Allen-Bradley

PowerFlex® 700S

Adjustable Frequency AC Drive

Phase II Control

Reference Manual

Rockwell Automation

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. "*Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls*" (Publication SGI-1.1 available from your local Rockwell Automation Sales Office or online at **http://www.ab.com/manuals/gi**) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will the Rockwell Automation be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, the Rockwell Automation cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual we use notes to make you aware of safety considerations.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.

Attentions help you:

- identify a hazard
- avoid the hazard
- recognize the consequences

Important: Identifies information that is especially important for successful application and understanding of the product.

Shock Hazard labels may be located on or inside the drive to alert people that dangerous voltage may be present.

This information summarizes the changes to the *PowerFlex® 700S Adjustable Frequency AC Drive - Phase II Control Reference Manual*, publication PFLEX-RM003 since the last release.

Manual Updates

Change	See Page...
Initial release of this publication	

Notes:

Specifications & Dimensions

PowerFlex 700S Specifications

Category	Specification											
		Frames 1-6 (690V Drive frames 5 & 6 only)						Frames 9 & up				
Protection		200-208V Drive	240V Drive	380/400V Drive	480V Drive	600V Drive	690V Drive	380/400V Drive	480V Drive	500V Drive	600V Drive	690V Drive
	AC Input Overvoltage Trip:	247VAC	285VAC	475VAC	570VAC	690VAC	863VAC	475VAC	570V AC	611V AC	690VAC	863VAC
	Bus Overvoltage Trip:	350VDC	405VDC	675VDC	810VDC	1013VDC	1164VDC	675VDC	810VDC	810VDC	1013VDC	1164VDC
	Bus Undervoltage Trip:	Adjustable						Adjustable				
	Nominal Bus Voltage:	281VDC	324VDC	540VDC	648VDC	810VDC	931VDC	540VDC	648VDC	645VDC	810VDC	931VDC
	Heat Sink Thermistor:	Monitored by microprocessor overtemp trip						Monitored by microprocessor overtemp trip				
	Drive Overcurrent Trip Software Current Limit: Hardware Current Limit: Instantaneous Current Limit:	 Calculated value, 105% of motor rated to 200% of drive rated 105% of 3 sec. rating (158%-210%) 143% of 3 sec rating (215%-287%)						 Calculated value, 105% of motor rated to 200% of drive rated 360% of rated Heavy Duty current (typical) —				
	Line Transients:	Up to 6000 volts peak per IEEE C62.41-1991						up to 6000 volts peak per IEEE C62.41-1991				
	Control Logic Noise Immunity:	Showering arc transients up to 1500V peak						Showering arc transients up to 1500V peak				
	Power Ride-Thru:	15 milliseconds at full load						15 milliseconds at full load				
	Logic Control Ride-Thru	0.25 sec., drive not running						0.25 seconds, drive not running				
	Ground Fault Trip:	Phase-to-ground on drive output						Phase-to-ground on drive output				
	Short Circuit Trip:	Phase-to-phase on drive output						Phase-to-phase on drive output				
Agency Certification		The drive is designed to meet applicable requirements of the following codes/standards: IEC 61800-2 Adjustable speed electrical power drive systems - General requirements IEC 61800-5-1 Adjustable speed electrical power drive systems - Safety requirements NFPA 70 – US National Electric Code NEMA 250 – Enclosures for Electrical Equipment						The drive is designed to meet applicable requirements of the following codes/standards: IEC 61800-2 Adjustable speed electrical power drive systems - General requirements IEC 61800-5-1 Adjustable speed electrical power drive systems - Safety requirements NFPA 70 - US National Electrical Code				
	C UL US	UL and cUL Listed to UL508C and CAN/CSA - 22.2 No. 14-95						UL and cUL Listed to UL508C and CAN/CSA - 22.2 No. 14-95				
	CE	Marked for all applicable European Directives EMC Directive (89/336/EEC) Emissions EN 61800-3 Adjustable Speed electrical power drive systems Part 3 Immunity EN 61800-3 Second Environment, Restricted Distribution Low Voltage Directive (73/23/EEC) EN 50178 Electronic Equipment for use in Power Installations						Marked for all applicable European Directives EMC Directive (89/336/EEC) Emissions EN 61800-3 Adjustable Speed electrical power drive systems Part 3 Low Voltage Directive (73/23/EEC) EN 50178 Electronic Equipment for use in Power Installations				
	TÜV Rheinland Product Safety / EMC Production inspected TÜV TUV Rheinland of North America EN 50178 TÜV Rheinland Bauart geprüft Functional Safety FS Type approved	TUV Rheinland (applies to frames 1 - 6, 200/400V, and frames 5 & 6, 690V only) TUV Functional Safety Report only for frames 1 - 4, 600V (no FS mark on the label)						TUV functional safety report only (no FS mark on the label)				

Category	Specification	Frames 1-6 (690V Drive frames 5 & 6 only)	Frames 9 & up
Environment	Altitude:	1000 m (3300 ft.) max. without derating	1000 m (3300 ft) max. without derating
	Surrounding Air Temperature without Derating: Open Type: IP20: NEMA Type 1: IP56, NEMA Type 4X:	0 to 50° C (32 to 122° F) 0 to 50° C (32 to 122° F) 0 to 40° C (32 to 104 ° F) 0 to 40 ° C (32 to 104 ° F) **Note**: Frames 9 & 10 are rated 0 to 40 ° C (32 to 104 ° F) surrounding air.	Based on drive rating, refer to Drive Frame chapters
	Storage Temperature (all const.):	-40 to 70° C (-40 to 158° F)	–40 to 70 degrees C (–40 to 158 degrees F)
	Relative Humidity:	5 to 95% non-condensing	5 to 95% non-condensing
	Shock:	10G peak for 11 ms duration (+/- 1.0 ms)	15G peak for 11ms duration (±1.0 ms)
	Vibration:	0.152 mm (0.006 in.) displacement, 1G peak, 5.5 Hz	2 mm (0.0787 in.) displacement, 1G peak EN50178 / EN60068-2-6
	Atmosphere	**Important:** Drive **must not** be installed in an area where the ambient atmosphere contains volatile or corrosive gas, vapors or dust. If the drive is not going to be installed for a period of time, it must be stored in an area where it will not be exposed to a corrosive atmosphere.	**Important:** Drive **must not** be installed in an area where the ambient atmosphere contains volatile or corrosive gas, vapors or dust. If the drive is not going to be installed for a period of time, it must be stored in an area where it will not be exposed to a corrosive atmosphere.
Electrical	AC Input Voltage Tolerance:	See Input Voltage Range/Tolerance on page 1-5 for Full Power and Operating Range	See Input Voltage Range/Tolerance on page 1-5 for Full Power and Operating Range
	Frequency Tolerance:	47-63 Hz	47-63 Hz.
	Input Phases:	Three-phase input provides full rating for all drives. Single-phase operation provides 50% of rated current.	Three-phase input provides full rating for all drives. Single-phase operation provides 50% of rated current.
	DC Input Voltage Tolerance	+/- 10% of Nominal Bus Voltage (above)	+/- 10% of Nominal Bus Voltage (above)
	Displacement Power Factor:	0.98 across speed range	0.98 across speed range
	Efficiency:	97.5% at rated amps, nominal line volts.	97.5% at rated amps, nominal line volts.
	Max. Short Circuit Current Rating: Using Recommended Fuse or Circuit Breaker Type	Maximum short circuit current rating to match specified fuse/ circuit breaker capability. ≤ 200,000 Amps	≤ 200,000 Amps
	Maximum Drive to Motor Power Ratio	The drive to motor rating cannot exceed a 2:1 ratio	The drive to motor rating cannot exceed a 2:1 ratio
Control	Method Induction Motor: Brushless Motor:	Sine coded PWM with programmable carrier frequency, Indirect Self-Organized, Field-Oriented Control, Current-regulated. Ratings apply to all drives. Refer to Derating Guidelines on page 1-8. The drive can be supplied as 6 pulse or 12 pulse in a configured package.	Sine coded PWM with programmable carrier frequency, Indirect Self-Organized, Field-Oriented Control, Current-regulated. Ratings apply to all drives. Refer to Refer to Derating Guidelines on page 1-8. The drive can be supplied as 6 pulse or 12 pulse in a configured package.
	Carrier Frequency	Drive rating: 4 kHz Settings: 2, 4, 6, 8, 10 kHz (6 kHz is for V/Hz operation only)	Drive rating: 2 kHz Settings: 2, 4, 6, 8, 10 kHz (6 kHz is for V/Hz operation only)
	Output Voltage Range:	0 to rated motor voltage	0 to rated motor voltage
	Output Frequency Range:	0 – 400 Hz	0 – 400 Hz
	Speed Control	Speed regulation - without feedback 0.1% of base speed across 120:1 speed range 120:1 operating range 50 rad/sec bandwidth	Speed regulation - without feedback 0.1% of base speed across 120:1 speed range 120:1 operating range 50 rad/sec bandwidth
		Speed regulation - with feedback 0.001% of base speed across 120:1 speed range 1000:1 operating range 744 rad/sec bandwidth	Speed regulation - with feedback 0.001% of base speed across 120:1 speed range 1000:1 operating range 300 rad/sec bandwidth
	Torque Regulation	Torque Regulation - without feedback +/-5%, 600 rad/sec bandwidth	Torque Regulation - without feedback +/-10%, 600 rad/sec bandwidth
		Torque Regulation - with feedback +/-2%, 2500 rad/sec bandwidth	Torque Regulation - with feedback +/-5%, 2500 rad/sec bandwidth
	Selectable Motor Control:	Field Oriented Control with and without a feedback device and permanent magnet motor control	Field Oriented Control with and without a feedback device and permanent magnet motor control
	Stop Modes:	Multiple programmable stop modes including – Ramp, Coast and Current Limit	Multiple programmable stop modes including – Ramp, Coast and Current Limit
	Accel/Decel	Independently programmable accel and decel times adjustable from 0 to 6553.5 in 0.1 second increments.	Independently programmable accel and decel times adjustable from 0 to 6553.5 in 0.1 second increments.
	S-Curve Time	Adjustable from 0.5 to 4.0 seconds	Adjustable from 0.5 to 4.0 seconds
	Intermittent Overload:	110% Overload capability for up to 1 minute 150% Overload capability for up to 3 seconds	110% Overload capability for up to 1 minute 150% Overload capability for up to 3 seconds
	Current Limit Capability:	Independent Motoring and Regenerative Power Limits programmable to 800% of rated output current	Independent Motoring and Regenerative Power Limits programmable to 800% of rated output current
	Electronic Motor Overload Protection	Class 10 protection with speed sensitive response. Investigated by U.L. to comply with N.E.C. Article 430 U.L. File E59272, volume 12.	Class 10 protection with speed sensitive response. Investigated by U.L. to comply with N.E.C. Article 430 U.L. File E59272, volume 12.

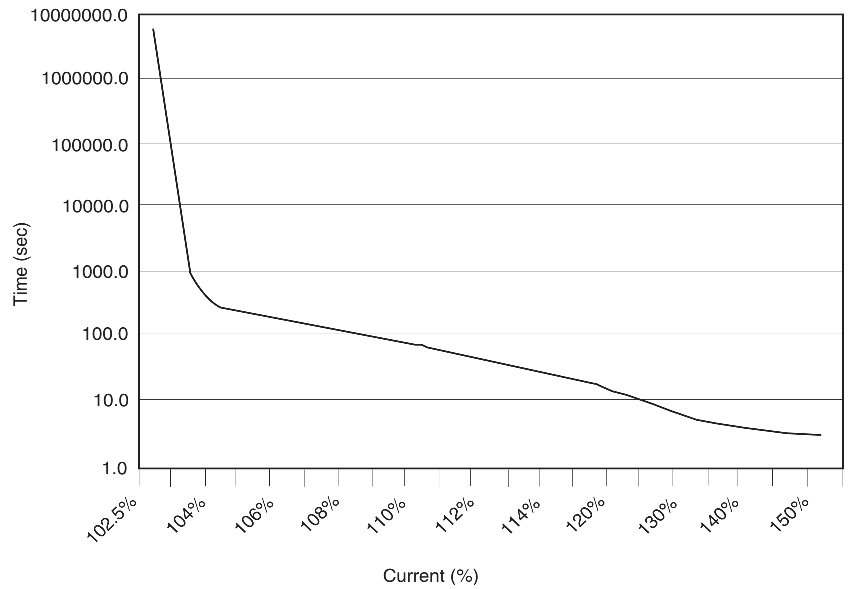
Category	Specification		
		Frames 1-6 (690V Drive frames 5 & 6 only)	**Frames 9 & up**
Feedback	Encoder Inputs (2):	Dual Channel Plus Marker, Isolated with differential transmitter Output (Line Drive) Incremental, Dual Channel Quadrature type	Dual Channel Plus Marker, Isolated with differential transmitter Output (Line Drive) Incremental, Dual Channel Quadrature type
	Encoder Voltage Supply:	5V DC or 12 V DC 320 mA/channel 5V DC requires an external power supply. 12 V DC minimum high state voltage of 7V DC, maximum low state voltage of 0.4V DC	5V DC or 12 V DC 320 mA/channel 5V DC requires an external power supply. 12 V DC minimum high state voltage of 7V DC, maximum low state voltage of 0.4V DC
	Maximum Input Frequency:	400 kHz	400 kHz
	Stegmann Option:		
	Encoder Voltage Supply:	11.5V DC @ 130 mA	11.5V DC @ 130 mA
	Hi-Resolution Feedback:	Sine/Cosine 1V P-P Offset 2.5	Sine/Cosine 1V P-P Offset 2.5
	Maximum Cable Length:	182 m (600 ft.)	182 m (600 ft.)
	RS-485 Interface:	Hi-Resolution Feedback Option card obtains the following information via the Hiperface RS-485 interface shortly after power-up: Address, Command Number, Mode, Number of turns, Number of Sine/Cos cycles, Checksum	Hi-Resolution Feedback Option card obtains the following information via the Hiperface RS-485 interface shortly after power-up: Address, Command Number, Mode, Number of turns, Number of Sine/Cos cycles, Checksum
	Customer-I/O Plug (P1) - Hi Res:	Allen-Bradley PN: S94262912 Weidmuller PN: BL3.50/90/12BK	Allen-Bradley PN: S94262912 Weidmuller PN: BL3.50/90/12BK
	Resolver Option:		
	Excitation Frequency:	2400 Hz	2400 Hz
	Excitation Voltage:	4.25-26 Vrms	4.25-26 Vrms
	Operating Frequency Range:	1 - 10 kHz	1 - 10 kHz
	Resolver Feedback Voltage:	2V ± 300 mV	2V ± 300 mV
	Maximum Cable Length:	304.8 meters (1000 ft.)	304.8 meters (1000 ft.)
DriveLogix	User Available MemoryBase:	1.5 megabytes	1.5 megabytes
	Battery:	1756-BA1 (Allen-Bradley PN 94194801) 0.59g lithium	1756-BA1 (Allen-Bradley PN 94194801) 0.59g lithium
	Serial Cable:	1761-CBLPM02 to 1761-NET-AIC 1761-CBLPA00 to 1761-NET-AIC 1756-CP3 directly to controller 1747-CP3 directly to controller category 3 (2)	1761-CBLPM02 to 1761-NET-AIC 1761-CBLPA00 to 1761-NET-AIC 1756-CP3 directly to controller 1747-CP3 directly to controller category 3 (2)
	Compact I/O Connection:	Up to (16) modules	Up to (16) modules
	Cable:	20D-DL2-CL3 20D-DL2-CR3	20D-DL2-CL3 20D-DL2-CR3

Input/Output Ratings

Each PowerFlex drive has heavy duty torque capabilities. The drive ratings can be found on pages 2-42 - 2-50. Also see Drive Overload on page 2-27.

The drive's IT protection dictates overload cap's amount and duty cycle. Ratings are in the tables listed below. Table 1.A shows expected times.

Table 1.A IT Curve



Current	Time On(s)	Time Off(s)	Duty Cycle
150%	3.0	57	5.0%
145	3.4	58	5.6
140	3.9	59	6.3
135	4.7	61	7.1
130	5.7	63	8.3
125	7.4	66	10.0
120	10.4	73	12.5
115	17.8	89	16.7
114	20.7	95	17.9
113	24.7	104	19.2
112	3038	117	20.8
111	40.7	138	22.7
110	60.0	180	25.0
109	69.2	180	27.8
108	81.8	180	31.2
107	100.0	180	35.7
106	128.6	180	41.7
105	180.0	180	50.0
104	300.0	180	62.5
103	900.0	180	83.3
102.5	4500000	180	100.0

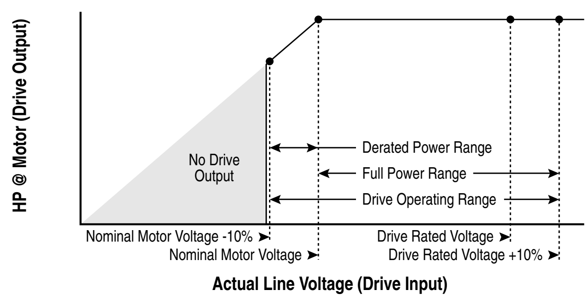
Time On(s) =time at current level shown
Time Off(s) = time at 100% current
Duty Cycle % =time on/(time on +time of)*100

The On Times/Off Times ratio is fixed. If only 1/2 of the listed time is spent at a given level, the only 1/2 the off time is necessary to reset the cycle.

Input Voltage Range/ Tolerance

Drive Rating	Nominal Line Voltage	Nominal Motor Voltage	Drive Full Power Range	Drive Operating Range
200-240	200	200†	200-264	180-264
	208	208	208-264	
	240	230	230-264	
380-400	380	380†	380-528	342-528
	400	400	400-528	
	480	460	460-528	
500-600 *(Frames 1-4 Only)*	600	575†	575-660	432-660
500-690 *(Frames 5 & 6 Only)*	600	575†	575-660	475-759
	690	690	690-759	475-759

Drive Full Power Range =	Nominal Motor Voltage to Drive Rated Voltage + 10%. Rated current is available across the entire Drive Full Power Range
Drive Operating Range =	Lowest† Nominal Motor Voltage - 10% to Drive Rated Voltage + 10%. Drive Output is linearly derated when Actual Line Voltage is less than the Nominal Motor Voltage

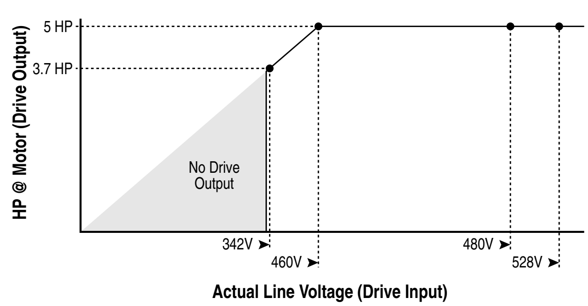


Example:

Calculate the maximum power of a 5 HP, 460V motor connected to a 480V rated drive supplied with 342V Actual Line Voltage input.

- Actual Line Voltage / Nominal Motor Voltage = 74.3%
- 74.3% × 5 HP = 3.7 HP
- 74.3% × 60 Hz = 44.6 Hz

At 342V Actual Line Voltage, the maximum power the 5 HP, 460V motor can produce is
3.7 HP at 44.6 Hz.



Heat Dissipation

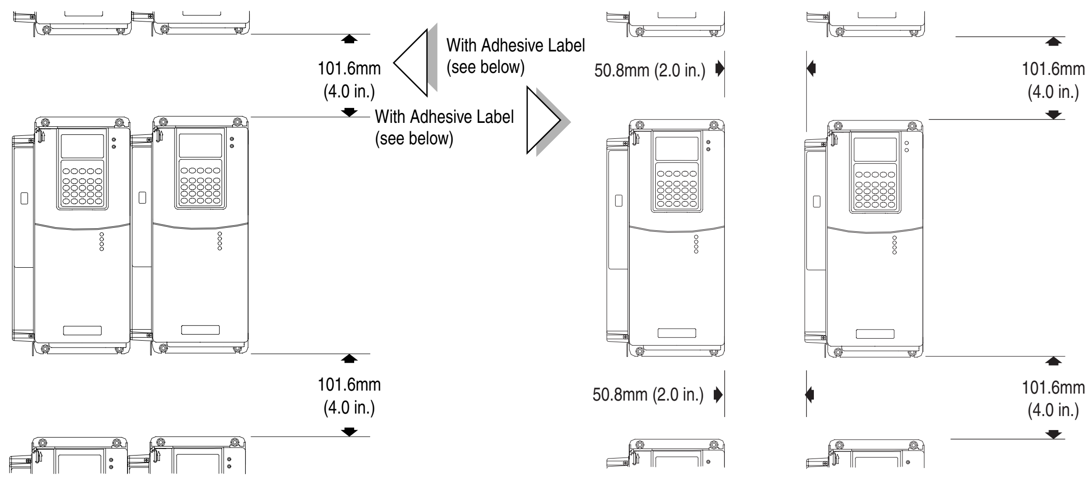
See Watts Loss on page 2-160

Mounting

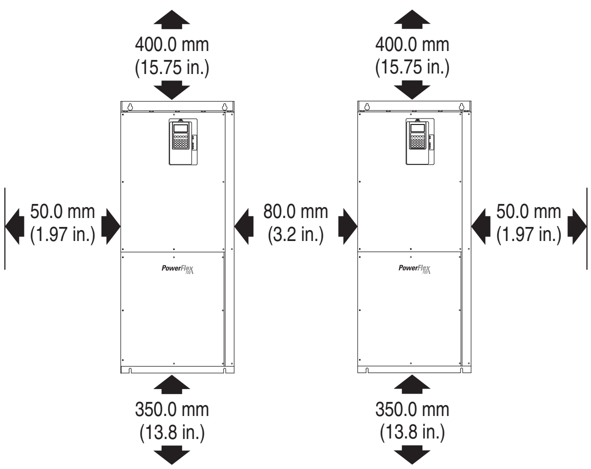
Mounting Clearances

Figure 1.1 Minimum Mounting Clearance Requirements

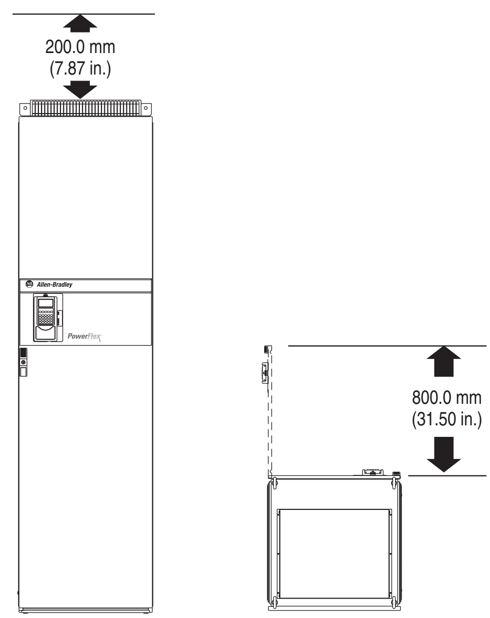
Frames 1-6



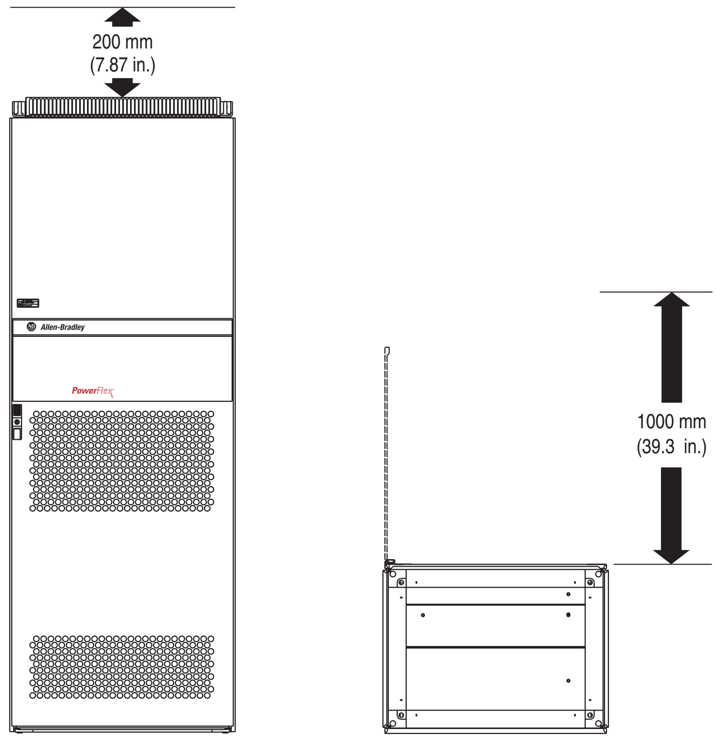
Frame 9



Frame 10



Frame 11



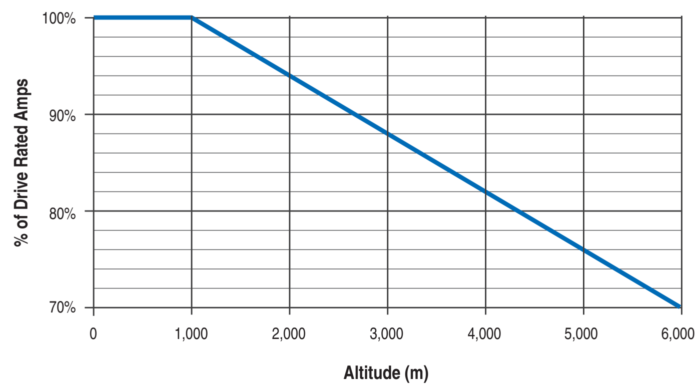
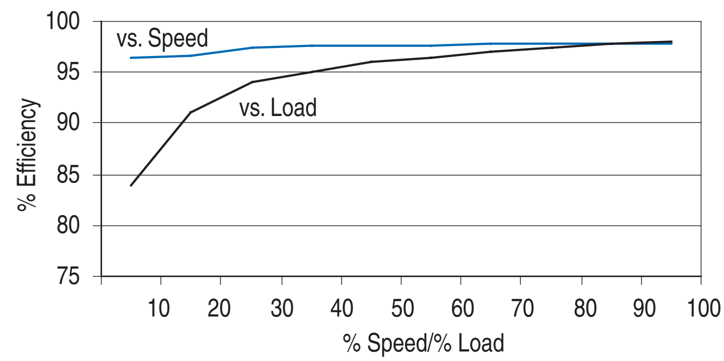
Acceptable Surrounding Air Temperature & Required Actions

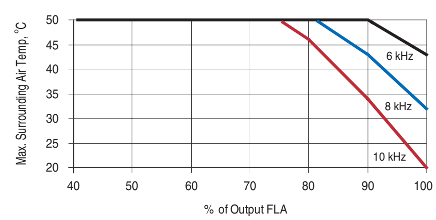
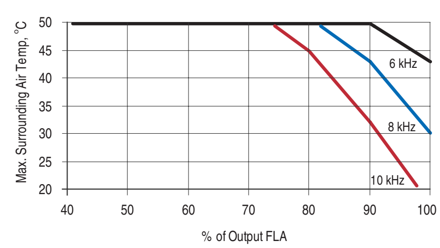
Drive Catalog Number	Required Action . . .		
	IP 20, NEMA Type 1	**IP 20, NEMA Type Open**	**IP 00, NEMA Type Open**
	No Action Required	Remove Top Label	Remove Top Label & Vent Plate
All *Except* 20DC072	40° C	50° C	NA
20DC072	40° C	45° C	50° C
Frame Size	**Normal Duty**		**Heavy Duty**
Frame 9 & up	0 to 40 degrees C (32 to 104 degrees F)		0 to 40 degrees C (32 to 104 degrees F)

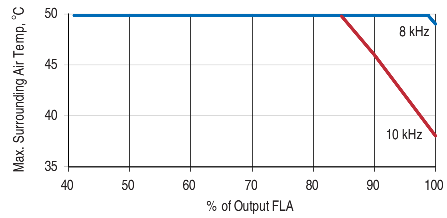
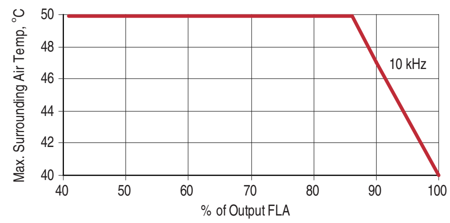
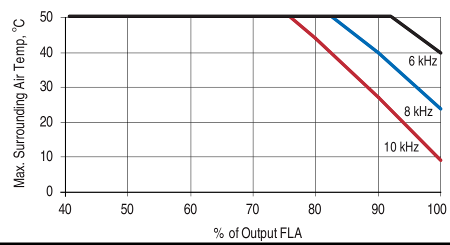
Removing the adhesive label from the drive changes the NEMA enclosure rating from Type 1 to Open type.

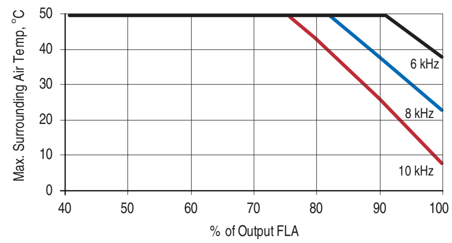
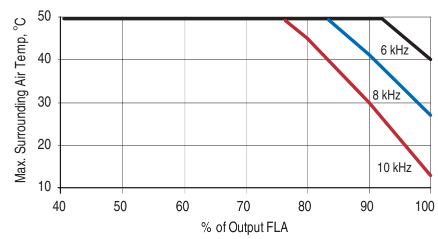
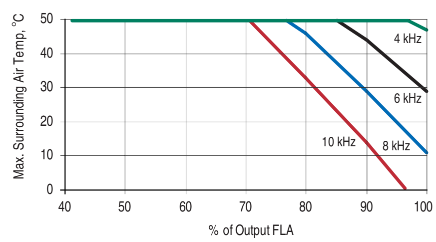
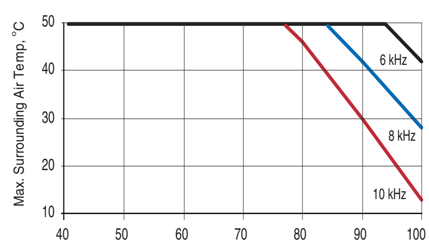
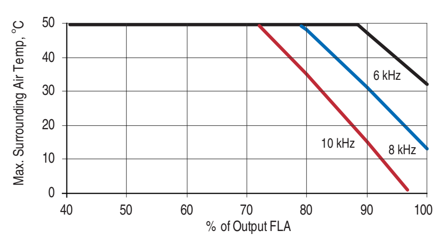
Derating Guidelines

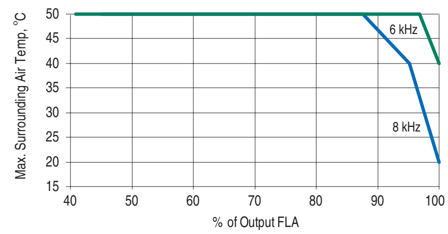
PowerFlex 700S Altitude and Efficiency

<table>
<tr><th>Frame</th><th>Type</th><th>Derate</th></tr>
<tr><td>All</td><td>Altitude</td><td>
</td></tr>
<tr><td></td><td>Efficiency (typical)</td><td>
</td></tr>
</table>

<table>
<tr><th>Frame</th><th>Voltage</th><th>ND Rating</th><th>Enclosure</th><th>Frequency(1)</th><th>Derate</th></tr>
<tr><td>1</td><td>400V</td><td>11 kW</td><td>• Open
• NEMA Type1
• IP20</td><td>2-6kHz</td><td>
</td></tr>
<tr><td></td><td>460V</td><td>15 HP</td><td>• Open
• NEMA Type1
• IP20</td><td>2-6kHz</td><td>
</td></tr>
</table>

Frame	Voltage	ND Rating	Enclosure	Frequency[1]	Derate
2	400V	15kW	• Open • NEMA Type1 • IP20		
	460V	20 HP	• Open • NEMA Type1 • IP20	10 kHz	
		25 HP	• Open • NEMA Type1 • IP20	6-10 kHz	

Frame	Voltage	ND Rating	Enclosure	Frequency(1)	Derate
3	400V	18.5 kW	• Open • NEMA Type1 • IP20	6-10 kHz	
	400V	22 kW	• Open • NEMA Type1 • IP20	2-10 kHz	None
		30 kW	• Open • NEMA Type1 • IP20	6-10 kHz	
		37 kW	• Open • NEMA Type1 • IP20	4-10 kHz	
	460 V	30 HP	• Open • NEMA Type1 • IP20	2-10 kHz	None
		40 HP	• Open • NEMA Type1 • IP20	6-10 kHz	
		50 HP	• Open • NEMA Type1 • IP20	6-10 kHz	

Frame	Voltage	ND Rating	Enclosure	Frequency(1)	Derate
5	400V	55 kW	• Open • NEMA Type1 • IP20	2-8 kHz	None
	460V	75 HP	• Open • NEMA Type1 • IP20	2-8 kHz	None
		100 HP	• Open • NEMA Type1 • IP20	4 kHz	None
				6-8 kHz	

(1) Consult the factory for further derate information at other frequencies.

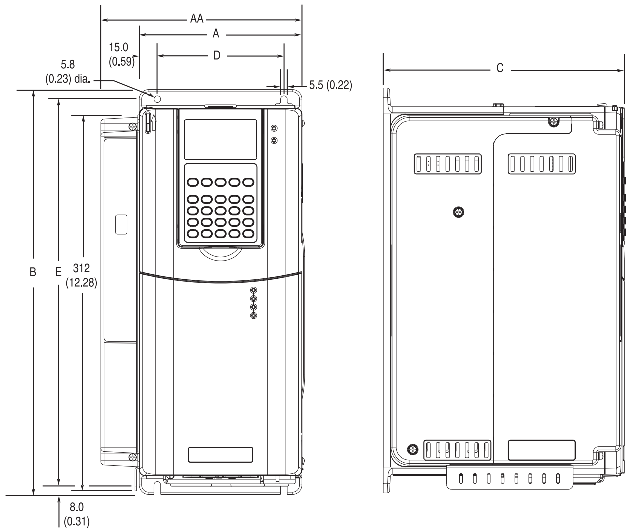
Dimensions

The following are the PowerFlex 700S dimensions.

Table 1.B PowerFlex 700S Frames

Frame	AC Input												DC Input			
	208		240		380 . . . 400V		480V		600V		690V		540V		650V	
	ND HP	HD HP	ND HP	HD HP	ND kW	HD kW	ND HP	HD HP	ND HP	HD HP	ND HP	HD HP	ND HP	HD HP	ND HP	HD HP
1	0.75	0.37	1.0	0.75	0.75	0.55	1	0.75	1	0.5	–	–	–	–	–	–
	1.5	0.75	2.0	1.5	1.5	0.75	2	1.5	2	1	–	–	–	–	–	–
	2.2	1.5	3.0	2.0	2.2	1.5	3	2	3	2	–	–	–	–	–	–
	4.0	2.2	5.0	3.0	4.0	2.2	5	3	5	3	–	–	–	–	–	–
	5.5	4.0	7.5	5.0	5.5	4.0	7.5	5	7.5	5	–	–	–	–	–	–
	–	–	–	–	7.5	5.5	10	7.5	10	7.5	–	–	–	–	–	–
	–	–	–	–	11	7.5	15	10	15	10	–	–	–	–	–	–
2	7.5	5.5	10	7.5	15	11	20	15	20	15	–	–	–	–	–	–
	–	–			18.5	15	25	20	25	20	–	–	–	–	–	–
3	11	7.5	15	10	22	18.5	30	25	30	25	–	–	–	–	–	–
	15	11	20	15	30	22	40	30	40	30	–	–	–	–	–	–
	–	–	–	–	37	30	50	40	50	40	–	–	–	–	–	–
4	18.5	15	25	20	45	37	60	50	60	50	–	–	–	–	–	–
	22	18.5	30	25	–	–	–	–	–	–			–	–	–	–
5	30	22	40	30	55	45	75	60	75	60	75	55	55	45	75	60
	30	30	50	40	55	45	100	75	100	75	90	75	55	45	75	60
	–	–	–	–	–	–	–	–	–	–	–	–	55	45	100	75
	–	–	–	–	–	–	–	–	–	–	–	–	55	45	100	75
6	45	37	60	50	90	75	125	100	125	100	110	90	90	75	125	100
	55	45	75	60	110	90	150	125	150	125	132	110	90	75	125	100
	66	55	100	75	132	110	200	150	–	–	–	–	110	90	150	125
	–	–	–	–	–	–	–	–	–	–	–	–	110	90	150	125
	–	–	–	–	–	–	–	–	–	–	–	–	132	110	200	150
	–	–	–	–	–	–	–	–	–	–	–	–	132	110	200	150
9	–	–	–	–	132	110	200	150	150	150	160	132	132	110	200	150
	–	–	–	–	160	132	250	200	200	150	200	160	160	132	250	200
10	–	–	–	–	200	160	300	250	250	200	250	200	200	160	300	250
	–	–	–	–	250	200	350	300	350	250	315	250	250	200	350	300
	–	–	–	–	250	250	450	350	400	350	355	315	250	250	450	350
	–	–	–	–	–	–	–	–	450	350	400	315	–	–	–	–
11	–	–	–	–	315	250	500	450	450	400	450	355	315	250	500	450
	–	–	–	–	355	315	500	500	500	450	500	450	355	315	500	500
	–	–	–	–	400	355	600	500	600	500	560	500	400	355	600	500
12	–	–	–	–	450	400	700	600	700	650	630	560	450	400	700	600
	–	–	–	–	500	450	800	700	800	700	710	630	500	450	800	700
	–	–	–	–	560	500	900	800	900	700	800	630	560	500	900	800

Figure 1.2 PowerFlex 700S Phase II Frame 1-3 *(Frame 1 Shown)*

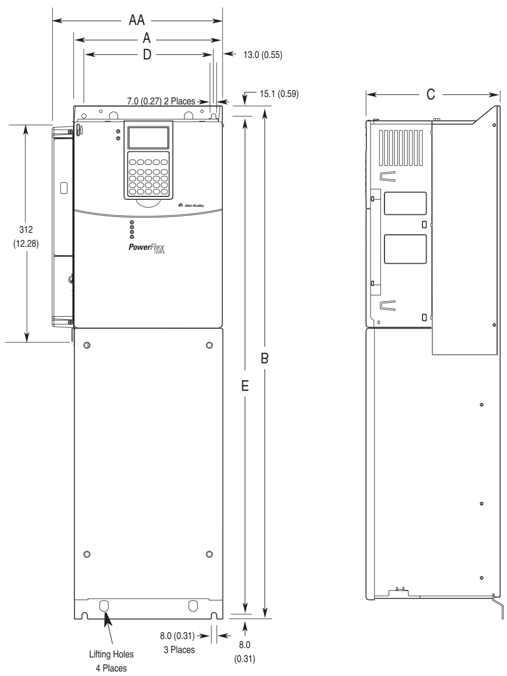


Dimensions are in millimeters and (inches)

Frame(1)	*Slim* A *(Max.)*	*Expanded* AA	B	C *(Max.)*	D	E	Weight (2) *kg (lbs.)*	
							Drive	**Drive & Packaging**
1	135.0 (5.31)	166.9 (6.57)	336.0 (13.23)	200.0 (7.87)	105.0 (4.13)	320.0 (12.60)	7.03 (15.5)	9.98 (22)
2	222.0 (8.74)	253.9 (9.99)	342.5 (13.48)	200.0 (7.87)	192.0 (7.56)	320.0 (12.60)	12.52 (27.6)	15.20 (33.5)
3	222.0 (8.74)	253.9 (9.99)	517.5 (20.37)	200.0 (7.87)	192.0 (7.56)	500.0 (19.69)	18.55 (40.9)	22.68 (50)

(1) Refer to Table 1.B for frame information.
(2) Weights include HIM, DriveLogix controller with ControlNet daughtercard, Hi-Resolution Encoder Option, and 20-COMM-C ControlNet adapter.

Figure 1.3 PowerFlex 700S Frame 4

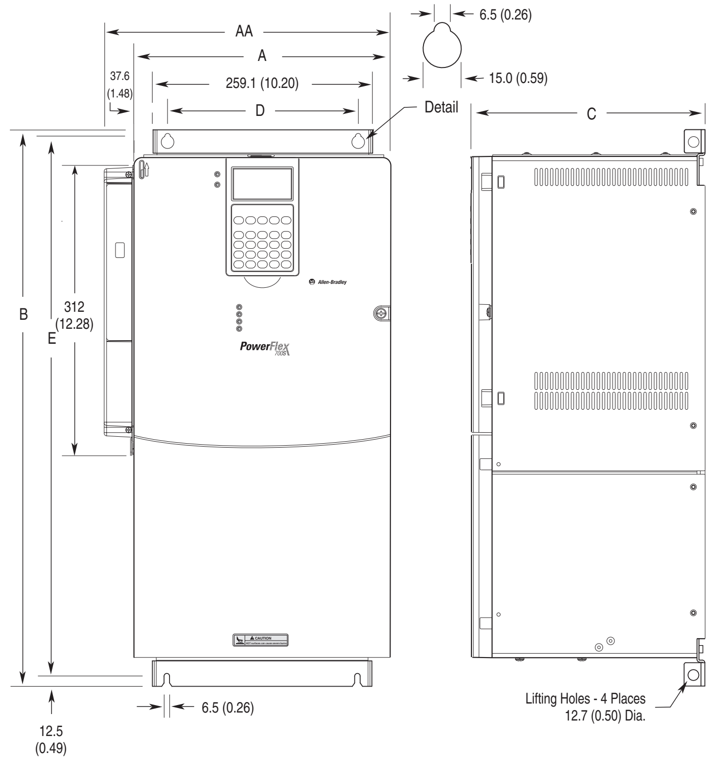


Dimensions are in millimeters and (inches)

Frame ❶	**Slim** A *(Max.)*	**Expanded** AA	B	C *(Max.)*	D	E	Weight ❷ *kg (lbs.)*	
							Drive	**Drive & Packaging**
4	220.0 (8.66)	251.9 (9.92)	758.8 (29.87)	201.7 (7.94)	192.0 (7.56)	738.2 (29.06)	24.49 (54.0)	29.03 (64.0)

❶ Refer to Table 1.B for frame information.
❷ Weights include HIM, DriveLogix controller with ControlNet daughtercard, Hi-Resolution Encoder Option, and 20-COMM-C ControlNet adapter.

Figure 1.4 PowerFlex 700S Frame 5

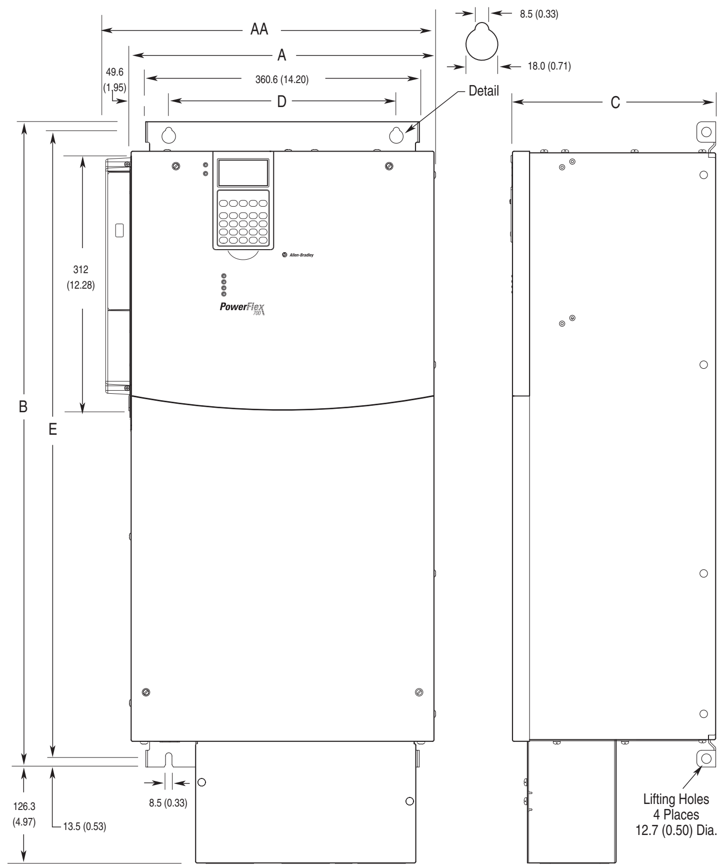


Dimensions are in millimeters and (inches)

Frame [1]	*Slim* **A** *(Max.)*	*Expanded* **AA**	**B**	**C** *(Max.)*	**D**	**E**	**Weight** [2] *kg (lbs.)* **Drive**	**Drive & Packaging**
5	308.0 (12.16)	339.9 (13.38)	644.5 (25.37) [3]	275.4 (10.84)	225.0 (8.86)	625.0 (24.61)	37.19 (82.0)	42.18 (93.0)

(1) Refer to Table 1.B for frame information.
(2) Weights include HIM, DriveLogix controller with ControlNet daughtercard, Hi-Resolution Encoder Option, and 20-COMM-C ControlNet adapter.
(3) When using the supplied junction box (100 HP drives Only), add an additional 45.1 mm (1.78 in.) to this dimension.

Figure 1.5 PowerFlex 700S Frame 6

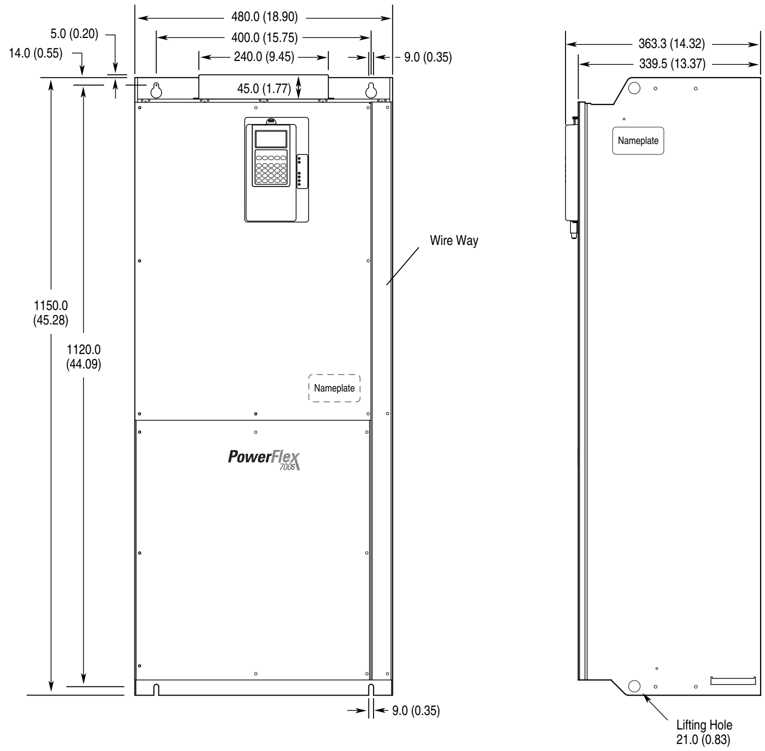


Dimensions are in millimeters and (inches)

Frame (1)	Slim A *(Max.)*	Expanded AA	B	C *(Max.)*	D	E	Approx. Weight (2) *kg (lbs.)* Drive
6	403.9 (15.90)	435.8 (17.16)	850.0 (33.46)	275.5 (10.85)	300.0 (11.81)	825.0 (32.48)	71.44 (157.5) (3)

(1) Refer to Table 1.B for frame information.
(2) Weights include HIM and Standard I/O.
(3) Add an additional 3.6 kg (8.00 lbs.) for 200 HP drives.

