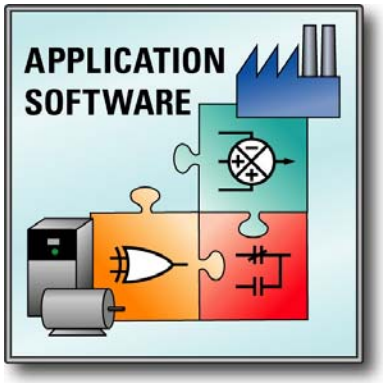
Drive Application Software
Application Set



Application Set Title	Position_Follower
Drive Product	PowerFlex 700S Phase II Drive
File Name for (AS)	AS_PF700SII_PositionFollower_A.dno
Date – Firmware Rev.	02/06/06 - 3.01

Attention: This document and related file(s) are designed to supplement configuration of the listed drive product. The information provided does not replace the drive products user manual and is intended for qualified personnel only.

Description: Position Follower application is designed to "follow" the encoder feedback from another machine section (the master). The speed loop and position loop in the PowerFlex 700S Phase II drive will be used to synchronize the speed feedback encoder of the follower PowerFlex 700S Phase II motor to the master encoder. Electronic gearing can be used to match the speed of (2) machines with different gear ratios or electronic gearing can be used to make the (2) machines run at different ratios.

Limitations: Requires that the motors connected to each PowerFlex 700S Phase II drive have encoders.

Options & Notes: Default configuration for 3Wire Control through digital inputs may be changed to 2Wire Control or for operation through 20-COMM-x module.
After downloading *.dno file, the Fdbk Config, Pwr Circuit Diag, Direction Test, Motor Tests, and Inertia Measure parts of the Startup routine should be performed to auto-tune the Power Flex 700S Phase II drive to the motor.

Drive Input & Output Connections:

Inputs	Function	Description
DI 1		
DI 2		
DI 3	Jog 1	This Option is used to independently jog the PF700S2 follower drive when the drive is not operating as a position follower.
DI 4	Start	
DI 5	Stop	
DI 6		
AI 1		
AI 2		
AI 3		
Encoder 0 (Primary)	PF700S Motor Feedback	Encoder Input 0 is wired to the quadrature encoder on the PF700S2 Motor.
Encoder 1 (Secondary)	Feedback from master	Encoder Input 1 is wired to the master encoder.
Outputs	Function	Description
DO 1		
DO 2		
DO 3		
AO 1		
AO 2		
AO 3		

Parameter Configurations
Changes from Default Parameter Settings

Par	Name	Value	Link	Description
10	Speed Ref 1		241	Speed feedback from Encdr1 (master) becomes the speed reference for the PF700S2.
11	Speed Ref 1 Div	1		Sets the ratio between the master speed reference and the PF700S2 follower. See notes on setting the gear ratio and speed reference scaling.
29	Jog Speed 1	100 RPM		Set per application requirements.
32	Accel Time	1		Set to a value lower than the master accel. Or the speed ramp can be disabled by turning on bit 0 in p151 [Logic Command].
33	Decel Time	1		Set to a value lower than the master decel. Or the speed ramp can be disabled by turning on bit 0 in p151 [Logic Command].
90	Spd Ref BW	10		Gain of the speed loop. The speed loop should be tuned before enabling the position loop. See the PowerFlex700S Reference Manual for tuning tips.
151	Logic Command	b13 = 1		Bit 13 can be turned on/off to enable/disable the position loop.
232	Encoder0 PPR	1024		Sets the PPR for the motor feedback.
242	Encoder1 PPR	1024		Sets the PPR for the master encoder.
740	Position Control	b01 = 1		Bit 1 is turned on to send the output of the position loop to the speed regulator.
742	Posit Ref Sel	1 - AuxPosit Ref		Sets the position loop to follow the auxiliary position reference, which in this case will be Encdr1 Position.
743	[Aux Posit Ref]		240	Encoder counts from Encdr1 (master) becomes the position reference.
745	PositRef EGR Mul	1		This sets the multiplier for the position reference electronic gear ratio. The settable range is -2000000 to +2000000. See notes on setting the gear ratio.
746	PositRef EGR Div	1		This sets the divider for the position reference electronic gear ratio. The settable range is 1 to 2000000. See notes on setting the gear ratio.
753	Posit Offset 1	0		This sets a position offset to advance or retard the follower if necessary. This can be set from a PLC and can be a positive or negative value. See notes on using the position offset.
755	Posit Offset Spd	175 RPM		Sets the speed change used to advance or retard the follower when a value set in p753. Set per application requirements.
768	PositRef P Gain	4		Sets the proportional gain for the position loop. Set to 1/5th (20%) of p90 after tuning the speed loop.
775	Xreg Spd LoLim	-175 RPM		Sets the negative speed limit for the output of the position loop. This should be set the same as the negative value of p755 [Position Offset Spd].
776	Xreg Spd HiLim	175 RPM		Sets the positive speed limit for the output of the position loop. This should be set the same as the positive value of p755 [Position Offset Spd].
146	FW Task Time Sel	2		Selects the regulators task time.

