High Sensitivity Speed Sensor IC with Dual Quadrature Outputs

1. Features

- Two independent digital quadrature A/B outputs
- High sensitivity
- South and North pole pre-induction possible
- High sensitivity
- Accurate true zero-crossing switch-point
- Over Voltage protection in all pins
- Reverse protection at supply terminal
- -40°C to 150°C operating temperature range
- 3.8V to 24V operating voltage range
- Package：TO-94

2. Product Application

- Motor encoder
- General speed sensor

3. Description

The SC963X is a differential Hall-effect sensor integrated circuit with two independent channels providing an orthogonal digital output. Its high sensitivity, stable temperature characteristics and symmetry give it a stable duty cycle per output at full temperature. The chip has two sets of differential hall disk, each group can detect the differential magnetic field generated by the rotating ring magnet or ferromagnetic target wheel, through the internal filter, comparator processing the final output digital signal, because the two hall disk in the physical there is a certain phase difference, so the final output of the two signals orthogonal. Each digital signal can be used as speed detection, and the phase relationship between the output of A/B is used as rotation direction identification.

In order to adapt to different tooth spacing (magnetic pole width) and output ideal orthogonal signals, the physical spacing distribution of the Hall disk inside the SC963X has three options, namely, the SC9632VB-BK with a spacing of 2.1mm, the SC9633VB-BK with a spacing of 1.2mm, and the SC9634VB-BK with a spacing of 1.8mm.

The chip adopts TO-94 package form, matte tin plating and halogen-free green material TO meet environmental protection requirements.

Fig.1 TO-94 Package Outline

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4. Terminal Configuration

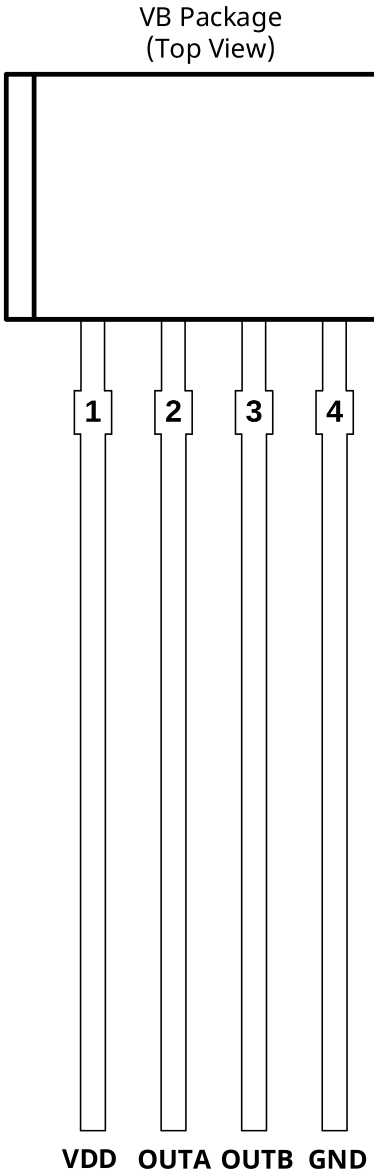


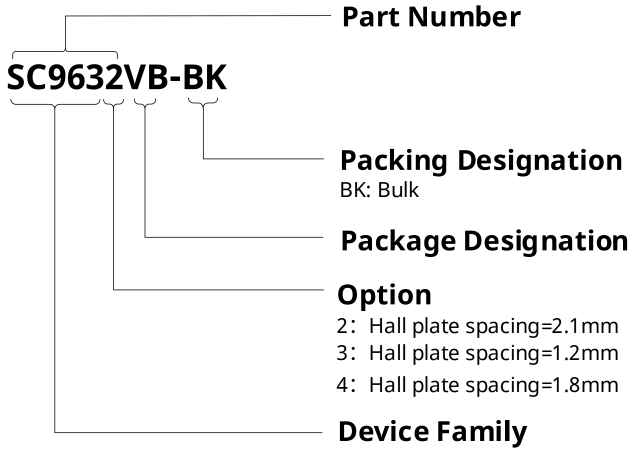
Fig.2 Pin Description

Terminal		Type	Description
Name	Number		
VDD	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

