SENTRON
a Melexis Company

2SA-10

Integrated 2-Axis Hall Sensor

Features

- Measures two components of a magnetic field at the same spot.
- Excellent matching of sensitivity along the two axes.
- Max. angle error from –40°C ..+125°C: < 1°
- Very high sensitivity
- Low quiescent current
- Fabricated in standard CMOS technology
- Very low hysteresis
- Surface mount SOIC-8 package

Applications

- 2-D position sensing
- Contactless potentiometer
- Angular position sensor for micro motors
- Miniaturized contactless encoder
- Contactless rotary switch
- 2-D magnetic field mapping
- Joystick

General Description

Sentron's new magnetic angular sensor 2SA-10 detects the absolute angular position of a small magnet that is positioned above the device surface. The 2SA-10 is an integrated combination of a CMOS Hall circuit and a thin ferromagnetic disk. The CMOS circuit contains two pairs of Hall-elements for each of the two directions parallel with the chip surface X and Y. The ferromagnetic disk amplifies the external magnetic field and concentrates it on the Hall elements.

The 2SA-10 is ideally suited for rotary position sensing in harsh automotive and industrial environments. It produces two linear, ratio-metric output voltages proportional to the sine and the cosine function of the angle of the applied magnetic field parallel to the chip surface.

The circuit is fabricated using a standard CMOS process and the ferromagnetic disk is added in a simple post-processing step. The monolithic device incorporates Hall elements, offset cancellation circuitry, current source, chopper stabilized amplification circuitry, parameter programming capability. By dynamic offset cancellation any offset voltage caused by temperature variations, packaging stress or others is strongly reduced. As a result, the device has an extremely stable signal output, is immune to mechanical stress and is virtually immune to temperature cycling.

Therefore, the circuit features a wide application range and very high accuracy.

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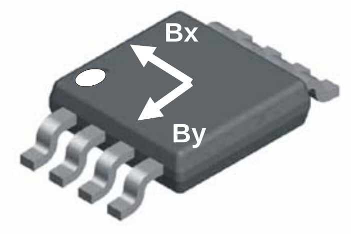
Package: SOIC-8

Pin-out:



1 CO_OUT, common output
2 PC, programming clock[1)]
3 VDD, Supply voltage
4 Y_OUT, Y-channel analog output
5 X_OUT, X-channel analog output
6 PD, programming data[1)]
7 PV, programming voltage[1)]
8 GND, Supply common

Note 1: Used for factory programming

Absolute Maximum Ratings

Symbol	Parameter	Min.	Max.	Unit	Remarks
V_{SUP}	Supply Voltage	0	6	V	
T	Ambient Temperature	-40	+125	°C	

Magnetic Input Conditions

Symbol	Parameter	Min.	Max.	Unit	Remarks
B_{MAX} [2)]	Max. Induction		>1000	mT	Device saturates,but is not damaged
D fc	Diameter of magnetic disk		0.2	mm	See Figure 5 for location of disk
ω	angular speed		100'000	rpm	

Note 2: At center of magnetic disc

Recommended Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit	Remarks
V_{SUP}	Supply Voltage	4.5	5	5.5	V	
I_{OUT}	Output Current	-1		1	mA	
C_L	Load Capacitance			1000	pF	
B [3)]	Magnetic Field			80	mT	

Note 3: At center of magnetic disc

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Electrical Characteristics

At T=-40°C to 150°C, V_{SUP}=4.5V to 5.5V if not otherwise specified.

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test conditions
I_{SUP}	Supply Current		16	18	mA	
CO_OUT	Common (reference) Output Voltage [4)]	V_{SUP}/2 -20mV	V_{SUP}/2	V_{SUP}/2 +20mV		I_{OUT}=0mA
BW	Bandwidth: DC to	10	15	18	kHz	

Note 4: Ratio-metric (proportional to V_{SUP})

Analog Output-Characteristics [5,6)]

With V_{SUP}= 5V and the temperature range -40°C to 150°C, if not otherwise specified.

