High Sensitivity Differential Speed Sensor IC

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℃ operating temperature range
- Protection against over-voltage in all PINs
- Reverse-current protection in V_{DD} PIN

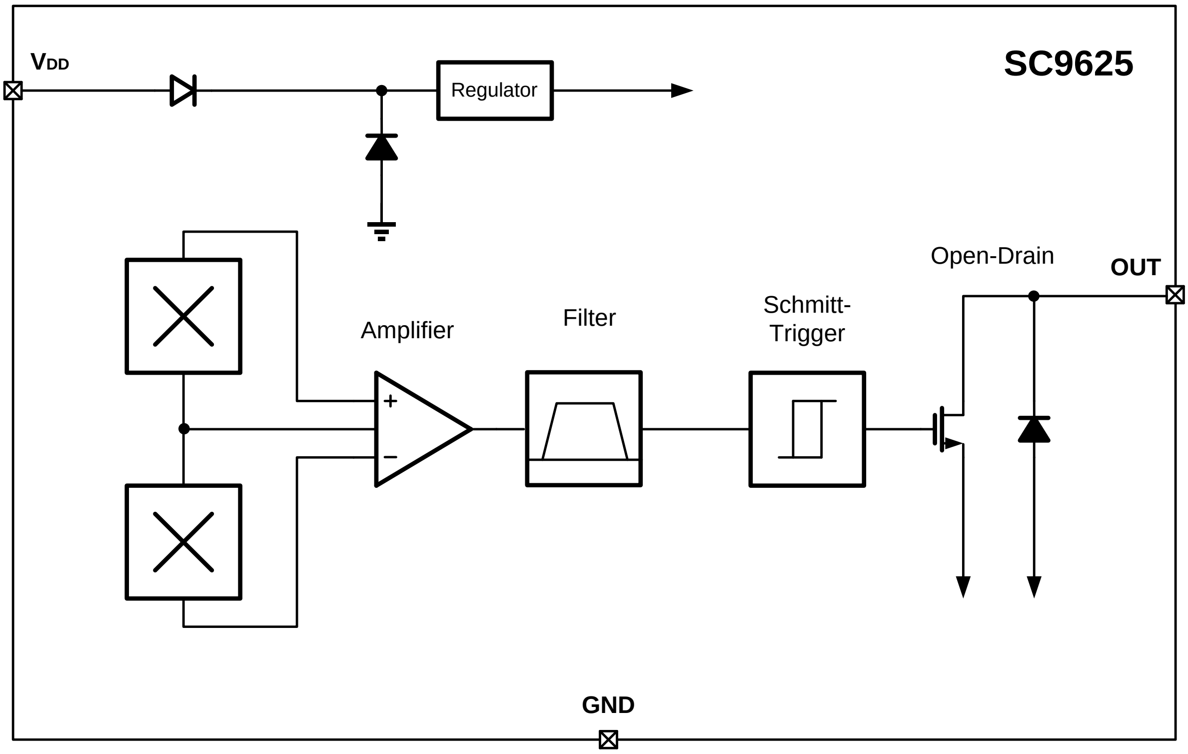
DESCRIPTION

The differential Hall Effect sensor SC9625 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

