High Sensitivity Speed Sensor IC with Dual Quadrature Outputs

FEATURES

- Two independent digital quadrature A/B outputs
- Large air gap
- South and North pole pre-induction possible
- Low start-up voltage: 3.8V (Typ.)
- Reduced power consumption: 6.5mA (Typ.)
- Accurate true zero-crossing switch-point
- -40℃-150℃ operating temperature range
- Over-voltage protection in all PIN
- Reverse-current protection in V_{DD} PIN
- Output protection against electrical disturbances

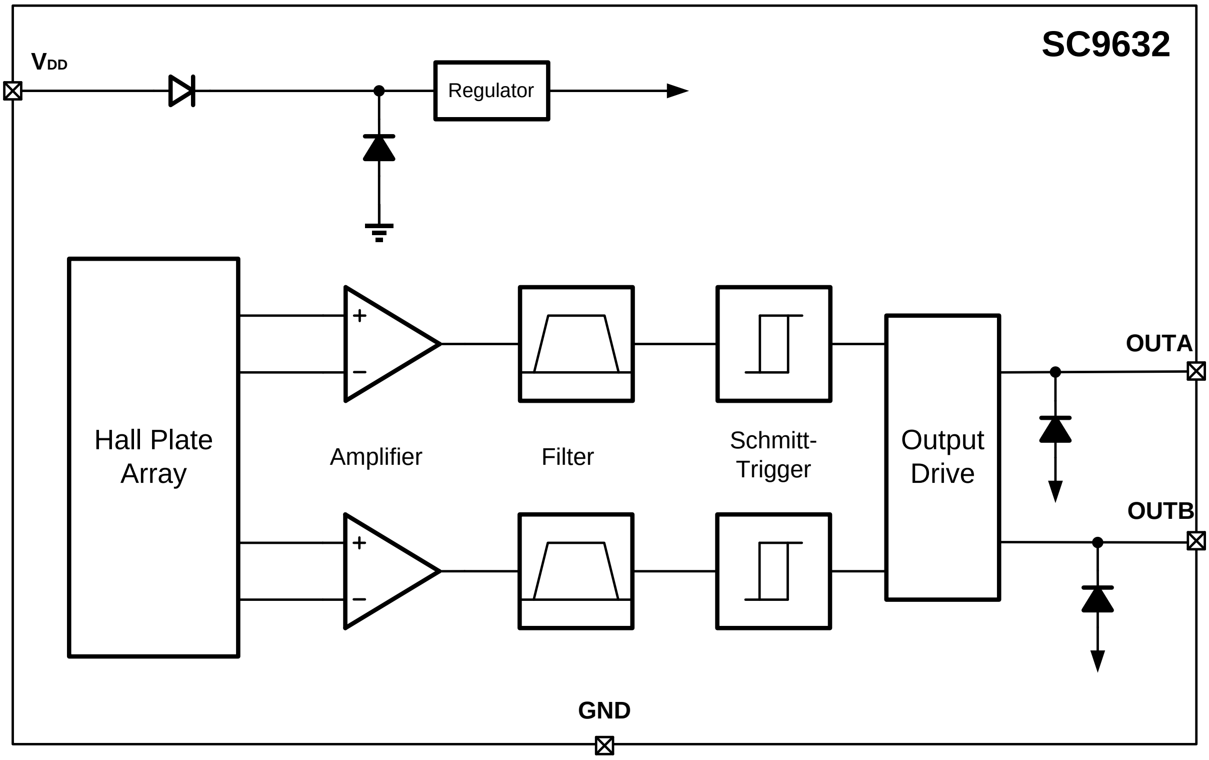
DESCRIPTION

SC9632 is a differential Hall Effect sensor IC with two independent channels providing quadrature outputs. The device 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. By use of the A/B quadrature outputs, the device is particularly suitable for speed and direction of magnetic ring or ferromagnetic toothed wheels.

