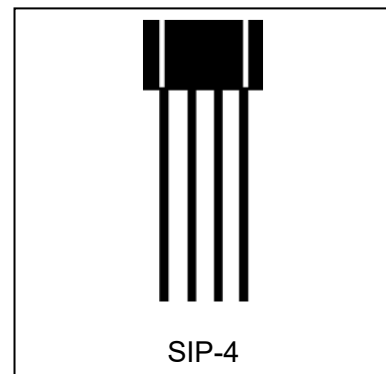


High Accuracy Differential Speed Sensor IC CYGTS9621 with Zero-Crossing Output Signal

The differential Hall Effect Gear Tooth sensor CYGTS9621 provides high sensitivity and superior stability over temperature and symmetrical thresholds to achieve a stable duty cycle. CYGTS9621 is particularly suitable for rotational speed detection and timing applications of ferromagnetic toothed wheels such as anti-lock braking systems, transmissions, crankshafts, etc. The integrated circuit, which is based on Hall Effect principle, is response to changing differential magnetic fields created by ferrous targets when coupled with a magnet. It provides a digital signal output with frequency proportional to the rotational speed. A differential Hall IC is not influenced by radial vibration within the effective airgap of the sensor and requires no external signal processing.

Features

- Integrated filter capacitor
- Accurate true zero-crossing switch-point
- South and North pole pre-induction possible
- Large air gap
- 3.8V to 24V supply operating range
- Wide operating temperature range -40°C ~150°C
- Protection against over-voltage in all PIN
- Reverse-current protection in power supply V_{DD} PIN
- Output protection against electrical disturbances



Applications

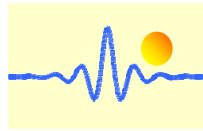
Automotive and Heavy-Duty Vehicles	Industrial Areas:
<ul style="list-style-type: none"> • Camshaft and crankshaft speed and position • Transmission speed • Tachometers • Anti-skid/traction control 	<ul style="list-style-type: none"> • Sprocket speed • Chain link conveyor speed/distance • Stop motion detector • High-speed low-cost proximity • Tachometers, counters.

Device Information

Part number	Packing	Mounting	Temperature range	Marking	Reference (verification required)
CYGTS9621VB	Bulk, 500pcs/bag	4-pin SIP	-40°C~150°C	9621	Infineon TLE4921-5U

Operating Range

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Back Bias Range	B _{Bias}	Operating	-500	--	500	mT
Differential Magnetic Field	ΔB	f=1kHz	-100	--	100	mT
Supply Voltage	V _{DD}	Operating	3.8	12	24	V
Operating Temperature	T _A		-40	~	150	°C
Storage Temperature	T _S		-65	~	175	°C



Electrical and Magnetic Specifications

Operating Parameters $T_A = -40^{\circ}\text{C}$ to 150°C , $V_{DD} = 12\text{V}$ (unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ.	Max	Unit
Supply Voltage	V_{DD}	Operating	3.8	12	24	V
Supply Current	I_{DD}	$V_{DD}=3.8$ to 24V	2.5	3.5	4.5	mA
Output Saturation Voltage	V_{sat}	$I_{out}=20\text{mA}$, $T_A=25^{\circ}\text{C}$	--	140	400	mV
Output Leakage Current	I_{Leak}	$V_{out}=24\text{V}$	--	--	10	μA
Overvoltage protection at supply voltage	V_{SP}	$I_{DD} = 10\text{mA}$	30	35	40	V
Overvoltage protection at output terminal	V_{OP}	$I_{out} = 1\text{mA}$, $V_{out}=\text{High}$	30	35	40	V
Over current protection	OCP ¹	$T_A=25^{\circ}\text{C}$	40	--	--	mA
Power on time	t_{po} ²	$V_{DD} > 3.8\text{V}$	--	3.8	9.0	ms
Settling time	t_{settle} ³	$V_{DD}>3.8\text{V}$, $f=1\text{kHz}$	0	--	50	ms
Response time	$t_{response}$ ⁴	$V_{DD}>3.8\text{V}$, $f=1\text{kHz}$	3.8	--	59	ms
Output Rise Time	T_R ⁵	$R1=1\text{k}\Omega$ $C=20\text{pF}$	--	--	0.2	μs
Output Fall Time	T_F	$R1=1\text{k}\Omega$ $C=20\text{pF}$	--	--	0.2	μs
Upper corner frequency	f_{cu}	-3dB, single pole	--	20	--	kHz
Lower corner frequency	f_{cl}	-3dB, single pole	--	5	--	Hz
Back Bias Range	B_{Bias}	Operating	-500		500	mT
Differential Magnetic Field	ΔB ⁶	$f=1\text{kHz}$	-100		100	mT
Hysteresis	B_{HYS}	$f=1\text{kHz}$, $\Delta B=5\text{mT}$	0.4	0.8	2.0	mT

1 I_{OUT} does not change state when $I_{OUT}=OCP$.

2 Time required initializing device.

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

4 Equal to $t_{po} + t_{settle}$.

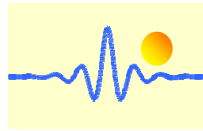
5 Output Rise Time will be dominated by the RC time constant.