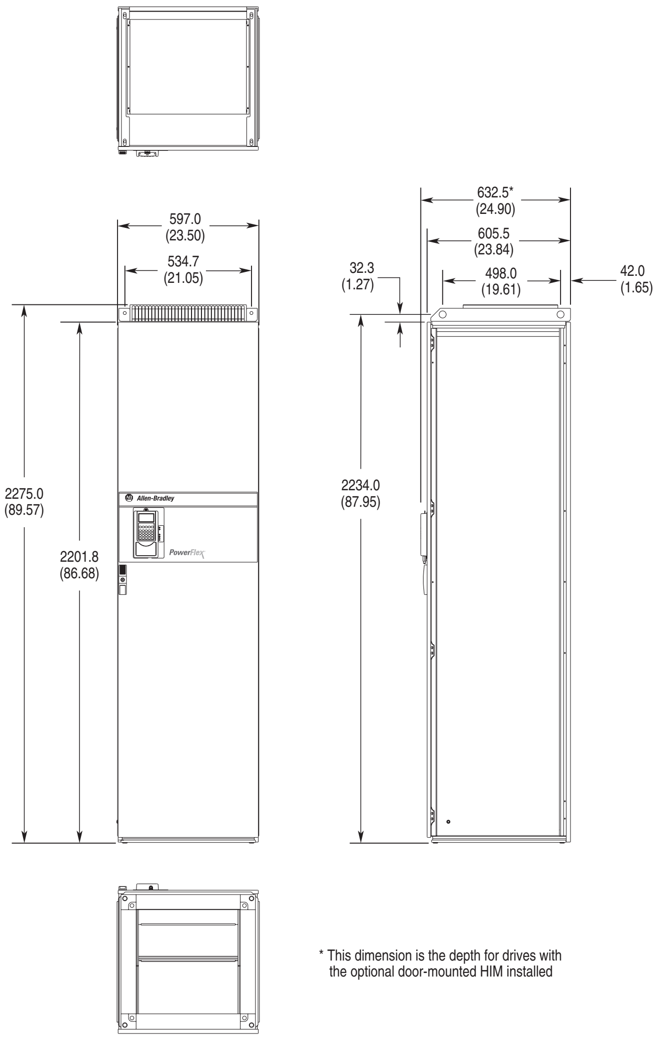
Figure 1.6 PowerFlex 700S Frame 9



Dimensions are in millimeters and (inches)

Frame	A	B	C	D	E	Weight *kg (lbs.)*	
						Drive	**Drive & Packaging**
9	480 (18.9)	1150 (45.28)	339 (13.37)	400 (15.75)	1120 (44.09)	142.9 (315)	176.9 (390)

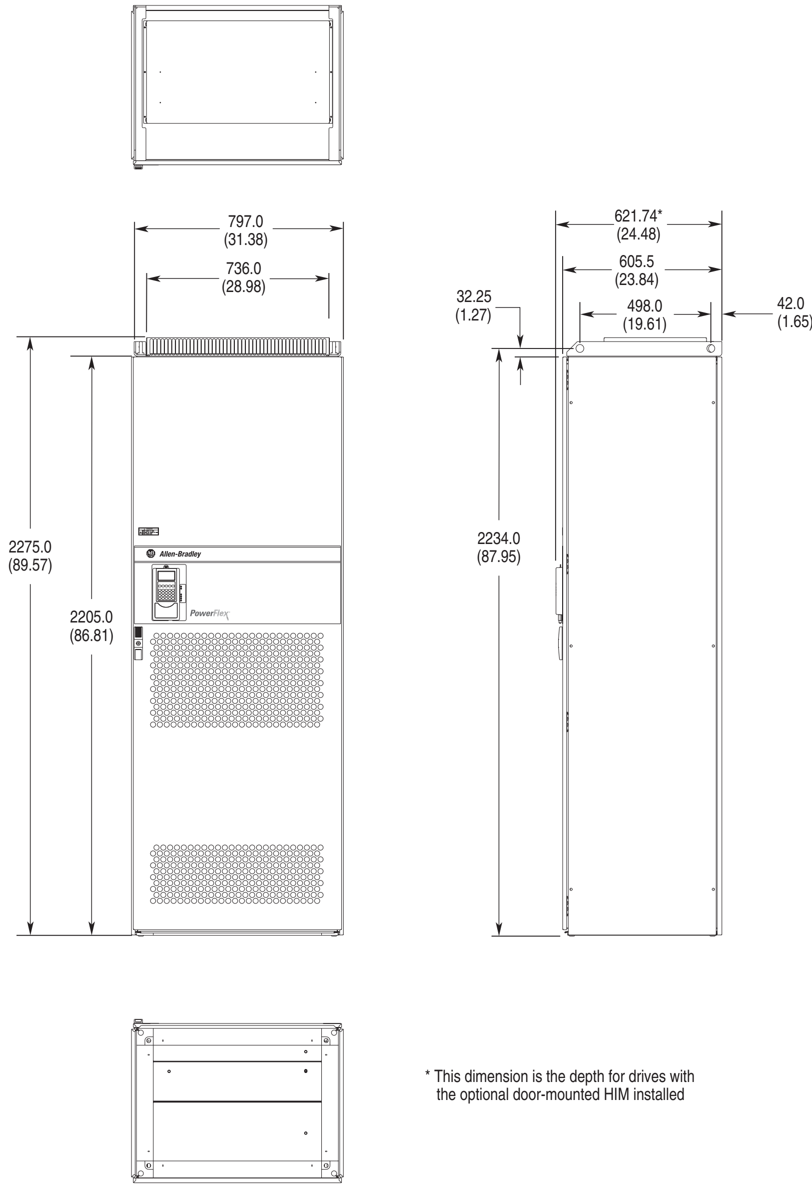
Figure 1.7 PowerFlex 700S Frame 10



Dimensions are in millimeters and (inches)

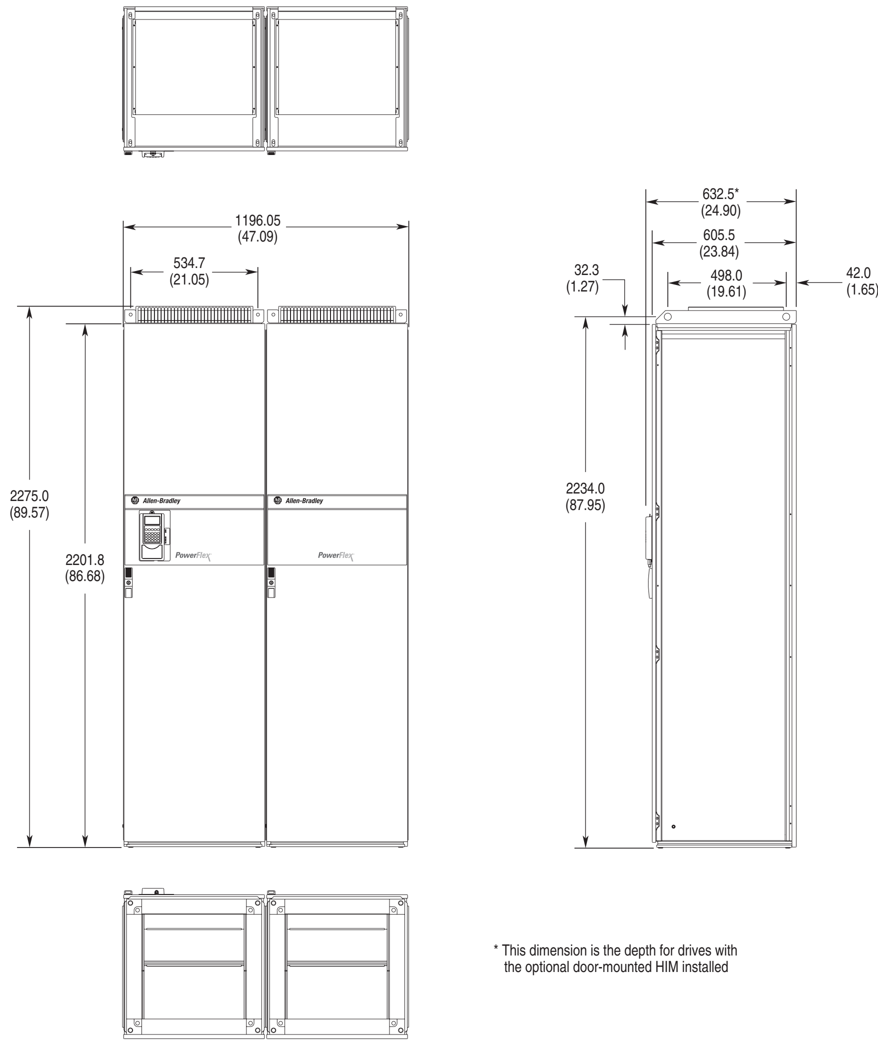
						Weight *kg (lbs.)*	
Frame	**A**	**B**	**C**	**D**	**E**	**Drive**	**Drive & Packaging**
10	597 (23.5)	2275 (89.57)	632.45 (24.9)	534 (21.05)	2201.75 (86.68)	432 (950)	447 (985)

Figure 1.8 PowerFlex 700S Frame 11



Dimensions are in millimeters and (inches)

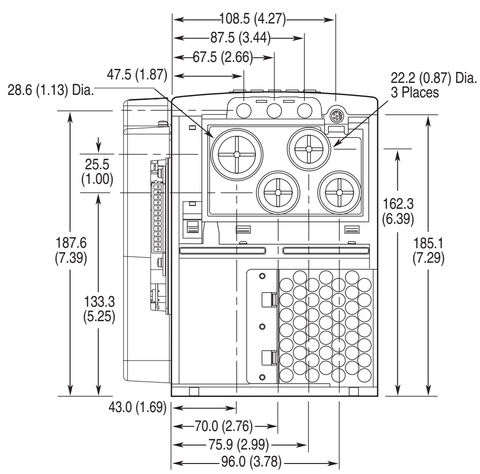
Figure 1.9 PowerFlex 700S Frame 12



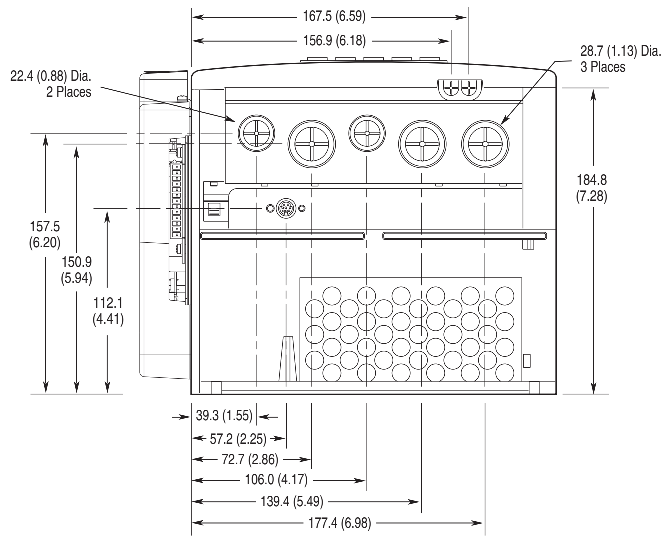
Dimensions are in millimeters and (inches)

Figure 1.10 PowerFlex 700S Bottom View Dimensions, Frame 1, 2, & 3

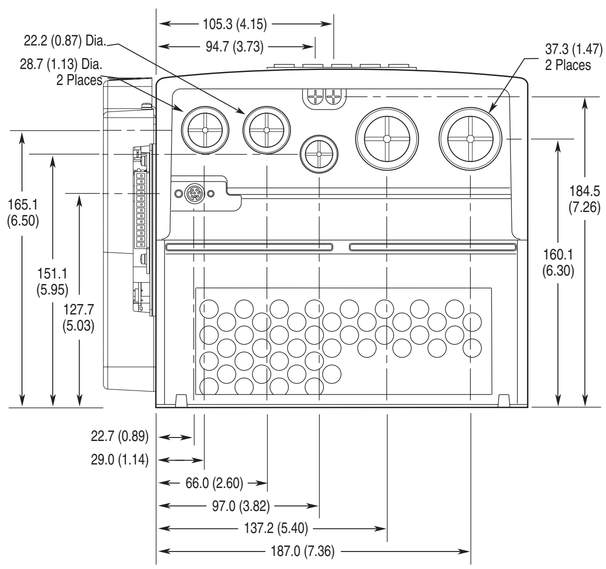
Frame 1



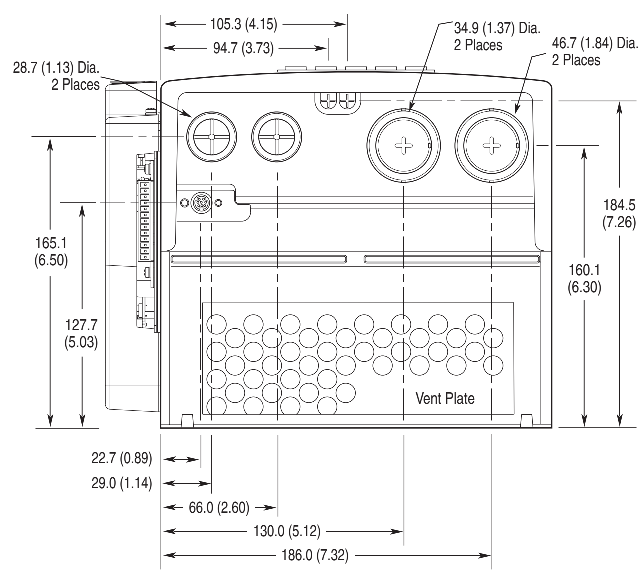
Frame 2



Frame 3 - All Drives, except 50 HP, 480V

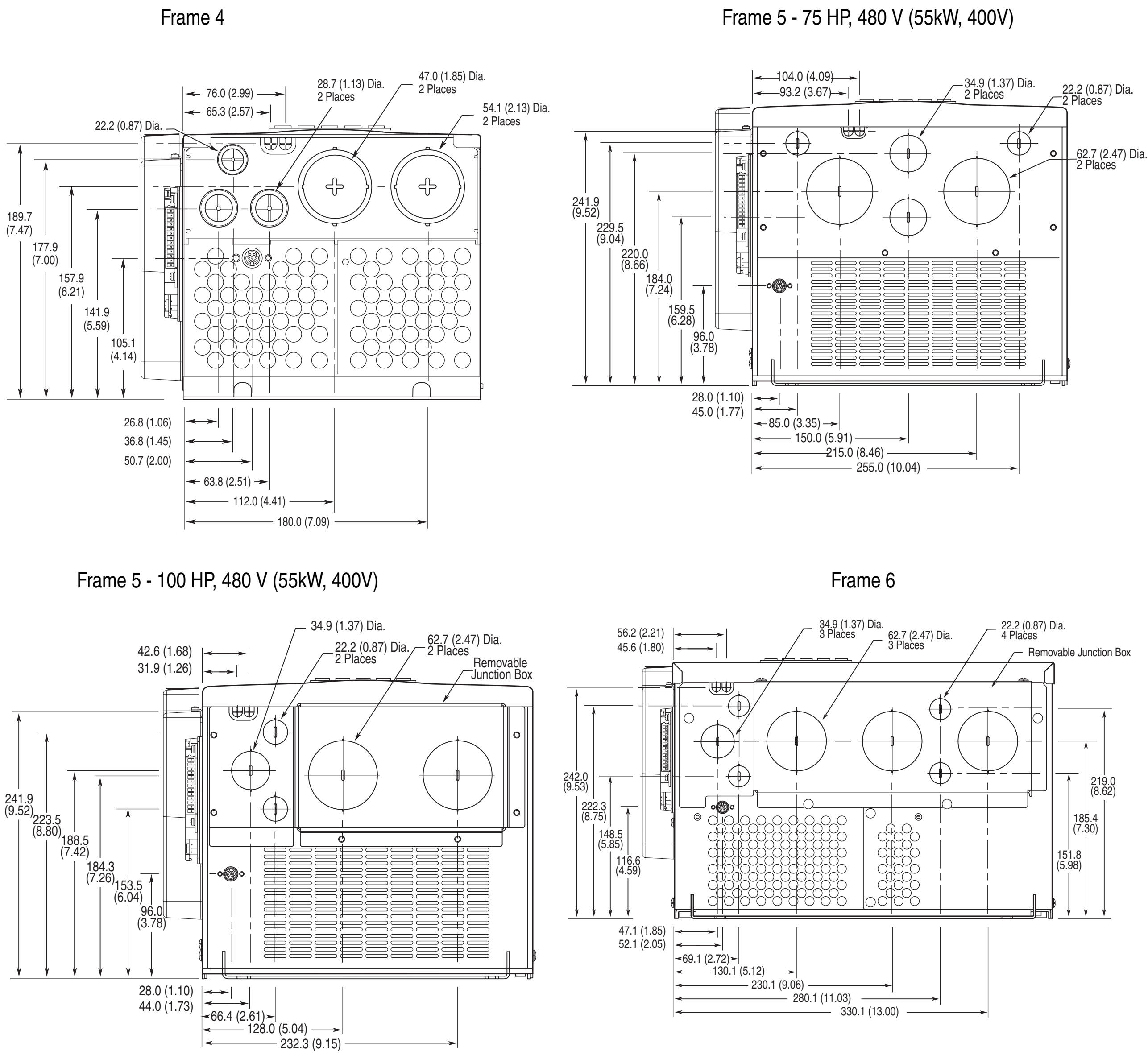


Frame 3 - 50 HP, 4800V Normal Duty Drive



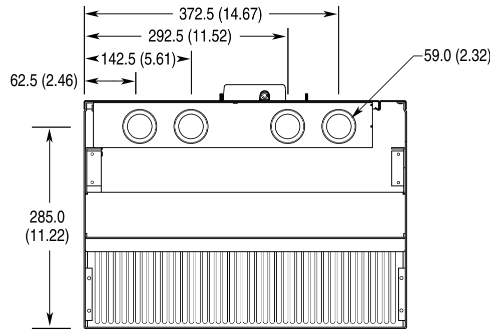
Dimensions are in millimeters and (inches)

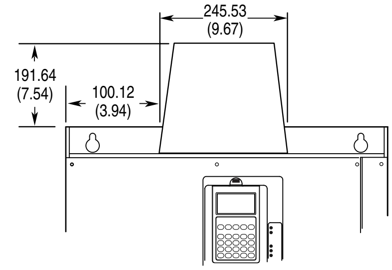
Figure 1.11 PowerFlex 700S Bottom View Dimensions, Frame 4, 5 & 6



Dimensions are in millimeters and (inches)

Figure 1.12 PowerFlex 700S Bottom View Dimensions, Frame 9





Detail A
Brake Option Top Hat

Dimensions are in millimeters and (inches)

Notes:

Detailed Drive Operation

This chapter explains PowerFlex 700S drive functions in detail. Explanations are organized in alphabetically by topic. Refer to the Table of Contents for a listing of topics in this chapter.

ATTENTION: Only **qualified personnel** familiar with the PowerFlex 700S Drive and associated machinery should plan or implement the installation, start-up and subsequent maintenance of the system. Failure to comply may result in personal injury and/or equipment damage. Refer to Chapter 2 - "Start-Up" of the *PowerFlex 700S High Performance AC Drive Phase I Control - User Manual*, publication 20D-UM001 for detailed information.

Accel Time

Parameter 32 [Accel Time] sets the rate at which the drive ramps up its output after a Start command or during an increase in desired speed (speed change).

The rate established is the result of the programmed Accel Time and the programmed motor rated speed, parameter 4 [Motor NP RPM].

$$\frac{\text{Parameter 4 [Motor NP RPM]}}{\text{Parameter 32 [Accel Time]}} = \text{Accel Rate}$$

Times are adjustable in 0.0001 second increments from 0.01 to 6553.5 seconds.

Alarms

Alarms indicate conditions within the drive that could affect drive operation or application operation. Alarms are selected during commissioning of the drive. Examples of alarms include: Encoder loss, communication loss or other exceptions within the drive.

Configuration:

Parameters 365 [Fdbk LsCnfg Pri] through 399 [Position ErrCnfg] program the response of the drive to various conditions. Responses include Ignore, Alarm, Fault Coast Stop, Fault Ramp Stop, and Fault Current Limit Stop.

Parameters 326 [Alarm Status 1] through 328 [Alarm Status 3] indicated any alarms that are active.

Application Example:

Parameter 376 [Inv Ol Pend Cnfg] is set to a value of 1 "Alarm". This configures the drive to set the alarm bit, parameter 326 [Alarm Status 1] bit 15 "Inv OL Pend" when the inverter overload pending event occurs. This alarm will allow the drive to continue running. The user can make the decision as to what action to take in relation to the alarm.

Analog Inputs

Analog Input Specifications

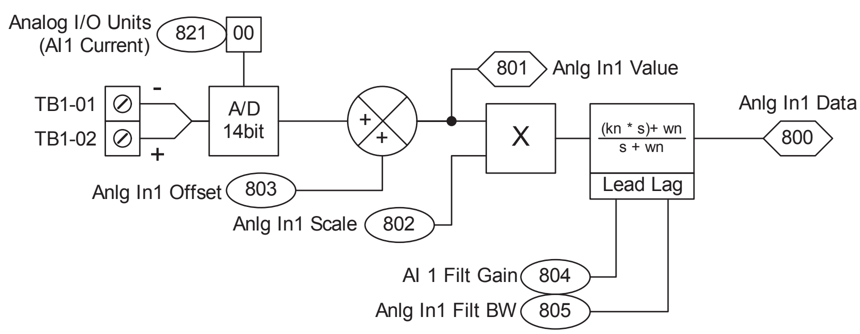
There are 3 analog inputs. Inputs 1 and 2 are differential, configurable for +/-10V or 0-20mA via dip switches. The A/D (analog to digital) converter is 13 bit plus the sign bit. Input 3 is 0-10V only, 10 bits and no sign bit.

Analog Input Configuration

Once the Analog Input is converted via the A/D converter, parameters 803, 809, and 815 [Anlg Inx Offset] can be applied. [Anlg Inx Offset] has a range of +/-20V. Parameters 801, 807, and 813 [Anlg Inx Value] is the sum of the A/D output and [Anlg Inx Offset]. [Anlg Inx Value] is displayed as either voltage or mA, depending on the dip switch setting of the input.

Parameters 802, 808, and 814 [Anlg Inx Scale] scales [Anlg Inx Value] to the range of parameters 800, 806, and 812 [Anlg Inx Data]. A destination parameter, such as a speed reference can then be linked to [Anlg Inx Data].

Parameters 801, 810, and 816 [Al x Filt Gain] and parameters 805, 811, and 817 [Anlg Inx Filt BW] are used to filter the analog input data. Refer to Lead-Lag Filter on page 2-33 for detailed information.



Configuration Example:

This example illustrates how to setup a speed reference to follow a 0-10V analog input signal and null out a small amount of offset from the A/D converter on the analog input.

Parameter 803 [Anlg In1 Offset] = -0.0144V

Parameter 802 [Anlg In1 Scale] = 0.1 per 1V

Parameter 804 [Anlg In1 Filt Gain] = 1

Parameter 805 [Anlg In1Filt BW] = 0

Parameter 10 [Spd Ref 1] is linked to parameter 800 [Anlg In1 Data]

With a desired parameter 801 [Anlg In1 Value] of 0V, the drive was reading 0.0144V. To null out analog input 1, parameter 803 [Anlg In1 Offset] was set to -0.0144V.

Parameter 10 [Spd Ref 1] is a per unit parameter, meaning that a value of 1 equates to base motor RPM. Therefore, to scale parameter 800 [Anlg In1 Data] to give us a value from 0 to 1 for a 0-10V signal, parameter 802 [Anlg In1 Scale] was set to 0.1 per 1V.

Parameter 805 [Anlg In1 Filt BW] was set to 0 so that no filtering took place on analog input 1.

Analog Outputs

Analog Output Specifications

There are two analog outputs, differential, configurable for +/-10V or 0-20mA via dip switches. The D/A (digital to analog) converter is 11 bits plus the sign bit.

Analog Output Configuration

Parameter 831 and 838 [Anlg Outx Sel] can be programmed to the following selections:

0	'User Select'	10	'PI Feedback'	20	"Scl Spd Fdbk"
1	"Output Freq"	11	"PI Error"	21	"RampedSpdRef"
2	"Sel Spd Ref"	12	"PI Output"	22	"Spd Reg Out"
3	"Output Curr"	13	"Reserved"	23	"MOP Level"
4	"Trq Cur (Iq)"	14	"Reserved"	24	"Trend 1 DInt"
5	"% Motor Flux"	15	"Motor TrqRef"	25	"Trend 1 Real"
6	"Output Power"	16	"MtrTrqCurRef"	26	"Trend 2 DInt"
7	"Output Volts"	17	"Speed Ref"	27	"Trend 2 Real"
8	"DC Bus Volts"	18	"Speed Fdbk"		
9	"PI Reference"	19	"Torque Est"		

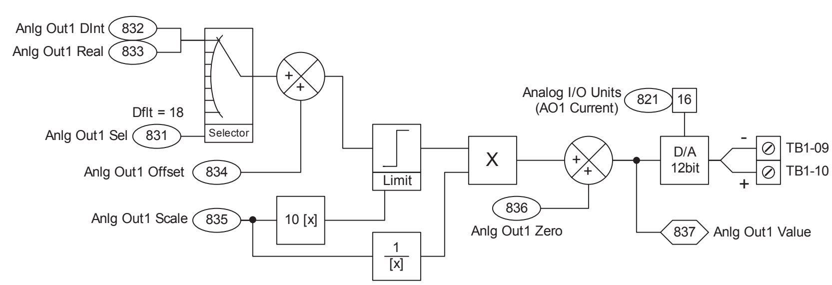
Additionally, the analog output can be user configured for some other value by setting [Analog Outx Sel] to 0 "User Select" and linking either parameter 832 or 839 [Anlg Outx DInt] to a DInt (double integer) parameter or linking parameter 833 or 840 [Anlg Outx Real] to a floating point (real) parameter.

Parameter 834 or 841 [Anlg Outx Offset] is added to [Anlg Outx Real] or [Anlg Outx DInt] before the scaling and limiting blocks.

The result of [Anlg Outx Offset] plus [Anlg Outx Real] or [Anlg Outx DInt] is limited by 10 times the value of parameter 835 or 842 [Anlg Outx Scale]. Then that limited value is divided by the value of [Anlg Outx Scale].

Parameter 836 or 843 [Anlg Outx Zero] is added after the scaling and limiting of the analog output value. [Anlg Outx Zero] can be used to null out any offset from the D/A converter.

Parameter 837 or 844 [Analog Outx Value] displays the voltage or current value for the analog output.



Example Configuration 1:

This configuration sends the motor torque current reference value to a 0-10V analog output signal.

- Parameter 831 [Analog Out1 Sel] = 15 "MotorTrqRef"
- Parameter 835 [Anlg Out1 Scale] = 0.1 per Volt

Motor torque is a per unit value where a value of 1 corresponds to 100% motor torque. Therefore, parameter 831 [Anlg Out1 Scale] is set to 0.1 per 1V so that when [Mtr Trq Ref] = 1p.u., the analog output = 1 / 0.1 = 10V.

Example Configuration 2:

This configuration sends parameter 763 [Position Actual] out to a 0-10V analog output signal.

- Parameter 831 [Analog Out1 Sel] = 0 "User Select"
- Parameter 832 [Anlg Out1 DInt] is linked to parameter 763 [Position Actual]
- Parameter 835 [Anlg Out1 Scale] is set to 214748364.7 per Volt

Parameter 763 [Position Actual] is an integer parameter with a range from -2147483648 to +2147483647. Parameter 832 [Anlg Out1 DInt] is used because parameter 763 [Position Actual] is an integer parameter.

Parameter 835 [Anlg Out1 Scale] is set to 214748364.7 per Volt so the analog output will give -10V when the position is -2147483647 and will give +10V when the position is +2147483647.

Auto/Manual

The Auto/Manual function on the LCD HIM is not functional on the PowerFlex® 700S.

Autotune

Auto-tuning is a procedure that involves running a group of tests on the motor/drive combination. Some tests are checking the drive hardware while others configure the drive parameters to maximize the performance of the attached motor.

The auto-tuning procedure can be done using the Start-Up menu of the HIM.

Autotune - Start-Up Menu

The Start-Up menu prompts the user for information and yes/no responses as required. The “Motor Control,” “Motor Data,” “Feedback Configuration,” “Power Circuit Test,” “Direction Test,” “Motor Tests,” and “Inertia Measure” submenus of the Start-Up Menu are all related to the autotuning of the drive/motor combination and will be covered in this section.

Motor Control

The Motor Control submenu asks you to select the motor control operating mode which sets the parameter 485 [Motor Ctrl Mode]. Choices are "FOC," "FOC2," "Pmag Motor," "V/Hz" and "Test."

- "FOC" selects field oriented control. This should be the selection for AC squirrel cage induction motors
- "FOC2" selects field oriented control and is only used for a specific type of AC induction motor with motor thermal feedback.
- For Phase II Control V2.003 or later, "V/Hz" selects volts per hertz control.
- "Pmag Motor" selects control for permanent magnet motors
- "Test" puts the drive in a test mode to perform the direction test. "Test" is automatically selected during the direction test portion of the Start-Up routine, and does not need to be set manually by the user.

Next, the motor control submenu asks you to select whether you have no dynamic braking, an internal resistor for dynamic braking, or an external resistor for dynamic braking. When no dynamic braking is selected, the bus regulator is turned on (see Bus Regulation/Braking of this manual for more details).

Motor Data

This submenu asks you to enter whether the motor power is in units of kW or HP. Then you are prompted to enter the motor nameplate data. Accurate motor nameplate data is important for tuning the drive to the connected motor.

Feedback Configuration

The Feedback Configuration submenu asks you to select the feedback device type. Possible selections are "Encoder 0," "Encoder 1," "Aux Speed," "Motor Sim," or "Option Card." Encoder 0 and Encoder 1 are for the encoders on the I/O board. When "Encoder 0" or "Encoder 1" are selected, you must also enter the encoder ppr. "Motor Sim" is to simulate a motor when there is no motor connected to the drive. "Option Card" can be chosen when either the Resolver or Hi-Resolution Encoder option cards are installed.

Power Circuit Test

This submenu allows you to perform a diagnostic check to check the output section of the drive power circuit for shorts or open circuits.

Direction Test

The direction test checks the actual direction relative to the commanded direction, and checks for proper encoder feedback. The test prompts you to answer if the motor direction is correct. When it is not, you can either power down and swap two of the motor leads, or change the drive's logic to change the motor direction. Then the test is performed again. The test then checks if the feedback is positive. When it is not, you can either power down and swap two of the encoder signals, or you can change the drive's logic to change the sign of the feedback. Then the test is performed again.

Motor Tests

This submenu performs the tests to measure the motor characteristics. These tests can be performed with the motor coupled or uncoupled to the load, but be aware that the motor will rotate during some of the tests.

For Field Oriented Control the following motor tests are performed:

Stator Resistance Test

This test identifies the motor stator resistance and stores the value into parameter 491 [StatorResistance]. The motor should not rotate during this test.

Stator Inductance Test

This test identifies the motor stator inductance and stores the value into parameter 490 [StatorInductance]. The motor should not rotate during this test.

Leakage Inductance Test

This test measures the inductance characteristics of the motor. A measurement of the motor inductance is required to determine references for the regulators that control torque. The motor should not rotate during this test. The test runs for approximately 1 minute and then stores the calculated value into parameter 492 [LeakInductance]. A typical value is between 15 and 25%.

Flux Current Test

This test is used to identify the value of motor flux current required to produce rated motor torque at rated current. When the flux test is performed, the motor will rotate. The drive accelerates the motor to the speed set in parameter 19 [Atune Spd Ref] (default is 85% of base speed) and then coasts for several seconds. This cycle may repeat several times, then decelerate to a low speed and shut off. This test stores the value for flux current in parameter 488 [Flux Current].

For Permanent Magnet Control the following motor tests are performed:

Stator Resistance Test

This test identifies the motor stator resistance and stores the value into parameter 522 [PM Stator Resist]. The motor should not rotate during this test.

Stator Inductance Test

This test identifies the motor stator inductance and stores the value into parameter 520 [PM Q Inductance]. The motor should not rotate during this test.

Encoder Offset

The absolute position sensor counter offset from the rotor flux center position for a Permanent Magnet (PM) motor. This value is determined by an automated measurement procedure, which uses parameter 505 [PM TestWait Time], 506 [PM Test Idc Ramp], 507 [PM Test FreqRamp], 508 [PM Test Freq Ref] and 509 [PM Test I Ref]. First, the Flux Producing (d-axis) current is applied to the stator, starting with 0A and with 0 Hz. Current increases with the ramp rate defined by parameter 506 [PM Test Idc Ramp] to the peak current value defined by parameter 509 [PM Test I Ref]. The current is continuously applied at this level for the time interval defined by parameter 505 [PM TestWait Time]. Then, the DC excitation position will be changed by 90 electrical degrees with the frequency defined by parameter 508 [PM Test Freq Ref] and the rate change of the frequency defined by parameter 507 [PM Test FreqRamp]. The 90 degree phase shifted d-axis current with the current value defined by parameter 509 [PM Test I Ref] is continuously applied for the time interval defined by parameter 505 [PM TestWait Time] The value of parameter 504 [PM AbsEnc Offst] is determined by value in the absolute position sensor counter.

Back EMF

Measures the permanent magnet motor CEMF (motor voltage feedback) coefficient and stores the value in parameter 523 [PM Mtr CEMF Coef].

Inertia Test

The final test is the inertia calculation. The motor and load (machine) inertia is used to set the bandwidth of the speed regulator. During the test the motor will accelerate to the speed set in parameter 74 [Atune Spd Ref] at a specified torque set by parameter 129 [Atune Torq Ref]. The test then calculates the time in seconds to accelerate the motor at rated torque from zero to base speed and stores that value in parameter 9 [Total Inertia].

Troubleshooting a "MC Commissn Fail" Fault during Autotune

The "MC Commissn Fail" fault occurs when either the Power Circuits diagnostics test fails or one of the Motor Tests fails. To find out specifically why the fault occurred, before clearing the fault, check the bits in the following parameters: 463 [MC Diag Error 1], 464 [MC Diag Error 2], or 465 [MC Diag Error 3].

Auxiliary Power Supply

You may use an auxiliary power supply to keep the 700S Control Assembly energized when input power is de-energized. This allows the Main Control Board, DriveLogix controller and any feedback option cards to continue operation. Refer to User Manual for connection information.

Frames 1-6

Refer to the Auxiliary Power Supply option (20-24V-AUX1) and publication PFLEX-IN010.

Frames 9 & Up

You must set Par 153 [Control Options]/bit 17 [Aux Pwr Sply] to enable this feature.

Auxiliary Power Supply Specifications

Voltage	Current (Min)	Power (Min)
24V DC ± 5%	3 A	75 W

Bus Regulation/Braking

Description

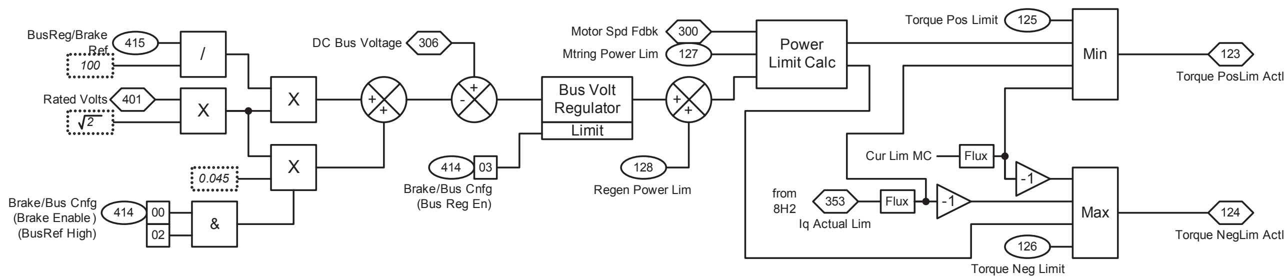
This information serves as a supplement to the *PowerFlex® 700S - Phase II Control User Manual*, publication 20D-UM006, addressing items specific to the PowerFlex 700S bus regulation and dynamic braking. Please refer to the User Manual for details on the 700S dynamic braking wiring and setup and the *PowerFlex® Dynamic Braking Resistor Calculator Selection Guide*, publication PFLEX-AT001, for application techniques on dynamic braking. These publications are available online at: http://literature.rockwellautomation.com/literature

Technical Information

The bus regulator limits the maximum bus voltage for systems that do not have (or have limited) braking or regenerative capabilities. The bus regulator limits the bus voltage by comparing the DC bus voltage feedback to a DC bus voltage reference. It then limits the regenerative power allowed back onto the DC bus to keep the DC bus voltage at or below the reference value and prevent a “DC Bus Overvolt” fault.

Dynamic braking uses a 7th insulated gate bipolar transistor (IGBT) and braking resistor to dissipate regenerative energy. The drive switches the 7th IGBT on and off to keep the DC bus voltage at or below the DC bus voltage reference. Parameters in the PowerFlex 700S specify whether the resistor is an internal or external resistor. For an external resistor, the user can program the resistor specifications for protection of the resistor. Only resistors specifically designed for pulse and high energy dissipation (dynamic braking) should be used.

The PowerFlex® 700S allows the user to select bus regulation, dynamic braking, or a combination of bus regulation and dynamic braking.



Bus Regulator/Braking Configuration

Parameter 414 [Bus/Brake Cnfg] determines the configuration of bus regulation and dynamic braking. Parameter 414 is broken down into the following bits:

Bit 0 - Brake Enable

When this bit is set to 1 it enables the internal brake transistor (7th IGBT). When this bit is set to 0 then the internal brake transistor is disabled.

Bit 1 - Brake Extern

When this bit is set to a 1 it configures the brake operation for an external resistor. Then the external brake resistor protection is based on the peak watts entered into parameter 416 [Brake PulseWatts] and the continuous watts entered in parameter 417 [Brake Watts]. When this bit is set to 0 it configures the brake operation for an internal resistor. Then 416 [Brake PulseWatts] and 417 [Brake Watts] are not active.

Bit 2 - BusRef Hi/Lo

This bit configures whether bus regulation or dynamic braking turns on first. This bit is only active when parameter 414 [Bus/Brake Cnfg] bits 0 and 3 are both set to 1. When this bit is set to 1 the dynamic braking turns on first (at the DC bus voltage set by parameter 415 [Bus Reg/Brake Ref]), and then the bus regulator turns on if the DC bus voltage continues to rise (at the DC bus voltage set by 415 [Bus Reg/Brake Ref] plus 4.5%). When this bit is set to 0 the bus regulator turns on first (at the DC bus voltage set by 415 [Bus Reg/Brake Ref]) and then the dynamic braking turns on when there are any transients above 415 [Bus Reg/Brake Ref].

Bit 3 - Bus Reg En

When this bit is set to 1, bus regulation is enabled. When this bit is set to 0, bus regulation is disabled.

Set parameter 414 [Bus/Brake Config] for your configuration. The following is a summary of possible settings for [Bus/Brake Config]:

Desired Operation	[Bus/Brake Config] Setting
External regeneration	0000
Dynamic braking with internal resistor	0001
Dynamic braking with external resistor	0011
Bus regulation only	1000
Bus regulation first, then dynamic braking with internal resistor	1001
Dynamic braking with internal resistor first, then bus regulation	1101
Bus regulation first, then dynamic braking with external resistor	1011
Dynamic braking with external resistor first, then bus regulation	1111

Parameter 415 [Bus Reg/Brake Ref] sets the turn-on bus voltage threshold for the bus regulator and the dynamic brake. Actual values are modified by the configuration selected in [Bus/Brake Config]. When using common DC bus drives, adjustment of [Bus Reg/Brake Ref] allows a limited coordination of brake operation with other drives. For example, when you have two common bus drives, and one drive is larger than the other, set the larger drive to turn on at a lower voltage than the smaller drive. In this manner, the smaller drive does not try to dissipate all of the dynamic braking energy.

Note: Actual bus voltage reference values are determined as a percentage of parameter 401 [Rated Volts] and the selected voltage class.

$$\text{bus voltage reference} = \frac{\sqrt{2} \times \text{Par 401 [Rated Volts]} \times \text{Par 415 [Bus Reg/Brake Ref]}}{100}\ \text{VDC}$$

For example, with a 480V rated drive and [BusReg/Brake Ref]=111%:

$$\text{bus voltage reference} = \frac{\sqrt{2} \times 480 \times 111}{100} = 753.5\ \text{VDC}$$

Note: When the low voltage class is selected an additional multiplier of 1.2 is used. For example parameter 401 [Rated Volts] = 400V AC, then parameter 401 * 1.2 = 480 VAC is used to determine the bus voltage reference:

$$\text{bus voltage reference} = \frac{(\sqrt{2} \times 400 \times 1.2 \times 111)}{100} = 753.5\ \text{VDC}$$

In this case, if a drive has a selected low voltage class, but is run on a high voltage class AC line, the dynamic brake will not automatically turn on.

Parameter 416 [Brake PulseWatts] sets the peak power reference for determining the protection for an external brake resistor. Parameter 416 is active only if the configuration is selected for an external brake (parameter 414 [Bus/Brake Cnfg] bit 1 is set to 1). When the internal brake resistor is used then the protection is determined from the drive-internal values. Normally this value is specified by the resistor vendor as the energy rating (in Joules) or a 1 second power rating (in Watts) with typical values in the range of 30 to 100 times higher than the resistor's continuous power rating.

Parameter 416 [Brake PulseWatts] = (Resistors peak energy in Joules)/1 Sec; where the resistor package's peak energy rating is obtained from the resistor manufacturer.

When the resistor package's peak energy rating cannot be obtained, there are a few other ways to approximate parameter 416 [Brake Pulse Watts]:

1. [Brake PulseWatts] = 75,000 (watts/lbs) x Resistor element weight (lbs); where 75,000 represents a specific heat of 0.11 cal/Kg ^{o}C (steel or nichrome) and a temperature rise of 350^{o}C, and the resistor element weight is the total weight of the resistor wire element in pounds (not the entire weight of the resistor cage).

   For example a resistor with a nichrome element that weights 10 lbs. would have:

   $$\text{Parameter 416 [Brake PulseWatts]} = 75{,}000 \times 10 = 750{,}000\ \text{Watts}$$

2. [Brake PulseWatts] = (Time Constant) x parameter 417 [Brake Watts]; where the Time constant equals the amount of time for the resistor to reach 63% of its rated temperature with applied rated watts (parameter 417 [Brake Watts]).

Parameter 417 [Brake Watts] sets the continuous watts for determining the protection for an external brake. Enter the continuous watt rating of the resistor cage (found on the resistor cage nameplate or from the resistor manufacturer) for this parameter. This parameter is active only if the configuration is selected for an external brake ([Bus/Brake Cnfg] bit 1 set to 1). When the internal brake resistor is used then the protection is determined from the drive-internal values.

Parameter 369 [Brake OL Cnfg] determines how the drive reacts when the brake protection is exceeded. Regardless of the setting in [Brake OL Cnfg], the drive prevents the 7th IGBT from switching when the brake resistor protection, determined in [Brake PulseWatts] and [Brake Watts], is exceeded. Some possible settings for this parameter are:

Parameter 369 [Brake OL Cnfg] Setting	Drive Operation
0 - “Ignore”	The drive does not generate the fault 38 “Brake OL Trip” or alarm “Brake OL Trip.”
1 - “Alarm”	The drive generates an alarm “Brake OL Trip,” but does not generate the fault 38 “Brake OL Trip.”
2 - “FltCoastStop”	The drive generates the fault 38 “Brake OL Trip” and issues a coast stop.
3 - “FltRampStop”	The drive generates the fault 38 “Brake OL Trip” and issues a ramp stop.
4 - “FltCurLimStop”	The drive generates the fault 38 “Brake OL Trip” and issues a current limit stop.

Parameter 418 [Brake TP Sel] selects a value to monitor for diagnostics of the dynamic brake protection. Possible selections for parameter 418 [Brake TP Sel] are:

Parameter 418 [Brake TP Sel] Setting	Description
0 - "Zero"	Do not monitor any test point for the brake protection.
1 - "Duty Cycle"	Actual duty cycle of the dynamic brake IGBT where a value of 0 in parameter 419 [Brake TP Data] = full open and 1 = full on.
2 - "Power Actual"	Actual power applied to the resistor (Watts).
3 - "Max BodyTemp"	Maximum temperature that the resistor body can handle (°C).
4 - "Max ElemTemp Act"	Maximum temperature that the resistor element can handle (°C).
5 - "BodyTemp Act"	Predicted temperature of the resistor body (°C).
6 - "ElemTemp Act"	Predicted temperature of the resistor element (°C).
7 - "BTmpTrip Stat"	Maximum resistor body temperature has been exceeded when parameter 419 [Brake TP Data] = 1.
8 - "ETmpTripStat"	Maximum resistor element temperature has been exceeded when parameter 419 [Brake TP Data] = 1.
9 - "Int DB Ohms"	Rating of internal resistor when internal resistor is installed (Ohms).
10 - "Data State"	A value of 0 in parameter 419 [Brake TP Data] = initial state, 1 = internal resistor data loaded, 2 = external resistor data loaded.
11 - "MC BrakeEnbl"	A value of 0 in parameter 419 [Brake TP Data] = dynamic braking disabled, 1 = dynamic braking enabled.
12 - "1/rdb"	Inverse of the resistance (1/Ohms).
13 - "1/th_eb"	Inverse of the thermal impedance from the resistor element to body (Watts/°C).
14 - "1/ce"	Inverse of the resistor element thermal mass (°C/W*sec).
15 - "tamax"	Maximum ambient temperature of resistor (°C).
16 - "1/th_ba"	Inverse of the thermal impedance from the resistor body to element (Watts/°C).
17 - "1/cb"	Inverse of the resistor body thermal mass (°C/W*sec).
18 - "DB IGBT Amp"	IGBT current rating (Amps).

Parameter 419 [Brake TP Data] displays the data selected in parameter 418 [Brake TP Sel].

Cable, Control

Refer to *"Wiring and Grounding Guidelines for Pulse Width Modulated (PWM) AC Drives,"* publication DRIVES-IN001 for detailed information. This publication is available online at:

http://literature.rockwellautomation.com/literature

Cable, Motor Lengths

Refer to *"Wiring and Grounding Guidelines for Pulse Width Modulated (PWM) AC Drives,"* publication DRIVES-IN001 for detailed information.

http://literature.rockwellautomation.com/literature

Cable, Power

Refer to *"Wiring and Grounding Guidelines for Pulse Width Modulated (PWM) AC Drives,"* publication DRIVES-IN001 for detailed information.

http://literature.rockwellautomation.com/literature

Cable Trays and Conduit

Refer to *"Wiring and Grounding Guidelines for Pulse Width Modulated (PWM) AC Drives,"* publication DRIVES-IN001 for detailed information.

http://literature.rockwellautomation.com/literature

Carrier (PWM) Frequency

See Chapter 1 for derating guidelines as they travel to carrier frequency.

Parameter 402 [PWM Frequency] sets the carrier frequency. In general, the lowest possible switching frequency that is acceptable for any particular application is the one that should be used. There are several benefits to increasing the switching frequency. Refer to Figure 2.1 and Figure 2.2. Note the output current at 2 kHz and 4kHz. The "smoothing" of the current waveform continues all the way to 10 kHz.

Figure 2.1 Current at 2kHz PWM Frequency

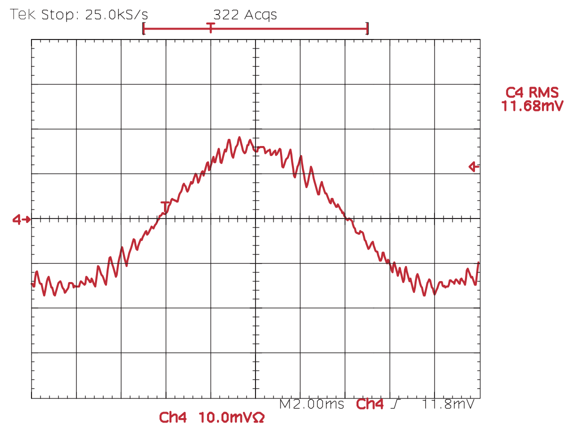
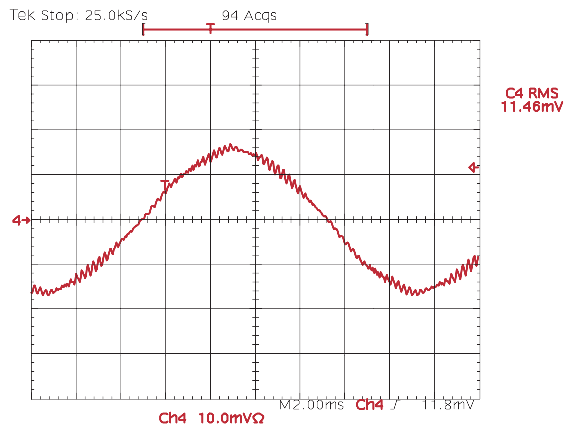


Figure 2.2 Current at 4kHz PWM Frequency



The benefits of increased carrier frequency include less motor heating and lower audible noise. An increase in motor heating is considered negligible and motor failure at lower switching frequencies is very remote. The higher switching frequency creates less vibration in the motor windings and laminations making lower audible noise. This may be desirable in some applications. Some undesirable effects of higher switching frequencies include derating ambient temperature vs. load characteristics of the drive, higher cable charging currents and higher potential for common mode noise.

A very large majority of all drive applications will perform adequately at 2-4 kHz.

Common Bus Systems

Refer to *"Common Bus"* publication DRIVES-IN001 for detailed information.

Communications

There are some special considerations for communicating to a PowerFlex® 700S through a 20-COMM module due to the use of DInt (double integer) and Real (floating-point) type parameters. How the data is handled depends somewhat on the type of controller used. Therefore, the considerations for ControlLogix® and 16 bit controllers (PLC-5 or SLC) are explained separately.

ControlLogix® System

Speed Reference/Feedback:

The DPI speed reference for the PowerFlex 700S is scaled:

- DPI speed reference to 700S = (Commanded RPM / Base Motor Speed) * 32767

The DPI speed feedback for the PowerFlex 700S is scaled:

- Feedback RPM = (DPI feedback from 700S / 32767) * Base Motor Speed

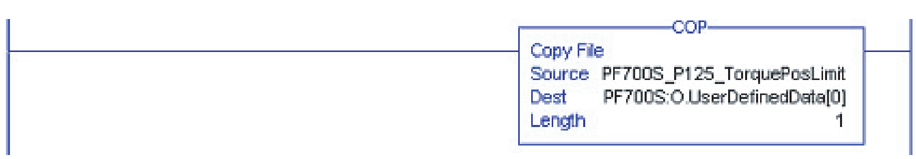
Datalinks:

In the ControlLogix system, Datalinks are transmitted as DInt. In order to send or receive Real (floating-point) parameters a COP (copy) instruction must be utilized. The copy instruction in ControlLogix performs a bitwise copy. Set the length of the copy instruction to a value appropriate for the destination data type.

Example to write a floating point Datalink:

Parameter 125 [Torque Pos Limit] sets the positive torque limit for the motor. [Torque Pos Limit] is a Real (floating point) parameter scaled in per unit (a value of 1.000 is equivalent to 100% motor torque). This example will write [Torque Pos Limit] with a Datalink.