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

CONTENTS

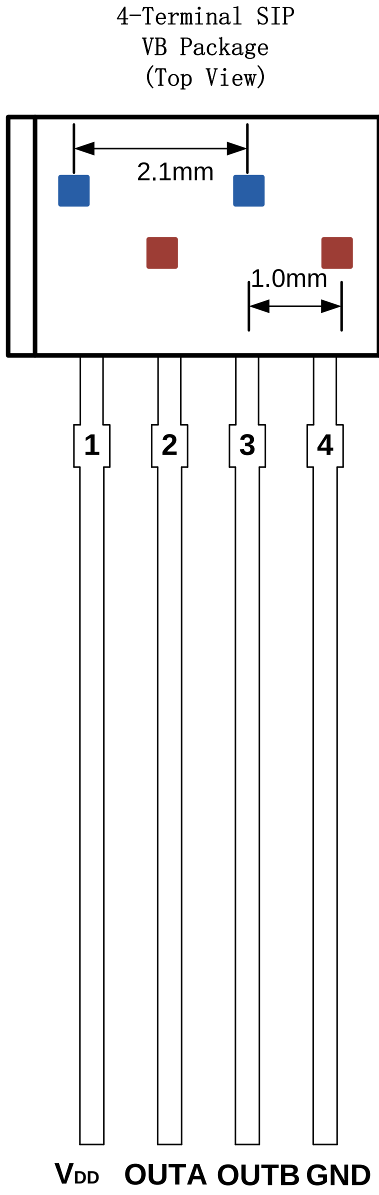
BLOCK DIAGRAM



ORDERING INFORMATION

Part Number	Packing	Mounting	Ambient, T_A	Marking
SC9632VB	Bulk, 500 pieces/bag	4-pin SIP	-40℃ to 150℃	9632

TERMINAL CONFIGURATION



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
OUTB	3	Output	Open-drain output required a pull-up resistor
GND	4	Ground	Ground

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Limit Values		Units
		Min.	Max.	
Power supply voltage	V_{DD}	-30	30	V
Output terminal voltage	V_{OUT}	-0.5	30	V
Output terminal current sink	I_{SINK}	0	40	mA
Operating junction temperature	T_J	-40	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.

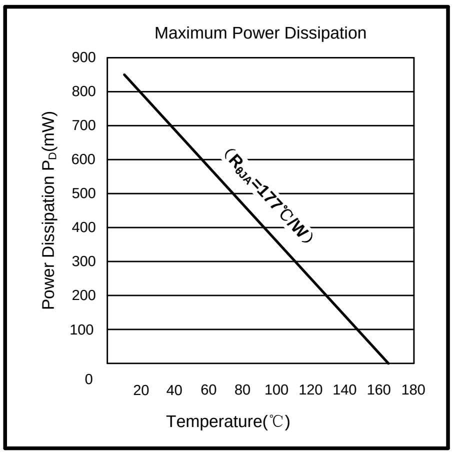
ESD PROTECTION

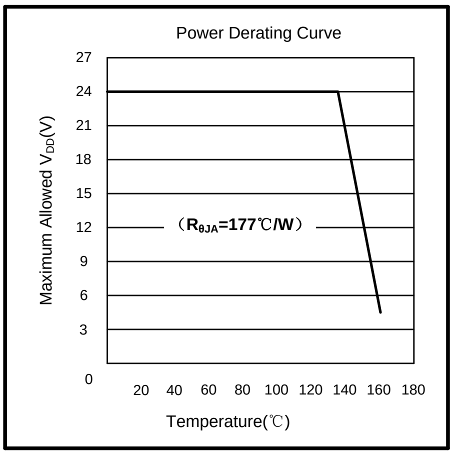
Human Body Model (HBM) tests according to: standard AEC-Q100-002、AEC-Q100-003

Parameter	Symbol	Limit Values		Units
		Min.	Max.	
HBM mode ESD stress	V_{ESD}	-4.0	4.0	kV
MM mode ESD stress	V_{ESD}	-300	300	V

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

Electrical parameters

over operating free-air temperature range (V_{DD}=5V, 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}=3.8V to 24 V	4.5	6.5	8.5	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 V_{DD} 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 at OUT terminal	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	--	0.4	1.0	µS
t_f	Output fall time	R1=1Kohm C_Q=20pF	--	0.35	1.0	µS
f_{cu}	Upper corner frequency	-3dB, single pole	--	20	--	kHz
f_{cl}	Lower corner frequency	-3dB, single pole	--	10	--	Hz

