# FAQ

**The Electric Encoder technology is in fact based on variable capacitance, which has been considered sensitive to temperature, moisture, noise pickup, etc? How can it claim the opposite?**
Some variable capacitance sensors are indeed quite sensitive to one or more of the above. However, the Electric Encoder™ breakthrough which was made in the context of defense applications has demonstrated the opposite and its superiority has been demonstrated in a wide range of applications besides defense. It is covered by several basic patents and relies on a continuous development effort since 1994.

**How does the Electric Encoder™ differ from the incremental, pulse counting, or other logic level output, optical encoders?**
The Electric Encoder™ provides the absolute position and its continuous, exceptionally smooth output signals proportional to the SIN and COS of the measured rotary (or linear) displacement. Rather than directly encoding the displacement it leaves the encoding task to the A/D converter and software optimized for it.

**Is it similar to optical Sine/Cosine encoders?**
Only in providing high resolution, but there are three main differences: its "**holistic**" nature (see technology section), its much **lower profile** and its significantly **simpler**, more durable, construction. Also it has significantly less electric cycles per revolution (EC/R).

**Does having a lower number of cycles per rotation imply inferior performance?**
Not necessarily, the relatively low number of EC/Rs adapts it for both low speed and high speed applications while its near-ideal Sine/Cosine outputs with low DC offsets, minimal harmonic distortion, perfect amplitude matching, and extremely high temperature stability enables higher depth quantization, resulting in very high resolution and accuracy.

**Is the output of the Electric Encoder™ absolute?**
Yes, the output signals convey the absolute rotary (or linear) position without any movement.

**How else does the Electric Encoder™ differs from the optical Sine/Cosine encoder?**
Thanks to the relatively low number of EC/R the output signals are confined to the low end of the frequency spectrum and are less prone to errors due to PWM noise.
The absence of temperature, or time, degradation mechanisms - ball bearings, LEDs, etc. virtually eliminate any failure mechanisms.

**Is it also unique mechanically?**
Yes, the rotary Electric Encoder™ high accuracy is exceptionally unaffected by shaft eccentricity and tilt, as in high accuracy optical encoders, and therefore needs no bearing of its own for aligning the rotor relative to the stator, as a result it is directly mountable on the host shaft. The absence of internal bearings not only makes its profile low, but also obviates the need for a

flexible shaft coupler, or flexible stator mounting, as a result the Electric Encoder™ provides both accuracy and compactness.

**How is the Rotary Electric Encoder™ compared to a resolver?**
The resolver is known for its mechanical ruggedness. The Electric Encoder™ is nearly as rugged, consisting of fiber-reinforced, high-temperature polymer components. Like the resolver it can be adapted for operation at 125°C, and intermittently even higher, and is nearly unaffected by condensation and contaminants. Unlike the resolver, however, it includes the processing electronics on-board and is DC in DC out. (not modulated as in resolvers) It is also more accurate and has a wider servo bandwidth. See following table for a more comprehensive comparison:

| | Property | Resolver | Electric encoder |
|---|---|---|---|
| 1 | Operating temp. range | -55º to +150º | -55º to +125º (+150º) |
| 2 | Weight to diameter ratio | Larger | Smaller |
| 3 | Profile | Larger | Smaller |
| 4 | Rotor | Active | Passive |
| 5 | Brushless rotor option | Adds axial length | Inherent |
| 6 | Sensitivity to magnetic field | Yes, unless shielded | Inherently insensitive |
| 7 | Power consumption | Several watts | Typically 50mW |
| 8 | Mounting tolerance | Relatively tight | Relatively loose |
| 9 | Power supply | AC | DC |
| 10 | Cost to performance ratio | Lower | Higher |
| 11 | Accuracy to diameter ratio | Lower | Higher |
| 12 | Servo bandwidth | Medium | High |
| 13 | Absolute position output | Yes | Yes |
| 14 | Number of wires | 6 | 6 |
| 15 | Redundancy option | Yes | Yes |

**Is it similar to the Inductosyn® - which in essence is a printed resolver?**
Yes, it is indeed similar to the Inductosyn®, which also has a "holistic" rotor, flat construction, and very high accuracy. However, it has a number of additional advantages:

- It consumes much lower power (in fact lower than any other position encoder)
- It needs no slip-rings, or rotary transformers
- It is much lower in weight
- It includes all of its support electronics on-board
- It is insensitive to magnetic fields and has no magnetic signature

**Is it suitable for space applications?**
Yes, the following advantages makes is space compatible:

- Low weight
- Low profile
- Low power consumption
- Wide temperature range
- Mechanical robustness
- Low outgassing
- High reliability
- Vacuum compatibility

**What actually happens inside the rotary Electric Encoder™?**
An internally generated space/time modulated electric field interacts with a rotor which is made of a dielectric composite material. The rotor includes a peripheral sinusoidally shaped 3D pattern that serves the Fine channel, and a recessed sinusoidal pattern that serves the Coarse channel. The electric field is integrated over the full rotor area (hence “holistic”) and the resulting signal is processed and separated into Sine and Cosine output channels. Since a common channel processes both the Sine and Cosine outputs they are nearly matched and the decoded angle is stable over time and temperature.

**What is the resolution of the Electric Encoder™?**
The inherent resolution is virtually infinite, because of the continuous outputs. In practice, the resolution in bits/360° is N+M+1 where N is the binary representation of the number of amplitude quantization steps in the A/D converter and M is the binary representation of the number of Fine channel EC/R.

**How can the Electric Encoder™ provide an angular resolution greater than the resolution of the A/D converter?**
As an example, the DS-58 mm Electric Encoder™ with 32 EC/R (M=5) and a 14-bit A/D converter will provide a resolution of 14+5+1=20 bits, i.e., equivalent to one million steps per revolution - see AN-05.

**How does the Electric Encoder™ performs over temperature?**
The operating temperature range may reach -55º C to +125º C (it can be extended to +150º C for short periods). The main reasons for this robustness are:
1. The "holistic" rotor averages out the effects of minor mechanical deformations that occur at extreme temperatures
2. The common processing channel for the Sine and Cosine signals. This makes electronic components tolerances and stability nearly irrelevant
3. The immunity to internal offset voltages due to AC operation.

**What about repeatability and accuracy?**
The output reading will repeat itself to within +/- 1/2 LSB, either for position move-and-return or power-up. The accuracy increases as the number of EC/R increases. With properly corrected parameters an error as low as 10 arc seconds or below can be achieved.

**What is the MTBF of the Electric Encoder™?**
The Electric Encoder™ is made of special polymer and includes low-power electronics (typically less than 50mW power consumption). It does not include components such as bearings or LEDs. Therefore, it has virtually no failure mechanism.

**How about RFI emissions?**
The Electric Encoder™ conforms to CE directives.

**How about RFI/EMI susceptibility?**
The Electric Encoder™ is inherently immune to magnetic fields, internally shielded from electrical fields, and is also insensitive to RFI as evidenced by many defense applications.

**How sensitive is the cabling?**
Because the differential output signals are of low frequency, they are easy to handle and protect from high-frequency pick-up noise. In fact, the Electric Encoder™ has been used in PWM environments with unshielded cables.

**How does the Electric Encoder™ performs in shock and vibration environment?**
Very well, since it integrates signals over the entire rotor area, averaging out vibration effects. It is being used in demanding defense applications.

**What protocols are supported?**
Standard Sine/Cosine analog outputs are available, which can be digitized and processed by the host system. However A Quad B incremental and SSI absolute serial protocols are also available.