Press Release

Zettlex
Precision in the Extreme

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Everything you always wanted to know about slab resolvers but were afraid to ask….

The Chief Engineer says "We could use a slab resolver for that" and you say: "That's a great idea boss" but you are actually thinking: "If I ask him what a slab resolver is I'm going to look like an idiot". Sound familiar? If so, this article is for you – it explains what slab resolvers are; how they work; where to use them and suggests some lower cost options.

What's a Slab Resolver?

Let's deal with he jargon first. After all, we engineers love jargon because it helps us to differentiate between engineers and normal people. A resolver is an electrical transformer used to measure angle of rotation. Most resolvers look a bit like an electric motor - with copper windings on the stator and a machined metal rotor. The inductive coupling between the transformer's windings varies according to angle. So, if we energize the resolver with an AC signal and measure the output from the transformer's windings, we get an AC electrical signal whose amplitude is proportional to angle.

Slab resolvers are ideal where there a large through shaft is necessary

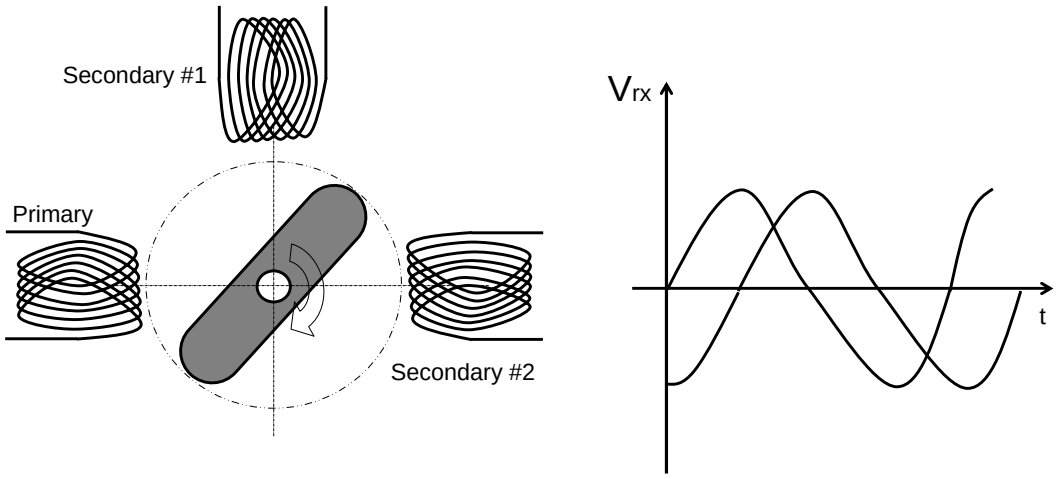
The ‘slab’ term simply refers to the resolver’s shape – flat. There is no hard and fast rule as to where traditional resolvers end and slab resolvers begin but, generally, a slab resolver’s (axial) height is less than its diameter. A slab resolvers’ diameter can be >10 times its height and often has a large bore to accommodate a through shaft, hydraulic pipes, electrical connections or a slip ring.

Confusingly, slab resolvers are also referred to as pancake resolvers. Strictly speaking, a pancake resolver is an unhoused or frameless slab resolver. However, to all intents and purposes, a pancake resolver is the same as a slab resolver and the terms are used interchangeably.

You may also see or hear the term ‘brushless resolver’. This simply means that there are no electrical connections to the resolver’s rotor. This means that there is no need to transfer power to the rotor via electrical brushes.

How do they work?

Whilst there are lots of variations on the theme, a typical resolver has three windings – a primary winding and two secondary windings. These windings are usually formed on the resolver’s stationary element – the stator. The primary is used as the input for an AC drive signal and each secondary is used as pick up or receive winding. In the diagram below, the rotor is made from a material such as iron or steel and is arranged relative to the windings such that it will couple varying amounts of energy in to the secondaries depending on its angle of rotation. In the diagram below, the output from the secondaries will be in the form of a sinusoid and cosinuoid. Accordingly, the ratio of signals varies in proportion to angle.