5. Ordering Information

Ordering Information	Marking	Hall plate spacing(mm)	Ambient, T_A(℃)	Package	Packing	Quantity
SC9632VB-BK	9632	2.1	-40 ~ 150	TO-94	Bulk	500/bag
SC9633VB-BK	9633	1.2	-40 ~ 150	TO-94	Bulk	500/bag
SC9634VB-BK	9634	1.8	-40 ~ 150	TO-94	Bulk	500/bag

Ordering Information Format



6. Absolute Maximum Ratings

over operating free-air temperature range

Symbol	Parameter	Test conditions	Min.	Max.	Units
V_{DD}	Power supply Voltage	Tj<150˚C	-30	30	V
V_{OUT}	Output terminal voltage	Tj<150˚C	-0.5	30	V
I_{SINK}	Output current sink		-	40	mA
T_A	Operating ambient temperature		-40	150	℃
T_J	Maximum junction temperature		-55	150	℃
T_{STG}	Storage Temperature		-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.

7. ESD Protection

Symbol	Parameter	Test conditions	Min.	Max.	Units
V_{ESD_HBM}	HBM	Refer to AEC-Q100-002E HBM standard, R=1.5kΩ, C=100pF	-4	+4	KV
V_{ESD_CDM}	CDM	Refer to AEC-Q100-011C CDM standard	-750	750	V

8. 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	5	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	-	150	400	mV
I_{QL}	Output leakage current	V_{DD}=24V，V_{OUT}=Low	-	-	10	uA
V_{DZ}	Overvoltage protection at VDD terminal	IDD=10mA	30	35	40	V
V_{OZ}	Overvoltage protection at OUT terminal	VOUT=High，IOUT=1mA	30	35	40	V
OCP	Over current protection at OUT terminal					
t_{PO}	Power-on time	V_{DD}＞3.8V	-	3.8	9	ms
t_{settle}	Settling time	V_{DD}＞3.8V，f=1KHz	0	-	50	ms
$t_{response}$	Response time	V_{DD}＞3.8V，f=1KHz	3.8	-	59	ms
t_r	Output rise time	R_{Pull}=1KΩ，C_{OUT}=20pF	-	0.4	1.0	us
t_f	Output fall time	R_{Pull}=1KΩ，C_{OUT}=20pF	-	0.35	1.0	us
f_{cu}	Upper corner frequency	-3dB，single pole	-	-	20	KHz
f_{cl}	Lower corner frequency	-3dB，single pole	10	-	-	Hz
Magnetic parameters						
B_{Back}	Pre-induction		-500	-	500	mT
$\triangle B_{OP(A/B)}$	Operate point	f=1KHz，B_{diff}=5mT	-	-	0	mT
$\triangle B_{RP(A/B)}$	Release point	f=1KHz，B_{diff}=5mT	0	-	-	mT
$B_{HYS(A/B)}$	Hysteresis		0.5	1.5	2.5	mT
$\triangle B_M$	Center of switching point	$(B_{OP}+B_{RP})/2$	-2	0	2	mT
SC9632VB-BK Hall plate spacing						
L_A	Hall plate spacing of channelA/B		-	2.1	-	mm
L_{A-B}	Hall plate spacing of channel A to channel B		-	0.9	-	mm
SC9633VB-BK Hall plate spacing						
L_A	Hall plate spacing of channelA/B		-	1.2	-	mm
L_{A-B}	Hall plate spacing of channel A to channel B		-	0.6	-	mm
SC9634VB-BK Hall plate spacing						
L_A	Hall plate spacing of channelA/B		-	1.8	-	mm
L_{A-B}	Hall plate spacing of channel A to channel B		-	0.9	-	mm

9. Typical Characteristics

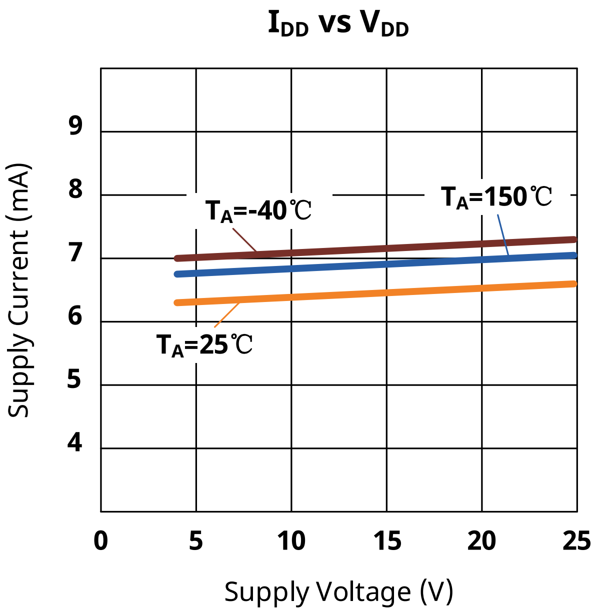


Fig.3 Supply Current versus Ambient Temp.