6 Exceeding this limit might result in decreased duty cycle performance and the phase accuracy.

Absolute Maximum Ratings

Parameter	Symbol	Minimal value	Maximal value	Unit
Power supply voltage	V_{DD}	-30	30	V
Power output 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	$^{\circ}\text{C}$
Maximum junction temperature	T_J	-55	165	$^{\circ}\text{C}$
Storage temperature	T_{STG}	-65	175	$^{\circ}\text{C}$

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.



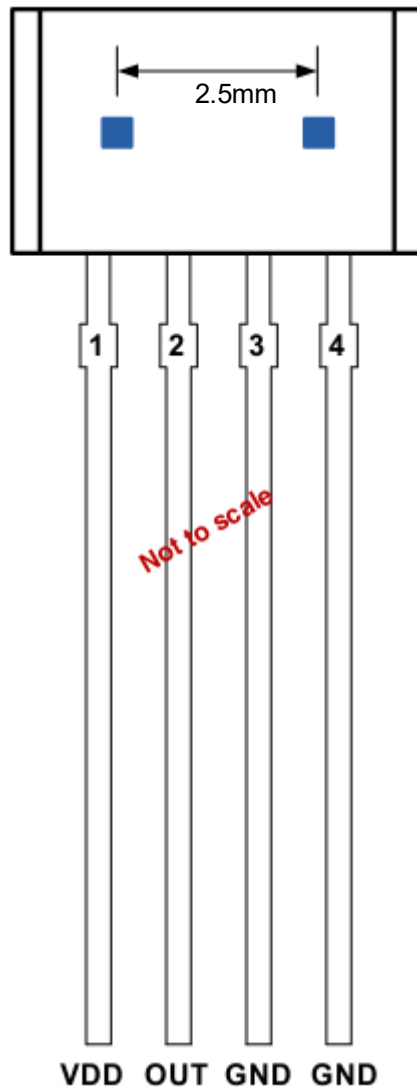
ESD (Emergency Shutdown System) Protection

Human Body Model (HBM) Tests

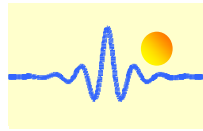
Parameter	Symbol	Max.	Unit	Note
ESD	V_{ESD}	± 4.0	kV	According to Standard EIA/JESD22-A114-B-HBM

Pin Configuration

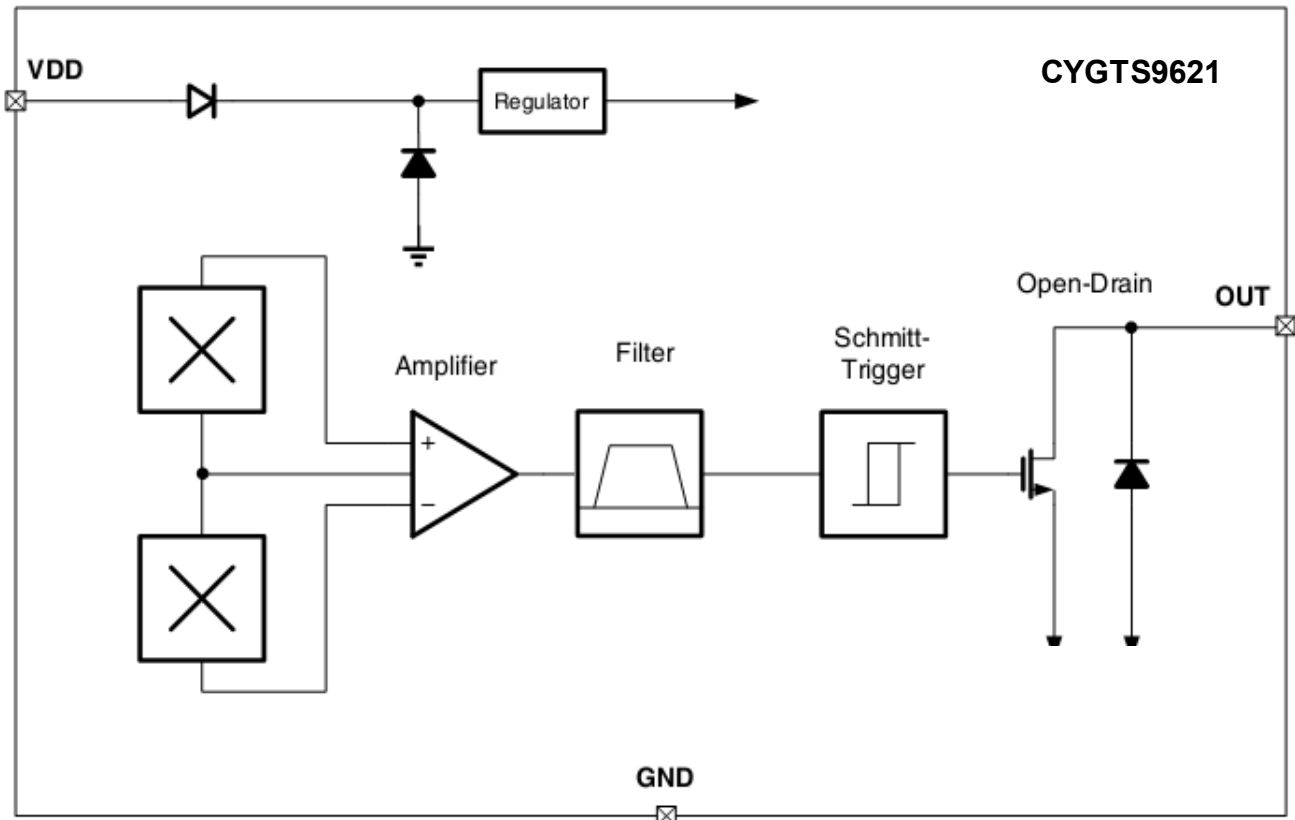
4-Terminal SIP VB package (Top View)



