Split Velocity/Position Feedback

Abstract

ORMEC’s GEN-III controllers derive both velocity and position feedback from a single encoder mounted on the back of the motor. In web feed applications, backlash or slippage between the motor and the driven load can cause feed length errors. In some cases this can be overcome by splitting the source of the velocity and position feedback to derive velocity feedback from the motor and position feedback directly from the driven load.

Example

The example shown in Figure 1 has a set of nip rolls driving a web for a feed to length application. If there is slippage between the nip rolls and the web, the feed length could be wrong. The remote encoder, driven by the measuring wheel, is used to eliminate the effect of the slippage. (This technique will only work if the measuring wheel has no slippage.)

![Figure 1, Example Application](image)

Components Needed

To use split feedback you will need the following:

- A DSP Axis Module with the "/A" 12 bit analog input option.
- A CBL-AT3/NN DSP card to terminal block cable.
- A TBC-D25 Terminal Block.
- A CBL-AET/NN (E series) or CBL-AST/NN (S series) Servo Drive to pigtail cable.
- A CBL-E25/NNN Remote Encoder cable.
- An ORMEC E series or S series Servo Drive and motor.

Notes:

NNN denotes cable length in feet
XRRRR denotes encoder resolution
* Older DSP Axis Modules require a CBL-AT/NNN in place of the CBL-AT3/NN
Interconnections

Figure 2 shows the cabling arrangement for the above components. Details of the pin outs for each connector and cable are included in Appendix E of the Generation III Model 20/40 Manual (GN3-040e).

![Cabling Diagram](image)

**Figure 2, Cabling Arrangement**

Initially you should leave the remote encoder disconnected and connect the encoder wires coming from the servo drive to the terminal block. This will allow you to operate the motor in the standard configuration.

**NOTE: The value of CW.FWD@**(axis) must be FALSE for this technique to work.

After using the SETUP.BAS program to verify the motor is properly tuned, you will need to calibrate the analog velocity output. Exit the SETUP.BAS program and save your configuration values.

From direct mode, enable the axis and make it run at 1000 RPM using a MOVE AT 1000 statement. While the motor is running, type:

```
REPEAT PRINT -1000/(AIN2@**(axis))*10/32767
```

The value displayed is the RPM per Volt value you will need later (note: the minus sign in front of the 1000 is needed since AIN2@() inverts the signal and the value must be positive).
Reconnecting For Split Feedback

Power the system down and disconnect the six wires carrying the encoder signals from the servo drive to the terminal block. Insulate the loose wires. In their place connect the wires in the CBL-E25/NNN cable from the remote encoder (nine wires).

Axis Configuration

Using the <F6> function key in MotionPRO™, call up the GEN III Configuration Menu and select Motor/Load Parameters.

After selecting the appropriate axis, set the Position Transducer Resolution (cnts/rev). Remember the value should be encoder counts per motor revolution taking into account the nip roll diameter, measuring wheel diameter and any gearing.

In the User Units screen and the various other screens, set the parameters in the usual way remembering that the encoder counts are counts per rev of the motor, not counts per rev of the encoder.

NOTE: The Forward Direction set in the Operating Parameters Screen must be Counter-Clockwise for this technique to work.

Program Modifications

When your program returns from executing the MP.CONFIG subroutine, you will need to set some additional parameters for the axis you are working with.

SET.FEEDBACK:
'this is where you set a variable to the percentage of velocity feedback you want to come from the analog velocity signal
'
A.PERCENT = 100
',
'this line sets the proportion of velocity feedback to come from the analog velocity signal based on the value of A.PERCENT
',
KVHA@(axis) = X * A.PERCENT/100
',
'this line sets the proportion of velocity feedback to come from the remote encoder based on the value of A.PERCENT.
',
KVH0@axis = 100 - A.PERCENT
RETURN

axis is the axis ID for the axis whose feedback you want to split.
X should be a value equal to the RPM per Volt of the analog velocity signal displayed in the earlier test.
Checking The System

CAUTION

IF THE POLARITY OF THE FEEDBACK IS REVERSED, THE FOLLOWING TEST COULD CAUSE THE MOTOR TO RUN AWAY AT HIGH SPEED. EXERCISE EXTREME CAUTION. MAKE SURE THE E-STOP SWITCH IS PROPERLY WIRED, IS OPERATIONAL AND IS WITHIN REACH BEFORE PROCEEDING.

1. Run the MP.CONFIG and SET.FEEDBACK sub-routines.
2. Enable the servo in velocity mode (MODE@ = 4).
3. Carefully disturb the motor position to verify it is stable and does not run away.
4. Type POS.ACT@(axis) = 0 <Enter> to zero the actual position.
5. Execute a MOVE axis FOR distance IN time statement with the values set for small distance in a fairly long time.
6. Check the new value of POS.ACT@, is it the same polarity as distance? Both should be positive or both should be negative. If it changed in the wrong direction you need to power down and reverse pins 1 and 2 on the terminal block, then try again.

Once you are sure the feedback is connected properly, you can enable the servo in position mode (MODE@ = 5) and check how well it works.

Fine Tuning

Now you are taking position feedback from the remote encoder, slippage at the nip roll will not affect feed accuracy (obviously slippage at the measuring wheel will). However, slippage and backlash at the nip roll may affect stability. If your system tends to hunt or overshoot you may be able to improve things by taking some of the velocity feedback from the analog signal and some from the remote encoder. You can experiment by setting the value of A.PERCENT in the SET.FEEDBACK sub-routine to a value less than 100 to see if it improves performance.

The more velocity feedback you take from the remote encoder, the better control you will have of actual web speed. However, the more susceptible the system will be to a runaway or instability should the measuring wheel slip or skip. It is probably not wise to set A.PERCENT to less than 50.

Runaway Protection

If something goes wrong and the encoder wheel stops being driven by the web, the nip rolls could go into a high speed runaway condition. To protect your system as much as possible you should set the maximum position error limit (PERR.MAX@(axis)) for the axis to the lowest possible value consistent with freedom from nuisance tripping.

CAUTION

BECAUSE THE MOTOR AND ITS POSITION FEEDBACK ARE NO LONGER TIGHTLY CONNECTED SPLIT FEEDBACK SYSTEMS ARE INHERENTLY MORE LIKELY TO EXPERIENCE RUNAWAYS AND OCCASIONAL SPEED SURGES THAN NORMAL CONFIGURATIONS.