Installation

EPC's TRP Measuring Wheel Encoder is available in a broad range of resolutions. Users can also reprogram the resolution of any TRP unit using a PR2 Programmer. When implementing a TRP measuring wheel encoder in a linear measurement application, several factors must be considered. This technical bulletin focuses specifically on resolution and measurement error.

Resolution has dependencies and trade-offs – higher resolution is not always better

Minimum Resolution: The encoder resolution should be at least ten times finer than the smallest measurement increment required by the application (Rule 1). For example, in a cut-to-length system with a specified tolerance of ±3.0 mm, the encoder's linear resolution should be finer than 0.3 mm to reliably achieve the required tolerance. Note that TRP resolution is defined as angular resolution, or counts per revolution (CPR), and is related to linear resolution through the wheel's circumference (Equation 1). EPC's online calculator

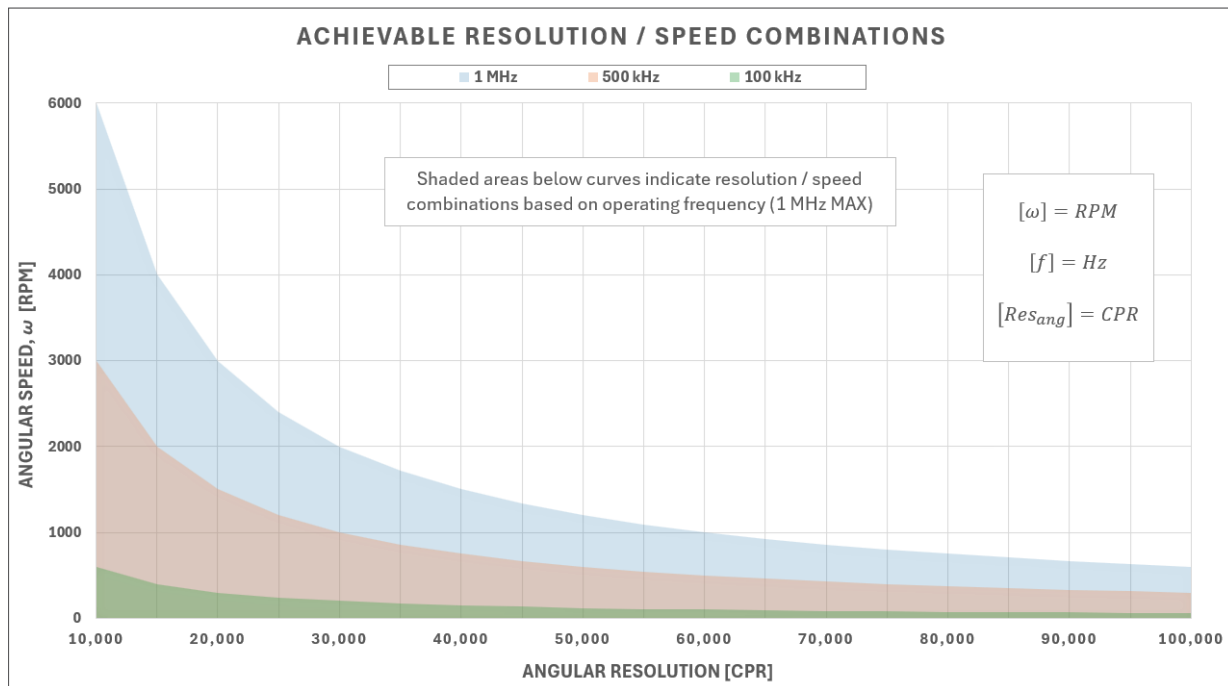$$Res_{linear} \geq \frac{Tol_{linear}}{10} \quad \textit{(Rule 1)} \qquad\qquad Res_{angular} \geq \frac{Circ}{Res_{linear}} \quad \textit{(Eq.1)}$$

Maximum Resolution: It is important to consider the application's maximum speed (velocity) and desired operating frequency when determining maximum resolution, as these factors are related through Equation 2. The relationship between angular (ω) and linear speed (v) is described by equation 3.

$$w = \frac{f}{Res_{ang}} \cdot 60 \quad \textit{(Eq.2)} \qquad\qquad w = \frac{v}{Circ} \cdot 60 \quad \textit{(Eq.3)}$$

The speed versus resolution chart illustrates how increasing resolution limits the maximum operating speed and how operating frequency influences the achievable combinations. Note that while three discrete frequencies are shown, the TRP can operate at any frequency up to 1 MHz. Also note that the chart's x-axis begins at 10,000 CPR. In measuring wheel applications, resolutions above 10,000 CPR are considered very high and should be selected with caution.