A resolver is an electrical transformer used to measure angle of rotations

The outputs from a ‘single speed’ resolver are unique over each rotation – in other words angle can be calculated absolutely over 360^{o}. A two-speed resolver has outputs which are unique over 180^{o}; a three-speed resolver has outputs which are unique over 120^{o} and so on. Typically, most resolvers are 1, 2, 4, 8, 16 or 32 speed.

Where do they get used?

Once upon a time, rotary electrical transformers – in all their various forms – were just about the only way to measure the angle of a continuously rotating shaft. Nowadays, optical encoders have taken over many applications but have never taken over in those applications that require high reliability and precision operation in harsh environments. Typically, such applications are common in the heavy industrial, aerospace, defence, oil and gas sectors. Simply put, optical encoders cannot cope with muck, vibration, shock or extreme temperatures whereas resolvers will remain largely unaffected.

Slab resolvers get used wherever there is a requirement for one or more of the following:-

- Large through shaft
- Requirement for absolute position measurement
- Integration with a large bearing
- Space constraints that require low axial height
- Radial mismatch between rotating and stationary parts
- Long life
- Harsh physical environment
- Continuous rotation.

Are they any good?

Resolvers have been around since World War II and have a solid reputation for reliability. They are often the automatic choice for high-reliability and safety related applications.

A common pitfall is that many resolver data sheets specify that the resolution of a resolver is infinite. Whilst this is theoretically true, in practice, it is daft because in most modern control systems, the resolver's analogue signals will converted to a digital signal of finite resolution. The actual resolution will be determined by the resolution of the analogue to digital conversion circuit.

This leads to a subtle but important point – to engineer a resolver based system a (separately specified and purchased) signal excitation & processing circuit is required. This means that there is a significant skills issue in using resolvers - you need to know what you are doing and typically there is no one-stop-shop.

Slab resolvers also have a reputation for being heavy, bulky and expensive. They are simply not economically viable for most mainstream industrial applications and, in general, are only regularly used in those sectors where capital cost is secondary to specification and performance.

What are the alternatives?

In theory, optical encoders are the natural alternative but in practice they simply cannot cope with harsh physical environments. In the larger slab or pancake formats (typically >4" diameter) optical devices are often just as costly as a slab resolver.

A new generation of device has become increasingly popular which can be thought of as a hybrid between an encoder and a resolver. Inductive encoders (or Incoders) use the same basic physics as a resolver but are less costly, lighter, more compact and more accurate. Importantly, they are also easier to use because they only require a DC supply and output a digital signal representing absolute angle. The skills issue is eradicated because inductive encoders do not require separate electronics processing circuitry – all the necessary electronics are integrated in to the stator. This means that Incoders have all the advantages of slab resolvers but with none of their disadvantages.

Example of an Inductive Encoder.

Rather than the traditional resolver's copper wire windings, Incoders use printed circuit boards as their main components. As with a resolver there is a stator and a rotor but because there is no requirement for precise location of the Incoder's stator and rotor, there is no need for any bearings. There is no need to specify single speed or multi-speed devices – Incoders have a digital output with a resolution of up to 16millions steps per revolution.

Since Incoders use printed circuit boards rather than wire windings, this means that they can be made with extremely high accuracy. Accuracies of <1 arc-minute common as are repeatability of <1 arc-second. An Incoder's basic design also means that they can be readily customised to suit a particular application's requirements.

Incoders are available in a wide range sizes up to 600mm diameter and have been used extensively in a variety of machine tools, gimbals systems, aerospace, defence and medical equipment.

Editor's Notes:

About Zettlex UK Ltd:

Zettlex is a sensors company. The company's range of sensors measure position or speed accurately and reliably, even in harsh conditions.

Zettlex designs and manufactures inductive position sensors as well as supplying sensor components and integrated circuits. The company offers bespoke sensor design and development for specific customer applications.

Unique technology and printed constructions, enable Zettlex to manufacture elegantly simple and reliable sensors with no contacts, no bearings, no delicate parts and no need for maintenance.

Zettlex sells directly to OEMs and system integrators across a broad range of industry sectors. Applications include position measurement, servos, motor controls, and user interfaces. Around 50 per cent of the company's business is safety-related or safety-critical.

Zettlex is ISO 9001 and BS EN 13980 certified for the manufacture of electromagnetic sensors, including sensors for intrinsically safe (ATEX) environments.

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