Determining MENCRES for Linear Motors

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MENCRES is the variable in the Servo Star drive that is used to inform the drive of the motor encoder resolution, (Motor Encoder Resolution). For a rotary motor, it is easily determined from the specified line count of the encoder. In most cases, the specifications from the manufacturer indicate the units for resolution is the number of lines per revolution. Historically, this comes from the masking "lines" on the encoder which interrupts the light source to generate the electrical signal. These 'lines' are the before the 4 times quadrature specification (which is counts per revolution). The range of line counts are typically from 100 lines per revolution up to 5000 lines per revolution. More is possible, but usually we see 1024 lines per revolution.

For linear motors the value for MENCRES is determined the same way. Look at the manufacturers data sheet and enter the proper value in the Servo Star drive. It would be nice if it were as a simple as a rotary encoder. We need an understanding of the linear terminology in order to make the proper calculations to determine the value of the encoder resolution.

Linear motors do not have a physical mechanical "revolution", but instead the characteristic that is in co□□on with a rotary motor is the electrical cycle. If we define a linear motor as having 2 poles, a north and south magnet, and a rotary motor with the same number of poles (2), each will generate a back Voltage called the "back EMF". Each revolution of the motor will or each linear movement of 32mm will generate one sine wave. This is true if the rotary motor is constructed as a two-pole motor. Typically the Goldline motors are 4 or 6 pole with some even being 8-pole design. This will generate a complete sine wave 4,6 or 8 times within the mechanical revolution.

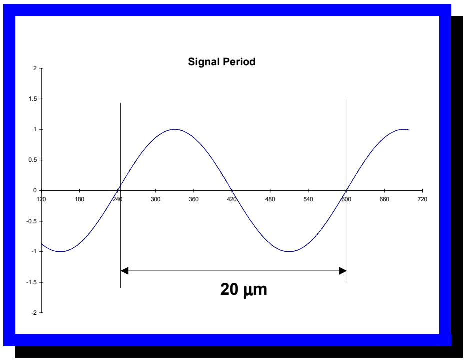
Now that we have defined the similarities of the electrical cycles for linear and rotary motors we can now discuss the encoder resolution as it pertains to one "Electrical cycle". electrical revolution.

The difference between lines per revolution and resolution is simple. Lines are always based on the grating period of the encoder, whereas resolution is typically refers to as the "quadrature decoded" encoder channels. "A quad B is sometime used to indicate resolution. Counts is another term that indicates that the encoder channels have been decoded and generated counts or ticks from the edges of Channel A, Channel A/ Channel B and Channel B/. This is the true resolution of the system, which is based on the counting of each encoder edge.

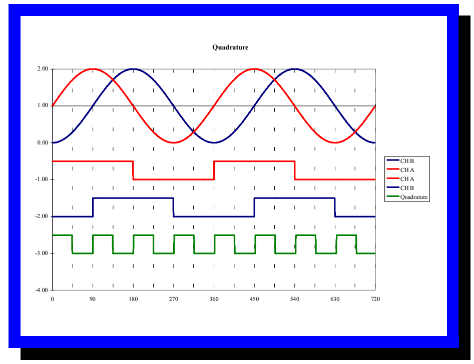
MENCRES is ALWAYS determined before QUADRATURE!

Now, what does one look for in the determination of the value of MENCRES? The manufactures of linear encoders use two definitions of encoder resolution. One is based on the **grating period** of the scale itself, this is known as the **signal period**. This is the raw output from the encoder light source or magnetic pitch of a magnetic encoder. Signal periods of 4 μm (micron) to 400 μm are the typical "SIGNAL PERIODS" that you would see in an optical encoder catalog. Heidenhain, RSF, Renishaw are a few of the well-known linear encoder manufactures. Other companies such as BEI, Zeiss, DRC, AMO make similar products, each with their own characteristics and form factors. But essentially, these encoder all do the same thing, produce counts electrical signal so the electronic controls can discern what is happening at the feedback or load of the system.

