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Tandem Encoders

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INTRODUCTION

'Tandem Encoder' is new term but one which is increasingly being used by mechanical and electrical designers. This article explains what a Tandem Encoders is; how they work; their technical features and where they are best utilized.

The term 'tandem encoder' refers to an encoder with at least two measurement axes but only one power input and one data output. In other words, two physically independent encoders but with a single electrical interface.

Tandem encoders are increasingly being used in those applications with one or more of the following factors – cost pressure, tight space constraints, weight limits or requirements for high-reliability. For most position encoders the single largest cost element is their electronics and the Tandem approach effectively spreads the cost of a single set of electronics across two (or more) encoders. The result is that the cost, weight and volume per sensor is reduced. Another important factor is the use of slip rings in the host equipment. If slip rings are being used to energize the encoders it is often the case that a tandem encoder is applicable. This is because the cost, size and complexity of a slip ring is directly proportional to the number of its contacts. Eradicating slip ring connections to a second encoder can be a major advantage for the tandem encoder approach.

Figure. 1 - Tandem Encoders are ideally suited to camera gimbals

A typical arrangement for a Tandem Encoder is shown below in Figure 2. If we consider the system as a gimbal mounted camera, we can see that Axis #1 is the elevation axis and Axis #2 is the azimuth axis. Only a single set of connections to both encoders is required via the slip ring.

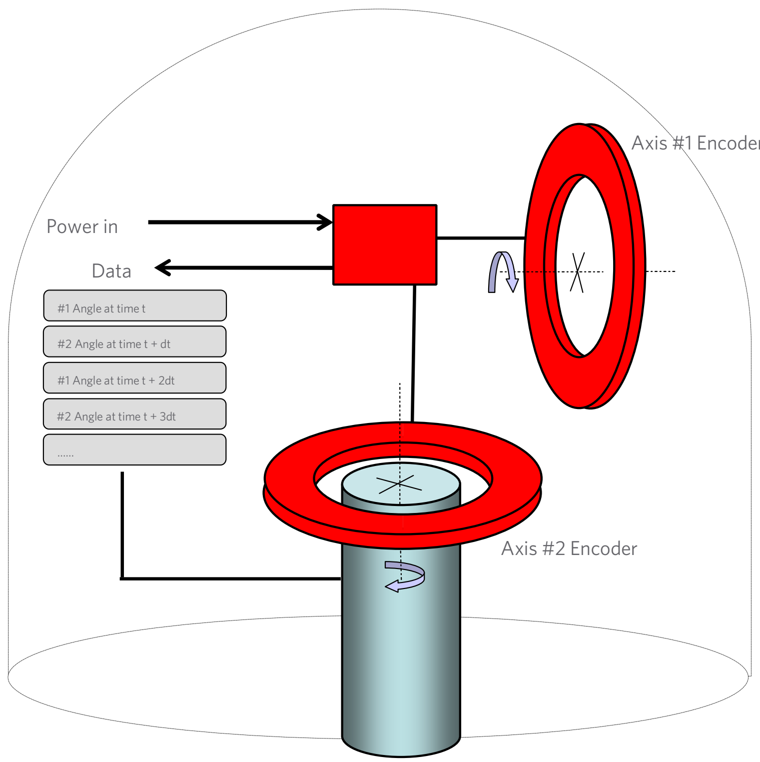

Figure. 2 - Tandem Encoder schematic

Of course, not all position sensing technologies are suited to Tandem Encoders. The Tandem Encoder approach is only applicable when the encoder electronics can be displaced away from the actual sensing point. The Tandem Encoder approach cannot be applied if electronics are required at the sensing point. Optical and magnetic devices both require electronic devices adjacent to the sensing point. The Tandem approach is however, suited to capacitive or inductive sensing technologies where the electronics required for sensor operation can be displaced away from the sensing point. Further, the electronics in capacitive or inductive techniques can be arranged so that they can be multiplexed across two or more sensors.

Capacitive encoders are compact and consume very little power. They are, however, susceptible to condensation and electrostatic build-up. Capacitance also varies with temperature, humidity, surrounding materials and foreign matter, which makes engineering a stable, high accuracy position sensor challenging. The components of the device have very small air gaps requiring careful installation.

The potential applications for Tandem Encoders include:

- CCTV & security cameras
- Electro-optic and infrared gimbals
- Remotely controlled weapons systems
- Rotary joints & gimbals
- Actuator servos and motor encoders
- Robotic arms & CNC Machine tools
- Test & calibration equipment
- Antenna pointing devices & range finders
- Packaging & laboratory automation.

Since most of these applications involve arduous operating or storage conditions then it is of little surprise that Tandem encoders have become mainly associated with inductive techniques. Such techniques are ideally suited to arrangements where the energization and signal processing is carried out remotely from the position sensing.

Traditionally inductive detectors, namely resolvers, use transformer constructions in the form of accurately wound wire spools. The basic principle is that as a passive, magnetically permeable element such as a rotor or a rod moves, it changes the electromagnetic coupling between at least one primary winding and one or more secondary windings. The energy which inductively couples into the secondary windings is directly proportional to the displacement of the rod or rotor relative to the primary windings. All windings must be wound accurately to achieve accurate position measurement and in order to achieve strong electrical signals, lots of wires are needed. This makes resolvers bulky, heavy and expensive.

Now there is a new generation of inductive encoders and these are particularly suitable to the Tandem Encoder approach. These new generation inductive encoders use the same fundamental physics as their traditional counterparts but rather than the traditional transformer or wire spool constructions, the new generation use printed circuits as their main components.

This means the coils can be produced from etched copper or printed on substrates such as polyester film, paper, epoxy laminates or ceramic. Such printed constructions can be made more accurately than windings. Hence a far greater measurement performance is attainable at less cost, bulk and weight -

whilst maintaining the inherent stability and robustness. The approach also allows the principle components of the inductive position sensors to be installed with relatively relaxed tolerances. Not only does this help to minimize costs of both sensor and host equipment, it also enables the principle components to be encapsulated. In turn, this enables the sensors to withstand very harsh local environments such as long term immersion, extreme shock, vibration or the effects of explosive gaseous or dust laden environments.

Electromagnetic noise susceptibility is often cited as a concern by engineers considering next generation inductive position sensors. The geometry of the PCB traces combined with the use of excitation signals of specific phase and frequency does however ensure a high degree of immunity to external electromagnetic interference.

The new generation inductive encoders are produced in either incremental or absolute form and output digital data. This means that a Tandem Encoder can produce a digital data stream with a single data stream carrying data for both axes.