ACHIEVABLE RESOLUTION / SPEED COMBINATIONS

Legend: ■ 1 MHz ■ 500 kHz ■ 100 kHz

Shaded areas below curves indicate resolution / speed combinations based on operating frequency (1 MHz MAX)

$$[\omega] = RPM$$
$$[f] = Hz$$
$$[Res_{ang}] = CPR$$

Y-axis: ANGULAR SPEED, ω [RPM]
X-axis: ANGULAR RESOLUTION [CPR]

Error in measuring wheel applications

Encoder Error (Encoder Accuracy): the encoders within EPC Tru-Trac™ products have a rated angular accuracy of ±0.01667° (1 arc-min) from true position. Using the wheel circumference, this angular error can be converted to linear error using Equation 4.

$$\varepsilon_{linear} = \varepsilon_{angular} \cdot \frac{Circ}{360} \quad \textit{(Eq. 4)}$$

Thus, the corresponding linear encoder error for standard TRP measuring wheels is ±0.00028 inches for a 6-inch circumference wheel and ±0.0093 mm for a 200-mm circumference wheel.

Wheel Diameter: All measuring wheels have a manufacturing tolerance, typically specified in terms of diameter. A wheel diameter variation as small as ±0.001 inches (EPC's standard measuring wheel tolerance), which translates to ±0.00314 inches of circumferential error, can introduce linear measurement errors up to ten times greater than the encoder's specified accuracy. This calculation assumes the wheel diameter is fixed, however depending on the wheel material and application conditions, the measuring wheel's contacting surface may wear over time, leading to increasing measurement error.

Surface irregularities of the material being measured also contribute to position error and must be considered in high-precision applications.

In linear measuring wheel applications positional error accumulates with each wheel revolution

Consider the common feedstock/conveyor application of measuring wheel encoder shown in the figure below. As the surface moves to the left, causing the measuring wheel to rotate clockwise, the tick mark on the 6-inch circumference wheel should land at the 6", 12" and 18" mark, respectively for 1,2 and 3 revolutions worth of linear travel. In this example, any system error will accumulate incrementally with each revolution.
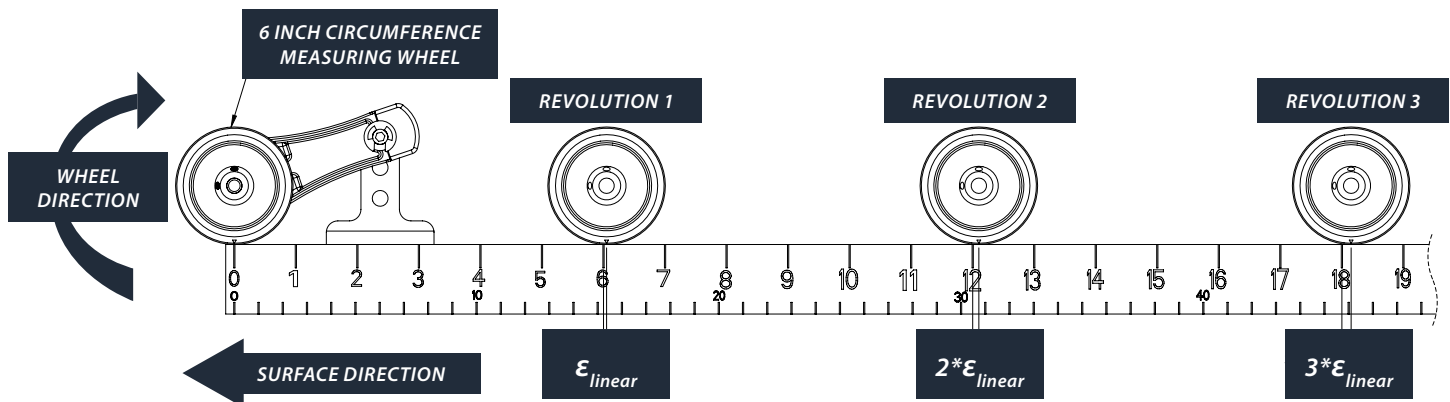
Use the PR2 to change TRP resolution and enhance system performance

Because part dimension and surface condition variations are significant and often unavoidable sources of positional error, some applications may benefit from adjusting the TRP's resolution using EPC's PR2 Programmer. Resolution adjustments can help mitigate the effects of product changeovers, wheel wear, and mechanical system slack, thereby improving measurement accuracy and ensuring consistent system performance.