PRODUCT FAMILY: Sure Servo
Number: AN-SERV-006
Subject: *Sure*servo as a follower with master encoder
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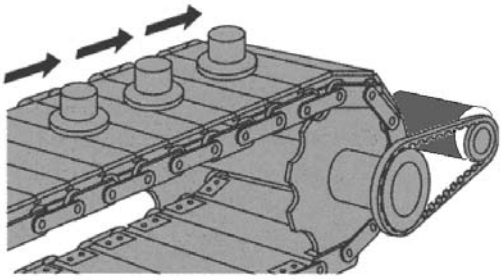
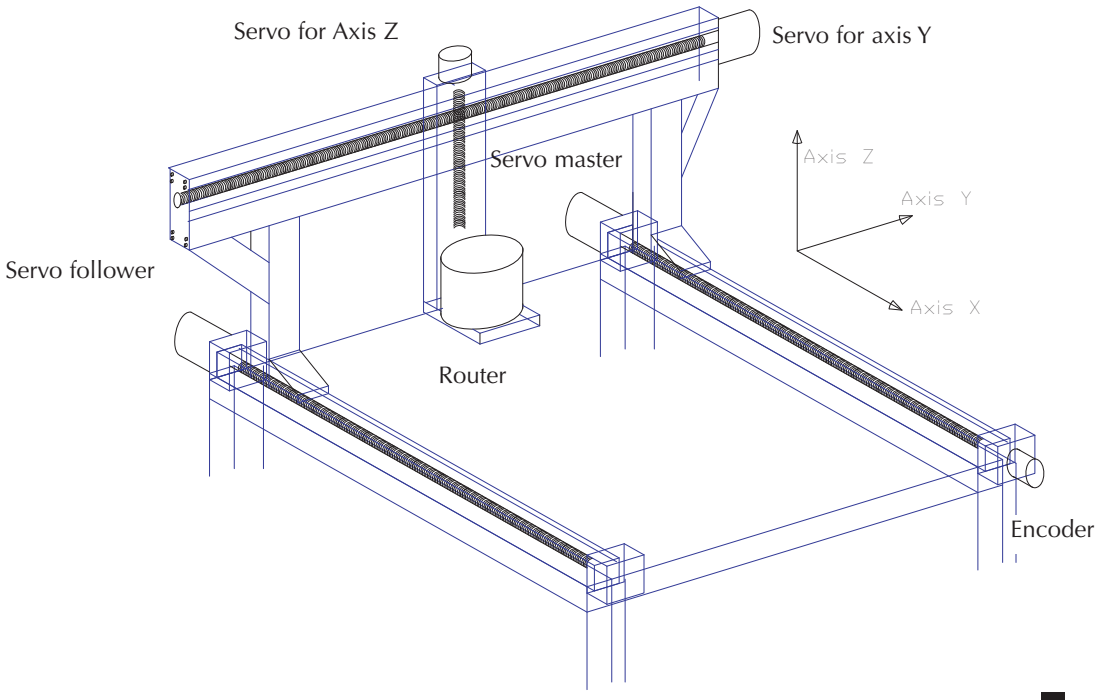
On several industrial applications it is necessary to use the servomotor as a follower with the master being an encoder. Examples of those conditions are indexing table conveyors, used with special chains, as the one on the next figure, or it may be a bridge crane longitudinal motion, where the wheels (not connected with a shaft) on each side has to be moved synchronously to avoid skew on the bridge.



We have developed this application note to show how determine the parameters based on a known encoder, **that will be moved in some way as a trapezoidal profile** or similar to that, how to wire to the servomotor and to set the parameters for this move. Otherwise, the servo may trip on overload.

See the following figure to explain the concept. The figure below shows a gantry router that has a bridge. This bridge should move longitudinally for the work over wood pieces. The operation requires to move the bridge by means of 2 ball screws on each side of the table, to control the X axis according to the controller doing the programmed profile from a CNC program on a PC. Obviously each ball screw should move synchronous to the other and keep the same speed.



The idea here will be to control only the right ball screw with the CNC controller and the other ball screw will follow the motion profile of the first one, to have equal forces and speed on both sides on the table.

This is easily accomplished by the installation of an encoder on the controlled ball screw, that can produce 2500 pulses per revolution.

This document describes the servo drive programming and encoder wiring to the servo drive.

Let's assume that we have a SVL-204 servomotor that can reach up to 5000 rpm, but in this example the ball screw can only reach at the most 500 rpm. Obviously we will have a gear box ratio of 10:1.

One way would be to use the pulse output of the controlled servo to do this follower operation. However, in this example we want to use an external encoder with 2000 pulses per revolution, 24 Volt such as the TRD-N2000-RZWD, which has a totem pole output configuration.

