AH4921

Dynamic Differential Hall-Effect Sensor IC

◆ Product Description

The AH4921 is a differential Hall Sensor IC which detects the motion and position of ferromagnetic and permanent magnet structures 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 AH4921 is comprised of a internal voltage regulator, a pair of Hall probes spaced at 2.5mm, differential amplifier, filter for offset compensation, Schmitt-trigger, and an open collector output.The AH4921 was designed to have a wide range of application parameter variations. Differential fields up to ± 80mT can be detected without influence to the switching performance. The pre-induction field can either come from a magnetic south or north pole, whereby the field strength up to 500mT 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 input/supply (Pin 1) for over-voltage and reverse polarity and against over-stress such as load dump, etc. The output (Pin 2) is protected against voltage peaks and electrical disturbances.

◆ Features and Benefits

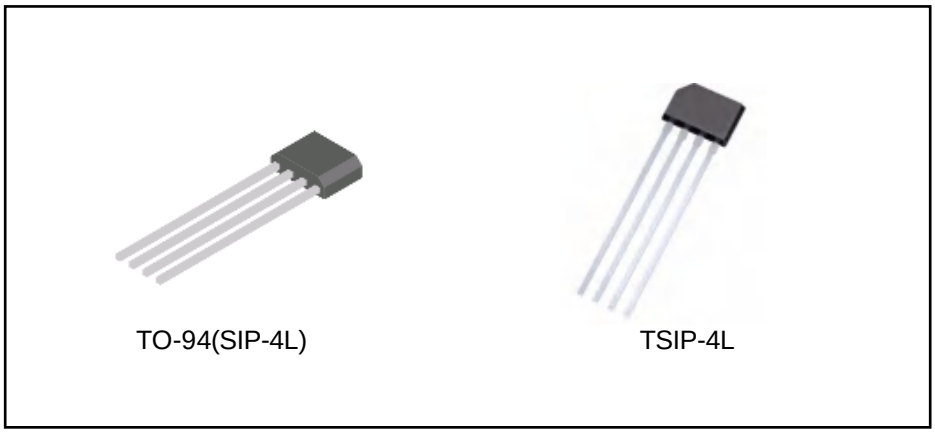
- Power supply voltage range: 3.8~30V
- Protection against reversed polarity
- Protection against over-voltage
- Output protection against electrical disturbances
- Operation temperature: -40~+150℃
- Digital output signal,Maximum output sink current 50mA with open-collector configuration
- Low cut-off frequency, maximum operation frequency: 20KHz
- AC coupled, Dynamic detection, High sensitivity
- Symmetrical thresholds
- High piezo resistivity
- Reduced power consumption
- South and north pole pre-induction possible
- Large airgap

◆ Target Applications

The AH4921 is particularly suitable for rotational speed detection and timing applications of ferromagnetic toothed wheels such as anti-lock braking systems, transmissions, crankshafts, etc. The AH4921 based on Hall effect, provides a digital signal output with frequency proportional to the speed of rotation. Unlike other rotational sensors differential Hall ICs are not influenced by radial vibration within the effective airgap of the sensor and require no external signal processing.

AH4921 ***Dynamic Differential Hall-Effect Sensor IC***

◆ Package Configuration



◆ Order Information

Product Type	Operation Temperature	Package	Package Type	Status
AH4921LZ4	L: -40～150℃	Z4: TO-94(SIP-4L)	Bulk	Mass production
AH4921LZX	L: -40～150℃	ZX: TSIP-4L	Bulk	Mass production

AH4921 ***Dynamic Differential Hall-Effect Sensor IC***

◆ Pin Configuration

Pin Description

Pin Number	Pin Name	Function
1	VCC	Power supply voltage
2	OUT	Output with open-collector
3	GND	Ground
4	CAP	Capacitor