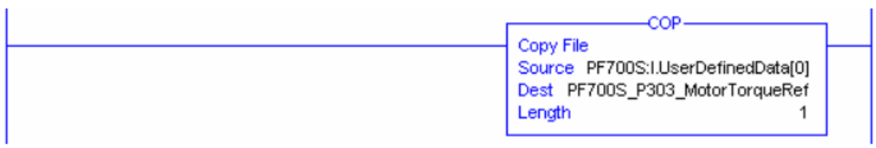
1. Link parameter 125 [Torque Pos Limit] to parameter 651 [DPI Data In A1].
2. Set parameter 650 [DPI In DataType] bit 0 "DPI A1 Real" = 1.
3. Verify that the Datalink is enabled in the 20-COMM module.
4. In RSLogix5000, create a tag "PF700S_P125_TorquePosLimit" of type "REAL".
5. Use the COP instruction to copy the tag "PF700S_P125_TorquePosLimit" to the DINT output tag for Datalink A1 (PF700S:O.UserDefinedData(0) in this example).
6. A value of 1.000 in the tag "PF700S_P125_TorquePosLimit" will write a value of 1.000 to parameter 125 in the drive.



Example to read a floating point Datalink:

Parameter 303 [Motor Torque Ref] displays the torque output to the motor. Parameter 303 is a Real (floating point) parameter scaled in per unit (a value of 1.000 is equivalent to 100% motor torque).

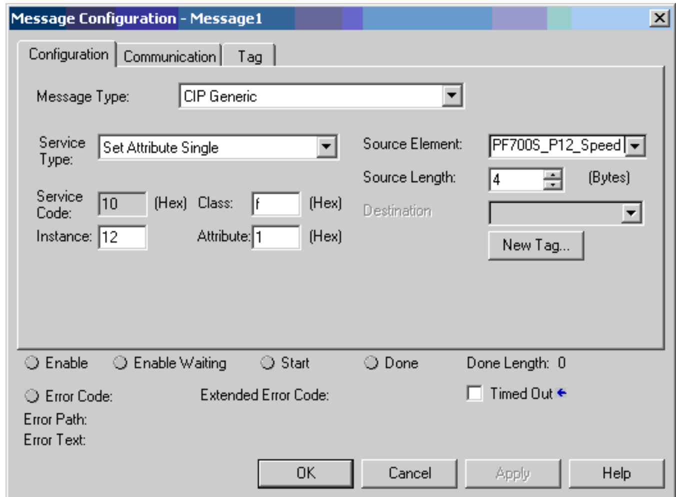
1. Link parameter 660 [DPI Data Out A1] to parameter 303 [Motor Torque Ref].
2. Set parameter 659 [DPI Out DataType] bit 0 "DPI A1 Real" = 1.
3. Verify that the Datalink is enabled in the 20-COMM module.
4. In RSLogix5000, create a tag "PF700S_P303_MotorTorqueRef" of type "REAL".
5. Use the COP instruction to copy the DINT input tag for Datalink A1 (PF700S:I.UserDefinedData(0) in this example) to the tag "PF700S_P303_MotorTorqueRef".
6. The tag "PF700S_P303_MotorTorqueRef" contains the value of parameter 303.



Explicit Messaging:

When using explicit messaging on DeviceNet, ControlNet, or Ethernet in the ControlLogix® system, the message type CIP Generic is used. The data is transferred over ControlNet in the same data type as the parameter in the PowerFlex® 700S. Make sure that the data type for the Source and Destination tags in your ControlLogix message instruction matches the data type for the parameter in the PowerFlex 700S. Also, the Source Length in the ControlLogix message instruction must match the size of the Source data. For example, to send an explicit message to write to parameter 12 [Speed Ref 2], which is a floating point:

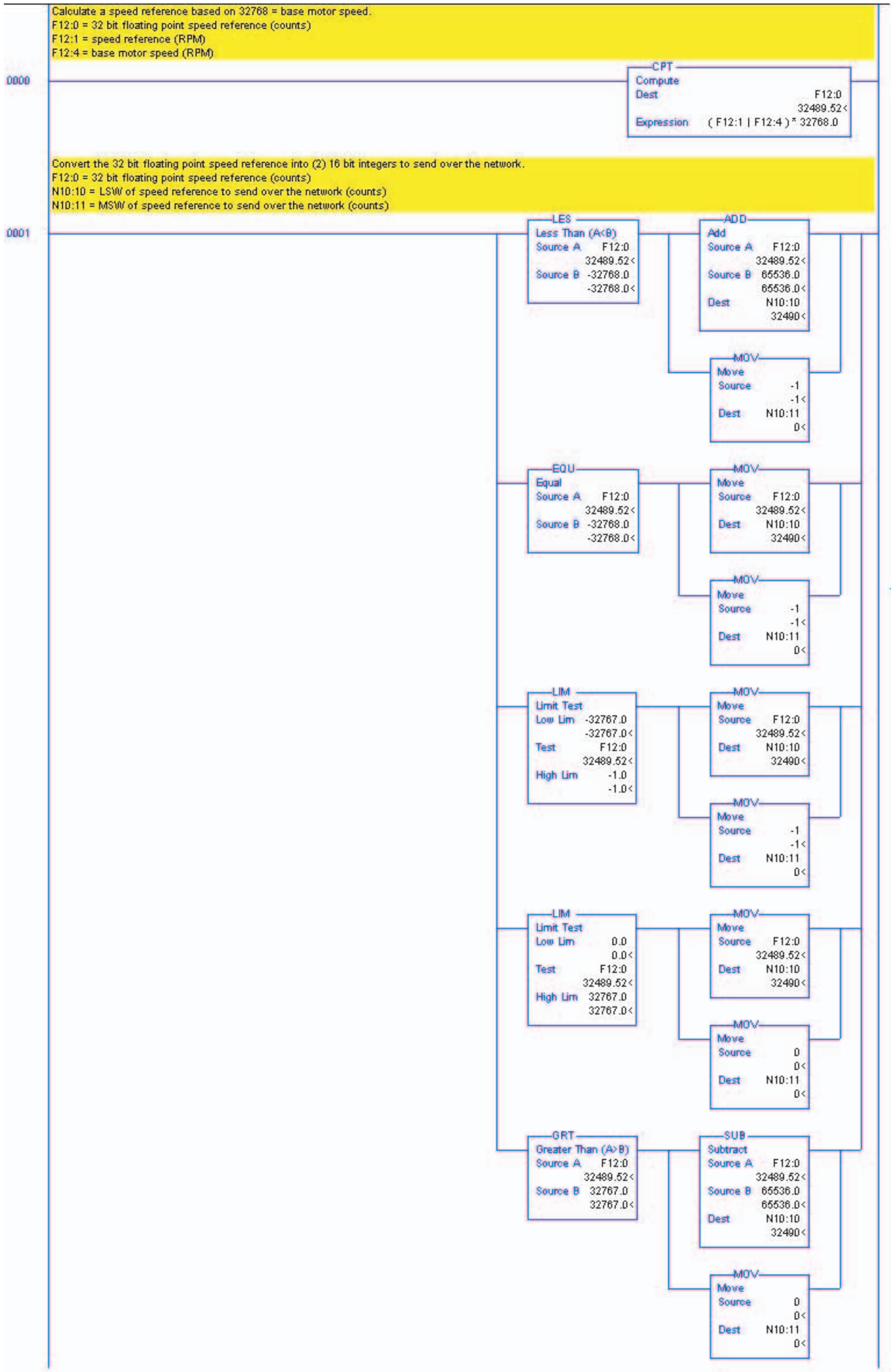
1. The Source Element tag would be of type REAL.
2. The Source Length would be 4 bytes since a REAL data type takes up 4 bytes of data.



PLC 5 or SLC System

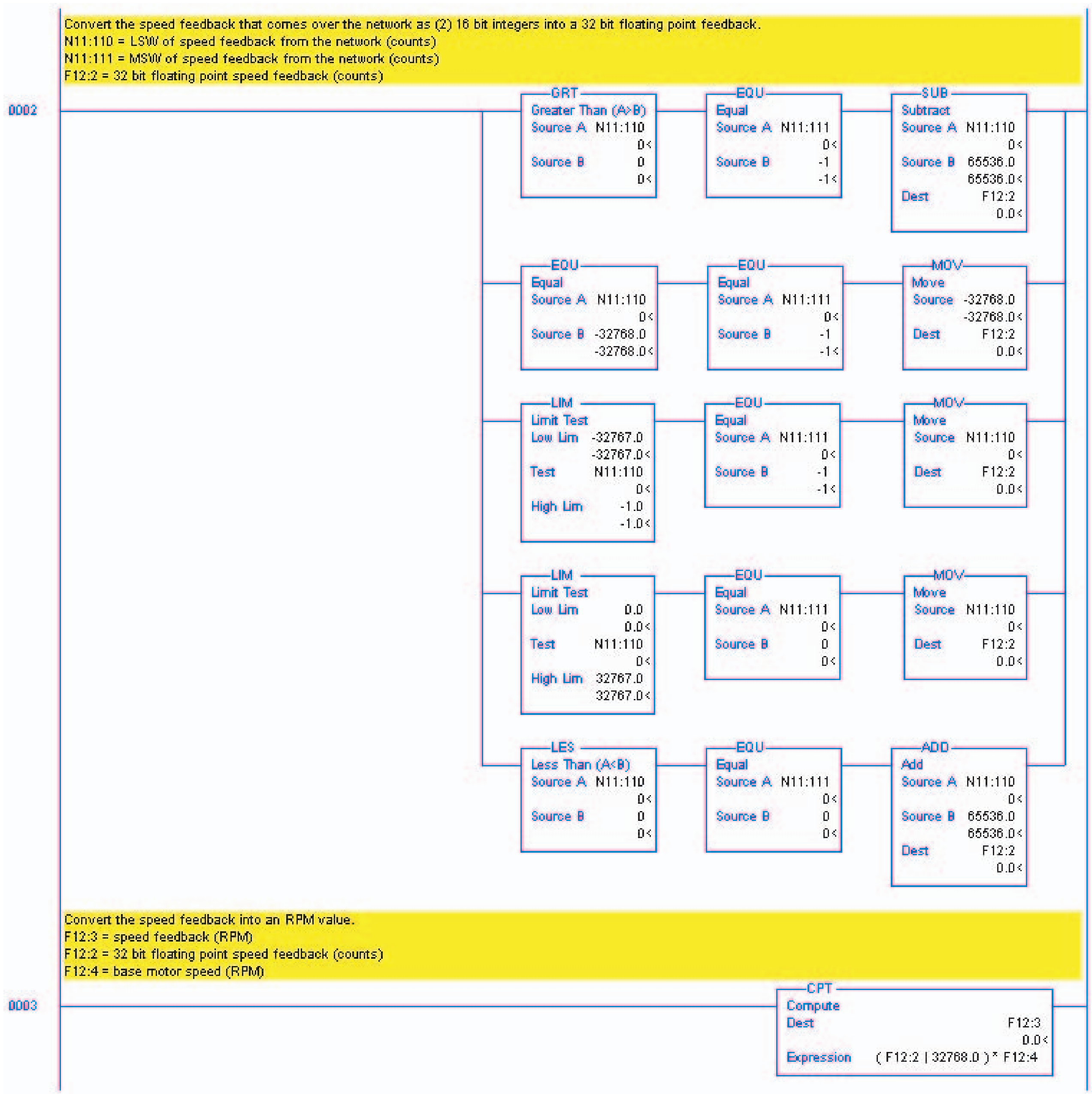
Reference/Feedback Programming

The reference is scaled so that base motor speed = 32767. The PLC can only handle 16 bit integers, so the reference has to be handled differently to account for references above 32767 or below -32768. The following example shows how to transmit references more than base motor speed and less than twice base motor speed.



Calculate a speed reference based on 32768 = base motor speed.
F12:0 = 32 bit floating point speed reference (counts)
F12:1 = speed reference (RPM)
F12:4 = base motor speed (RPM)
0000
CPT Compute Dest F12:0 32489.52< Expression (F12:1 | F12:4) * 32768.0
Convert the 32 bit floating point speed reference into (2) 16 bit integers to send over the network.
F12:0 = 32 bit floating point speed reference (counts)
N10:10 = LSW of speed reference to send over the network (counts)
N10:11 = MSW of speed reference to send over the network (counts)
0001
LES Less Than (A<B) Source A F12:0 32489.52< Source B -32768.0 -32768.0<
ADD Add Source A F12:0 32489.52< Source B 65536.0 65536.0< Dest N10:10 32490<
MOV Move Source -1 -1< Dest N10:11 0<
EQU Equal Source A F12:0 32489.52< Source B -32768.0 -32768.0<
MOV Move Source F12:0 32489.52< Dest N10:10 32490<
MOV Move Source -1 -1< Dest N10:11 0<
LIM Limit Test Low Lim -32767.0 -32767.0< Test F12:0 32489.52< High Lim -1.0 -1.0<
MOV Move Source F12:0 32489.52< Dest N10:10 32490<
MOV Move Source -1 -1< Dest N10:11 0<
LIM Limit Test Low Lim 0.0 0.0< Test F12:0 32489.52< High Lim 32767.0 32767.0<
MOV Move Source F12:0 32489.52< Dest N10:10 32490<
MOV Move Source 0 0< Dest N10:11 0<
GRT Greater Than (A>B) Source A F12:0 32489.52< Source B 32767.0 32767.0<
SUB Subtract Source A F12:0 32489.52< Source B 65536.0 65536.0< Dest N10:10 32490<
MOV Move Source 0 0< Dest N10:11 0<

The feedback is also scaled so that base motor speed = 32767. The PLC can only handle 16 bit integers, so the feedback has to be handled differently to account for references above 32767 or below -32768. The following example shows how to read feedback values more than base motor speed and less than twice base motor speed.



Datalink Programming

Datalinks are transmitted and received through messages on Ethernet, ControlNet or DeviceNet and through block transfers on RIO. The PLC and SLC are limited to 16 bit integers and floating point. In order to send or receive floating point Datalinks we have to swap the LSW and MSW and utilize the COP (copy) instruction. Because the PLC and SLC do not support 32-bit integers, 32-bit Datalinks remain split into (2) 16 bit integers. The following examples are for transmitting and receiving the different types of Datalinks. The following program examples are from an SLC but function the same in a PLC 5.

Figure 2.3 Reading DINT Datalinks in an SLC or PLC 5.

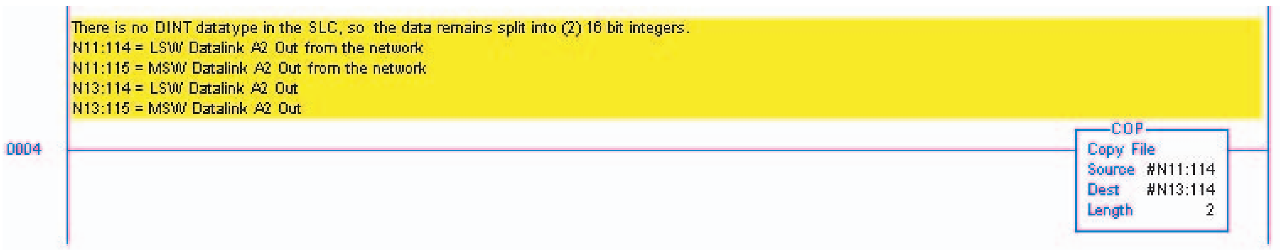


Figure 2.4 Writing DINT Datalinks in an SLC or PLC 5.

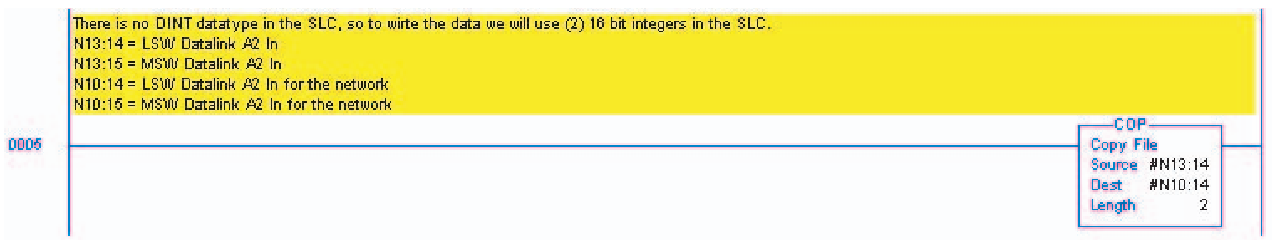


Figure 2.5 Reading Floating Point Datalinks in an SLC or PLC 5.

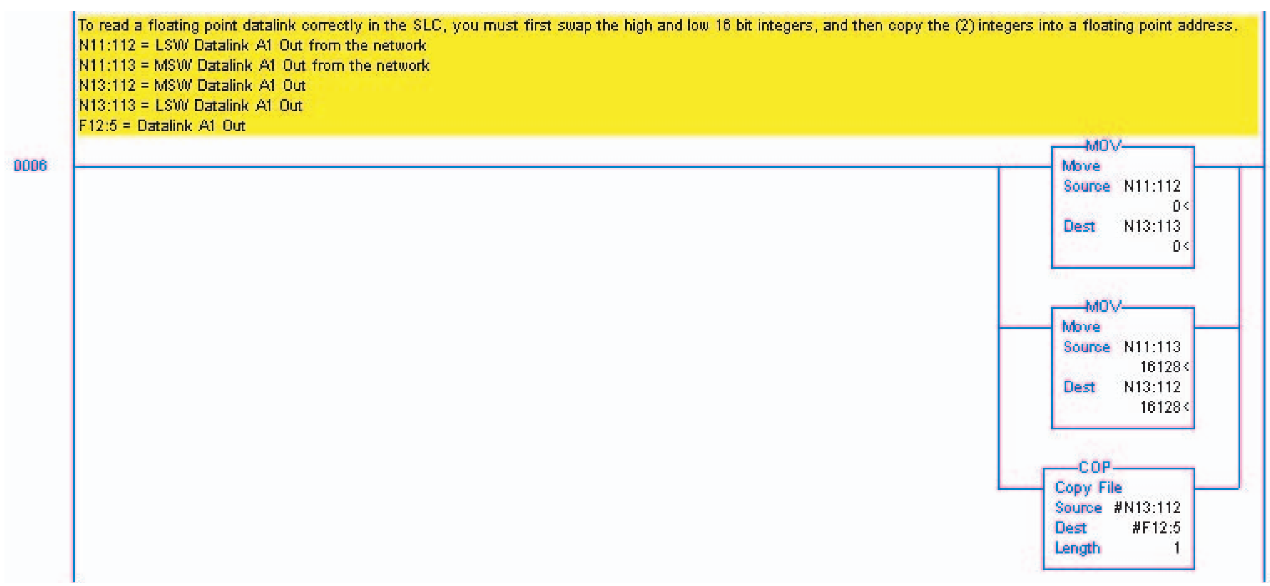
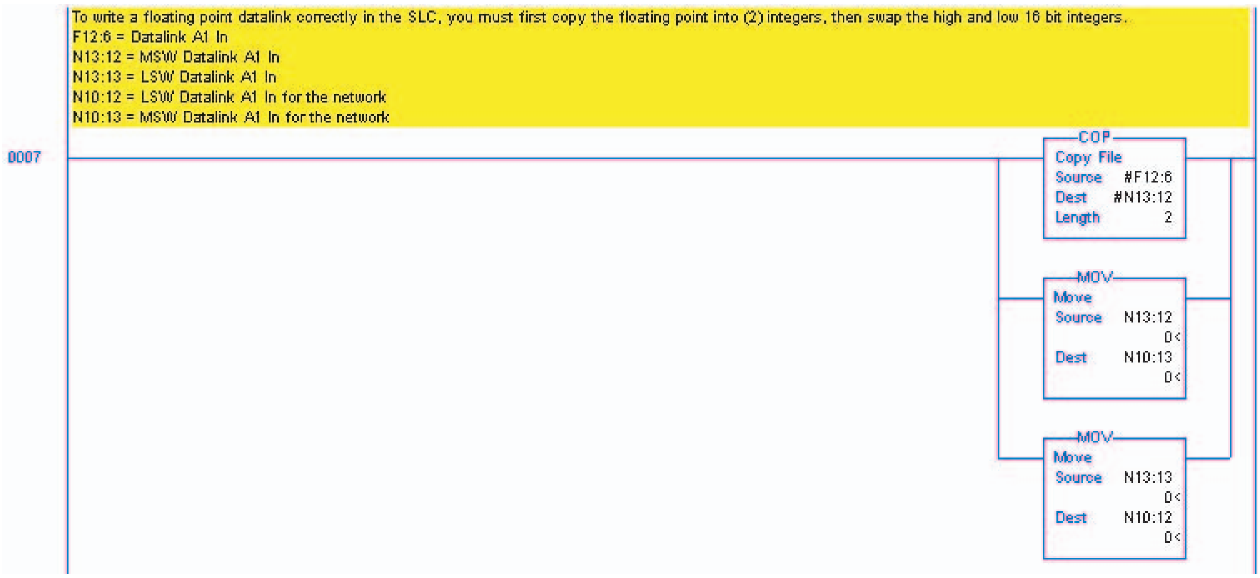


Figure 2.6 Writing Floating Point Datalinks in an SLC or PLC 5.



Copy Cat

This feature allows you to upload a complete set of parameters to the LCD HIM. This information can then be used as backup or can be transferred to another drive by downloading the memory. Generally, the transfer process manages all conflicts. If a parameter from HIM memory does not exist in the target drive, the value stored is out of range for the drive, or the parameter cannot be downloaded because the drive is running, the download will stop and a text message will be issued. The user than has the option of completely stopping the download or continuing after noting the discrepancy for the parameter that could not be downloaded. These parameters can then be adjusted manually. The LCD HIM will store a number of parameter sets (memory dependant) and each individual set can be named for clarity.

Current Limit

Par 356 [Mtr Current Lim]

The following methods are available for a drive to use to protect itself from an overcurrent or overload condition.

- **Instantaneous Over Current Trip** - This is a feature that instantaneously trips or faults the drive if the output current exceeds this value. The value is fixed by hardware and is typically 250% of drive rated amps. This feature cannot be disabled.
- **Software Over Current Trip** - This is a configurable trip function. If parameter 377 [Inv OL Trip Cnfg] is set to Fault Coast to Stop, the drive will trip on inverter overload. This will occur when the Open Loop or Closed Loop IT function has detected an overload condition. See the Drive Overload section for a description of the Open Loop and Closed Loop IT functions.
- **Software Current Limit** - This feature selectively limits the current the drive will provide based on the several factors. The setting in parameter 356 [Mtr Current Lim] will limit the current to the user changeable level; range is 105% of Motor Flux Current to 800% of the motor nameplate entered in 2 [Motor NP FLA]. The Open Loop IT function can also limit the output current if the calculation determines it is in the overload area of operation. The Open Loop IT function and the Motor Current Limit parameters are routed to a minimum selection, the algebraic minimum of the inputs is used as the current limit. Also, the Closed Loop IT function can limit the current output by the drive. The Closed Loop IT function and the Torque Current Reference are compared and the algebraic minimum is used for the Torque Current Reference. See the Drive Overload section for a description of the Open Loop and Closed Loop IT Functions.

Datalinks

Datalinks are used to transfer I/O data from a communication adapter [i.e. ControlNet (20-COMM-C) or DeviceNet (20-COMM-D)] to a controller. Datalinks allow parameter values to be changed without using messaging.

Configuring Datalinks

This section contains information on configuring the Datalink parameters in the PowerFlex 700S. There are also parameters in the communication adapters that must be configured to use Datalinks. See the sections on the individual adapters (i.e. 20-COMM-C, 20-COMM-D) for more information on setting up the Datalinks in the adapter.

"Data In" Parameters

Parameters 651 [DPI Data In A1] through 658 [DPI Data In D2] are inputs to the drive from the controller and are used to write to parameters. To write to a parameter, that parameter must be linked to one of the parameters 651 through 659. Then set the appropriate bit in parameter 650 [DPI In DataType] to indicate if that parameter is a DInt (double integer) or Real (floating point). Turn the bit off for DInt and turn the bit on for floating point. A total of eight parameters can be written with the "Data In" parameters.

Example Configuration #1 - Writing a DInt Parameter using a Datalink

- Parameter 740 [Position Control] is linked to parameter 651 [DPI Data In A1]
- Parameter 650 [DPI In DataType] bit 0 "DPI A1 Real" is set to 0

The value that is sent to [DPI Data In A1] from the controller will show up in [Position Control].

Example Configuration #2 - Writing a Real Parameter using a Datalink

- Parameter 111 [Torque Ref1] is linked to parameter 651 [DPI Data In A1]
- Parameter 650 [DPI In DataType] bit 0 "DPI A1 Real" is set to 1

The value that is sent to [DPI Data In A1] from the controller will show up in [Torque Ref 1].

"Data Out" Parameters

Parameters 660 [DPI Data Out A1] through 667 [DPI Data Out D2] are outputs from the drive to the controller and are used to read parameters. To read to a parameter, one of the parameters 660 through 667 must be linked to it. Then set the appropriate bit in parameter 659 [DPI Out DataType] to indicate if that parameter is a DInt or floating point. Turn the bit off for DInt and turn the bit on for floating point. A total of 8 parameters can be read with the "Data Out" parameters.

Example Configuration #3 - Reading a DInt Parameter using a Datalink

- Parameter 660 [DPI Data Out A1] is linked to parameter 741 [Position Status]
- Parameter 659 [DPI Out DataType] bit 0 “DPI A1 Real” is set to 0

The value from [DPI Data Out A1] to the controller contains the value of [Position Status].

Example Configuration #4 - Reading a Real Parameter using a Datalink

- Parameter 660 [DPI Data Out A1] is linked to parameter 307 [Output Voltage]
- Parameter 659 [DPI Out DataType] bit 0 “DPI A1 Real” is set to 1

The value from [DPI Data Out A1] to the controller contains the value of [Output Voltage].

Decel Time

Parameter 33 [Decel Time 1] sets the rate at which the drive ramps down its output during a ramp Stop command or during a decrease in commanded speed.

The rate established is the result of the programmed Decel Time and the programmed motor rated speed parameter 4 [Motor NP RPM] as follows:

$$\frac{\text{Motor RPM (Parameter 4)}}{\text{Decel Time (Parameter 33)}} = \text{Decel Rate (RPM/sec)}$$

Times are adjustable in 0.0001 second increments from 0.01 to 6553.5 seconds. Programming zero seconds will cause the drive to use 0.1 second.

Digital Inputs

Technical Information

There are a total of six Digital Inputs.

- Digital Input 1 and Digital Input 2 are 12VDC or 24VDC, Sinking, Hi-Speed. They are configured for 12 VDC or 24VDC via DIP switches (default 24VDC). Use Digital Input 1 and Digital Input 2 for position registration.
- Digital Input 3 is 24VDC, Sinking.
- Shared Common for Digital Inputs 1, 2 and 3.
- Digital Inputs 4, 5 and 6 are 24VDC or 115VAC, Sink/Source. They are configured for 24VDC or 115VAC via DIP switches (default 24VDC).
- Shared Common for Digital Inputs 4, 5 and 6.
- Digital Input 6 is a HW Enable by default. A jumper is used to disable HW Enable and use Digital Input 6 for other functions.

Digital Input Configuration

Parameter 825 - 830 [DigIn x Sel] can be set to the following values:

0	"Reserved"	13	"Jog 2"	26	"PI Trim En"
1	"Enable"	14	"Normal Stop"	27	"PI Trim Hold"
2	"Clear Faults"	15	"Spd Ref Sel0"	28	"PI Trim Rst"
3	"Ext Fault"	16	"Spd Ref Sel1"	29	"Trend Trig"
4	"Norm Stop-CF"	17	"Spd Ref Sel2"	30	"PreCharge En"
5	"Start"	18	"CurLim Stop"	31	(See Note below table)
6	"Reverse"	19	"Coast Stop"	32	"+Hrd OvrTrvl"
7	"Run"	20	"AccelDecel2"	33	"-Hrd OvrTrvl"
8	"Reserved"	21	"Indx Step"	34	"UserGen Sel0"
9	"Reserved"	22	"Indx StpRv"	35	"UserGen Sel1"
10	"Jog 1"	23	"MOP Inc"	36	"UserGen Sel2"
11	"Reserved"	24	"MOP Dec"	37	"UserGen Sel3"
12	"Reserved"	25	"MOP Reset"	38	"ExtFault Inv"

Note: Option 31 is "Regis 1 Ltch" for Digital Input 1 and "Regis 2 Ltch" for Digital Input 2.

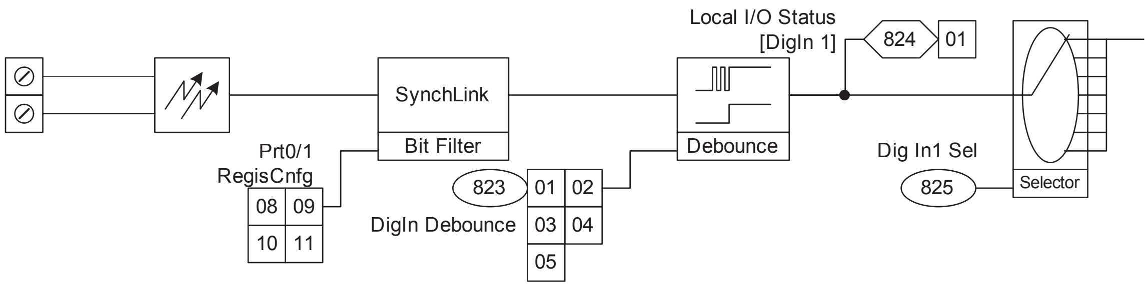
In addition, the Digital inputs can be used for other functions by using parameter 824 [Local I/O Status] and the Bit Swap User Function. Refer to Bit Swap on page 2-149 for an example.

Parameter 823 [DigIn Debounce] sets the filtering for each Digital Input.

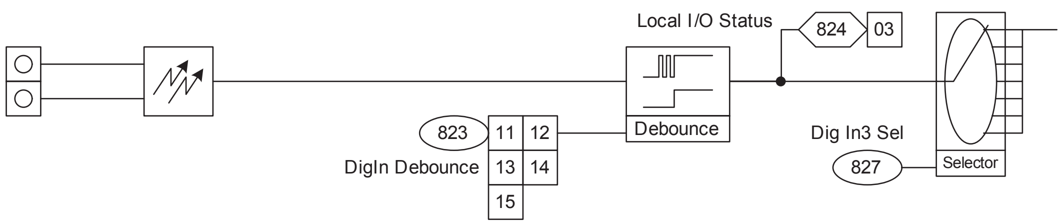
Options	Reserved	DigIn6 8.0ms	DigIn6 4.0ms	DigIn6 2.0ms	DigIn6 1.0ms	DigIn6 0.5ms	DigIn5 8.0ms	DigIn5 4.0ms	DigIn5 2.0ms	DigIn5 1.0ms	DigIn5 0.5ms	DigIn4 8.0ms	DigIn4 4.0ms	DigIn4 2.0ms	DigIn4 1.0ms	DigIn4 0.5ms	DigIn3 8.0ms	DigIn3 4.0ms	DigIn3 2.0ms	DigIn3 1.0ms	DigIn3 0.5ms	DigIn2 8.0ms	DigIn2 4.0ms	DigIn2 2.0ms	DigIn2 1.0ms	DigIn2 0.5ms	DigIn1 8.0ms	DigIn1 4.0ms	DigIn1 2.0ms	DigIn1 1.0ms	DigIn1 0.5ms	Reserved
Default	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

0 = False
1 = True

High Speed Digital Inputs:



Standard Digital Inputs:



Digital Input Status Bits:

Parameter 824 [Local I/O Status] bits 1 through 6 give the status of the digital inputs. When the bit in [Local I/O Status] associated with the digital input is on, this means that the PowerFlex 700S recognizes that the digital input is on. When the bit associated with the digital input is off, this means that the PowerFlex 700S recognizes that the digital input is off.

Digital Outputs

Technical Information

There are three digital outputs total.

- Two Digital Outputs are 24Vdc, Sourcing / Sinking, Open Collector Type. Max Load -Internal Source = 150mA, External = 750mA
- The 3rd Output is a Relay, Form C, 24Vdc / 120Vac, Max Load 2A

Digital Output Configuration

Parameters 845 and 850 [Digital Outx Sel] can be set to the following settings:

0	"User Select"	10	"At Setpt 1"	20	"Actual Dir"
1	"Not Fault"	11	"Above Setpt 2"	21	"Jogging"
2	"Not Alarm"	12	"At ZeroSpeed"	22	"In Position"
3	"Ready"	13	"Speed Limit"	23	"Posit Watch1"
4	"Running"	14	"CurrentLimit"	24	"Posit Watch2"
5	"Reserved"	15	"Torque Limit"	25	"Cmpr 1 A</=B"
6	"Reserved"	16	"Power Limit"	26	"Cmpr 1 A>/=B"
7	"Enable On"	17	"Fault"	27	"Cmpr 2 A</=B"
8	"Active"	18	"Alarm"	28	"Cmpr 2 A>/=B"
9	"At Speed"	19	"Command Dir"		

In addition, the digital output can be used for other functions when [Digital Outx Sel] is set to 0 "User Select".

Example for user configured digital output:

This example will turn on the programmed digital output when Digital Input 1 is on.

Parameter 845 [Dig Out1 Sel] = 0 "User Select"

Parameter 846 [Dig Out1 Data] is linked to parameter 824 [Local I/O Status]

Parameter 847 [Dig Out1 Bit] = 1

Digital Output Status Bits

Parameter 824 [Local I/O Status], bits 16-18 give the status of the digital outputs and can be used for troubleshooting the digital outputs. When the bit in [Local I/O Status] associated with the digital output is on, this means that the logic in the PowerFlex® 700S is telling that digital output to turn on. When the bit associated with the digital input is off, this means that the logic in the PowerFlex 700S is telling that digital output to turn off.

Options	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Relay Out 3	DigOut 2	DigOut 1	SafeOffInput	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	DigIn 6	DigIn 5	DigIn 4	DigIn 3	DigIn 2	DigIn 1	Hw Enbl Byps
Default	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

0 = False
1 = True

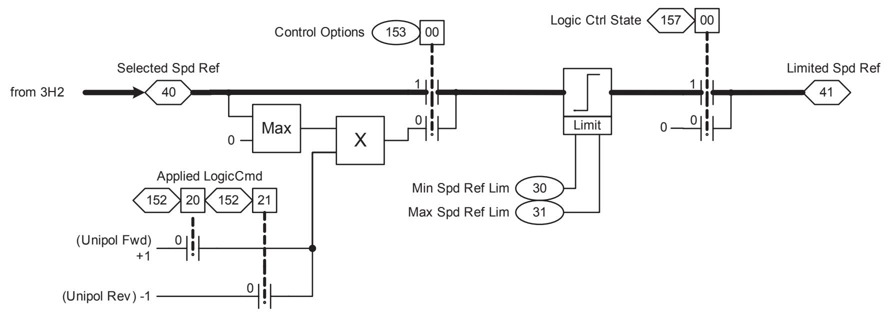
Direction Control and Bipolar Reference

The direction of rotation of the motor can be controlled by a forward/reverse command or by the use of a bipolar signal. Parameter 153 [Control Options] bit 0 - "Bipolar Sref" selects this option.

When this bit is enabled (1) a bipolar speed reference is used. In bipolar reference mode, parameter 40 [Selected Spd Ref] indicates both the speed magnitude and the direction: Positive speed reference values (+) = forward direction and negative speed reference values (–) = reverse direction. When this bit is disabled a unipolar speed reference is used. In unipolar mode, the speed reference is limited to a minimum value of zero (0), shown by the Max selection block (as shown in the diagram below). In this case parameter 40 [Selected Spd Ref] supplies only the speed magnitude. The direction is determined by parameter 152 [Applied LogicCmd] bits 20 “Forward” and 21 “Reverse”. The forward/reverse direction button on the HIM is one possible source for the [Applied LogicCmd] direction bits. The following chart explains the effect that the direction button on the HIM has based on the condition of the “Bipolar SRef” bit:

Bipolar	Reference Controlled By HIM?	HIM Direction Button
Enabled	Yes	Changes the motor direction due to a HIM supplied (+) or (-) command signal.
Enabled	No	Has no effect on motor direction. Direction determined by sign of Par 40 [Selected SpdRef].
Disabled	Yes	Changes the motor direction due to a HIM supplied forward or reverse [Applied LogicCmd] bit.
Disabled	No	Changes the motor direction due to a HIM supplied forward or reverse [Applied LogicCmd] bit.

In either Bipolar or Unipolar mode, the selected direction can be determined from the sign of parameter 41 [Limited Spd Ref]. Positive values indicate forward rotation and negative values indicate reverse rotation.



Drive Peripheral Interface (DPI)

DPI is an enhancement SCANport™ that provides more functions and better performance. SCANport was a CAN based, Master-Slave protocol, created to provide a standard way of connecting motor control products and optional peripheral devices together. It allows multiple (up to 6) devices to communicate with a motor control product without requiring configuration of the peripheral. SCANport and DPI both provide two basic message types called Client/Server (C/S) and Producer/Consumer (P/C). C/S messages are used to transfer parameter and configuration information in the background (relative to other message types). P/C messages are used for control and status information. DPI adds a higher baud rate, brand specific enabling, Peer-to-Peer (P/P) communication, and Flash Memory programming support. This communication interface is the primary way to interact with, and control the drive.

ATTENTION:

- The PowerFlex® 700S only supports the DPI communication protocol.
- The PowerFlex 700S will not communicate with SCANport devices.
- The PowerFlex 700S does not support LED HIMs.

Client/Server

C/S messages operate in the background (relative to other message types) and are used for non-control purposes. The C/S messages are based on a 10ms "ping" event that allows peripherals to perform a single transaction (i.e. one C/S transaction per peripheral per time period). Message fragmentation (because the message transaction is larger than the standard CAN message of eight data bytes) is automatically handled by C/S operation. The following types of messaging are covered:

- Logging in peripheral devices
- Read/Write of parameter values
- Access to all parameter information (limits, scaling, default, etc.)
- User set access
- Fault/Alarm queue access
- Event notification (fault, alarm, etc.)
- Access to all drive classes/objects (e.g. Device, Peripheral, Parameter, etc.)

Producer/Consumer Operation Overview

P/C messages operate at a higher priority than C/S messages and are used to control/report the operation of the drive (e.g. start, stop, etc.). A P/C status message is transmitted every 5ms (by the drive) and a command message is received from every change of state in any attached DPI peripheral. Change of state is a button being pressed or error detected by a DPI peripheral. P/C messages are of a fixed size, so support of message fragmentation is not required. The following types of messaging are covered:

- Drive status (running, faulted, etc.)
- Drive commands (start, stop, etc.)
- Control logic parsing operations (e.g., mask and owner parameters)
- Entering Flash programming mode
- “Soft” login and logout of peripheral devices (enabling/disabling of peripheral control)

Peer-to-Peer Operation

Peer-to-Peer messaging allows two devices to communicate directly rather than through the master or host (i.e. drive). They are the same priority as C/S messages and will occur in the background. If an LCD HIM is attached to the PowerFlex® 700S drive, it will be able to directly request off-board parameters using Peer-to-Peer messages (i.e. no proxy support needed in the drive). PowerFlex 700S drives can use all six communication ports because Peer-to-Peer proxy operations are not needed. All Peer-to-Peer operations occur without any intervention from the user (regardless whether proxy or normal P/P operation), no setup is required. No Peer-to-Peer proxy operations are required while the drive is in Flash mode.

All the timing requirements specified in the DPI system, Control, and Messaging specifications are supported. Peripheral devices will be scanned (“pinged”) at a 10ms rate. Drive status messages will be produced at a 5ms rate, while peripheral command messages will be accepted (by the drive) as they occur (i.e. change of state). Based on these timings, the following worst case conditions can occur (independent of the baud rate and protocol):

- Change of peripheral state (e.g. Start, Stop, etc.) to change in the drive - 10ms
- Change in reference value to change in drive operation - 10ms
- Change in Datalink data value to change in the drive - 10ms
- Change of parameter value into drive - 20ms times the number of attached peripherals

The maximum time to detect the loss of communication from a peripheral device is 500ms.

The following timing specifications apply to DPI devices:

- Host status messages only go out to peripherals once they log in and at least every 125ms (to all attached peripherals). Periphals will time-out if more than 250ms passes without a response. Actual time is dependent on the number of peripherals attached. The minimum time goal is 5ms (may have to be dependent on the Port Baud Rate). DPI allows a minimum 5ms status at 125k and 1ms status at 500k.
- The host determines the Minimum Update Time (MUT) based on the number of attached peripherals. Range of values from 2 to 125ms. Minimum goal time of 5ms. DPI allows 2ms at 500k and 5ms minimum at 125k.

- Peripheral command messages (including Datalinks) generated on change-of-state, but not faster than Host MUT and at least every 250ms. Host will time out if it is more then 500ms.
- Peer messages requests cannot be sent any faster than 2x of MUT.
- Host must ping every port at least every 2 seconds. Peripherals time if more then 3 seconds pass. Host will wait a maximum of 10ms (125k) or 5ms (500k) for peripheral response to ping. Peripherals typical response time is 1ms. Periphals allow only one pending explicit message (i.e. ping response or peer request) at a time.
- Response to an explicit request or fragment must occur within 1 second or device will time out (applies to Host or Peripheral). Time-out implies retry from beginning. Maximum number of fragments per transaction is 16. Flash memory is exception with 22 fragments allowed.
- During Flash mode, host stops ping, but still supports status/command messages at a 1-5 second rate. drive will use 1 second rate. Data transfer occurs via explicit message as fast as possible (i.e. peripheral request, host response, peripheral request, etc.) but only between two devices.

The MUT, is based on the message type only. A standard command and Datalink command could be transmitted from the same peripheral faster than the MUT and still be O.K. However, two successive Datalink commands will have to be separated by the MUT.

DriveLogix

See the *DriveLogix® 5730 Controller User Manual*, publication 20D-UM003.

Drive Overload

Theory of Operation

The following discussion assumes that the IT curve does not change with Pulse Width Modulated (PWM) carrier frequency or drive output frequency.

A drive has three rated current values; a continuous current rating, a 1-minute current rating, and a 3-second current rating. Typically, the 1-minute rating will be close to 110% of the continuous rating, and the 3-second rating will be close to 150% of the continuous rating. This may vary from drive to drive to optimize the performance of each frame size. In the following examples the 1-minute rating is 110% and the 3-second rating is 150%.

Open Loop Current Limit

The drive can thermally allow 102.5%.

The 1-minute current rating assumes a duty cycle of 1 minute on, followed by 3 minutes at 100%. This results in an average current of 102.5%.

110% * 60 sec + 100%*180 sec
average current = -- = 102.5%

The 3-second current rating assumes a duty cycle of 3 seconds on, followed by 57 seconds at 100%. This results in an average current of 102.5%.

150% * 3 sec + 100%*57 sec
average current = -- = 102.5%

Typically the drive will have a sixty-second rating of 110% of continuous current and a three-second rating at 150% of the continuous current. Under normal operating conditions, the open loop function sets this current limit to the short term (three-second) rating. If the function detects an overload, it lowers the limit to the continuous level. If the function is in the continuous level limit, this can be lower than the Motor Current limit. After a period of time (typically one to three minutes), the function returns the limit to the short term rating.

Closed Loop IT Function

The drive will also adjust the torque current limit level based on the values in Parameter 358 [Iq Ref Limited], parameter 313 [Heatsink Temp] and the thermal characteristics of the drive contained in the power EE memory. Under normal operating conditions, the function typically sets the limit at 250% of the continuous drive rating. If the function determines that the power device junction temperature is approaching maximum, it will reduce this limit to the level required to prevent additional heating of the inverter. This level could be as low as the continuous rating of the drive output amps. If the inverter temperature decreases, the function will raise the limit to a higher level.

Drive Overload Status

Drive Overload Status can be monitored in parameter 346 [Drive OL Status].

- Bit 0 “NTC Shorted” indicates the Negative Temperature Coefficient (NTC) device has a short circuit.
- Bit 1 “NTC Open” indicates the NTC has an open circuit.
- Bit 2 “HS OverTemp” indicates heatsink temperature is above: 105° C for ratings 1.1-11.0A, 115° C for 14-34A, 100 °C for 40-52A.
- Bit 3 “HS Pending” indicates heatsink temperature is above: 95° C for ratings 1.1 -11A, 105° C for 14- 34A, 90° C for 40- 52A.
- Bit 4 “IT Trip” indicates the drive has exceed the 3 second rating of either the 150% normal duty rating or 200% of the heavy duty rating.
- Bit 5 “IT Pending” indicates the drive OL integrator is at 50% of the time out time.
- Bit 6 “IT Foldback indicates the drive closed loop current limit is in a fold back condition. The value of the fold back is proportional to the calculated junction temperature.
- Bit 7 “Jnc Over Temp” indicates the junction temperature has exceeded the maximum temperature for the power semiconductor device.

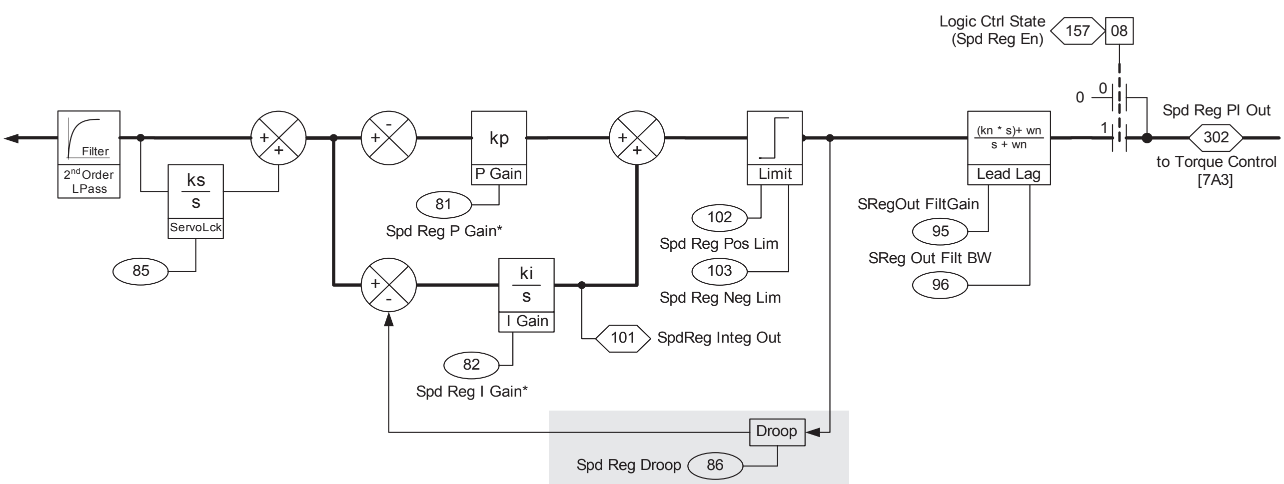
Drive Over Temperature (Frame 9 Only)

The drive over temperature fault is set at 92º C. The fault is detected if the heat-sink temperature, parameter 313 [Heatsink Temp] or parameter 345 [Drive OL JnctTmp] exceeds 125º C.

The open loop current limit is originally designed for 25% duty cycle at 110% output current. On the other side, the High Horsepower drive allows 10% duty cycle at 110% output current. The open loop current limit function cannot prevent the drive from having an over temperature fault.

Droop

Droop is used to "shed" load and is usually used when a soft coupling of two motors is present in an application. The master drive speed regulates and the follower uses droop so it does not "fight" the master. The input to the droop block comes from the torque output of the speed regulator before limiting. The output of the droop block reduces the speed reference. Parameter 86 [Spd Reg Droop] sets the amount of base motor speed that the speed reference is reduced when at full load torque. [Spd Reg Droop] is in units of per unit torque/per unit speed. For example, when [Spd Reg Droop] is set to 0.1 and the drive is running at 100% rated motor torque, the droop block would subtract 10% from the speed reference.



Dynamic Braking

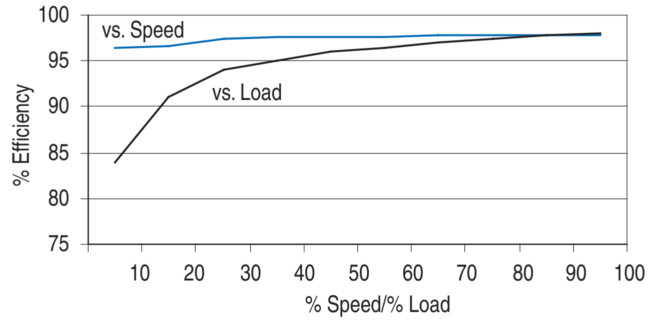
Refer to Bus Regulation/Braking.

For resistor sizing, refer to the *PowerFlex® Dynamic Braking Resistor Calculator Selection Guide*, publication PFLEX-AT001. This publication is available online at:

http://literature.rockwellautomation.com/literature

Efficiency

The following chart shows typical efficiency for PWM variable frequency drives, regardless of size. Drives are most efficient at full load and full speed.



Electronic Gearing

See Position Loop - Follower (Electronic Gearing)

CE Conformity

Conformity with the Low Voltage (LV) Directive and Electromagnetic Compatibility (EMC) Directive has been demonstrated using harmonized European Norm (EN) standards published in the Official Journal of the European Communities. PowerFlex® drives comply with the EN standards listed below when installed according to the User and Reference Manual.

Declarations of Conformity are available online at:
http://www.ab.com/certification

Low Voltage Directive (73/23/EEC)

- EN50178 Electronic equipment for use in power installations.
- EN60204-1 Safety of machinery - Electrical equipment of machines.

EMC Directive (89/336/EEC)

EN61800-3 Adjustable speed electrical power drive systems Part 3: EMC product standard including specific test methods.