Calculations to define the electronic gearing

Let's relate the encoder motion with the servo. We know that the servo has to receive 10,000 pulses to rotate one revolution.

Since the encoder will have 2000 pulses per revolution, the servo will see the quadrature signal as 8000 pulses per revolution.

Then the output ratio should be corrected by 10,000/8000 by the reason of different rates and also there is a gearbox of ratio 10:1 , that is the real ratio between pulse frequency outputs and inputs is (10,000/8,000)x10 = 12.5 .

This is easily accomplished with the change of parameters P1-44 and P1-45. P1-44 would be set to 125 and P1-45 would be set to 10 (P1-44/P1-45)=125/10 = 12.5. This gives the necessary ratio.

Second example

On other application, not related to this example, a client in the printing press area was trying to do a follower action, where the servo has to follow the speed of a shaft that has an incremental quadrature encoder, and the ratio has to be variable in the range of 12:1 but can be adjusted to a lowest ratio of 6:1 or 18:1 and the adjustment has to be done with a HMI (operator interface located at about 100 feet from the servo location).

The operator will adjust the ratio from a C-more panel by means of a MODBUS RTU RS-485 link. This is easily accomplished with the change of parameter P1-44, with precision of one decimal place or more, depending on the selection of the numbers there.

The C-more panel will have a numeric entry object to change the ratio at any time, even if the servo is running.

This client also needs to change the direction of the servo once in a while. In this case, the only way, with the current technology, is to use a hardwired switch to the direction signal on a pulse and direction command or using a small PLC, such as the PLC DL05 to use one output to make the same functionality.

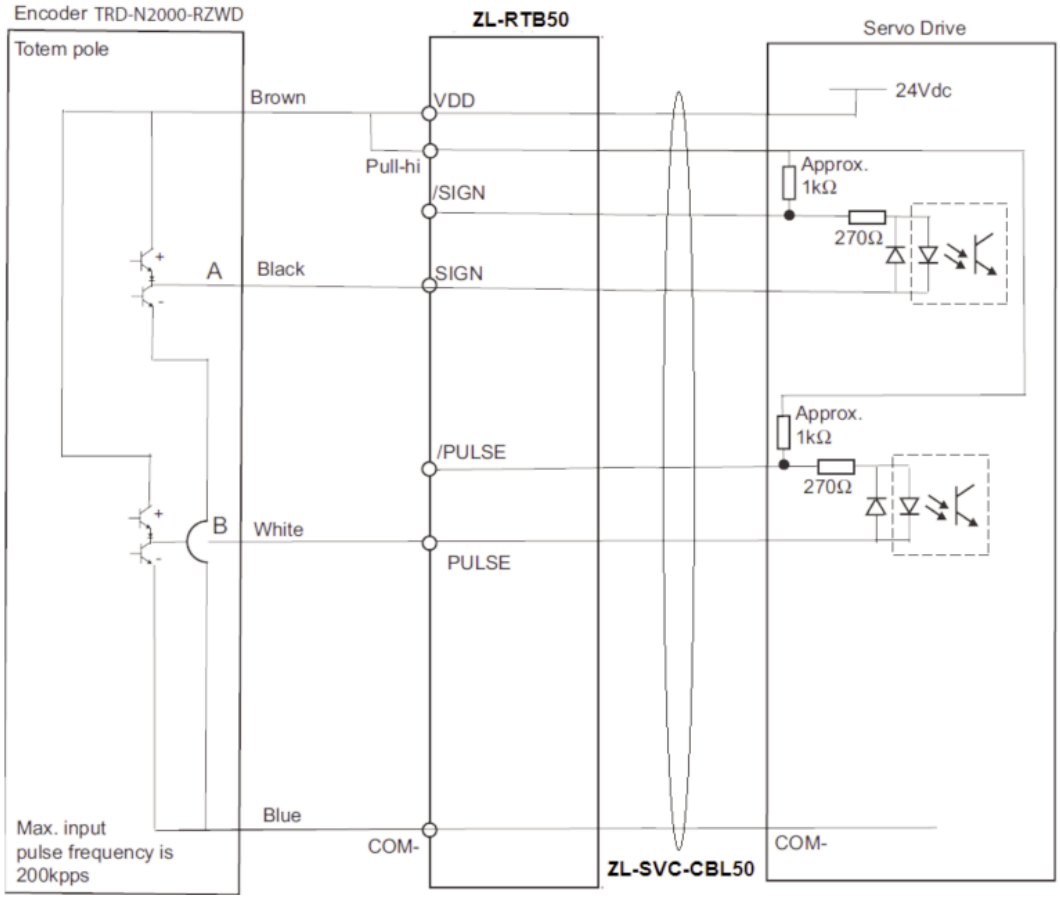
The *Sure*servo drive and the PLC will be slaves on the MODBUS network.

