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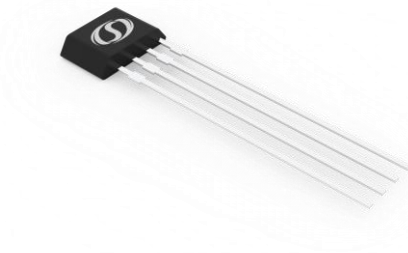
FEATURES

- Integrated filter capacitor

- Accurate true zero-crossing switch-point

- South and North pole pre-induction possible

- Large air gap

- 3.8 to 24V supply operating range

- -40℃-150℃ temperature range

- Protection against over-voltage in all PIN

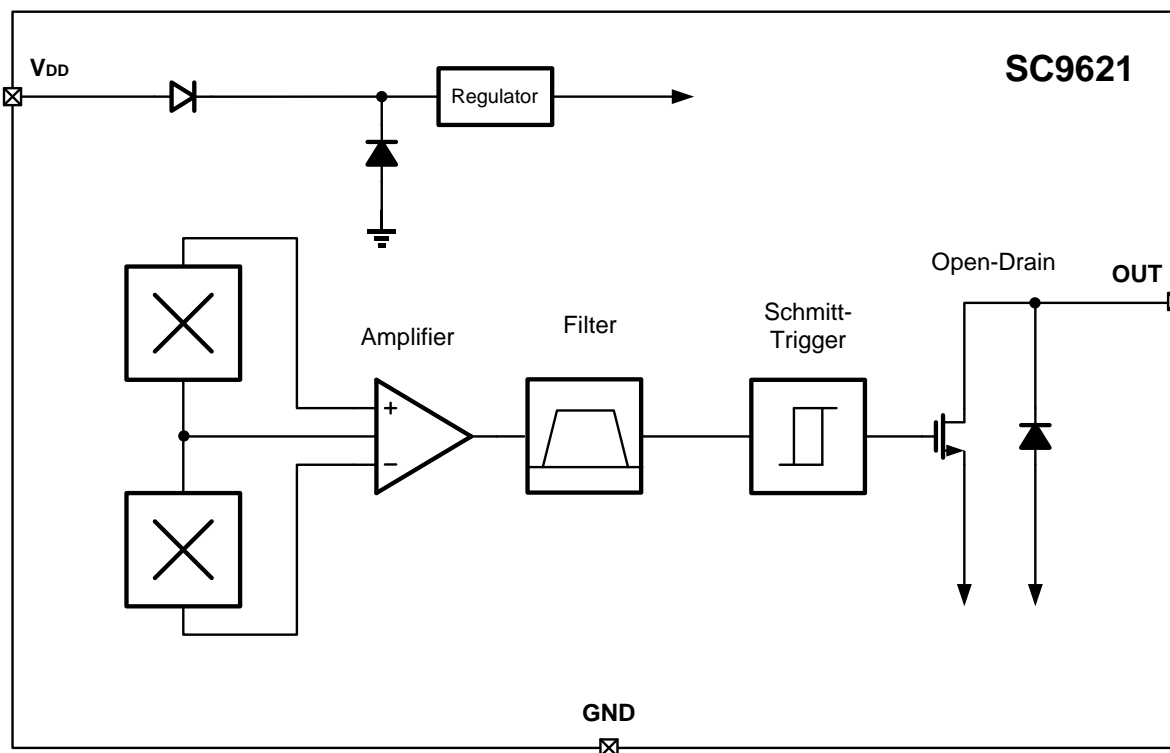- Reverse-current protection in VDD PIN

DESCRIPTION

The differential Hall Effect sensor SC9621 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 lead frame.

CONTENTS

BLOCK DIAGRAM

ORDERING INFORMATION

Part Number	Packing	Mounting	Ambient, T_A	Marking
SC9621VB	Bulk, 500 pieces/bag	4-pin SIP	-40℃ to 150℃	9621

TERMINAL CONFIGURATION

4-Terminal SIP
VB Package
(Top View)