◆ Functional Block Diagram

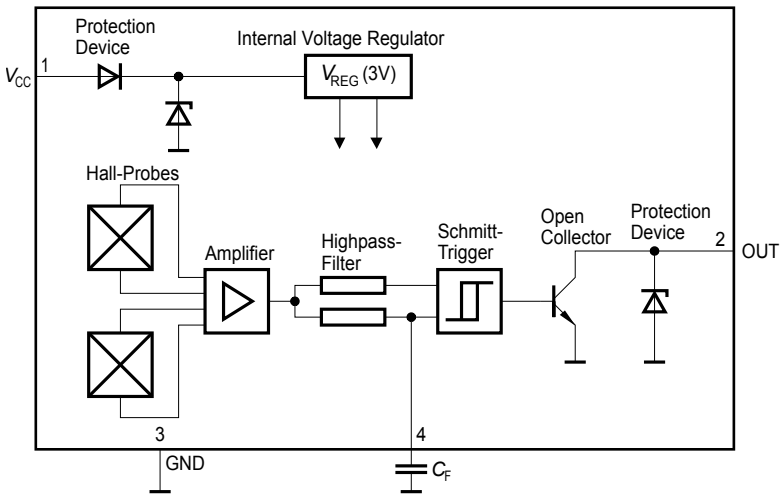


Figure 1. Functional Block Diagram of AH4921

AH4921 ***Dynamic Differential Hall-Effect Sensor IC***

◆ Abslute Maximum ratings

T_j = -40 to +150°C

Parameter	Symbol	Limit Values		Unit	Remarks
		Min.	Max.		
Supply voltage	V_{CC}	-35	35	V	Reverse current < 10 mA
Output voltage	V_{OUT}	-0.7	35	V	
Output current	I_{OUT}	–	50	mA	
Output reverse current	$-I_{ROUT}$	–	50	mA	
Capacitor voltage	V_C	-0.3	3	V	
Junction temperature	T_j	–	150	°C	5000 h
		–	160		2500 h
Storage temperature	T_S	-40	150	°C	
Thermal resistance	R_{thJA}	–	197	°C/W	
Current through input-protection device	I_{CCZ}	–	200	mA	t < 2 ms; v = 0.1
Current through output-protection device	I_{OUTZ}	–	200	mA	t < 2 ms; v = 0.1

◆ Recommended Operating Conditions

Parameter	Symbol	Limit Values			Unit	Remarks
		Min.	Typ.	Max.		
Supply voltage	V_{CC}	3.8	–	30	V	
Junction temperature	T_j	-40	–	150	°C	5000 h
		–	–	160		2500 h
		–	–	170		1000 h
Pre-induction	B_{BIAS}	-500	–	500	mT	at Hall probe; independent of magnet orientation
Differential induction	ΔB	-80	–	80	mT	

AH4921 ***Dynamic Differential Hall-Effect Sensor IC***

◆ Electrical and magnetic parameters

Parameter	Symbol	Limit Values			Unit	Test Condition
		Min.	Typ.	Max.		
Supply current	I_{CC}	4.3	6.5	8.8	mA	V_{OUT} = High
Output saturation voltage	$V_{OUT(SAT)}$	–	0.25	0.6	V	I_{OUT} = 40 mA
Output leakage current	I_{OL}	–	–	5	μA	V_{OUT} = 30 V
Operate point	ΔB_{OP}	–	–	0	mT	f = 200 Hz, ΔB = 20 mT
Release point	ΔB_{RP}	0	–	–	mT	f = 200 Hz, ΔB = 20 mT
Hysteresis	ΔB_{H}	0.5	1.5	2.5	mT	f = 200 Hz, ΔB = 20 mT
Overvoltage protection at supply voltage at output	V_{CCZ} V_{OUTZ}	38 38	– –	45 45	V V	I_{CC} = 20 mA I_{OUT} = 20 mA
Output rise time	t_r	–	–	0.5	μs	I_{OUT} = 40 mA C_{OUT} = 10 pF
Output fall time	t_f	–	–	0.5	μs	I_{OUT} = 40 mA C_{OUT} = 10 pF
Delay time	t_{dop} t_{drp} t_{dop} - t_{drp}	– – –	– – 0	25 10 15	μs μs μs	f = 10 kHz ΔB = 5 mT
Filter input resistance	R_C	35	43	52	kΩ	25°C ±2°C
Filter sensitivity to ΔB	S_C	–	-5	–	mV/mT	–
Filter bias voltage	V_C	1.6	2	2.4	V	ΔB = 0
Operaion Frequency	f	*(1)*	–	20	KHz	ΔB = 5 mT

Note:

(1) Depends on filter capacitor C_F. The cut-off frequency is given by

$$f = \frac{1}{2\pi \times R_C \times C_F}$$

The switching points are guaranteed over the whole frequency range, but amplitude modification and shift.

