

# EMS22 NON-CONTACTING ROTARY 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, 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 quadrature or tachometer (direction / step) output modes. The Bourns® Model EMS22 Non-Contacting Encoder Series has this capability. The following information will assist in understanding the output form and expectations in incremental mode.

## Model EMS22Q (A/B Quadrature) and Model EMS22D (Direction / Step)

Output Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6
A/B Quadrature	A	B	GND	Index	VCC*	CS**

\* Can be 5 or 3.3 VDC depending on the version.  
\*\*Active low chip select pin; if not used connect pin 6 to GND.

Output Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6
Direction/Step	Pulse	Direction	GND	Index	VCC*	CS**

\* Can be 5 or 3.3 VDC depending on the version.  
\*\*Active low chip select pin; if not used connect pin 6 to GND.

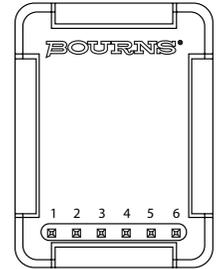


Figure 1 | Pin Configurations

For Model EMS22Q, the phase shift between channel A and B indicates the direction of the magnet movement. Channel A leads channel B at a clockwise rotation of the magnet by 90 electrical degrees. Channel B leads channel A at a counterclockwise rotation.

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### Model EMS22Q (A/B Quadrature) and Model EMS22D (Direction / Step) (Continued)

For Model EMS22D, Output Pulse reflects the Least Significant Bit (LSB) of the programmed incremental resolution (512 to 64). The Output Direction (Dir) provides information about the rotational direction of the shaft (1 = clockwise; 0 = counterclockwise; top view). Dir is updated with every LSB change. In both modes (Model EMS22Q and Model EMS22D), the resolution and the index output are user selectable. The index pulse indicates the zero position and is by default one angular step (1 LSB) wide. However, it can be ordered with three LSBs by part number selection.

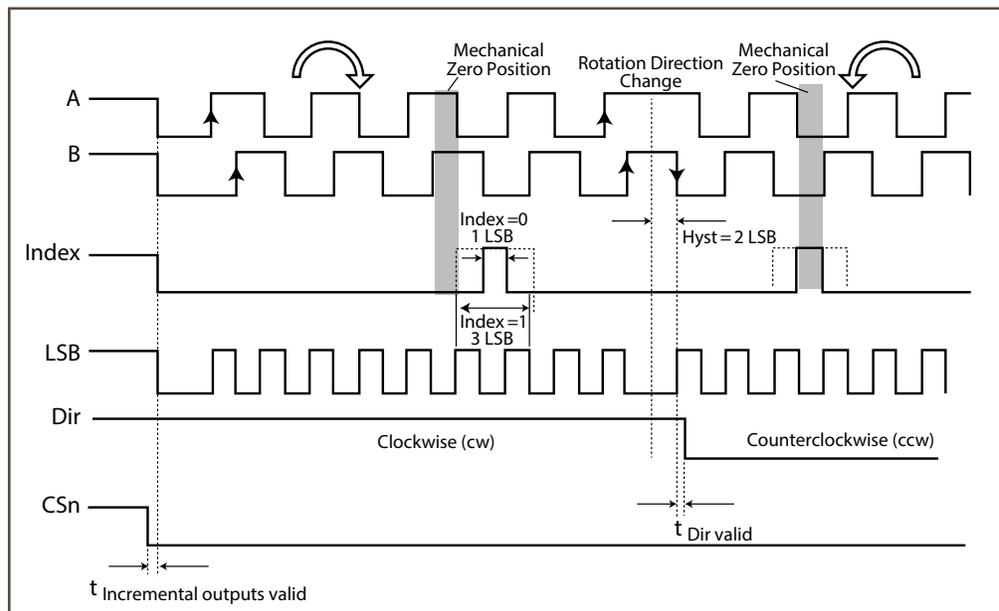


Figure 2 Incremental Mode Output Signals  
(source: austriamicrosystems AG)

Table 1 Incremental Output Operating Conditions

Parameter	Symbol	Max	Unit	Note
Incremental outputs valid after power-up	$t_{\text{incremental outputs valid}}$	500	ns	Time between first falling edge of CSn after power-up and valid incremental outputs
Directional indication valid	$t_{\text{dir valid}}$	500	ns	Time between rising or falling edge of LSB output and valid directional indication