2.5mm

| 1 | 2 | 3 | 4 |

V$_{DD}$ OUT GND GND
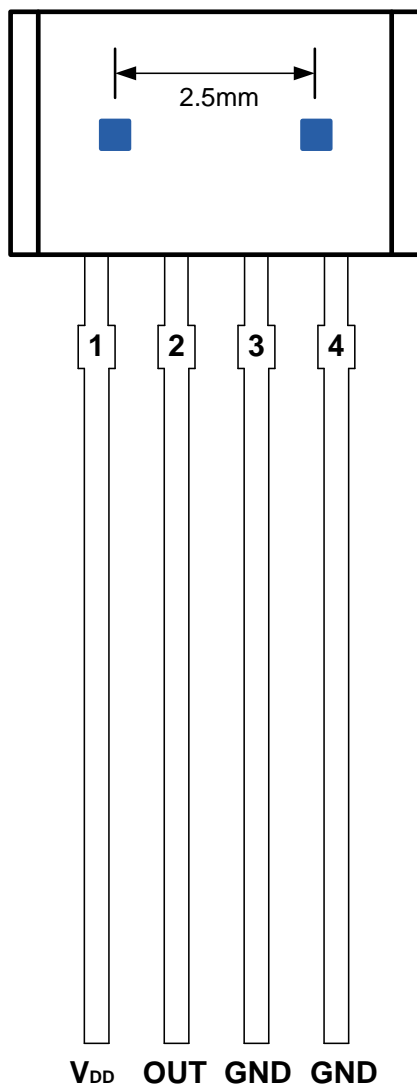
Terminal		Type	Description
Name	Number		
V$_{DD}$	1	PWR	3.8V ~24 V power supply
OUTA	2	Output	Open-drain output required a pull-up resistor
GND	3	Ground	Ground terminal
GND	4	Ground	Ground terminal

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 AEC-Q100-002

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
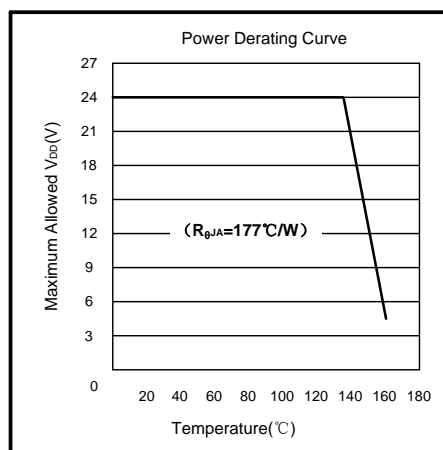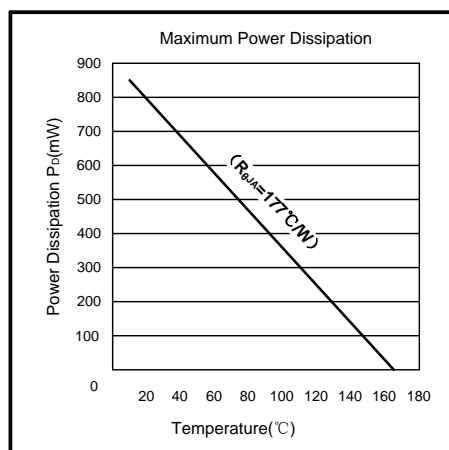
# Electro Magnetic Compatibility – (values depend on R$_{Series}$!)

Ref. ISO 7637-2; see the test circuit for EMC tests;

$\triangle B_{PP}$ =10mT (ideal sinusoidal signal); V$_{DD}$=13.5V, f$_B$=1 kHz; T$_A$=25℃; R$_{Series}$≥200 Ω;

Parameter	Symbol	Level / Typ.	Status
Test pulse 1		IV / -150V	C
Test pulse 2		IV / 112V	C
Test pulse 3a	V$_{EMC}$	IV / -220V	A
Test pulse 3b		IV / 150V	A
Test pulse 5		IV / 34V	C

1. *Test criteria for status A: No missing pulse no additional pulse on the IC output signal plus duty cycle and jitter are in specification limits.*

2. *Test criteria for status B: No missing pulse 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
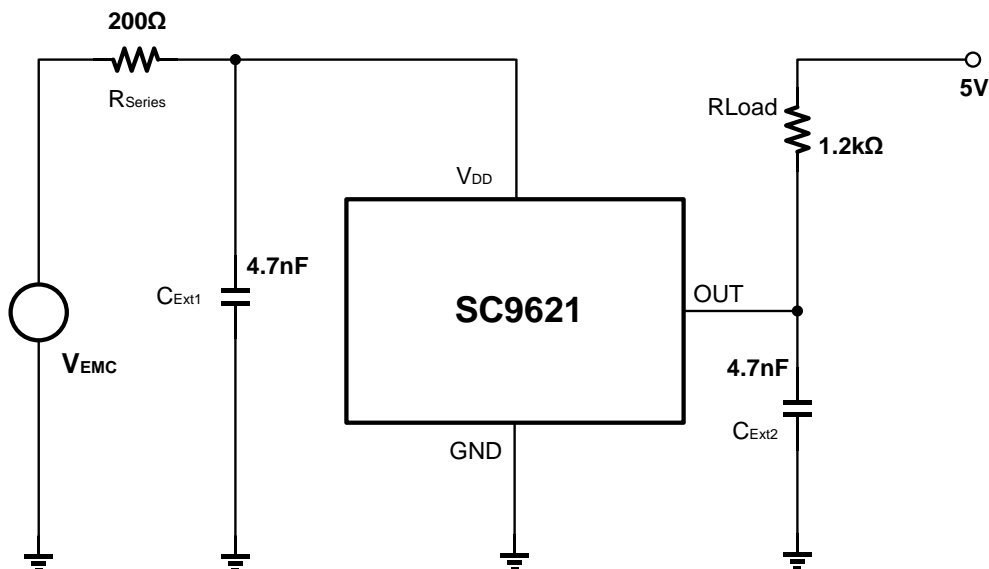
OPERATING CHARACTERISTICS

