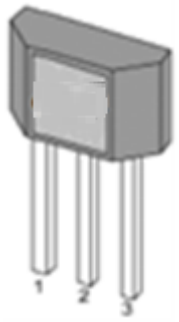
CH502E

AEC-Q100 Qualified, Hall-Effect Geartooth Sensor IC

Features

- Geartooth Sensor
- Zero Speed Detection
- Insensitive to Orientation
- High speed operation Frequency
- Short Circuit Protection
- Self-Adjusting Magnetic Range
- On-chip 10 bit A/D Converter
- No Chopper Delay
- RoHs Compliant 2011/65/EU

Package

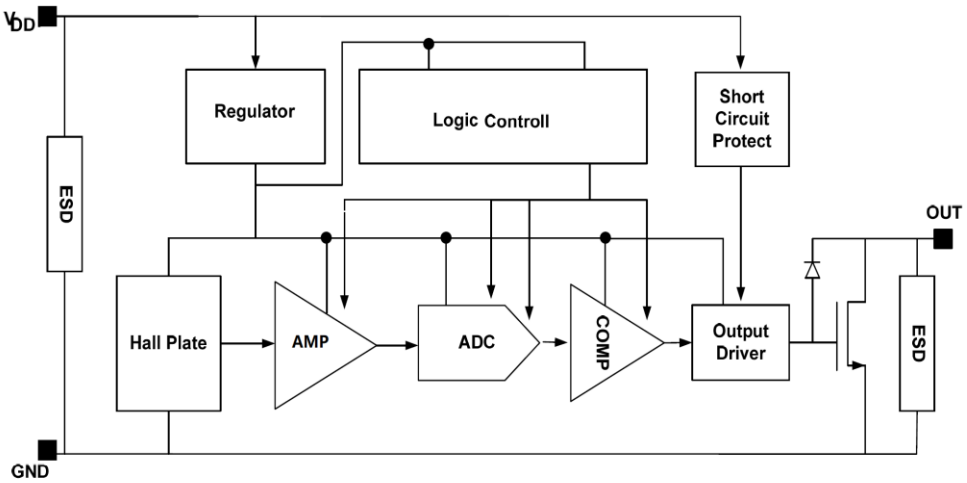


TO-92S

Application

- Geartooth Sensor
- Speed Sensor
- Camshaft Sensor
- Direction Detection

Functional Block Diagram



Description

The CH502E is gear tooth sensor IC for use in automotive camshaft sensing. CH502E is used with a bias magnet south facing the back (no mark) side of the IC. The technology used for the IC is Hall-effect based. The Chip incorporate Hall Effect plate, an A/D converter with self-calibrates the internal gain of the device to adjust the air-gap variations. And digital sample and hold circuit. Schmitt trigger and an open drain output with short circuit protected.
As the gear tooth rotate, the chip samples an in increasing or decreasing flux density. When the flux has reached its minimum value and increased hysteresis flux, the output will turn on (BOP). When the flux has reached its maximum value and decreased hysteresis flux, the output will turn off (BRP).

The CH502E is ideal for use in gather speed, position and direction detection to those gear-tooth based configurations. Particularly suited to those applications that require accurate duty cycle or accurate edge detection, such as automotive camshaft sensing.

Revision History

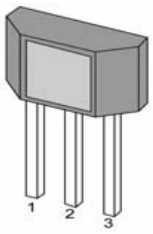
Date	Revision	Change
Nov 2021	1	First Release.

Table of Contents

1 Product Family Members

Part Number	Mark	Option Code	Description
CH502ETB	C502E	000	CST-000 level; Flat TO-92S package, bulk packing (1000pcs/bag)
CH502ETB	C502E	001	CST-001 level; Flat TO-92S package, bulk packing (1000pcs/bag)

2 Pin Definitions and Descriptions



TO-92S

TO-92S	Name	Type	Function
1	VDD	Supply	Supply Voltage pin
2	GND	Ground	Ground pin
3	OUT	Output	Output pin

3 Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Units
Supply Voltage	VDD	-	30	V
Supply Current (fault)	IDD	-	50	mA
Output Voltage	VOUT	-	30	V
Output Current (Fault)	IOUT	-	30	mA
Output Current (Fault)	Ifault		50	mA
Power Dissipation	P_D		100	mW
Operating Ambient Temperature	TA	-40	150	°C
Storage Temperature	TS	-65	150	°C
Junction temperature	TJ		175	°C

Note: Exceeding the absolute maximum ratings may cause permanent damage. Exposure to absolute-maximum- rated conditions for extended periods may affect device reliability.