AH4921 **Dynamic Differential Hall-Effect Sensor IC**

◆ Application Configurations

Two possible applications are shown in Figure 2 (Toothed and Magnetic Wheel).

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 (e.g. $SmCO_5$ (Vacuumschmelze VX145)) with the dimensions 8 mm × 5 mm × 3 mm) which should cover both Hall probes.

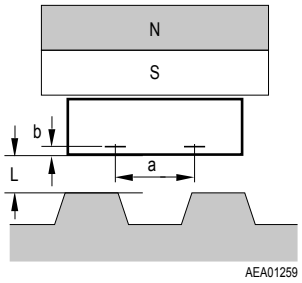
The maximum air gap depends on:

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

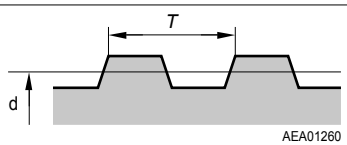
Sensor Spacing

a centered distance of Hall probes
b Hall probes to IC surface
L IC surface to tooth wheel

a = 2.5 mm
b = 0.3 mm



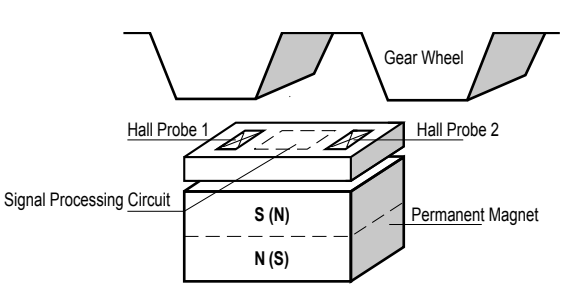
Tooth Wheel Dimensions



Conversion DIN – ASA
m = 25.4 mm/p
T = 25.4 mm CP

DIN
d diameter (mm)
z number of teeth
m module $m = d/z$ (mm)
T pitch $T = \pi \times m$ (mm)

ASA
p diameter pitch $p = z/d$ (inch)
PD pitch diameter PD = z/p (inch)
CP circular pitch CP = 1 inch × π/p



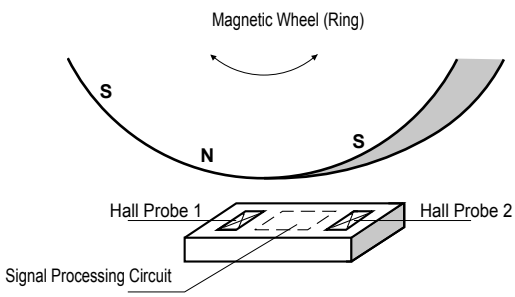
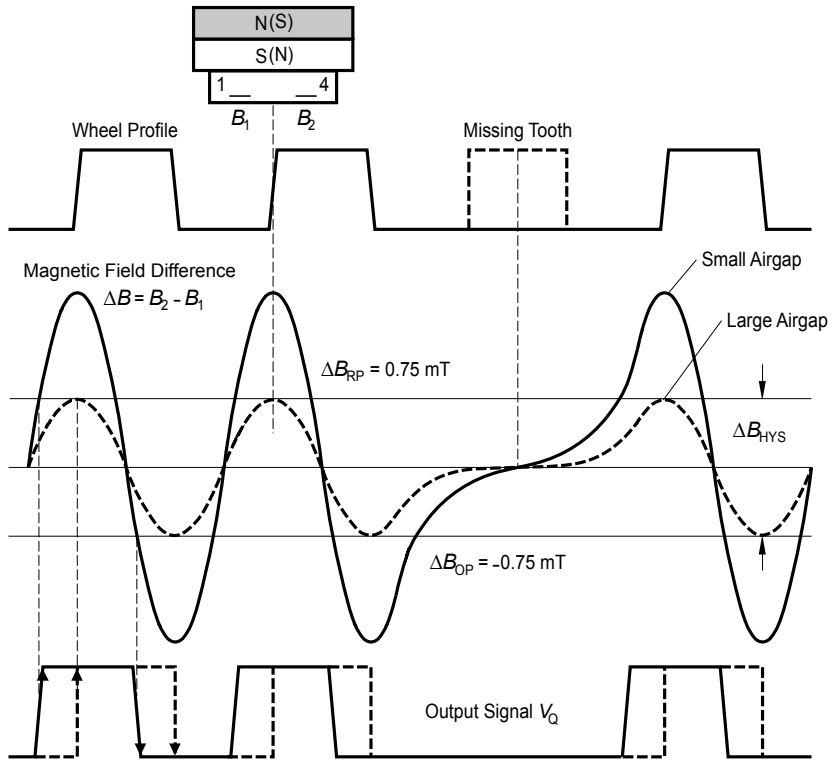