over operating free-air temperature range (V$_{DD}$=5V, 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$_{DD}$=3.5 to 24 V	2.5	3.5	4.5	mA
V$_{Qsat}$	Output saturation voltage	I$_Q$=20mA, T$_A$=25℃	--	150	400	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$_{DD}$>3.5V	--	3.8	9	mS
t$_{settle}$[3]	Settling time	V$_{DD}$>3.5V, f=1kHz	0	--	50	mS
t$_{response}$[4]	Response time	V$_{DD}$>3.5V, 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		-500	--	500	mT
B$_{Diff}$[6]	Differential fields	f=1kHz	-100	--	100	mT
B$_{HYS}$	Postive and negtive hysteresis	f=1kHz, B$_{Diff}$=5mT	0.4	1.2	2.0	mT
△B$_M$	Center of switch points	(B$_{OP}$+B$_{RP}$)/2	-0.3	0	+0.3	mT

[1]I$_Q$ does not change state when I$_Q$=OCP.

[2]Time required to initialize device.

[3]Time required for the output switch points to be within specification.
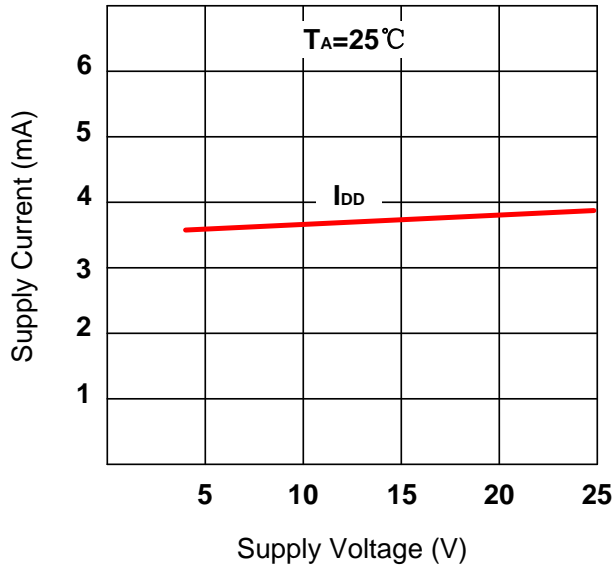
[4] Equal to t$_{po}$ + t$_{settle}$.

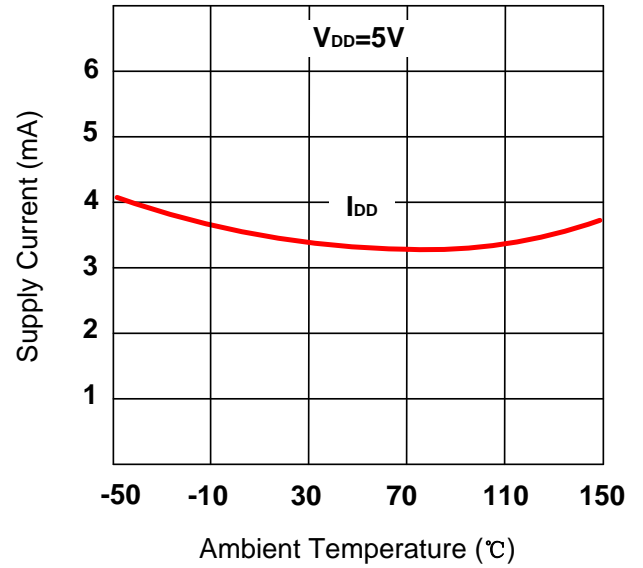[5]Output Rise Time will be dominated by the RC time constant.

