

MANUFACTURER DOCUMENT PACKAGE

Manufacturer's Manual

AI-Tek 70085-1010-412

70085 Series passive variable-reluctance speed sensor

OFFICIAL SOURCE

AI-Tek Instruments product and principles documents

01

DOCUMENT SCOPE

The appended manufacturer pages contain the exact 70085-1010-412 selection row, hazardous-location model drawing and ratings, and the operating principle for passive variable-reluctance sensors.

Passive Sensor Selection Guide

Thread Size	Part Number	Output * Guarantee Voltage (P-P)	Termination	Thread Length (in)	Sensor Length (in)	Agency Approval	Temp Rating (deg C)	Page
3/4-20	70085-1010-405	9.4	Cable	2.75	4	X	-55 to 220	19
3/4-20	70085-1010-413	13.4	Wires	1.5	2.75	X	-65 to 95	18
3/4-20	70085-1010-005	13.4	Wires	1.875	3.125	X	-65 to 95	18
3/4-20	70085-1010-541	13.4	Cable	1.88	3.13	X	-20 to 220	19
3/4-20	70085-1010-542	13.4	Cable	2.75	4	X	-20 to 220	19
3/4-20	70085-1010-327	13.4	Wires	2.75	4	X	-65 to 95	18
3/4-20	70085-1010-540	13.4	Cable	4	5.25	X	-20 to 220	19
3/4-20	70085-1010-328	13.4	Wires	4	5.25	X	-65 to 95	18
3/4-20	70085-1010-543	13.4	Cable	6	7.25	X	-40 to 220	19
3/4-20	70085-1010-414	13.4	Wires	6	7.25	X	-65 to 100	18
3/4-20	70085-3030-222	13.4	Cable	2.75	4	X	-65 to 95	20
M16 x 1.5	70085-1010-425	4.9	Connector	3	4.125		-55 to 107	12
M16 x 1.5	70085-3030-235	13.4	Cable	1.5	2.75	X	-65 to 95	20
M16 x 1.5	70085-3030-237	13.4	Cable	1.5	2.75	X	-65 to 95	20
5/8-18	70084-1713-111	13.4	Connector	1.125	2.5		-40 to 150	11
5/8-18	70085-1010-001	3.4	Connector	1.125	2.25		-55 to 107	8
5/8-18	70085-1010-003	3.4	Connector	2.625	3.75		-55 to 107	8
5/8-18	70085-1010-018	3.4	Connector	3.625	4.75		-55 to 107	8
5/8-18	70085-1010-118	3.4	Connector	5	6.125		-55 to 107	8
5/8-18	70085-1010-002	12.9	Connector	1.125	2.25		-55 to 107	8
5/8-18	70085-1010-175	12.9	Connector	2.625	3.75		-55 to 107	8
5/8-18	70085-1010-026	12.9	Connector	3.625	4.75		-55 to 107	8
5/8-18	70085-1010-408	12.9	Connector	5	6.125		-55 to 107	8
5/8-18	70085-1010-028	21.5	Connector	1.437	2.53		-55 to 107	9
5/8-18	70085-1010-004	4.3	Wires	1.125	2.125		-70 to 107	9
5/8-18	70085-1010-469	4.3	Wires	2.750	3.75		-70 to 107	9
5/8-18	70085-1010-131	15.1	Cable	1.687	1.687		-30 to 85	10
5/8-18	70085-1010-214	15.1	Cable	2.937	2.937		-30 to 85	10
5/8-18	70085-1010-078	3.4	Wires	1.812	1.812		-55 to 107	10
5/8-18	70085-1010-137	3.4	Wires	2.937	2.937		-55 to 107	10
5/8-18	70085-1010-220	12.8	Wires	2.937	2.937		-55 to 107	11
5/8-18	70085-1010-421	4.9	Connector	2.475	3.6		-55 to 107	12
5/8-18	70085-1010-424	4.9	Connector	4.493	5.618		-55 to 107	12
5/8-18	70085-1010-081	13.4	Wires	1.5	2.75	X	-65 to 95	18
5/8-18	70085-1010-544	13.4	Cable	1.88	3.13	X	-40 to 220	19
5/8-18	70085-1010-411	13.4	Wires	1.875	3.125	X	-65 to 95	18
5/8-18	70085-1010-329	13.4	Wires	2.75	4	X	-65 to 95	18
5/8-18	70085-1010-330	13.4	Wires	4	5.25	X	-65 to 95	18
5/8-18	70085-1010-412	13.4	Wires	6	7.25	X	-65 to 95	18
5/8-18	70085-1010-404	13.4	Cable	1.5	2.75	X	-20 to 220	19
5/8-18	70085-1010-406	13.4	Cable	2.75	4	X	-20 to 220	19
5/8-18	70085-1010-417	13.4	Cable	4	5.25	X	-20 to 220	19
5/8-18	70085-1010-420	13.4	Cable	6	7.25	X	-20 to 220	19
5/8-18	70085-1010-403	9.4	Cable	1.5	2.75	X	-55 to 220	19
5/8-18	70085-1010-415	9.4	Cable	4	5.25	X	-55 to 220	19
5/8-18	70085-1010-416	9.4	Cable	6	7.25	X	-55 to 220	19
5/8-18	70085-3030-111	13.4	Cable	1.5	2.75	X	-65 to 95	20
5/8-18	70085-3030-112	13.4	Cable	2.75	4	X	-65 to 95	20
5/8-18	70085-3030-113	13.4	Cable	4	5.25	X	-65 to 95	20
5/8-18	70085-3030-114	13.4	Cable	6	7.25	X	-65 to 95	20
5/8-18	70085-3030-211	9.4	Cable	1.5	2.75	X	-65 to 95	20
5/8-18	70085-3030-212	13.4	Cable	2.75	4	X	-65 to 95	20
5/8-18	70085-3030-213	9.4	Cable	4	5.25	X	-65 to 95	20
5/8-18	70085-3030-214	9.4	Cable	6	7.25	X	-65 to 95	20
5/8-18	70085-8080-003	12.8	Wires	1.812	1.812		-55 to 107	11