General Notes

- If the adhesive label is removed from the top of the drive, the drive must be installed in an enclosure with side openings less than 12.5 mm (0.5 in.) and top openings less than 1.0 mm (0.04 in.) to maintain compliance with the LV Directive.
- The motor cable should be kept as short as possible in order to avoid electromagnetic emission as well as capacitive currents.
- Use of line filters in ungrounded systems is not recommended.
- PowerFlex® drives may cause radio frequency interference if used in a residential or domestic environment. The user is required to take measures to prevent interference, in addition to the essential requirements for CE compliance listed below, if necessary.
- Conformity of the drive with CE EMC requirements does not guarantee an entire machine or installation complies with CE EMC requirements. Many factors can influence total machine/installation compliance.

Essential Requirements for CE Compliance

Conditions 1-6 listed below must be satisfied for PowerFlex drives to meet the requirements of EN61800-3.

1. Standard PowerFlex® 700S CE compatible drive.
2. Review important precautions/attentions statements throughout this document and the *PowerFlex 700S User Manual*, publication 20D-UM006, before installing drive.
3. Grounding as described on page 1-4 of the user manual.
4. Output power, control (I/O) and signal wiring must be braided, shield cable with a coverage of 75% or better, metal conduit or equivalent attention.
5. All shielded cables should terminate with proper shielded connector.
6. Conditions in Table 2.A PowerFlex 700S EN61800-3 EMC Compatibility(1).

Table 2.A PowerFlex 700S EN61800-3 EMC Compatibility(1)

Frame(s)	Second Environment	First Environment Restricted Distribution	
	Restrict Motor Cable to 30 m (98 ft.)	*Restrict Motor Cable to 150 m (492 ft.)*	
	Any Drive and Option	*Any Drive and Option*	*External Filter Required*
1 - 6	✔	✔	✔

(1) External filters for First Environment installations and increasing motor cable lengths in Second Environment installations are available. Roxburgh models KMFA (RF3 for UL installations) and MIF or Schaffner FN3258 and FN258 models are recommended. Refer to http://www.deltron-emcon.com and http://www.mtecorp.com (USA) or http://www.schaffner.com, respectively.

Faults

Faults occur due to conditions within and/or outside the drive that could affect drive operation or application operation. These events or conditions are considered to be of significant magnitude that drive operation should or must be discontinued. Faults are reported to the user via the HIM, communications and/or contact outputs. Faults are selected during commissioning of the drive. Examples of faults include: Encoder loss, communication loss or other exceptions within the drive.

Configuration:

Parameters 365 [Fdbk LsCnfg Pri] through 399 [Position ErrCnfg] program the response of the drive to various conditions. Responses include Ignore, Alarm, Fault Coast Stop, Fault Ramp Stop, and Fault Current Limit Stop.

Parameters 323 [Fault Status 1] through 325 [Fault Status 3] indicated any faults that are active.

Application Example

Parameter 371 [Mtr OL Trip Cnfg] is set to a value of 2 "FltCoastStop". This configures the drive to set the fault bit, parameter 323 [Fault Status 1] bit 10 "Mtr OL Trip" when the motor overload trip event occurs.

Filters

The PowerFlex® 700S has various filters used to assist tuning of the drive. The following section will assist the user in using the filter using frequency and time domain analysis.

Key Words

Frequency response, radians, filter, notch,

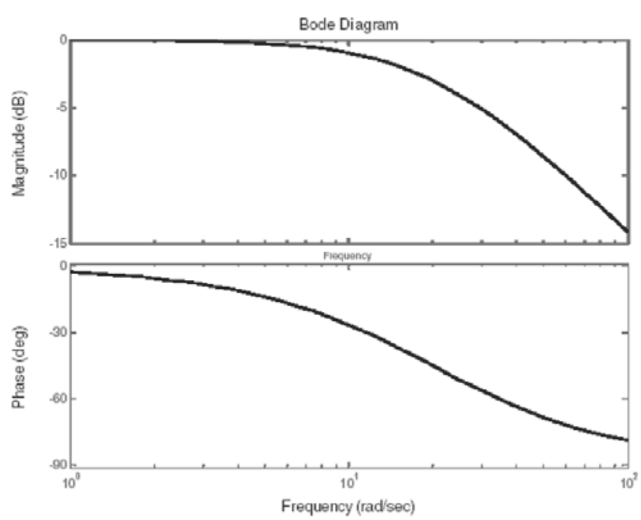
Nomenclature:

Symbol	Description of Symbol	Units
s	Laplace Operator	
ω	Frequency	radians/sec
ω_{co}	Cut-off Frequency	radians/sec

Low Pass Filter

A low pass filter is designed to pass low frequencies and attenuate high frequencies. The break point between high and low is called the cut off frequency.

Figure 2.7 Bode Plot Low Pass Filter (ω_{co} = 10 rad/sec)

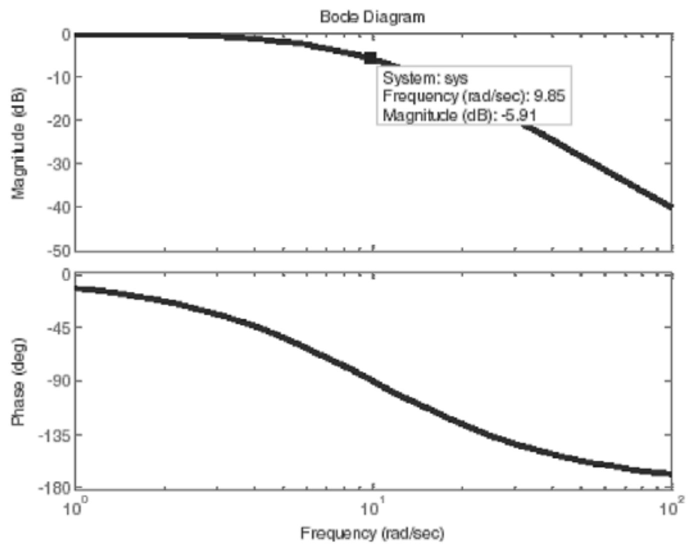


The Process Control Loop has a low pass filter immediately after the error signal. The break frequency is set by parameter 184 [PI Lpass Filt BW]. The filter is used to eliminate unwanted noise in the feedback. Typical range is between 10 rad/sec to 50 rad/sec.

Second Order Low Pass Filter

A second order low pass filter is similar to a low pass filter, however the magnitude rolls off twice as fast as a first order low pass filter. Also the phase shift of a second order filter is from 0 to 180º compared to 0 to 90º of a first order filter.

Figure 2.8 Second Order Low Pass Filter



There is a second order low pass filter in the Speed Control-Regulator. This filter is located after the speed error signal. The break frequency is set by parameter 89 [Spd Err Filt BW]. The break frequency is set to five times (5x) the Speed Loop Bandwidth. This filter is used to attenuate any high frequency noise that the speed loop would not be able to control.

Lead-Lag Filter

The PowerFlex® 700S incorporates a generic lead lag filter. The filter has the following Laplace transfer function:

$$\frac{Kn \times s + wn}{s + wn}$$

Kn is the gain term for the filter and Wn is the frequency term for the filter.

Lead-Lag Filter "lag"

When Kn is less than one (Kn<1) the filter behaves like a low pass filter.

Figure 2.9 Kn < 1 "Lag Filter"

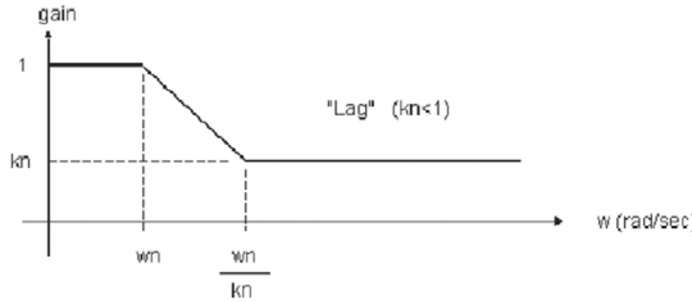
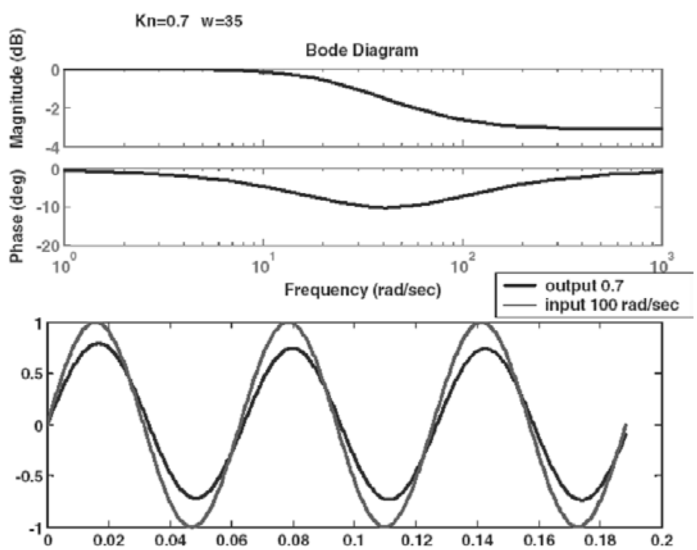


Figure 2.9 shows the lead lag in a "lag configuration." The unique aspect of this filter is that the gain stops once the input frequency is equal to Wn/Kn. Another aspect to this filter is that there is a mild phase shift during the attenuation.

Figure 2.10 shows the bode plot of the lag configuration. Kn is set to 0.7 and Wn is set to 35 rad/sec. The time domain shows a 100 rad/sec sinusoidal input. Notice that the phase shift between input and output are marginal.

Figure 2.10 Bode Plot and Time Domain of Lag



The lag configuration is good for eliminating unwanted noise and disturbance such as backlash. There are two lead-lag blocks used in the speed regulator loop. One is in the forward path and the other is in the feedback path.

	Kn	Wn
Forward Path	Parameter 95 [SRegOut FiltGain]	Parameter 96 [SReg Out Filt BW]
Feedback Path	Parameter 93 [SRegFB Filt Gain]	Parameter 94 [SReg FB Filt BW]

For moderate filtering:

Set Kn=0.7, Wn=0.35

For Heavy filtering:

Set Kn=0.5, Wn=20

Both the Forward and Feedback filters can be set to the same value to increase their effectiveness.

Lead-Lag Filter "Lead"

When Kn is greater than one (Kn>1), the lead-lag filter operates as lead filter. The original equation is re-written into a term that can be used to utilize the lead function. Wn is divided throughout the equation. Two new terms are developed. The lead term (Wld) is used to display the lead of the filter. The lag term (Wlg) is used to show the lag of the filter.

$$\frac{Kn \times s + wn}{s + wn}$$

$$\frac{Kn \times s/(wn + 1)}{s/(wn + 1)}$$

$$\frac{s/(Wld + 1)}{s/(Wlg + 1)}$$

$$wn = Wlg$$

$$Kn = \frac{Wlg}{Wld}$$

Figure 2.11 Kn > 1 "Lead Filter"

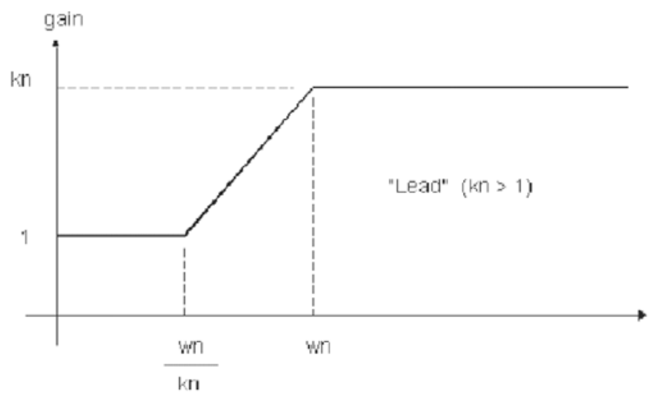


Figure 2.11 shows the bode plot of the lead function. The lead term is used to counteract lags in the system. The speed loop bandwidth appears to the position loop as a low pass filter or a lag. The lead filter can be used to cancel the speed loop lag and replace it with a faster lag.

In the following example:

- The system appears as a lag with a 5 radian/second response.
- The lead filter was set to compensate for the 5 radian/second response (Wld=5)
- The lag filter was set to 50 radian/second response (Wlg=50)
- Kn is set to Wlg/Wld (50/5) = 10
- Wn is set to Wlg = 50

Figure 2.12 Lead Filter Added to System

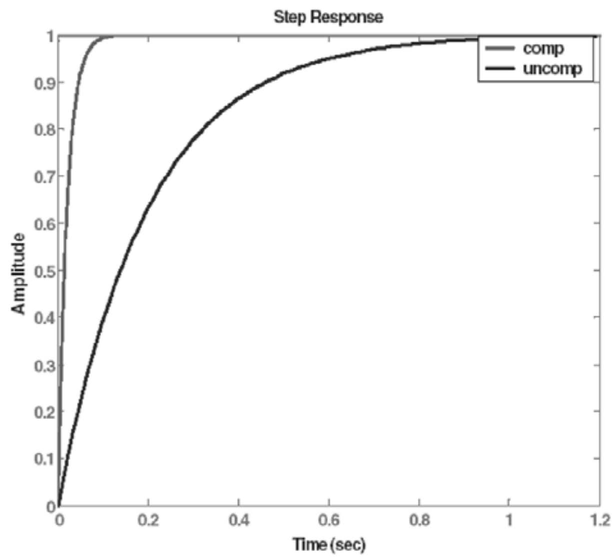


Figure 2.12 shows the results of adding the lead-lag. The system had a response of 5 radians/second. By adding the lead-lag filter the system response was increased to 50 radians/second.

There is lead lag filter for the position loops speed reference. The parameters are Kn=Parameter 25 [STrim2 Filt Gain], Wn=Parameter 26 [SpdTrim2 Filt BW].

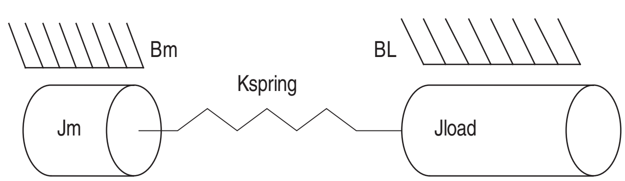
A typical use would be to set the lead function (Wld) to the velocity bandwidth (parameter 90 [Spd Reg BW]) and the lag (Wlg) function to approximately five times (5x) the lead term.

Notch Filter

A Notch Filter is used to remove a specific frequency. On analog inputs and outputs, a notch filter could be used to eliminate any 60Hz noise received from adjacent 120 volt digital input and output wires.

The PowerFlex® 700S has a notch filter that is used to eliminate any resonant signal created by mechanical gear train. The mechanical gear train consists of two masses (the motor and the load) and spring (mechanical coupling between the two loads). This is shown in Figure 2.13.

Figure 2.13 Mechanical Gear Train



The resonant frequency is defined by the following equation:

Jm is the motor inertia (seconds).

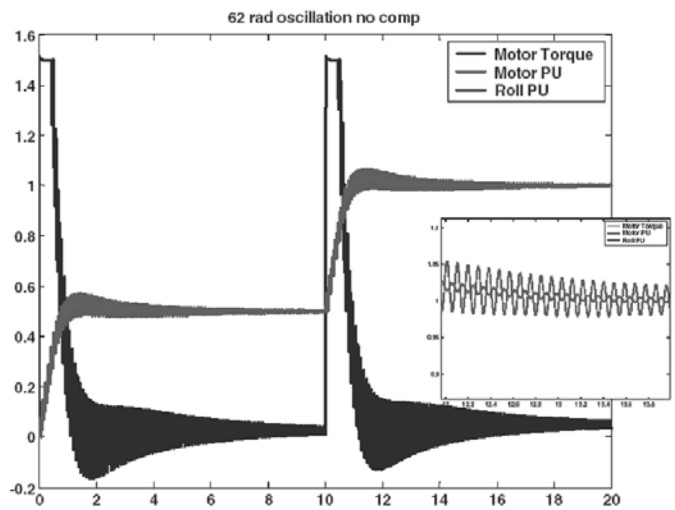
Jload is the load inertia (seconds).

Kspring is the coupling spring constant (rad^2/sec).

$$resonance = \sqrt{Kspring \times \frac{(Jm + Jload)}{Jm \times Jload}}$$

Figure 2.14 shows a two mass system with a resonant frequency of 62 radians/second. One Hertz is equal to 2π radians/second.

Figure 2.14 Resonance

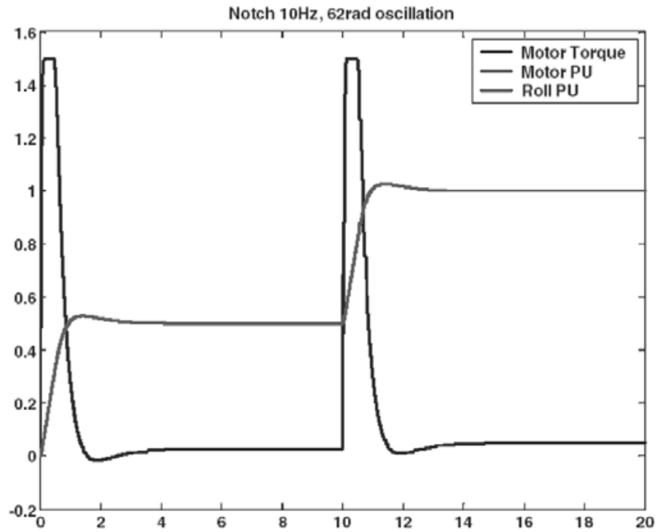


The small inset shows a better representation of resonant frequency better.

The PowerFlex® 700S has a notch filter in the torque reference loop to eliminate such noise from the system. The notch filter frequency is parameter 118 [Notch Filt Freq]. Due to the fact that most mechanical frequencies are described in Hertz, [Notch Filt Freq] is in Hertz as well.

Figure 2.15 shows the same mechanical gear train as in Figure 2.14. [Notch Filt Freq] is set to 10.

Figure 2.15 10 Hz Notch



Conclusion

There are several filters used in the PowerFlex® 700S for various applications.

The process trim uses a simple low pass filter to eliminate undesirable noise in the feedback circuit. The cut off frequency of the low pass filter is set by parameter 184 [PI Lpass Filt BW]. Typical values would range from 15-20 radians/second.

The speed loop uses a second order low pass filter after the speed error term is developed. The cut off frequency of the second order low pass filter is by parameter 89 [Spd Err Filt BW]. Typical value for this parameter is five times (5x) the speed loop bandwidth (parameter 90 [Spd Reg BW]).

There are several lead lag filters used in the PowerFlex 700S. The lead lag filter has two terms. The first term is the filter gain (Kn) and the second term is the filter frequency (Wn). The filter can be used as "lag" to eliminate noise from entering the control loop. The filter can be used as a "lead" to increase overall system performance.

To eliminate noise (lag) use with the light or heavy filter.

	Kn	Wn
Light	0.7	35
Heavy	0.5	20

To use the lead function:

1. Set Wld equal to the desired lead in radians/second
2. Set Wlg equal to 5x Wld
3. Wn=Wlg
4. Kn=Wlg/Wld

The torque reference has a notch filter used to eliminate resonance signals. The notch frequency is set by parameter 118 [Notch Filt Freq]. This frequency is set to the mechanical resonance in hertz.

Firmware Functions

Parameter 147 [FW Functions En] allows the user to enable and display firmware functions in the drive. When a function is disabled, the parameters cannot be changed. The parameters associated with the disabled function will not be displayed on the HIM module. Parameter 149 [FW Functions Actl] will display the actual functions that are enabled or disabled. Making a change to [FW Functions En] will take affect as soon as the change is made.

To view parameters in DriveExecutive™ for a firmware function that has just been turned on you can either create a new database after you have enabled the function in the drive, or turn on the show hidden parameters feature in DriveExecutive by selecting **View > Options > Components**.

Flying Start

ATTENTION: The Flying Start function is only used for sensorless operation. In all other cases the motor speed is known from the feedback device and a normal start may be used even if the motor is rotating, provided the user has determined that the system is safe for re-starting while rotating.

The Flying Start feature is used in sensorless mode to start a rotating motor, as quickly as possible, and resume normal operation with a minimal impact on load or speed.

When a drive running in sensorless mode is started in its normal mode it initially applies a frequency of 0 Hz and ramps to the commanded speed. If the drive is started in this mode with the motor already spinning, large currents will be generated. An overcurrent trip may result if the current limiter cannot react quickly enough. The likelihood of an overcurrent trip is further increased if there is residual voltage on the spinning motor when the drive starts. Even if the current limiter is fast enough to prevent an overcurrent trip, it may take an unacceptable amount of time for synchronization to occur and for the motor to reach its desired frequency. In addition, larger mechanical stress is placed on the application, increasing downtime and repair costs while decreasing productivity.

The flying start function works by using the voltage feedback from the motor to determine the speed of the motor. When the speed is determined, the drive provides flux up time for the motor. Then the drive begins ramping the motor to the commanded speed from the speed determined by the voltage feedback. This process will prevent an overcurrent trip and significantly reduce the time for the motor to reach its desired frequency. Since the motor is "picked up "smoothly at its rotating speed and ramped to the proper speed, little or no mechanical stress is present. Note that if the voltage feedback from the motor is zero (0), the drive will ramp the motor up to the commanded speed from zero speed.

Configuration

Sensorless flying start is enabled by setting parameter 153 [Control Options] bit 3 "Flying Start" = 1. When set to zero (0) the sensorless flying start function is disabled.

Parameter 170 [Flying StartGain] sets the gain for the flying start. Increasing the value in [Flying StartGain] increases the responsiveness of the flying start. [Flying StartGain] is not functional at time of publication.

Friction Compensation

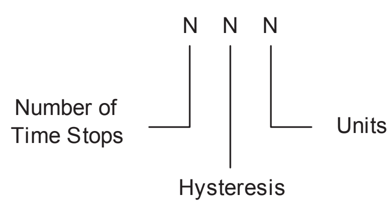
The friction compensation block is used to calculate breakaway torque and the torque needed just to keep the motor running at a constant speed due to friction.

Parameter 64 [FricComp Spd Ref] is linked to parameter 43 [Ramped Spd Ref]. The speed reference is needed because the torque needed due to friction is much more near 0 speed than at higher speeds.

Friction compensation is enabled by setting parameter 151 [Logic Command] bit 11 - "Frict Comp" to “1”.

Parameter 65 [FricComp Setup] is used to configure the friction compensation algorithm. This is a packed word of 3 digits. Each digit has a possible selection of 10 levels.

- The least significant digit sets the speed threshold in intervals of 0.0005 pu speed.
- The next (middle) digit sets the hysteresis band for the "units" digit in intervals of 0.0005 pu velocity.
- The most significant digit sets the number of time steps from stick to slip, each step is 0.002 sec.



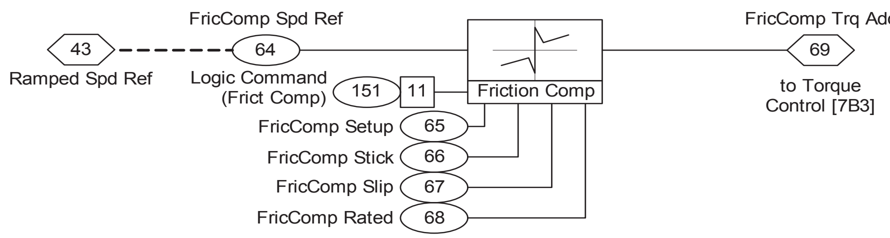
Example: Fsetup = 524 means: 5 time steps between stick and slip, each of 0.002 sec. duration, 2 counts of hysteresis or 0.001 pu_speed (each count is 0.0005 pu speed), and 4 counts or 0.002 pu_speed is the trigger threshold (each count is 0.0005 pu speed).

Parameter 66 [FricComp Stick] sets the torque reference needed to break away from zero speed. Breakaway torque due to friction is always greater than running torque due to friction. This parameter is in per unit, so a value of 1 equals 100% motor torque.

Parameter 67 [FricComp Slip] sets the torque level to sustain very low speed once breakaway has been achieved. Again, the torque required to run very close to 0 speed due to friction will be greater than the torque required to run at higher speeds due to friction. This parameter is in per unit, so a value of 1 equals 100% motor torque.

Parameter 68 [FricComp Rated] sets the torque needed to keep the motor running at base motor speed and with no process loading. This parameter is in per unit, so a value of 1 equals 100% motor torque. The friction compensation algorithm assumes a linear or viscous component of friction between [FricComp Slip] and [FricComp Rated].

The friction compensation block calculates the torque needed due to friction, which shows up in parameter 69 [FricComp TrqAdd]. [FricComp TrqAdd] is summed with the output of the inertia compensation block and the torque generated by the speed reference loop. That summed torque enters the torque selection block refer to Torque Reference for more information).



Fuses and Circuit Breakers

The following tables provide drive ratings (including continuous, 1 minute and 3 second) and recommended AC line input fuse and circuit breaker information. Both types of short circuit protection are acceptable for UL and IEC requirements. Sizes listed are the recommended sizes based on 40^{o} C and the U.S. N.E.C. Other country, state or local codes may require different ratings.

Fusing

If fuses are chosen as the desired protection method, refer to the recommended types listed below. If available amp ratings do not match the tables provided, the closest fuse rating that exceeds the drive rating should be chosen. IEC - BS88 (British Standard) Parts 1 & 2 (1), EN60269-1, Parts 1 & 2, type gG or equivalent should be used.

UL - UL Class CC, T, RK1 or J must be used.

Circuit Breakers

The “non-fuse” listings in the following tables include both circuit breakers (inverse time or instantaneous trip) and 140M Self-Protecting Motor Starters. If one of these is chosen as the desired protection method, the following requirements apply. IEC and UL - Both types of devices are acceptable for IEC and UL installations.

208 Volt AC Input Protection Devices, Frames 1- 6 *(See page 2-49 for Notes)*

Drive Catalog Number	Frame	kW Rating		Input Ratings		Output Amps			Dual Element Time Delay Fuse		Non-Time Delay Fuse		Circuit Breaker [3]	Motor Circuit Protector [4]	140M Motor Starter with Adjustable Current Range [5][6]				Power Dissipation
		ND	*HD*	*Amps*	*kVA*	*Cont.*	*1 Min.*	*3 Sec.*	*Min.* [1]	*Max.* [2]	*Min.* [1]	*Max.* [2]	*Max.* [10]	*Max.* [10]	*Available Catalog Numbers* [7]				*Watts*
20DB2P2	1	0.5	0.33	1.9	0.7	2.2	2.8	3.8	3	6	3	10	15	3	140M-C2E-B25	140M-D8E-B25	–	–	NA
20DB4P2	1	0.75	0.37	3.7	1.3	4.8	5.6	7.0	6	10	6	17.5	15	7	140M-C2E-B63	140M-D8E-B63	–	–	NA
20DB6P8	1	1.5	0.75	6.8	2.4	7.8	10.4	13.8	10	15	10	30	30	15	140M-C2E-C10	140M-D8E-C10	140M-F8E-C10	–	NA
20DB9P6	1	2.2	1.5	9.5	3.4	11	12.1	17	12	20	12	40	40	15	140M-C2E-C16	140M-D8E-C16	140M-F8E-C16	–	NA
20DB015	1	4	2.2	15.7	5.7	17.5	19.3	26.3	20	35	20	70	70	30	140M-C2E-C20	140M-D8E-C20	140M-F8E-C20	–	NA
20DB022	1	5.5	4	23.0	8.3	25.3	27.8	38	30	50	30	100	100	30	140M-C2E-C25	140M-D8E-C25	140M-F8E-C25	140M-CMN-2500	NA
20DB028	2	7.5	5.5	29.6	10.7	32.2	38	50.6	40	70	40	125	125	50	–	–	140M-F8E-C32	140M-CMN-4000	NA
20DB042	3	11	7.5	44.5	16.0	48.3	53.1	72.5	60	100	60	175	175	70	–	–	140M-F8E-C45	140M-CMN-6300	NA
20DB052	3	15	11	51.5	17.1	56	64	86	80	125	80	200	200	100	–	–	–	140M-CMN-6300	NA
20DB070	4	18.5	15	72	25.9	78.2	86	117.3	90	175	90	300	300	100	–	–	–	140M-CMN-9000	NA
20DB080	4	22	18.5	84.7	30.5	92	117.3	156.4	110	200	110	350	350	150	–	–	–	140M-CMN-9000	NA
20DB104	5	30	–	113	40.7	120	132	175	150	250	150	475	350	150	–	–	–	–	NA
		–	22	84.7	30.5	92	138	175	125	200	125	350	300	150	–	–	–	140M-CMN-9000	NA
20DB130	5	30	–	122	44.1	130	143	175	175	275	175	500	375	250	–	–	–	–	NA
		–	30	98	35.3	104	156	175	125	225	125	400	300	150	–	–	–	–	NA
20DB154	6	45	–	167	60.1	177	195	266	225	350	225	500	500	250	–	–	–	–	NA
		–	37	141	50.9	150	225	300	200	300	200	500	450	250	–	–	–	–	NA
20DB192	6	55	–	208	75.0	221	243	308	300	450	300	600	600	400	–	–	–	–	NA
		–	45	167	60.1	177	266	308	225	350	225	500	500	250	–	–	–	–	NA
20DB260	6	66	–	255	91.9	260	286	390	250	450	250	600	600	400	–	–	–	–	NA
		–	55	199	71.7	205	305	410	350	550	350	750	750	400	–	–	–	–	NA

240 Volt AC Input Protection Devices, Frames 1 - 6 *(See page 2-49 for Notes)*

Drive Catalog Number	Frame	HP Rating		Input Ratings		Output Amps			Dual Element Time Delay Fuse		Non-Time Delay Fuse		Circuit Breaker [3]	Motor Circuit Protector [4]	140M Motor Starter with Adjustable Current Range [5][6]				Power Dissipation
		ND	HD	Amps	kVA	Cont.	1 Min.	3 Sec.	Min. [1]	Max. [2]	Min. [1]	Max. [2]	Max. [10]	Max. [10]	Available Catalog Numbers [7]				Watts
20DB2P2	1	0.5	0.33	1.7	0.7	2.2	2.4	3.3	3	6	3	10	15	3	140M-C2E-B25	140M-D8E-B25	–	–	NA
20DB4P2	1	1	0.75	3.3	1.4	4.2	4.8	6.4	5	8	5	15	15	7	140M-C2E-B63	140M-D8E-B63	–	–	NA
20DB6P8	1	2	1.5	5.9	2.4	6.8	9	12	10	15	10	25	25	15	140M-C2E-C10	140M-D8E-C10	140M-F8E-C10	–	NA
20DB9P6	1	3	2	8.3	3.4	9.6	10.6	14.4	12	20	12	35	35	15	140M-C2E-C10	140M-D8E-C10	140M-F8E-C10	–	NA
20DB015	1	5	3	13.7	5.7	15.3	16.8	23	20	30	20	60	60	30	140M-C2E-C16	140M-D8E-C16	140M-F8E-C16	–	NA
20DB022	1	7.5	5	19.9	8.3	22	24.2	33	25	50	25	80	80	30	140M-C2E-C25	140M-D8E-C25	140M-F8E-C25	140M-CMN-2500	NA
20DB028	2	10	7.5	25.7	10.7	28	33	44	35	60	35	100	100	50	–	–	140M-F8E-C32	140M-CMN-4000	NA
20DB042	3	15	10	38.5	16.0	42	46.2	63	50	90	50	150	150	50	–	–	140M-F8E-C45	140M-CMN-6300	NA
20DB052	3	20	15	47.7	19.8	52	63	80	60	100	60	200	200	100	–	–	–	140M-CMN-6300	NA
20DB070	4	25	20	64.2	26.7	70	78	105	90	150	90	275	275	100	–	–	–	140M-CMN-9000	NA
20DB080	4	30	25	73.2	30.5	80	105	136	100	180	100	300	300	100	–	–	–	140M-CMN-9000	NA
20DB104	5	40	–	98	40.6	104	115	175	125	225	125	400	300	150	–	–	–	–	NA
		–	30	73	30.5	80	120	160	100	175	100	300	300	100	–	–	–	140M-CMN-9000	NA
20DB130	5	50	–	122	50.7	130	143	175	175	275	175	500	375	250	–	–	–	–	NA
		–	40	98	40.6	104	156	175	125	225	125	400	300	150	–	–	–	–	NA
20DB154	6	60	–	145	60.1	154	169	231	200	300	200	600	450	250	–	–	–	–	NA
		–	50	122	50.7	130	195	260	175	275	175	500	375	250	–	–	–	–	NA
20DB192	6	75	–	180	74.9	192	211	288	225	400	225	600	575	250	–	–	–	–	NA
		–	60	145	60.1	154	231	308	200	300	200	600	450	250	–	–	–	–	NA
20DB260	6	100	–	255	91.9	260	286	390	250	450	250	600	600	400	–	–	–	–	NA
		–	75	199	71.7	205	305	410	350	550	350	750	750	400	–	–	–	–	NA

400 Volt AC Input Protection Devices, Frames 1 - 6 *(See page 2-49 for Notes)*

Drive Catalog Number	Frame	kW Rating		Input Ratings		Output Amps			Dual Element Time Delay Fuse		Non-Time Delay Fuse		Circuit Breaker [3]	Motor Circuit Protector [4]	140M Motor Starter with Adjustable Current Range [5][6]			Power Dissipation
		ND	HD	Amps	kVA	Cont.	1 Min.	3 Sec.	Min. [1]	Max. [2]	Min. [1]	Max. [2]	Max. [10]	Max. [10]	Available Catalog Numbers [7]			Watts
20DD2P1	1	0.75	0.55	1.8	1.3	2.1	2.4	3.2	3	6	3	8	15	3	140M-C2E-B25	140M-D8E-B25	–	NA
20DD3P4	1	1.5	0.75	3.2	2.2	3.5	4.5	6.0	6	7	6	12	15	7	140M-C2E-B40	140M-D8E-B40	–	NA
20DD5P0	1	2.2	1.5	4.6	3.2	5.0	5.5	7.5	6	10	6	20	20	7	140M-C2E-B63	140M-D8E-B63	–	NA
20DD8P0	1	4	2.2	7.9	5.5	8.7	9.9	13.2	15	17.5	15	30	30	15	140M-C2E-C10	140M-D8E-C10	140M-F8E-C10	NA
20DD011	1	5.5	4	10.8	7.5	11.5	13	17.4	15	25	15	45	45	15	140M-C2E-C16	140M-D8E-C16	140M-F8E-C16	NA
20DD014	1	7.5	5.5	14.4	10.0	15.4	17.2	23.1	20	30	20	60	60	20	140M-C2E-C20	140M-D8E-C20	140M-F8E-C20	NA
20DD022	1	11	7.5	20.6	14.3	22	24.2	33	30	45	30	80	80	30	140M-C2E-C25	140M-D8E-C25	140M-F8E-C25	NA
20DD027	2	15	11	28.4	19.7	30	33	45	35	60	35	120	120	50	–	–	140M-F8E-C32	NA
20DD034	2	18.5	15	35.0	24.3	37	45	60	45	80	45	125	125	50	–	–	140M-F8E-C45	NA
20DD040	3	22	18.5	40.7	28.2	43	56	74	60	90	60	150	150	60	–	–	–	NA
20DC052	3	30	22	53	36.7	56	64	86	70	125	70	200	200	100	–	–	–	NA
20DD065	3	37	30	68.9	47.8	72	84	112	90	150	90	250	250	100	–	–	–	NA
20DD077 [8]	4	45	–	81.4	56.4	85	94	128	110	200	110	300	300	150	–	–	–	NA
		–	37	68.9	47.8	72	108	144	90	175	90	275	300	100	–	–	–	NA
20DD096	5	55	–	100.5	69.6	105	116	158	125	225	125	400	300	150	–	–	–	NA
		–	45	81.4	56.4	85	128	170	110	175	110	300	300	150	–	–	–	NA
20DD125	5	55	–	121.1	83.9	125	138	163	150	275	150	500	375	250	–	–	–	NA
		–	45	91.9	63.7	96	144	168	125	200	125	375	375	150	–	–	–	NA
20DD156	6	90	–	164	126	170	187	255	250	375	250	600	500	250	–	–	–	NA
		–	75	136	103	140	210	280	200	300	200	550	400	250	–	–	–	NA
20DD180 [9]	6	110	–	199	148	205	220	289	250	450	250	600	600	400	–	–	–	NA
		–	90	164	126	170	255	313	250	375	250	600	500	250	–	–	–	NA
20DD248	6	132	–	255	177	260	286	390	350	550	350	750	750	400	–	–	–	NA
		–	110	199	138	205	308	410	250	450	250	600	600	400	–	–	–	NA

400 Volt AC Input Protection Devices, Frames 9 - 11 *(See page 2-49 for Notes)*

Drive Catalog Number	Frame	kW Rating		Input Ratings		Output Amps			Dual Element Time Delay Fuse		Non-Time Delay Fuse		Circuit Breaker[3]	Motor Circuit Protector[4]	140M Motor Starter with Adjustable Current Range[5][6]			Power Dissipation
		ND	HD	Amps	kVA	Cont.	1 Min.	3 Sec.	Min.[1]	Max.[2]	Min.[1]	Max.[2]	Max.[10]	Max.[10]	Available Catalog Numbers[7]			Watts
20DD261	9	132	-	256	171	261	287	410	325	500	325	700	700	400	–	–	–	NA
		-	110	201	139	205	308	410	250	400	250	550	600	400	–	–	–	NA
20DD300	9	160	-	294	204	300	330	450	375	675	375	800	800	400	–	–	–	NA
		-	132	240	166	245	368	490	325	500	325	650	700	400	–	–	–	NA
20DD385	10	200	-	377	261	385	424	600	500	800	500	1000	800	800	–	–	–	NA
		-	160	294	204	300	450	600	375	675	375	800	800	600	–	–	–	NA
20DD460	10	250	-	451	312	460	506	770	575	900	575	1200	1200	800	–	–	–	NA
		-	200	377	261	385	578	770	500	800	500	1000	800	800	–	–	–	NA
20DD500	10	250	-	490	339	500	550	750	625	1100	625	1400	1200	800	–	–	–	NA
		-	200	411	285	420	630	840	525	1000	525	1000	1200	800	–	–	–	NA
20DD590	11	315	-	590	408	590	649	1040	750 (1 per phs) 375 (2 per phs)	1300 (1 per phs) 600 (2 per phs)	750 (1 per phs) 375 (2 per phs)	1700 (1 per phs) 850 (2 per phs)	1600	1200	–	–	–	NA
		-	250	520	360	520	780	1040	650 (1 per phs) 325 (2 per phs)	1100 (1 per phs) 550 (2 per phs)	650 (1 per phs) 325 (2 per phs)	1500 (1 per phs) 750 (2 per phs)	1200	800	–	–	–	NA
20DD650	11	355	-	650	450	650	715	1180	900 (1 per phs) 450 (2 per phs)	1300 (1 per phs) 650 (2 per phs)	900 (1 per phs) 450 (2 per phs)	1700 (1 per phs) 850 (2 per phs)	1600	1200	–	–	–	NA
		-	315	590	408	590	885	1180	750 (1 per phs) 375 (2 per phs)	1300 (1 per phs) 650 (2 per phs)	750 (1 per phs) 375 (2 per phs)	1700 (1 per phs) 850 (2 per phs)	1600	1200	–	–	–	NA
20DD730	11	400	-	730	506	730	803	1095	1000 (1 per phs) 500 (2 per phs)	1500 (1 per phs) 750 (2 per phs)	1000 (1 per phs) 500 (2 per phs)	2000 (1 per phs) 1000 (2 per phs)	2000	2000	–	–	–	NA
		-	355	650	450	650	945	1260	900 (1 per phs) 450 (2 per phs)	1300 (1 per phs) 650 (2 per phs)	900 (1 per phs) 450 (2 per phs)	1700 (1 per phs) 850 (2 per phs)	1600	1200	–	–	–	NA

480 Volt AC Input Protection Devices, Frames 1 - 6 *(See page 2-49 for Notes)*

Drive Catalog Number	Frame	HP Rating		Input Ratings		Output Amps			Dual Element Time Delay Fuse		Non-Time Delay Fuse		Circuit Breaker [3]	Motor Circuit Protector [4]	140M Motor Starter with Adjustable Current Range [5][6]				Power Dissipation
		ND	HD	Amps	kVA	Cont.	1 Min.	3 Sec.	Min. [1]	Max. [2]	Min. [1]	Max. [2]	Max. [10]	Max. [10]	Available Catalog Numbers [7]				Watts
20DD2P1	1	1	0.75	1.6	1.4	2.1	2.4	3.2	3	6	3	8	15	3	140M-C2E-B25	–	–	–	103
20DD3P4	1	2	1.5	2.6	2.2	3.4	4.5	6.0	4	8	4	12	15	7	140M-C2E-B40	140M-D8E-B40	–	–	117
20DD5P0	1	3	2	3.9	3.2	5.0	5.5	7.5	6	10	6	20	20	7	140M-C2E-B63	140M-D8E-B63	–	–	135
20DD8P0	1	5	3	6.9	5.7	8.0	8.8	12	10	15	10	30	30	15	140M-C2E-C10	140M-D8E-C10	140M-F8E-C10	–	210
20DD011	1	7.5	5	9.5	7.9	11	12.1	16.5	15	20	15	40	40	15	140M-C2E-C16	140M-D8E-C16	140M-F8E-C16	–	243
20DD014	1	10	7.5	12.5	10.4	14	16.5	22	17.5	30	17.5	50	50	20	140M-C2E-C16	140M-D8E-C16	140M-F8E-C16	–	271
20DD022	1	15	10	19.9	16.6	22	24.2	33	25	50	25	80	80	30	140M-C2E-C25	140M-D8E-C25	140M-F8E-C25	140-CMN-2500	389
20DD027	2	20	15	24.8	20.6	27	33	44	35	60	35	100	100	50	–	–	140M-F8E-C32	140-CMN-4000	467
20DD034	2	25	20	31.2	25.9	34	40.5	54	40	70	40	125	125	50	–	–	140M-F8E-C45	140-CMN-4000	519
20DD040	3	30	25	36.7	30.5	40	51	68	50	90	50	150	150	50	–	–	140M-F8E-C45	140-CMN-4000	543
20DD052	3	40	30	47.7	39.7	52	60	80	60	110	60	200	200	70	–	–	–	140M-CMN-6300	708
20DD065	3	50	40	59.6	49.6	65	78	104	80	125	80	250	250	100	–	–	–	140M-CMN-9000	NA
20DD077	4	60	–	72.3	60.1	77	85	116	100	170	100	300	300	100	–	–	–	140M-CMN-9000	NA
		–	50	59.6	49.6	65	98	130	80	125	80	250	250	100	–	–	–	140M-CMN-9000	NA
20DD096	5	75	–	90.1	74.9	96	106	144	125	200	125	350	350	125	–	–	–	–	NA
		–	60	72.3	60.1	77	116	154	100	170	100	300	300	100	–	–	–	140M-CMN-9000	NA
20DD125	5	100	–	117	97.6	125	138	163	150	250	150	500	375	150	–	–	–	–	NA
		–	75	90.1	74.9	96	144	168	125	200	125	350	350	125	–	–	–	–	NA
20DD156	6	125	–	147	122	156	172	233	200	350	200	600	450	250	–	–	–	–	NA
		–	100	131	109	125	188	250	175	250	175	500	375	250	–	–	–	–	NA
20DD180	6	150	–	169	141	180	198	270	225	400	225	600	500	250	–	–	–	–	NA
		–	125	147	122	156	234	312	200	350	200	600	450	250	–	–	–	–	NA
20DD248	6	200		233	194	248	273	372	300	550	300	700	700	400	–	–	–	–	NA
			150	169	141	180	270	360	225	400	225	600	500	250	–	–	–	–	NA

480 Volt AC Input Protection Devices, Frames 9 - 11 *(See page 2-49 for Notes)*

Drive Catalog Number	Frame	HP Rating		Input Ratings		Output Amps			Dual Element Time Delay Fuse		Non-Time Delay Fuse		Circuit Breaker [3]	Motor Circuit Protector [4]	140M Motor Starter with Adjustable Current Range [5][6]				Power Dissipation
		ND	HD	Amps	kVA	Cont.	1 Min.	3 Sec.	Min. [1]	Max. [2]	Min. [1]	Max. [2]	Max. [10]	Max. [10]	Available Catalog Numbers [7]				Watts
20DD261	9	200	-	245	204	261	287	410	325	500	325	700	700	400	–	–	–	–	2700
		-	150	193	160	205	308	410	250	400	250	550	600	400	–	–	–	–	2700
20DD300	9	250	-	282	234	300	330	450	375	675	375	800	800	400	–	–	–	–	3100
		-	200	230	191	245	368	490	325	500	325	650	700	400	–	–	–	–	3100
20DD385	10	300	-	362	301	385	424	600	500	800	500	1000	800	800	–	–	–	–	4700
		-	250	282	234	300	450	600	375	675	375	800	800	600	–	–	–	–	4700
20DD460	10	350	-	432	359	460	506	770	575	900	575	1200	1200	800	–	–	–	–	5500
		-	300	362	301	385	578	770	500	800	500	1000	800	800	–	–	–	–	5500
20DD500	10	450	-	469	390	500	550	750	625	1100	625	1400	1200	800	–	–	–	–	6400
		-	350	394	328	420	630	840	525	1000	525	1000	1200	800	–	–	–	–	6400
20DD590	11	500	-	590	490	590	649	956	750 (1 per phs) 375 (2 per phs)	1300 (1 per phs) 600 (2 per phs)	750 (1 per phs) 375 (2 per phs)	1700 (1 per phs) 850 (2 per phs)	1600	1200	–	–	–	–	NA
		-	450	520	532	520	780	956	650 (1 per phs) 325 (2 per phs)	1100 (1 per phs) 550 (2 per phs)	650 (1 per phs) 325 (2 per phs)	1500 (1 per phs) 750 (2 per phs)	1200	800	–	–	–	–	NA
20DD650	11	500	-	650	540	650	715	1062	900 (1 per phs) 450 (2 per phs)	1300 (1 per phs) 650 (2 per phs)	900 (1 per phs) 450 (2 per phs)	1700 (1 per phs) 850 (2 per phs)	1600	1200	–	–	–	–	NA
		-	500	590	490	590	885	1062	750 (1 per phs) 375 (2 per phs)	1300 (1 per phs) 650 (2 per phs)	750 (1 per phs) 375 (2 per phs)	1700 (1 per phs) 850 (2 per phs)	1600	1200	–	–	–	–	NA
20DD730	11	600	-	730	607	730	803	1095	1000 (1 per phs) 500 (2 per phs)	1500 (1 per phs) 750 (2 per phs)	1000 (1 per phs) 500 (2 per phs)	2000 (1 per phs) 1000 (2 per phs)	2000	2000	–	–	–	–	NA
		-	500	650	540	650	975	1170	900 (1 per phs) 450 (2 per phs)	1300 (1 per phs) 650 (2 per phs)	900 (1 per phs) 450 (2 per phs)	1700 (1 per phs) 850 (2 per phs)	1600	1200	–	–	–	–	NA

600 Volt AC Input Protection Devices, Frames 1 - 6 *(See page 2-49 for Notes)*

Drive Catalog Number	Frame	HP Rating		PWM Freq.	Temp.	Input Ratings		Output Amps			Dual Element Time Delay Fuse		Non-Time Delay Fuse		Circuit Breaker [3]	Motor Circuit Protector [4]	140M Motor Starter with Adjustable Current Range [5][6]				Power Dissipation
		ND	HD	kHz	°C	Amps	kVA	Cont.	1 Min.	3 Sec.	Min. [1]	Max. [2]	Min. [1]	Max. [2]	Max. [10]	Max. [10]	Available Catalog Numbers [7]				Watts
20DE1P7	1	1	0.5	4	50	1.3	1.4	1.7	2	2.6	2	4	2	6	15	3	M-C2E-B16	–	–	–	NA
20DE2P7	1	2	1	4	50	2.1	2.1	2.7	3.6	4.8	3	6	3	10	15	3	M-C2E-B25	–	–	–	NA
20DE3P9	1	3	2	4	50	3.0	3.1	3.9	4.3	5.9	6	9	6	15	15	7	M-C2E-B40	M-D8E-B40	–	–	NA
20DE6P1	1	5	3	4	50	5.3	5.5	6.1	6.7	9.2	9	12	9	20	20	15	M-C2E-B63	M-D8E-B63	–	–	NA
20DE9P0	1	7.5	5	4	50	7.8	8.1	9	9.9	13.5	10	20	10	35	30	15	M-C2E-C10	M-D8E-C10	M-F8E-C10	–	NA
20DE011	1	10	7.5	4	50	9.9	10.2	11	13.5	18	15	25	15	40	40	15	M-C2E-C10	M-D8E-C10	M-F8E-C10	–	NA
20DE017	1	15	10	4	50	15.4	16.0	17	18.7	25.5	20	40	20	60	50	20	M-C2E-C16	M-D8E-C16	M-F8E-C16	–	NA
20DE022	2	20	15	4	50	20.2	21.0	22	25.5	34	30	50	30	80	80	30	M-C2E-C25	M-D8E-C25	M-F8E-C25	-CMN-2500	NA
20DE027	2	25	20	4	50	24.8	25.7	27	33	44	35	60	35	100	100	50	–	–	M-F8E-C25	-CMN-2500	NA
20DE032	3	30	25	4	50	29.4	30.5	32	40.5	54	40	70	40	125	125	50	–	–	M-F8E-C32	-CMN-4000	NA
20DE041	3	40	30	4	50	37.6	39.1	41	48	64	50	90	50	150	150	100	–	–	M-F8E-C45	-CMN-4000	NA
20DE052	3	50	40	4	50	47.7	49.6	52	61.5	82	60	110	60	200	200	100	–	–	–	M-CMN-6300	NA
20DE062	4	60	50	2	50	58.2	60.5	62	78	104	80	125	80	225	225	100	–	–	–	M-CMN-6300	NA
20DE077	5	75	–	2	50	72.3	75.1	77	85	116	90	150	90	300	300	100	–	–	–	M-CMN-9000	NA
		–	60	2	50	58.2	60.5	63	94	126	90	125	90	250	250	100	–	–	–	M-CMN-6300	NA
20DE099	5	100	–	2	40	92.9	96.6	99	109	126	125	200	125	375	375	150	–	–	–	–	NA
		–	75	2	40	72.3	75.1	77	116	138	100	175	100	300	300	100	–	–	–	M-CMN-9000	NA
20DE125	6	125	–	2	50	117	122	125	–	–	150	250	150	375	375	250	–	–	–	–	NA
		–	100	2	50	92.9	96.6	99	–	–	125	200	125	375	375	150	–	–	–	–	NA
20DE144	6	150	–	2		135	141	144	–	–	175	300	175	400	400	250	–	–	–	–	NA
		–	125	2		117	122	125	–	–	150	275	150	375	375	250	–	–	–	–	NA

690 Volt AC Input Protection Devices *(See Notes below)*

Drive Catalog Number	Frame	kW Rating		PWM Freq.	Temp.	Input Ratings		Output Amps			Dual Element Time Delay Fuse		Non-Time Delay Fuse		Circuit Breaker (3)	Motor Circuit Protector (4)	Power Dissipation
		ND	*HD*	*kHz*	*°C*	*Amps*	*kVA*	*Cont.*	*1 Min.*	*3 Sec.*	*Min.* (1)	*Max.* (2)	*Min.* (1)	*Max.* (2)	*Max.* (10)	*Max.* (10)	*Watts*
20DF052	5	45	–	4	50	46.9	56.1	52	57	78	60	110	60	175	175	–	NA
		–	37.5	4	50	40.1	48.0	46	69	92	50	90	50	150	150	–	NA
20DF060	5	55	–	4	50	57.7	68.9	60	66	90	80	125	80	225	225	–	NA
		–	45	4	50	46.9	56.1	52	78	104	60	110	60	175	175	–	NA
20DF082	5	75	–	2	50	79.0	94.4	82	90	120	100	200	100	375	375	–	NA
		–	55	2	50	57.7	68.9	60	90	123	80	125	80	225	225	–	NA
20DF098	5	90	–	2	40	94.7	113	98	108	127	125	200	125	375	375	–	NA
		–	75	2	40	79.0	94.4	82	123	140	100	200	100	375	375	–	NA
20DF119	6	110	–	2	50	115	137	119	131	179	150	250	150	400	–	–	NA
		–	90	2	50	94.7	113	98	147	196	125	200	125	375	–	–	NA
20DF142	6	132	–	2	50	138	165	142	156	213	175	300	175	450	–	–	NA
		–	110	2	50	115	137	119	179	238	150	250	150	400	–	–	NA

Notes:

(1) Minimum protection device size is the lowest rated device that supplies maximum protection without nuisance tripping.
(2) Maximum protection device size is the highest rated device that supplies drive protection. For US NEC, minimum size is 125% of motor FLA. Ratings shown are maximum.
(3) Circuit Breaker - inverse time breaker. For US NEC, minimum size is 125% of motor FLA. Ratings shown are maximum.
(4) Motor Circuit Protector - instantaneous trip circuit breaker. For US NEC minimum size is 125% of motor FLA. Ratings shown are maximum.
(5) Bulletin 140M with adjustable current range should have the current trip set to the minimum range that the device will not trip.
(6) Manual Self-Protected (Type E) Combination Motor Controller, UL listed for 208 Wye or Delta, 240 Wye or Delta, 480Y/277 or 600Y/ 347. Not UL listed for use on 480V or 600V Delta/Delta systems.
(7) The AIC ratings of the Bulletin 140M Motor Protector may vary. See publication 140M-SG001.
(8) 20BC085 current rating is limited to 45 degrees C ambient.
(9) 20BC205 current rating is limited to 40 degrees C ambient.
(10) Maximum allowable rating by US NEC. Exact size must be chosen for each installation.