[6]Exceeding this limit might result in decreased duty cycle performance and the phase accuracy.
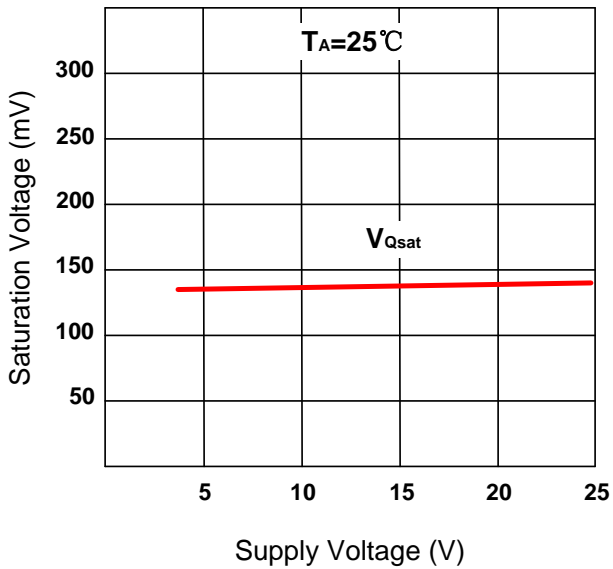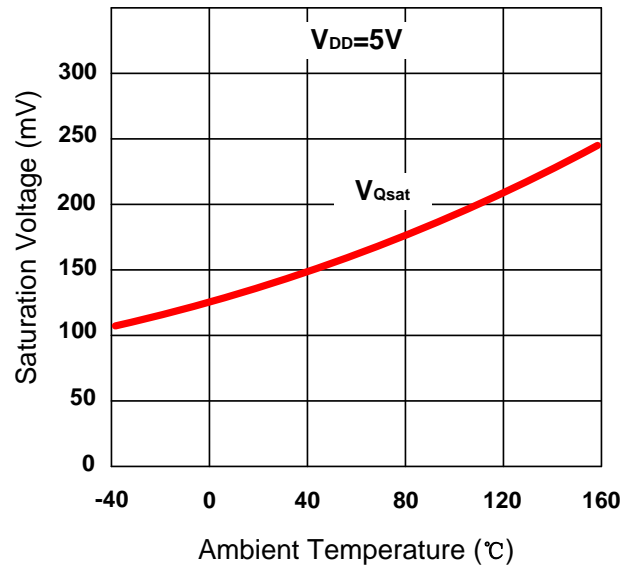
TYPICAL CHARACTERISTICS
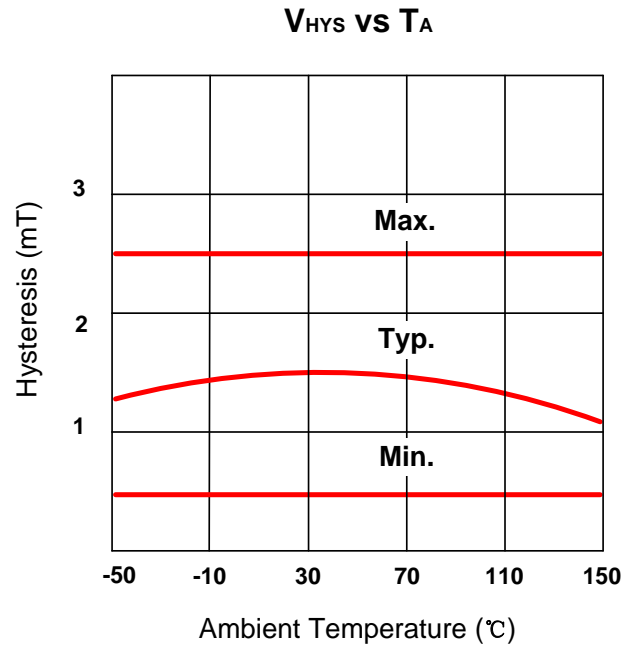
I_{DD} vs V_{DD}

I_{DD} vs V_{DD}

I_{DD} vs T_A

I_{DD} vs T_{A}

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

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

V_{Q(sat)} vs T_A

$V_{Q(sat)}$ vs T_{A}

TYPICAL CHARACTERISTICS（continued）

△B$_M$ vs T$_A$

$B_M=(B_{OP}+B_{RP})/2$

Max.

Typ.

Min.

Center of switching point (mT)

Ambient Temperature (℃)

V$_{HYS}$ vs T$_A$

Max.

Typ.

Min.