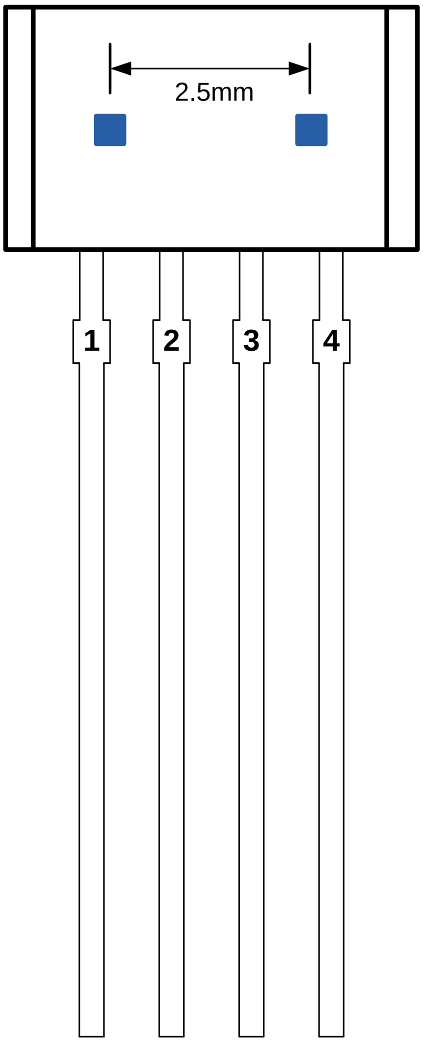


ORDERING INFORMATION

Part Number	Packing	Mounting	Ambient, T_A	Marking
SC9625VB	Bulk, 500 pieces/bag	4-pin SIP	-40℃ to 150℃	9625

TERMINAL CONFIGURATION

4-Terminal SIP
VB Package
(Top View)



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.

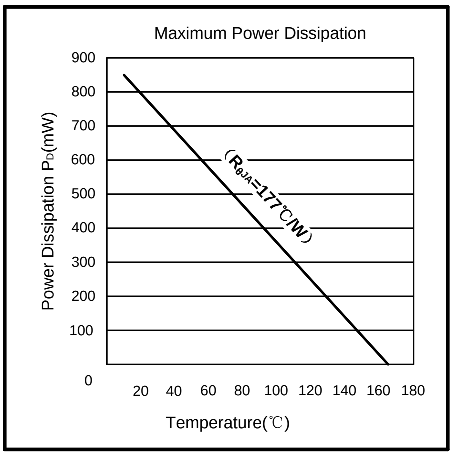
ESD PROTECTION

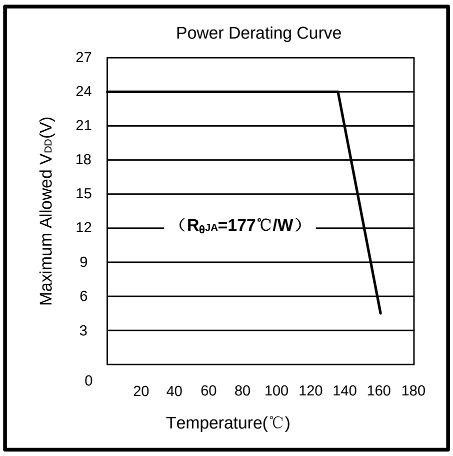
Human Body Model (HBM) tests according to: standard AEC-Q100-002

Parameter	Symbol	Limit Values		Units
		Min.	Max.	
ESD-Protection	V_{ESD}	-4.0	4.0	kV

Thermal Characteristics

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





OPERATING CHARACTERISTICS

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		-500	--	500	mT
B_{Diff}[6]	Differential fields	f=1kHz	-100	--	100	mT
B_{OP}	Output on switch point	f=1kHz, B_{Diff} increasing	+0.3	+0.45	+0.6	mT
B_{RP}	Output off switch point	f=1kHz, B_{Diff} decreasing	-0.3	-0.45	-0.6	mT
B_{HYS}	Hysteresis	f=1kHz, B_{Diff}=5mT	0.6	0.9	1.2	mT
$\triangle B_M$	Center of switch points	(B_{OP} + B_{RP}) / 2	-0.3	0	+0.3	mT

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

[2] *Time required to initialize device.*

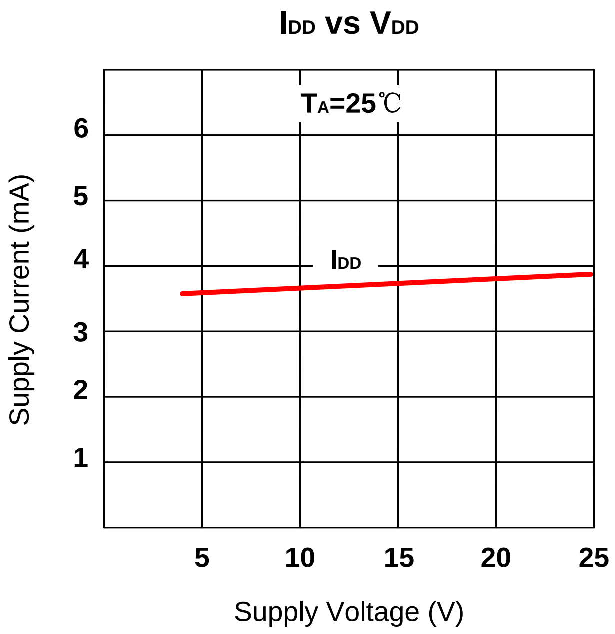
[3] *Time required for the output switch points to be within specification.*