4 ESD Protections

Parameter	Value	Unit
All pins [1)]	±8000	V
All pins [2)]	±200	V

1) HBM (human body model, 100pF, 1.5 kohm) according to MIL-883C, Method 3015.7 or EIA/JESD22A-114A
2) Machine Model: C=200pF; R=0Ω

5 Electrical Characteristics

The voltages are referred to GND.
3V < VDD < 28V; TA =-40 to 150°C, unless otherwise specified.

Symbol	Parameter	Test Condition	Min	Typ.	Max	Units
VDD	Supply voltage	Operating	3	5	28	V
IDD1	Supply Current	VDD = 12V	1.5	3.0	4.5	mA
IDD2	Supply Current	VDD = 3V to 28V	1		6	mA
VSAT	Output saturation voltage	VDD=12V, IOUT=25mA			0.6	V
ILEAK	Output Leakage Current	VOUT = 3V to 28V			1	uA
TR	Output rise time	VDD=12V R1 = 880 Ω C1 = 20pf			0.4	us
TF	Output fall time	VDD=12V R1 = 880 Ω C1 = 20pf			0.4	us
IFAULT	Output Short Circuit Current	Fault	50	100	150	mA
TFAULT	Output Short Circuit Shutdown	Fault	10	-	20	uS
FCLK	Clock Frequency		300	500	800	kHz
BW	bandwidth				15	kHz
BBIAS	Back Bias Range	Operating Temperature Range	-30	-	500	mT(1)
Bhys	Hysteresis	(CST-000 Level)	1.8	3.2	8	mT
		(CST-001 Level) (2)	2.0	3.2	6	mT

Note: (1) 1mT=10Gauss
(2) Special order should be applied.

6 Function Description

The CH502E is a sophisticated IC featuring an on-chip 10-bit A/D Converter and logic that acts as a digital sample and hold circuit. A separate 4-bit A/D converter provides a fixed hysteresis. The CH502E does not have a chopper delay. The CH502E uses a single Hall plate which is immune to rotary alignment problems. The bias magnet can be from 50 to 500mT.

As the signal is sampled, the logic recognizes an increasing or decreasing flux density. The output will turn on (BOP) after the flux has reached its peak and decreased by an amount equal to the hysteresis. Similarly the output will turn off (BRP) after the flux has reached its minimum value and increased by an amount equal to the hysteresis.

7 Application information

7.1 Application note

Maximum dynamic range is 500 mT. The hysteresis is fixed at 3.2 mT as typical data. Best angular accuracy will be obtained when the magnetic circuit provides peak magnetic flux at the chip near the high end of the linear range of 500 mT. EMC protection using external components are recommended. Two possibilities are shown on the following page. Normally the South pole faces the unbranded side of the device. A North pole will enable a test sequence used in factory testing.

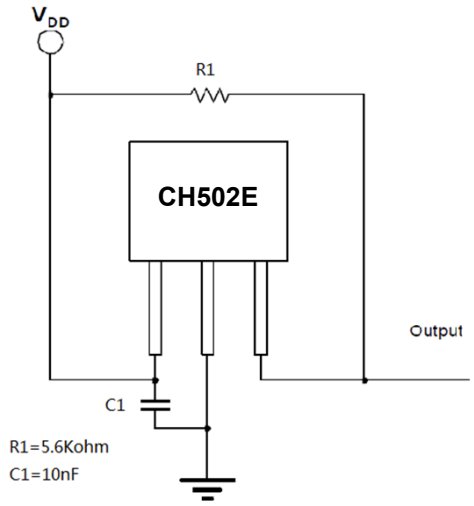
7.2 Unique Features

The output is reset to the high state at power on (output driver is off) whatever the field is. The output only changes after the first min is detected. The reset state holds no information about the field. If the supply of the chip is raised slowly, the reset state is not stable. This has been observed at 0 field but it should be the same with small and large fields.