Pin No.	Symbol	Type	Description
1	V_{DD}	Supply voltage	3.8V to 24V power supply
2	OUT	Output	Open-drain output required a pull-up resistor
3	GND	Ground	Ground terminal
4	GND	Ground	Ground terminal



Functional Block Diagram

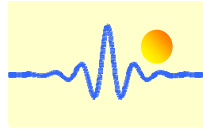


Functional Description

The CYGTS9621 sensor IC contains two integrated Hall sensor elements that are used to differentially respond to a magnetic field across the surface of the IC. The trigger switches the output off (output high) when the differential magnetic field crosses zero while increasing in strength (referred to positive direction) and switches the output on (output low) when the differential magnetic field crosses zero while decreasing strength (the negative direction).

The operation is achieved using two separate comparators. Both comparators use the same reference point, 0G, to provide high accuracy, but one comparator has a positive hysteresis, BHYS1, and the other a negative hysteresis, BHYS2. Therefore, one comparator switches (BOP) at the zero crossing on an increasing differential signal and the other switches (BRP) at the zero crossing on a decreasing differential signal. The hysteresis on each comparator precludes false switching on noise or target jitter.

The CYGTS9621 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.



Electro Magnetic Compatibility – (values depend on R_{Series} !)

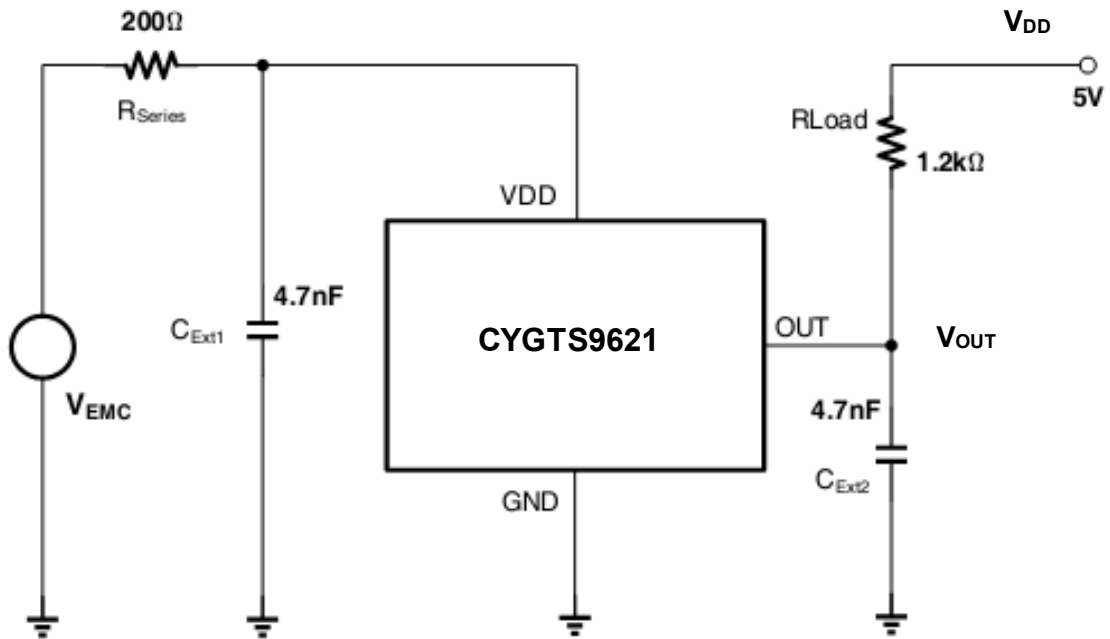
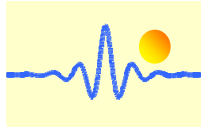
Ref. ISO 7637-1; see the test circuit for EMC tests;

$\Delta B_{PP} = 10\text{mT}$ (ideal sinusoidal signal); $V_{DD} = 13.5\text{V}$, $f_B = 1\text{ kHz}$; $T_A = 25^\circ\text{C}$; $R_{Series} \geq 200\Omega$;

Parameter	Symbol	Level /Typ.	Status
Test pulse 1	V_{EMC}	IV /-100V	C
Test pulse 2		IV / 100V	C
Test pulse 3a		IV /-150V	A
Test pulse 3b		IV / 100V	A
Test pulse 4		IV /-7V	A
Test pulse 5		IV / 86.5V	C

1. *Test criteria for status A: No missing pulse and no additional pulse on the IC output signal, and duty cycle and jitter are in specification limits.*
2. *Test criteria for status B: No missing pulse and no additional pulse on the IC output signal.*
3. *Test criteria for status C: One or more parameter can be out of specification during the exposure but returns automatically to normal operation after exposure is removed.*