Magnetic Sensor Selection

The following information is supplied for assistance in selecting the proper sensors for your particular applications. One of the fundamental questions to be answered is, "Will there be enough sensor output voltage at the lowest operating speed?"

The sensor output voltage depends on:

- Surface Speed - speed target passes pole piece
- Gap - distance between target and pole piece
- Target Size - geometric relationship of pole piece and target
- Load Impedance - connected to sensor

The surface speed of a gear depends upon its diameter and RPM. Surface speed is expressed in terms of inches per second (IPS).

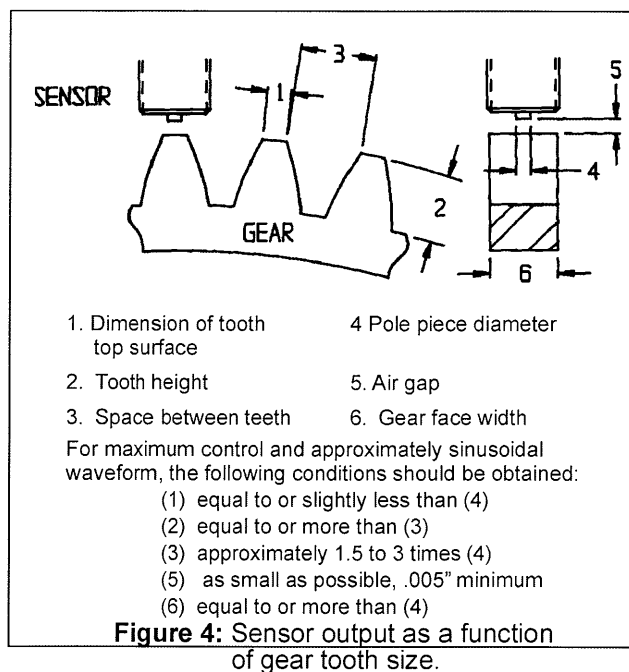
$$\text{Surface Speed (IPS)} = \frac{\text{RPM} \times \text{Outside Dia. (in.)} \times \pi}{60}$$

There is an optimum pitch (or tooth size) to obtain the highest possible output from a sensor, but this is seldom necessary. Figure 4 illustrates the relationship of tooth size and spacing for optimum magnetic sensor output. Using a fine tooth gear, relative to a large pole piece diameter sensor, results in a lower generated voltage because the flux also passes into adjacent teeth, resulting in a lower total flux variation.

The relationship between pole piece diameter and gear pitch and its effect on the output of a sensor is described in Table A.

Table A: Relative Output Vs. Gear Pitch

Pole Piece Dia. (in)	Gear Pitch						
	8	12	16	20	24	32	48
.187	1.00	0.83	0.33	0.16	—	—	—
.106	1.41	1.41	1.27	1.00	0.70	0.28	0.07
.093	1.25	1.25	1.25	1.00	0.75	0.37	0.12
.062	0.95	1.07	1.00	1.00	0.92	0.90	0.36
.040	1.00	1.00	1.00	1.00	1.00	0.90	0.60



The load impedance, with relation to the internal impedance of the sensor, dictates the amount of sensor output voltage that will be seen by that load. Magnetic sensors are designed with the lowest practical impedance consistent with providing maximum output. The load impedance should be high in relation to the impedance of the sensor to minimize the voltage drop across the coil and to deliver the maximum output to the load.