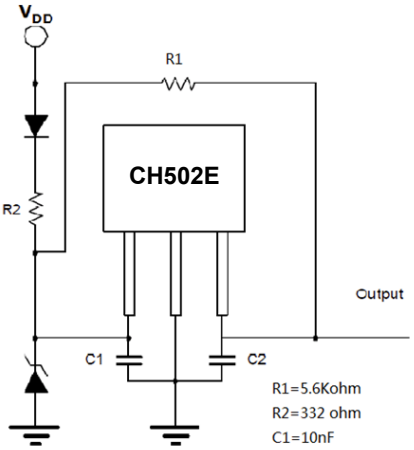
Gear tooth sensors often need to be adjusted after the module is assembled to align the magnet with differential Hall plates or orient with teeth. However the CH502E is “self adjusting” over a wide range of back bias flux eliminating the need for any trimming in the application. The magnet may be glued to the back surface (non branded side) of the IC using a cyanoacrylate adhesive or suitable epoxy.

7.3 Application Circuit

Recommended Wiring and Minimum Protection Circuit



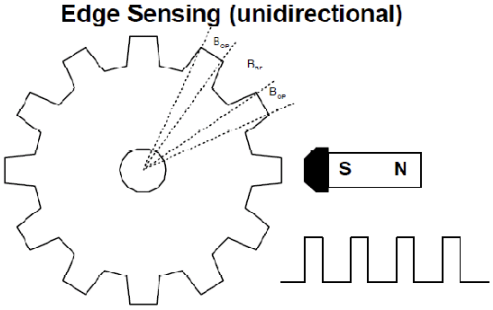
Severe Environment and Automotive Protection Circuit



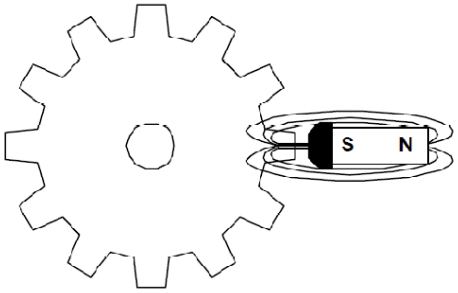
In severe cases it may be necessary to include a Zener diode to clamp positive interference and Schottky dioces to clamp negative excursions.

7.4 Application Examples

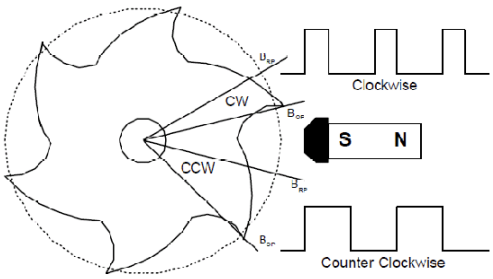
Edge Sensing (unidirectional)



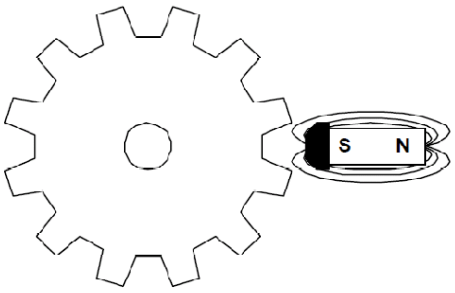
Flux Concentration - Tooth Position



Lobe Sensing (bidirectional)