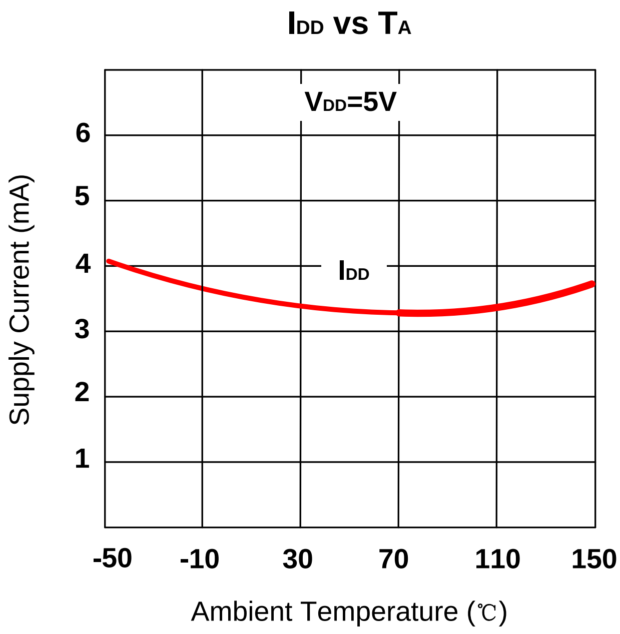
[4] *Equal to t_{po} + t_{settle}.*

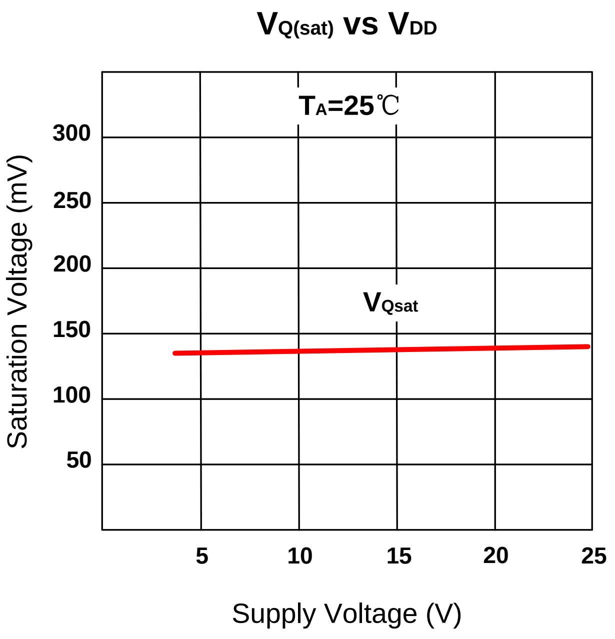
[5] *Output Rise Time will be dominated by the RC time constant.*

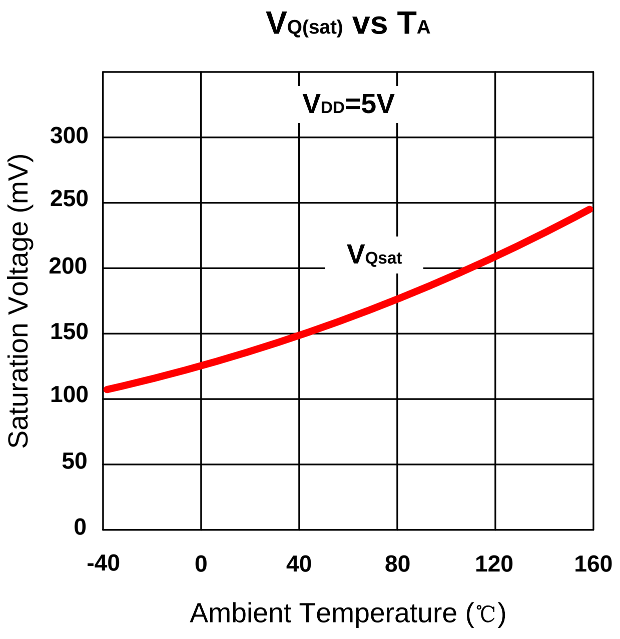
[6] *Exceeding this limit might result in decreased duty cycle performance and the phase accuracy.*