Most of the output voltages listed in this catalog are based on a load impedance of 100k ohms. To use a generality, the load impedance should be 10 times that of the sensor. In order to assist you in selecting your sensor, **AI-Tek Instruments** has developed an output vs. speed curve for each sensor family. By looking at the application extremes of highest speed/lowest gap and lowest speed/highest gap, the full variation of sensor output can easily be determined. We also specify each family in two ways: **Standard** - minimum output voltage at 1000 IPS, 0.005 in. gap. **Guarantee Point** - minimum output voltage at 500 IPS, 0.030 in. gap. Sensors with .187" dia. pole piece are tested with an 8 D.P. gear, 100k ohms load; .106" dia. & smaller pole piece sensors are tested with a 20 D.P. gear, 100k ohms load. Sensors with connectors also use a 250 pf capacitor shunted across the load.

Introducing Ai-Tek Instruments' Speed Sensors

Unlock precision and reliability with Ai-Tek Instruments' extensive range of speed sensors. Our catalog highlights a selection of standard units meticulously crafted through years of design expertise, ensuring swift solutions tailored to your speed control and indication needs. While we offer a large variety of specialized designs catering to unique applications, our standard lineup promises versatility and adaptability.

Crafted to withstand the rigors of industrial, automotive, and aerospace environments, Ai-Tek speed sensors guarantee uninterrupted operation even in the harshest conditions. Engineered to combat challenges like vibration, shock, extreme temperatures, and corrosive atmospheres, our sensors assure longevity and dependability. Whether it is elevated temperatures, varied speeds, specific targets, or precision timing, our sensors excel, utilizing innovative technologies like variable reluctance and Hall effect to translate motion into electronic signals.

Explore our comprehensive catalog available through our network of distributors, offering a myriad of options to suit your needs. Cannot find the perfect match? Reach out to your local distributor, and we will work to tailor a solution to your specifications. As a global leader in speed sensor innovation, Ai-Tek Instruments guarantees unbeatable performance at a competitive price point.

Elevate your control and protection circuits with Ai -Tek's Passive Magnetic Sensors. Leveraging variable reluctance technology, these sensors require minimal components and boast no moving parts, ensuring reliability even in extreme conditions. From aircraft engines to automobile wheels, our sensors offer:

- High reliability
- Effortless installation
- Longevity without moving parts
- Self-powered operation
- Versatile shapes and sizes
- Simple alignment
- Adaptability to any environment

From consumer products to high-precision automotive systems and aircraft controls, Ai-Tek's variable reluctance and hall effect sensors deliver unparalleled performance.

It is the customer's responsibility to determine whether the product is proper for customer's use and application.

The information contained herein is subject to change without notice. Refer to the factory for verification of any details.

Principles of Operation

The internal construction of the typical **AI-Tek** variable reluctance sensor is a magnet, pole piece and coil (See figure 1). A magnetic field (lines of flux) extends from the magnet, through the pole piece and coil out into the air space at the end of the sensor. The return path of the magnetic field is from the air space to the other end of the magnet. As a ferrous object approaches the tip of the pole piece, the magnetic field increases and then decreases as the object moves away from the pole piece. The snap or the rapid change in the magnetic field induces an AC voltage signal in the coil. With an ideal target and

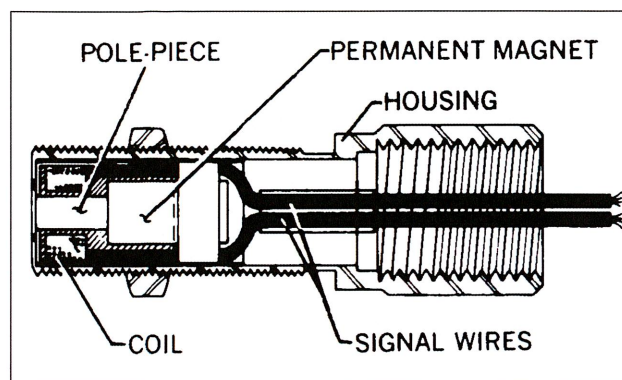


Figure 1 - Internal configuration of typical sensors.

matching sensor, the induced voltage is in the shape of a sine wave.

As can be seen, the generated frequency signal is directly proportional to the number of ferrous objects passing the pole piece per unit time. The amplitude of the voltage output is proportional to the speed of the ferrous objects passing the pole piece.