Main parameter settings

The most important concept here is that the servo parameter P1-01 is set as 00, which defines terminal position with forward rotation defined as clockwise rotation.

The next parameter to be defined is the parameter P1-00 as quadrature input.

This bring us to define how the encoder will be wired to the Servo drive, thru the Ziplink module ZL-RTB50. Please see the following figure.



The list of parameters for the first example on the next pages resume what we have described here. Notice that we do not show the programming of the servo drive master, because this should be configured based on the way the CNC controller will move the right side servo motor.

The second example has not been developed at this time.

Automation Direct SureServo PRO Drives Configuration Report
Config Name: encoder master-follower.ssc
Motor Code: 12

Parameter	Value
P0.00 - Software Version	2105
P0.01 - Drive Fault Code	0
P0.02 - Drive Status (Front panel display)	0
P0.03 - Analog Monitor Outputs	0
P0.04 - Status Monitor 1	0
P0.05 - Status Monitor 2	0
P0.06 - Status Monitor 3	0
P0.07 - Status Monitor 4	0
P0.08 - Status Monitor 5	0
P1.00 - External Pulse Input Type	0
P1.01 - Control Mode and Output Direction	0
P1.02 - Speed and Torque Limit	0
P1.03 - Output Polarity Setting	0
P1.04 - Analog Monitor Output Scaling 1 (CH1)	100
P1.05 - Analog Monitor Output Scaling 2 (CH2)	100
P1.06 - Analog Velocity Command Low-pass Filter	0
P1.07 - Analog Torque Command Low-pass Filter	0
P1.08 - Position Command Low-pass Filter	0
P1.09 - Preset Velocity Command / Limit 1	60
P1.10 - Preset Velocity Command / Limit 2	60
P1.11 - Preset Velocity Command / Limit 3	60
P1.12 - Preset Torque Command / Limit 1	100
P1.13 - Preset Torque Command / Limit 2	100
P1.14 - Preset Torque Command / Limit 3	100
P1.15 - Position 1 Command (Revolutions)	0
P1.16 - Position 1 Command (Counts)	0
P1.17 - Position 2 Command (Revolutions)	0
P1.18 - Position 2 Command (Counts)	0
P1.19 - Position 3 Command (Revolutions)	0
P1.20 - Position 3 Command (Counts)	0
P1.21 - Position 4 Command (Revolutions)	0
P1.22 - Position 4 Command (Counts)	0
P1.23 - Position 5 Command (Revolutions)	0

P1.24 - Position 5 Command (Counts)	0
P1.25 - Position 6 Command (Revolutions)	0
P1.26 - Position 6 Command (Counts)	0
P1.27 - Position 7 Command (Revolutions)	0
P1.28 - Position 7 Command (Counts)	0
P1.29 - Position 8 Command (Revolutions)	0
P1.30 - Position 8 Command (Counts)	0
P1.31 - Motor Code	12
P1.32 - Motor Stop Mode Selection	0
P1.33 - Position Control Mode (Internal Indexer)	0
P1.34 - Acceleration Time (Internal Indexer)	200
P1.35 - Deceleration Time (Internal Indexer)	200
P1.36 - Accel / Decel S-Curve	1
P1.37 - Inertia Mismatch Ratio	50
P1.38 - Zero Speed Output Threshold	10
P1.39 - Target Speed Output Threshold	3000
P1.40 - Max Analog Velocity Cmd or Velocity Limit	3000
P1.41 - Max Analog Torque Cmd or Torque Limit	40
P1.42 - On Delay Time of Electromagnetic Brake	20
P1.43 - Off Delay Time of Electromagnetic Brake	20
P1.44 - Electronic Gear Numerator 1	125
P1.45 - Electronic Gear Denominator	10
P1.46 - Encoder Output Scaling Factor	1
P1.47 - Homing Mode	0
P1.48 - Homing Speed 1 Fast Search Speed	1000
P1.49 - Homing Speed 2 Creep Speed	50
P1.50 - Home Position Offset (Revolutions)	0
P1.51 - Home Position Offset (Counts)	0
P1.52 - Regenerative Resistor Value	40
P1.53 - Regenerative Resistor Capacity	60
P1.54 - In Position Window	100
P1.55 - Maximum Speed Limit	1000
P2.00 - Proportional Position Loop Gain (KPP)	35
P2.01 - Position Loop Gain Boost	100
P2.02 - Position Feed Forward Gain (KFF)	5000
P2.03 - Smoothing Constant of Position Feed Forward Gain	5
P2.04 - Velocity Loop Proportional Gain (KVP)	500
P2.05 - Velocity Loop Gain Boost	100