TYPICAL CHARACTERISTICS

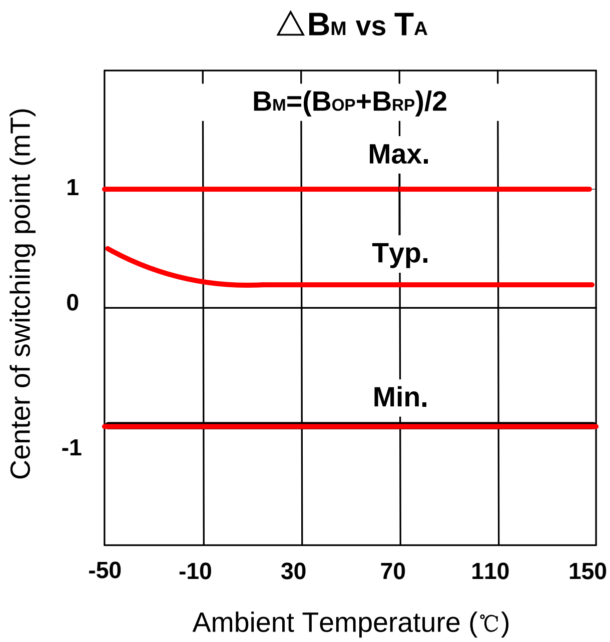


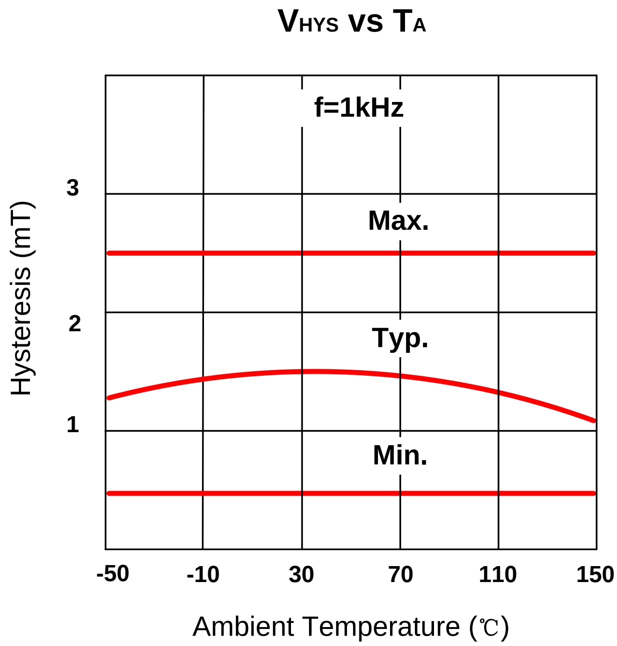




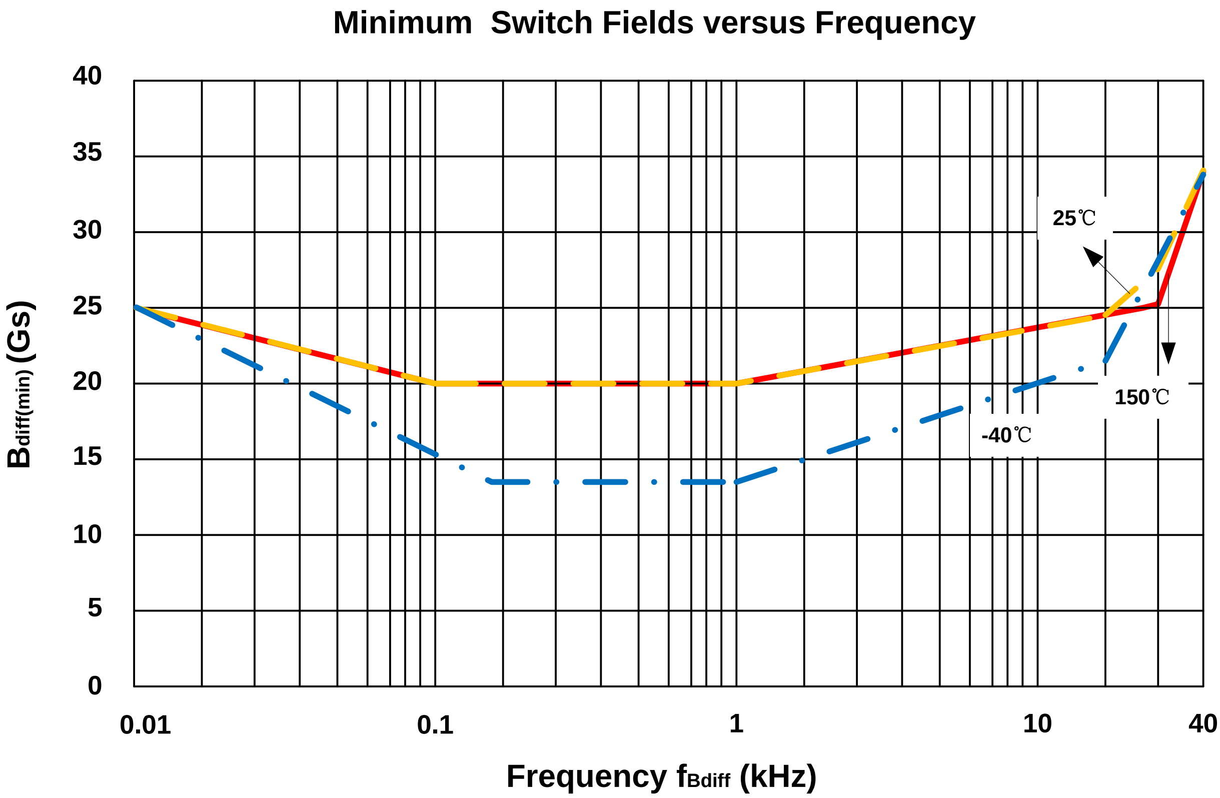


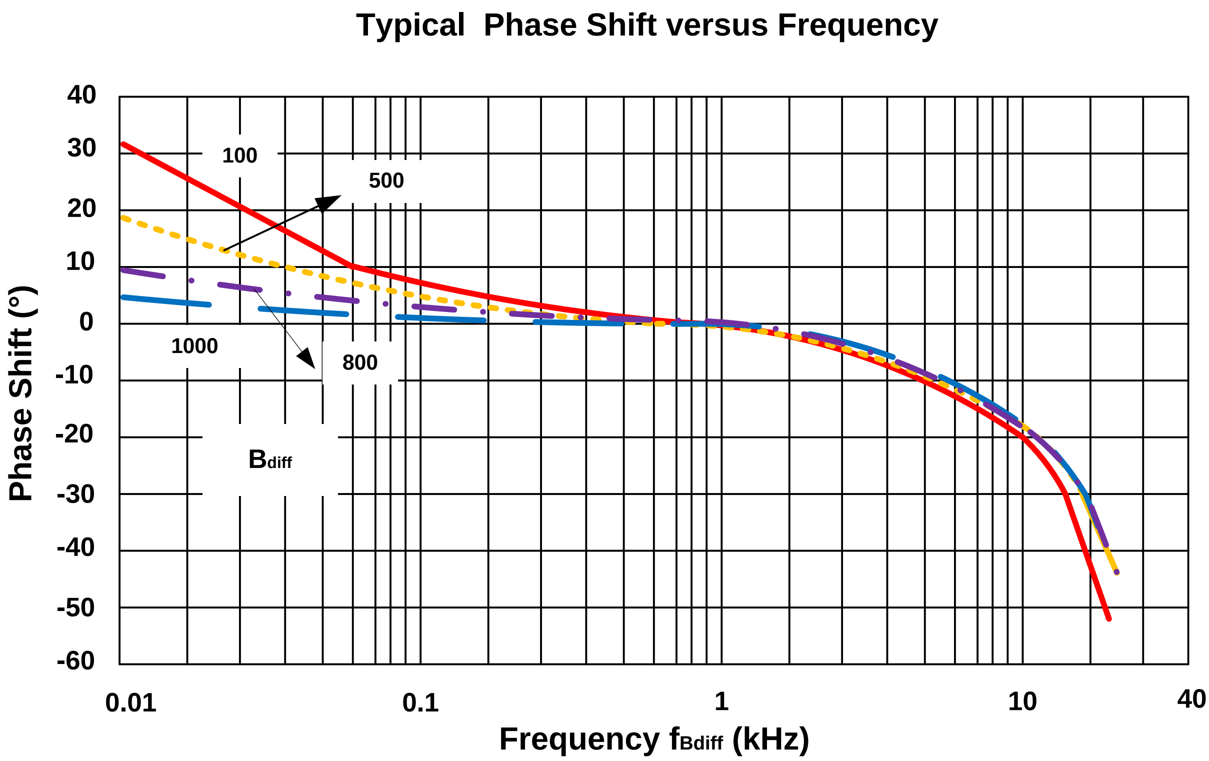
TYPICAL CHARACTERISTICS（continued）





SIMULATION RESULT