Many applications of **AI-Tek** magnetic sensors use gears as targets. Typical sensor output wave forms with various targets are illustrated in Figure 3. Testing sensors with gears rather than other ferrous discontinuities such as sprockets, keyways, boltheads, etc. is because the output is predictable and repeatable. See Figure 2 for commonly used gear terminology.

$$\text{Diametral Pitch} = \frac{\text{No. of Teeth} + 2}{\text{Outside Dia. of Gear (in.)}}$$

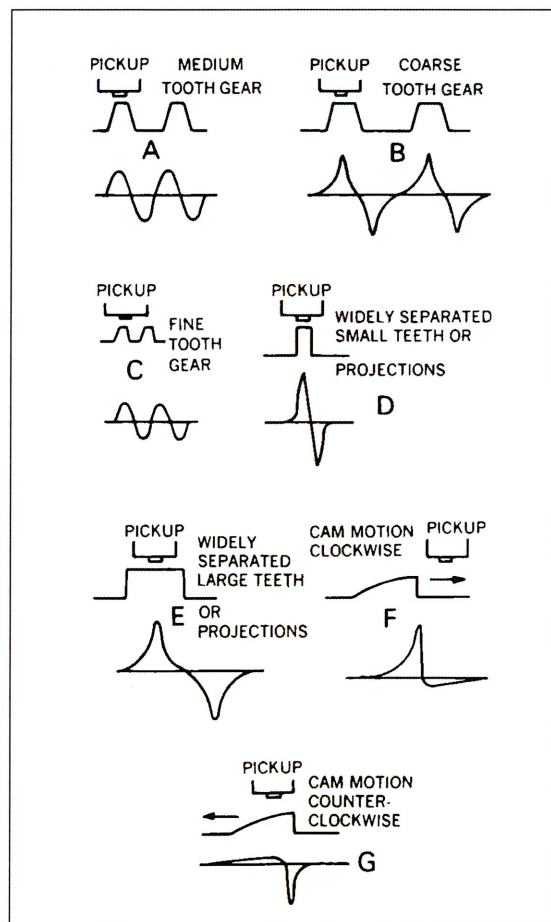


Figure 3 - Generated voltage waveforms.

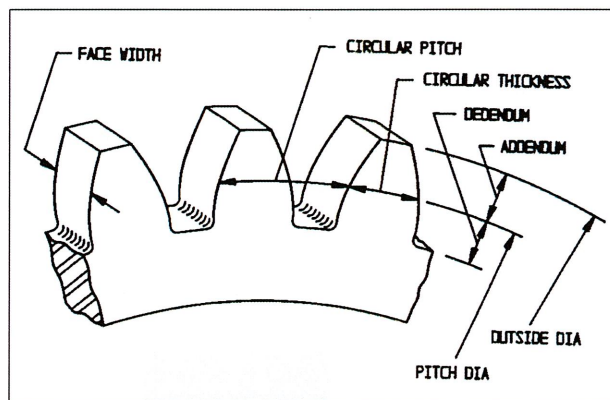


Figure 2 - Common terms used in defining gears.

The performance of a sensor can be easily defined when using a gear for a target; it also allows for estimated performance with alternate targets. **AI-Tek** sensors are tested with AGMA standard gears; the performance curves are included in this catalog.

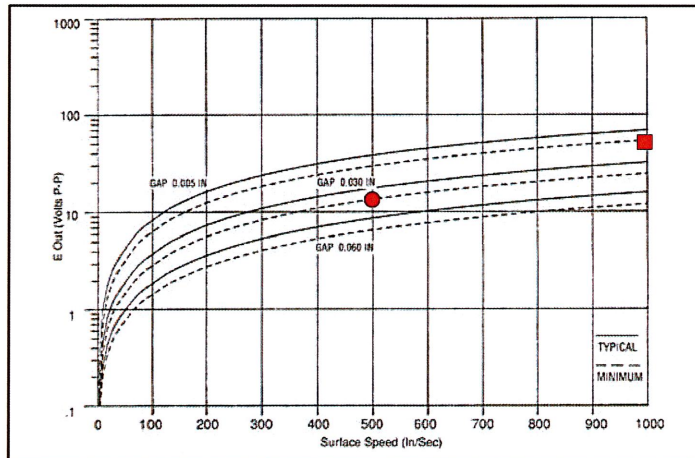
AI-Tek Instruments differs from most sensor manufacturers in the presentation of performance curves and test parameters. Most existing data is specified at a surface speed of 1000 in/sec and 0.005 in. air gap; we feel that a 0.030 in. air gap and 500 in. sec. surface speed (1800 RPM motor with 5 to 6 in. dia. gear) are more realistic parameters to specify performance.