Test Circuit for EMC Tests

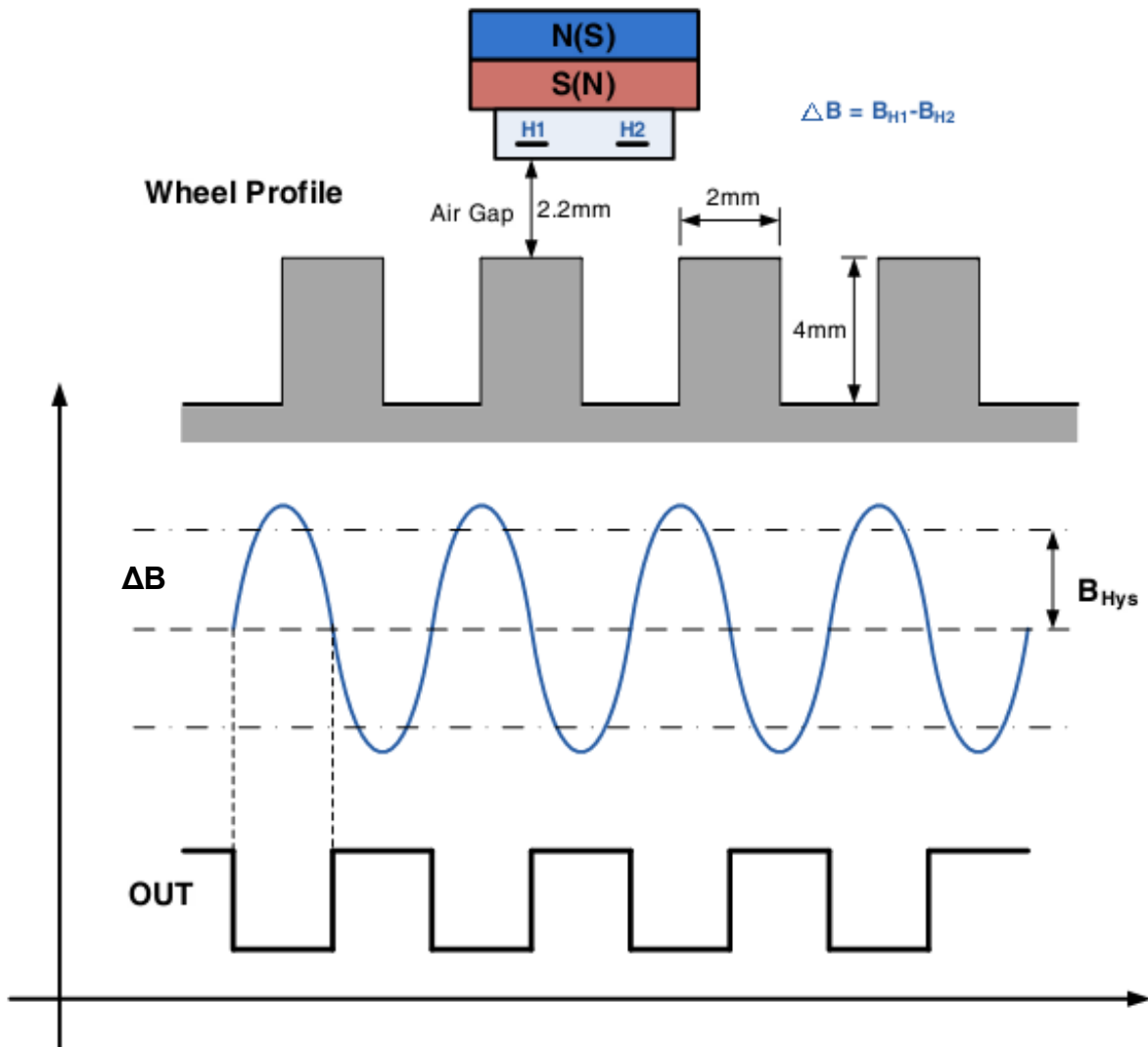
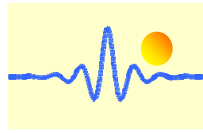


Gear Tooth Sensing

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

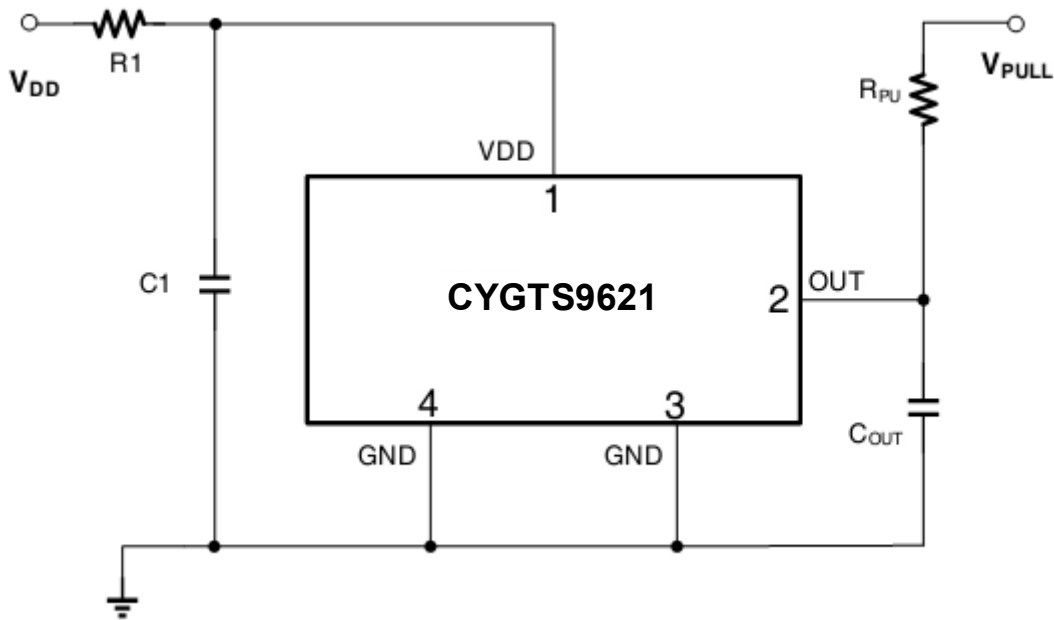
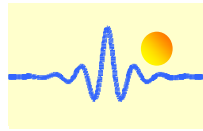
- the magnetic field strength (magnet used; pre-induction), and
- the toothed wheel that is used (dimensions, material, etc.)



