

AN151

16-132879

ServoTube Interpolator

Introduction

The purpose of this app note is to explain how to set up a Copley servo drive to work as an Interpolator with a ServoTube linear motor.

An Interpolator converts the output analog signals from the ServoTube (Sin/Cos 1Vp-p differential signal for position interpolation and analog Hall) into emulated digital incremental quadrature counts A, /A, B, /B, X, /X, and digital Halls outputs U, V, W with respect to ground. These signals can be used with controllers that do not support Sin/Cos 1Vp-p analog Halls. Such as the Rockwell AB (Allen Bradley) Ultra 3000 or Kinetix 300 with EtherNet/IP. By default, the Copley interpolator outputs 4096 interpolations of the magnetic pair length and Hall states independent of motor used, so no configuration is required.

Additionally, Dunkermotoren has discontinued the SI-10 Interpolator, so therefore the objective of this app note is to explain how Copley drives can be utilized to achieve the same 10um of resolution and same Hall states as the obsolete interpolator. This app note provides guidance for the required wiring connections and CME software configurations.

Hardware

Necessary hardware for connection example:

Copley Drive	Drive Hardware	Communication
800-2111 (ADP-090-09) Emulator	ADP-CK connector kit	SER-USB-RJ11 serial adapter



First connect 24 volts to Copley (J1) power input, and then connect the ServoTube motor feedback output to Copley (J2) feedback.

ServoTube Motor Accelnet ADP-ARM Encoder Emulator Sensor Cable 800-2111 ServoTube Motor with ADP-ARM Encoder Emulator for Allen-Bradley Ultra 3000 Servo Drive 14 Blue +SIN Sin(+) 8/23/2021, Copley Controls Corp. 13 Black paired with Blue -SIN Sin(-) 12 J2 White +COS Cos(+) 11 Black paired with White -cos Cos(-) Red 4 +5Vd.c. +5V @ 250 mA 5 Allen-Bradley Black paired with Red Signal Ground OV Ultra 3000 Green Wire +THFeedback Connector to Black paired with Green High-Density D-Sub -TH AB 15-pos female 1 Green Frame Ground Pink-White 1 26 AM+ Enc A White-Pink 2 25 Enc /A AM-Orange-White 3 24 BM+ Enc B White-Orange 4 23 Enc /B BM-22 Yellow-White 5 Enc X -IM+ 10 J3 21 White-Yellow Enc /X IM-CN2 6 Green-White 19 Signal Ground ECOM 12 16 Blue-White Hall U **S**1 13 17 Violet-White **S**2 Hall V 8 18 Grey-White **S**3 Hall W 11 Green From ServoTube Black TS+ 15 TS-DC Power Supply White-Green +24 Vdc Frame Ground Connector Shell

The example below shows a connected Copley (J3) interpolated and emulated digital Hall output signals to an Allen Bradley Ultra 3000 or Kinetix 300(Rockwell does not take Sin/Cos 1Vp-p analog Hall):

Reference	Copley Controls Colors	Older Servotube Colors	New Servotube Colors	Pin# Copley Drive
+SIN	Blue	Blue	Blue	14
-SIN	Black + Blue	White + Blue	Red	13
+COS	White	Green	White	12
-COS	Black + White	White + Green	Brown	11
+5V	Red	Orange	Yellow	4
0V	Black + Red	White +Orange	Green	5
Frame Ground	Green	Green	N/A	1

5

4

+

HV

GND

J1

Drive Mounting Screw Stainless Steel

External tooth SEMS

CE (Connect to Earth)

#6 or M4

Note: The motor temperature connections (+TH & -TH) should be connected directly to an Allen-Bradley. Make sure the drive case and all shields find a good path to earth; without good grounding, noise can be injected into the signals.

Software

CME software configuration is optional as the emulator by default uses 12 bit or 4096 interpolations emulating A /A B /B, and output digital Halls on OUT1,2,3 on any magnetic pair length from the SIN/COS analog signal received by the 1Vp-p analog differential input.

11mm diameter rod pitch 25.6mm/ 4096 = 6.25um resolution.
25mm diameter rod pitch 51.2mm / 4096 = 12.5um resolution
38mm diameter rod pitch 71.2mm / 4096 = 17.38um resolution

If 10um resolution is required, or if the Hall state sequency needs to be changed, then CME can be used to modify the configuration and save it to a .ccx file for future use.

- 1. Connect to the Copley drive using serial communication. Copley recommends using the Copley USB to Serial adapter. Part# SER-USB-RJ11.
- 2. On the Setup screen, adjust motor pitch and interpolation for various motors if a 10um resolution is required for the controller.

etup		
Motor Feedback		
Electrical Cycle Length:	71.2	mm
<u>C</u> ounts/cycle:	71200	
Interpolated Resolution:	0.001	mm

11mm diameter rod pitch 25.6mm/ 2560 = 10um resolution 25mm diameter rod pitch 51.2mm / 5120 = 10um resolution 38mm diameter rod pitch 71.2mm / 7120 = 10um resolution

Note: Accuracy is based on magnet spacing. The resolution is based on interpolation. 12-bit A/D is more than sufficient given the variation in magnet spacing, but high resolution can be obtained using 16-bit A/D

- 3. Use CME to configure the phasing angle and feedback direction. Open the Tools menu and select the Manual Phase option.
- 4. In the Manual Phase screen use the various configurations to configure the phasing angle and feedback direction. For example, to advance 180 Deg type, +/-180° for Hall Offset.

Configuration	Monitor	
Halls Invert Input: Analog Hall Hall Offset -180 deg Motor Feedback Invert Input Motor Invert Output	amplifier is disabled by the hardware. Analog Halls Sine: -259.1 mV Cosine: -497.4 mV Hall Angle: 208 deg Motor Phase Angle: 63deg Motor Feedback: 4069 c Actual Current: U: 0 A	Motor Phase Angle Black Hall Angle in Red
Control Increment Rate: 90 e Current: 0 A	lec deg/s Set Zero Position	

- 5. Once finished, click the OK button to save the current configuration.
- 6. The default Hall state is given by default Configuration U Hall OUT1 30 deg, V Hall OUT2 150 deg, W Hall OUT3 270 Deg.

To configure the Hall state outputs, go to the Tools menu and select the ASCII Command Line option. Type the syntax for each output separately and press the Enter key.

Output	Hall	Syntax
Output 1	Hall U	s f0x70 8 30
Output 2	Hall V	s f0x71 8 150
Output 3	Hall W	s f0x72 8 270

Verification

Once all connections and CME setup are done, the buily-in Scope tool in CME can be used to verify all the configurations.

Open the Amplifier menu, and select the Scope option. In the Scope screen, select the following options for each scope channel:

Ch 1 Actual Motor Position	Trigger Setup	
Ch 2 Analog Sin Input	AutoSetup	
Ch 3 Analog Cos Input	Single Trace	
Ch 4 Output 1	Auto Scale Lock	
Ch 5 Output 2	Trace Time: 1.25 \$ \	
Ch 6 Output 3	Sample Rate: 933 µs	

Note: For the trigger setup, select rising edge for the trigger type.

When moving the ServoTube by hand the results in the Scope screen should look similar to the image below. Note that the sine & cosine waves (+or – 500 millivolts peak to peak) should be 90° apart, and the Halls states should be proportional:



Revision History

Date	Version	Revision
11/2/2021	Rev 00	Initial release