Hysteresis (mT)

Ambient Temperature (℃)
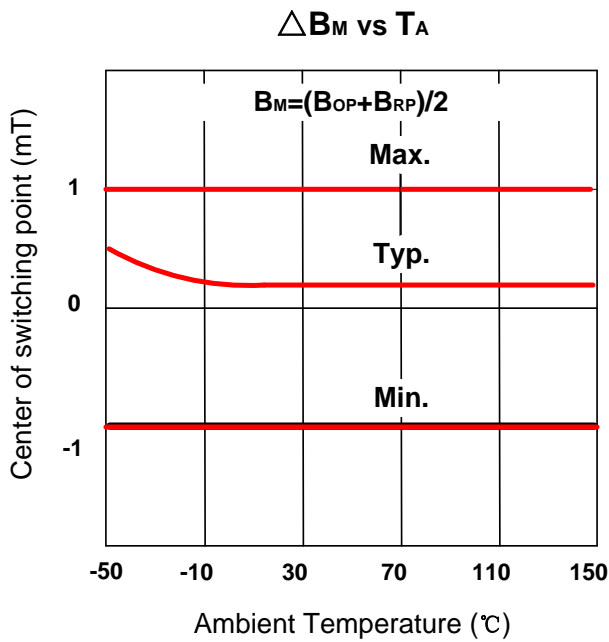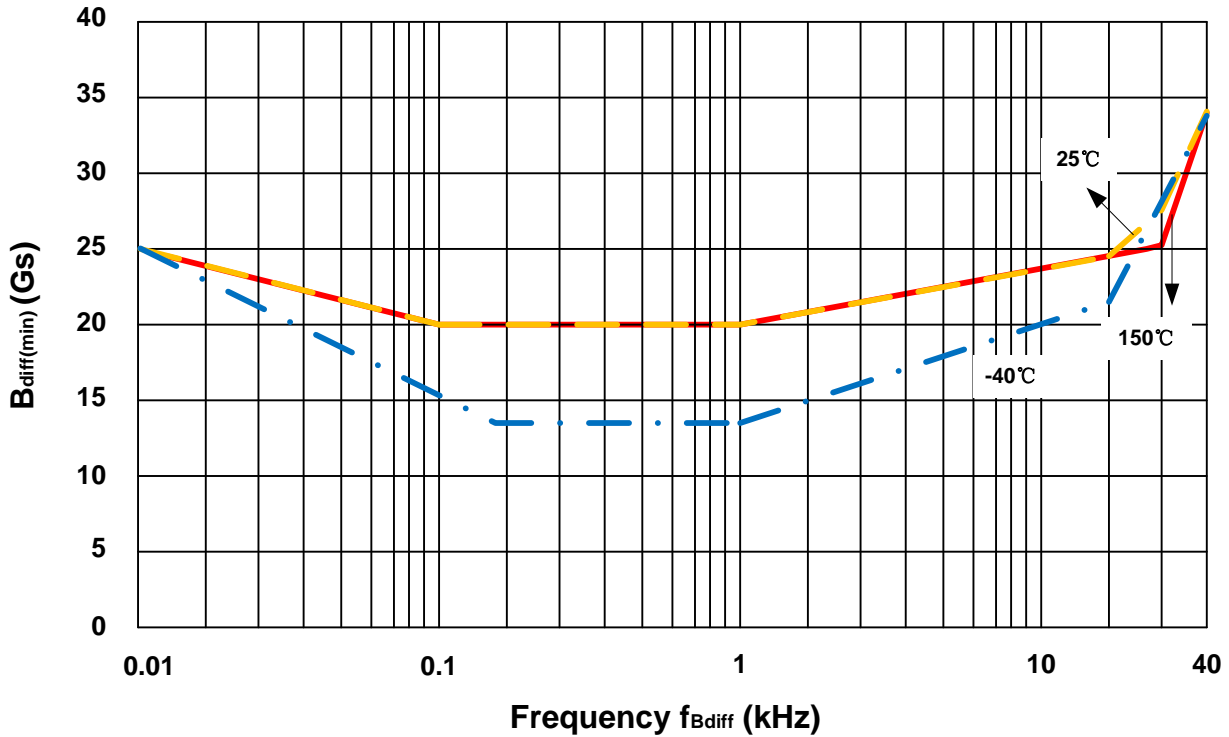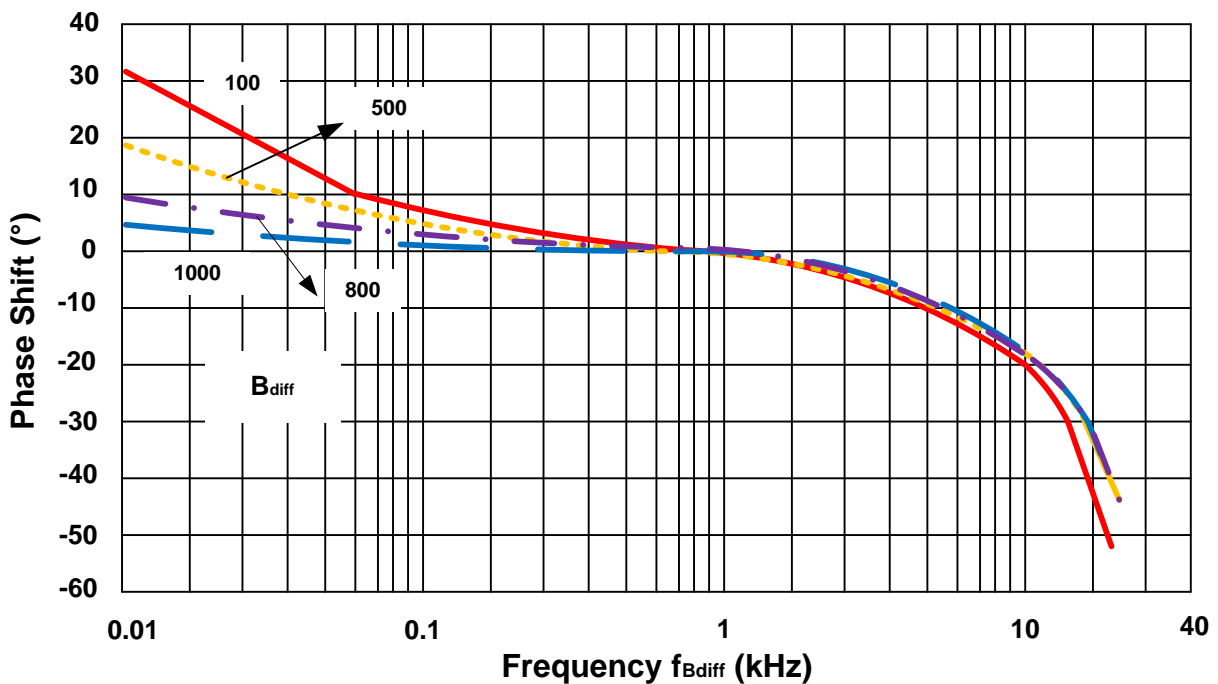
SIMULATION RESULT

