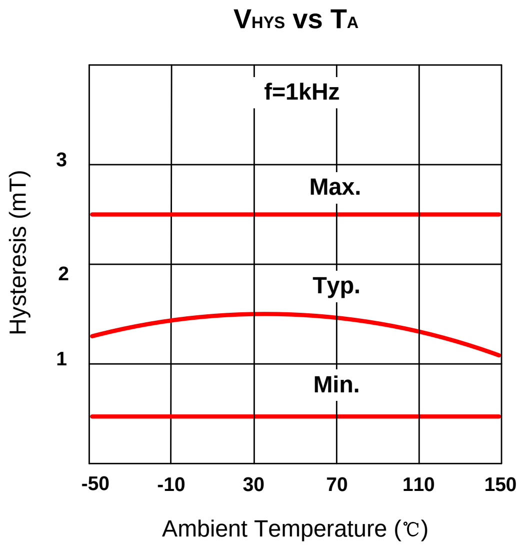

$V_{Q(sat)}$ vs $V_{DD}$




$V_{Q(sat)}$ vs $T_A$






## 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 $P_D$.

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

For example $TA=25℃, V_{DD}=5V, I_{DD}=6.5mA, R_{\theta JA}=177℃/W$.

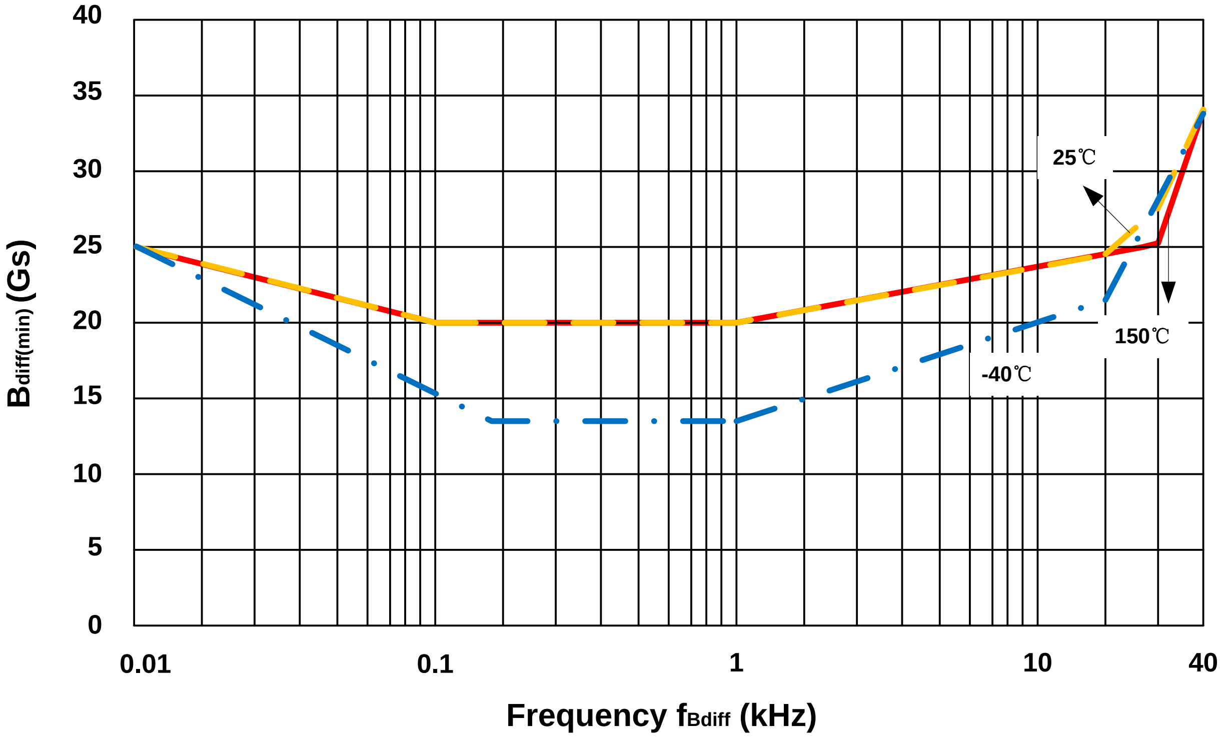
$$P_D=V_{DD} \times I_{DD}=5V \times 6.5mA=32.5mW$$