Recommended Application

The CYGTS9621 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 Connection

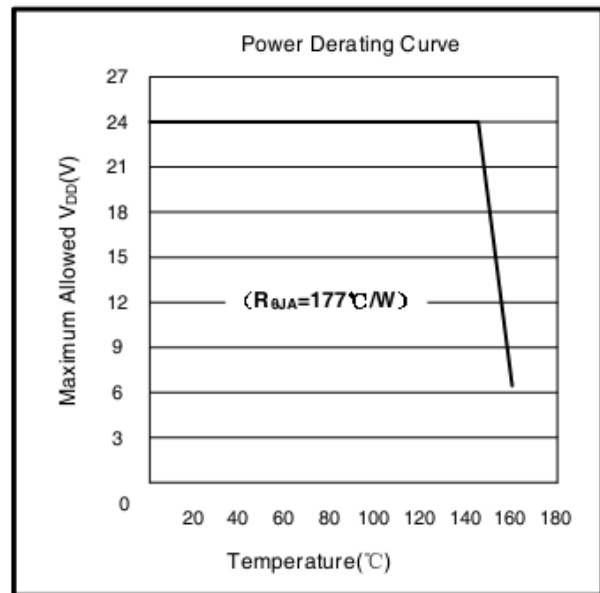
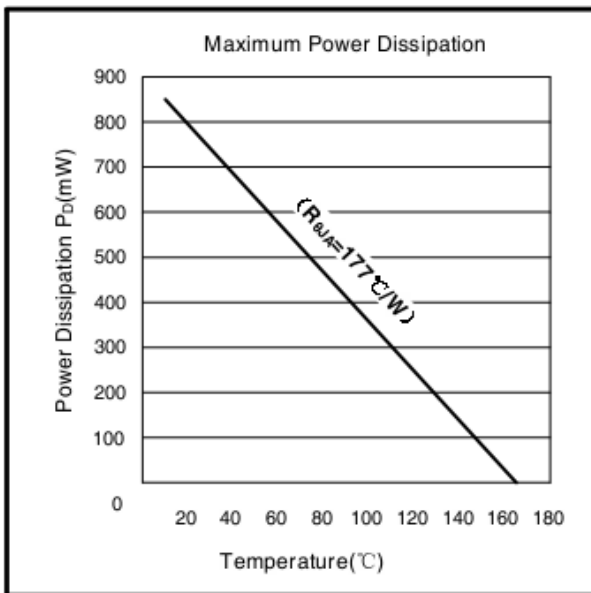
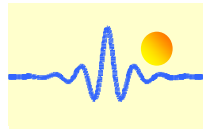


Component	Value	Units
R _{PU}	1.2	kΩ
R1	200	Ω
C1	0.1	μF
C _{OUT}	1.0	μF

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

Thermal Characteristics

Symbol	Parameter	Test Conditions	Rating	Units
R _{QJA}	VB Package thermal resistance	Single-layer PCB, with copper limited to solder pads	177	°C/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 an 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 .