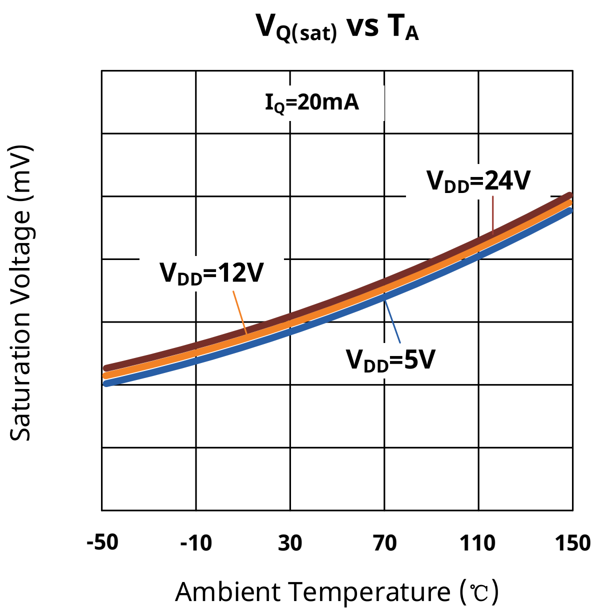


Fig.4 $V_{OUT(sat)}$ versus Ambient Temp.

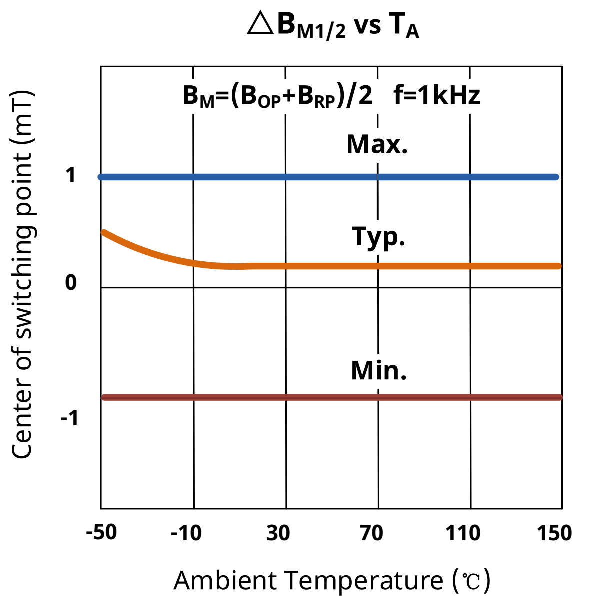


Fig.5 Symmetry of magnetic field versus Ambient Temp.

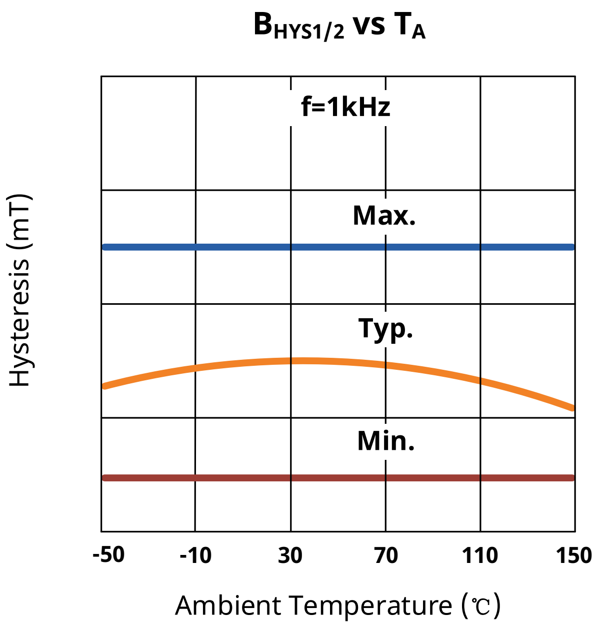


Fig.6 Hysteresis versus Ambient Temp.