Par	Name	Value	Link	Description
147	FW Functions En	b16=1		Enables the position regulator task.
827	DigIn3 Sel	Jog 1		Used to independently jog the PF700S2 follower when the position loop is disabled.
828	DigIn4 Sel	Start		Start input for 3Wire Control.
829	DigIn5 Sel	Normal Stop		Stop input for 3Wire Control.

Notes for jogging the PowerFlex 700S Phase II follower drive independently:
Command Jog 1 through a digital input or communication network. During a jog command, the position loop output of the drive is automatically disabled.

Notes for controlling the position offset of the PowerFlex 700S Phase II follower drive:
Before advancing or retarding the PowerFlex 700S Phase II follower drive, p755 [Posit Offset Spd] needs to be set to a value other than 0. p755 [Posit Offset Spd] sets the speed **change** used to advance or retard the follower. During the advance or retard operation it is added or subtracted from the speed the follower already running. p755 [Posit Offset Spd] is in units of RPM's, and is set to a positive value. p755 [Posit Offset Spd] can remain set throughout the PowerFlex 700S Phase II follower's normal operation.

To advance or retard the follower using a relative position offset, perform the following steps:

1. Add a value (in counts) in p753 [Posit Offset 1]. For a positive move, add a positive value to p753. For a negative move, add a negative value to p753. For example, with a 1024 ppr encoder, add a value of 4096 to p753 to advance the follower forward one motor revolution.

To advance or retard the follower using an absolute position offset, perform the following steps:

1. Set a value (in counts) in p753 [Posit Offset 1]. For a positive move, set p753 to a positive value. For a negative move, set p753 to a negative value. For example, with a 1024 ppr encoder, set p753 to a value of 4096 to move forward one motor revolution.
2. After the move is done, set p740 [Position Control], bit 5 "X Offset Ref" to a 1.
3. Set p753 [Posit Offset 1] = 0.
4. Set p740 [Position Control], bit 5 "X Offset Ref" to a 0.

p753 [Posit Offset 1] and p740 [Position Control] can be controlled over a communication network.

Notes for setting the gear ratio and speed reference scaling on the PowerFlex 700S Phase II follower drive:
Example 1: Matching speeds of (2) machines with different gear ratios
In this example, the encoders are mounted on the motors. There is a gear box between each motor and each machine. Each gear box has a different ratio. We want to match the speeds on the output side of the gear box (machine side). Here is the given information:

PPR_m =1024 PPR
PPR_f = 1024 PPR
$Input_m$: $Output_m$ = 533:236
$Input_m$: $Output_f$ = 533:163

where
PPR_m = the PPR of the master encoder
PPR_f = the PPR of the follower encoder
$Input_m$: $Output_m$ = gear ratio of master gear box (number of input teeth : number of output teeth)
$Input_f$: $Output_f$ = gear ratio for follower gear box (number of input teeth : number of output teeth)

$$\frac{p745}{p746} = \frac{PPR_f \bullet Input_f \bullet Output_m}{PPR_m \bullet Input_m \bullet Output_f} = \frac{1024 \bullet 533 \bullet 236}{1024 \bullet 533 \bullet 163}$$

Solving for the lowest common denominator, the 1024s on the top and bottom cancel out and the 533s on the top and bottom cancel out so that:

$$\frac{p745}{p746} = \frac{236}{163}$$

Therefore, P745 [PositRef EGR Mul] = 236 and P745 [PositRef EGR Div] = 163. This will close the position loop and the angular velocities of the master and follower will match exactly.

p11 [Speed Ref 1 Div] is calculated:

$$p11 = \frac{Input_m \bullet Output_f}{Input_f \bullet Output_m} = \frac{533 \bullet 163}{533 \bullet 236} = 0.6907$$

Notice that the encoder PPRs should not be included in the calculation for P11.
This parameter is rounded to the 4th decimal place. The position loop gear ratios will be exact, so that the master and follower track exactly.

Example 2: Using electronic gearing to make the (2) machines run at different ratios.
In this example the encoders are mounted on the motors. The motors are directly coupled to the load and we want the follower to run at 4 times the speed of the master.

PPR_m =1024 PPR
PPR_f = 1024 PPR
$Ratio_f$: $Ratio_m$ = 4:1

where;
PPR_m = the PPR of the master encoder
PPR_f = the PPR of the follower encoder
$Ratio_f$: $Ratio_m$ = the desired ratio between the follower speed and the master speed

$$\frac{p745}{p746} = \frac{PPR_f \bullet Ratio_f}{PPR_m \bullet Ratio_m} = \frac{1024 \bullet 4}{1024 \bullet 1}$$

Solving for the lowest common denominator, the 1024's on the top and bottom cancel out so that:

$$\frac{p745}{p746} = \frac{4}{1}$$

Therefore, P745 [PositRef EGR Mul] = 4 and P745 [PositRef EGR Div] = 1. This will set up the position loop of the follower to move 4 counts for every 1 count of the master.

p11 [Speed Ref 1 Div] is calculated:

$$p11 = \frac{Ratio_m}{Ratio_f} = \frac{1}{4} = 0.25$$

Notice that the encoder PPR's should not be included in the calculation for p11.
This parameter is rounded to the 4th decimal place. The position loop gear ratios will be exact, so that the follower tracks at 4 times the master's speed.