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test conditions
S	Magnetic Sensitivity [6)]	40	50	60	V/T	
$\Delta S/S\Delta T$	Magnetic Sensitivity Temperature drift	-0.05		0.05	%/°C	I_{OUT}=0mA T=-40°C to 150°C
Sx/Sy	Magnetic Sensitivity mismatch (X-Y) [6)]		0	2	%	B = B_L [7)]
∠Sx-Sy	Phase matching	-0.3	0	0.3	°	B = B_L [7)]
Voff	Offset Voltage	-10	0	10	mV	B=0T [7)], I_{OUT}=0mA T=-20°C to 80°C
$\Delta Voff/\Delta T$	Offset Voltage Temperature drift	-0.05		0.05	mV/°C	B=0T [7)], I_{OUT}=0mA
B_{FS} [7,8)]	Full Scale Magnetic Field Range	-45		45	mT	
B_L [7,8)]	Linear Magnetic Field Range	-40		40	mT	
NL	Non Linearity		0.1	0.2	%	For B ≤ B_L [7)]
			0.5	1	%	For B ≤ B_{FS} [7)]
ΔBnoise [7)]	Input referred magnetic noise spectrum density (RMS)			750	$nT/\sqrt{Hz}$	B_W=1Hz to 10kHz
X_OUT max	Max. full scale output voltage	5% V_{SUP}		95% V_{SUP}	V	|B| ≥ 50mT
Y_OUT max	Max. full scale output voltage	5% V_{SUP}		95% V_{SUP}	V	|B| ≥ 50mT
Hys max	Maximum Hysteresis			0.03	% B_{FS}	|B| ≥ B_{MAX}

Note 5: When the analog output pins X_OUT and Y_OUT are used in differential mode (i.e. Vx=X_OUT-CO_OUT)
Note 6: Ratio-metric (proportional to V_{SUP})
Note 7: At center of magnetic disk
Note 8: The 2SA-10 can also be ordered with Sensitivity of 25V/T for B_L=60mT and B_{FS}=80mT

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Block Diagram 2SA-10

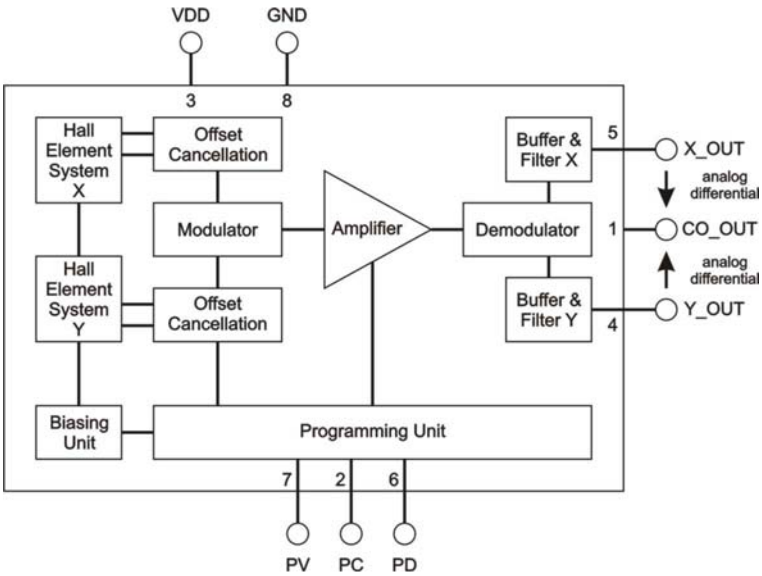
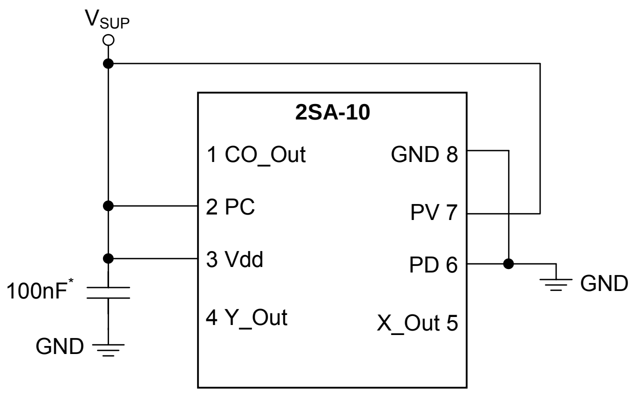


Fig. 1 Block Diagram 2SA-10

Connection Diagram 2SA-10

IMPORTANT For reliable operation within the specifications the sensor must be connected as follows:

Connect Pin 6 (PD) to Pin 8 (GND)
Connect Pin 2 (PC) to Pin 3 (Vdd)
Connect Pin 7 (PV) to Pin 3 (Vdd)
Put a 100nF capacitor close to the chip between Pin 3 (Vdd) and Pin 8 (GND)



* If the supply voltage is disturbed by EMI it can be useful to place a second capacitor (100pF, ceramic) parallel to the 100nF capacitor.