$$P_D = V_{DD} \times I_{DD} \quad (1)$$

$$\Delta T = P_D \times R_{\theta JA} \quad (2)$$

$$T_J = T_A + \Delta T \quad (3)$$

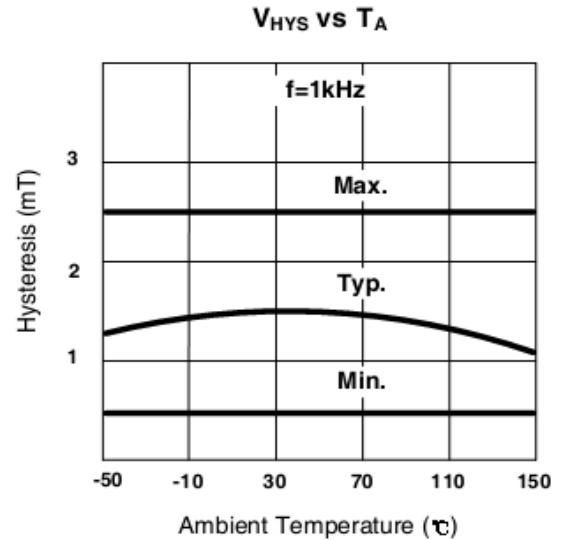
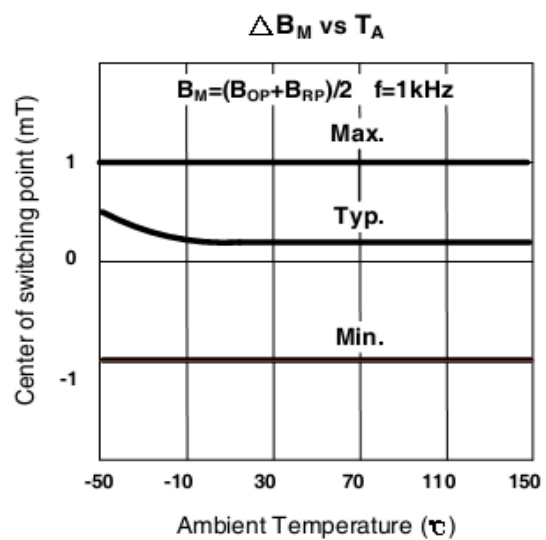
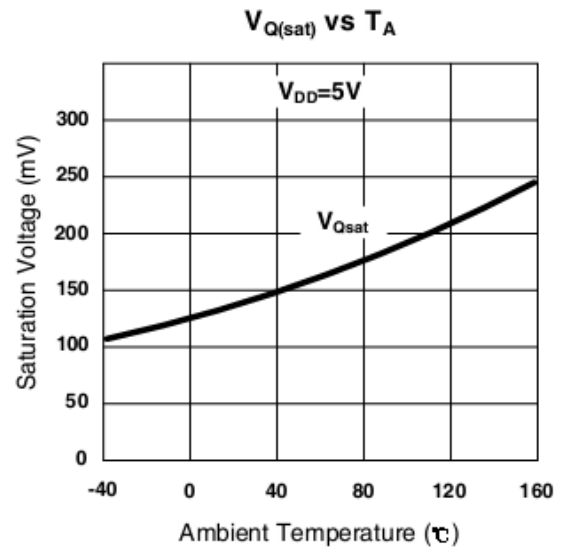
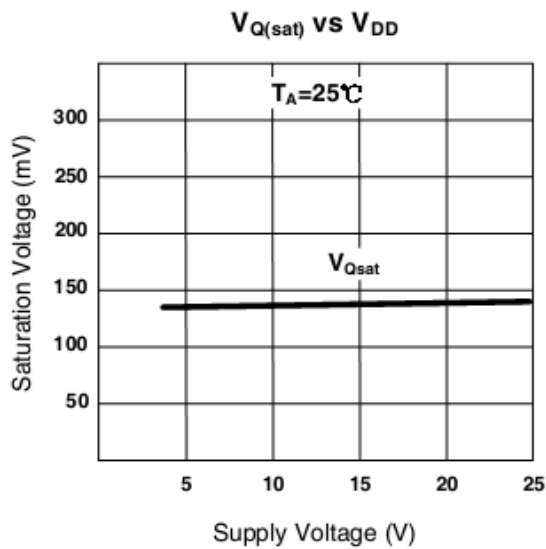
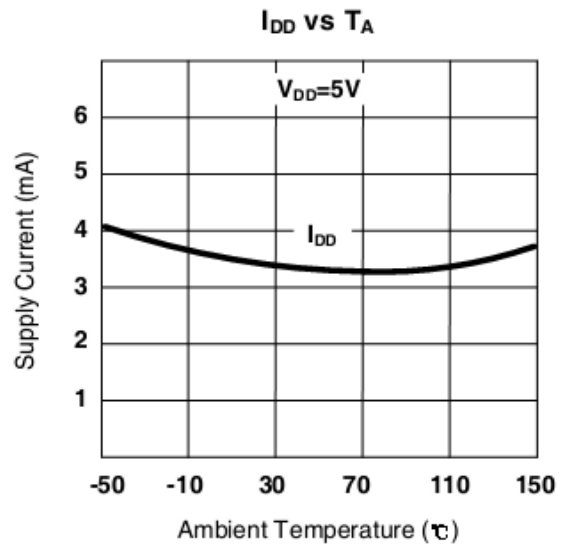
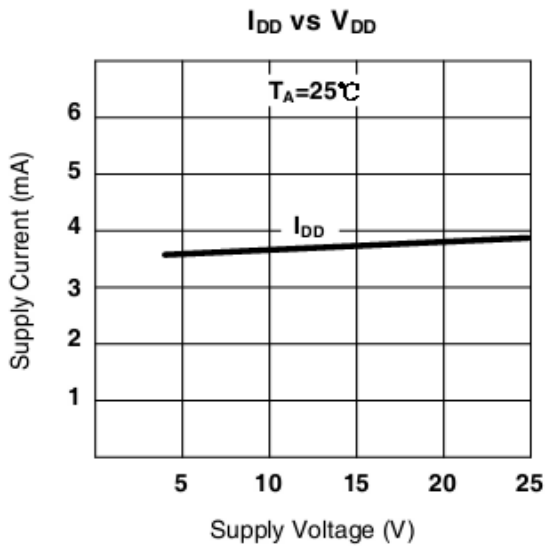
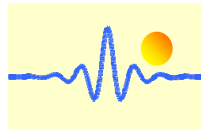
For example $T_A = 25^\circ\text{C}$, $V_{DD} = 12\text{V}$, $I_{DD} = 3.5\text{mA}$, $R_{\theta JA} = 177^\circ\text{C/W}$, we get