10. Block Diagram

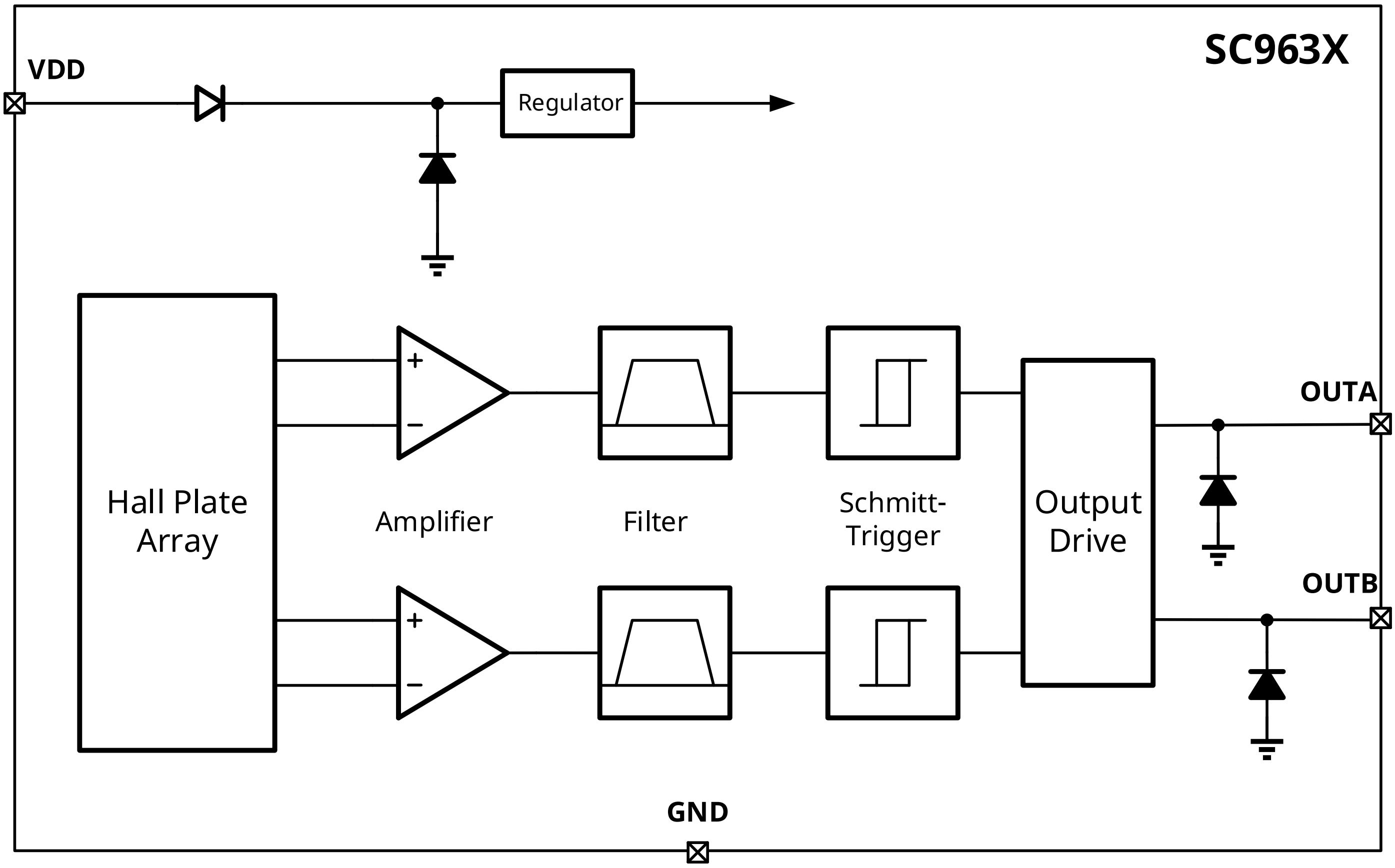


Fig.7 Block Diagram

11. Function Description

The SC963X integrates two independent differential halls to detect the magnetic wheel directly, or the ferromagnetic gear behind the magnet. The rotation of the target wheel will generate differential magnetic fields on the two differential hall disks, which will be converted into differential analog voltage signals through the Hall disk, and then output corresponding digital signals through internal calculation.