Operating conditions:  $T_{\text{amb}} = -40$  to  $+125$  °C,  $V_{\text{DD}5\text{V}} = 3.0 - 3.6$  V (3 V operation)  $V_{\text{DD}5\text{V}} = 4.5 - 5.5$  V (5 V operation) unless otherwise noted

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### Incremental Power-Up Lock Option

After power-up, the incremental outputs can optionally be locked or unlocked, depending on the status of the CS pin:

#### ***CS = Low at Power-Up:***

CS has an internal pull-up resistor and must be externally pulled low ( $R_{ext} \leq 5 \text{ k}\Omega$ ). If CS is low at power-up, the incremental outputs (A, B, and Index) will be high until the internal offset compensation is finished.

This unique state ( $A = B = \text{Index} = \text{high}$ ) may be used as an indicator for the external controller to shorten the waiting time at power-up. Instead of waiting for the specified maximum power-up time (0), the controller can start requesting data from the austriamicrosystems® AS5040 Hall Effect Sensor as soon as the state ( $A = B = \text{Index} = \text{high}$ ) is cleared.

#### ***CS = High or Open at Power-Up:***

In this mode, the incremental outputs (A, B, and Index) will remain at logic high state, until CS goes low or a low pulse is applied at CS. This mode allows intentional disabling of the incremental outputs until, for example, the system microcontroller is ready to receive data.

### Incremental Output Hysteresis

To avoid flickering incremental outputs at a stationary magnet position, a hysteresis is introduced. In case of a rotational direction change, the incremental outputs have a hysteresis of 2 LSB. Regardless of the programmed incremental resolution, the hysteresis of 2 LSB always corresponds to the highest resolution of 10 bits. In absolute terms, the hysteresis is set to 0.704 degrees for all resolutions. For constant rotational directions, every magnet position change is indicated at the incremental outputs. If, for example, the magnet turns clockwise from position “x + 3” to “x + 4”, the incremental output would also indicate this position accordingly. A change of the magnet’s rotational direction back to position “x + 3” means that the incremental output still remains unchanged for the duration of 2 LSB, until position “x + 2” is reached. Following this direction, the incremental outputs will again be updated with every change of the magnet position.

## INCREMENTAL MODE

# Bourns®

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### Incremental Output Hysteresis (*Continued*)

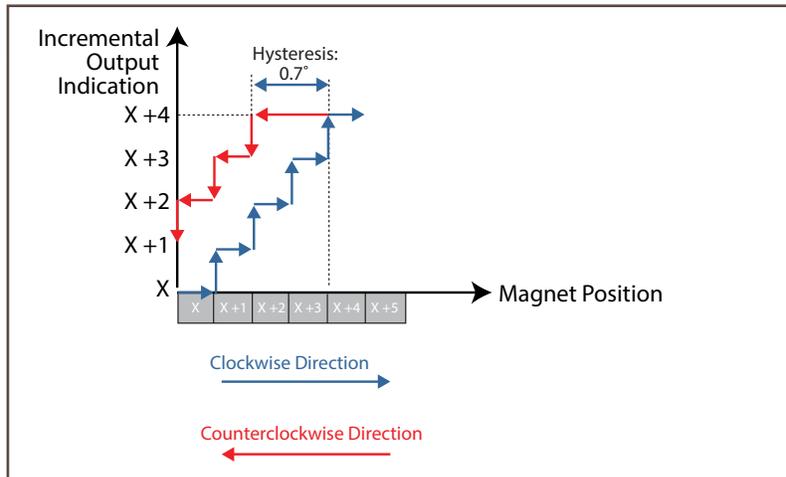


Figure 3 Hysteresis with Magnet Rotation  
(source: austriamicrosystems AG)

### Conclusion

The Bourns® Model EMS22 Non-Contacting Magnetic Rotary Encoder Series has the capability to operate in the digital realm with either quadrature or tachometer (direction / step) 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 Non-Contacting 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

[www.bourns.com](http://www.bourns.com)

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