540 Volt DC Input Protection Devices *(Footnotes found on page 50)*

Drive Catalog Number	Frame	HP Rating		DC Input Ratings		Output Amps			Fuse	Non-Time Delay Fuse(2)
		ND	*HD*	*Amps*	*kW*	*Cont.*	*1 Min.*	*3 Sec.*		
20DD014	1	10	7.5	14.7	9.5	15.4	16.5	22	30	HSJ25
20DD022	1	15	10	23.3	15.1	22	24.2	33	45	HSJ400
20DD027	2	20	15	28.9	18.8	30	33	44	60	HSJ50
20DD034	3	25	20	36.4	23.6	37	40.5	54	70	HSJ70
20DD040	3	30	25	42.9	27.8	43	51	68	80	HSJ90
20DD052	3	40	30	55.7	36.1	56	60	80	100	HSJ100
20DD065	3	50	40	69.7	45.4	72	78	104	150	HSJ125
20DD077	4	60	–	84.5	54.7	77	85	116	150	HSJ150
		–	50	67.9	45.4	65	98	130	150	HSJ150
20DJ096 (1)	5	55	–	105.3	68.3	105	116	158	200	HSJ175
		–	45	84.5	54.7	85	128	170	150	HSJ175
20DJ125 (1)	5	55	–	137.1	88.9	125	138	163	250	HSJ200
		–	45	105.3	68.3	96	144	168	200	HSJ200
20DJ156 (1)	6	90	–	171.2	110.9	170	187	255	300	HSJ350
		–	75	137.1	88.9	140	210	280	250	HSJ350
20DJ180 (1)	6	110	–	204.1	132.2	205	220	289	400	HSJ350
		–	90	171.2	110.9	170	255	313	300	HSJ350
20DJ248	6	132	–			260	286	390	550	HSJ400
		–	111			205	308	410	400	HSJ400
20DJ261	9	200	-	299	186	261	287	410	500	170M6608
		-	150	235	146	205	308	410	500	170M6608
20DJ300	9	250	-	343	213	300	330	500	630	170M6610
		-	200	281	174	245	368	490	630	170M6610
20DJ385	10	300	-	441	274	385	424	600	700	170M6611
		-	250	343	213	300	450	600	700	170M6611
20DJ460	10	350	-	527	327	460	506	770	900	170M6613
		-	300	441	274	385	578	770	900	170M6613
20DJ500	10	450	-	572	356	500	550	750	1000	170M6608
		-	350	481	299	420	630	840	1000	170M6608
20DJ590	11	500	-	676	420	590	649	956	630 (2 per phs)	170M6609
		-	450	595	370	520	780	956	630 (2 per phs)	170M6609

Drive Catalog Number	Frame	HP Rating		DC Input Ratings		Output Amps			Fuse	Non-Time Delay Fuse(2)
		ND	HD	Amps	kW	Cont.	1 Min.	3 Sec.		
20DJ650	11	500	-	744	463	650	715	1062	700 (2 per phs)	170M6610
		-	500	676	420	590	885	1062	700 (2 per phs)	170M6610
20DJ730	11	600	-	836	520	730	803	1095	700 (2 per phs)	170M6611
		-	500	744	463	650	975	1170	700 (2 per phs)	170M6611

(1) Also applies to "P" voltage class.
Fuses must be applied in the (+) leg and (-) leg of the DC Common Bus.
(2) The power source to Common Bus inverters must be derived from AC voltages 600V or less, as defined in NFPA70; Art 430-18 (NEC)
Battery supplies or MG sets are not included.
The following devices were validated to break current of the derived power DC Bus:
Disconnects: Allen-Bradley Bulletin No. 1494, 30 to 400 A; Bulletin No. 194, 30 to 400 A, or ABB: OESA, 600 & 800 A; OESL, all sizes.
Fuses: Bussmann Type JKS, all sizes;Type 170M, Case Sizes 1, 2 and 3, or Ferraz Shawmut Type HSJ, all sizes.
For any other devices, please contact the factory.

650 Volt DC Input Protection Devices

Drive Catalog Number	Frame	HP Rating		DC Input Ratings		Output Amps			Fuse	Non-Time Delay Fuse(2)
		ND	HD	Amps	kW	Cont.	1 Min.	3 Sec.		
20DD014	1	10	7.5	14.7	9.5	14	16.5	22	30	HSJ30
20DD022	1	15	10	23.3	15.1	22	24.2	33	45	HSJ40
20DD027	2	20	15	28.9	18.8	27	33	44	60	HSJ50
20DD034	2	25	20	36.4	23.6	34	40.5	54	70	HSJ60
20DD040	3	30	25	42.9	27.8	40	51	68	80	HSJ80
20DD052	3	40	30	55.7	36.1	52	60	80	100	HSJ90
20DD065	3	50	40	69.7	45.4	65	78	104	150	HSJ100
20DD077	4	60	–	84.5	54.7	77	85	116	150	HSJ150
		–	50	67.9	45.4	65	98	130	150	HSJ150
20DJ096(1)	5	75	–	105.3	68.3	96	106	144	200	HSJ175
		–	60	84.5	54.7	77	116	154	150	HSJ175
20DJ125 (1)	5	100	–	137.1	88.9	125	138	163	250	HSJ200
		–	75	105.3	68.3	96	144	168	200	HSJ200
20DJ156(1)	6	125	–	171.2	110.9	156	172	234	300	HSJ300
		–	100	137.1	88.9	125	188	250	250	HSJ300
20DJ180(1)	6	150	–	204.1	132.2	180	198	270	400	HSJ400
		–	125	171.2	110.9	156	234	312	300	HSJ400
20DJ248	6	200	–			248	273	372	550	HSJ400
		–	150			180	270	360	400	HSJ400
20DJ261	9	200	-	299	186	261	287	410	500	170M6608
		-	150	235	146	205	308	410	500	170M6608
20DJ300	9	250	-	343	213	300	330	500	630	170M6610
		-	200	281	174	245	368	490	630	170M6610
20DJ385	10	300	-	441	274	385	424	600	700	170M6611
		-	250	343	213	300	450	600	700	170M6611
20DJ460	10	350	-	527	327	460	506	770	900	170M6613
		-	300	441	274	385	578	770	900	170M6613
20DJ500	10	450	-	572	356	500	550	750	1000	170M6608
		-	350	481	299	420	630	840	1000	170M6608
20DJ590	11	500	-	676	420	590	649	956	630 (2 per phs)	170M6609
		-	450	595	370	520	780	956	630 (2 per phs)	170M6609
20DJ650	11	500	-	744	463	650	715	1062	700 (2 per phs)	170M6610
		‘	500	676	420	590	885	1062	700 (2 per phs)	170M6610
20DJ730	11	600	-	836	520	730	803	1095	700 (2 per phs)	170M6611
		-	500	744	463	650	975	1170	700 (2 per phs)	170M6611

(1) Also applies to "R" voltage class.
Fuses must be applied in the (+) leg and (-) leg of the DC Common Bus.
(2) The power source to Common Bus inverters must be derived from AC Voltages 600V or less, as defined in NFPA70; Art 430-18 (NEC).
Battery supplies or MG sets are not included
The following devices were validated to break current of the derived power DC Bus:
Disconnects: Allen-Bradley Bulletin No. 1494, 30 to 400 A; Bulletin No. 194, 30 to 400 A, or ABB: OESA, 600 & 800 A; OESL, all sizes
Fuses: Bussmann Type JKS, all sizes;Type 170M, Case Sizes 1, 2 and 3, or Ferraz Shawmut Type HSJ, all sizes.
For any other devices, please contact the factory.

Grounding, General

Refer to *"Wiring and Grounding Guidelines for Pulse Width Modulated (PWM) AC Drives,"* publication DRIVES-IN001 for detailed information. This publication is available online at:

http://literature.rockwellautomation.com/literature

HIM Memory

See Copy Cat

HIM Operations

The User Display

The User Display is shown when module keys have been inactive for a predetermined amount of time. The display can be programmed to show pertinent information.

Setting the User Display

Step	Key(s)	Example Displays
1. Press the Up Arrow or Down Arrow to scroll to Operator Intrfc. Press Enter.	▲ ▼	Operator Intrfc: Change Password User Display Parameters
2. Press the Up Arrow or Down Arrow to scroll to User Display. Press Enter.	↵	
3. Select the desired user display. Press Enter. Scroll to the parameter that the user display will be based on.	Sel	
4. Press Enter. Set a scale factor.		
5. Press Enter to save the scale factor and move to the last line.		
6. Press the Up Arrow or Down Arrow to change the text.		
7. Press Enter to save the new user display.		

Setting the Properties of the User Display

The following HIM parameters can be set as desired:

- User Display - Enables or disables the user display.
- User Display 1 - Selects which user display parameter appears on the top line of the user display.
- User Display 2 - Selects which user display parameter appears on the bottom line of the user display.
- User Display Time - Sets how many seconds will elapse after the last programming key is touched before the HIM displays the user display.

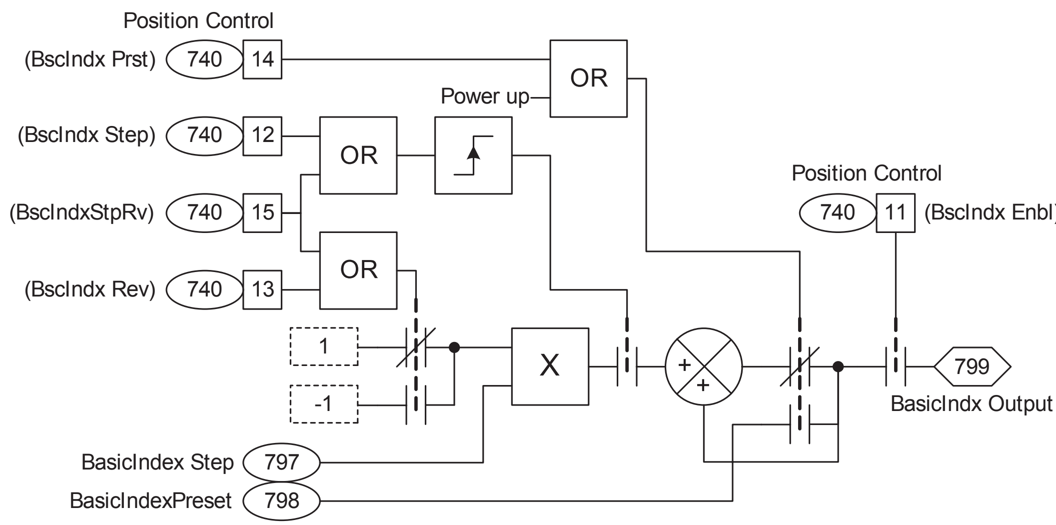
Indexer

The indexer function takes a step increment and adds to or subtracts from a DInt parameter. The indexer output would normally be used in conjunction with the point to point position loop or with a position offset. Typical applications for the indexer are indexing conveyors, such as a conveyor feeding a punch press.

Enabling the Indexer

The firmware function for the position loop must be turned on by setting parameter 147 [FW Functions En] bit 16 - "Position Ctrl" = 1.

Set parameter 740 [Position Control] bit 11 "BscIndx Enbl" = 1.



Configuring the Indexer

Parameter 797 [BasicIndx Step] sets the position units for each indexer step. When the indexer is used in conjunction with the point to point loop, parameters 745 [PositRef EGR Mul] and 746 [PositRef EGR Div] are used to scale the position reference.

The indexer could be used in conjunction with the point to point position loop or with a position offset. To use the indexer to control the point to point position, link parameter 758 [Pt-Pt Posit Ref] to parameter 799 [BasicIndexOutput]. Refer to Position Loop - Point to Point on page 2-74 for further details on using the point to point loop. To use the indexer to control a position offset link parameter 753 [Posit Offset 1] or parameter 754 [Position Offset 2] to parameter 799 [BasicIndx Output]. Note that the position offset can be used in either the Point to Point Position or the Position Follower modes.

Parameter 798 [BasicIndx Preset] is a value that is preloaded into the indexer output on drive power up. By default, [BasicIndx Preset] is set to 0. Toggling parameter 740 [Position Control] bit 14 "BscIndx Prst" will also preload the value of [BasicIndx Preset] into the indexer output.

Controlling the Indexer from Digital Inputs:

Program one of the digital inputs, parameters 825 [Dig In1 Sel] through 830 [Dig In6 Sel], to 21 "Indx Step". Toggle that digital input to index forward.

Program a second digital input, parameters 825 [Dig In1 Sel] through 830 [Dig In6 Sel], to 22 "Indx StepRev". Toggle that digital input to index reverse.

Controlling the Indexer from a Network or DriveLogix:

Toggle parameter 740 [Position Control] bit 12 "BscIndx Step" to index forward. Toggle 740 [Position Control] bit 15 "BscIndxStpRv" to index reverse.

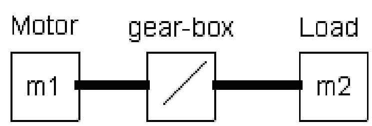
[Position Control] can be controlled by from a network by using a Datalink. Refer to Datalinks on page 2-20 for details on using Datalinks.

[Position Control] can be controlled from DriveLogix by linking it to one of the FromDriveLogix words (parameters 602 to 622). See the *DriveLogix® 5730 Controller User Manual*, publication 20D-UM003.

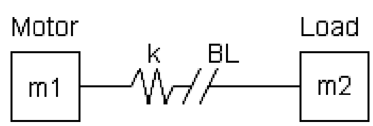
Inertia Adaptation

Inertia adaptation is used to compensate for lost motion, which occurs when a gear box and/or "springy" coupling is present. Inertia adaptation can allow the user to increase the speed regulator bandwidth by up to four (4) times.

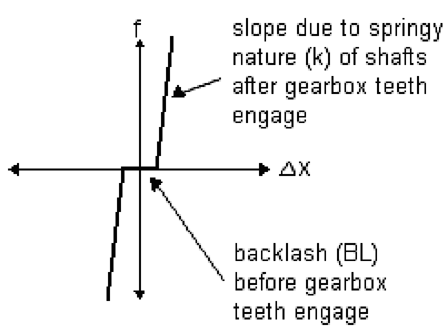
For example, a motor connected to a gearbox is shown:



This gearbox can be represented by a spring (k) and gear back lash (BL):

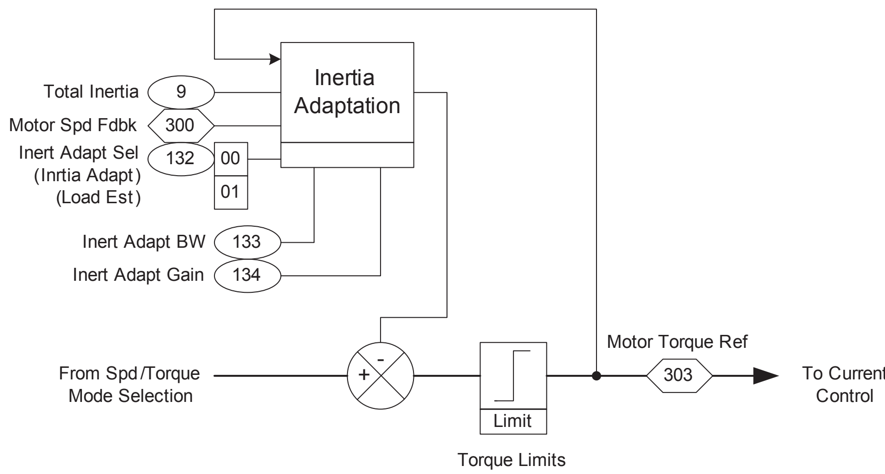


When the speed of the motor increases, there is a period of time (represented by Δx) before the teeth of the gearbox engage. After that time, there will be some twisting (like a spring) in the shaft after the teeth of the gearbox engage. This lost motion causes mechanical instability and limits how high the speed regulator bandwidth can be set without causing instability. Inertia adaptation detects the lost motion and a higher speed regulator bandwidth can be achieved without instability.



Configuration:

See Speed PI Regulator - Advanced Tuning for the Speed Regulator with Gearbox or Belt on page 2-126 for details on using inertia adaptation.



Inertia Compensation

During speed changes, a certain level of torque is required due to load inertia. That level of torque is above the torque used to run at constant speed. Inertia compensation calculates that torque based on the acceleration or deceleration rate. Then that acceleration or deceleration torque can be fed forward into the torque control, making for smoother accels and decels, especially with high inertia loads.

Parameter 56 [Inertia SpeedRef] is linked to parameter 43 [Ramped Spd Ref]. This becomes the speed reference that the inertia compensation block uses to calculate the acceleration or deceleration rate, also known as the derivative of speed with respect to time.

Inertia compensation is enabled by turning on parameter 151 [Logic Command], bit 10 - "Inertia Comp".

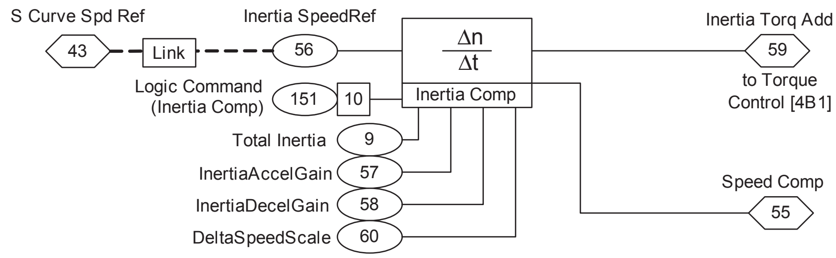
Parameter 9 [Total Inertia] is calculated during the autotune and is used along with the calculated acceleration or deceleration rate to calculate the torque adder.

Parameter 57 [InertiaAccelGain] determines the gain for the inertia compensation during acceleration. A gain of 1 results in 100% compensation. Parameter 58 [InertiaDecelGain] determines the gain for the inertia compensation during deceleration.

Parameter 60 [DeltaSpeedScale] is a multiplier for the torque output of the inertia compensation block. It is used in center wind and center unwind applications to compensate for diameter build-up.

The inertia compensation outputs the calculated torque to the parameter 59 [Inertia Torq Add]. [Inertia Torq Add] is summed with the output of the friction compensation block and the torque generated by the speed reference loop. That summed torque enters the torque selection block (refer to Torque Reference for more information).

Parameter 55 [Speed Comp] contains the rate of acceleration or deceleration calculated in the inertia compensation block. This parameter is used in following applications. Link parameter 23 [Speed Trim 3] to [Speed Comp] and set parameter 24 [SpeedTrim3 Scale] to 0.002 to reduce position error in following applications.



Input Devices

Contactors

Refer to Motor Start/Stop Precautions

Circuit Breakers/Fuses

Refer to Fuses and Circuit Breakers

Filters, EMC

Refer to CE Conformity

Input Modes

Refer to Start/Stop Modes.

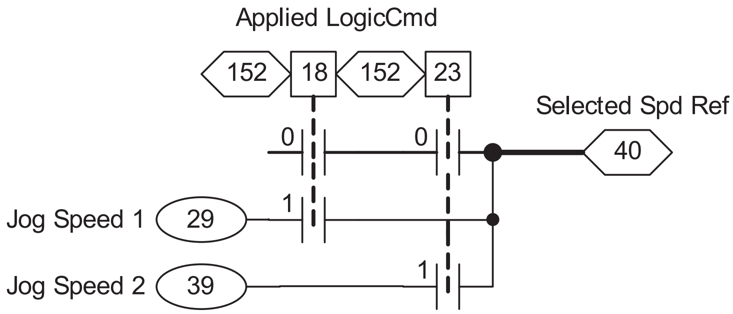
Input Power Conditioning

Refer to *"Wiring and Grounding Guidelines for Pulse Width Modulated (PWM) AC Drives,"* publication DRIVES-IN001 for detailed information. This publication is available online at:

http://literature.rockwellautomation.com/literature

Jog

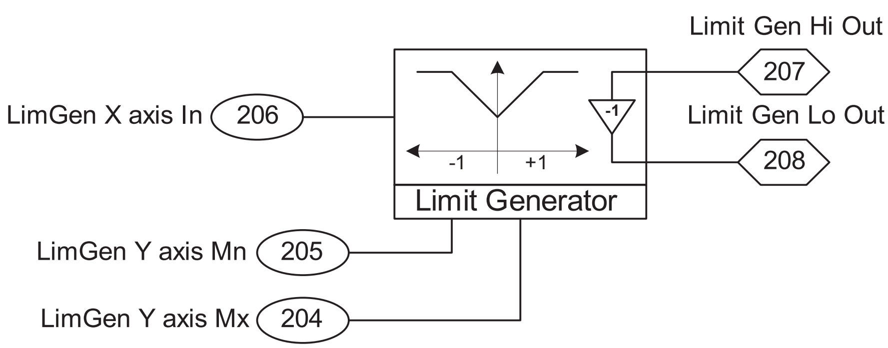
A jog reference is usually used to run the motor at some preset, low speed. Two separate jog speeds can be used as a speed reference - parameter 29 [Jog Speed 1] or parameter 39 [Jog Speed 2]. A jog could be initiated by a Digital Input, by the Logic Command word from a DPI Adapter such as a HIM, or by the Logic Command word from DriveLogix. In turn, a valid jog command initiated from one of those adapters will turn on either bit 18 in parameter 152 [Applied LogicCmd] to select jog speed 1 or bit 23 in [Applied LogicCmd] to select jog speed 2. Note that the jog command is a maintained type of logic, so that the jog speed will be active while the jog command bit is maintained.



Limit Generator

The limit generator generates a high and low limit based on an input.

- The input parameter 206 [LimGen X axis In] is a linkable destination. The input range is 0.0000 to 1.0000.
- The output is equal to parameter 205 [LimGen Y axis Mn] when the input is equal to 0.0000.
- The output is equal to parameter 204 [LimGen Y axis Mx] when the input is equal to 1.0000.
- The output is available as a positive output parameter 207 [Limit Gen Hi Out] and a negative output parameter 208 [Limit Gen Lo Out].

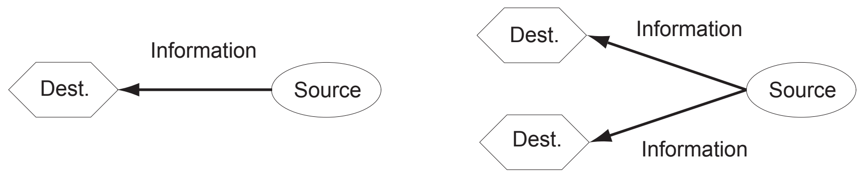


Links

Links are software connections between two parameters. This allows one parameter to receive information from another parameter.

Parameter Type	Description	Parameter Symbol
Source	Provides information	Source
Destination	Receives information	Dest.

Each destination parameter can only have one source parameter. However, source parameters may be linked to multiple destination parameters. The information from the link always flows from the source to the destination parameter.



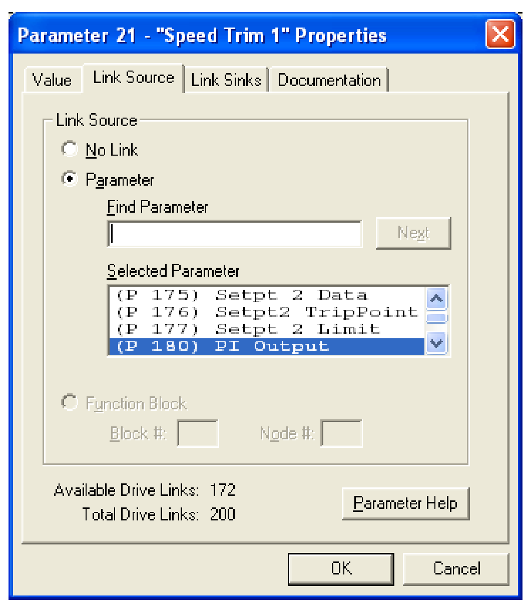
Several default links are set in the drive as default. Modifying these links can be done two ways:

Using the HIM

Access the destination parameter you wish to use for the link. (This cannot be done from the ALT Parameter view window, only the parameter list). When you access the parameter you want to edit, press the ALT, then the View button. This will display a window with the mode selection. Use the up/down arrow keys on the top row of buttons to select "Defined Link" and press Enter. When in this mode, pressing the Select button will allow you to enter the source parameter number.

Using Drive Executive

Double-click on the destination parameter. The parameter XX dialog box displays. Click on the Link Source tab. Select the Parameter radio button and select the source parameter in the Selected Parameter field.



Masks

A mask is a parameter that contains one bit for each of the possible adapters. Each bit acts like a valve for issued commands. Closing the valve (setting a bit value to 0) stops the command from reaching the DriveLogix. Opening the valve (setting a bit value to 1) allows the command to pass through the mask into the DriveLogix.

Table 2.B Mask Parameters and Functions

Parameter Name	No.	Function
[Logic Mask]	670	Determines which adapters can control the drive. When the bit for an adapter is set to "0," the adapter will have no control functions except for stop.
[Start Mask]	671	Controls which adapters can issue start commands.
[Jog Mask]	672	Controls which adapters can issue jog commands.
[Direction Mask]	673	Controls which adapters can issue forward/reverse direction commands.
[Fault Clr Mask]	674	Controls which adapters can clear a fault.

The individual bits for each parameter are as follows:

- Bit 0 - "Terminal Blk"
- Bit 1 - "Local HIM"
- Bit 2 - "Ext DPI Comm"
- Bit 3 - "Aux DPI Comm"
- Bit 4 - "Reserved"
- Bit 5 - "Int DPI Comm"
- Bit 6 - "Reserved"
- Bit 7 - "DriveLogix"

Example: A customer's process is normally controlled by a remote PLC, but the drive is mounted on the machine. The customer does not want anyone to walk up to the drive and reverse the motor because it would damage the process. The local HIM (drive mounted Adapter 1) is configured with an operator's panel that includes a "REV" Button. To assure that only the PLC (connected to Adapter 5) has direction control, the [Direction Mask] can be set as follows:

Direction Mask	0 0 1 0 0 0 0 0
Adapter #	7 6 5 4 3 2 1 0

This "masks out" the reverse function from all adapters except Adapter 5, making the local HIM (Adapter 1) REV button inoperable. See Owners later in this chapter or *PowerFlex 700S User Manual*, publication 20D-UM006, for more information.

Motor Control Mode

Parameter 485 [Motor Ctrl Mode] selects the type of motor control to use. This parameter is set during the HIM assisted startup when asked to select the Motor Control. The settings for Parameter 485 [Motor Ctrl Mode] are

- 0 - "FOC" selects field oriented control. Field oriented control is used with AC squirrel cage induction motors for high performance.
- 1 - "FOC2" selects field oriented control and is only used for a specific type of AC induction motor with motor thermal feedback.
- 2 - "Pmag Motor" selects control for permanent magnet motors.
- 3 - "V/Hz" selects volts per hertz control. This selection is available in v2.003 and later.
- 4 - "Test" puts the drive in a test mode to perform the direction test. "Test" is automatically selected during the direction test portion of the Start-Up routine and does not need to be set manually by the user.

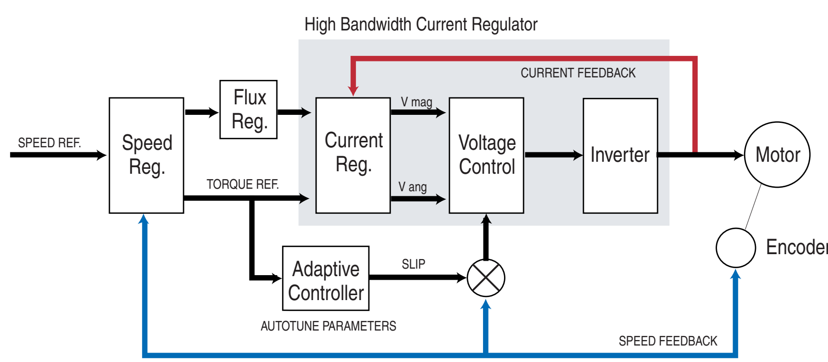
Field Oriented Control, Permanent Magnet Motor Control, and Volts/Hertz Control are described in further detail below.

Field Oriented Control

Field oriented control is used with AC squirrel cage induction motors for high performance. Motor data and an autotune is required for correct operation in this mode (refer to Autotune on page 2-4 for details). Field oriented control is selected by setting parameter 485 [Motor Ctrl Mode] = 0 "FOC".

In field oriented control, the drive takes the speed reference that is specified by the Speed Reference Selection Block and compares it to the speed feedback. The speed regulator uses Proportional and Integral gains to adjust the torque reference for the motor. This torque reference attempts to operate the motor at the specified speed. The torque reference is then converted to the torque producing component of the motor current.

This type of speed regulator produces a high bandwidth response to speed command and load changes. In field oriented control the flux and torque producing currents are independently controlled. Therefore, you can send a torque reference directly instead of a speed reference. The independent flux control also allows you to reduce the flux in order to run above base motor speed.



Permanent Magnet Control

Permanent magnet control is used with permanent magnet motors. Permanent magnet motor control is selected by setting parameter 485 [Motor Ctrl Mode] = 2 "Pmag Motor".

- Permanent magnet motor control requires either a hi-resolution Stegmann encoder or compatible resolver feedback on the motor. Refer to the *PowerFlex® 700S User Manual*, publication 20D-UM006 for a list of compatible hi-resolution Stegmann encoders and compatible resolvers.

- Motor data and an autotune is required for correct operation in this mode. Refer to Autotune on page 2-4 for details on the autotune. Refer to Permanent Magnet Motors on page 2-67 for a list of compatible Allen-Bradley permanent magnet motors and motor data to be used with the PowerFlex 700S.

Volts/Hertz Control - v2.003 and later

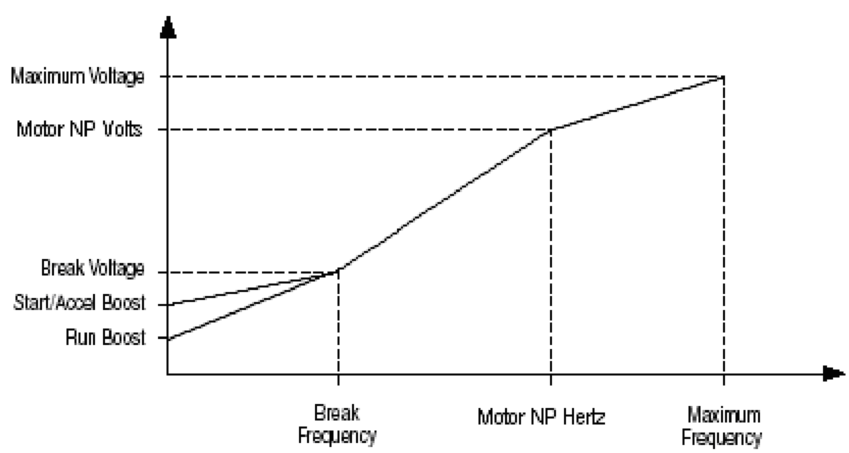
Volts/Hertz control is used in fan, pump, or multi-motor applications. Volts/Hertz operation creates a fixed relationship between output voltage and output frequency.

Configuration:

Volts/Hertz control is selected by setting parameter 485 [Motor Ctrl Mode] = 3 "V/Hz".

Volts/Hertz allows a wide variety of patterns using linear segments. The default configuration is a straight line from zero to rated voltage and frequency. This is the same volts/hertz ratio that the motor would see if it were started across the line. As seen in the diagram below, the volts/hertz ratio can be changed to provide increased torque performance when required. The shaping takes place by programming five distinct points on the curve:

1. Parameter 527 [Start/Acc Boost] is used to create additional torque for breakaway from zero speed and acceleration of heavy loads at lower speeds.
2. Parameter 528 [Run Boost] is used to create additional running torque at low speeds. The value is typically less than the required acceleration torque. The drive will lower the boost voltage to this level when running at low speeds (not accelerating). This reduces excess motor heating that could be caused if the higher start/accel boost level were used.
3. Parameters 529 [Break Voltage] and 530 [Break Frequency] are used to increase the slope of the lower portion of the Volts/Hertz curve, providing additional torque.
4. Parameters 1 [Motor NP Volts] and 3 [Motor NP Hertz] set the upper portion of the curve to match the motor design and mark the beginning of the constant horsepower region.
5. Parameters 531 [Maximum Voltage] and 532 [Maximum Freq] slope that portion of the curve used above base speed.



Motor Nameplate

Parameter		
Name	**No.**	**Function**
[Motor NP Volts]	1	The motor nameplate base voltage defines the output voltage, when operating at rated current, rated speed, and rated temperature.
[Motor NP FLA]	2	The motor nameplate defines the output amps, when operating at rated voltage, rated speed, and rated temperature. It is used in the motor thermal overload, and in the calculation of slip.
[Motor NP Hertz]	3	The motor nameplate base frequency defines the output frequency, when operating at rated voltage, rated current, rated speed, and rated temperature.
[Motor NP RPM]	4	The motor nameplate RPM defines the rated speed, when operating at motor nameplate base frequency, rated current, base voltage, and rated temperature. This is used to calculate slip.
[Motor NP Power]	5	The motor nameplate power is used together with the other nameplate values to calculate default values for motor parameters to and facilitate the commissioning process. This may be entered in horsepower or in kilowatts as selected in the previous parameter or kW for certain catalog numbers and HP for others.
[Motor NP Pwr Units]	6	The rated power of the motor may be entered in horsepower or in kilowatts. This parameter determines the units on the following parameter.
[Motor Poles]	7	The number of motor poles - only even numbers are allowed (this may or may not appear on the nameplate)

Motor Overload

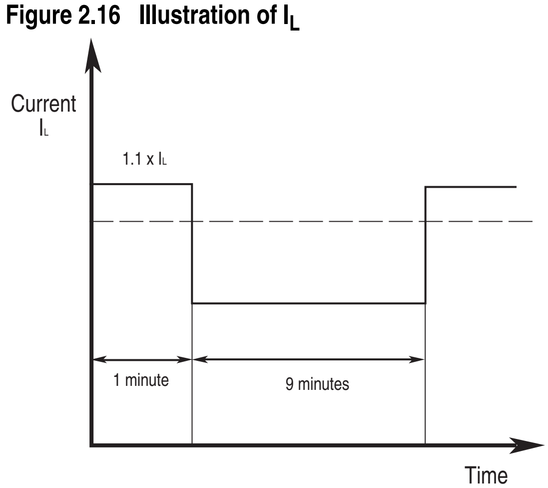
The overload capability applies to the rated speed range.

Low Overload

After continuous operation at the rated output current, overload may be 110% rated output current (I_L) for 1 minute as long as it is followed by a period of load less than the rated current so that the output current over the duty cycle does not exceed the rated output current (I_L).

Example: If the duty cycle requires 110% rated output current for 1 minute of every 10 minutes, the remaining 9 minutes must be at approximately 98% rated current or less to maintain output current less than 100%. If the requirement is 1 minute out of 60 minutes, the remaining 59 minutes must be at approximately 99% rated current or less.

Figure 2.16 Illustration of I_L



High Overload

After continuous operation at the rated output current, overload may be 150% rated output current (I_H) for 1 minute as long as it is followed by a period of load less than the rated current so that the output current over the duty cycle does not exceed the rated output current (I_H).

Example: If the duty cycle requires 150% rated output current for 1 minute of every 10 minutes, the remaining 9 minutes must be at approximately 92% rated current or less to maintain output current less than 100%. If the requirement is 1 minute out of 60 minutes, the remaining 59 minutes must be at approximately 98% rated current or less.

Motor Start/Stop Precautions

Input Contactor Precautions

ATTENTION: A contactor or other device that routinely disconnects and reapplies the AC line to the drive to start and stop the motor can cause drive hardware damage. The drive is designed to use control input signals that will start and stop the motor. If an input device is used, operation must not exceed one cycle per minute or drive damage will occur.

ATTENTION: The drive start/stop/enable control circuitry includes solid state components. If hazards due to accidental contact with moving machinery or unintentional flow of liquid, gas or solids exist, an additional hardwired stop circuit may be required to remove the AC line to the drive. An auxiliary braking method may be required.

Output Contactor Precaution

ATTENTION: To guard against drive damage when using output contactors, the following information must be read and understood. One or more output contactors may be installed between the drive and motor(s) for the purpose of disconnecting or isolating certain motors/loads. If a contactor is opened while the drive is operating, power will be removed from the respective motor, but the drive will continue to produce voltage at the output terminals. In addition, reconnecting a motor to an active drive (by closing the contactor) could produce excessive current that may cause the drive to fault. If any of these conditions are determined to be undesirable or unsafe, an auxiliary contact on the output contactor should be wired to a drive digital input that is programmed as ìEnable.î This will cause the drive to execute a coast-to-stop (cease output) whenever an output contactor is opened.

Mounting

As a general rule, drives should be mounted on a metallic flat surface in the vertical orientation. If considering other orientation, contact the Factory for additional data. Refer to the Chapter 1 - Installation/Wiring in the *PowerFlex 700S User Manual*, publication 20D-UM006, for mounting instructions and limitations. This publication is available online at:

http://literature.rockwellautomation.com/literature

Output Devices

Drive Output Disconnection

ATTENTION: Any disconnecting means wired to the drive output terminals U, V and W must be capable of disabling the drive if opened during drive operation. If opened during drive operation, the drive will continue to produce output voltage between U, V, W. An auxiliary contact must be used to simultaneously disable the drive.

Allen-Bradley Drives can be used with an output contactor between the drive and motor. This contactor can be opened under load without damage to the drive. It is recommended, however, that the drive have a programmed “Enable” input and that this input be opened at the same time as the output contactor.

Cable Termination

Refer to *“Wiring and Grounding Guidelines for Pulse Width Modulated (PWM) AC Drives,”* publication DRIVES-IN001 for detailed information. This publication is available online at:

http://literature.rockwellautomation.com/literature

Output Reactor

Bulletin 1321 Reactors can be used for drive input and output. These reactors are specifically constructed to accommodate IGBT inverter applications with switching frequencies up to 20 kHz. They have a UL approved dielectric strength of 4000 volts, opposed to a normal rating of 2500 volts. The first two and last two turns of each coil are triple insulated to guard against insulation breakdown resulting from high dv/dt. When using motor line reactors, it is recommended that the drive PWM frequency be set to its lowest value to minimize losses in the reactors.

By using an output reactor the effective motor voltage will be lower because of the voltage drop across the reactor - this may also mean a reduction of motor torque.

Output Display

Output Current (Parameter 308)

Displays measured RMS drive output current. Parameter 297 [Output Curr Disp] which is the integer equivalent of parameter 308 with * internal storage in 1/10 Amps (10 = 1.0amp).

Output Frequency (Parameter 310)

This parameter displays the actual output frequency of the drive. The output frequency is created by a summation of commanded frequency and any active speed regulator such as slip compensation, PI Loop, bus regulator. The actual output may be different than the commanded frequency.

Output Power (Parameter 311)

This parameter displays the output kW of the drive. Motor Power is the calculated product of the torque reference and motor speed feedback. A 125ms filter is applied to this result. Positive values indicate motoring power; negative values indicate regenerative power. The output power is a calculated value and tends to be inaccurate at lower speeds. It is not recommended for use as a process variable to control a process.

Output Voltage (Parameter 307)

Displays RMS line-to-line fundamental output voltage at the drive output terminals. This data is averaged and updated every 50 milliseconds. The actual output voltage may be different than that determined by the sensorless vector or V/Hz algorithms because it may be modified by features such as the Auto-Economizer.

Overspeed Limit

The absolute overspeed limit parameter, parameter 335 [Abs OverSpd Lim], is an adjustable setting. This sets a limit tolerance below parameter 75 [Rev Speed Lim] and above parameter 76 [Fwd Speed Lim], that is allowable. This can be used as a safe working speed limit.

Example 1 Speed reference is set to equal parameter 76 [Fwd Speed Lim]. Based on tuning of the drive, the speed could overshoot the commanded speed. If parameter 335 [Abs OverSpd Lim] is set to zero and an overshoot in speed occurs, the drive will fault on an absolute overspeed.

Example 2 Drive is configured as a torque follower. If the mechanical connection to the load is severed, the torque command to the drive will probably be greater than the motor unloaded will require to maintain the system speed. This will cause the motor speed to increase until the torque command is met. Setting parameter 335 [Abs OverSpd Lim] to the desired tolerance will cause the fault to occur when the motor speed exceeds the limit of [Fwd Speed Lim] or [Rev Speed Lim] +/– [Abs Overspd Lim].

Owners

An owner is a parameter that contains one bit for each of the possible adapters. The bits are set high (value of 1) when its adapter is currently issuing that command, and set low when its adapter is not issuing that command.

Table 2.C Owner Parameters and Functions

Parameter		
Name	**No.**	**Function**
[Stop Owner]	677	Indicates the adapters that are presently issuing a valid stop command.
[Start Owner]	678	Indicates the adapters that are presently issuing a valid start command.
[Jog Owner]	679	Indicates the adapters that are presently issuing a valid jog command.
[Direction Owner]	680	Indicates the adapter that currently has exclusive control of direction changes.
[Fault Clr Owner]	681	Indicates the adapters that are presently issuing a valid start command.

The bits for each parameter are broken down as follows:

- Bit 0 - "Terminal Blk"
- Bit 1 - "Local HIM"
- Bit2 - "Ext DPI Comm"
- Bit 3 - "Aux DPI Comm"
- Bit 4 - "Reserved"
- Bit 5 - "Int DPI Comm"
- Bit 6 - "Reserved"
- Bit 7 - "DriveLogix"

Ownership falls into two categories:

1. Exclusive: Only one adapter at a time can issue the command and only one bit in the parameter will be high.

2. Non Exclusive: Multiple adapters can simultaneously issue the same command and multiple bits may be high.

Some ownership must be **exclusive;** that is, only one Adapter at a time can issue certain commands and claim ownership of that function. For example, it is not allowable to have one Adapter command the drive to run in the **forward** direction while another Adapter is issuing a command to make the drive run in **reverse**. Direction Control, therefore, is **exclusive ownership**.

Conversely, any number of adapters can simultaneously issue Stop Commands. Therefore, Stop Ownership is **not** exclusive.

Example: The operator presses the Stop button on the Local HIM to stop the drive. When the operator attempts to restart the drive by pressing the HIM Start button, the drive does not restart. The operator needs to determine why the drive will not restart.

The operator first views the Start owner to be certain that the Start button on the HIM is issuing a command.

		DriveLogix	Not Used	Adapter 5	Not Used	Adapter 3	Adapter 2	Adapter 1	Terminal Block - Digital Input
Start Owner	Bit	7	6	5	4	3	2	1	0
	Adapter #	0	0	0	0	0	0	1	0

When the local Start button is pressed, the display indicates that the command is coming from the HIM.

		DriveLogix	Not Used	Adapter 5	Not Used	Adapter 3	Adapter 2	Adapter 1	Terminal Block - Digital Input
Start Owner	Bit	7	6	5	4	3	2	1	0
	Adapter #	0	0	0	0	0	0	1	0

The [Start Owner] indicates that there is not any maintained Start commands causing the drive to run.

		DriveLogix	Not Used	Adapter 5	Not Used	Adapter 3	Adapter 2	Adapter 1	Terminal Block - Digital Input
Stop Owner	Bit	7	6	5	4	3	2	1	0
	Adapter #	0	0	0	0	0	0	0	1

The operator then checks the Stop Owner. Notice that bit 0 is a value of "1," indicating that the Stop device wired to the Digital Input terminal block is open, issuing a Stop command to the drive.

Until this device is closed, a permanent Start Inhibit condition exists and the drive will not restart.

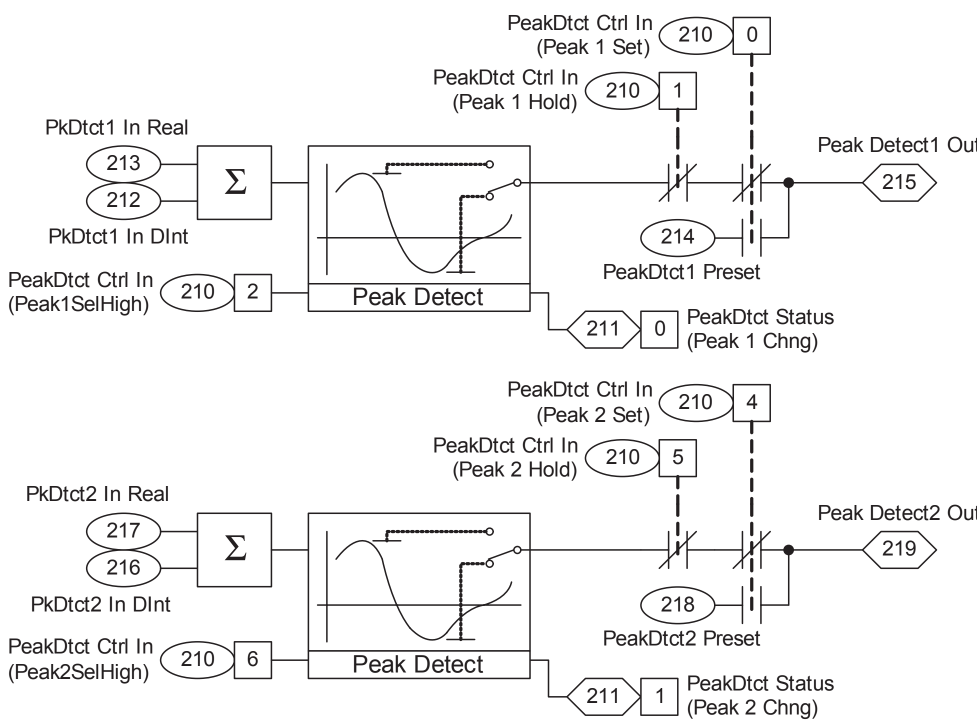
Peak Detect

There are two peak detectors that can be used to detect the peak for a parameter value.