UL/ATEX/CSA Sensors

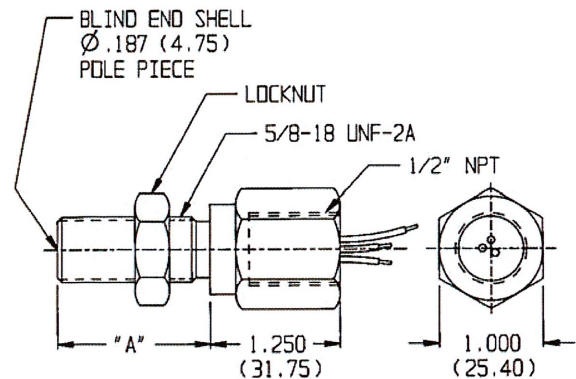
Ordering Part #	Thread Length (A)	
70085-1010-081	1.500	(38.10)
70085-1010-411	1.875	(47.63)
70085-1010-329	2.750	(69.85)
70085-1010-330	4.000	(101.60)
70085-1010-412	6.000	(152.40)

Rating: UL and CSA listed for hazardous locations. Class I, Div 1, Groups A, B, C & D; Class II, Div 1, Groups E, F, G. Temp Code T3C. ATEX Group II, Category 3G, Zone 2

Performance Curves



Based on 8 D.P. Gear



Specifications:

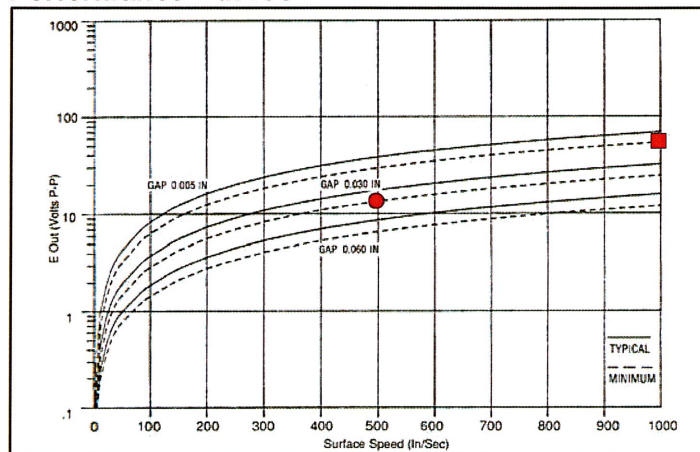
- Output Voltage (Standard): 54 V (P-P)
- Output Voltage (Guarantee Point): 13.4 V (P-P)
- DC Resistance: 240 ohms max.
- Typical Inductance: 30 mH ref.
- Output Polarity: White lead positive
- Operating Temperature: -65 to 95°C
- Lead Length: 10 ft (3.05 m)
- Housing Ground: Green/Yellow Tracer
- Net Weight: 14 oz. max.

UL/ATEX/CSA Sensors

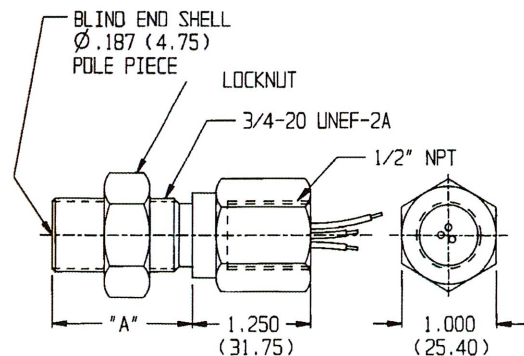
Ordering Part #	Thread Length (A)	
70085-1010-413	1.500	(38.10)
70085-1010-005	1.875	(47.63)
70085-1010-327	2.750	(69.85)
70085-1010-328	4.000	(101.60)
70085-1010-414	6.000	(152.40)

Rating: ATEX, IECE, North American Certified, please contact us for further certification information.

Performance Curves



Based on 8 D.P. Gear



Specifications:

- Output Voltage (Standard): 54 V (P-P)
- Output Voltage (Guarantee Point): 13.4 V (P-P)
- DC Resistance: 240 ohms max.
- Typical Inductance: 30 mH ref.
- Output Polarity: White lead positive
- Operating Temperature: -65 to +100°C
- Lead Length: 10 ft (3.05 m)
- Housing Ground: Green/Yellow Tracer
- Net Weight: 14 oz. max.

Dimensions in inches and (mm).