[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.*

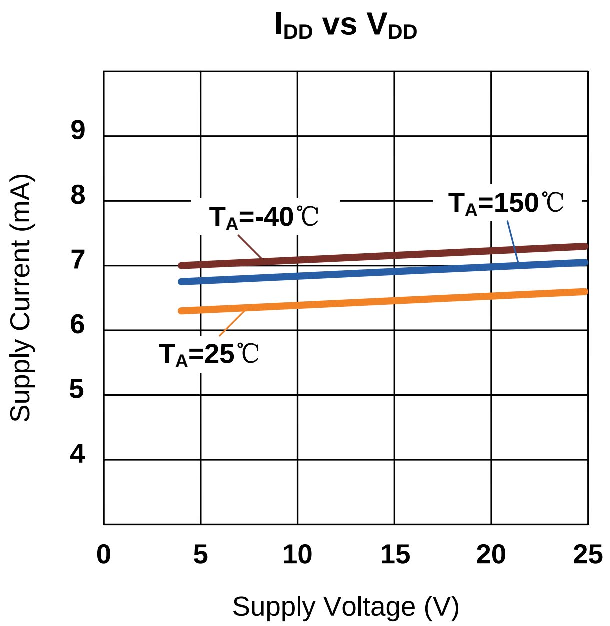
[4] *Equal to t_{po} + t_{settle}.*

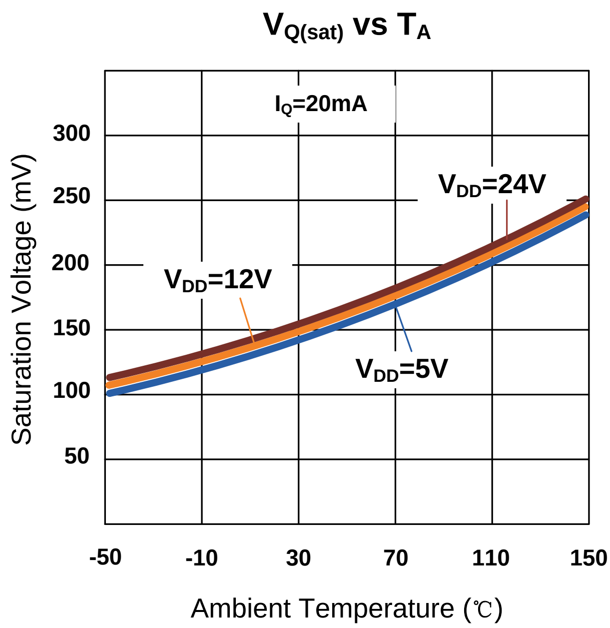
[5] *Output Rise Time will be dominated by the RC time constant.*

