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 to95	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

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Thread Size	Part Number	Output * Guarentee Voltage (P-P)	Termination	Thread Length (in)	Sensor Length (in)	Agency Approval	Temp Rating (deg C)	Page
3/8-24	70085-1010-007	1.6	Wires	0.812	1.252		-55 to 107	13
3/8-24	70085-1010-056	1.6	Wires	3.625	4.065		-55 to 107	13
3/8-24	70085-1010-086	3.6	Wires	0.812	1.252		-55 to 107	13
3/8-24	70085-1010-355	3.6	Wires	0.812	1.252		-55 to 107	13
3/8-24	70085-1010-041	2	Wires	0.812	1.252		-73 to 232	14
3/8-24	70085-1010-428	2	Wires	1.5	1.94		-73 to 232	14
3/8-24	70085-1010-458	2	Wires	3.625	4.065		-73 to 232	14
3/8-24	70085-1010-174	3.6	Wires	0.812	1.252		-54 to104	14
3/8-24	70085-8080-001	4.2	Wires	1.5	1.5		-55 to 107	15
.375 no thd	70085-1010-314	4.2	Cable	1.375	1.375		-55 to 110	15
.375 no thd	70085-8080-004	4.2	Cable	2.5	2.5		-53 to 110	15
1/4-40	70085-1010-024	0.4	Wires	0.687	1		-73 to 232	16
1/4-40	70085-1010-472	0.4	Wires	0.687	1.187		-73 to 232	16
1/4-40	70085-1010-227	0.4	Wires	1.687	2		-73 to 232	16
10-32	70085-1010-037	0.6	Wires	0.5	0.5		-55 to 107	17
10-32	70085-1010-299	0.6	Wires	1.25	1.25		-55 to 107	17
10-32	70085-1010-182	0.3	Wires	0.5	0.5		-73 to 148	17
10.32	70085-1010-289	0.3	Wires	1.25	1.25		-73 to 148	17

* Output is based on .030" air gap at 500 IPS

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).

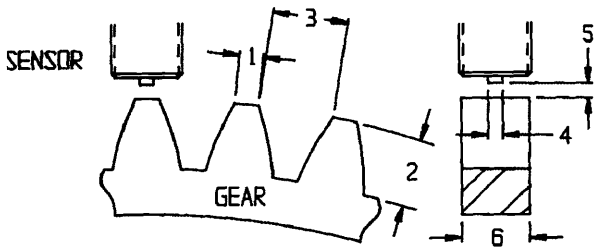
$$\text{Surface Speed (IPS)} = \frac{\text{RPM} \times \text{Outside Dia. (in.)} \times \pi}{60}$$

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



1. Dimension of tooth top surface
2. Tooth height
3. Space between teeth
4 Pole piece diameter
5. Air gap
6. Gear face width

For maximum control and approximately sinusoidal waveform, the following conditions should be obtained:
(1) equal to or slightly less than (4)
(2) equal to or more than (3)
(3) approximately 1.5 to 3 times (4)
(5) as small as possible, .005" minimum
(6) equal to or more than (4)

Figure 4: Sensor output as a function of gear tooth size.

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, **Al-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.

Calculation of Output Voltage

Selection of the proper **AI-Tek** magnetic sensor may require the calculation of sensor output voltage to assure proper operation in your specific application. To assist in this area, let us consider the following typical application: Requirement is speed display with overspeed and underspeed control as well as 4-20 mA signal to a PLC. Speed range is 0-3600 RPM with low speed set point at 300 RPM, available shaft diameter for mounting a gear is 2.000 in. and a .030 in. air gap is ideal.

You have selected a Tachtrol 30, P/N T77630-10, with a 60T steel, split gear, P/N G79870-202-1901, and you are considering to use sensor P/N 70085-1010-001. The question is if the sensor has enough output voltage at 300 RPM.

We can list the following parameters:

a. Tachtrol 30: Load impedance - 12k-ohms
   Sensitivity - 200 mV peak

b. Split gear: Outside dia. - 5.166 in.
   D.P. - 12
   No. of Teeth - 60

c. Sensor:
   Standard output voltage - 40V (P-P) min.
   Guarantee Point - 3.4V P-P min.
   D.C. Resistance - 130 ohms max.
   Typical inductance - 33 mH ref.

Step 1: Calculate surface speed of gear:

$$SS = \frac{RPM \times Outside\ Dia. \times \pi}{60} = \frac{300 \times 5.166 \times 3.14}{60} \qquad SS = 81\ IPS$$

Step 2: Determine Peak-to-Peak output voltage:
Referring to the performance curves of sensor P/N 70085-1010-001 the min. output voltage is approx.0.3 V (P-P) at 81 IPS and 0.030 in. gap. It is a fact that output voltage vs. surface speed is a near linear function; therefore, another method of determining output voltage is to set up a ratio using the guarantee point:

$$\frac{3.4V\ (P\text{-}P)}{500\ IPS} = \frac{E}{81} \qquad E = .55V\ (P\text{-}P)$$

Step 3: Correction for pitch:
For a 0.106 in. pole piece dia. and a 12 D.P. gear the correction factor from Table A is 1 .41. (See pg. 5)

$E_C = .55 \times 1.41 = .78\ V\ (P\text{-}P)$

Step 4: Converting to peak voltage: Simply divide by 2. $E_C = .78 \div 2 = .39V$ peak.

Step 5: Correction for load:
The .39V or 390mV sensor output voltage will be divided across the impedance of the load and sensor. The load impedance is 12000 ohms resistive. The impedance of the sensor has a resistive and inductive element. At low frequencies the inductive element is very small and can therefore be disregarded, leaving the max. DC resistance of 130 ohms for consideration.
The load correction factor (f_L) can be expressed as:

$$(f_L) = \frac{Z\ (load)}{Z\ (load) + Z\ (sensor)} = \frac{12000}{12130} = .99$$

$E_C = .99 \times 390 = 386$ mV peak

The final adjusted value is 386 mV peak

As stated earlier, the sensitivity or threshold of the Tachtrol 30 is 200mV peak at the stated conditions, the selection of P/N 70085-1010-001 is acceptable.

By setting up ratios, you can determine that the minimum sensed speed is 155 RPM.

If the final value of E_C had been slightly less than 200 mV, a reduction of the air gap (from .030" to .025") would boost the output above 200 mV.

If it should be determined that the required sensor cannot be selected from the catalog models, the best procedure is to compile a list of all your requirements and contact your area distributor to assist you in the selection of the correct sensor.