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Dynamic Differential Hall Effect Sensor IC CYGTS9921

The differential Hall Effect Gear Tooth sensor CYGTS9921 provides a high sensitivity and a superior stability over temperature and symmetrical thresholds in order to achieve a stable duty cycle. CYGTS9921 is particularly suitable for rotational speed detection and timing applications of ferromagnetic toothed wheels such as anti-lock braking systems, transmissions, crankshafts, etc. The integrated circuit, which is based on Hall Effect principle, provides a digital signal output with frequency proportional to the rotational speed. A differential Hall IC is not influenced by radial vibration within the effective airgap of the sensor and require no external signal processing.

Features

- Advanced performance
- High sensitivity
- Symmetrical thresholds
- High piezo resistivity
- Reduced power consumption
- South and north pole pre-induction possible
- AC coupled
- Digital output signal
- Two-wire and three-wire configuration possible
- Large temperature range
- Large airgap
- Low cut-off frequency
- Protection against overvoltage
- Protection against reversed polarity
- Output protection against electrical disturbances

PG-SSO-4-1

Applications

Automotive and Heavy Duty Vehicles	Industrial Areas:
• Camshaft and crankshaft speed and position • Transmission speed • Tachometers • Anti-skid/traction control	• Sprocket speed • Chain link conveyor speed/distance • Stop motion detector • High speed low cost proximity • Tachometers, counters.

Operating Range

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Back Bias Range	B_{Bias}	Operating	-500		500	mT
Differential Magnetic Field	ΔB		-80		80	mT
Supply Voltage	V_{DD}	Operating	4.5	12	24	V
Operating Temperature	T_A		-40		150	°C
Storage Temperature	T_S		-40		150	°C

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Electrical and Magnetical Specifications

DC Operating Parameters T_A = -40°C to 150°C, V_{DD} = 4.5V to 24V (unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Supply Voltage	V_{DD}	Operating	4.5	12	24	V
Supply Current	I_{DD}	$V_{o=High,}$ Iout=0mA	3.8	5.3	8.0	mA
		Vo=LOW, Iout=40mA	4.3	5.9	8.8	mA
Output Leakage Current	I_{Leak}	V_{out} =24V	--	--	50	µA
Output Saturation Voltage	V_{sat}	I_{out}=40mA	--	250	600	mV
Overvoltage protection at supply voltage at output	V_{SP} V_{OP}	I_{DD} = 16 mA Iout = 16 mA	27 27	-- --	35 35	V V
Center of switching points: (ΔB_{OP} + ΔB_{RP}) / 2	ΔB_m	-20 mT < ΔB < 20 mT f = 200 Hz	-1	0	1	mT
Operate point	ΔB_{OP}	f = 200 Hz, ΔB = 20 mT	--	--	0	mT
Release point	ΔB_{RP}	f = 200 Hz, ΔB = 20 mT	0	--	--	mT
Hysteresis	ΔB_H	f = 200 Hz, ΔB = 20 mT	0.5	1.5	2.5	mT
Output Rise Time	T_R	Iout =40mA, C=10pF	--	--	0.5	µs
Output Fall Time	T_F	Iout =40mA, C=10pF	--	--	0.5	µs
Deley Time	t_{dop} t_{drp} t_{dop} - t_{drp}	f = 10 kHz ΔB = 5 mT	-- -- --	-- -- 0	25 10 15	µs µs µs
Frequency Bandwidth	BW	Operating	--	--	20	kHz
Thermal Resistance	RTH	Operating	--	--	190	K/W