$$\triangle T=P_D \times R_{\theta JA}=32.5mW \times 177℃/W=5.8℃$$

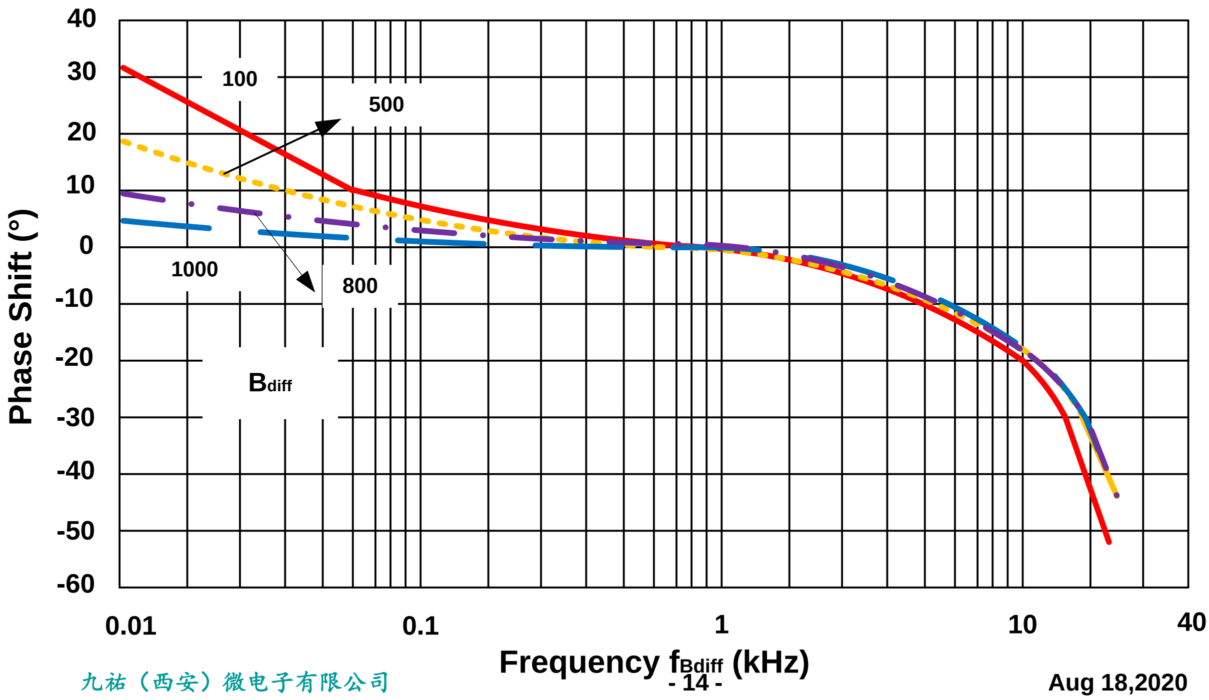
$$T_J=T_A+\triangle T=25℃+5.8℃=30.8℃$$

## Simulation Result

**Minimum Switch Fields versus Frequency**




**Typical Phase Shift versus Frequency**

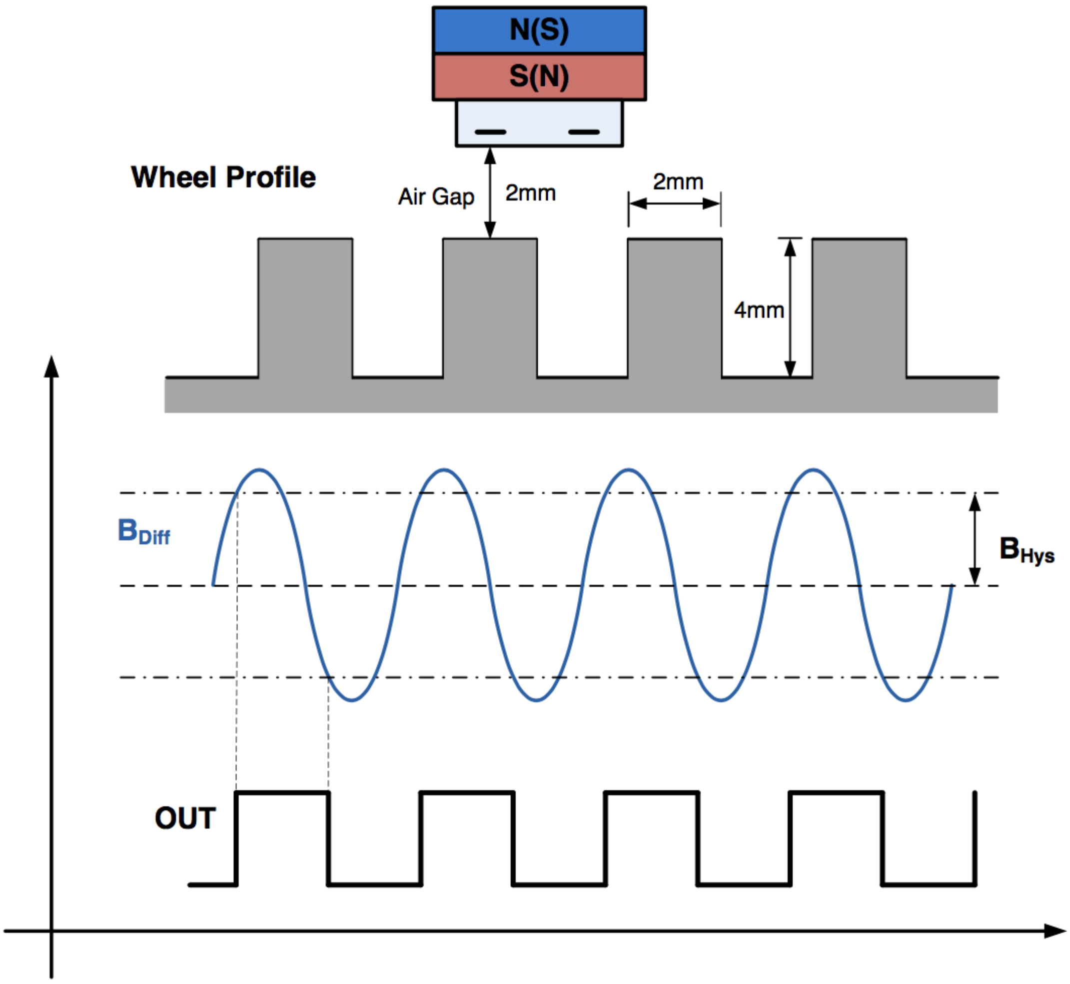


## Gear Tooth Sensing

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

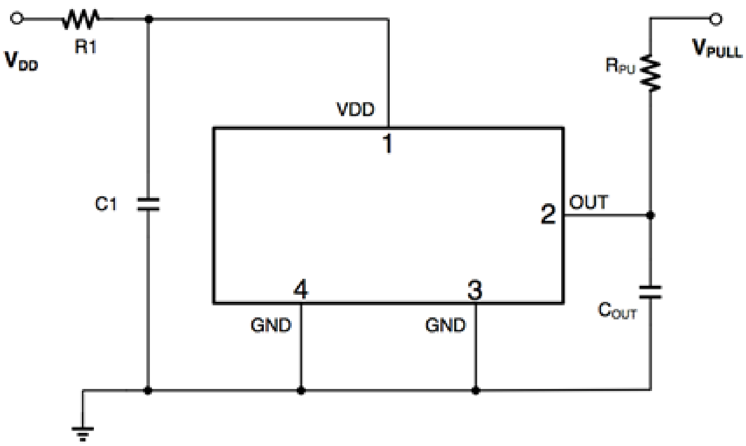
1. - the magnetic field strength (magnet used; pre-induction), and
2. - the toothed wheel that is used (dimensions, material, etc.)