Configuration:

- Link parameter 213 [PkDtct1 In Real] or parameter 212 [PkDtct1 In Int] to the parameter that you wish to detect a peak, depending on the data type.
- To detect positive peak values, turn on parameter 210 [PeakDtct Ctrl In] bit 2 "Peak1 Sel". To detect negative peak values, turn off parameter 210 [PeakDtct Ctrl In] bit 2 "Peak1 Sel".
- The peak value is contained in parameter 215 [Peak Detect1 Out].
- To reset the output of the peak detector, toggle on then off parameter 210 [PeakDtct Ctrl In] bit 0 "Peak 1 Set". The output will match the value in parameter 214 [PeakDtct1 Preset], which is a default of 0.
- To hold the output of the peak detector at the present value turn on parameter 210 [PeakDtct Ctrl In] bit 1 "Peak 1 Hold".

The change bit, parameter 211 [PeakDtct Status] bit 0 "Peak 1 Chng" is set to “true” for one scan if the peak detect value changes, otherwise the change bit is set to “False”. The change bit is also set to “False” if the detector is in Set or Hold mode.



Example:

- Link parameter 213 [PkDtct1 In Real] to parameter 300 [Motor Spd Fdbk].
- Verify that parameter 210 [PeakDtct Ctrl In] bit 0 "Peak 1 Set" and bit 1 "Peak 1 Hold" are off.
- For parameter 210 [PeakDtct Ctrl In], turn on bit 2 "Peak1 SelHigh".
- Parameter 215 [Peak Detect1 Out] will contain the positive peak value of [Motor Spd Fdbk].
- To reset the output of the peak detector, for parameter 210 [PeakDtct Ctrl In] toggle on and then off bit 0 "Peak 1 Set".

Permanent Magnet Motors

The following table contains a list of specifications for the permanent magnet motors compatible with PowerFlex® 700S drives. Note that you must have a high resolution Stegmann or compatible resolver.

Table 2.D Motor Name Plate and Rating Specifications

Model Number	Motor NP Volts (Line-Line V rms)	Motor NP FLA (A rms)	Motor NP Frequency (Hz)	Motor NP RPM (Oper. RPM)	Motor NP Power (KW)	Motor Poles	Current peak (A rms)	System Cont. Stall Torque (N-m)	Motor Max RPM
Parameter #	1	2	3	4	5	7			
MPL-A310P	230	3.4	294.0	4410	0.73	8	9.9	1.58	5000
MPL-A310F	230	2.1	185.3	2780	0.46	8	6.6	1.58	3000
MPL-A320P	230	6.4	271.3	4070	1.30	8	20.9	3.05	5000
MPL-A320H	230	4.6	208.7	3130	1.00	8	13.6	3.05	3500
MPL-A330P	230	8.5	280.7	4210	1.80	8	26.9	4.08	5000
MPL-A420P	230	9.0	268.7	4030	2.00	8	32.5	4.74	5000
MPL-A430P	230	11.9	234.0	3510	2.20	8	47.4	5.99	5000
MPL-A430H	230	8.6	184.7	2770	1.80	8	31.8	6.21	3500
MPL-A4520P	230	12.4	234.0	3510	2.20	8	35.4	5.99	5000
MPL-A4520K	230	10.6	223.3	3350	2.10	8	30.4	5.99	4000
MPL-A4530F	230	9.5	144.7	2170	1.90	8	29.7	8.36	2800
MPL-A4530K	230	14.4	196.0	2940	2.50	8	43.8	8.13	4000
MPL-A4540C	230	6.6	93.3	1400	1.50	8	20.5	10.20	1500
MPL-A4540F	230	13.0	162.0	2430	2.60	8	38.2	10.20	3000
MPL-A520K	230	16.3	208.0	3120	3.50	8	46.0	10.70	4000
MPL-A540K	230	29.3	180.7	2710	5.50	8	84.9	19.40	4000
MPL-A560F	230	29.3	125.3	1880	5.50	8	84.9	27.90	3000
MPL-B310P	460	1.7	290.0	4350	0.72	8	3.0	1.58	5000
MPL-B320P	460	3.2	281.3	4220	1.30	8	5.0	2.94	5000
MPL-B330P	460	4.3	258.7	3880	1.70	8	7.0	4.18	5000
MPL-B420P	460	4.5	255.3	3830	1.90	8	9.2	4.74	5000
MPL-B430P	460	6.5	233.3	3500	2.40	8	12.0	6.55	5000
MPL-B4520P	460	6.0	260.7	3910	2.50	8	17.0	6.10	5000
MPL-B4530F	460	5.0	167.3	2510	2.20	8	13.4	8.36	3000
MPL-B4530K	460	7.8	198.0	2970	2.60	8	19.1	8.36	4000
MPL-B4540F	460	6.4	187.3	2810	3.00	8	16.3	10.20	3000
MPL-B4560F	460	8.3	144.7	2170	3.20	8	25.5	14.10	3000
MPL-B520K	460	8.1	208.0	3120	3.50	8	23.3	10.70	4000
MPL-B540K	460	14.5	177.3	2660	5.40	8	42.4	19.40	4000
MPL-B560F	460	14.5	123.3	1850	5.40	8	42.4	27.90	3000
MPL-B580F	460	18.4	132.7	1990	7.10	8	66.5	34.00	3000
MPL-B580J	460	22.6	101.3	1520	5.40	8	66.5	34.00	3800
MPL-B640F	460	22.7	106.0	1590	6.10	8	46.0	36.70	3000
MPL-B660F	460	27.2	81.3	1220	6.15	8	67.9	48.00	3000
MPL-B680D	460	24.0	123.3	1850	9.30	8	66.5	48.00	2000
MPL-B680F	460	33.9	79.3	1190	7.50	8	67.9	60.00	3000
MPL-B860D	460	33.6	96.0	1440	12.50	8	67.5	83.00	2000
MPL-B880C	460	33.6	72.7	1090	12.60	8	69.0	110.00	1500

Model Number	Motor NP Volts (Line-Line V rms)	Motor NP FLA (A rms)	Motor NP Frequency (Hz)	Motor NP RPM (Oper. RPM)	Motor NP Power (KW)	Motor Poles	Current peak (A rms)	System Cont. Stall Torque (N-m)	Motor Max RPM
Parameter #	**1**	**2**	**3**	**4**	**5**	**7**			
MPL-B880D	460	40.3	86.7	1300	15.00	8	113.2	110.00	2000
MPL-B960B	460	29.7	78.7	1180	16.00	8	63.6	130.00	1200
MPL-B960C	460	38.9	76.0	1140	14.80	8	88.4	124.30	1500
MPL-B960D	460	50.2	98.0	1470	20.00	8	102.5	130.00	2000
MPL-B980B	460	31.8	72.0	1080	17.00	8	70.7	150.00	1000
MPL-B980C	460	48.2	67.3	1010	16.80	8	99.0	158.20	1500
MPL-B980D	460	63.6	93.3	1400	22.00	8	141.4	150.00	2000
MPG-A004-031	230	1.8	222.7	3340	0.21	8	4.0	0.60	6000
MPG-A010-031	230	2.1	189.3	2840	0.36	8	6.0	1.21	4875
MPG-A010-091	230	0.9	295.3	4430	0.19	8	2.3	0.41	5900
MPG-A025-031	230	9.9	181.0	1810	0.88	12	19.8	4.65	5200
MPG-A025-091	230	3.0	168.0	1680	0.52	12	8.5	2.95	5625
MPG-A050-031	230	24.7	120.0	1200	1.50	12	53.0	11.90	2510
MPG-A050-091	230	5.0	275.0	2750	0.75	12	15.6	2.60	3775
MPG-A110-031	230	20.2	122.0	1220	2.20	12	53.0	17.20	2875
MPG-A110-091	230	17.0	184.0	1840	1.60	12	33.2	8.30	3500
MPG-B010-031	460	1.6	162.7	2440	0.34	8	4.4	1.33	6450
MPG-B010-091	460	0.7	357.3	5360	0.23	8	1.5	0.41	6450
MPG-B025-031	460	4.0	219.0	2190	0.92	12	11.3	4.02	4838
MPG-B025-091	460	1.9	175.0	1750	0.54	12	5.2	2.95	5900
MPG-B050-031	460	16.3	92.0	920	1.20	12	32.5	12.40	2510
MPG-B050-091	460	3.4	290.0	2900	0.79	12	9.9	2.60	4560
MPG-B110-031	460	12.9	112.0	1120	2.00	12	31.1	17.00	2420
MPG-B110-091	460	10.6	184.0	1840	1.60	12	20.5	8.30	3500
1326AB-B410G	460	2.5	118.0	3540	1.00	4	7.4	2.70	5000
1326AB-B410J	460	3.5	165.0	4950	1.40	4	10.4	2.70	7250
1326AB-B420E	460	2.8	70.0	2100	1.10	4	8.5	5.00	3000
1326AB-B420H	460	5.5	137.3	4120	2.20	4	15.6	5.10	6000
1326AB-B430E	460	3.9	67.7	2030	1.40	4	11.7	6.60	3000
1326AB-B430G	460	5.6	114.3	3430	2.30	4	16.8	6.40	5000
1326AB-B515E	460	6.1	70.3	2110	2.30	4	18.3	10.40	3000
1326AB-B515G	460	9.5	88.7	2660	2.90	4	28.5	10.40	5000
1326AB-B520E	460	6.7	71.0	2130	2.90	4	20.1	13.00	3000
1326AB-B520F	460	8.8	70.3	2110	2.90	4	26.4	13.10	3500
1326AB-B530E	460	9.5	74.3	2230	4.20	4	28.5	18.00	3000
1326AB-B720E	460	17.5	70.0	2100	6.80	4	52.5	30.90	3500
1326AB-B720F	460	27.5	117.0	3510	11.70	4	66.5	31.80	5000
1326AB-B730E	460	22.8	78.3	2350	9.60	4	66.5	39.00	3350
1326AB-B740C	460	20.9	52.3	1570	8.70	4	62.7	53.00	2200
1326AB-B740E	460	32.0	79.7	2390	12.70	4	66.5	50.80	3400
			0.0						
1326AS-B310H	460	0.8	204.5	4090	0.30	6	2.4	0.70	6200
1326AS-B330H	460	2.1	204.5	4090	0.90	6	6.0	2.10	6500
1326AS-B420G	460	2.6	179.0	3580	1.20	6	7.8	3.20	5250
1326AS-B440G	460	5.4	149.0	2980	2.00	6	16.2	6.40	5250
1326AS-B460F	460	6.2	148.5	2970	2.80	6	18.6	9.00	4300
1326AS-B630F	460	7.8	142.7	2140	2.40	8	18.5	10.70	4500
1326AS-B660E	460	11.8	100.7	1510	3.40	8	29.8	21.50	3000
1326AS-B690E	460	19.0	87.3	1310	5.00	8	41.3	36.40	3000
1326AS-B840E	460	21.2	79.3	1190	4.70	8	39.5	37.60	3000
1326AS-B860C	460	17.6	77.3	1160	6.00	8	44.4	49.30	2000
1326AH-B330F	460	2.1	0.0	3000	0.75		9.0		3000
1326AH-B440F	460	3.3	0.0	2500	1.22		13.8		2500
1326AH-B540F	460	11.1	0.0	2500	2.60		47.2		2500
3050R-7	390	66.0	50.0	500	30.00	12	132.0		500
11050R-7	390	218.0	50.0	500	110.00	12	436.0		500

PET

Pulse Elimination Technique - See Reflected Wave.

Position Loop - Follower (Electronic Gearing)

Technical Information

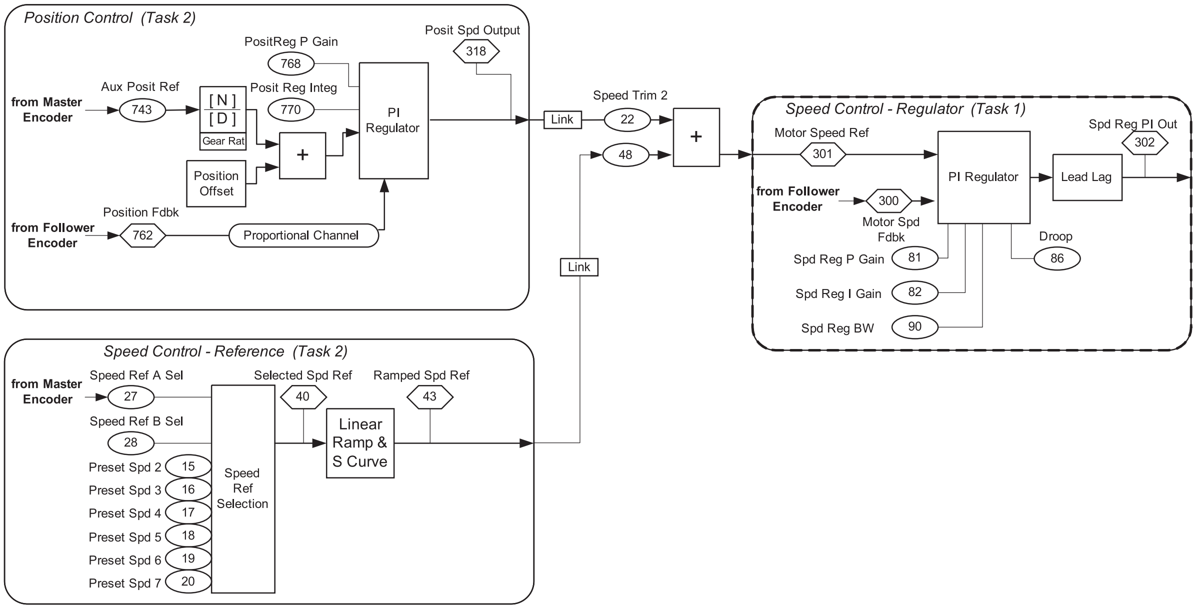
General facts about using the Position Loop for follower applications:

1. Parameter 768 [PositReg P Gain] is used for tuning.
2. Parameter 770 [Posit Reg Integ] is normally not needed for position following applications and is disabled by factory default.
3. The number of position counts per revolution depends on the type of feedback device used:
   a. When using an encoder for positioning, the drive uses quadrature counts, i.e., 1024 encoder = 4096 counts per motor revolution.
   b. When using a Stegmann absolute hi-resolution encoder, the drive counts 1048576 counts per revolution.
   c. When using a Resolver, the drive counts 65536 counts per revolution.
4. Speed regulator tuning directly affects the position loop performance. The speed regulator should be tuned before the position loop.
5. For best performance, positioning should be used with a dynamic brake or regenerative system.

Overview

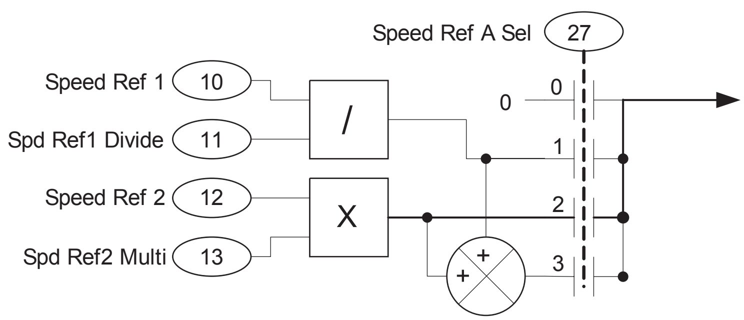
The position follower feature in the PowerFlex® 700S gives the user the ability to follow the position of a master motor without an external position controller. The position loop adds to or subtracts from the speed reference (using Speed Trim 2) to correct for the following error and keep the positions of both encoders locked. The resulting motor speed reference enters the speed regulator loop. Gear ratios can be set up to follow at different rates of speed and position. Typical applications for a geared follower would be for a roller following another part of a machine, and a filler and capper machine for bottling.

The following is a block diagram overview of the position follower mode:



Speed Reference Selection

For the position following mode to work properly, there needs to be a feed forward speed reference for the speed loop of the drive to follow.



For example, to follow Encoder 1, link parameter 12 [Speed Ref 2] to parameter 241 [Encdr1 Spd Fdbk]. Set parameter 27 [Speed Ref A Sel] = 2 "Speed Ref 2". When a gear ratio is used in the position loop, parameter 13 [Spd Ref2 Multi] must be setup to match the gear ratio set in the position loop.

Speed Reference Ramp

The speed reference ramp should be disabled when using the drive as a position follower. To disable the speed reference ramp, set parameter 151 [Logic Command] bit 0 "SpdRamp Dsbl" = 1.

Enabling the Position Loop

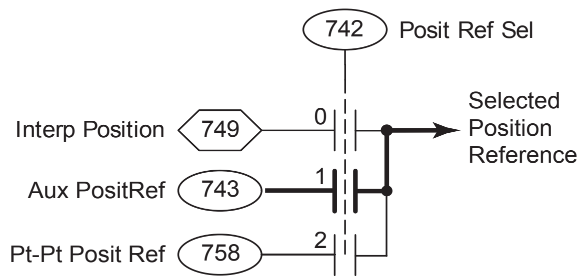
The firmware function for the position loop must be turned on by setting parameter 147 [FW Functions En] bit 16 "Position Ctrl" = 1.

To enable the position loop, set parameter 151 [Logic Command] bit 13 "Position En" = 1.

Then to allow the output of the position loop to trim the speed set parameter 740 [Position Control] bit 1 "Speed Out En" = 1.

Position Reference Selection

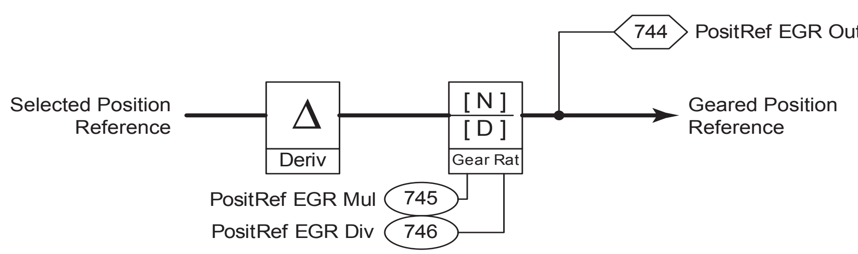
For a position follower application set parameter 742 [Posit Ref Sel] = 1 "Aux PositRef". The auxiliary position reference is generally used for position following applications.



Link parameter 743 [Aux Posit Ref] to the position for the feedback device. For example, to follow Encoder 1 link parameter 743 [Aux Posit Ref] to parameter 240 [Encdr1 Position]. Encoder 1 position becomes the position reference for the position loop.

Setting the Electronic Gear Ratio (EGR) and Speed Reference Scaling

The position reference can scaled by using the EGR scaling. Parameters 745 [PositRef EGR Mul] and 746 [PositRef EGR Div] are used to scale the position reference.



Example: 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 four (4) times the speed of the master.

PPRm	=	1024 PPR
PPRf	=	1024 PPR
Ratiof:Ratiom	=	4:1

where:

PPRm	=	the PPR of the master encoder
PPRf	=	the PPR of the follower encoder
Ratiof:Ratiom	=	the desired ratio between the follower speed and the master speed

$$\frac{[\text{PositRef EGR Mul}]}{[\text{PositRef EGR Div}]} = \frac{CPRf \text{ x } Ratiof}{CPRm \text{ x } Ratiom} = \frac{4096 \text{ x } 4}{4096 \text{ x } 1}$$

where:

CPRf = the counts per revolution of the follower feedback device. For an incremental encoder this is four (4) times the encoder PPR. For a Stegmann Hi-Res encoder this is 1048576. For a Resolver this is 65536.

CPRm = the counts per revolution of the master encoder. For an incremental encoder this is four (4) times the encoder PPR. For a Stegmann Hi-Res encoder this is 1048576. For a Resolver this is 65536.

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

$$\frac{[\text{PositRef EGR Mul}]}{[\text{PositRef EGR Div}]} = \frac{4}{1}$$

Therefore, parameter 745 [PositRef EGR Mul] = 4 and parameter 746 [PositRef EGR Div] = 1. This will set up the position loop of the follower to move four (4) counts for every one (1) count of the master.

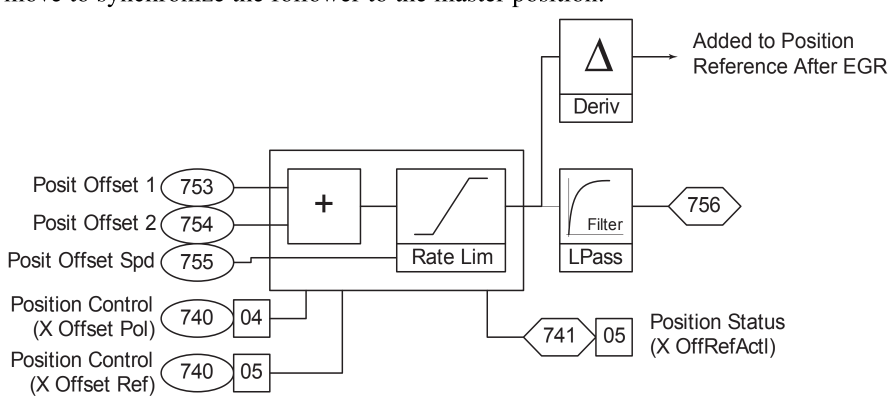
[Spd Ref 2 Multi] is calculated:

$$[\text{Spd Ref2 Multi}] = \frac{Ratiof}{Ratiom} = \frac{4}{1} = 4$$

Notice that the encoder PPRs should not be included in the calculation for parameter 13 [Spd Ref2 Multi]. [Spd Ref2 Multi] 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.

Position Offset

Offsets can be added to the position reference. Offsets are used to make a correction move to synchronize the follower to the master position.



There are two offsets, parameters 753 [Posit Offset 1] and 754 [Posit Offset 2]. The offset speed must be entered in parameter 755 [Posit Offset Spd] - if this is left at zero the move will not occur. The position offset must be entered in counts of feedback because it is added to the position reference after the EGR scaling. Offsets must be maintained to keep the position, I.E. if you enter a 300 in the offset the position loop will move 300 counts extra. If you zero the offset command the motor will return to the previous position. When it is necessary to zero the offset after a move without returning to the previous position, set parameter 740 [Position Control] bit 5 "Xoff ReRef" =1. Then set the offset value = 0. Then set [Position Control] bit 5 "Xoff ReRef" = 0. The system will not make an offset move when [Position Control] bit 5 "Xoff ReRef" is on.

Position Loop Output Limits

Parameter 775 [Xreg Spd LoLim] sets the negative speed limit at which the position regulator will output. The default is set to -10% of the base motor speed.

Parameter 776 [Xreg Spd HiLim] sets the positive speed limit at which the position regulator will output. The default is set to +10% of the base motor speed.

In position follower, the position loop only needs to trim the speed a small amount because the drive is setup to follow the master speed reference. Therefore, [Xreg Spd LoLim] and [Xreg Spd HiLim] can be left at the defaults.

Tuning Tips

The speed regulator of the drive must be tuned prior to tuning the Position Loop. Refer to Speed PI Regulator of this manual for tips on tuning the speed regulator.

Typically parameter 768 [PositReg P Gain] should be set between 1/5th to 1/3rd of parameter 90 [Spd Reg BW].

Parameter 768 [PositReg P Gain] may be set higher using lead compensation on the Position Regulator Output. Lead/Lag filtering of the position regulator output is accomplished via the speed trim 2 filter. Set parameter 25 [STrim2 Filt Gain] and parameter 26 [SpdTrim2 Filt BW] so that:

$$\frac{[\text{SpdTrim2 Filt BW}]}{[\text{Strim2 Filt Gain}]} = [\text{Speed Reg BW}]$$

For example, with parameter 90 [Spd Reg BW] = 40 rad/sec, set parameter 26 [SpdTrim2 Filt BW] = 200 rad/sec and set parameter 25 [STrim2 Filt Gain] = 5. The lead/lag filter will effectively cancel the 1/40 sec lag. This will allow a higher value for parameter 768 [PositReg P Gain] for increased stability.

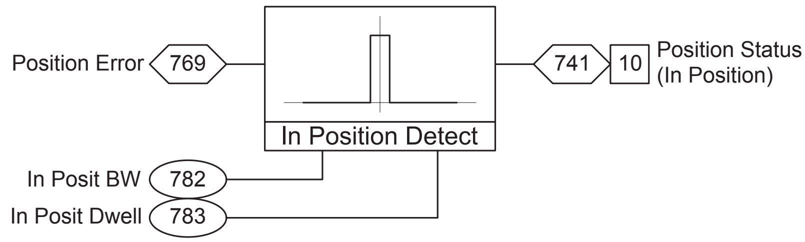
Parameter 770 [PositReg Integ] is the integral gain for the position loop. [PositReg Integ] can be used but is disabled by default and is normally not needed for position follower applications. To enable [PositReg Integ], set parameter 740 [Position Control], bit 2 "Integ En" = 1. When [PositReg Integ] is used, parameter 772 [XReg Integ LoLim] and parameter 773 [XReg Integ HiLim] should be set with narrow limits (approximately -10% and 10% of base motor speed).

Jogging a Position Follower Independent from the Master

The jog can be performed while the position loop is enabled and while the position loop output is turned on.

Position Loop - In Position Detect

The In Position Detection determines if parameter 769 [Position Error] is within a user defined value. Parameter 769 [Position Error] is the result of parameter 747 [Position Cmmd] - parameter 762 [Position Fdbk].



Parameter 782 [In Posit BW] sets the absolute number of position counts that parameter 769 [Position Error] must be within for parameter 741 [Position Status] bit 10 "In Position" to turn on.

Parameter 783 [In Posit Dwell] sets a delay time in seconds that parameter 769 [Position Error] must be within parameter 782 [In Posit BW] before parameter 741 [Position Status] bit 10 "In Position" turns on.

Position Loop - Point to Point

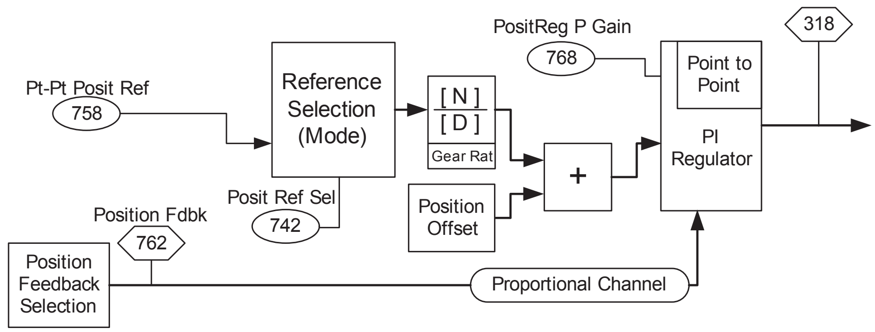
Technical Information

General facts about the point to point position loop:

1. Uses only parameter 768 [PositReg P Gain] for tuning. Parameter 770 [Posit Reg Integ] is not used in point to point mode.
2. The number of position counts per revolution depends on the type of feedback device used:
   a. When using an encoder for positioning, the drive uses quadrature counts, i.e., 1024 encoder = 4096 counts per motor revolution.
   b. When using a Stegmann absolute hi-resolution encoder, the drive counts 1048576 counts per revolution.
   c. When using a Resolver, the drive counts 65536 counts per revolution.
3. Speed regulator tuning directly affects the position loop performance. The speed regulator should be tuned before the position loop.
4. For best performance, positioning should be used with a dynamic brake or regenerative system.

Overview

The point to point positioning feature gives the user the ability to position the load without an external position controller. The point to point function of the position loop moves from the current location to the commanded location then holds that position until given a new reference or a stop command. The position loop can be scaled to different units other than feedback counts, I.E. Degrees or Inches. Typical applications for the point to point function would be turn-tables and storage retrieval machines.



Speed Reference Selection

The speed reference should be set to zero speed when using point to point positioning. For example, set parameter 27 [Speed Ref A Sel] = 0 "Zero Speed".

Enabling the Position Loop

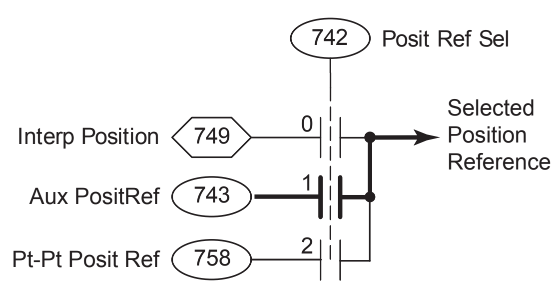
The firmware function for the position loop must be turned on by setting parameter 147 [FW Functions En] bit 16 "Position Ctrl" = 1.

To enable the position loop, set parameter 151 [Logic Command] bit 13 "PositionEnbl" = 1.

Then to allow the output of the position loop to trim the speed set parameter 740 [Position Control] bit 1 "Posit Spd Output" = 1.

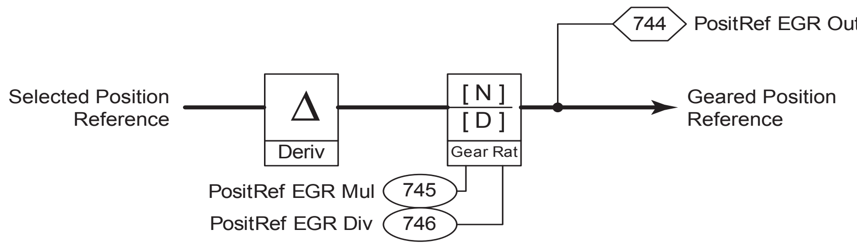
Position Reference Selection

For point to point positioning set parameter 742 [Posit Ref Sel] = 2 "Pt to Pt". Parameter 758 [Pt-Pt Posit Ref] becomes the reference for the position.



Position Reference Scaling

Position reference can be entered in user units by using the EGR scaling. Parameters 745 [PositRef EGR Mul] and 746 [PositRef EGR Div] are used to scale the position reference.



Example: To use degrees of motor revolution for the positioning units, scale as follows:

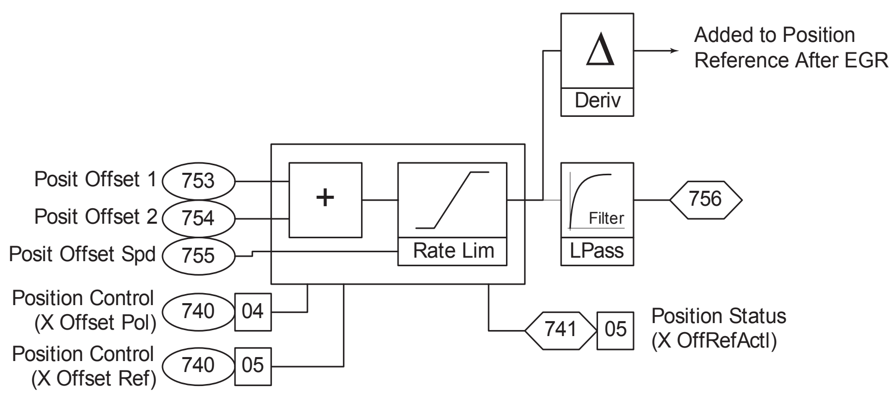
With a 1024 encoder on the motor, this translates to 4096 counts per revolution quadrature position counts.

Parameter 745 [PositRef EGR Mul] = 4096
Parameter 746 [PositRef EGR Div] = 360

This scaling translates the position reference of 0-360 degrees to 0-4096 position counts. This will allow you to enter degrees of motor rotation for the position reference.

Position Offset

Offsets can be added to the position reference. Offset are used to make a correction move to synchronize the follower to the master position.



There are two offsets, parameters 753 [Posit Offset 1] and 754 [Posit Offset 2]. The offset speed must be entered in parameter 755 [Posit Offset Spd] - if this is left at zero the move will not occur. The position offset must be entered in counts of feedback because it is added to the position reference after the EGR scaling. Offsets must be maintained to keep the position, I.E. if you enter a 300 in the offset the position loop will move 300 counts extra. If you zero the offset command the motor will return to the previous position. When it is necessary to zero the offset after a move without returning to the previous position, set parameter 740 [Position Control] bit 5 "Xoff ReRef" =1. Then set the offset value = 0. Then set [Position Control] bit 5 "Xoff ReRef" = 0. The system will not make an offset move when [Position Control] bit 5 "Xoff ReRef" is set.

Point to Point Acceleration and Deceleration

Parameter 759 [Pt-Pt Accel Time] sets the acceleration time in seconds from zero to base motor speed.

Parameter 760 [Pt-Pt Decel Time] sets the deceleration time in seconds from base motor speed to zero.

The [Pt-Pt Accel Time] and [Pt-Pt Decel Time] are only active in Point to Point mode. The Default = 10 seconds.

Position Loop Output Limits

Parameter 772 [Xreg Spd LoLim] sets the negative speed limit at which the position regulator will output. The default is set to -10% of the base motor speed. Set this to the negative speed at which you want the drive to run for point to point moves.

Parameter 773 [Xreg Spd HiLim] sets the positive speed limit at which the position regulator will output. The default is set to +10% of the base motor speed. Set this to the positive speed at which you want the drive to run for point to point moves.

Tuning Tips

The speed regulator of the drive must be tuned prior to tuning the Position Loop. Refer to Speed PI Regulator of this manual for tips on tuning the speed regulator.

Do not attempt to set the accel/decel rates of the point to point position loop faster than can be accomplished by the system. Attempting to set the accel/decel rates faster than the system can handle will cause instability in the position loop. Do not attempt to operate beyond the torque limits of the drive motor combination.

Typically parameter 768 [PositReg P Gain] should be set between 1/5th to 1/3rd of parameter 90 [Spd Reg BW].

Parameter 768 [PositReg P Gain] may be set higher using lead compensation on the Position Regulator Output. Lead/Lag filtering of the position regulator output is accomplished via the speed trim 2 filter. Set parameter 25 [STrim2 Filt Gain] and parameter 26 [SpdTrim2 Filt BW] so that:

$$\frac{[\text{SpdTrim2 Filt BW}]}{[\text{Strim2 Filt Gain}]} = [\text{Speed Reg BW}]$$

For example, with parameter 90 [Spd Reg BW] = 40 rad/sec, set parameter 26 [SpdTrim2 Filt BW] = 200 rad/sec and set parameter 25 [Strim2 Filt Gain] = 5. The lead/lag filter will effectively cancel the 1/40 sec lag. This will allow a higher parameter 768 [PositReg P Gain] for increased stability.

Parameter 761 [Pt-Pt Filt BW] sets the bandwidth of a low pass filter which affects smoothness at the start of deceleration in point to point mode. A high filter bandwidth will produce a more square deceleration torque, one with a higher level of jerk. Typical values are 5 to 100 (rad/sec). A zero value will bypass the filter. Too high of a value in [Pt-Pt Filt BW] will cause unstable operation at the end of the move. The Default = 25 rad/sec.

Jogging

The jog can be performed while the position loop output is enabled and while the position loop output is turned on.

Point to Point Re-Reference

Parameter 740 [Position Control] bit 10 "Pt-Pt ReRef" allows the user to perform a position re-reference when active. When this bit is set, the position reference in parameter 758 [Pt-Pt Posit Ref] can be changed to the position value desired for the current location. This can be used as a home setup by moving the load to the home position and then performing a position re-reference.

Example: Set parameter 740 [Position Control] bit 10 "Pt-Pt ReRef" = 1. Then set parameter 758 [Pt-Pt Posit Ref] = 0. If [Pt-Pt Posit Ref] is set to a different number, that will become the new position value. After setting parameter 758 [Pt-Pt Posit Ref] to the desired value, set parameter 740 [Position Control] bit 10 "Pt-Pt ReRef" = 0.

Absolute Point to Point Positioning:

The Point to Point positioning mode may be configured to operate in an absolute mode. The absolute mode allows the point to point position regulator to remain active at all times, even when the drive is stopped and restarted. An absolute feedback device such as a Stegmann Hi-resolution multi-turn encoder can also be used in absolute mode in order to retain position feedback during power loss. Hi-Resolution Stegmann encoders provide absolute position feedback for up to 4096 motor revolutions.

To enable absolute mode, set parameter 740 [Position Control] bit 6 "AbsPositCtrl" = 1.

To define zero position, position the motor shaft to where you would like zero position to be. Set parameter 740 [Position Control] bit 9 "SetZeroPosit" = 1. This setting redefines where the zero position of the motor shaft will be. Then set parameter 740 [Position Control] bit 9 "SetZeroPosit" = 0.

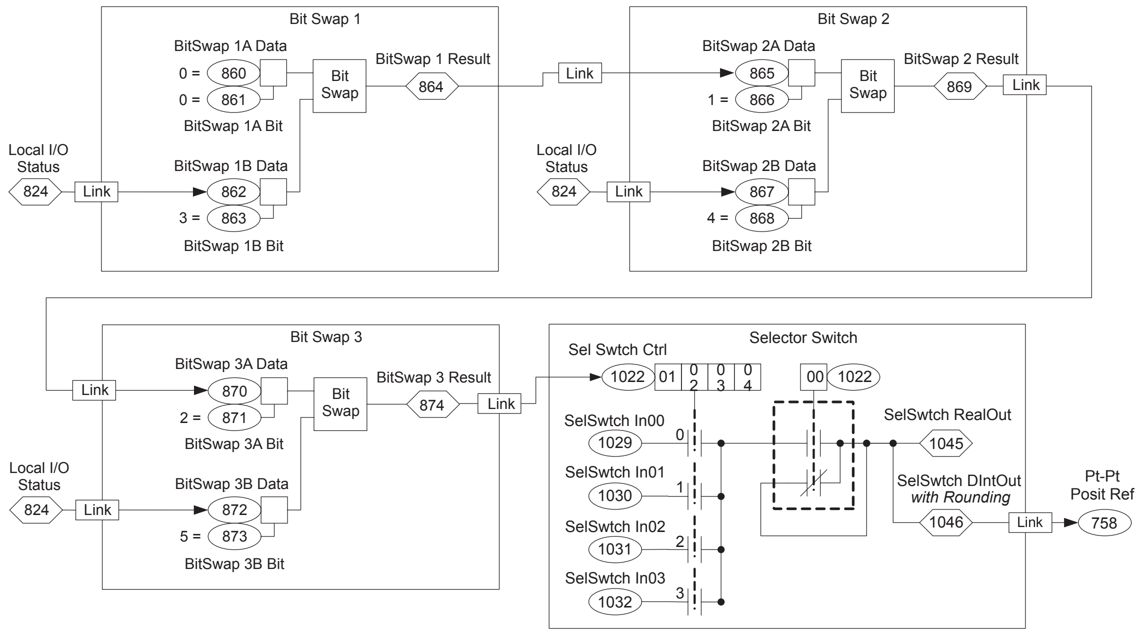
Parameters 745 [PositRef EGR Mul] and 746 [PositRef EGR Div] are not used in absolute mode. Therefore, the position reference is always scaled to feedback counts in absolute mode.

ATTENTION: When absolute mode is on, if the motor shaft is moved while the drive is stopped or powered down, the drive will move to the position reference set in parameter 758 [Pt-Pt Posit Ref] when started. For applications where the motor shaft should not move on the initial start, load the value from parameter 763 [Position Actual] into parameter 758 [Pt-Pt Posit Ref] before starting the drive.

Example to Control the Point to Point Position with Digital Inputs:

Digital Inputs can be used to control up to 16 positions for the point to point loop by using the Bit Swap and Selector Switches user functions.

This example is used to control the selector switch function block to select 4 different positions from digital inputs 4 and 5 (note that we can select up to 16 positions with the selector switch, but this example only uses 4). Once the desired position is selected, digital input 3 is used to pass the chosen position through the switch to parameter 758 [Pt-Pt Posit Ref].



Pt to Pt Reference Setup:

- Link parameter 758 [Pt-Pt Posit Ref] to parameter 1046 [SelSwtch DIntOut]. The point to point reference comes from the output of the selector switch.
- Program parameters 1029 [SelSwtch In00] through parameter 1032 [SelSwtch In03] for the 4 positions desired.

Bit Swap 1 Setup:

- Set parameter 860 [BitSwap 1A Data] = 0. Parameter 860 [BitSwap 1A Data] sets up any data you would like to pass through to the result.
- Set parameter 861 [BitSwap 1A Bit] = 0. Parameter 861 [BitSwap 1A Bit] sets the bit that you would like to turn on in the result and is set to bit 0 in order to use bit swap 1 to turn on bit 0 of parameter 1022 [Sel Switch Ctrl].
- Link parameter 862 [Bit Swap 1B Data] to parameter 824 [Local I/O Status]. Parameter 862 [Bit Swap 1B Data] sets the data to compare.
- Set Parameter 863 [BitSwap 1B Bit] = 3. [BitSwap 1B Bit] sets which bit of parameter 824 [Local I/O Status] is used. Bit 3 of parameter 824 indicates that digital input 3 has turned on.
- The overall function of BitSwap 1 is that when digital input 3 turns on, bit 0 is turned on as the result, which is eventually passed through to control bit 0 "SSW DataPass" of parameter 1022 [Sel Switch Ctrl].

Bit Swap 2 Setup:

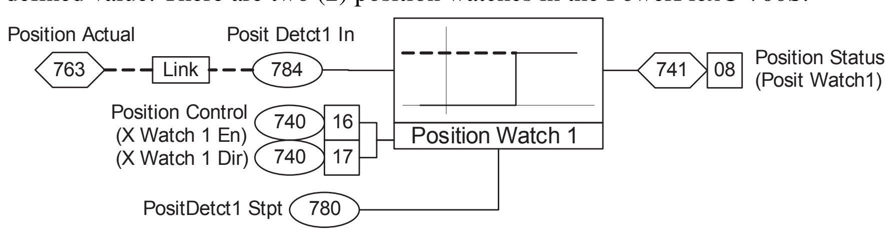
- Link parameter 865 [BitSwap 2A Data] to parameter 864 [BitSwap 1 Result]. Parameter 865 [BitSwap 2A Data] sets up any data you would like to pass through to the result and is linked to the result from bit swap 1.
- Set parameter 866 [BitSwap 2A Bit] = 1. Parameter 866 [BitSwap 2A Bit] sets the bit that you would like to turn on in the result and is set to bit 1 in order to use bit swap 2 to turn on bit 1 of parameter 1022 [Sel Switch Ctrl].
- Link parameter 867 [Bit Swap 2B Data] to parameter 824 [Local I/O Status]. Parameter 867 [Bit Swap 2B Data] sets the data to compare.
- Set parameter 868 [BitSwap 2B Bit] = 4. Parameter 868 [BitSwap 2B Bit] sets which bit of parameter 824 [Local I/O Status] is used. Bit 4 of parameter 824 indicates that digital input 4 has turned on.
- The overall function of BitSwap 2 is that when digital input 4 turns on, bit 1 is turned on as the result, which is eventually passed through to control bit 1 "Sel Swtch 00" of parameter 1022 [Sel Switch Ctrl].

Bit Swap 3 Setup:

- Link parameter 870 [BitSwap 3A Data] to parameter 869 [BitSwap 2 Result]. Parameter 870 [BitSwap 3A Data] sets up any data you would like to pass through to the result and is linked to the result from bit swap 2.
- Set parameter 871 [BitSwap 3A Bit] = 2. Parameter 871 [BitSwap 3A Bit] sets the bit that you would like to turn on in the result, and is set to bit 2 because in order to use bit swap 3 to turn on bit 2 of parameter 1033 [Sel Switch Ctrl].
- Link parameter 872 [Bit Swap 3B Data] parameter 824 [Local I/O Status]. Parameter 872 [Bit Swap 3B Data] sets the data to compare.
- Set parameter 873 [BitSwap 3B Bit] = 5. Parameter 873 [BitSwap 3B Bit] sets which bit of parameter 824 [Local I/O Status] is used. Bit 5 of parameter 824 indicates that digital input 5 has turned on.
- The overall function of BitSwap 3 is that when digital input 5 turns on, bit 2 is turned on as the result, which is eventually passed through to control bit 2 "Sel Swtch 01" of parameter 1033 [Sel Switch Ctrl].

Position Loop - Position Watch

The position watch is used to determine when the position feedback reaches a user defined value. There are two (2) position watches in the PowerFlex® 700S.



Parameter 784 [Posit Detct1 In] sets the position feedback that you would like to watch. By default, [Posit Detct1 In] is linked to parameter 763 [Position Actual].

Note: In order for the value in parameter 763 [Position Actual] to change the firmware function for the position loop must be turned on by setting parameter 147

[FW Functions En] bit 16 "Position Ctrl" = 1 and the position loop must be enabled by setting parameter 151 [Logic Command] bit 13 "Position En" = 1.

Parameter 780 [PositDetct1 Stpt] is used to set the position set point for which to watch.

Setting parameter 740 [Position Control] bit 17 "X Watch 1 Dir" = 1 causes the drive to detect when the position feedback becomes greater than the set point. Setting [Position Control] bit 17 "X Watch 1 Dir" = 0 causes the drive to detect when the position feedback becomes less than the set point.

Setting parameter 740 [Position Control] bit 16 "X Watch 1 En" = 1 enables the position detection function to detect the next position. Setting [Position Control] bit 16 "X Watch 1 En" = 0 resets position detection.

Setting parameter 741 [Position Status] bit 8 "Posit Watch1" = 1 indicates that the position set point has been passed.

Example:

- Set parameter 147 [FW Functions En] bit 22 "PosWtch/Dtct" = 1.
- Link parameter 784 [Posit Detct1 In] to parameter 240 [Encdr1 Position].
- Set parameter 780 [PositDetct1 Stpt] = 100000 counts.
- Set parameter 740 [Position Control] bit 17 "X Watch 1 Dir" = 1.
- Set parameter 740 [Position Control] bit 16 "X Watch 1 En" = 1.
- When parameter 240 [Encdr1 Position] becomes greater than 100000 counts, parameter 741 [Position Status] bit 8 "Posit Watch1" is set to 1. Note that the position must pass 100000 counts. If the motor position is already past 100000 counts when the position watch is enabled, the position watch status bit will not detect the position until 100000 counts is passed again.
- Set parameter 740 [Position Control] bit 16 "X Watch 1 En" = 0 to reset parameter 741 [Position Status] bit 8 "Posit Watch1" to 0.

Position Loop - Registration

The PowerFlex® 700S drive has the ability to capture the feedback position upon an event occurrence using registration. When using DriveLogix™ Motion with the PowerFlex 700S, the Motion Arm Registration (MAR) can be used to control registration.

Encoder 0 and 1 Registration

There are two registration latches where each one can be configured for Encoder 0 or Encoder 1.

- Parameter 235 [RegisLtch0 Value] displays the registration data of port 0 and indicates the position reference counter value latched by the external strobes. The strobe signal used to trigger the latch is configurable by Parameter 236 [RegisLtch 0/1 Cnfg].
- Parameter 236 [RegisLtch 0/1Cnfg] configures the registration latch at port 0 or port 1 to be used with Encoder 0 or Encoder 1, respectively.

- Bits 0 “RL0 Encoder 1” and 16 “RL1 Encoder 1” select the encoder for the input source of latched data. Setting bit 0 selects encoder 1, resetting the bit to zero selects encoder 0.
- Bits 1 “RL0 TrgSrc0”, 2 “RL0 TrgSrc1”, 17 “RL1 TrgSrc0” and 18 “RL1 TrgSrc1” select the trigger source (see Table 2.E Trigger Source Settings).
- Bits 3 “RL0 TrgEdg0”, 4 “RL0 TrgEdg1”, 19 “RL1 TrgEdg0” and 20 “RL1 TrgEdg1” select which edges signal the position (see Table 2.F Edge Selection Settings).
- Bits 5 “RL0 DirRev”, 6 “RL0 DirFwd”, 21 “RL1 DirRev” and 22 “RL1 DirFwd” set the direction of position capture (see Table 2.G Trigger Direction Settings).
- Bits 8 “SL DI Filt 0”, 9 “SL DI Filt 1”, 10 “SL DI Filt 2”, and 11 “SL DI Filt 3” configure a filter for the digital input 1 and 2 (see Table 2.H Filter Settings). The filter requires the input signal to be stable for the specified time period. Input transitions within the filter time setting will be ignored. Bits 8-11 add 100ns filter per stage to external trigger.

Table 2.E Trigger Source Settings

Bit 2/18	Bit 1/17	Description
0	0	Encoder Ch Z AND Ext Trig A
0	1	Ext Trig B (Digital Input 2)
1	0	Ext Trig A (Digital Input 1)
1	1	Encoder 0 (Primary Encoder) Z phase

Table 2.F Edge Selection Settings

Bit 4/20	Bit 3/19	Description
0	0	Capture on rising edge
0	1	Capture on falling edge
1	0	Capture on both edges
1	1	Disable capture

Table 2.G Trigger Direction Settings

Bit 6/22	Bit 5/21	Description
0	0	Not Configured
0	1	Reverse
1	0	Forward
1	1	Both Directions

Table 2.H Filter Settings

Bit	11	10	9	8	Input Filter Setting
	0	0	0	0	Filter disabled
	0	0	0	1	100 ns filter
	0	0	1	0	200 ns filter
	0	0	1	1	300 ns filter
	0	1	0	0	400 ns filter
	0	1	0	1	500 ns filter
	0	1	1	0	600 ns filter
	0	1	1	1	700 ns filter
	1	0	0	0	800 ns filter (default setting)
	1	0	0	1	900 ns filter
	1	0	1	0	1000 ns filter
	1	0	1	1	1100 ns filter
	1	1	0	0	1200 ns filter
	1	1	0	1	1300 ns filter
	1	1	1	0	1400 ns filter
	1	1	1	1	1500 ns filter

- Parameter 237 [RegisLtch0/1 Ctrl] configures the control for registration latch 0 and 1.
  - Set bit 0 “RL0 Arm Req” or bit 16 “RL1 Arm Req” to arm the registration logic for the next trigger event. The particular latch will be armed and ready to be strobed on the next occurrence of the trigger input.
  - Set bit 1 “RL0 DisarmReq or bit 17 “RL1 DisarmReq” to disarm the registration logic for next trigger event.
- Parameter 238 [RegisLtch0/1Stat] indicates the control status of registration ltach 0 and 1.
  - Bit 0 “RL0 Armed” or bit 16 “RL1 Armed” indicates the registration latch is armed.
  - Bit 1 “RL0 Found” or bit 17 “RL1 Found” indicates the registration event has triggered the latch.
  - Rising edge of “Arm request” will set the “Armed” status bit.
  - Rising edge of “Disarm request” will clear the “Armed” status bit.