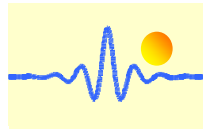
$$P_D = V_{DD} \times I_{DD} = 12\text{V} \times 3.5\text{mA} = 42\text{mW}$$

$$\Delta T = P_D \times R_{\theta JA} = 42\text{mW} \times 177^\circ\text{C/W} = 7.5^\circ\text{C}$$

$$T_J = T_A + \Delta T = 25^\circ\text{C} + 7.5^\circ\text{C} = 32.5^\circ\text{C}$$

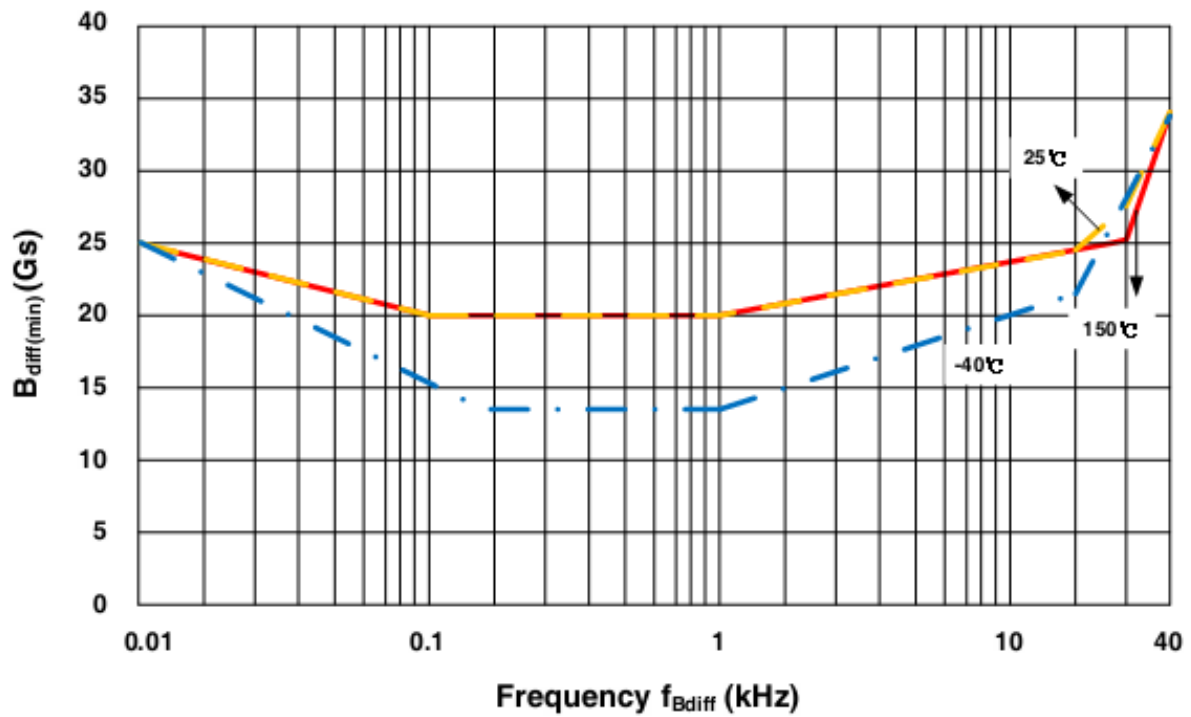
Empirical Result



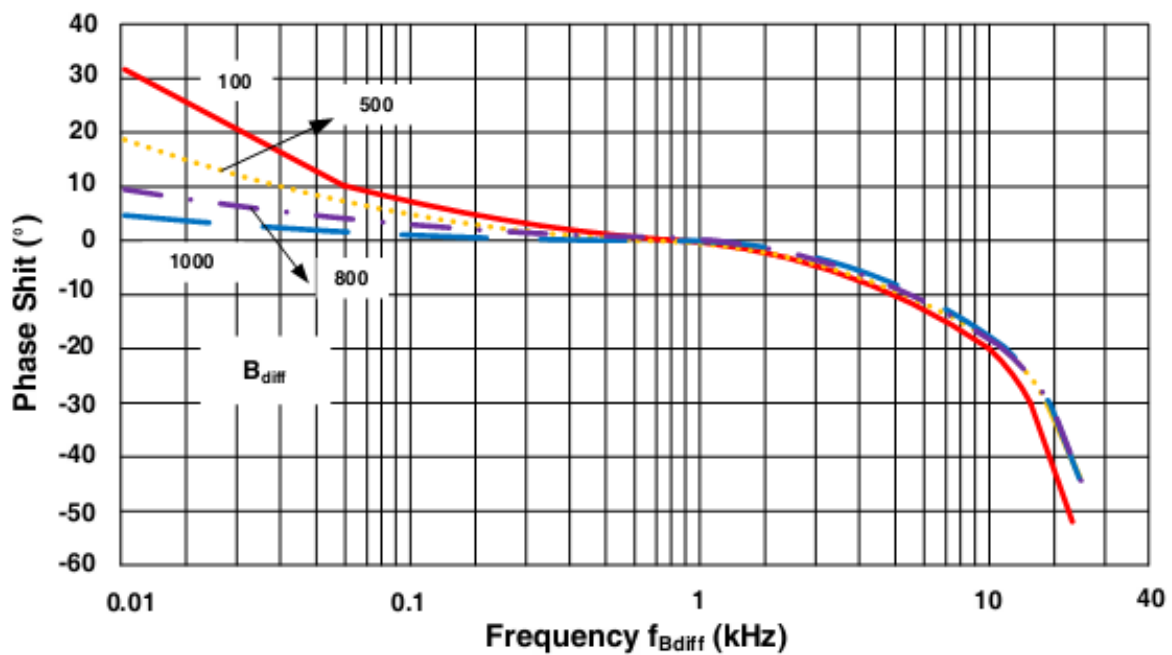


