Variable Torque Clutch

Associated QuickControl Program File: Variable Torque Clutch.qcp

Overview

Variable Torque Clutch.qcp turns the servo into a variable torque brake or variable torque slip clutch. The servo will resist movement in both the clockwise and counter clockwise directions with a torque proportional to an analog input. As the analog input varies from 0 to full scale, the SilverLode servo varies holding torque from zero to full torque.

NOTE: This example uses SilverLode's full scale analog input. This example will work for the analog inputs of both the SilverNugget (0-5V) and the SilverDust (0-3.3V).

In summary, the program reads the analog input, scales it, then copies it to the Closed Loop Torque register.

Variable Torque Clutch.qcp

Set Error Limits

The servo is put into "Drag" mode using the Error Limits (ERL) command. This will make it resist movement up to 50 counts (Holding Error Limit) and then "Drag" or slip. For example, if the shaft is turned 50 counts and released, it will servo back to its previous position. If the shaft is turned 1000 counts and released, it will servo back 50 counts thus slipping 950 counts. The larger this number the more the servo will "recoil" when released. See Drag Mode in User Manual and ERL in Command Reference for details.

Note, the Kill Motor Conditions (KMC) command overrides the default initialization file’s KMC command to disable the Moving and Holding Errors. Otherwise, a kill motor condition would occur as soon as the servo begins to “slip”.

Read Analog Input

The desired torque is read in through Analog Input#1. The SilverLode servo automatically converts the input to 0-32767. For example, a value of 32767 would represent 5V on a SilverNugget and 3.3V on a SilverDust.

An ACR command is used to continuously read Analog Input#1 into register 30 (see ACR command in Command Reference or Analog Inputs in User Manual for more details).

Scaling

We use the following equations to convert the 0-32767 analog input to SilverLode Torque Units (STU) of 0-20000 (0-100% torque). See Scaling in User Manual for details.

Torque (T) = 0 - 20000 (0-100%)
Analog Input (X) = 0-32767 (0-full scale volts)
Analog Input Full Scale (Afs) = 32767
Torque Full Scale (Tfs)= 20000

T = Tfs/Afs * X

where
Tfs/Afs = 20000/32767
Tfs/Afs = 0.6103

We use a method called "Integer Decimal Point Math" to handle the decimal number. This is a simple method of multiplying both sides of the equation by 65535 (2^16) to get rid of the fraction, evaluate the equations and then divide the result by 65535.

65535 * T = 65535 * Tfs/Afs * X

where
65535 * Tfs/Afs = 39996

Let this equal Scale (S)
S = 39996

Therefore
65535 * T = 65535 * Tfs/Afs * X = 39996 * X = S * X
T = (S * X)/65535

Dividing something by 65535 (2^16) is the same as shifting right by 16 bits. In a 32 bit word, shifting right 16 bits is the same as moving the HIGH WORD to the LOW WORD.

In other words:

T = (S * X)/65535
T = S * X >> 16
T = HIGH WORD (S * X)

See the program for details on how the equations are realized.

Calculate Torque

The main control loop uses the following registers to realize the equation:

T = HIGH WORD (S * X)

Register Definitions (use Register Watch to view contents):
Register 26: Calculated Torque (T)
Register 30: Raw Analog Input (X)
Register 31: Scale (S)

The resultant Torque (T) is then copied into the high word of register 206. Register 206 is the Closed Loop Torque register, where the high word is the Holding torque and the low word is the Running torque. As this register is modified in real time so is the servo's maximum torque. See Technical Document “QCI-TD051 Torque Control” for more details.