

HIGH-SPEED OPERATION

Bourns®

EMS22 ROTARY MAGNETIC ENCODER SERIES

TECHNICAL NOTE



Introduction

Technological advancements in the semiconductor industry have created a broad use of electronically controlled systems. This developing technology promotes the need for sensors that operate in the digital realm, are capable of operating at high speeds and can handle harsh environments where extreme levels of temperature, moisture and particles are present. For many system manufacturers, there is a need to utilize components that can operate in either incremental or absolute output modes. The Bourns® Model EMS22 Rotary Magnetic Encoder Series has this capability. The following information will assist in understanding the output form and expectations in high-speed operation.

Sampling Rate

The Bourns® Model EMS22 Rotary Magnetic Encoder samples the angular value at a rate of 10.42 k samples per second. As a result, the incremental and the absolute outputs are updated every 96 µs. At a stationary position of the magnet, this sampling rate creates no additional errors.

Absolute Mode with Serial Communication

With the given sampling rate of 10.4 kHz, the number of samples (n) per turn for a magnet rotating at high speed, can be calculated with the following formula:

$$n = \frac{60}{rpm * 96 \mu s}$$

In practice, there is no upper speed limit. The resulting limitation is fewer samples per revolution as the speed increases. Regardless of the rotational speed, the absolute angular value is always sampled at the highest resolution of 10 bits. Likewise, for a given number of samples per revolution (n), the maximum speed can be calculated with the following formula:

$$rpm = \frac{60}{n * 96 \mu s}$$

In absolute mode with serial communication, 610 RPM is the maximum speed, where 1024 readings per revolution can be obtained.

In incremental mode, the maximum error caused by the sampling rate of the Analog-to-Digital Converter (ADC) is 0/+96 µs. It has a peak of 1 Least Significant Bit (LSB) = 0.35 ° at 610 RPM. At higher speeds, this error is reduced again due to interpolation and the output delay remains at 192 µs as the Digital Signal Processing (DSP) requires two sampling periods (2 x 96 µs) to synthesize and redistribute any missing pulses.

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Absolute Mode with Pulse-Width Modulation (PWM)

The principle is the same as with the serial communication. The PWM output is refreshed with a rate of 1.025 µs and the number of samples (n) per turn for a magnet rotating at high speed can be calculated with the following formula:

$$n = \frac{60}{\text{rpm} * 1.025 \mu\text{s}}$$

In absolute mode with PWM output (Model EMS22P), 57 RPM is the maximum speed, where 1024 readings per revolution can be obtained. Above the maximum speed, the absolute position will still be read but it will be delayed.

Incremental Mode

Incremental encoders are usually required to produce no missing pulses up to several thousand RPMs. Therefore, the Bourns® Model EMS22 Series Encoder has a built-in interpolator, which ensures that there are no missing pulses at the incremental outputs for rotational speeds of up to 10,000 RPM, even at the highest resolution of 10 bits (512 pulses per revolution).

Table 1 | Bourns® EMS22 Non-Contacting Encoder Revolution Specifications

Absolute Output Mode Model EMS22A	Incremental Output Mode Model EMS22Q & EMS22D
610 RPM = 1024 samples / turn	No missing pulses
1220 RPM = 512 samples / turn	@ 10 bit resolution (512 PPR*):
2441 RPM = 256 samples / turn	
Etc.	Max. speed = 10,000 RPM

* Pulses per Revolution

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Conclusion

The Bourns® Model EMS22 Non-Contacting Encoder has the capability to operate in the digital realm with either incremental or absolute output modes. These encoders can handle designated harsh environments where extreme levels of temperature, moisture and particles are present with no effect on performance characteristics. Design engineers with constraints such as cost, space, circuit complexity and resolution will appreciate the unique features and benefits of the Bourns® Model EMS22 Rotary Magnetic Encoder Series.

The EMS22 non-contacting encoder is ideal for use in harsh environments where extreme levels of temperature, moisture and particles are present. The outstanding performance of this device is attributed to the non-contacting technology and superior performance of the austriamicrosystems* AS5040 Hall Effect ASSP. In addition, this product is sealed to IP** 65 with an optional upgrade to IP 67.

* Pulses per Revolution

** Ingression Protection

For more information on the Bourns® EMS22 Rotary Magnetic Encoder Series,
please visit

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Americas: Tel +1-951 781-5500
Fax +1-951 781-5700

EMEA: Tel +36 88 520 390
Fax +36 88 520 211

Asia-Pacific: Tel +886-2 256 241 17
Fax +886-2 256 241 16