Encoder 0 Example

This example will set up registration to capture Encoder 0 position. Digital input 1 will be the trigger.

- Parameter 236 [RegisLtch 0/1 Cnfg]:
  - Bit 0 "RL0 Enc1" = 0; selects Encoder 0
  - Bit 1 "RL0 TrgScrc0" = 0 and Bit 2 "RL0 TrgScrc1" = 1; selects digital Input 1 for the trigger
  - Bit 3 "RL0 TrgeEdg0" = 0 and Bit 4 "RL0 TrgEdg1 = 0; configures the registration to capture position on the rising edge of Digital Input 1
  - Bit 5 "RL0 DirRev" = 1and Bit 6 "RL0 DirFwd" = 1; configures the registration to capture position when Encoder 1 feedback is forward (counting up) or reverse (counting down)
  - All other bits left at default. Note that bits 16 through 22 are for the second registration latch and are not used in this example
- Set parameter 237 [RegisLtch 0/1 Ctrl] Bit 0 "RL0 Arm Req" = 1 to arm the registration. Parameter 238 [RegisLtch 0/1 Stat] Bit 0 "RL0 Armed" will be set to 1.
- When Digital input 1 turns on, parameter 238 [RegisLtch 0/1 Stat] Bit 1 "RL0 Found" will be set to 1 and parameter 235 [RegisLtch0 Value] will contain the position counts of Encoder 0 that was captured. Parameter 237 [RegisLtch 0/1 Ctrl] Bit 0 "RSL0 Arm Req" will be set back to 0 when the registration is found.
- To arm the registration again, set parameter 237 [RegisLtch 0/1 Ctrl] Bit 0 "RSL0 Arm Req" = 1 to arm the registration. Parameter 238 [RegisLtch 0/1 Stat] Bit 0 "RSL0 Armed" will be set to 1 again and Bit 1 "RL0 Found" will be set back to 0 until Digital Input 1 turns on again.

Note: To disarm the registration if it has not been found you can set parameter 237 [RegisLtch 0/1 Ctrl] Bit 1 "RSL0 Disarm Req" = 1. Parameter 237 [RegisLtch 0/1 Ctrl] Bit 0 "RSL0 Arm Req" will be set back to 0. Then set parameter 237 [RegisLtch 0/1 Ctrl] Bit 1 "RSL0 Disarm Req" back to 0.

Feedback Option 0 and 1 Registration

There is one registration latch that can be configured for Feedback Option 0 and one registration latch that can be configured for Feedback Option 1. Note that for the feedback option port 0 and 1 registration, the trigger source is always Digital Input 1.

- Parameter 254 [Opt0/1 RegisCnfg] Configures the registration latch for port 0 and port 1 of the feedback option card.
  - Bits 3 “O0 RLTrgEdg0”, 4 “O0 RLTrgEdg1”, 19 “O1 RLTrgEdg0” and 20 “O1 RLTrgEdg1” select which trigger edges signal the position (see Table 2.I Edge Selection Settings).
  - Bits 5 “O0 RL DirRev”, 6 “O0 RL DirFwd”, 21 “O1 RL DirRev” and 22 “O1 RL DirFwd” set the direction of position capture (see Table 2.J Direction Settings).
  - Bits 8-11 configure a digital filter for the registration trigger signal. This filter can be used to reject spurious noise. The filter works by waiting a programmed time before deciding that the signal is valid. This waiting imposes a mandatory delay in the registration signal. The filter delay is programmable in increments of 100 nanoseconds from 0 (or no delay) up to 700 nanoseconds.

Table 2.I Edge Selection Settings

Bit 4/20	Bit 3/19	Description
0	0	Capture on rising edge
0	1	Capture on falling edge
1	0	Capture on both edges
1	1	Disable capture

Table 2.J Direction Settings

Bit 6/22	Bit 5/21	Description
0	0	Not Configured
0	1	Reverse
1	0	Forward
1	1	Both Directions

- Parameter 255 [Opt0/1 RegisCtrl] configures the registration control on port 0 and port 1 of the feedback option card.
  - Set bit 0 “O0 Arm Req” or bit 16 “O1 Arm Req” to arm the registration logic for the next trigger event. The particular latch will be armed and ready to be strobed on the next occurrence of the trigger input.
  - Set bit 1 “O0 DisarmReq” or bit 17 “O1 DisarmReq” to disarm the registration logic for next trigger event

- Parameter 256 [Opt0/1 RegisStat] indicates the registration control status on port 0 and port 1 of the feedback option card.
  - Bit 0 "Opt0 Armed" or bit 16 "Opt0 Armed" indicates the registration latch is armed
  - Bit 1 "Opt0 Found" or bit 17 "Opt1 Found" indicates the registration event has triggered the latch
  - Rising edge of 'Arm request' will set the 'Armed' status bit
  - Rising edge of 'Disarm request' will clear the 'Armed' status bit
- Parameter 257 [Opt 0 Regis Ltch] displays the registration data of the feedback option card port 0. The registration data is the position reference counter value latched by the external strobes. The strobe signal used to trigger the latch is configurable by the parameter 254 [Opt0/1 Regis Cnfg].
- Parameter 258 [Opt 1 Regis Ltch] displays the registration data of the feedback option card port 0. The registration data is the position reference counter value latched by the external strobes. The strobe signal used to trigger the latch is configurable by the Par 254 [Opt0/1 Regis Cnfg].

Power Loss/Ride Through

The precharge function provides a current limited charging of the drive's bus capacitor(s) and, when charging is complete, bypasses the current limiting device. This current limited charging primarily protects the drive's input fuses and front end rectifiers (or SCRs) from excessive inrush current. The bypass function is needed for normal drive operation to avoid overloading the current limiting device. In general, when precharge is active, the current limiting device is in the circuit and when precharge is done the bypass device is active (see exceptions below).

The ride through function can provide a motor coast, precharge and auto-restart sequence of operation in the event of an input power dropout (power loss and return). First the drive stops pulse-width modulation (PWM) operation "coasting the motor" and saving any remaining power stored in the drive's bus capacitor(s) for extended control logic operating time. Next, the precharge function limits the drive's inrush current in the event that the incoming power to the drive is restored. Last, after the power is restored and the precharge has completed, auto-restart allows the drive to continue normal operation by applying power to the motor again. This operation is intended to protect the drive from excessive inrush currents in the presence of input AC line disturbances and allow the drive to continue normal operation without user intervention. However, there is also a concern for safe auto-restart operation. By default the drive is configured to fault and not auto-restart if the power line dropout lasts more than two seconds.

ATTENTION: The user must determine safe auto-restart and fault configuration at the system and user level. Incorrect selection(s) may result in personal injury due to machine motion.

Precharge Frames 1 through 4

The precharge implementation and control varies with drive size and type. For frames 1 through 4 the precharge hardware is located on the power circuit board. This is basically a resistor and bypass relay in series with the positive DC bus between the front-end rectifier and the bus capacitor. The bypass relay control is described below. Also note that these drives can be wired for either AC line power or DC common bus. The precharge function will work the same for either AC or DC power input.

Precharge Frames 5 and Higher AC Input "Stand Alone Drives"

For frames 5 and higher (AC Input) the precharge function is implemented with an SCR rectifier such that the SCRs are phase advanced to limit the inrush current into the bus capacitor(s). This phase advanced precharge is not controlled by the drive and should normally be completed by the minimum precharge time required by the drive. The drive will not complete precharge until the bus voltage is stable and above the under voltage level.

Precharge Frames 5 and Higher DC Input "Common Bus Drives"

There are two versions of these DC Input or common bus drives. The first has a resistor with an SCR bypass in series with the positive DC bus in front of the bus capacitor. The second does not have any precharge hardware and is intended for user applications where the precharge hardware and control is provided by the user. Drives with the resistor and SCR bypass (internal) have the same precharge control as frame 1-4 above.

ATTENTION: In cases where the user is providing the precharge hardware and control incorrect configuration and/or control may result in drive damage.

Ride Through Operation

An incoming power loss to the drive is detected by a 22% volt drop in bus voltage or a bus voltage that drops below the under voltage level (as determined in parameter 408 [Power Loss Level] - see table below). The return of incoming power is detected by an 11% rise in bus voltage and a bus voltage level greater than the undervoltage level set in parameter 409 [Line Undervolts]. If the undervoltage condition is selected as a fault, parameter 393 [BusUndervoltCnfg] = “2 - FltCoastStop”, then the drive will not restart if the incoming power returns. Upon sensing a power loss the drive can be configured to coast, continue operation or change to flux only operation. (See Ride Through Configuration below).

408	**Power Loss Level** Sets the bus voltage level at which ride-through begins and modulation ends. When bus voltage falls below this level, the drive prepares for an automatic reset. Enter a percentage of the bus voltage derived from the high voltage setting for the voltage class For example: on a 400-480V drive, $0.221 \times 480Vac \times \sqrt{2} = 150Vdc$	Units: % Default: 22.1 Min/Max: 15/95		✓	16-bit Integer

In cases where the precharge control is independent or external to the drive (firmware) the ride through function can still be used to stop PWM operation saving controller power and restart operation after the return of power is sensed. In this case, the ride through sequence will not be directly coordinated with the precharge operation. For external precharge hardware functionality is provided so that the user may provide coordinated operation.

Ride Through Configuration

The drive's response to a power disturbance can be selected in parameter 406 [Power Loss Mode].

Settings for Parameter 406 [Power Loss Mode]:

0	Coast
1	Reserved
2	Continue
3	Reserved
4	Reserved
5	Flux Only

Coast (default): The coast mode stops power to the motor (PWM disabled) and the motor coasts until power returns or a fault occurs. At the time when the motor PWM is disabled the precharge device bypass (where controlled by the drive) is also opened. Then the precharge logic is reset so that the drive starts another precharge cycle. After the incoming power returns and the precharge cycle has completed, the drive restarts normal operation.

Continue: This setting disables the ride through function. In this case the drive will attempt to continue running the motor if the incoming power is disrupted. If power returns before the drive has shut down, the precharge device is bypassed and a large inrush current may occur. In this case drive damage is likely.

Flux Only: The drive's torque is set to zero when a power disturbance is detected. The motor flux is continued until the disturbance goes away or until a power down occurs (extended power loss). If the power loss duration is very short or there is sufficient input impedance to limit the inrush current when power returns, the drive will continue normal operation after the disturbance passes. However, if the power returns causing a large inrush current (precharge device is still bypassed) drive damage is likely.

Ride Through Timeout Fault

Parameter 407 [Power Loss Time] sets the amount of time allowed to pass for the incoming power to return before a ride through fault occurs. This limits the time within which an auto-start for the drive could occur. The default value for this time is 2 seconds, with a minimum value of 0 seconds and a maximum value of 60 seconds. The ride through timeout fault is shown in Parameter 321 [Exception Event2] bit 8 "RidethruTime." The ride through timeout fault will inhibit the drive auto start function requiring a fault clear and commanded start to run the drive again.

ATTENTION: The user must determine the safe amount of time allowed for the drive to automatically start.

Precharge Operation

The drive will not run until the controller's precharge function has completed. Also, the precharge function in the drive runs independent of drive precharge hardware (for the most part) and the hardware control. The drive will not restart precharge any time that the drive is running (see Ride Through Operation on page 2-87). The drive control is in precharge (or bus capacitor charging mode) any time that the precharge is not "done" (parameter 555 [MC Status] bit 11 “PreChrg Done” = 0). This process is independent of whether or not the drive control actually controls the precharge hardware.

For the control to complete precharge and allow drive enable, the following five conditions must be met:

1. A user controlled precharge enable must be present. The precharge enable can be provided by hardware input or parameter configuration. When one of the digital input selection parameters (825-830 [Dig Inx Sel]) is set to 30 - "PreCharge En" then the hardware precharge control is selected and the digital input controls the user precharge enable. If none of the digital inputs are set to precharge enable then the control uses parameter 411 [PreChrg Control] as the source for the precharge enable. In this case, when parameter 411 = 0, the precharge control is disabled (held in precharge) and the drive is inhibited from running (see parameter 156 [Start Inhibits]). Otherwise, when parameter 411 = 1 the user precharge is enabled. Using a digital input for the precharge enable is recommended for common bus systems where a drive may be disconnected and reconnected to the common bus system. The digital input should be connected through an auxiliary contact on the cabinet disconnect switch. Failure to provide a hardware disconnect precharge control may lead to very large inrush currents and associated drive damage if a reconnection is made before the drive can sense the power loss. This precharge enable provides a user controlled permissive to the precharge function.

2. The drive must not be in an undervoltage condition. Parameter 409 [Line Undervolts] sets the under voltage level as a percent of drive rated volts (parameter 401 [Rated Volts]). An undervoltage is detected by comparing the parameter 306 [DC Bus Voltage] to the percent of line voltage set in parameter 409 [Line Undervolts] times parameter 401 [Rated Volts] times the square root of 2. The undervoltage condition is displayed in parameter 555 [MC Status] bit 15 "DC Bus Low".

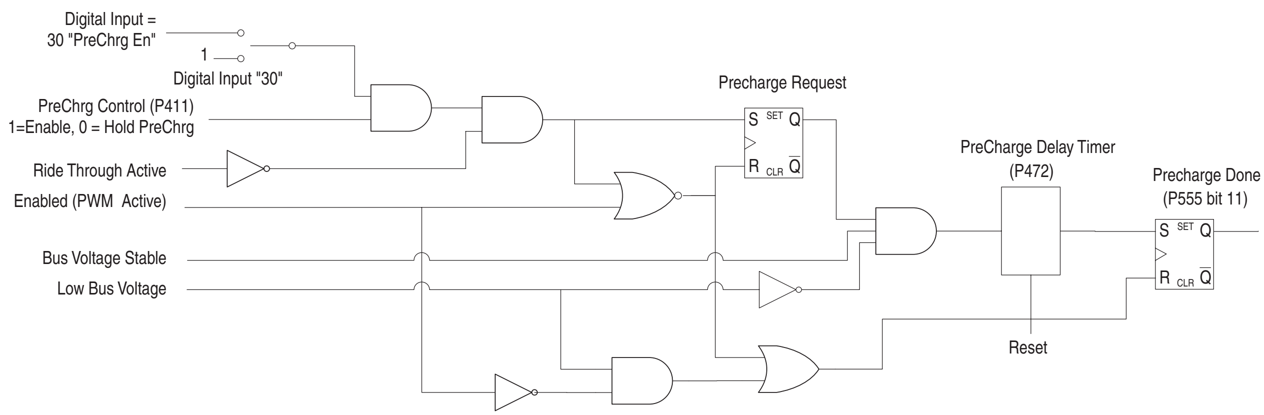
3. The drive bus voltage must be stable (not rising). The bus voltage stable condition is determined by comparing the bus voltage to a filtered value of the bus voltage. Initially, when power is applied to the drive the bus voltage will rise as determined by the limited current controlled by the precharge device. The filtered value of bus voltage will lag behind the actual bus voltage until the bus capacitor charging is complete, then the values will converge. A difference between the filtered and actual bus voltage determines if the bus voltage is stable.

4. The drive must not be running (PWM active), except in coordination with ride through. After the initial drive precharge has completed, a power loss may present conditions for precharge to be restarted (ex. low bus voltage). However, if the drive output is active (parameter 155 [Logic Status], bit 0 "Enabled"), the restart of precharge will be inhibited until the drive is stopped (PWM not active). Also refer to Power Loss/Ride Through for controller coordinated PWM disable and precharge operation. If the drive is running and the user removes the precharge enable, this condition will be ignored until the drive is disabled (PWM stops). Then the precharge function will be started again.

5. The drive precharge delay must be completed. After conditions 1 through 4 above are met, parameter 472 [PreCharge Delay] must be completed before the precharge device bypass is commanded. If any of the above conditions become false during the precharge delay period, the delay timer is reset. If parameter

472 [PreCharge Delay] is set less than 200 mSec then an internal 200 mSec delay is used. Parameter 472 [PreCharge Delay] has a calculated maximum value based on parameter 410 [PreChrg TimeOut]; [PreCharge Delay] = [PreChrg TimeOut] - 1.0 second. (Also see Precharge Staging for common and shared bus drives below).

Precharge Control Functional Diagram



Precharge Timeout Fault

The precharge control logic has an associated precharge timeout fault to alert the user if the precharge is not completed within the timeout period. Parameter 381 [PreChrg Err Cnfg] provides the configuration control for the precharge timeout fault. Parameter 410 [PreChrgTimeout] sets the period or delay for this timeout fault (default = 30 seconds). The timeout timer is not started until the user requests a precharge either through the hardware input (digital input) or through parameter 411 [PreChrg Control]. The precharge timeout fault is intended only to alert the user that there may be a problem in the precharge control. The precharge fault, for the most part, it does not affect the precharge operation. If conditions change to complete or restart precharge, the precharge control will function as described above independent of whether or not a precharge timeout fault has occurred.

If the drive does not complete precharge due to an unstable bus voltage, then after the precharge timeout period the precharge control will complete precharge providing all of other conditions for precharge are met. This control is based on the precharge timeout status and is independent of whether or not the precharge timeout is configured as a fault, warning or none. This feature could be useful in cases where bus disturbances are created by another drive in a common or shared bus installation.

Settings for parameter 381 [PreChrg Err Cnfg]:

"0 "Ignore": This disables the precharge timeout fault. With this setting the drive ignores condition 3 above so that the drive does not check for an unstable bus voltage. Then after the precharge timeout period the precharge control will complete precharge providing all of the other conditions for precharge are met. This feature could be useful in cases where bus disturbances are created by another drive in a common or shared bus installation.

"1 "Alarm": If the precharge does not complete within the timeout period, the drive does not fault, but it sets an alarm bit in parameter 326 [Alarm Status 1] bit 30 "Precharge Er".

"2 "FltCoastStop": This is the factory default setting. If the precharge does not complete within the timeout period, the drive faults and disables the PWM output.

External Precharge

In cases where the user must provide external drive precharge hardware and control, the following should be considered:

- The current limit necessary to protect the drive and fuses
- The breaking capability of the precharge device
- The regenerative capability of the drive/system
- Whether or not ride through control will be accommodated
- Impedance isolation that may be needed between drives
- Braking requirements
- Sharing between drives
- The power disconnect operation in a system

The drive's precharge and ride through functions will still run even though the actual precharge hardware is not controlled by the drive. The drive's enable (parameter 155 [Logic Status], bit 0 "Active"), precharge enable (controlled with a digital input or parameter 411 [PreChrg Control]) and precharge done (parameter 555 [MC Status] bit 11 "PreChrg Done") parameters are available for the external precharge/ride through control in cases where the users would like to provide coordinated operation between the external precharge and the drive's ride through operation.

Precharge Staging

Parameter 472 [PreCharge Delay] can be used in conjunction with precharge enable (see 1 above) to coordinate the precharge operation of a group of drives. Typical uses may include common bus or shared bus applications. The precharge coordination can be open loop, using different precharge delay times or could be closed loop by monitoring the precharge done status (parameter 555 [MC Status] bit 11) of each drive before the next drive in the sequence is enabled for precharge. The maximum value for PreCharge Delay is limited by parameter 410 [PreChrgTimeout]. The maximum value for [PreCharge Delay] is determined by the following calculation:

[PreCharge Delay] max = [PreChrgTimeout] - 1

Motor Sim Mode

When the motor simulation mode is selected the precharge requirements are ignored and the precharge done condition is not needed for running the drive.

External Power Supply

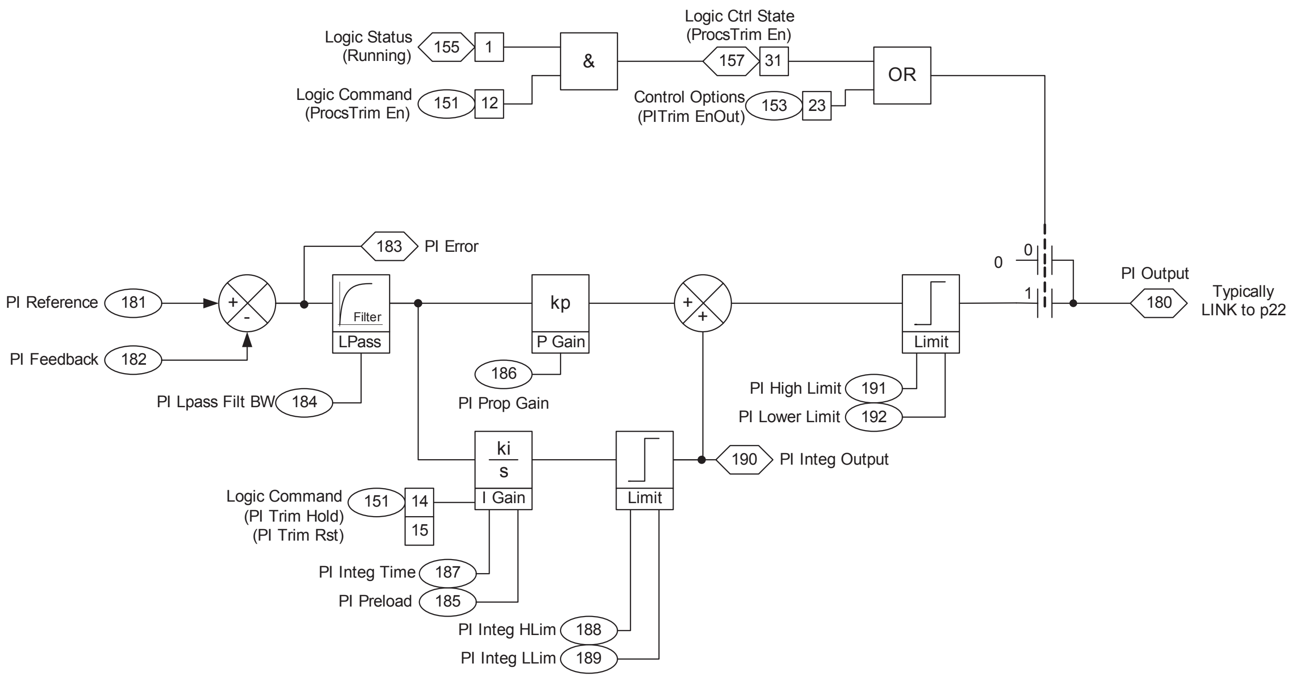
If the drive is used with an external power supply, the user should not request a precharge until the drive incoming power is available. If the user does request a precharge without incoming drive power a precharge timeout fault will occur (if configured for a fault).

Preset Speeds

There are seven (7) preset speeds available for use. Refer to Speed Reference for more information.

Process PI Loop

The drive has a process PI loop that can be used to trim speed, torque, or some other function.



Process PI Reference and Feedback

The reference and feedback signals are the values present in parameter 181 [PI Reference] and parameter 182 [PI Feedback]. [PI Reference] could be a set value or linked to a variable parameter such as an analog input. Typically [PI Feedback] is linked to an analog input value received from a process line transducer.

The reference and feedback values are compared and an error signal is created. This error signal is sent to a low pass filter. The filter bandwidth is set by parameter 184 [PI Lpass Filt BW] in radian/second. The output of the filter is sent to the process PI regulator.

Process PI Regulator

Parameter 185 [PI Preload] presets the process time. When the PI Output is enabled, the integral term of the process regulator will be preset to start parameter 180 [PI Output] at the value set in [PI Preload].

Parameter 187 [PI Integ Time] is the integral term for the regulator. It is in units of 1/seconds. For example, when the [PI Integ Time] is 2, the integrator output equals 1 per unit in 1 second for 1 per unit error. 1 per unit means 100%.

The output of the integrator is limited by parameter 188 [PI Integ Hlim] and parameter 189 [PI Integ Llim]. [PI Integ Hlim] is in per unit and has a range from 0 to 8. A value of 1 for [PI Integ Hlim] can represent base motor speed, rated motor torque, or 100% of some external function.

The output of the integrator after the integrator limits can be viewed in parameter 190 [PI Integ Output].

[PI Prop Gain] sets the proportional gain of the regulator. For example, when [PI Prop Gain] is 2, the output of the proportional block will equal 2 per unit in 1 second for a 1per unit error.

The output of the integrator, parameter 190 [PI Integ Output], and the output of the proportional block are summed together.

Process PI Limits

To prevent the regulator output from exceeding a range, an upper and lower limit can be programmed.

Parameter 191 [PI High Limit] sets the high limit for parameter 180 [PI Output] signal. [PI High Limit] is in per unit and has a range from 0 to 8. A value of 1 for [PI High Limit] can represent base motor speed, rated motor torque, or 100% of some external function.

Process PI Output

At this point of the process PI loop, some conditions must be met to turn on the PI output (otherwise the PI output is 0).

The PI output can be turned on in one of two ways:

1. Parameter 151 [Logic Command] bit 12 - “PI Trim En” is turned on and the drive is running. The running state is indicated by parameter 155 [Logic Status] bit 1. When both of these conditions are true, parameter 157 [Logic Ctrl State] bit 31 “ProsTrim En” will be on.
2. Parameter 153 [Control Options] bit 23 - “PITrim EnOut” is turned on.

Now the PI output is used to trim speed, torque, or some external loop.

To trim the speed loop, link parameter 21 [Speed Trim 1] or parameter 23 [Speed Trim 3] to parameter 180 [PI Output].

To trim the torque loop, link parameter 115 [Torque Trim] to the [PI Output].

To trim some other loop, link the desired parameter to [PI Output]. For example, to use analog output 1 as a trim signal to other equipment, link [Anlg Out 1 Real] to [PI Output].

Reflected Wave

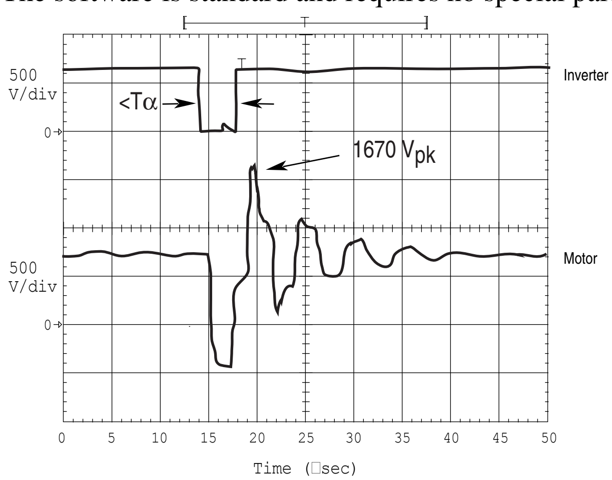
Parameter 510 [FVC Mode Config] bit 9 “ReflWaveComp” enables reflected wave compensation. The pulses from a Pulse Width Modulation (PWM) inverter using IGBTs are very short in duration (50 nanoseconds to 1 millisecond). These short pulse times combined with the fast rise times (50 to 400 nanoseconds) of the IGBT, will result in excessive over-voltage transients at the motor.

Voltages in excess of twice the DC bus voltage (650V DC nominal at 480V input) will occur at the motor and can cause motor winding failure.

The patented reflected wave correction software in the PowerFlex® 700S will reduce these over-voltage transients from a VFD to the motor. The correction software modifies the PWM modulator to prevent PWM pulses less than a minimum time from being applied to the motor. The minimum time between PWM pulses is 10 microseconds. The modifications to the PWM modulator limit the over-voltage transient to 2.25 per unit volts line-to-line peak at 600 feet of cable.

400 V Line = 540V DC bus x 2.25 = 1215V
480 V Line = 650V DC bus x 2.25 = 1463V
600 V Line = 810V DC bus x 2.25 = 1823 V

The software is standard and requires no special parameters or settings.

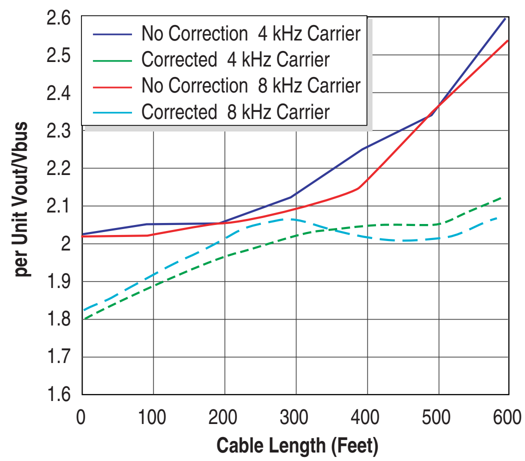


The above figure shows the inverter line-to-line output voltage (top trace) and the motor line-to-line voltage (bottom trace) for a 10 HP, 460V AC inverter, and an unloaded 10 HP AC induction motor at 60 Hz operation. 500 ft. of #12 AWG cable connects the drive to the motor.

Initially, the cable is in a fully charged condition. A transient disturbance occurs by discharging the cable for approximately 4ms. The propagation delay between the inverter terminals and motor terminals is approximately 1ms. The small time between pulses of 4ms does not provide sufficient time to allow the decay of the cable transient. Thus, the second pulse arrives at a point in the motor terminal voltage's natural response and excites a motor over-voltage transient greater than 2 pu. The amplitude of the double pulsed motor over-voltage is determined by a number of variables. These include the damping characteristics of the cable, bus voltage, and the time between pulses, the carrier frequency, modulation technique, and duty cycle.

The plot below shows the per unit motor overvoltage as a function of cable length. This is for no correction versus the modulation correction code for varied lengths of #12 AWG cable to 600 feet for 4 and 8 kHz carrier frequencies. The output line-to-line voltage was measured at the motor terminals in 100 feet increments.

No Correction vs Correction Method at 4 kHz and 8 kHz Carrier Frequencies - Vbus = 650, fe = 60 Hz



Without the correction, the overvoltage increases to unsafe levels with increasing cable length for both carrier frequencies.

The patented modulation correction code reduces the overvoltage for both carrier frequencies and maintains a relatively flat overvoltage level for increasing cable lengths beyond 300 feet.

To determine the maximum recommended motor cable lengths for a particular drive refer to Cable, Motor Lengths.

Refer to **http://www.ab.com/support/abdrives/documentation/index.html** for detailed technical papers.

RFI Filter Grounding

Refer to *"Wiring and Grounding Guidelines for Pulse Width Modulated (PWM) AC Drives,"* publication DRIVES-IN001 for detailed information. This publication is available online at:

http://literature.rockwellautomation.com/literature

S-Curve

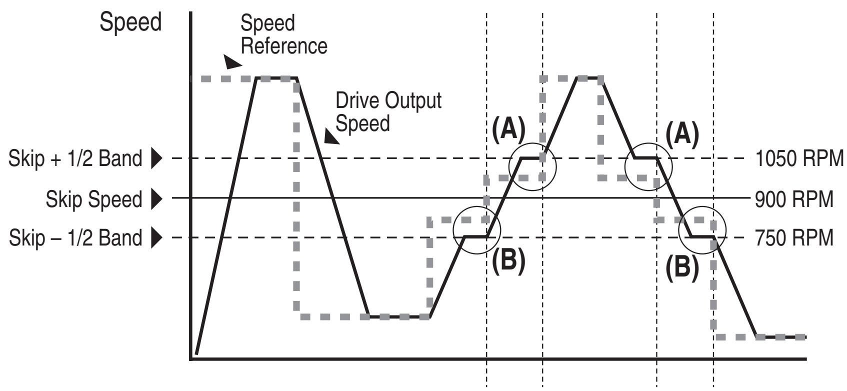
See Speed Reference on page 2-113.

Skip Speeds

Note: Skip speeds are only active when parameter 485 [Motor Ctrl Mode] = 3 “V/Hz".

Some machinery may have a resonant operating speed that must be avoided to minimize the risk of equipment damage. To assure that the motor cannot continuously operate at one or more of the points, skip speeds are used.

Configuration:



Parameters 136 [Skip Speed 1] through 138 [Skip Speed 3] are available to set the speeds to be avoided.

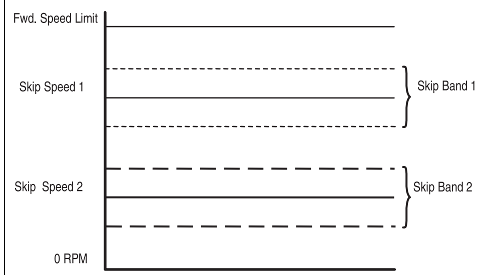
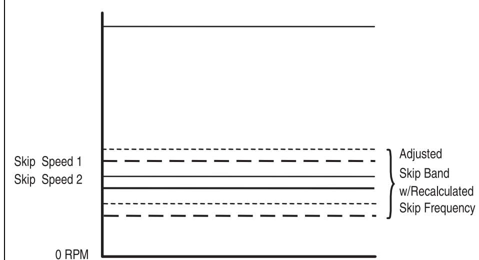
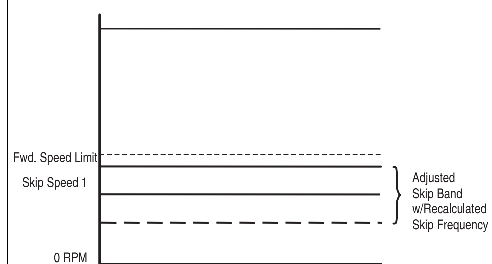
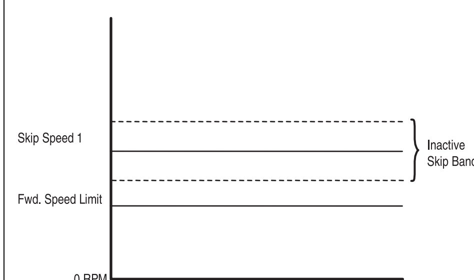
The value programmed into the skip speed parameters sets the center point for an entire "skip band" of speeds. The width of the band (range of speed around the center point) is determined by parameter 139, [Skip Speed Band]. The range is split, half above and half below the skip speed parameter.

If the commanded speed of the drive is greater than or equal to the skip (center) speed and less than or equal to the high value of the band (skip plus 1/2 band), the drive will set the output speed to the high value of the band. See example A in Figure 2.17.

If the commanded speed is less than the skip (center) speed and greater than or equal to the low value of the band (skip minus 1/2 band), the drive will set the output speed to the low value of the band. See example C in Figure 2.17.

Acceleration and deceleration are not affected by the skip speeds. Normal accel/decel will proceed through the band once the commanded speed is greater than the skip speed. See example A & B in Figure 2.17. This function affects only continuous operation within the band.

Figure 2.17 Skip Speed Examples

A	The skip speed will have hysteresis so the output does not toggle between high and low values. Three distinct bands can be programmed. If none of the skip bands touch or overlap, each band has its own high/low limit.	
B	If skip bands overlap or touch, the center speed is recalculated based on the highest and lowest band values.	
C	If a skip band(s) extends beyond the speed limits, the highest band value will be clamped at the speed limit. The center speed is recalculated based on the highest and lowest band values.	
D	If the band is outside the speed limits, the skip band is inactive.	

Slip Compensation

Note: Slip compensation is only active when parameter 485 [Motor Ctrl Mode] = 3 "V/Hz".

As the load on an induction motor increases, the rotor speed or shaft speed of the motor decreases, creating additional slip (and therefore torque) to drive the larger load. This decrease in motor speed may have adverse effects on the process. If speed control is required to maintain proper process control, the slip compensation feature of the PowerFlex drives can be enabled by the user to more accurately regulate the speed of the motor without speed feedback.

When the slip compensation mode is selected, the drive calculates an amount to increase the output frequency to maintain a consistent motor speed independent of load.

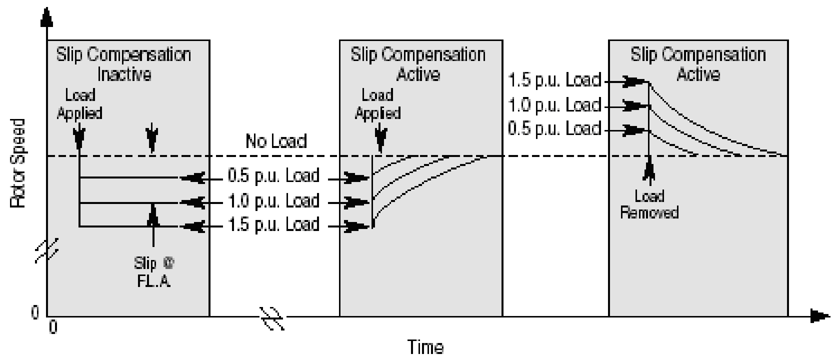
Configuration:

Slip compensation is enabled by setting parameter 153 [Control Options] bit 19 "SlipComp En" = 1.

The amount of slip compensation to provide is selected in parameter 98 [Slip RPM @ FLA]. If desired, the user may adjust parameter 98 to provide more or less slip.

As mentioned above, induction motors exhibit slip which is the difference between the stator electrical frequency, or output frequency of the drive, and the induced rotor frequency. The slip frequency translates into a slip speed resulting in a reduction in rotor speed as the load increases on the motor. This can be easily seen by examining Figure 2.18.

Figure 2.18 Rotor Speed With/Without Slip Compensation



Without slip compensation active, as the load increases from no load to 150% of the motor rating, the rotor speed decreases approximately proportional to the load.

With slip compensation, the correct amount of slip compensation is added to the drive output frequency based on motor load. Thus, the rotor speed returns to the original speed. Conversely, when the load is removed, the rotor speed increases momentarily until the slip compensation declines to zero.

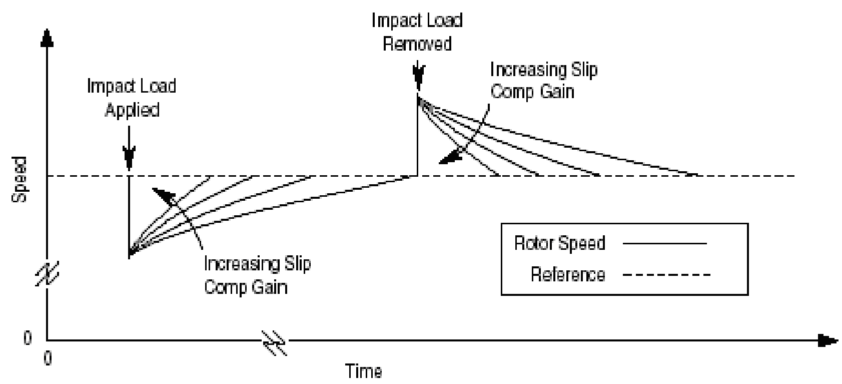
The amount of slip added to the speed command is displayed in parameter 107 [Slip RPM Meter].

Slip compensation also affects the dynamic speed accuracy (ability to maintain speed during "shock" loading). The effect of slip compensation during transient operation is illustrated in Figure 2.19. Initially, the motor is operating at some speed and no load. At some time later, an impact load is applied to the motor and the rotor speed decreases as a function of load and inertia. And finally, the impact load is removed and the rotor speed increases momentarily until the slip compensation is reduced based on the applied load.

When slip compensation is enabled the dynamic speed accuracy is dependent on the filtering applied to the torque current. The filtering delays the speed response of the motor/drive to the impact load and reduces the dynamic speed accuracy. Reducing the amount of filtering applied to the torque current can increase the dynamic speed accuracy of the system.

However, minimizing the amount of filtering can result in an unstable motor/drive. The user can adjust parameter 99 [Slip Comp Gain] to decrease or increase the filtering applied to the torque current and improve the system performance. For parameter 99 a higher value decreases filtering and a lower value increases filtering.

Figure 2.19 Rotor Speed Response Due to Impact Load and Clip Compensation Gain



Speed Control, Speed Mode, Speed Regulation

See Speed/Position Feedback section for information about feedback devices and speed regulation with and without a speed feedback device.

See the Speed PI Regulator section for information about the speed regulator.

See the Torque Reference section for information about choosing the output of the speed regulator as the reference to the torque loop.

Speed/Position Feedback

The speed feedback block selects the feedback device and scales the feedback signal. This section will describe in detail how each of these functions operates.

Feedback Device

Parameter 222 [Mtr Fdbk Sel Pri] selects the feedback device for motor speed and position feedback. The possible settings for parameter 222 are:

- 0 - "Encoder 0"
- 1 - "Encoder 1"
- 2 - "Sensorless"
- 3 - "Reserved" (this setting is not used)
- 4 - "Motor Sim"
- 5 - "FB Opt Port0"

Parameter 223 [Mtr Fdbk Alt Sel] selects an alternate feedback device when a feedback loss is detected on the primary device. The possible settings for [Mtr Fdbk Alt Sel] are the same as the possible settings for [Mtr Fdbk Sel Pri].

Encoder

There is one standard encoder input. A second encoder input board is optional. The encoder inputs are rated for Incremental, Dual Channel Quadrature type, Isolated with differential transmitter Output (Line Drive).

The encoder inputs can accept 5V DC or 12V DC (selected via dip switches). There is a encoder supply on the drive that can be set for 5V DC or 12V DC via dip switches.

An encoder offers good performance for both speed and torque regulation applications. Encoder feedback is required for applications with high bandwidth response, tight speed regulation, torque regulation of (+/- 2%) or when the motor is required to operate at less than 1/120th of its' base speed.

Parameters 232 [Encoder0 PPR] and 242 [Encoder1 PPR] set the pulse per revolution rating of the encoders. These parameters have a range from 10 to 20000 PPR. Parameter 156 [Start Inhibits] bit 10 “Encoder PPR” will be set if the PPR value doesn't correspond with any of these cases:

n =	2^n =	x	mod 75	mod 125	mod 225	mod 375	mod 625	mod1125
0	1		75	125	225	375	625	1125
1	2		150	250	450	750	1250	2250
2	4		300	500	900	1500	2500	4500
3	8		600	1000	1800	3000	5000	9000
4	16		1200	2000	3600	6000	10000	18000
5	32		2400	4000	7200	12000	20000	--
6	64		--	--	--	--	--	--
7	128		--	--	--	--	--	--
8	256		--	--	--	--	--	--
9	512		--	--	--	--	--	--
10	1024		--	--	--	--	--	--
11	2048		--	--	--	--	--	--
12	4096		--	--	--	--	--	--
13	8192		--	--	--	--	--	--
14	16384		--	--	--	--	--	--

Parameter 233 [Encdr 0/1 Config] sets the configuration options for the encoders. The bits for [Encder 0/1 Config] are defined as follows:

Options	Reserved	Reserved	Reserved	En1SmplRt b2	En1SmplRt b1	En1SmplRt b0	Reserved	Reserved	Enc1 EdgTime	Enc1 Dir	Enc1 A Phs	Enc1 4x	Enc1 Filt b3	Enc1 Filt b2	Enc1 Filt b1	Enc1 Filt b0	Reserved	Reserved	Reserved	En0SmplRt b2	En0SmplRt b1	En0SmplRt b0	Reserved	Reserved	Enc0 EdgTime	Enc0 Dir	Enc0 A Phs	Enc0 4x	Enc0 Filt b3	Enc0 Filt b2	Enc0 Filt b1	Enc0 Filt b0	
Default	0	0	0	0	1	1	0	0	1	0	0	1	1	0	1	0	0	0	1	0	1	1	1	0	1	0	0	1	1	0	1	0	0 = False
Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	1 = True

The function of the bits in [Encder 0/1 Config] are as follows:

- Bits 0 “Enc0 Filt bt0” through 3 “Enc0 Filt bt3”, or Bits 16 “Enc1 Filt bt0” through 19 “Enc1 Filt bt3” configure the encoder input filter (see Table 2.K Encoder Input Filter Settings). The filter requires the input signal to be stable for the specified time period. Input transitions within the filter time setting will be ignored. Bits 0-3 (or 16 - 19) add 100ns filtering per stage to encoder inputs.

- Bits 4 “Enc0 4x” and 5 “Enc0 A Phs” or 20 “Enc1 4x” and 21 “Enc1 A Phs” determine how the encoder channel A and B signals will be interpreted. Typically, both encoder phases A and B are used so that direction information is available. Parameter 230 [Encdr0 Position] counts up for forward rotation and down for reverse rotation. If bit 5 (or 21) is set, then the B phase signal is ignored. As a result, the encoder position will only increase, regardless of rotation direction. Bits 4 and 5 (or 20 and 21) together also determine the number of edges counted per encoder pulse (see Table 2.L Multiplier and Direction Settings). "4x" sampling counts both rise and fall of both A and B encoder phases, hence 4 edges per pulse. In 4x mode, the encoder position will change by four times the encoder pulses per revolution rating (PPR) per encoder revolution (e.g., it increments the value in parameter 230 by 4096 for one revolution of a 1024 PPR encoder).
- Bit 6 “Enc0 Dir” or 22 “Enc1 Cir” inverts the channel A input, thus reversing the direction of the feedback. Note that changes in encoder direction (bit 6 or 22) may require changing parameter 153 [Control Options], bit 10 ”Motor Dir”.
- Bit 7 “Enc0 EdgTime” or bit 23 “Enc1 EdgTime” configures the method of sampling used by the Velocity Position Loop (VPL). Setting the bit chooses "Edge to Edge" sampling, while resetting the bit to zero chooses "Simple Difference" sampling. "Simple Difference" sampling calculates speed by examining the difference between pulse counts over a fixed sample time. "Edge to Edge" sampling adjusts the sample time to synchronize with the position count updates from the daughter card - improving the accuracy of the speed calculation.
- Bits 10 “En0SmplRate bt0” through 12 “En0SmplRate bt2” or bits 26 “En1SmplRate bt0” through 28 “En1SmplRate bt2” sets the number of taps for an Finite Impulse Response (FIR) filter (see Table 2.M FIR Filter Settings).

Table 2.K Encoder Input Filter Settings

Bit	3/19	2/18	1/17	0/16	Encoder Bit Filter Settings
	0	0	0	0	Filter disabled
	0	0	0	1	100 ns filter
	0	0	1	0	200 ns filter
	0	0	1	1	300 ns filter
	0	1	0	0	400 ns filter
	0	1	0	1	500 ns filter
	0	1	1	0	600 ns filter
	0	1	1	1	700 ns filter
	1	0	0	0	800 ns filter (default setting)
	1	0	0	1	900 ns filter
	1	0	1	0	1000 ns filter
	1	0	1	1	1100 ns filter
	1	1	0	0	1200 ns filter
	1	1	0	1	1300 ns filter
	1	1	1	0	1400 ns filter
	1	1	1	1	1500 ns filter

Table 2.L Multiplier and Direction Settings

Bit	5/21	4/20	Mult.	Directions	Comments
	0	0	2x	fwd/rev	Counts rise/fall of phase A, phase B only used to find direction
	0	1	4x	fwd/rev	Counts rise/fall of both A and B phases (default setting)
	1	0	1x	fwd only	Counts rise of phase A. Phase B ignored.
	1	1	2X	fwd only	Counts rise of phase A. Phase B ignored.

Table 2.M FIR Filter Settings

Bit	12/28	11/27	10/26	Number of Taps
	0	0	0	1
	0	0	1	2
	0	1	0	4
	0	1	1	8
	1	0	0	16
	1	0	1	32
	1	1	0	64
	1	1	1	127

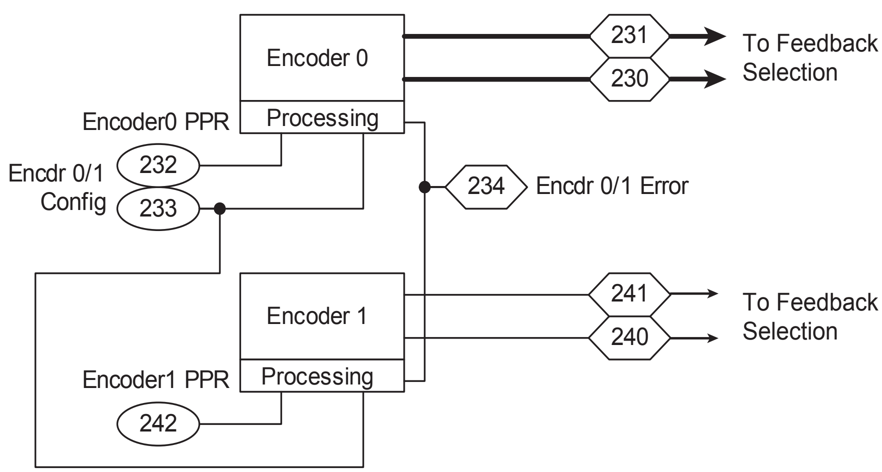
Parameter 234 [Encdr 0/1 Error] indicates the error status of the encoder when there is an error. The bits for [Encdr 0/1 Error] are broken down as follows:

Options	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Enc1 PhseLev	Enc1 PhseLos	Enc1 QuadLos	Enc1 Missing	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Phase Level	Enc0 PhseLos	Enc0 QuadLos	Enc0 Missing
Default	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

0 = False
1 = True

The encoder blocks generate position feedback, seen in parameter 230 [Encdr 0 Position] or parameter 240 [Encdr1 Position]. Encoder position is in quadrature counts (the drive counts 4x the encoder PPR per motor revolution).