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 SC9625, 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 SC9625 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.

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

$$\triangle T = P_D \times R_{\theta JA} \qquad (2)$$

$$T_J = T_A + \triangle T \qquad (3)$$

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

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

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

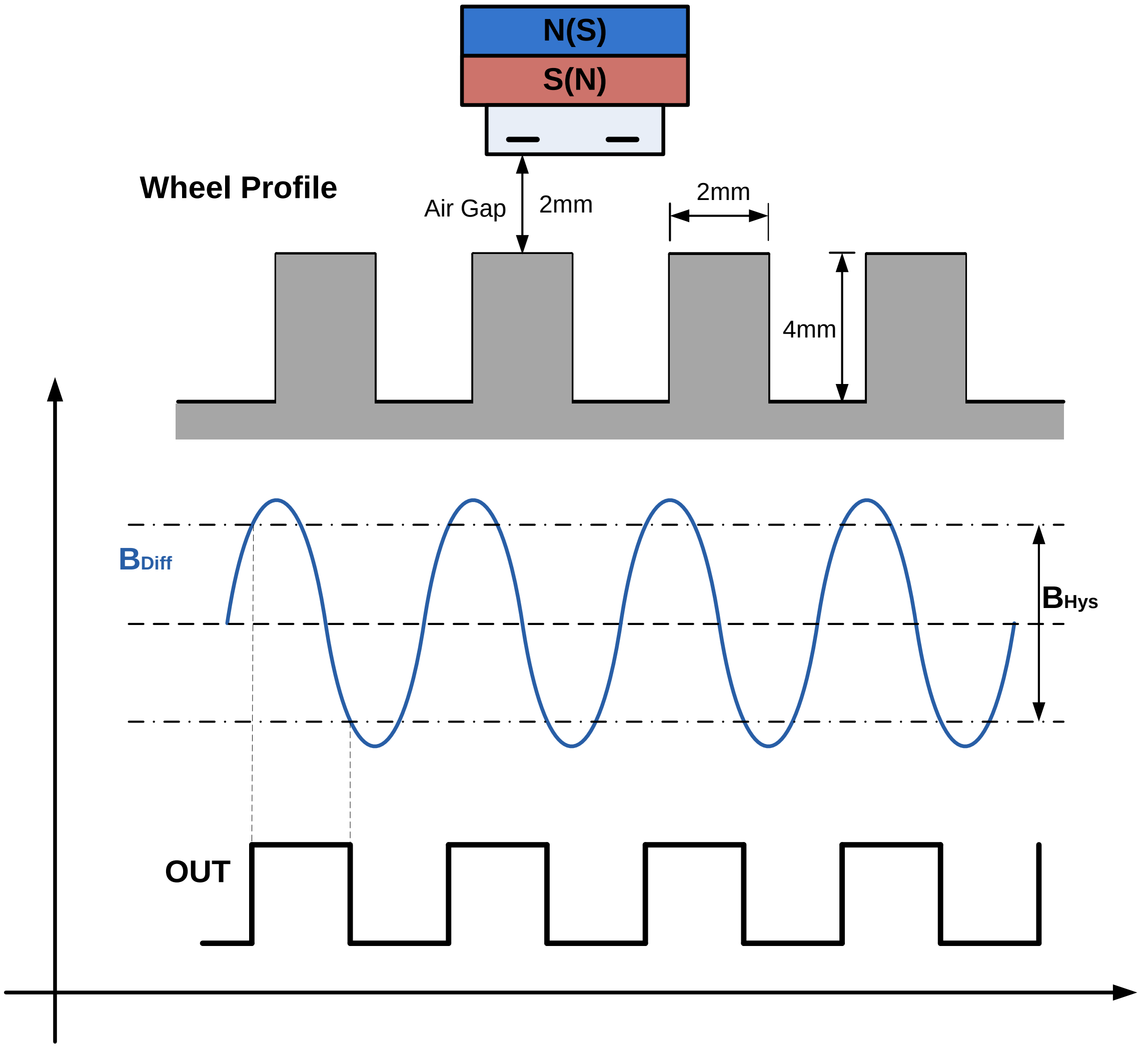
$$T_J = T_A + \triangle T = 25℃ + 5.8℃ = 30.8℃$$