Figure 2. AH4921, with Ferromagnetic Toothed Wheel or Magenetic Wheel (Ring)

AH4921 ***Dynamic Differential Hall-Effect Sensor IC***

◆ Application Configurations



Operate point: $B_2 - B_1 < \Delta B_{OP}$ switches the output ON (V_{OUT} = LOW)
Release point: $B_2 - B_1 > \Delta B_{RP}$ 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.

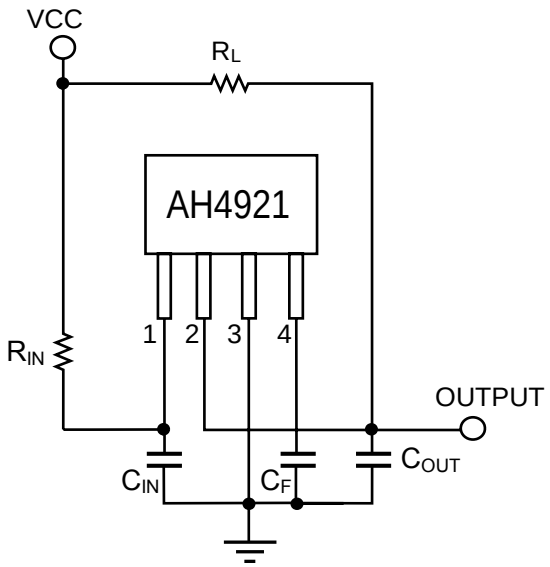
Figure 3. System Operation of AH4921

◆ Application Circuits

The AH4921 contains an on-chip voltage regulator and can operate over a wide supply voltage range. For the AH4921 device that need to operate from an unregulated power supply, transient and double-battery protection should be added externally. For applications using a regulated supply, external EMI/RFI protection is often required. Insufficient protection can result in unexplained pulses on the output line, providing inaccurate sensing information to the user.

The filter capacitor and EMI protection circuitry can easily be added to a PC board for use with the AH4921 device.

The AH4921 device requires minimal protection circuitry during operation from a low-voltage regulated line. The on-chip voltage regulator provides immunity to power supply variations between 3.8V and 30V. However, even while operating from a regulated line,some supply and output filtering is required to provide immunity to coupled and injected noise on the supply line. A basic RC low-pass circuit (R_{IN}&C_{IN}) on the supply line and an optional output capacitor (C_{OUT}) is recommended for operation in noisy environments. Because the device has an open-collector output, an output pull-up resistor R_L must be included either at the sensor output or by the signal processor input.



C_F=470nF，R_L=2kΩ

R_{IN}=10Ω，R_{IN} is optinal;

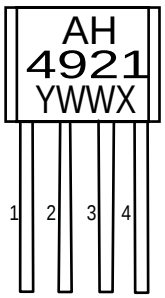
C_{IN}=4.7nF，C_{IN} is optinal;

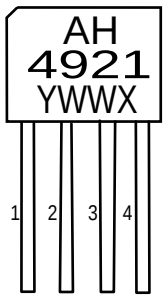
C_{OUT}=4.7nF，C_{OUT} is optinal;