Fig. 2 Connection diagram of 2SA-10

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Package dimensions SOIC-8

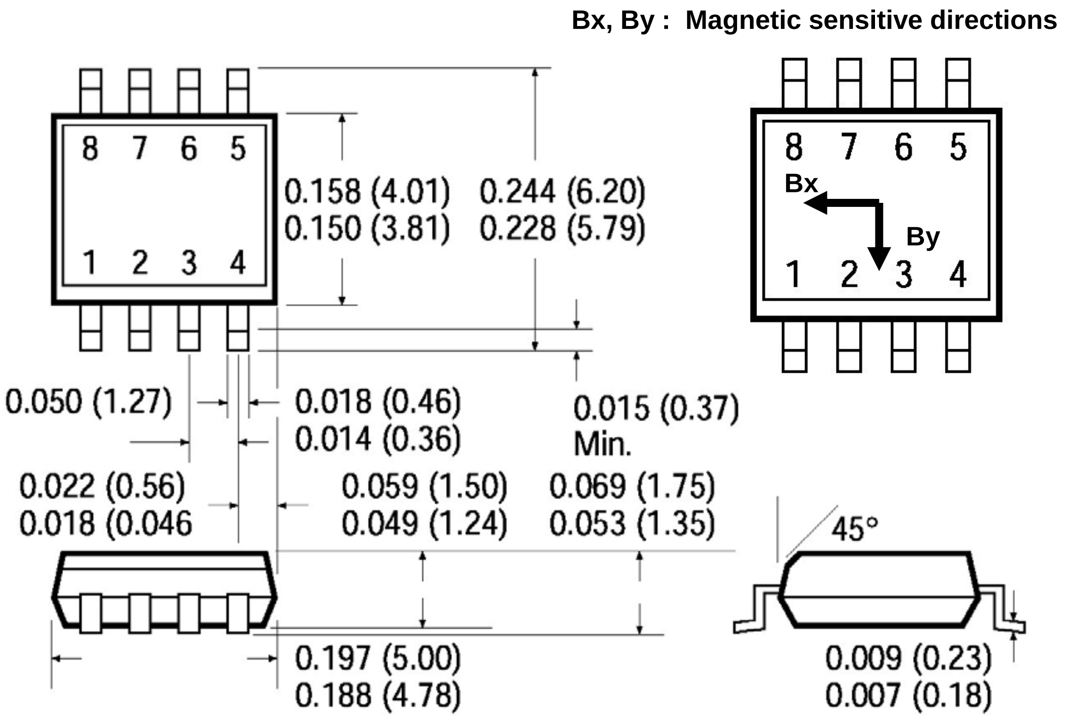

Fig. 3 Package dimensions and magnetic sensitive directions

Dimension and Pads 2SA-10 in dice form

(all dimensions in µm)