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

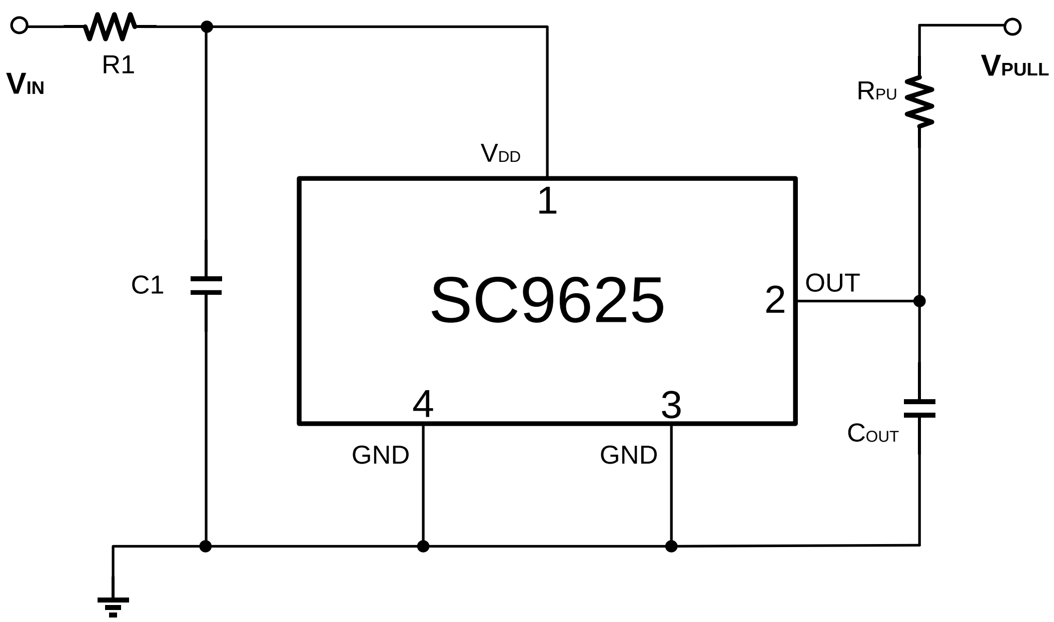
The maximum air gap depends on

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



TYPICAL APPLICATION

The SC9625 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.