## Recommended Application

The JYM16929 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**



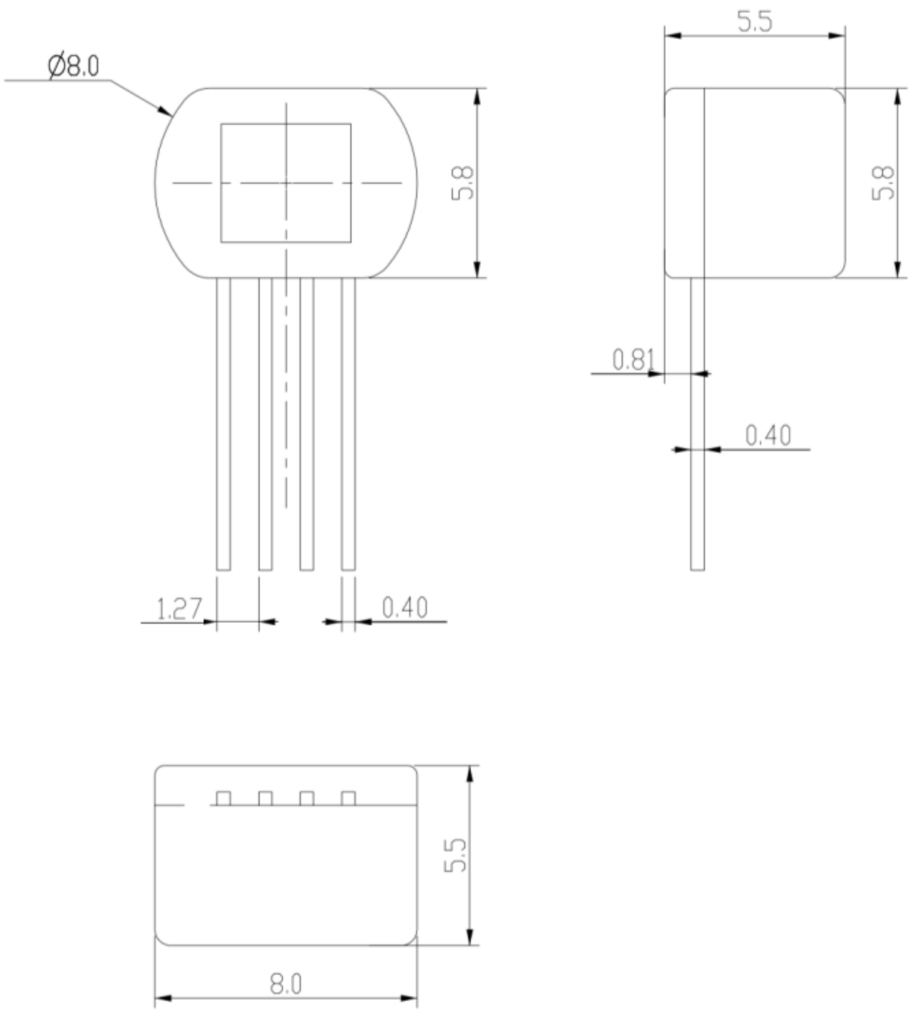

| Component | Value | Units |
|---|---|---|
| $R_{PU}$ | 2 | kΩ |
| R1 | 100 | Ω |
| C1 | 100 | nF |
| $C_{OUT1}$ | 1 | nF |

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

*2.R1 is for improved CI performance*

*3. $C_{OUT}$ 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.*