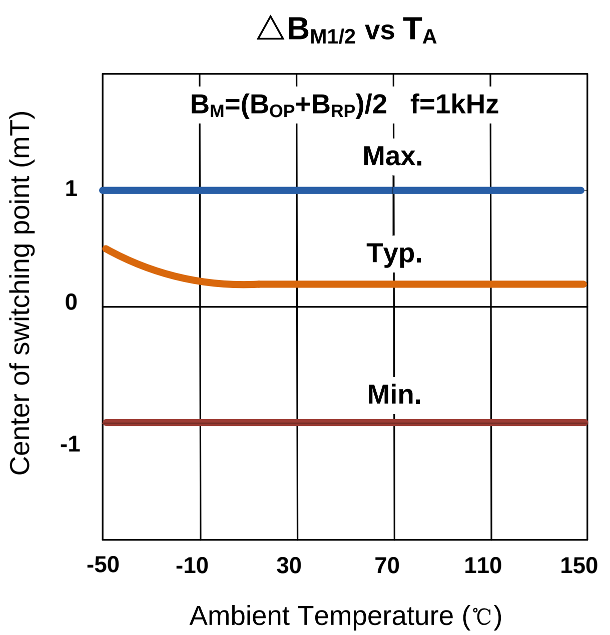
Magnetic Characteristics

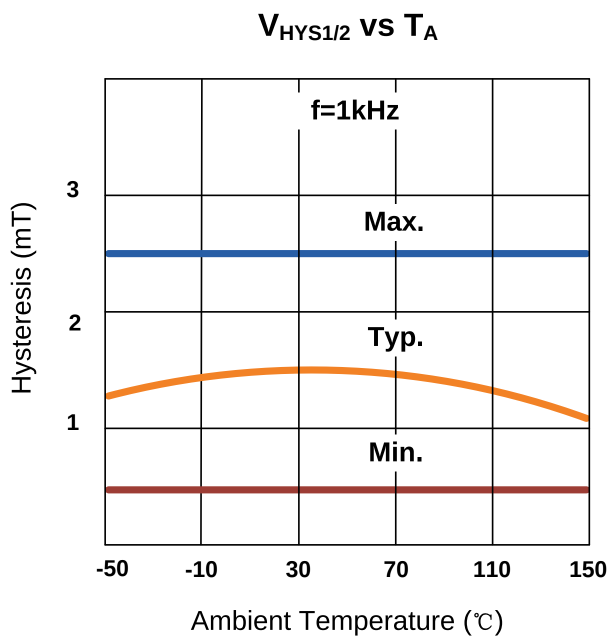
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
B_{Back}	Pre-induction		-500	--	500	mT
$\triangle B_{OP1}$	Operated point of channel1	f=1kHz,B_{diff}=5mT	--	--	0	mT
$\triangle B_{RP1}$	Released point of channel1	f=1kHz,B_{diff}=5mT	0	--	--	mT
B_{HYS1}	Hysteresis of channel1		0.5	1.5	2.5	mT
$\triangle B_{M1}$	Center of switching point of channel1	$(B_{OP} + B_{RP}) / 2$	-2.0	0	+2.0	mT
$\triangle B_{OP2}$	Operated point of channel2	f=1kHz,B_{diff}=5mT	--	--	0	mT
$\triangle B_{RP2}$	Released point of channel2	f=1kHz,B_{diff}=5mT	0	--	--	mT
B_{HYS2}	Hysteresis of channel2		0.5	1.5	2.5	mT
$\triangle B_{M2}$	Center of switching point of channel1	$(B_{OP} + B_{RP}) / 2$	-2.0	0	+2.0	mT

TYPICAL CHARACTERISTICS









FUNCTIONAL DESCRIPTION

The SC9632 integrates two independent differential Hall-effect sensor IC. The Hall IC supports four Hall elements, with magnet back-biased, which sense the magnetic profile of the ferrous gear target simultaneously, but at different points, generating two differential internal analog voltages, that is processed for precise switching of the digital output signals.

For each of two independent channels, the device detects the motion and position of ferromagnetic or 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 SC9632, 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 Hall IC is self-calibrating with a temperature compensated amplifier and offset cancellation circuitry. Its internal 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 rejection circuitry. The Hall transducers and signal processing electronics are integrated on the same silicon substrate, using a proprietary BiCMOS process.

The SC9632 is offered in a lead (Pb) free 4-pin SIP package with a 100% matte tin plated lead frame.

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.