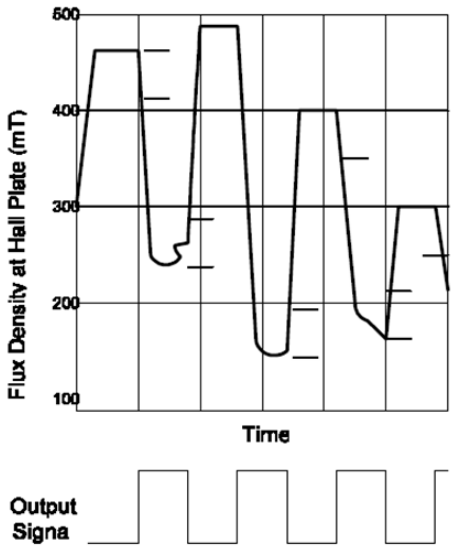


Flux Concentration - Valley Position

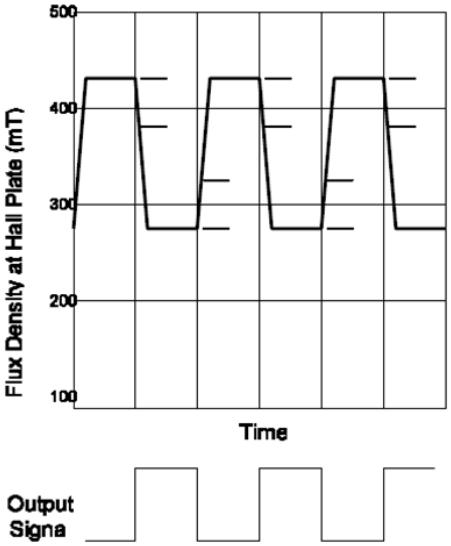


7.5 *Performance Graphs*

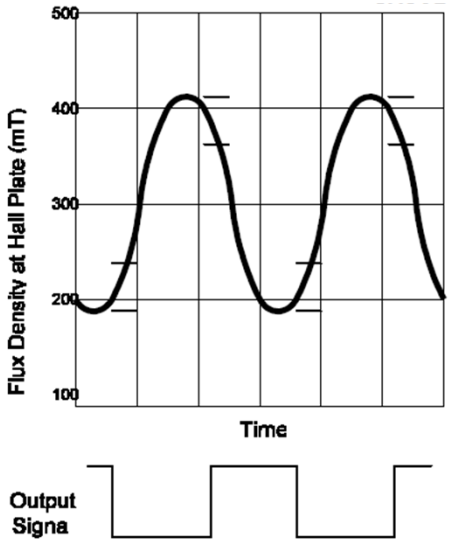
Switch Points versus Irregular Magnetic Signal (Worn Gear)



Switch Points versus Regular Magnetic Signal (New Gear)



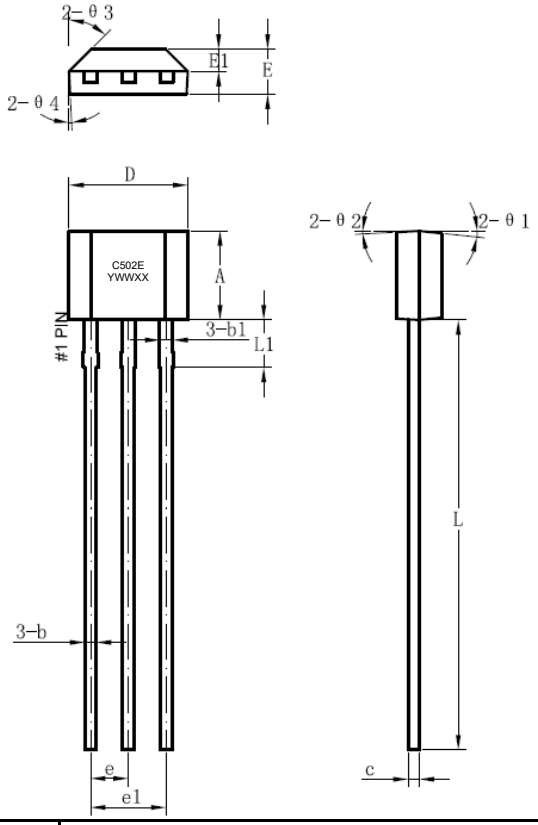
Switch Points versus Analog Magnetic Signa (Cam Lobe)



8 Package Information

Symbol	Parameter	Test Condition	Min	Typ	Max	Units
RTH	Thermal Resistance				200	°C/W

Package Designator
TO-92S



Symbol	Dimensions in Millimeters		
	Min.	Typ.	Max.
A	3.08	3.18	3.28
b	0.38	0.44	0.56
b1		0.44	
c	0.36	0.38	0.51
D	4.0	4.1	4.2
E	1.47	1.57	1.67
E1		0.76	
e		1.27	
e1		2.54	
L	13.5	14.5	15.5
L1		2.8	
θ1		6°	
θ2		3°	
θ3		45°	
θ4		3°	

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