Abstract

This Tech Note shows the calculations and REPEAT GEAR syntaxes needed to implement a registered reciprocating flying shear.

Description

A knife or die is mounted in on a carriage which moves back and forth parallel to a moving web of material. The web has marks which can be sensed by a suitable sensor. The objective is to sense the mark then accelerate the carriage to match the web speed so that the die is exactly aligned with the mark. While the speeds are matched, the die is fired to cut or form the material. The carriage must then decelerate and return to its ready position in time to react to the next mark. The system uses a pacer encoder running at the same speed as the web to gain web position and speed information.

![Diagram of Registered Reciprocating Flying Shear](image)

**Figure 1**

Solution

This application can be solved using MotionBASIC’s REPEAT GEAR, ELS and DIO@ EVENT features. Using these features allows a solution that is interrupt driven, thus allowing your program to be handling other tasks while the shear is running.

Implementation

The MotionBASIC® statements used to implement this sequence are:

REPEAT GEAR FOR 0 IN DELAY.DIST AFTER ASEN@
REPEAT GEAR FOR STROKE IN WEB.DIST,ACCW,DECW
REPEAT GEAR FOR -STROKE IN RETN.DIST,RETN.DIST*ACC!,RETN.DIST*DEC!
You will need the following information about your application:

- **SENSOR OFFSET**: Distance from the die to the sensor with carriage at the ready position.
- **ACCEL**: Distance the carriage needs to accelerate.
- **CRUISE**: Distance you want the carriage to travel in sync with the web.
- **DECEL**: Distance the carriage needs to decelerate.
- **WAIT.DIST**: The safety margin you want to avoid missed cycles. This is the nominal distance from the registration mark to the sensor at the instant the carriage reaches the ready position. If this value is too small, you may experience missed cycles.
- **CUT.LENGTH**: The product length you want to cut (the nominal distance between registration marks).
- **RETN.TIME**: The fastest time time in which the carriage can return to the ready position.
- **ACC!**: The fraction of RETN.TIME the carriage needs to accelerate.
- **DEC!**: The fraction of RETN.TIME the carriage needs to decelerate.

From these you calculate the following:

- **STROKE**: Length of the forward stroke of the carriage.
- **WEB.DIST**: Distance the web travels during the forward stroke of the carriage.
- **ACCW**: Distance moved by the WEB while the carriage is accelerating.
- **DECW**: Distance moved by the WEB while the carriage is decelerating.
- **RETN.DIST**: Distance moved by the WEB during the carriage return stroke.
- **MAX.SPD**: The maximum web speed for the desired product length.

These equations define the values and limits for the parameters used in the gear statements:

\[
\begin{align*}
\text{SENSOR OFFSET} & \geq \text{ACCEL} \\
\text{ACCW} & = \text{ACCEL} \times 2 \\
\text{DECW} & = \text{DECEL} \times 2 \\
\text{WEB.DIST} & = \text{ACCW} + \text{CRUISE} + \text{DECW} \\
\text{DELAY.DIST} & = \text{SENSOR OFFSET} - \text{ACCEL} \\
\text{STROKE} & = \text{ACCEL} + \text{CRUISE} + \text{DECEL} \\
\text{RETN.DIST} & = \text{CUT.LENGTH} - \text{DELAY.DIST} - \text{WAIT.DIST} - \text{WEB.DIST} \\
\text{MAX.SPD} & = \frac{\text{RETN.DIST}}{\text{RETN.TIME}}
\end{align*}
\]

The values in your MP.CONFIG must be set so that the carriage axis and pacer encoder position units are the same.

**Controlling the Die**

Assuming the carriage return position is 0, set POS.MOD@ to a value 1.5 times the maximum travel of the carriage. Then set an ELS output to turn on at the appropriate position and off at a point past the end of the carriage travel. The turn on position should greater than ACCEL.
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The ELS should be connected to a DIO EVENT input which is programmed to turn the DIE output on for a preset time when the ELS turns on.

The DIE output will then turn off after the preset time. Since the ELS remains on for the rest of the stroke and only turns off when it retracts past the turn-on point, the DIE output will not fire again until the next cycle.

Pacer Encoder Selection

Caution must be used to provide adequate pacer encoder resolution in applications where the carriage motor must run at a significantly higher speed than the pacer encoder. Contact your ORMEC Sales Engineer for assistance in such cases.