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

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

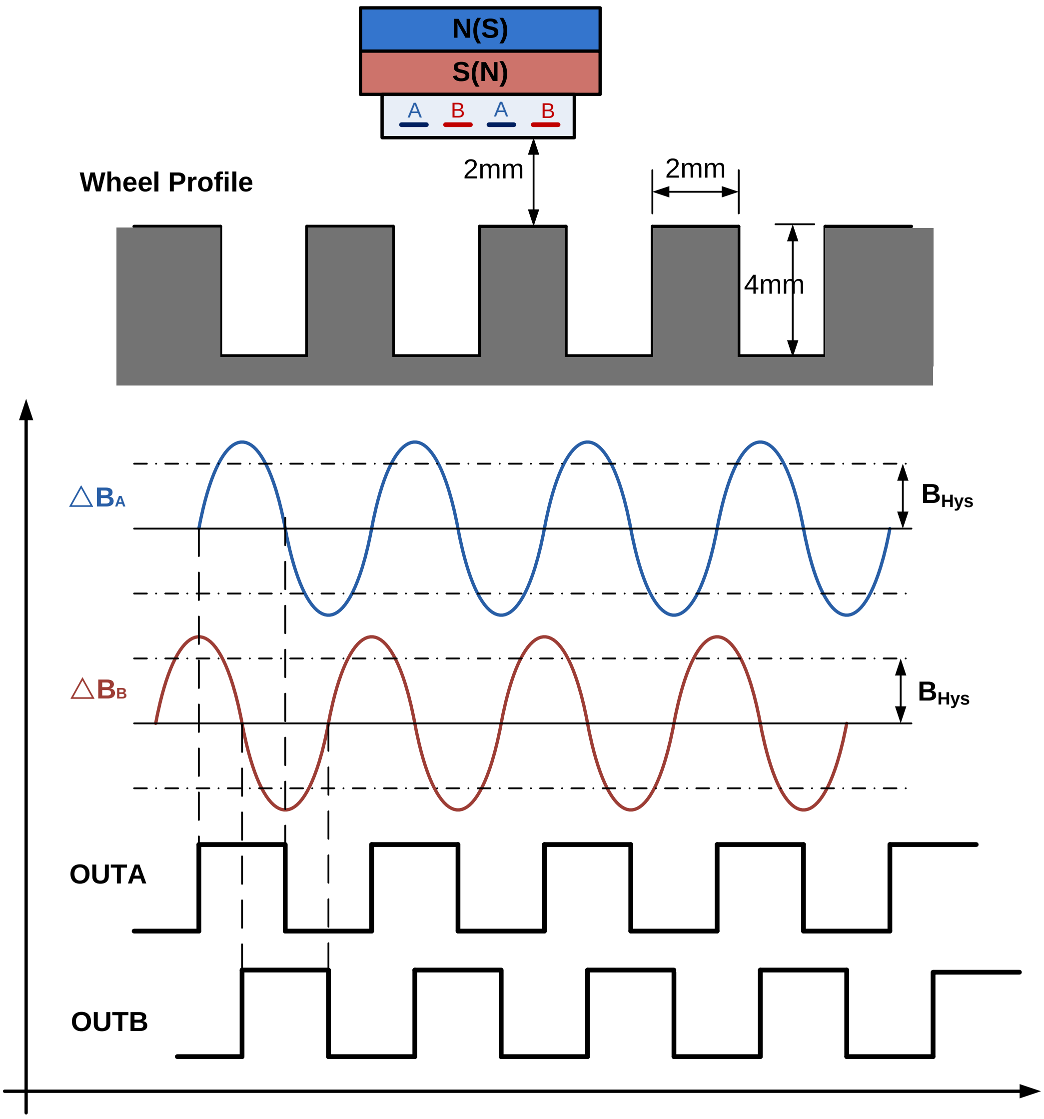
$$P_D=V_{DD} \times I_{DD}=5V \times 6.5mA=32.5mW$$
$$\triangle T=P_D \times R_{\theta JA}=32.5mW \times 177℃/W=5.8℃$$
$$T_J=T_A+\triangle T=25℃+5.8℃=30.8℃$$

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

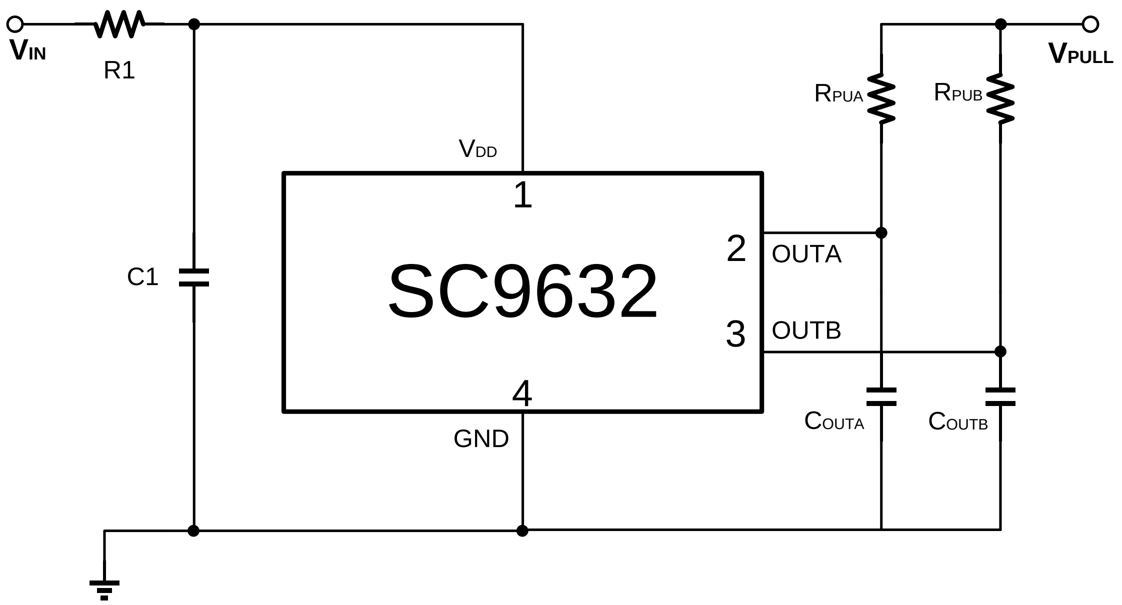
The maximum air gap depends on：

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



TYPICAL APPLICATION

The SC9632 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.