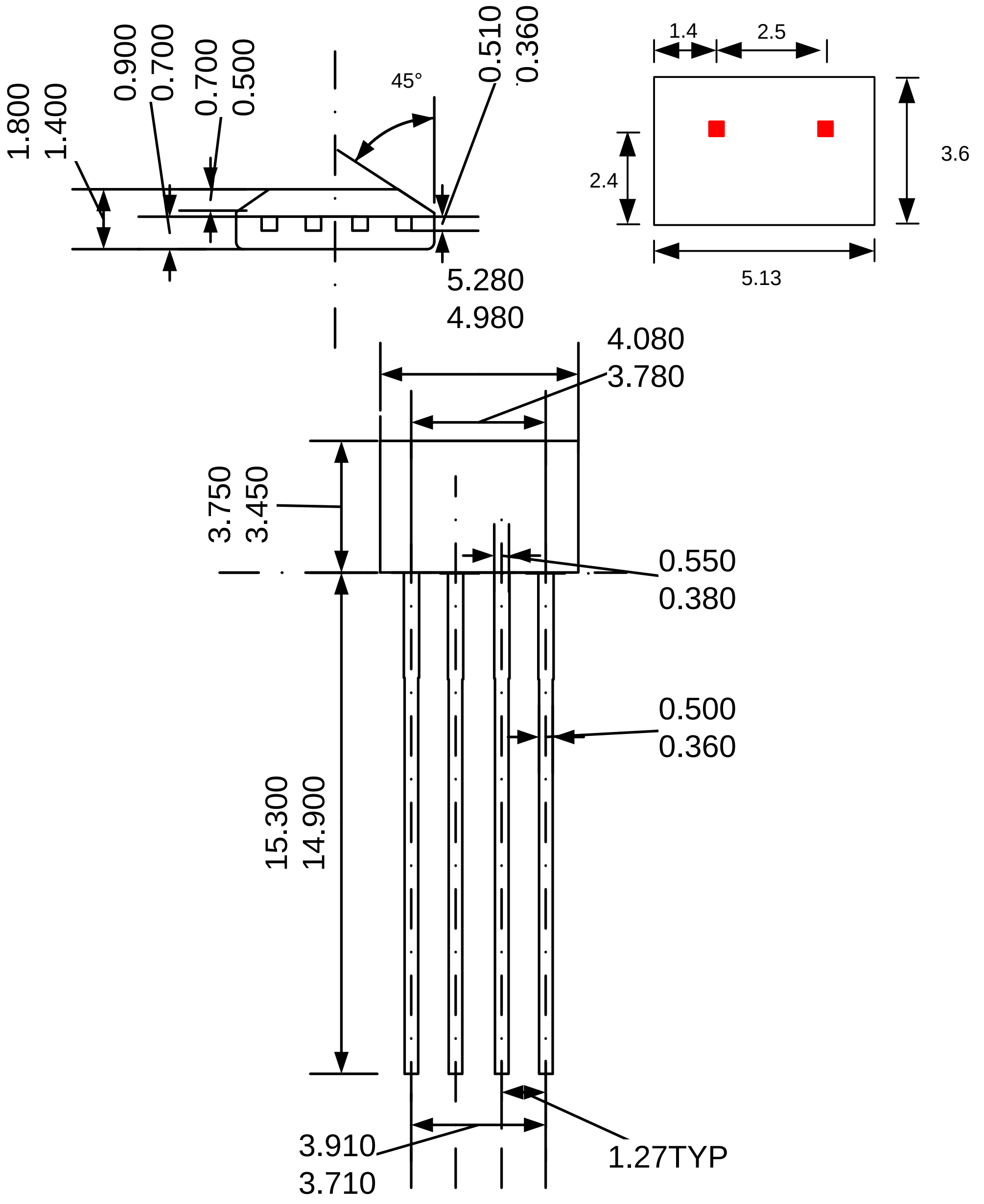
Component	Value	Units
R_{PU}	2	kΩ
R1	100	Ω
C1	100	nF
C_{OUT1}	1.0	nF

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	2017-09-19	Preliminary datasheet
Rev2.3	2018-05-04	The final revision of old datasheet
RevA/1.0	2020-12-28	Unified datasheet format