P2.06 - Velocity Loop Integral Compensation (KVI)	100
P2.07 - Velocity Feed Forward Gain (KVF)	0
P2.08 - Factory Defaults and Security	0
P2.09 - Bounce Filter	2
P2.10 - Digital Input Terminal 1 (DI1)	101
P2.11 - Digital Input Terminal 2 (DI2)	102
P2.12 - Digital Input Terminal 3 (DI3)	124
P2.13 - Digital Input Terminal 4 (DI4)	111
P2.14 - Digital Input Terminal 5 (DI5)	108
P2.15 - Digital Input Terminal 6 (DI6)	0
P2.16 - Digital Input Terminal 7 (DI7)	0
P2.17 - Digital Input Terminal 8 (DI8)	0
P2.18 - Digital Output Terminal 1 (DO1)	101
P2.19 - Digital Output Terminal 2 (DO2)	103
P2.20 - Digital Output Terminal 3 (DO3)	109
P2.21 - Digital Output Terminal 4 (DO4)	105
P2.22 - Digital Output Terminal 5 (DO5)	7
P2.23 - Notch Filter (Resonance Suppression)	1000
P2.24 - Notch Filter Attenuation (Resonance Suppression)	0
P2.25 - Low-pass Filter (Resonance Suppression)	2
P2.26 - External Anti-Interference Gain	0
P2.27 - Gain Boost Control	0
P2.28 - Gain Boost Switching Time	10
P2.29 - Gain Boost Switching Condition	10000
P2.30 - Auxiliary Function	0
P2.31 - Auto and Easy Tuning Mode Response Level	68
P2.32 - Tuning Mode	4
P2.33 - Reserved	0
P2.34 - Overspeed Fault Threshold	5000
P2.35 - Position Deviation Fault Window	30000
P2.36 - Position 1 Velocity	1000
P2.37 - Position 2 Velocity	1000
P2.38 - Position 3 Velocity	1000
P2.39 - Position 4 Velocity	1000
P2.40 - Position 5 Velocity	1000
P2.41 - Position 6 Velocity	1000
P2.42 - Position 7 Velocity	1000
P2.43 - Position 8 Velocity	1000

P2.44 - Digital Output Mode	0
P2.45 - Index Mode Output Signal Delay Time	1
P2.46 - Index Mode Stations	6
P2.47 - Position Deviation Clear Delay Time	0
P2.48 - Backlash Compensation (Index Mode)	0
P2.49 - Jitter Suppression	0
P2.50 - Clear Position Mode	0
P2.51 - Servo Enable Command	0
P2.52 - Dwell Time 1 - Auto Index Mode	0
P2.53 - Dwell Time 2 - Auto Index Mode	0
P2.54 - Dwell Time 3 - Auto Index Mode	0
P2.55 - Dwell Time 4 - Auto Index Mode	0
P2.56 - Dwell Time 5 - Auto Index Mode	0
P2.57 - Dwell Time 6 - Auto Index Mode	0
P2.58 - Dwell Time 7 - Auto Index Mode	0
P2.59 - Dwell Time 8 - Auto Index Mode	0
P2.60 - Electronic Gear Numerator	1
P2.61 - Electronic Gear Numerator 3	1
P2.62 - Electronic Gear Numerator 4	1
P2.63 - Velocity and Position Deviation Scaling Factor	0
P3.00 - Communication Address	2
P3.01 - Transmission Speed	5
P3.02 - Communication Protocol	8
P3.03 - Communication Fault Action	0
P3.04 - Communication Watchdog Time Out	0
P3.05 - Communication Selection	0
P3.06 - Reserved	0
P3.07 - Communication Response Delay Time	0
P3.08 - Digital input Software control mask	0
P4.00 - Fault Record - Most recent (N)	9
P4.01 - Fault Record (N-1)	19
P4.02 - Fault Record (N-2)	9
P4.03 - Fault Record (N-3)	9
P4.04 - Fault Record (N-4)	9
P4.05 - JOG Function	20
P4.06 - Force Outputs Command	0
P4.07 - Input Status	1
P4.08 - Reserved	0

P4.09 - Output Status	11
P4.22 - Analog Velocity Input Offset	0
P4.23 - Analog Torque Input Offset	0

Notice that the digital input Servo Enable (DI1) should be ON for the follower to run properly.

On the test done in our office, we see the following behavior, using an encoder whose shaft was activated with the fingers.

Note that the limit of speed on parameter P1-55 of 1000 rpm was really limiting the speed and creating a position deviation.