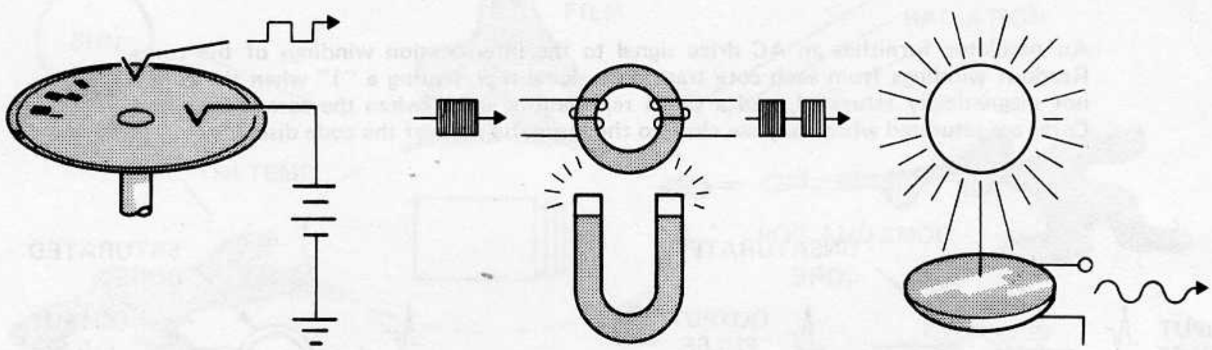
Reliability of Magnetic Encoders

WHAT IS THE MOST RELIABLE ENCODER TYPE AVAILABLE?

CONTACT ? MAGNETIC? OPTICAL ?



Digital encoders are electromechanical devices which translate input shaft angle information into digital electrical signals.

Encoders are classified either as contact or non-contact encoders in reference to the method used to read coded information on a disc. The coded information allows a digital output signal to uniquely identify the angular position of the input shaft.

Contact encoders utilize direct physical contact of electrically conductive pickoffs to sense the coded information on the disc by completing the circuit with conductive area on the disc.

Non-contact encoders are similar to the contact type except that direct physical contact with the coded disc is not made. Sensing of the disc information is generally accomplished by optical or magnetic means.

Optical encoders use a light sensing device which detects a light source transmitted through a mask and clear segments of a disc coded with clear and opaque segments. A logical "one" is detected by this sensor when light passes through and a "zero" is indicated by the absence of light.

Magnetic encoders operate by simple magnetic saturation. A disc is magnetized with a flux pattern for the particular code desired. Positioned close to the surface of the code. A "square loop" ferrite sensor, similar to cores of the type used in computer memories reads out each track. The reading head has two windings; a primary for the interrogate (excitation) input and a secondary for signal output (readout).

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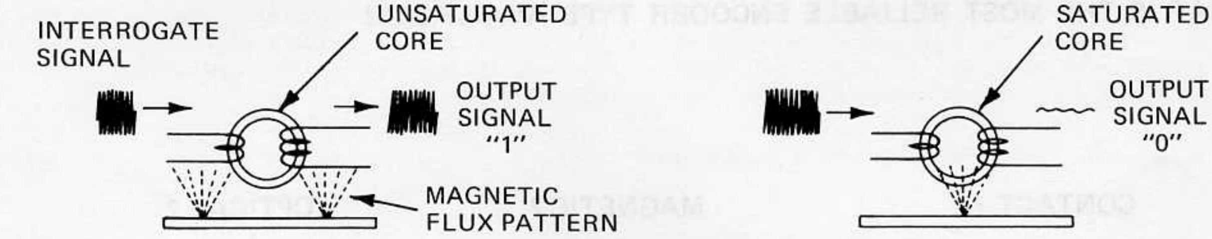
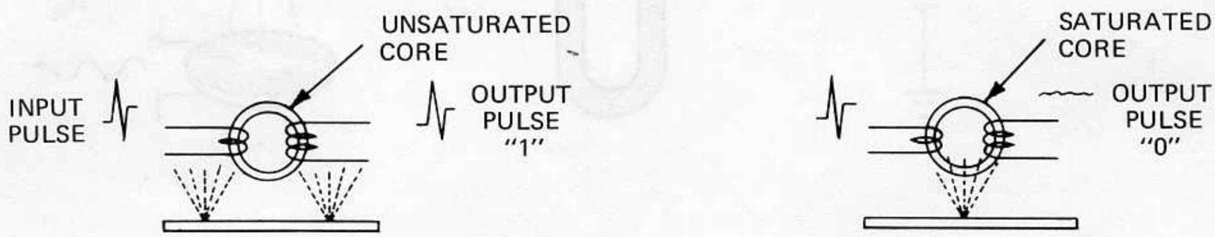
In simplified form, the following diagram shows how the magnetic non-contacts work:



An oscillator furnishes an AC drive signal to the interrogation windings of the cores. Readout windings from each core transmit a signal representing a "1" when the core is not magnetically saturated, and a signal representing a "0" when the core is saturated. Cores are saturated when they are close to the magnetic areas of the code disc.



A simplified method of interrogating a magnetic encoder is to treat the sensor cores as in computer memory core matrixes. A single pulse interrogates the sensor cores to produce an output pulse for a "1", or none for "0".

The input interrogate signal may be sine wave or square wave. Pulsed input is preferable because demodulation is not required in the output. If a pulsed input is used, it must have an alternating polarity of sufficient amplitude and rate of change to alternately set and reset the ferrite reading head. Frequencies of 20 kHz to 200 kHz for the interrogate signal are used.