There are two independent channels inside the chip, both of which can detect the movement or position change of the target wheel. This differential design provides immunity to radial vibration within the SC963X's operating air gap by suppressing common-mode signals. The static deviation of the back magnetic field and the deviation of the system offset can be eliminated by the differential bandpass filter inside the chip, which also has a certain immunity to the interference of the electromagnetic source.

The distance between the two hall disks in the chip is half of the distance between the two hall disks in a single chip. When the tooth distance of the target wheel is equal to the distance between the hall disks in a single chip, the output signals of the two channels are just 90° orthogonal. SC9632VB-BK recommended detection distance ≤2mm, SC9633VB-BK and SC9634VB-BK recommended detection distance ≤1.5mm.

The chip uses a temperature-compensated amplifier and a bias cancellation circuit to self-calibrate. Its internal voltage regulator provides power supply noise suppression over the entire operating voltage range. Stable amplifier design and magnetic deviation suppression circuit, so that temperature changes do not have a large impact on the device.

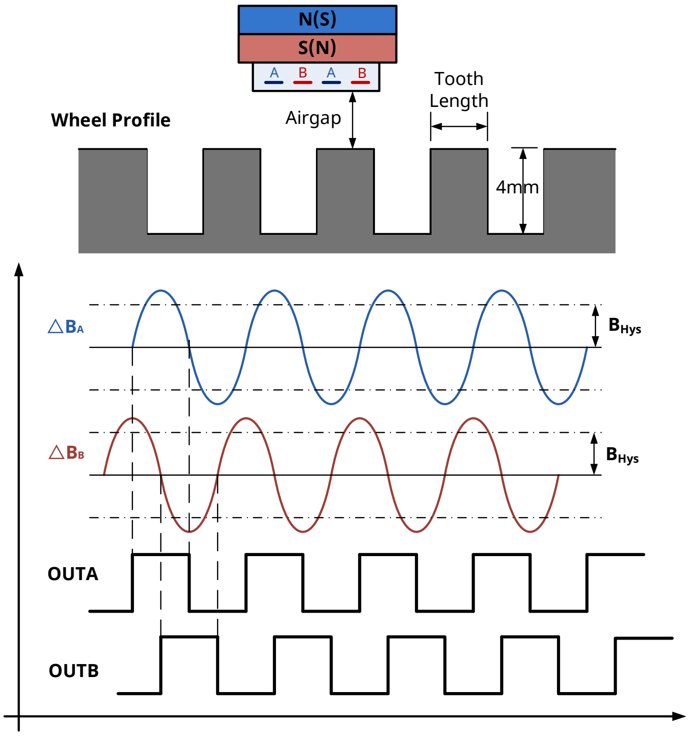


Fig.8 Gear position-differential magnetic field-output response

12. Typical Application

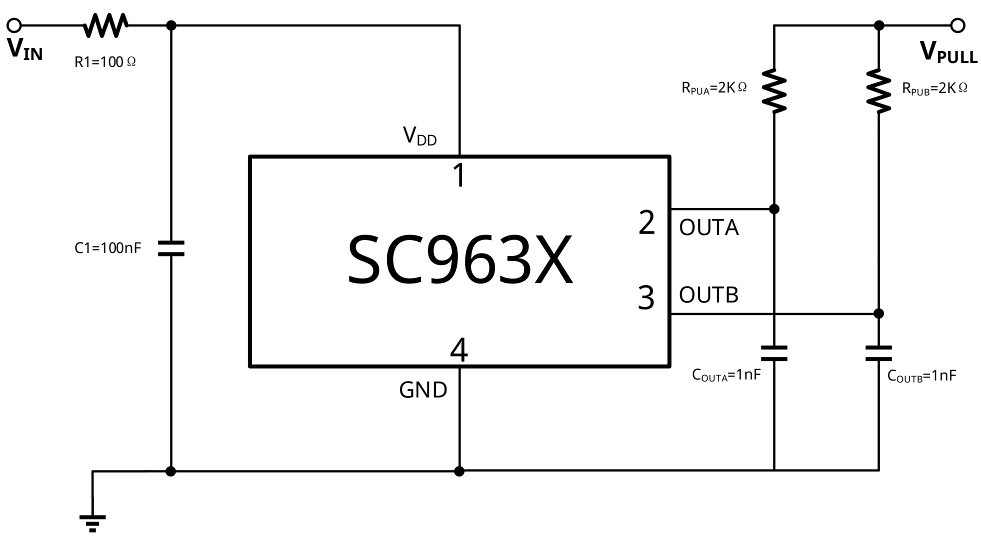
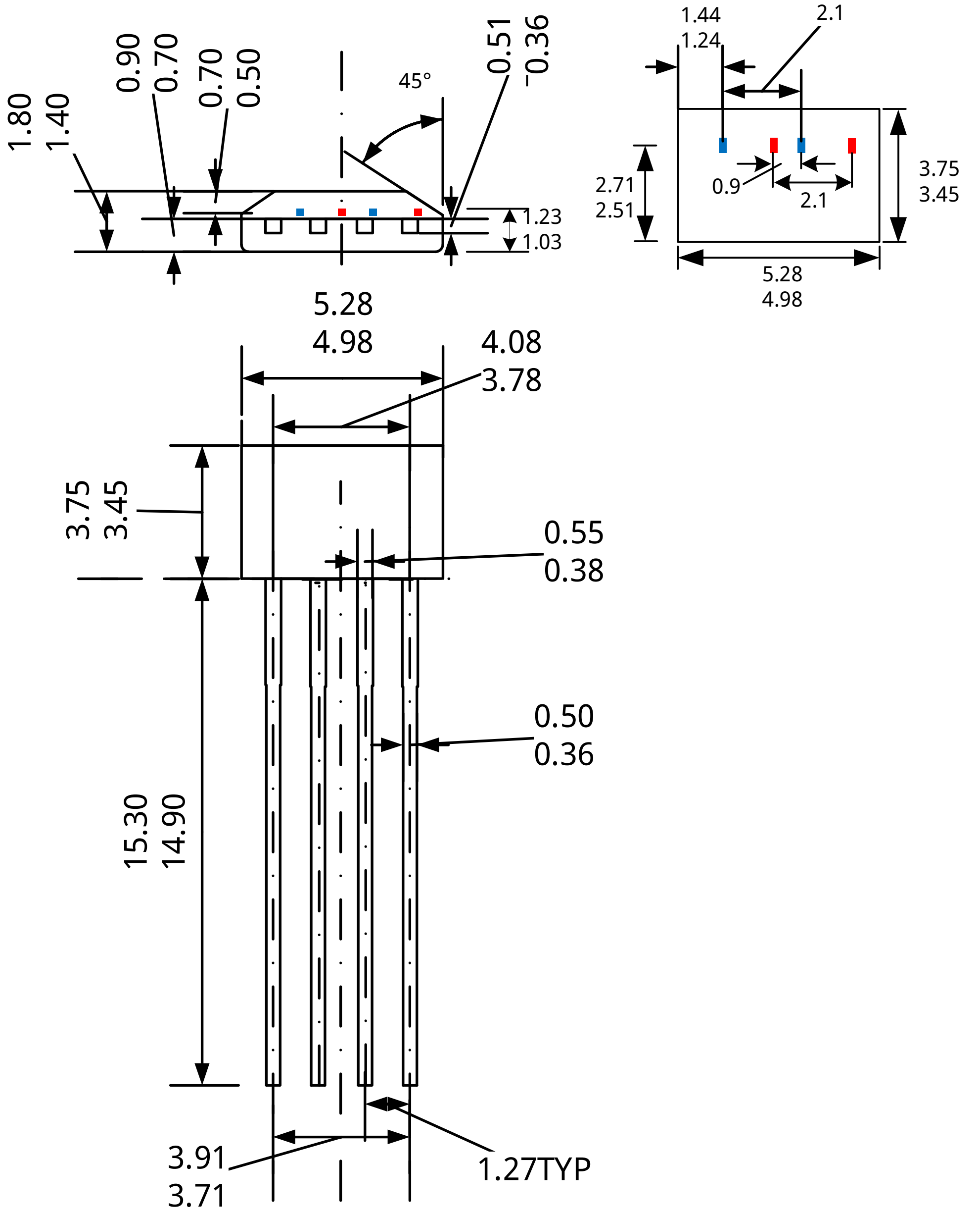