Figure 4. Application Circuit of AH4921

AH4921 ***Dynamic Differential Hall-Effect Sensor IC***

◆ Marking Informations



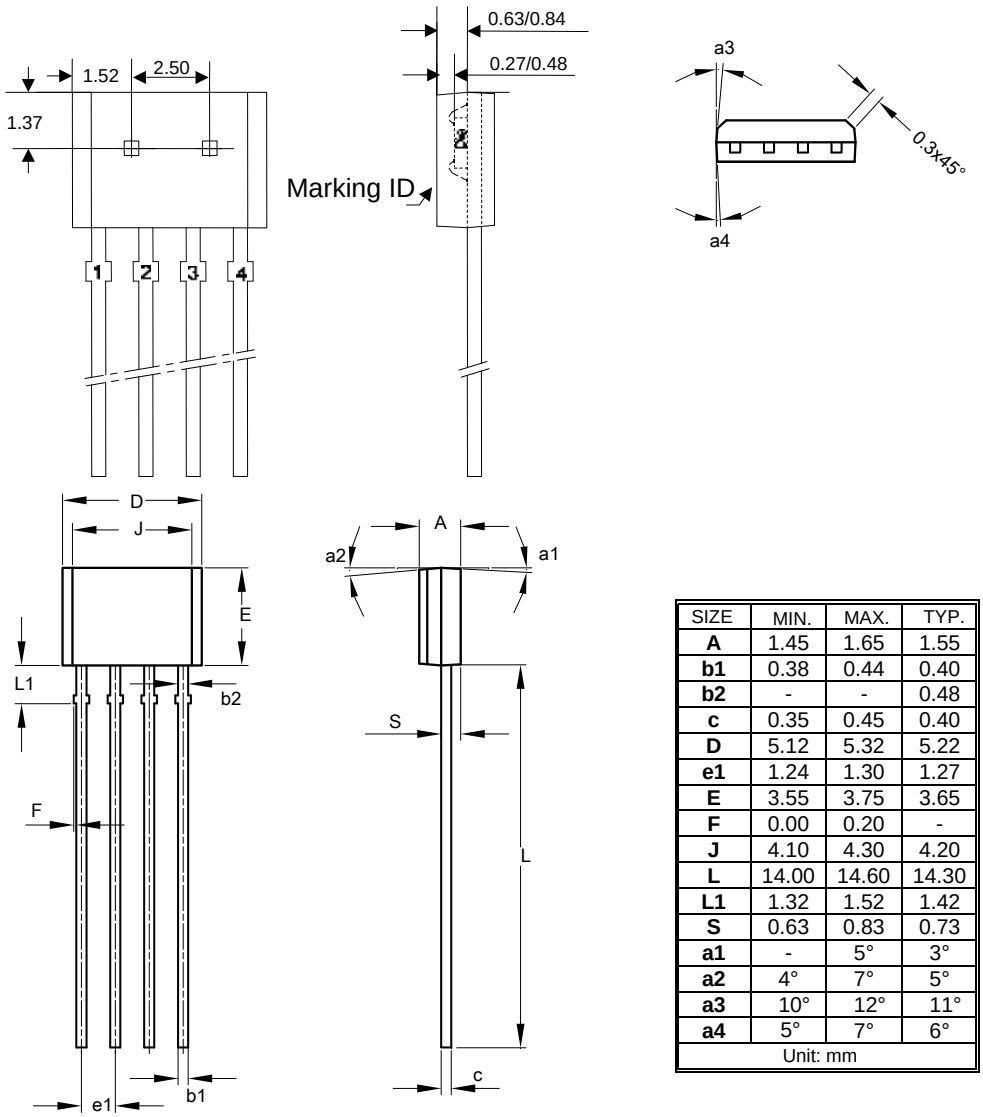


Device part number

Y: Last digit of year of manufacture, "3"=2023,0~9
WW: Nth Week of manufacture,01~52
X: Internal Code.

◆ Package Informations

TO-94 (SIP-4L), Unit: mm



SIZE	MIN.	MAX.	TYP.
A	1.45	1.65	1.55
b1	0.38	0.44	0.40
b2	-	-	0.48
c	0.35	0.45	0.40
D	5.12	5.32	5.22
e1	1.24	1.30	1.27
E	3.55	3.75	3.65
F	0.00	0.20	-
J	4.10	4.30	4.20
L	14.00	14.60	14.30
L1	1.32	1.52	1.42
S	0.63	0.83	0.73
a1	-	5°	3°
a2	4°	7°	5°
a3	10°	12°	11°
a4	5°	7°	6°
Unit: mm			

AH4921 ***Dynamic Differential Hall-Effect Sensor IC***

◆ Package Informations

Thin SIP-4L (TSIP-4L), Unit: mm