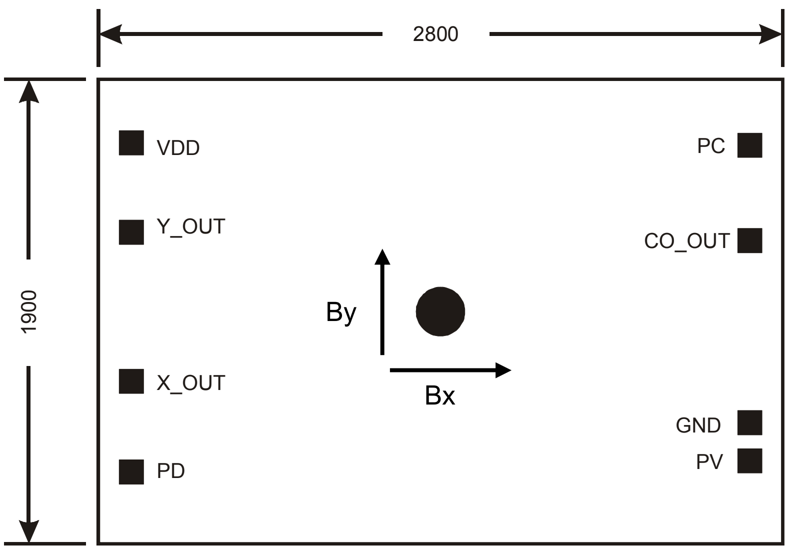

Fig. 4 2SA-10 dimensions of dice

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Location of Disk

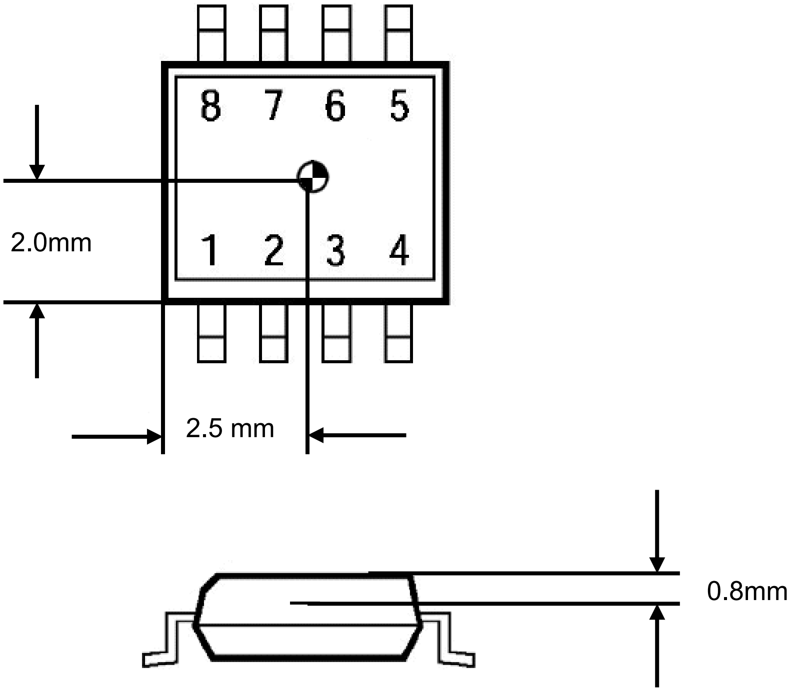

Fig. 5 2SA-10 location of disk

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Applications

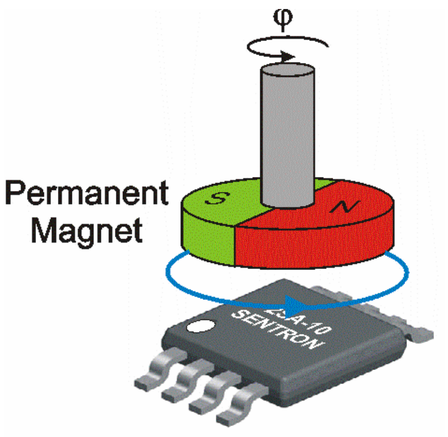
The unique integrated two-axis Hall-sensor offers a rugged, low cost solution for any rotational reference detection. Application examples are found in contactless angular sensors and encoders, in rotational switches, in brushless dc motors and in joysticks

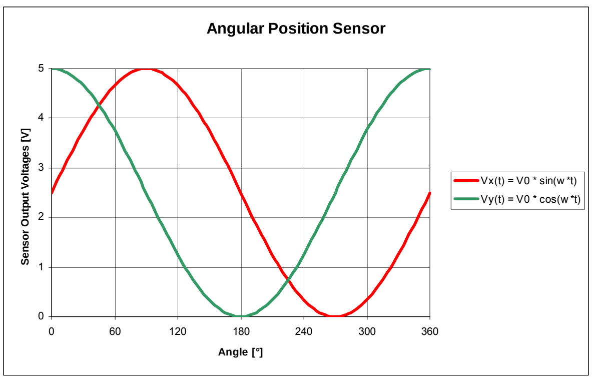
The 2SA-10 is applied in a way very similar to magnetoresistive GMR and AMR angular sensors by sensing the rotation of a magnetic field component parallel with the chip. However, the full integration of magnetic field sensor and programmable signal conditioning circuit of the 2SA-10 offers an exceptional cost effectiveness.

Sentron's 2SA-10 combines the advantage of a miniaturized angular sensor solution and simultaneously higher product performance and reliability. The features of high sensitivity, low offset and low temperature drift meets even the most demanding requirements across many industries.