Fig.9 Typical Application Circuit

13. Package Information “TO-94”

4-Terminal
VB Package

Dimension:mm

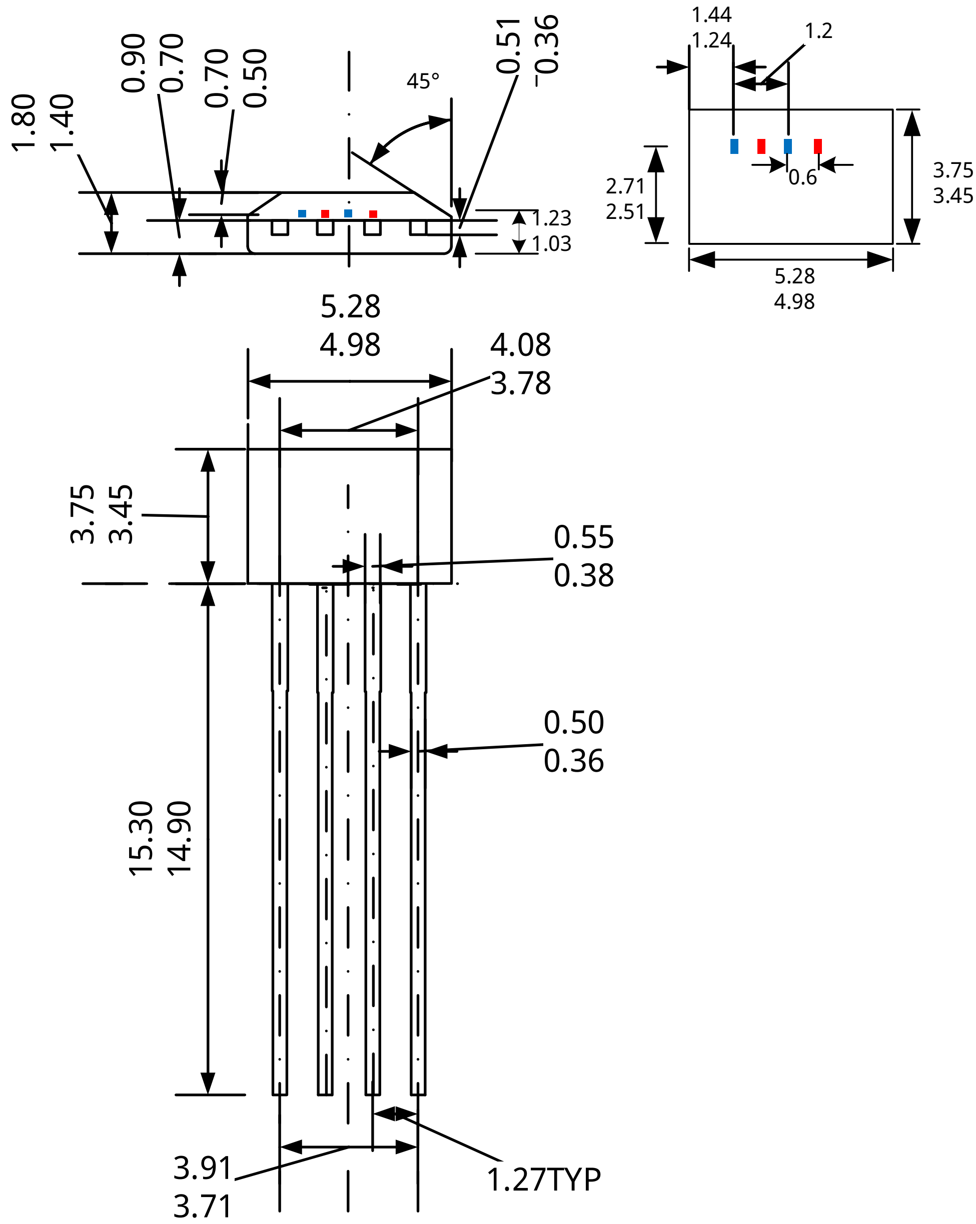


Notes:
1.Exact body and lead configuration at vendor’s option within limits shown.
2.Height does not include mold gate flash.
3.The plating thinckness is 7-17um
4.Fine dimension information reference POD-TO94-231229-001

Fig.10 Package Dimensions(SC9632VB-BK)

