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 3, P/N T77310-11, with a 60T cast iron, split gear, P/N G79870-202-0301, 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 3: Load impedance - 2000 ohms
Sensitivity - 200 mV rms

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:

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

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. 25.)

E_C = .55 x 1.41 = .78 V (P-P)

Step 4: Converting to rms voltage:

Simply divide by 3, a method which is close enough. (If the peak-to-peak output voltage is a sine function, the divisor is 2 times the square root of 2 or 2.83).

E_C = .78 ÷ 3 = .26 V rms

Step 5: Correction for load:

The .26V or 260 mV rms sensor output voltage will be divided across the impedance of the load and sensor. The load impedance is 2000 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:

$$(f_L) = \frac{Z\ (\text{load})}{Z\ (\text{load}) + Z\ (\text{sensor})} = \frac{2000}{2130} = .94$$

E_C = .94 x 260 = 244 mV rms

The final adjusted value is 244 mV rms.

As stated earlier, the sensitivity or threshold of the Tachtrol•3 is 200 mV rms at the stated conditions, the selection of P/N 70085-1010-001 is acceptable.

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.