Minimum Switch Fields versus Frequency

Typical Phase Shift versus Frequency

FUNCTIONAL DESCRIPTION

The SC9621 sensor IC contains two integrated Hall transducers 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 (the negative direction).

The operation is achieved through the use of two separate comparators. Both comparators use the same reference point, 0 G, to provide high accuracy, but one comparator has a positive hysteresis, B_{HYS1}, and the other a negative hysteresis, B_{HYS2}. Therefore, one comparator switches (B_{OP}) at the zero crossing on an increasing differential signal and the other switches (B_{RP}) at the zero crossing on a decreasing differential signal. The hysteresis on each comparator precludes false switching on noise or target jitter.

The SC9621 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.

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.

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

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

$$P_D = V_{DD} \times I_{DD} = 5V \times 6.5mA = 32.5mW$$
$$\triangle T = P_D \times R_{\vartheta JA} = 32.5mW \times 177\,℃/W = 5.8\,℃$$
$$T_J = T_A + \triangle T = 25\,℃ + 5.8\,℃ = 30.8\,℃$$

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.)
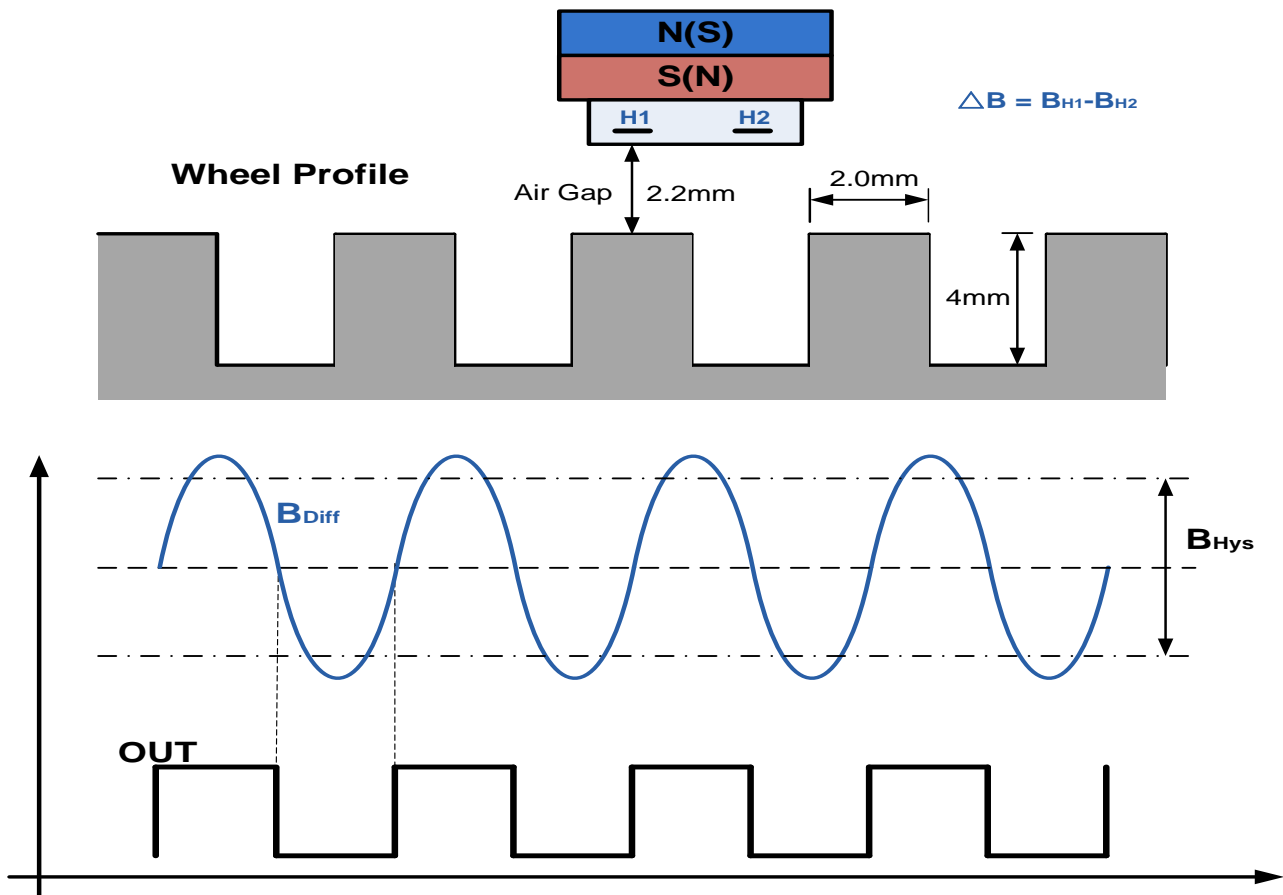
TYPICAL APPLICATION

The SC9621 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, EMI/RFI protection may still be required.
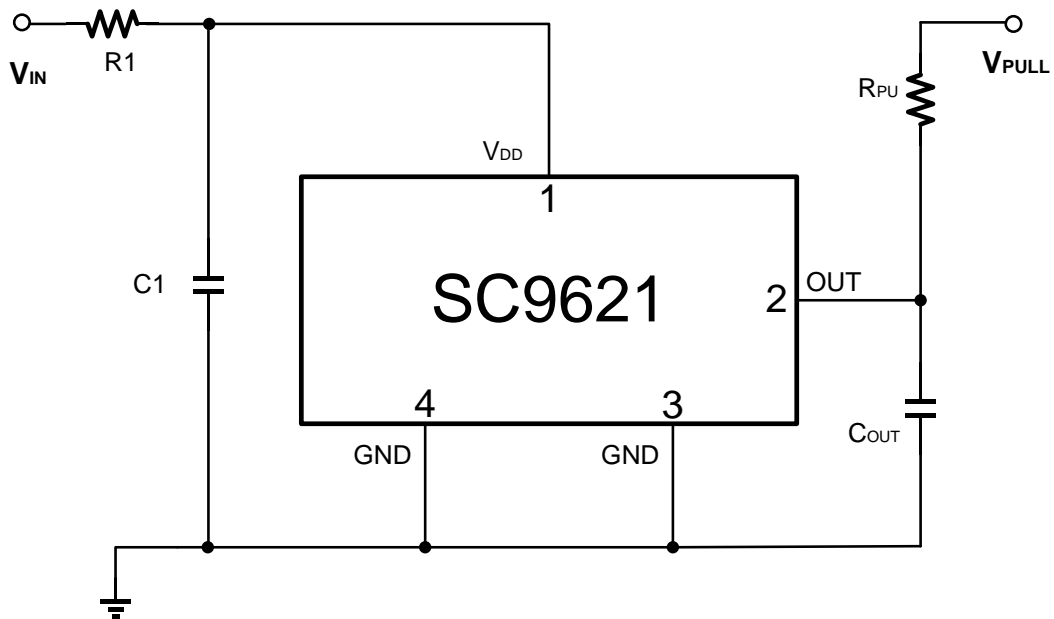
Component	Value	Units
R_{PU}	2	kΩ
R1	100	Ω
C1	100	nF
C_{OUT1}	1.0	nF