4-Terminal
VB Package

Dimension:mm

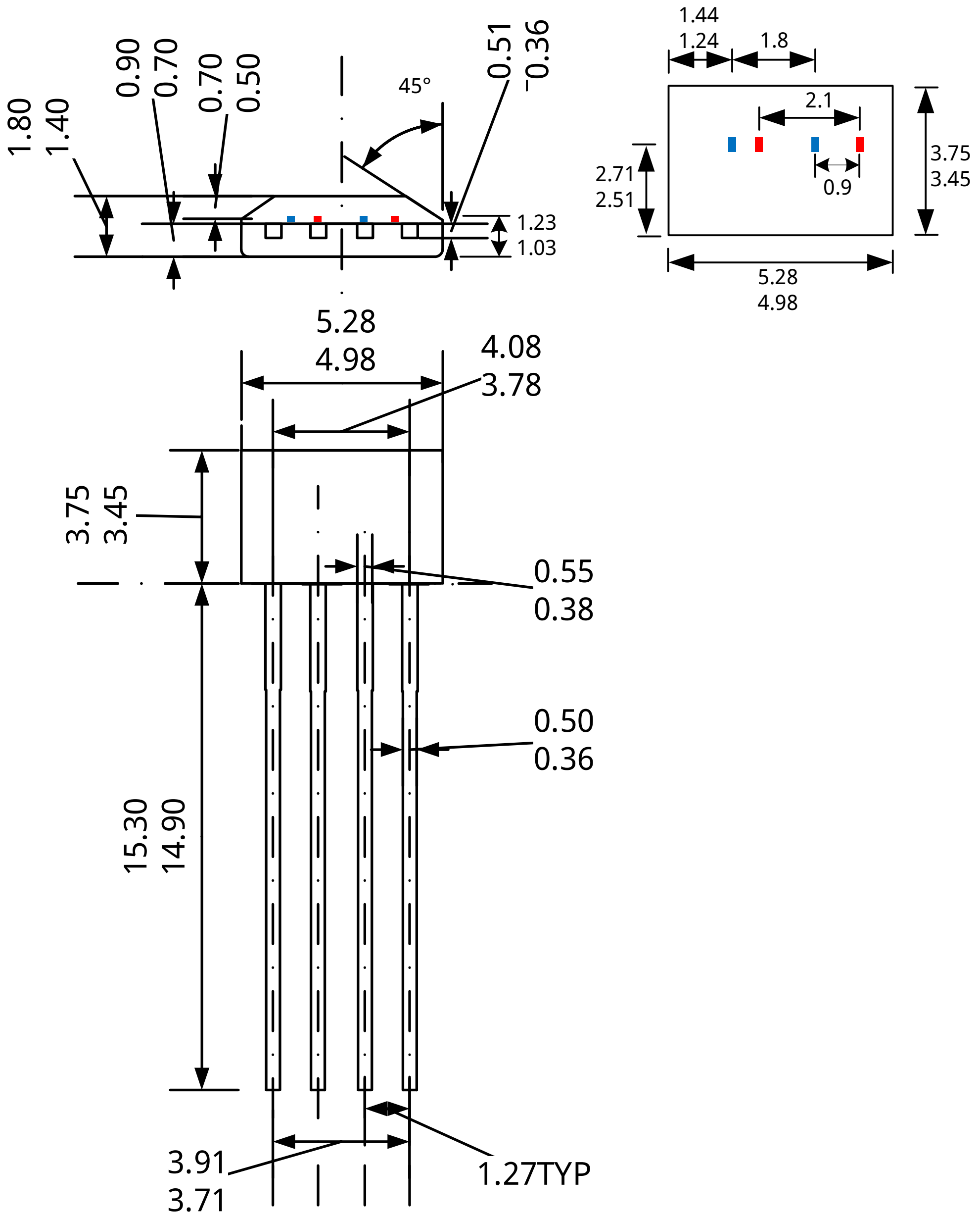


Notes:
1.Exact body and lead configuration at vendor ’ s option within limits shown.
2.Height does not include mold gate flash.
3.The plating thinckness is 7-17um
4.Fine dimension information reference POD-TO94-231229-001

Fig.11 Package Dimensions(SC9633VB-BK)

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.
3.The plating thinckness is 7-17um
4.Fine dimension information reference POD-TO94-231229-001

Fig.12 Package Dimensions(SC9634VB-BK)

14. Revision History

Revision	Date	Description
Rev.0.1	2017-09-23	Initial revision
Rev.2.3	2018-11-07	The final revision of old format
Rev.A1.0	2020-11-19	A separate specification for each part number
Rev.A1.1	2025-02-17	Update ordering information into one datasheet