Absolute Angle Sensor

The 2SA-10 is positioned under a rotating magnet mounted at the shaft end of a rotating axis. The magnet is magnetized diametrically, so that by rotating the shaft the field through the sensor also rotates. The generated voltages Vx and Vy of the 2SA-10 represent the sine and cosine of the magnetic field direction. Even though the signal amplitudes depend upon the vertical distance between sensor and magnet, the angle information, which is calculated by the ratio of Vx and Vy is not depending on this value. In this manner the angle sensor is very robust towards sensitivity temperature drift, magnet temperature drift and ageing effects as well as assembly tolerances.





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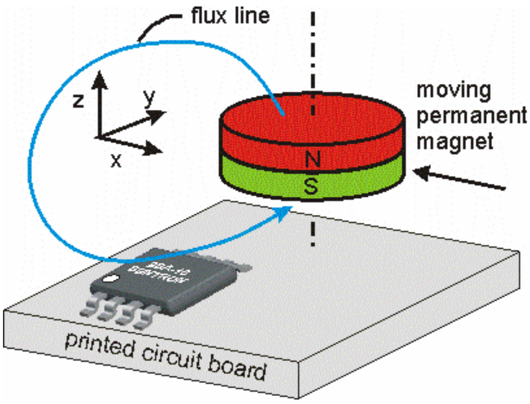
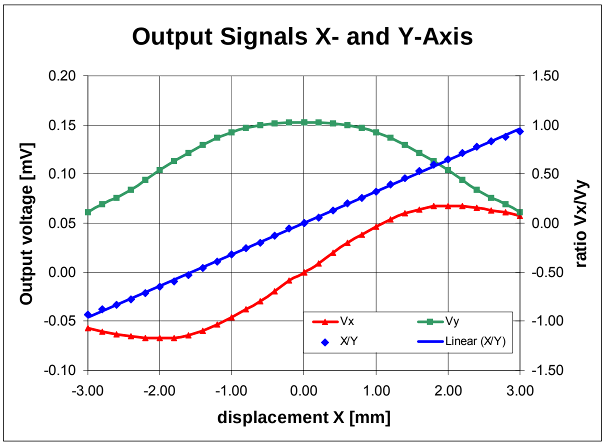
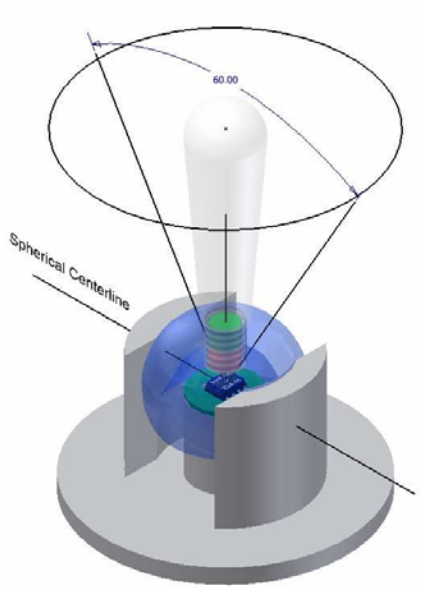
Linear Position Sensor

The 2SA-10 is positioned in the vicinity underneath a small permanent magnet with round shape. The magnetization axis of the magnet is perpendicular to the sensor plane. When the magnet moves parallel to the plane, the magnetic field at the sensor rotates. The output signal Vx of the 2SA-10 behaves like X*B/r^2 and the output signal Vy like Y*B/r^2 with X and Y being the coordinates of the magnet with respect to the sensor, B being the field strength at the sensor and r being the distance between magnet and sensor. If the magnet now moves parallel to the x-axis, the coordinate Y is constant and the ratio Vx/Vy = X/const. is a very linear measure of the position of the magnet. Using a second 2SA-10 sensor the principle can be extended to very linear two-dimensional position sensing.





Position Sensor / Joystick



The 2SA-10 is positioned in the rotation center of a joystick control handle, which holds a permanent magnet at its lower end. In centered position the field emanating from the magnet is exactly perpendicular to the chip surface and the sensor output is zero for X and Y. As soon as the stick is inclined, the sensor output becomes positive or negative on X and Y. The output signal is linear with the inclination angle for a range of about ± 30° of inclination

Please contact us for documentation such as application notes, technical papers and others.

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