Absolute Maximum Ratings

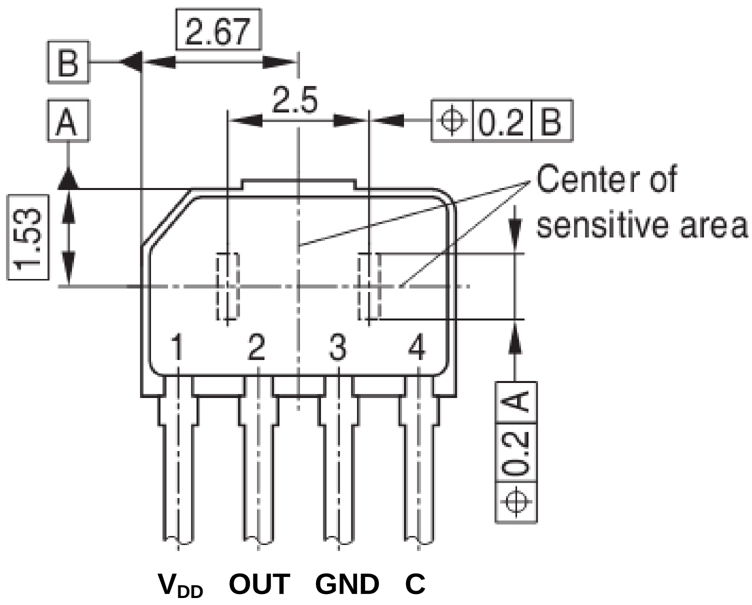
Parameter	Minimal value	Maximal value
Supply Voltage V_{DD}	-35V	30V
Output Voltage V_{OUT}	-0.7V	30V
Supply Current (Fault) I_{DD}	--	50mA
Output Current I_{out}	--	50mA
Output Reverse Current	--	50mA
Junction temperature, T_J (5000h) Junction temperature, T_J (2000h) Junction temperature, T_J (1000h) Junction temperature, T_J (40h)	-- -- -- --	150°C 160°C 170°C 210°C
Current through input-protection device	--	200mA
Current through output-protection device	--	200mA

ESD (Emergency Shutdown System) Protection

Human Body Model (HBM) Tests

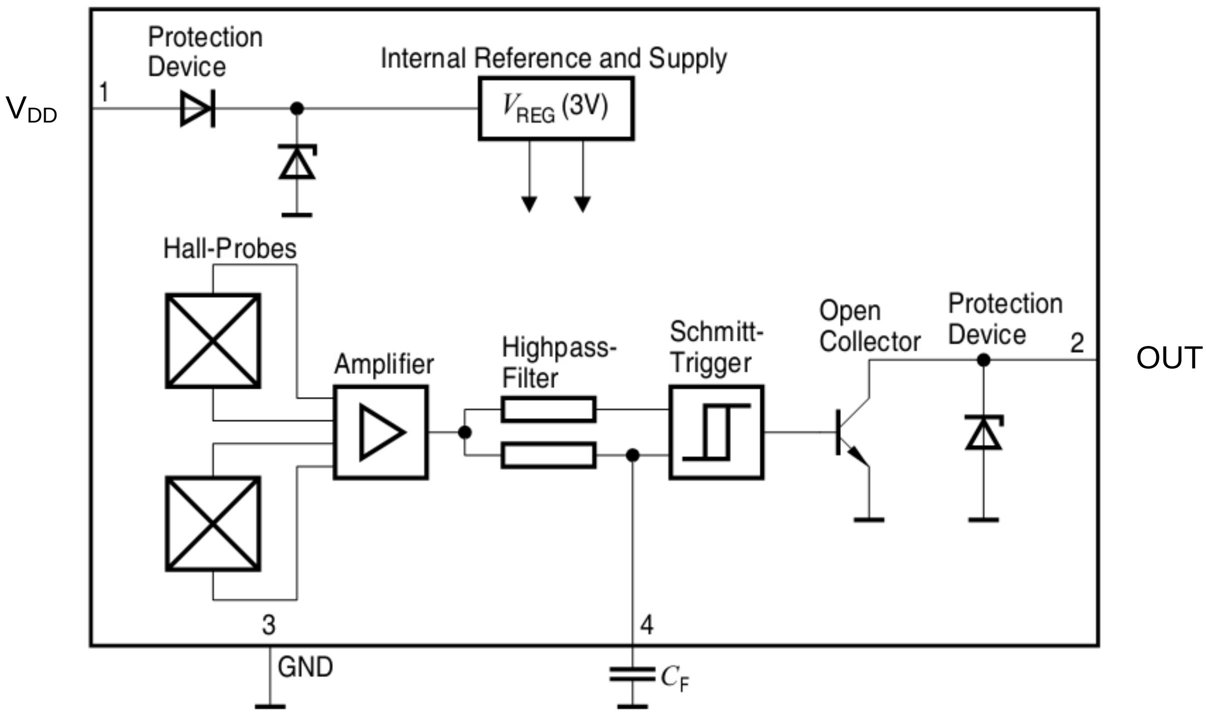
Parameter	Symbol	Max.	Unit	Note
ESD	V_{ESD}	±2.0	kV	According to Standard EIA/JESD22-A114-B-HBM

Pin Configuration



Pin No.	Symbol	Function
1	V_{DD}	Supply voltage
2	OUT	Output
3	GND	Ground
4	C	Capacitor

Block Diagramm



Functional Description

The Differential Hall Sensor IC CYGTS9921 detects the motion and position of a ferromagnetic target wheel or a multipolar permanent magnet by measuring the differential flux density of the magnetic field. To detect ferromagnetic objects the magnetic field must be provided by a back biasing permanent magnet (**south or north** pole of the magnet attached to the rear unmarked side of the IC package).