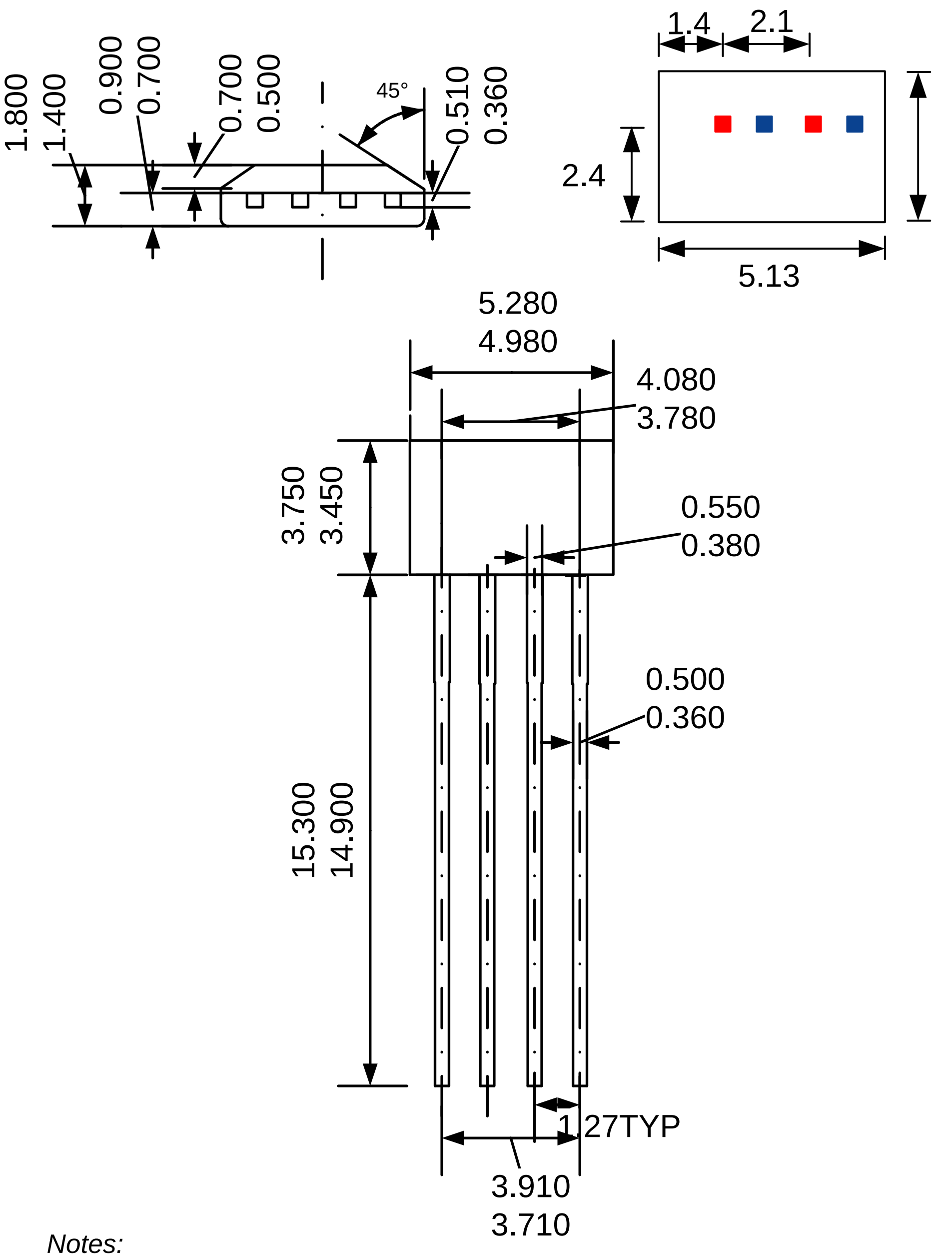
Component	Value	Units
R_{PUA} / R_{PUB}	2	kΩ
R1	100	Ω
C1	100	nF
C_{OUTA}/C_{OUTB}	1	nF

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	2017-09-09	Preliminary datasheet
Rev2.3	2018-08-19	The final revision of old datasheet
RevA/1.0	2020-12-15	Unified datasheet format