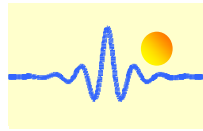
Simulation Result

Minimum Switch Fields versus Frequency

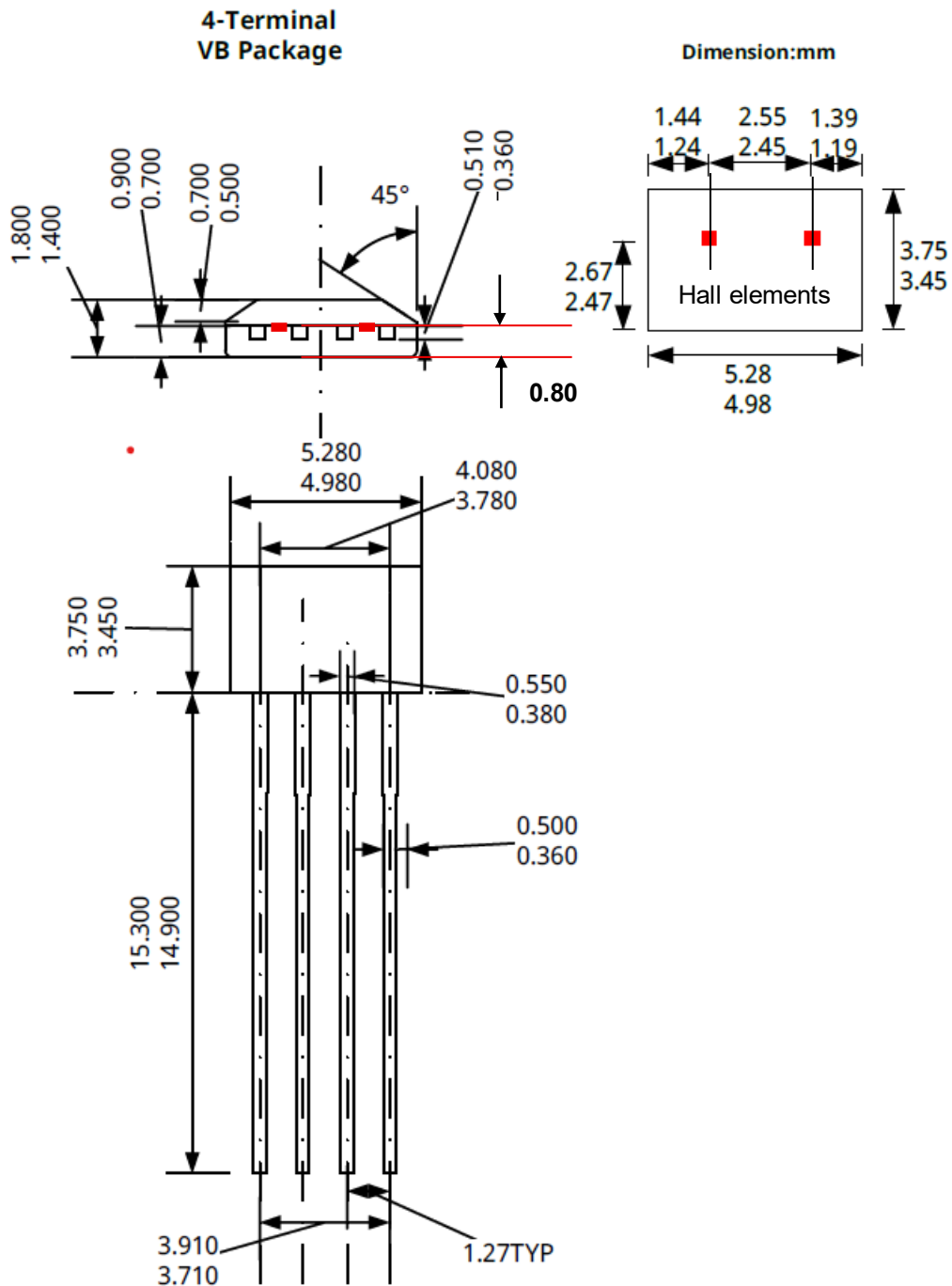


Typical Phase Shift versus Frequency





Package Designator



Notes:

1. Exact body and lead configuration at vendor's option within limits shown.
2. Height does not include mold gate flash.
3. Where no tolerance is specified, dimension is nominal.