1. R1、C1 is for improved EMC performance

PACKAGE INFORMATION

**4-Terminal
VB Package**
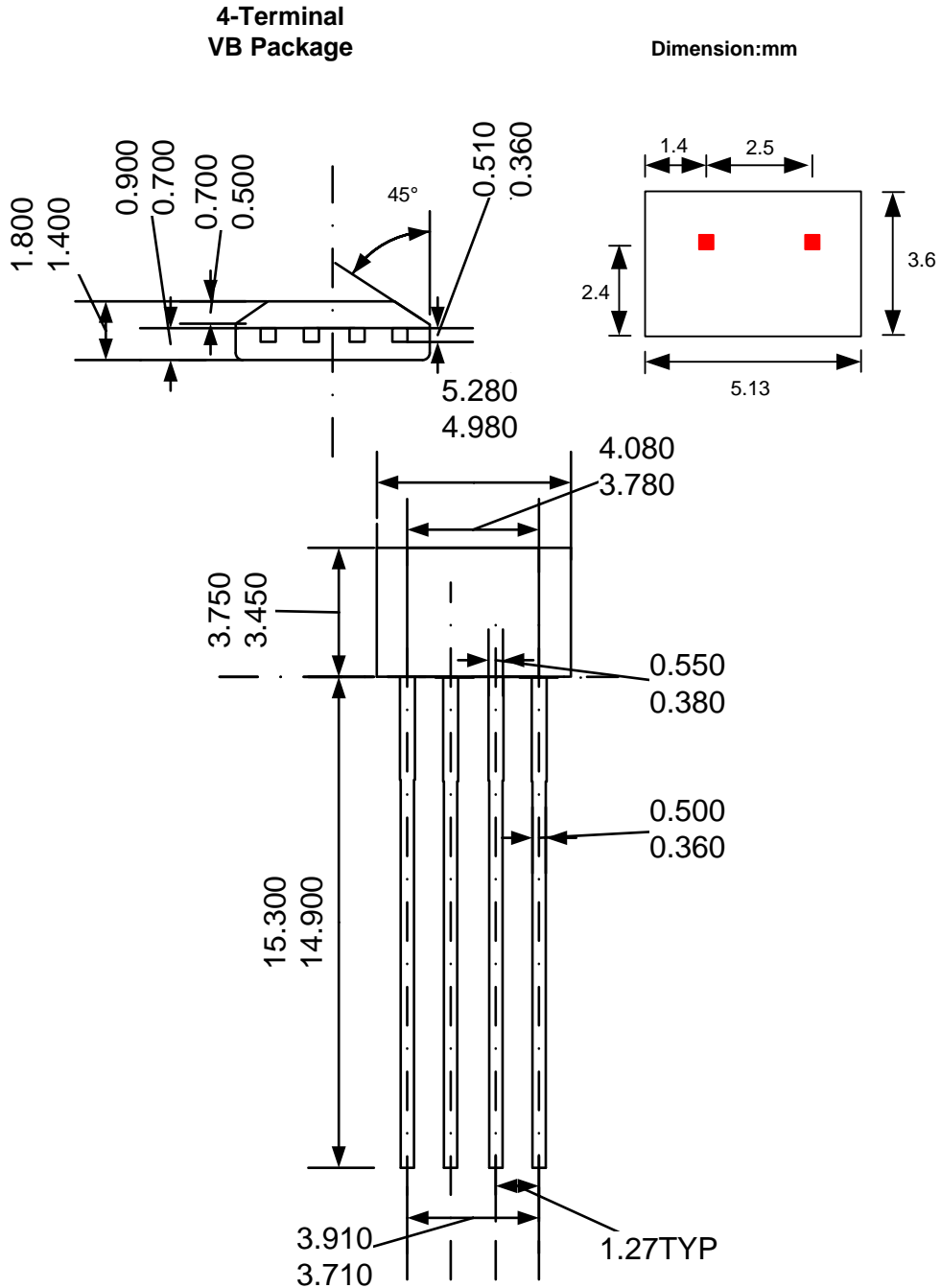
Dimension:mm

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.

REVISON HISTORY

Revision	Date	Description
Rev0.1	2017-08-19	Preliminary datasheet
Rev2.3	2019-08-06	The final revision of old datasheet
RevA/1.0	2020-12-20	Unified datasheet format