Using an external capacitor the generated Hall voltage signal is slowly adjusted via an active high pass filter with a low cut-off frequency. This causes the output to switch into a biased mode after a time constant is elapsed. The time constant is determined by the external capacitor. Filtering avoids ageing and temperature influence from Schmitt-trigger input and eliminates device and magnetic offset.

The CYGTS9921 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 CYGTS9921 can be operated in a two-wire as well as in a three-wire-configuration. The output is logic compatible by high/low levels regarding on and off.

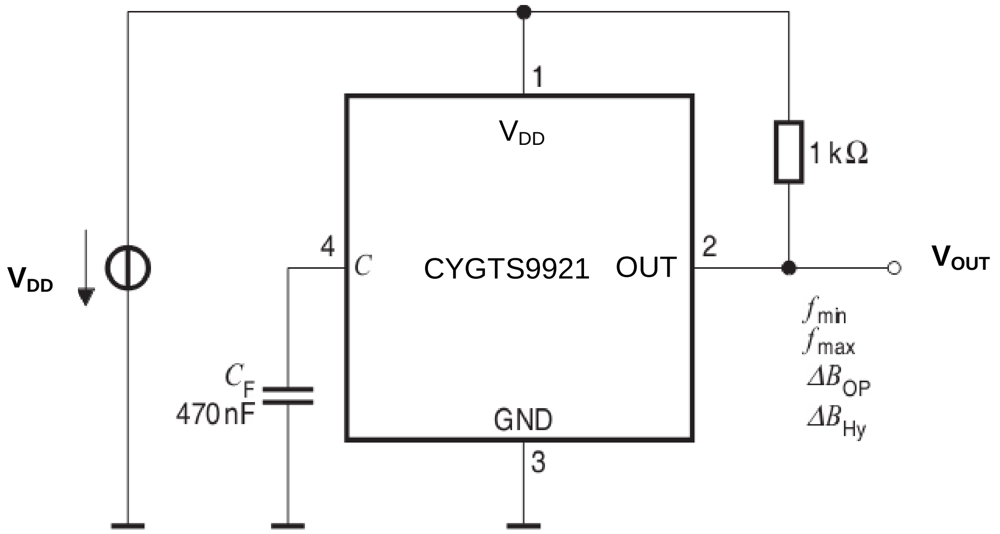
Description of Block Diagram

The CYGTS9921 is comprised of a supply voltage reference, a pair of Hall probes spaced at 2.5 mm, differential amplifier, filter for offset compensation, Schmitt trigger, and an open collector output.