The signal from the readout windings is modulated as a function of the angular sweep of the disc past the readout head. Normally the interrogate windings are connected in series and driven by a single transistor oscillator.

Contact encoder reliability is characterized by an increasing time dependent failure rate due to physical wear on the disc and sliding contacts which have led to many studies regarding predictability of contact closures. The sliding action, inherent in all contact encoders, also causes particles to be dislodged from the conductive surfaces and deposited on nonconducting surfaces and impair the conductivity of the junction of the generally dissimilar metals and the capability of distinguishing the coded information.

Optical encoders are also characterized by an increasing time dependent failure rate, due primarily to the decaying characteristics of the light source. These devices require efficient production and transfer of light for reliable operation, which can be interrupted by failure of the light source, or degradation light transmissibility through the optical surfaces by deposition of dust, condensation and chemical films. Light sources commonly used in optical encoders exhibit an increasing, time dependent failure rate and a maximum useful life of approximately 10,000 hours. The characteristics of both the sensors and the light source are subject to drifting at temperature extremes and require considerable electronics in various temperature compensating schemes. A mechanical aspect not often considered is the requirement for stringent code wheel end play and run out requirements for optical discs. This is accomplished through excessive loading of the shaft bearings with the result that bearing life in optical encoders is often limited.

Some optical encoders employ multiple light sources which further increase the probability of failure in accordance

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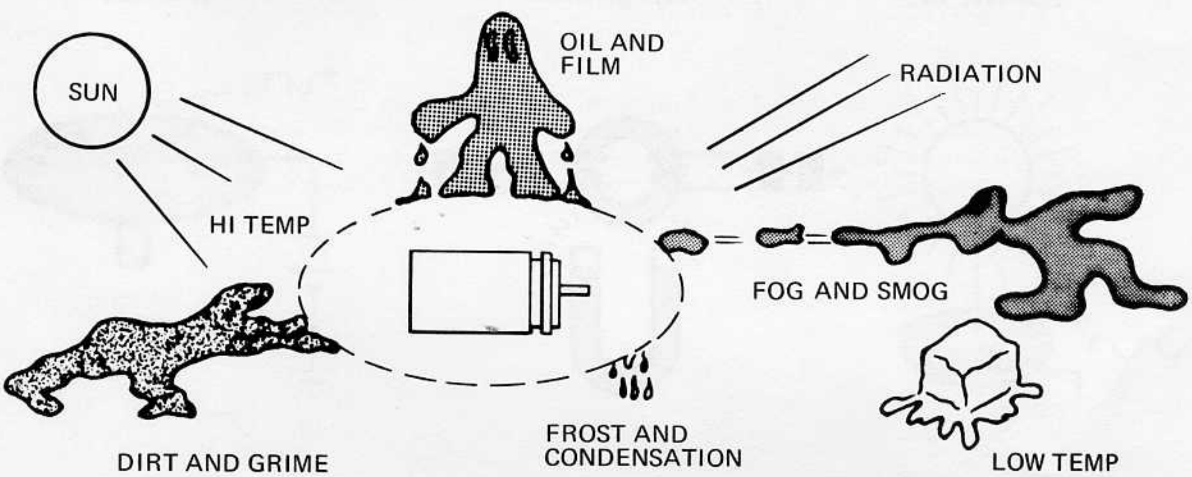
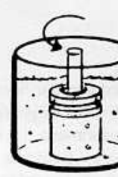
with the series-exponential math model which states that the failure of one or more light sources constitutes failure of the encoder.

Magnetic encoders avoid the inherent reliability problems of both contact and optical encoders since operation is not dependent on sliding contacts, light sources or transmissibility of materials. Magnetic devices, such as coils, cores, etc., do not exhibit a characteristic wearout or degradation failure mode with time. For this reason prediction computations are restricted only to the catastrophic failure rate which is constant with time and extremely low when compared with the useful life of 1×10^9 revolutions for the shaft bearing. Operation of the magnetic phenomena is not impaired even in extreme environmental conditions of temperature, humidity, moisture and radiation which is normally detrimental to semiconductor light sensors or emitters.

Magnetic encoders are also unaffected by hostile environments . . .



. . . and even total immersion in selected liquids is tolerated.



ADVANTAGES OF MAGNETIC NONCONTACT ENCODERS OVER OTHER TYPES

CHARACTERISTICS	REASON
A. MOST RELIABLE - 15 YEARS OF PROVEN RELIABILITY.	• NO SLIDING NOR PIN CONTACT • NO LENSES OR LIGHT SOURCES • MAGNETIC CORES AND COILS DO NOT WEAR WITH TIME
B. LONGEST USEFUL LIFE	• LIMITED ONLY BY MECHANICAL SHAFT BEARING
C. RESISTS EXTREME ENVIRONMENTS	• UNAFFECTED BY MOISTURE, OIL, DIRT, DUST, HEAT, ETC., ON CODE WHEEL • RESISTS EXTREME SHOCK AND VIBRATION UNLIKE OPTICAL ENCODERS
D. OPERATES IN MOST LIQUIDS LIKE OIL, JP-4, JP-6 AND HYDRAULIC FLUIDS	• INHERENT MAGNETIC PRINCIPLE
E. OPERATES UNDER WIDE TEMPERATURE RANGE −55°C to 125°C STANDARD. SPECIAL WIDE RANGE −55°C to 205°C (−65°F to 400°F)	• INHERENT MAGNETIC PRINCIPLE
F. RESISTANCE TO SURVIVABILITY/VULNERABILITY ENVIRONMENTS (EMP AND RADIATION)	• INHERENT MAGNETIC PRINCIPLE

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