Heidenhain uses the term **signal period** extensively in their catalogs and mention what the recommended resolutions would be with subdividing electronics (another article, sine encoder card vs. interpolation boxes vs. interpolation integral in the drive). So you will see 20 µm, 40 µm as some of the typical values for the number of lines per, now distance that the encoder outputs. The term signal period is defined as such that each 20 µm of linear displacement equates to one electrical cycle of the output



Signal Period



Resolution

Rsf, Renishaw typically use the term **resolution,** and refer to the AFTER quadrature resolution of the quadrature decoded signal. Signal periods of 100 µm, 200 µm are common with an RSF encoder. RSF most always uses on board (on the encoder readhead) interpolation of the analog signal. 5, 10 20 up to 50? Is embedded in the readhead and the spec shows resolution with higher number than the competition. Renishaw follows a similar path in the specmanship. Just remember which spec you are looking at when determining what MENCRES should be. Remember that, that is the topic of this discussion.

Example 1,

A customer has a Heidenhain encoder with a "Signal period" of 20 µm, determine the following:

1. RESOLUTION
2. MENCRES

1. RESOLUTION = SIGNAL PERIOD / QUADRATURE
   = 20 µm /4
   RESOLUTION = 5 µm

2. MENCRES = ROTARY: lines per revolution
   or,
   LINEAR: lines per electrical cycle

The pitch of the linear motor is 32 mm and the number of poles for this motor is (2).
MPITCH = 32 and MPOLES = 2

MENCRES = lines/electrical cycle

= Signal Period X conversion X MPITCH X MPOLES

= 1 line/20 µm X 1000 µm /1 mm X 32 mm /2 poles X 2 poles/Electrical cycle

MENCRES = 1600 lines/electrical cycle

Example 2:

A customer has a Heidenhain encoder with a "Signal period" of 40 µm and 50 times interpolation subdividing electronics, determine the following:

1. RESOLUTION = SIGNAL PERIOD / SUBDIVIDING INTERPOLATION / QUADRATURE
   = 40 µm / 50 / 4
   RESOLUTION = 0.2 µm

2. MENCRES = ROTARY: lines per revolution
   or,
   LINEAR: lines per electrical cycle

The pitch of the linear motor is 32 mm and the number of poles for this motor is (2).
MPITCH = 32 and MPOLES = 2

MENCRES = lines/electrical cycle

= Signal Period X conversion X Interpolation factor X MPITCH X MPOLES

= 1 line/40 µm X 1000 µm /1 mm X 50 X 32 mm/2 poles X 2 poles/Electrical cycle

MENCRES = 40,000 lines/electrical cycle

Example 3:

A customer has a RSF encoder with a "Resolution" of 5 µm
determine the following:

1. MENCRES

=   LINEAR: lines per electrical cycle

The pitch of the linear motor is 32 mm and the number of poles for this motor is (2).
MPITCH = 32 and MPOLES = 2

MENCRES = lines/electrical cycle

= Resolution X 4 X conversion X MPITCH X MPOLES

= 1 / 5 μm X 1 line / 4 counts X 1000 μm / 1 mm X 32 mm /2 poles X 2 poles/Electrical cycle

MENCRES =1,600 lines/electrical cycle

Summary,

These few examples illustrate the conversion required to determine the value of the motor encoder resolution for linear encoders. The terminology is the crucial element here. Terms such as Signal period, Resolution, Grating period need to be understood in order to properly set the drives feedback characteristics. I suggest that the reader takes a catalog from any manufacturer and goes through the calculation for MENCRES. Practice is what gives us the ability to look at either term (Resolution, Signal period etc.) and determine in your head what the resolution is.

In the next discussion on setting up the encoder, I will discuss verification of the proper setting of MENCRES. This is a physical check with the linear motor system connected to a Servo Star with use of the Servo Star tools for verification.

Good luck! If there are any question I can be reached at 540 633-4134 email flocascio@kollmorgen.com