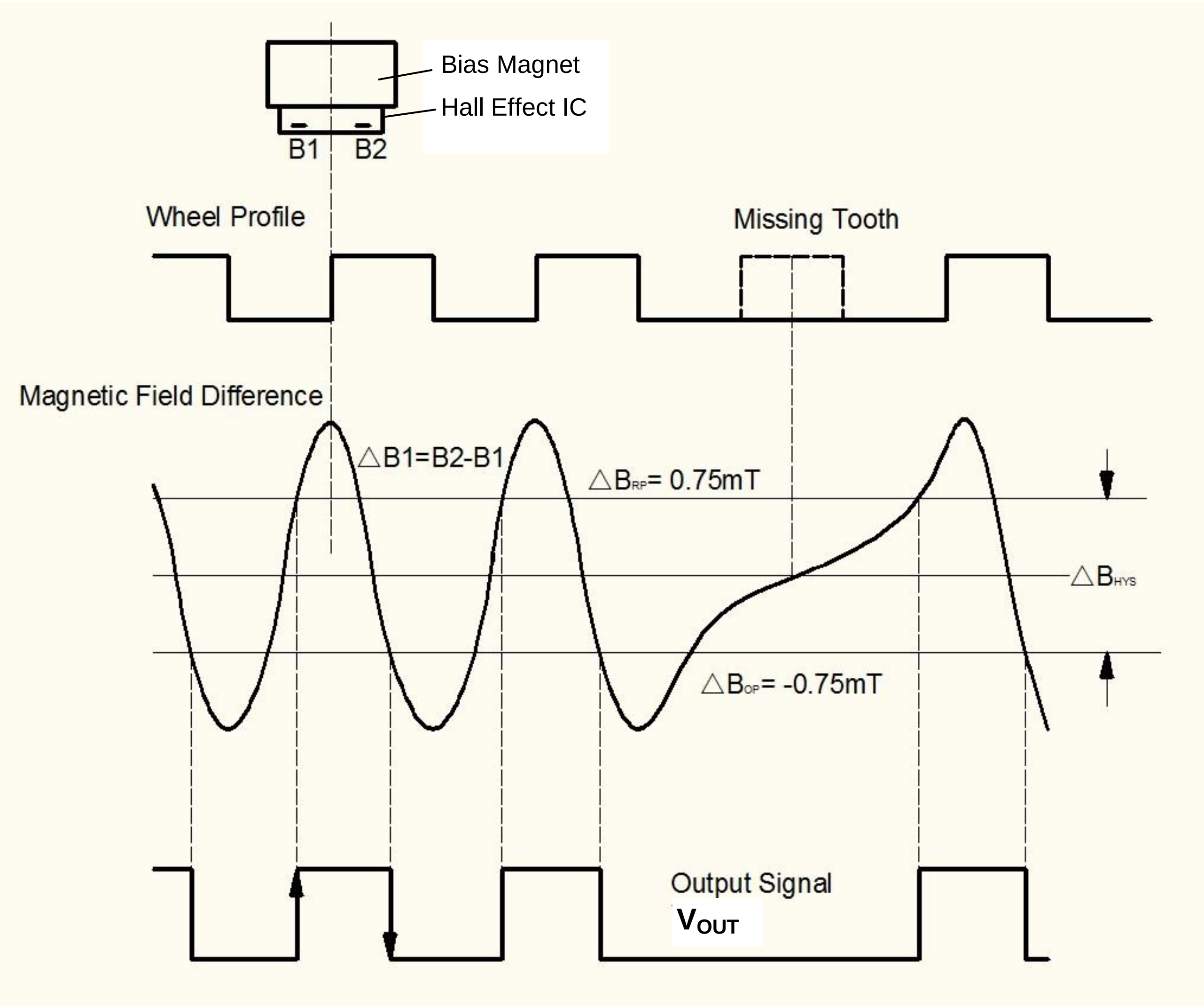
The CYGTS9921 was designed to have a wide range of application parameter variations. Differential magnet fields up to ± 80 mT can be detected without influence to the switching performance. The bias magnet field can either come from a magnetic south or north pole, whereby the field strength up to 500 mT or more will not influence the switching points. The improved temperature compensation enables a superior sensitivity and accuracy over the temperature range. Finally the optimized piezo compensation and the integrated dynamic offset compensation enable easy manufacturing and elimination of magnet offsets.

Protection is provided at the power supply (pin 1) for overvoltage and reverse polarity and against over-stress such as load dump, etc., in accordance with ISO-TR 7637 and DIN 40839. The output (pin 2) is protected against voltage peaks and electrical disturbances.

Test Circuit



Gear Tooth Sensing



Operating point: B2-B1 < ΔB_{OP} switches the output ON (V_{OUT} = LOW)
Release point: B2-B1 > ΔB_{RP} switches the output OFF (V_{OUT} = HIGH)
$\Delta B_{RP} = \Delta B_{OP} + \Delta B_{HYS}$

The magnetic field is defined as positive if the south pole of the magnet shows towards the rear side of the IC housing.

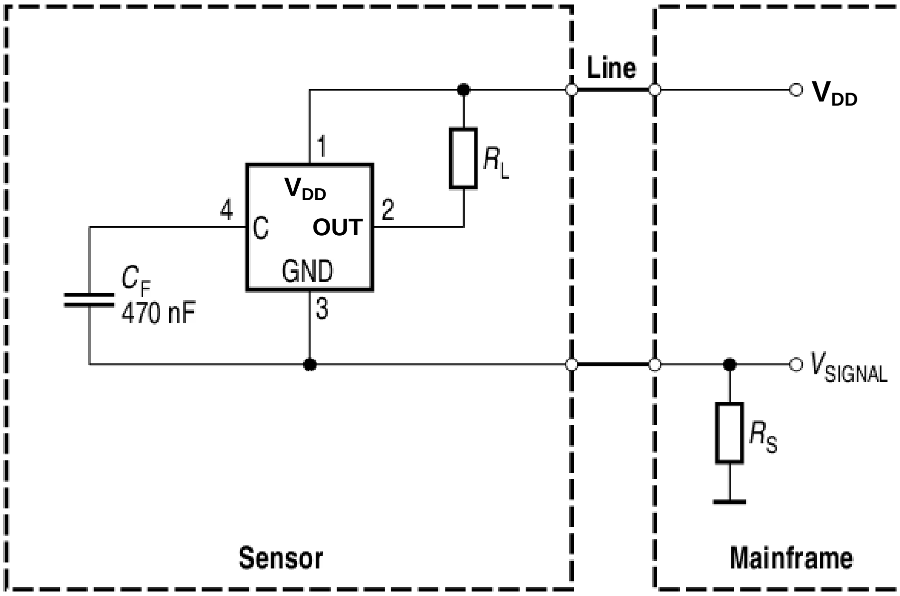
In the case of ferromagnetic toothed wheel application the IC has to be biased by the south or north pole of a disc or block Bias permanent magnet which should cover both Hall probes.

The maximum air gap depends on:

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

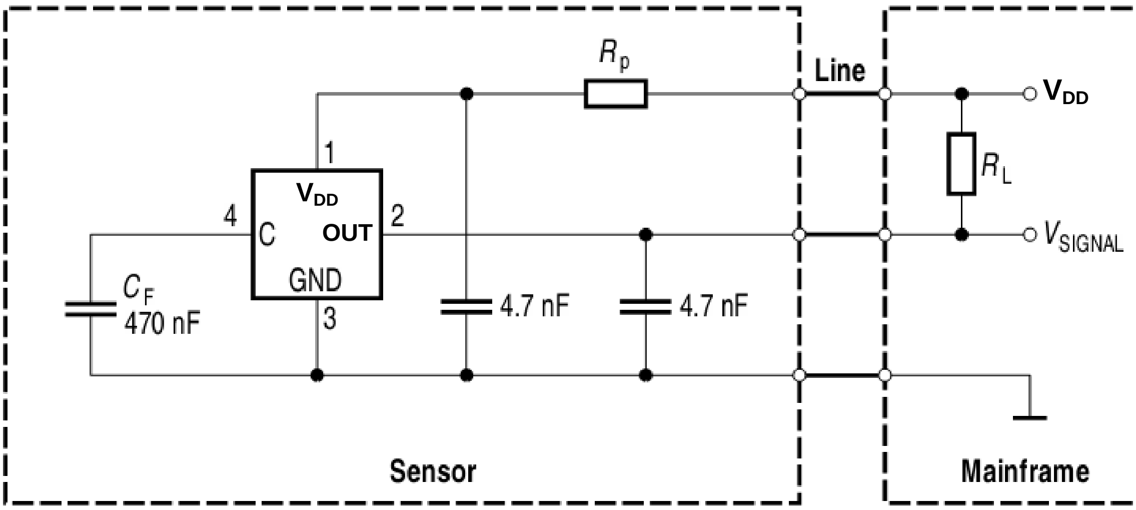
Application Circuits

Two-Wire Connection



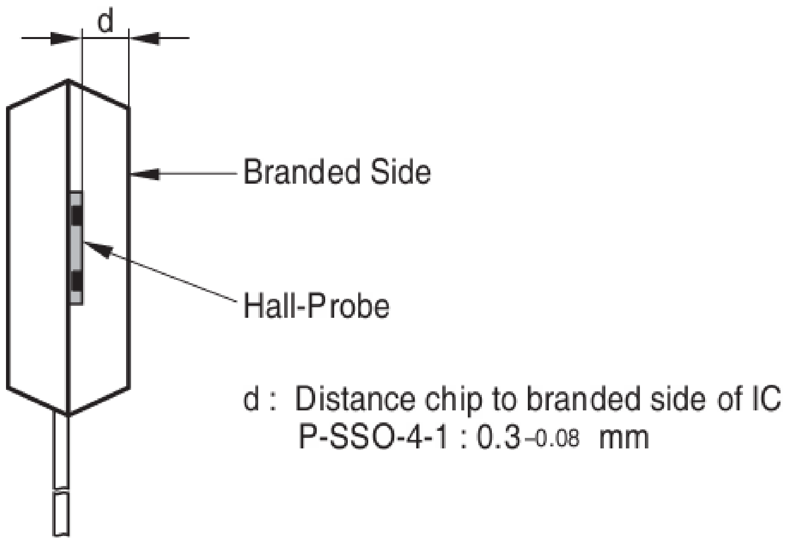
for example : $R_L = 330\ \Omega$
$R_S = 120\ \Omega$

Three-Wire Connection



for example : $R_L = 330\ \Omega$
$R_P = 0 \ldots 330\ \Omega$

Distance Chip to Upper Side of IC



Package Outlines