The encoder blocks generate speed feedback, seen in parameter 231 [Encdr 0 Spd Fdbk] and parameter 241 [Encdr0 Spd Fdbk].



FIR Filter

The recommended setting for the FIR filter is eight (8) taps when parameter 146 [FW TaskTime Sel] is set to 0 or 1 (0.5ms for task 1). When parameter 146 [FW

TaskTime Sel] is set to 2 (0.25 ms for task 1) the recommended setting for the FIR filter is 16 taps. This sets the noise bandwidth for 120 rad/sec. The recommended setting reduces the effect of noisy feedback on the system, but values above 120 rad/sec for the speed regulator bandwidth may not be effective.

In some cases, it may be desirable to increase the noise bandwidth in order to allow a speed regulator bandwidth higher than 120 rad/sec. The setting of the FIR filter and parameter 89 [Spd Err Filt BW] can be changed to achieve a higher noise bandwidth according to the following tables:

FIR and P89 [Spd Err Filt BW] Settings when P146 [FW TaskTime Sel] = 0 or 1:

FIR filter setting (taps)	1	2	4	8	16	32	64	127
Spd Err Filt BW (rad/sec)	2000	1500	1300	600	300	150	75	38
Noise bandwidth (rad/sec)	400	300	220	120	60	30	18	8

FIR and P89 [Spd Err Filt BW] Settings when P146 [FW TaskTime Sel] = 2:

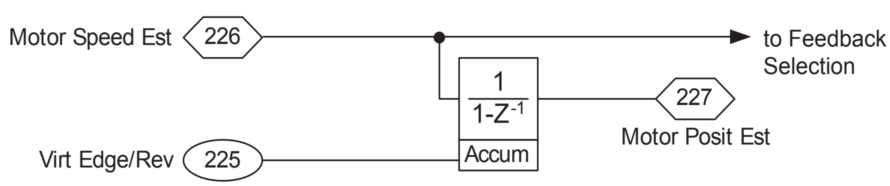
FIR filter setting (taps)	1	2	4	8	16	32	64	127
Spd Err Filt BW (rad/sec)	4100	3200	2200	1300	600	300	150	75
Noise bandwidth (rad/sec)	690	530	380	240	120	60	30	15

Sensorless

Sensorless mode is used when zero speed or more than a 120:1 speed range is **not** required.

Parameter 226 [Motor Speed Est] contains the estimated motor speed, used when sensorless mode is selected. The estimated speed feedback is based on voltage feedback from the motor.

Parameter 227 [Motor Posit Est] is an estimated position for sensorless mode. It is calculated based on parameter 226 [Motor Speed Est] and the value in parameter 225 [Virtl Edge/Rev]. [Virt Edge/Rev] is a user defined value for the number of pulses per motor revolution.

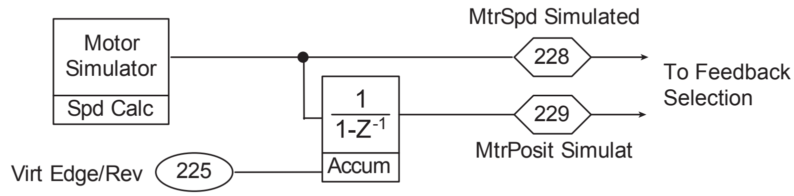


Motor Simulator

The simulator mode allows the drive to be operated without a motor connected and is meant for demo purposes only. If a motor is connected with this mode selected very erratic and unpredictable operation will occur.

Parameter 228 [MtrSpd Simulated] contains the simulated speed feedback.

Parameter 229 [MtrPosit Simulat] contains the simulated position feedback. It is calculated based on the simulated speed feedback and the value in parameter 225 [Virt Edge/Rev]. [Virt Edge/Rev] is a user defined value for the number of pulses per motor revolution.



Feedback Option Cards

There are three different feedback option cards that can be installed on the PowerFlex® 700S:

1. The Stegmann Hi-Resolution Encoder Feedback Option Card
2. The Resolver Feedback Option Card
3. The Multi Device Interface (MDI) Option Card

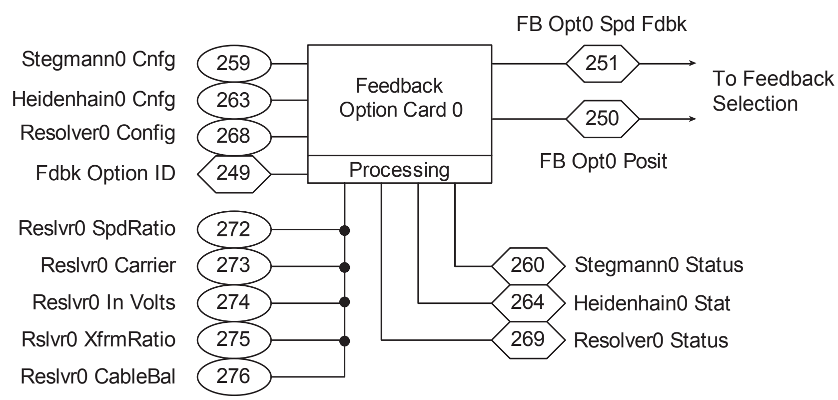
Only one of the option cards above can be physically installed on the drive at a time. When the Stegmann Hi-Resolution encoder option or Resolver option is installed, the data is processed by feedback option card port 0. When the MDI option is installed, it has a Stegmann Hi-Resolution encoder processed by feedback option card port 0 and a linear sensor processed by feedback option card port 1. Note that feedback option port 1 is used for position feedback only and **cannot** be used for motor feedback.

Parameter 250 [FB Opt0 Posit] contains the position feedback from either the Stegmann Hi-Resolution encoder or the Resolver connected at port 0.

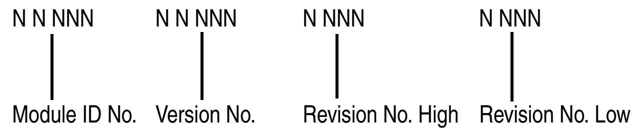
Parameter 251 [FB Opt0 Spd Fdbk] contains the speed feedback from either the Stegmann Hi-Resolution encoder or the Resolver connected at port 0.

Parameter 252 [FB Opt1 Posit] contains the position feedback from the linear sensor when the MDI option is installed.

Parameter 253 [FB Opt1 Spd Fdbk] contains the speed feedback from the linear sensor when the MDI option is installed.



Parameter 249 [Fdbk Option ID] displays information about the feedback option installed in feedback option card port 0. Options:



- Bits 15-11 contain the module ID number.
- Bits 10 - 6 contain the version number.
- Bits 5 - 3 contain the revision number high.
- Bits 2 - 0 contain the revision number low.

Hexadecimal 1000 indicates a resolver, hexadecimal 2000 indicates an old high-resolution board, and hexadecimal 2040 indicates a new high-resolution board.

Stegmann Hi-Resolution Encoder Feedback Option

The position feedback (seen in parameter 250 [FB Opt0 Posit]) from a Stegmann Hi-Resolution encoder counts at a rate of 1,048,576 counts per motor revolution.

Parameter 251 [FB Opt0 Spd Fdbk] contains the speed feedback from the Stegmann Hi-Resolution encoder when connected at port 0.

Parameter 259 [Stegmann0 Cnfg] is used to configure the Hi-Resolution encoder.

- Bit 5 “Direction” determines the counting direction. If set to “0”, the direction is forward or up. If set to “1”, the direction is reverse or down.
- Bits 10 “SmplRate bt0” - 12 “SmplRate bt2” configure the sample interval for measuring speed (Table 2.N FIR Filter Settings). Increasing the encoder sample interval improves speed measurement near zero speed. Decreasing allows the speed control regulator to perform with high gains at high speeds.
- The remaining bits are reserved (not used).

Table 2.N FIR Filter Settings

Bit	12	11	10	Number of Taps
	0	0	0	1
	0	0	1	2
	0	1	0	4
	0	1	1	8
	1	0	0	16
	1	0	1	32
	1	1	0	64
	1	1	1	127

Resolver Feedback Option

The position feedback (seen in parameter 250 [FB Opt0 Posit]) from a Resolver counts at a rate of 65536 counts per motor revolution.

Parameter 251 [FB Opt0 Spd Fdbk] contains the speed feedback from the Resolver when connected at port 0.

Parameter 268 [Reslvr0 Config] is used to configure the Resolver Feedback Option. The bits for [Reslvr0 Config] are defined as follows:

Options	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
Default	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16

Options	Reserved	Reserved	Reserved	SmplRate bt2	SmplRate bt1	SmplRate bt0	Reserved	Reserved	Reserved	Reserved	Resolver Dir	Energize	Resolution 1	Resolution 0	Reserved	Cable Tune
Default	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

0 = False
1 = True

- Setting bit 0 “Cable Tune” enables the cable tuning test, resetting the bit to zero disables the test.
- Bit 1 is reserved (not used).
- Bits 2 “Resolution 0” and 3 “Resolution 1” select the resolver resolution (see Table 2.O Resolution Settings). The resolution setting determines the number of significant bits that are calculated in parameter 250 [FB Opt0 Posit]. It does not affect the number of counts created per resolver revolution (see Table 2.P Resolution and Least Significant Bits Used). However, the resolution sets a limit on the maximum tracking speed (see Table 2.Q Resolution and Resolver Tracking Speed).
- Setting bit 4 “Energize” energizes the resolver, resetting the bit to zero de-energizes the resolver.
- Bit 5 “Resolver Dir” determines the counting direction. If set to “0”, direction is forward or up. If set to “1”, the direction is reverse or down.
- Bits 10 “SmplRate bt0” through 12 “SmplRate bt2” configure the sample interval for measuring speed (see Table 2.R FIR Filter Settings). Increasing the encoder sample interval improves speed measurement near zero speed. Decreasing allows the speed control regulator to perform with high gains at high speeds.

Table 2.O Resolution Settings

Bit	3	2	
	0	0	10 bit resolution
	0	1	12 bit resolution (default setting)
	1	0	14 bit resolution
	1	1	16 but resolution

Table 2.P Resolution and Least Significant Bits Used

Resolution	LSB Not Used	Parameter 250 Increments by
16 bit	All bits used	1
14 bit	2 LSB not used	4
12 bit	4 LSB not used	8
10 bit	6 LSB not used	64

The following table shows the maximum rpm of the motor depending on resolution setting:

Table 2.Q Resolution and Resolver Tracking Speed

Resolution	Maximum Carrier Frequency	Tracking Speed for X1 Resolver	Tracking Speed for X2 Resolver	Tracking Speed for X5 Resolver
10 bit	34 kHz	55 K-rpm	27.5 K-rpm	11 K-rpm
12 bit	24 kHz	13.8 K-rpm	6.9 K-rpm	2.76 K-rpm
14 bit	14 kHz	3480 rpm	1740 rpm	696 rpm
16 bit	10 kHz	900 rpm	450 rpm	180 rpm

Table 2.R FIR Filter Settings

Bit	12/28	11/27	10/26	Number of Taps
	0	0	0	1
	0	0	1	2
	0	1	0	4
	0	1	1	8
	1	0	0	16
	1	0	1	32
	1	1	0	64
	1	1	1	127

Parameter 277 [Reslvr0 Type Sel] specifies the type of resolver. [Reslvr0 Type Sel] automatically sets parameters 272 [Reslvr0 SpdRatio] through 276 [Reslvr0 CableBal]. Parameters 273 [Reslvr0 Carrier] through 276 [Reslvr0 CableBal] cannot be changed by the user.

The following are the possible resolver settings:

P277 [Reslvr0 Type Sel]	272 [Reslvr0 Spd Ratio	273 [Reslvr0 Carrier]	274 [Reslvr0 InVolts]	275 [Reslvr0 XfrmRatio]	Description
0 - Disabled	1	0	0	0.0	No resolver configured
1 -T2014/2087x1	1	2381	26	0.4538	Tamagawa, TS-2014N181E32, TS-2087N1E9, TS-2087N11E9
2 -T2014/2087x2	2	2381	26	0.4538	Tamagawa, TS-2014N182E32, TS-2087N2E9, TS-2087N12E9
3 -T2014/2087x5	5	2381	26	0.4538	Tamagawa, TS-2014N185E32, TS-2087N5E9
4 - MPL 460v	1	4000	8	0.25	AB Motor with integrated Resolver
5 - Reserved	1	9300	22	0.5	Not supported
6 - Siemens 1FT6	1	4000	5	0.5	Siemens, 1FT6 series Motors with integrated Resolver
7 - PrkrHn ZX600	1	7000	4.25	0.4706	Parker Hannifin, ZX600 series Motor with integrated Resolver
8 - Reserved	1	2500	12	0.5	Not Supported for Speed Regulation
9 - 1326Ax 460v	1	4000	8	0.25	AB Motor with integrated Resolver
10 - Reserved	1	9000	15.5	0.5013	Not Supported for Speed Regulation
11 - Reserved	1	2500	7	1.7	Not Supported for Speed Regulation
12 - Reserved	1	9300	22	0.5	Not Supported
13 - Reserved	1	2000	6.36	0.5	Not Supported for Speed Regulation
14 - AmciR11XC107	1	2381	26	0.4538	Advanced Micro Controls, R11X-C107

Parameter 272 [Reslvr0 SpdRatio] specifies the speed ratio for the resolver option card at port 0. The speed ratio comes from the following formula.

Speed ratio = electrical revolutions / mechanical revolutions = pole count / 2.

Parameter 273 [Reslvr0 Carrier] specifies the resolver carrier frequency for the resolver option card at port 0.

Parameter 274 [Reslvr0 In Volts] specifies the resolver input voltage for the resolver option card at port 0.

Parameter 275 [Rslvr0 XfrmRatio] specifies the resolver transformation ratio for the resolver option card at port 0.

Parameter 276 [Reslvr0 CableBal] specifies the resolver cable balance for the resolver option card at port 0.

Parameter 269 [Reslvr0 Status] indicates status of the resolver option card port 0. The bits are defined as follows:

- Bit 0 “Cable Tune” indicates a cable tune is in progress.
- Bit 1 “Tune Result” indicates the tuning Parameter type. When set, it indicates the tuning is using the parameter database. When cleared, it indicates the tuning is using derived data.
- Bit 2 “Mtr Turning” indicates that the motor is turning.
- Bit 3 “Cable Comp”
- Bit 4 “Energized” indicates the resolver is energized.
- Bit 5 “Resolver Dir” indicates the resolver direction.
- Bit 8 “Open Wire” indicates a problem with the cable (open circuit).
- Bit 9 “Power Supply” indicates problem with the option card's power supply.
- Bit 10 “Diag Fail” indicates the option card has failed its power-up diagnostics.
- Bit 11 “Select OK”

Options	Reserved	Reserved	Reserved	Reserved	Select OK	Diag Fail	Power Supply	Open Wire	Reserved	Reserved	Resolver Dir	Energized	Cable Comp	Mtr Turning	Tune Result	Cable Tune
Default	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

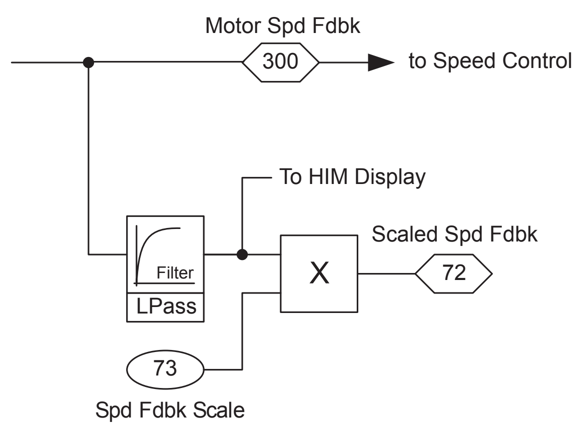
0 = False
1 = True

Motor Speed Feedback and Scaled Speed Feedback

The motor speed feedback is selected according to the feedback device selection. The value for motor speed feedback appears in parameter 300 [Motor Spd Fdbk]. The speed feedback enters the speed regulation loop from [Motor Spd Fdbk]. The filter for the speed feedback is shown in the speed regulation loop section.

A low pass filter branches off of the motor speed feedback. This low pass filter filters out high frequency before displaying the speed feedback on the HIM.

Parameter 72 [Scaled Spd Fdbk] provides a user scalable speed feedback. It is multiplied by the value in parameter 73 [Spd Fdbk Scale].



Position Feedback

Parameter 777 [Position Fdbk] selects the position feedback device for the position control loop.The feedback device used for Position control may be an independent selection from the motor speed control feedback device in Par 222 [Motor Fdbk Sel]. If the position feedback is to be the same as the Motor feedback, select option 3 "Motor Fdbk". This selection will set the selected feedback of Par 222 [Motor Fdbk Sel] as the Position regulators position feedback. The following options are available:

0 = "Encoder 0"
1 = "Encoder 1"
2 = "Reserved"
3 = "Mtr Fdbk Pri"
4 = "Motor Sim"
5 = "FB Opt Port0"
6 = "FB Opt Port1"

Note: Options 5 and 6 are only available when compatible feedback option card is installed. Option 3 is the default setting.

Speed Feedback Loss Ride Through

The speed feedback loss ride through function provides an automatic switch over from the primary motor speed feedback device to the alternate motor speed feedback device when a primary motor speed feedback device fault is sensed. If the alternate speed feedback device has failed the switching will not be allowed and the drive will fault. The active device can be monitored and manual switching between the primary and alternate devices is available. This function has also been referred to as tach loss switch over and encoder loss ride through.

The drive determines that the encoder has faulted based on a combination of hardware detection and monitoring the rate of change of the motor speed. The hardware fault detection is based on illegal encoder states and improper encoder switching patterns. The rate of change of motor speed detection is determined by a rate of change greater than a user-defined speed change.

Hardware detection of feedback loss for the feedback option cards is based on the type of device used and specific fault detection implemented on the feedback option card. The rate of change of motor speed detection is the same implementation as for encoder feedback.

Speed feedback loss ride through is not allowed in position mode. If the encoder loss ride through function was allowed in a positioning system it is likely that the alternate feedback device will supply an arbitrary position feedback value when an encoder loss is detected. This, in turn, could result in unintended motion in the drive system.

ATTENTION: Even though the encoder loss ride through function attempts to automatically switch feedback devices with minimum disturbance, a system disturbance will occur. In some cases feedback device degradation may occur before complete failure takes place. The user must determine if the encoder loss ride through function is appropriate for each application.

Speed Feedback Loss Ride Through Configuration

Parameter 151 [Logic Command] bit 2, "TackLoss Rst" provides a manual switch between primary and alternate speed feedback devices with a “0” to “1” bit transition. A transition from “1” to “0” does not cause a change in operation.

Parameter 152 [Applied LogicCmd] bit 2, "TachLoss Rst" shows the status of parameter 151 [Logic Command] bit 2 "TachLoss Rst" switch.

Setting parameter 153 [Control Options], bit 16 "Auto Tach Sw" to a value of “1” enables the automatic switching of speed feedback devices when a failure is detected. A value of “0” disables the automatic switching of speed feedback devices. Only automatic switching from the primary device specified in parameter 222 [Mtr Fdbk Sel Pri] to the alternate device specific in parameter 223 [Mtr Fdbk Sel Alt] is available. Switching from the alternate to the primary device must be done manually by setting parameter 151 [Logic Command], bit 2 "TackLoss Rst" from “0” to “1”.

Parameter 155 [Logic Status] bit 12, "Tach Loss Sw," shows which speed feedback device is currently active. A value of “0” in bit 12 indicates that the primary speed feedback device selected in [Mtr Fdbk Sel Pri] is active. A value of “1” in bit 12 indicates that the alternate speed feedback device selected in [Mtr Fdbk Sel Alt] is active.

Parameter 222 [Mtr Fdbk Sel Pri] selects the primary speed feedback device. It is not intended to use the sensorless selection as the primary (or active) speed feedback device as there is no feedback loss detection used with sensorless operation.

Parameter 223 [Mtr Fdbk Sel Alt] selects the alternate speed feedback device. Any selection of feedback devices, including sensorless operation is available providing a corresponding motor type and associated feedback device is present.

Settings for parameter 222 [Mtr Fdbk Sel Pri] and parameter 223 [Mtr Fdbk Sel Alt]:

0 =	Encoder 0	3 =	Reserved
1 =	Encoder 1	4 =	Motor Sim
2 =	Sensorless	5 =	FB Opt Port0

Parameter 224 [TachSwitch Level] sets the detection level for the automatic speed loss switch over routine. A drop in feedback speed at the percent of rated speed over a 0.5 mSec interval will cause a tach switch from primary to alternate device. Setting this level lower will make the speed detection more sensitive and lower the minimum speed at which a speed switch could occur. Setting this level higher will make the speed switch less sensitive and raise the minimum speed for speed switch detection.

Parameter 320 [Exception Event1] bits 2 through 5 show the error status of the corresponding speed feedback device.

2 =	Encdr0 Loss
3 =	Encdr1 Loss
4 =	FB Opt0 Loss
5 =	FB Opt1 Loss

Parameter 365 [Fdbk LsCnfg Pri] and parameter 366 [Fdbk LsCnfg Alt] set the feedback loss configuration for each feedback device. The primary feedback device should be configured to 1 "Alarm". The alternate feedback device should typically be configured to 2 "FltCoastStop".

Settings for [Fdbk LsCnfg Pri] and [Fdbk LsCnfg Alt]:

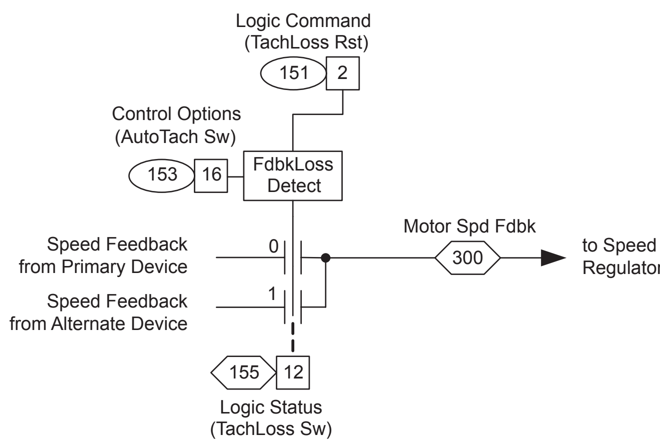
1 =	Alarm
2 =	FltCoastStop

Parameter 510 [FVC Mode Config] bit 22 “SrLss RdThru” must be set to “1” if sensorless operation is selected in [Mtr Fdbk Sel Alt]. In all other cases Parameter 510 bit 22 should be set to “0”.

Speed Feedback Loss Ride Through Operation

Setting up the feedback loss ride through function requires the following steps:

1. Enter a valid feedback device selection in parameter 222 [Mtr Fdbk Sel Pri]
2. Enter a valid feedback device selection in parameter 223 [Mtr Fdbk Sel Alt]
3. Setting parameter 365 [Fdbk LsCnfg Pri] to 1 "Alarm"
4. Setting parameter 366 [Fdbk LsCnfg Alt] to 2 "FltCoastStop" (recommended but not necessary)
5. Setting the speed change detection level in parameter 224 [TachSwitch Level]
6. Setting parameter 153 [Control Options] bit 16 "Auto Tach Sw" to 1 for automatic switch over
7. Setting parameter 510 [FVC Mode Config] bit 22 "SrLssRdThru" to 1 when sensorless operation is selected in parameter 223



Automatic and manual switching of feedback devices is inhibited if a loss in parameter 320 [Exception Event1] bits 2-4 (as appropriate) is sensed on the device to which switching was to take place. The drive will fault when it is configured for speed feedback loss ride through and the primary device fails when the alternate device has failed and is also configured to fault. If the alternate device is not configured to fault, then switching to the alternate device will be inhibited and operation on the primary feedback device will continue. Note that operation on the primary device will continue even with that device's failure since that fault must be configured for an alarm to allow for automatic device switch over.

Manual Speed Feedback Device Switching

Parameter 151 [Logic Command] bit 2, "TackLoss Rst," provides a manual switch between active and non-active primary or alternate speed feedback devices with a “0” to “1” bit transition. Resetting bit 2 from a “1” to a “0” causes no change in operation. The switch is between the active feedback device (either primary or alternate) to the non-active device. For example, if prior to the reset the alternate device selected in Parameter 223 [Mtr Fdbk Sel Alt] is active, then after the reset the primary feedback device selected in Parameter 222 [Mtr Fdbk Sel Pri] will be used as the active speed feedback device. The reset activation is prohibited if a failure is sensed in the speed feedback device to which the drive is switching. The active device selection command is shown in parameter 152. Manual switching between primary and alternate devices can be made while the drive is running.

Speed Reference

The speed reference control loop consists of speed reference scaling, speed reference selection, jogging, speed reference limiting, ramping, s-curve, and filtering. Each part of the speed reference loop is explained in this section.

Speed Reference Select

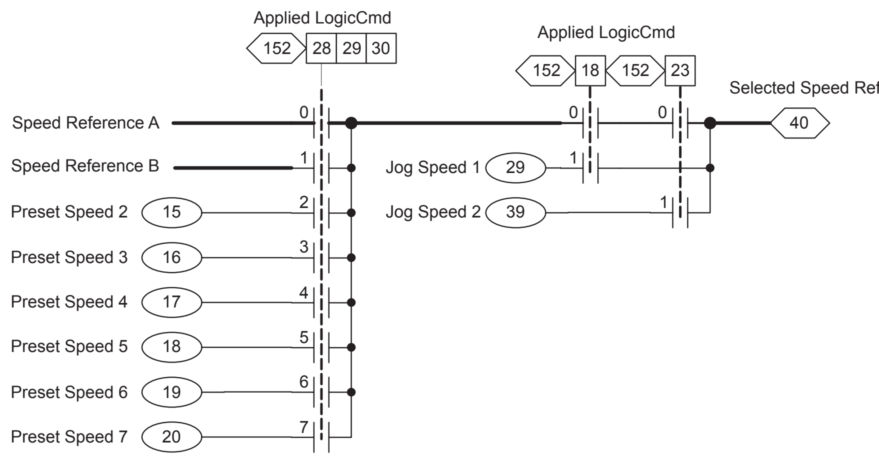
The selection of the active speed reference can be made through digital inputs, DPI (communication) command or DriveLogix™. The input selected by any of these sources is show in parameter 152 [Applied LogicCmd] bit 28 "Spd Ref Sel0", bit 29 "Spd Ref Sel1", and bit 30 "Spd Ref Sel2". Table 2.S Speed Reference Select Inputs shows the truth table for the selected speed reference based on Spd Ref Sel0, 1, and 2 and Figure 2.20 Selected Speed Reference shows the diagram for the selected speed reference.

Table 2.S Speed Reference Select Inputs

2	1	0	Auto Reference Source
0	0	0	Reference A
0	0	1	Reference B
0	1	0	Preset Speed 2
0	1	1	Preset Speed 3
1	0	0	Preset Speed 4
1	0	1	Preset Speed 5
1	1	0	Preset Speed 6
1	1	1	Preset Speed 7

Note: to use Preset Speed 1, program parameter 27 [Speed Ref A Sel] or 28 [Speed Ref B Sel] = 5 "Preset Speed 1".

Figure 2.20 Selected Speed Reference



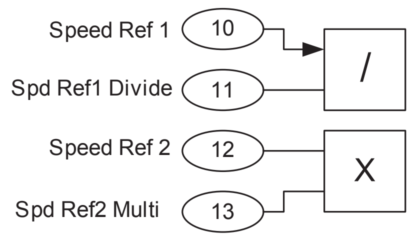
Parameter 27 [Speed Ref A Sel] and parameter 28 [Speed Ref B Sel] determine the source of Reference A and B. Parameter 27 and 28 can be set to the following values:

Setting	Description
0 - Zero Speed	Zero Speed is selected as the speed reference.
1 - Spd Ref 1	Parameter 10 [Speed Ref 1] is selected as the speed reference
2 - Spd Ref 2	Parameter 11 [Speed Ref 2] is selected as the speed reference
3 - Sum SRef 1+2	The sum of [Speed Ref 1] and [Speed Ref 2] is selected as the speed reference. Note that there is no "Speed Ref 3" parameter
4 - MOP Level	Speed reference from motor operated pot, parameter 1090 [MOP Level Real].
5 - Preset Spd 1	Parameter 14 [Preset Spd 1] is selected as the speed reference
6 - Preset Spd 2	Parameter 15 [Preset Spd 2] is selected as the speed reference
7 - Preset Spd 3	Parameter 16 [Preset Spd 3] is selected as the speed reference
8 - Preset Spd 4	Parameter 17 [Preset Spd 4] is selected as the speed reference
9 - Preset Spd 5	Parameter 18 [Preset Spd 5] is selected as the speed reference
10 - Preset Spd 6	Parameter 19 [Preset Spd 6] is selected as the speed reference
11 - Preset Spd 7	Parameter 20 [Preset Spd 7] is selected as the speed reference
12 - DPI Port 1	The speed reference comes from local drive mounted HIM
13 - DPI Port 2	The speed reference comes from the external DPI communication module
14 - DPI Port 3	The speed reference comes from the auxiliary external DPI communication module
15 - Reserved	Reserved
16 - DPI Port 5	The speed reference comes from the internal DPI communication module

Speed Reference Scaling

Parameter 10 [Speed Ref 1] and parameter 12 [Speed Ref 2] are real parameters with units of per unit, where a value of 1 per unit equals base motor speed. Speed reference 1 and 2 each have their own scaling blocks. The speed reference value in parameter 10 [Speed Ref 1] is divided by the scaling parameter 11 [Speed Ref1 Divide]. The speed reference value for parameter 12 [Speed Ref 2] is multiplied by the scaling parameter 13 [Speed Ref2 Multi].

Parameter 11 [Speed Ref1 Divide] and parameter 13 [Speed Ref2 Multi] are linkable parameters. This allows speed reference 1 and 2 to be scaled "dynamically" with an input signal if desired. An example would be to have an analog input linked to the scale parameter. The speed reference and the scale would then affect the value sent to the reference select block.



Jog Reference

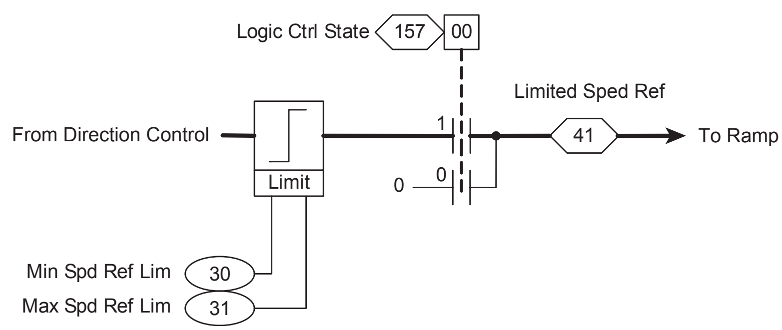
Two separate jog speeds can be used as a speed reference - parameter 29 [Jog Speed 1] or parameter 39 [Jog Speed 2]. For more information on jog speeds refer to Jog on page 2-55.

Direction Control and Bipolar Reference

The direction of rotation of the motor can be controlled by a forward/reverse command or by the use of a bipolar (+/-) signal. For more information on direction control, refer to Direction Control and Bipolar Reference on page 2-24.

Speed Reference Limits

Parameter 30 [Min Spd Ref Lim] and parameter 31 [Max Spd Ref Lim] are used to set the forward and reverse speed limits for the speed reference. Parameter 30 [Min Spd Ref Lim] sets the negative speed limit and parameter 31 [Max Spd Ref Lim] sets the positive speed limit. These limits are set to -125% and 125% of parameter 4 [Motor NP RPM] by default. Parameter 41 [Limited Spd Ref] contains the value of the limited speed reference.



Stop Command

When a stop command is issued, parameter 157 [Logic Ctrl State] bit 0 - “Spd Ref En” is set to “0”, causing a zero speed to be selected. When [Logic Ctrl State] bit 0 is set to “1” the selected speed or jog reference is used.

Accel/Decel Ramp and S-Curve

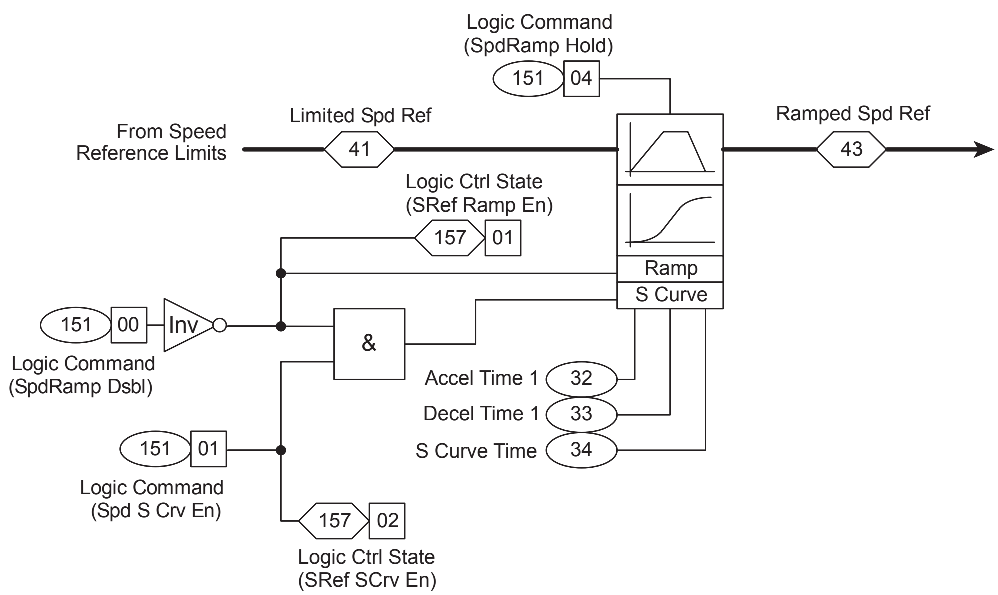
Parameter 32 [Accel Time 1] sets the acceleration time in seconds from 0 speed to the speed in parameter 4 [Motor NP RPM]. Parameter 33 [Decel Time 1] sets the deceleration time in seconds from the speed in parameter 4 [Motor NP RPM] to 0.

The ramp rate in RPM/sec can be determined. For example, the ramp rate for acceleration would be [Motor NP RPM]/[Accel Time].

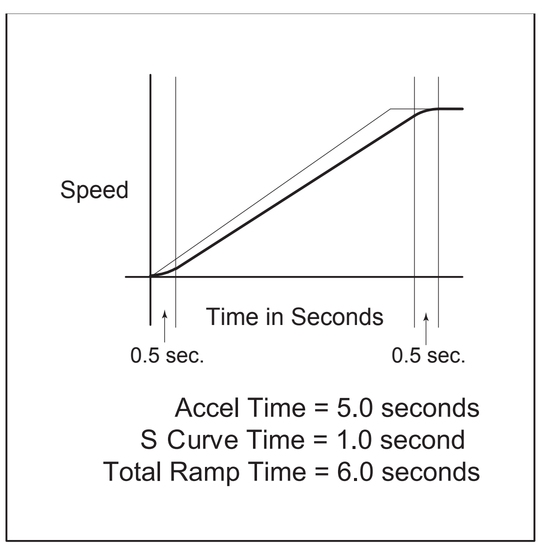
The ramped reference can be viewed in parameter 43 [Ramped Spd Ref].

The accel/decel ramp generator can be bypassed for certain functions. When parameter 151 [Logic Command] bit 0 "SpdRamp Dsbl" = 1, the ramp is bypassed.

The output of the accel/decel ramp can also be held at its present value by setting parameter 151 [Logic Command] bit 4 "SpdRamp Hold" = 1.

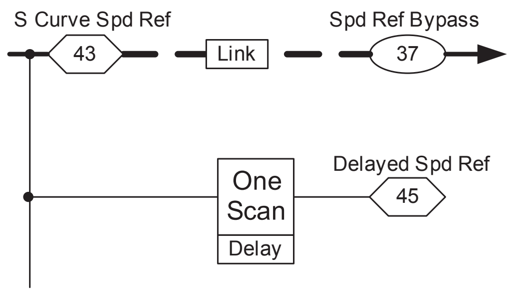


The drive can produce a linear ramp output or an S-curve signal. The S-curve is used when parameter 151 [Logic Command] bit 1 "Spd S Curve En" is on and the ramp is not bypassed. Parameter 34 [S Curve Time] sets the time, in seconds, that the S-curve will be applied at the beginning and at the end of the ramp. Half of the time specified in parameter 34 is added to the beginning of the ramp and half to the end of the ramp (as shown in the example below). The result of the S-curve block can be seen in parameter 43 [Ramped Spd Ref].



Speed Reference Bypass and Delayed Speed Reference

By default, parameter 37 [Spd Ref Bypass] is linked to parameter 43 [Ramped Spd Ref]. However, if you wish to bypass the rest of the speed reference control loop, [Spd Ref Bypass] gives the capability to link to other parameters.



Parameter 45 [Delayed Spd Ref] is delayed by one scan of the speed control loop. Parameter 37 [Spd Ref Bypass] can be linked to parameter 45 [Delayed Spd Ref] instead of parameter 43 [Ramped Spd Ref] for use in SynchLink applications. See SynchLink™ for more details.

Inertia Compensation

Inertia compensation is used to calculate the level of torque required due to load inertia during speed changes. For more information on inertia compensation, see Inertia Compensation.

Friction Compensation

The friction compensation block is used to calculate breakaway torque and the torque needed just to keep the motor running at a constant speed due to friction. For more information on friction compensation, see Friction Compensation.

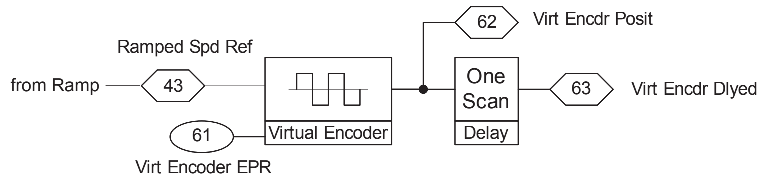
Virtual Encoder

The virtual encoder can be used as a position master for position following applications (see the Position Loop - Follower (Electronic Gearing) section of the Position Loop section for details on position control). The advantage of following a virtual encoder instead of an actual encoder feedback is that the virtual encoder reference is much smoother and is not subject to noise.

The virtual encoder block generates a position counter based on the speed reference in parameter 43 [Ramped Spd Ref]. Parameter 61 [Virt Encoder EPR] is used to specify the desired edges per revolution for the virtual encoder. For example if parameter 61 is 4096 EPR, this would be equivalent to a 1024 PPR quadrature encoder.

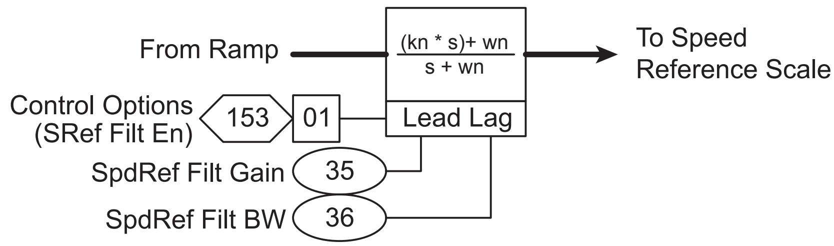
Parameter 62 [Virt Encdr Posit] is a 32 bit integer that contains the pulse count output of the virtual encoder block.

Parameter 63 [Virt Encdr Dlyed] is a 32 bit integer that contains the pulse count output of the virtual encoder block delayed by one scan of the speed reference loop. This parameter can be used to send a virtual position reference over SynchLink for position follower applications. Refer to SynchLink™ on page 2-134 for more details.



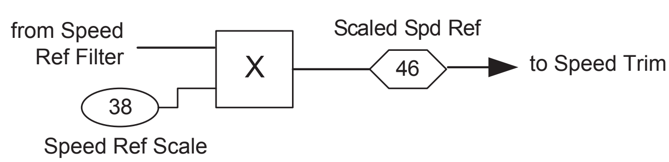
Speed Reference Filter

A lead lag filter for the selected speed reference can be turned on by setting parameter 153 [Control Options] bit 1 - "Sref Filt En" = “1”. Parameter 35 [SpdRef Filt Gain] sets the gain for the filter and parameter 36 [SpdRef Filt BW] sets the bandwidth for the filter. For more information on lead/lag filters see Lead-Lag Filter on page 2-33.



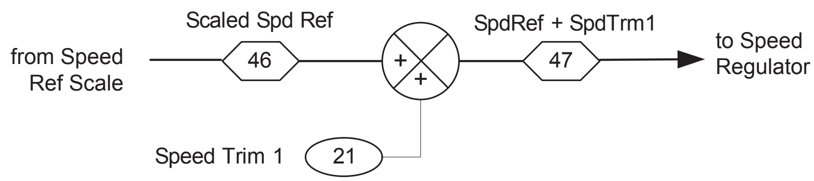
Speed Reference Scale

The speed reference value up to this point is multiplied by the scaling parameter 38 [Speed Ref Scale]. [Speed Ref Scale] is applied to all of the selected speed references, as opposed to the specific scaling parameters for speed reference 1 and 2. [Speed Ref Scale] is a linkable parameter. This allows the speed reference value to be scaled "dynamically" with an input signal if desired. An example would be to have an analog input linked to the scale parameter. The speed reference and the scale would then affect the value sent to the speed regulator.



Speed Trim 1

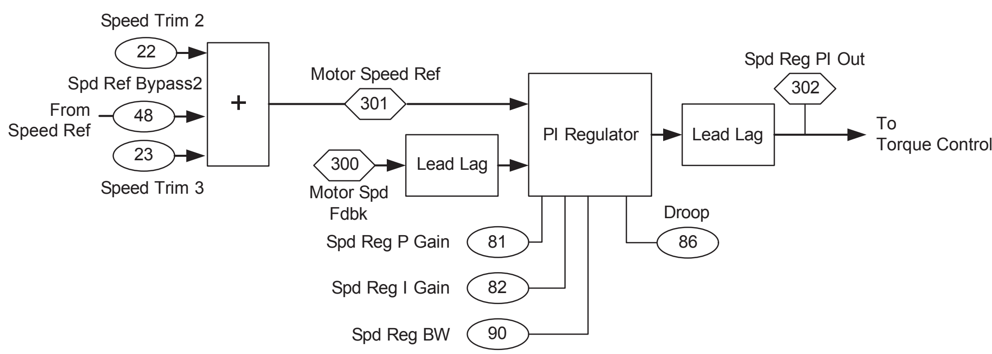
At this point in the speed reference control loop, parameter 21 [Speed Trim 1] is added to the speed reference. [Speed Trim 1] can be used as a trim to the speed reference. For example, [Speed Trim 1] can be linked to parameter 180 [PI Output], which is the output of the Process PI loop. The resulting parameter 47 [SpdRef + SpdTrm1] is sent into the speed regulator loop.



Speed PI Regulator

The drive takes the speed reference specified by the speed reference control loop and compares it to the speed feedback. The speed regulator uses proportional and integral gains to adjust the torque reference sent to the motor. This torque reference attempts to operate the motor at the specified speed. This regulator also produces a high bandwidth response to speed command and load changes.

Figure 2.21 Overview of the Speed PI Regulator Loop



The main purpose of the speed PI regulator is to produce a torque reference for the current regulator block. The following sections describe each portion of the speed PI regulator.

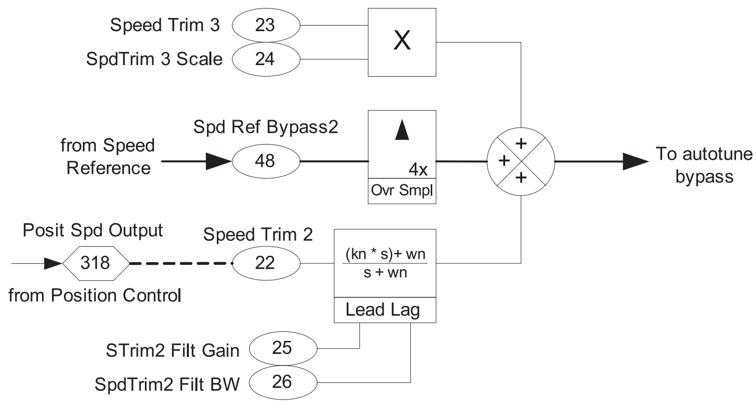
Speed Trim

The speed trim blocks are used to sum the speed reference from the speed reference control loop with speed trim values from other sources.

Parameter 22 [Speed Trim 2] provides a trim value with a lead/lag filter. By default, it is linked to the output of the position loop (parameter 318 [Posit Spd Output]). For more information on lead/lag filters refer to Lead-Lag Filter on page 2-33.

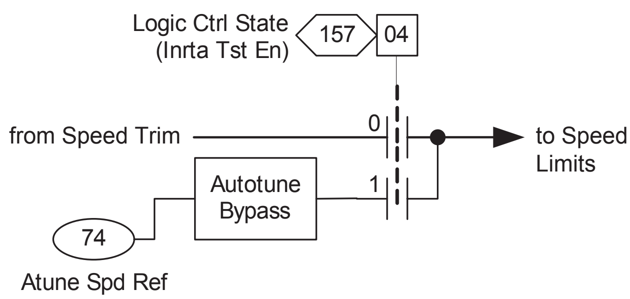
Parameter 23 [Speed Trim 3] provides a scalable speed trim value. The speed reference value for [Speed Trim 3] is multiplied by the scaling parameter 24 [Spd Trim 3 Scale]. [Spd Trim 3 Scale] is a linkable parameter. This allows speed trim 3 to be scaled "dynamically" with an input signal if desired. An example would be to have an analog input linked to the scale parameter. The speed trim and the scale would then affect the value sent to the summation block.

The speed trim values are summed with the speed reference from the speed reference control loop.



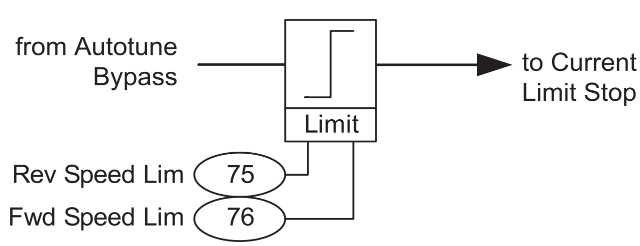
Autotune Speed Reference

During the inertia test, the autotune speed reference is used instead of the output of the speed trim summation. Parameter 74 [Atune Spd Ref] sets the speed for the inertia test. Bit 4 "Inrta Tst En" of parameter 157 [Logic Ctrl State] turns on during the inertia test and allows the autotune speed reference to bypass the output of the speed trim summation.



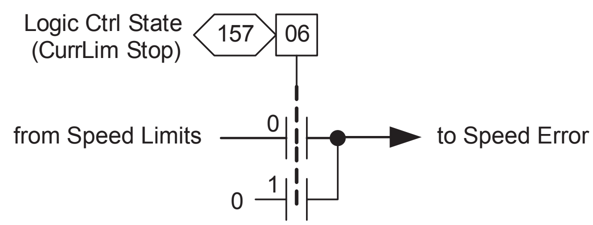
Speed Reference Limits

At this point the summed speed reference is limited by parameters 75 [Rev Speed Limit] and parameter 76 [Fwd Speed Limit]. Those limits are set to -125% and 125% of parameter 4 [Motor NP RPM] by default.



Current Limit Stop

When a current limit stop is commanded, parameter 157 [Logic Ctrl State] bit 6 "CurrLim Stop" is set. Then a 0 speed reference command is sent into the speed regulator, bypassing the ramp and speed trim.

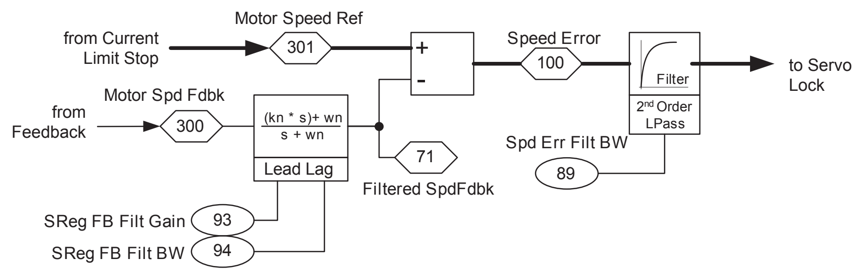


Speed Error

The summed speed reference becomes parameter 301 [Motor Speed Ref]. Then the filtered motor speed feedback (parameter 300 [Motor Spd Fdbk]) is subtracted from the motor speed reference to create a speed error.

There is a lead/lag filter that can be used to filter the motor speed feedback. The filter is setup by parameters 93 [Sreg FB Filt Gain] and 94 [Sreg FB Filt BW]. The filtered speed feedback is configured in parameter 71 [Filtered SpdFdbk].

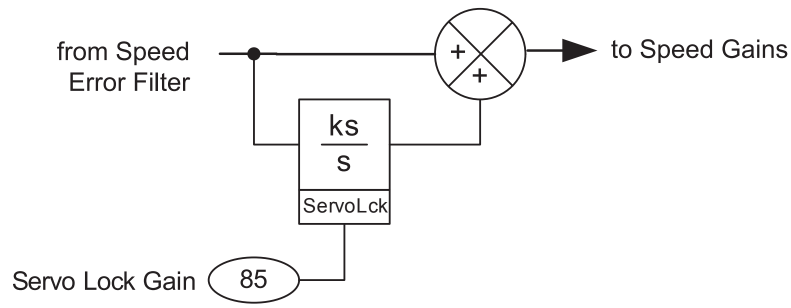
The speed error can be filtered by a low pass filter by adjusting parameter 89 [Spd Err Filt BW]. For more information on lead/lag and low pass filters see Lead-Lag Filter on page 2-33.



Servo Lock

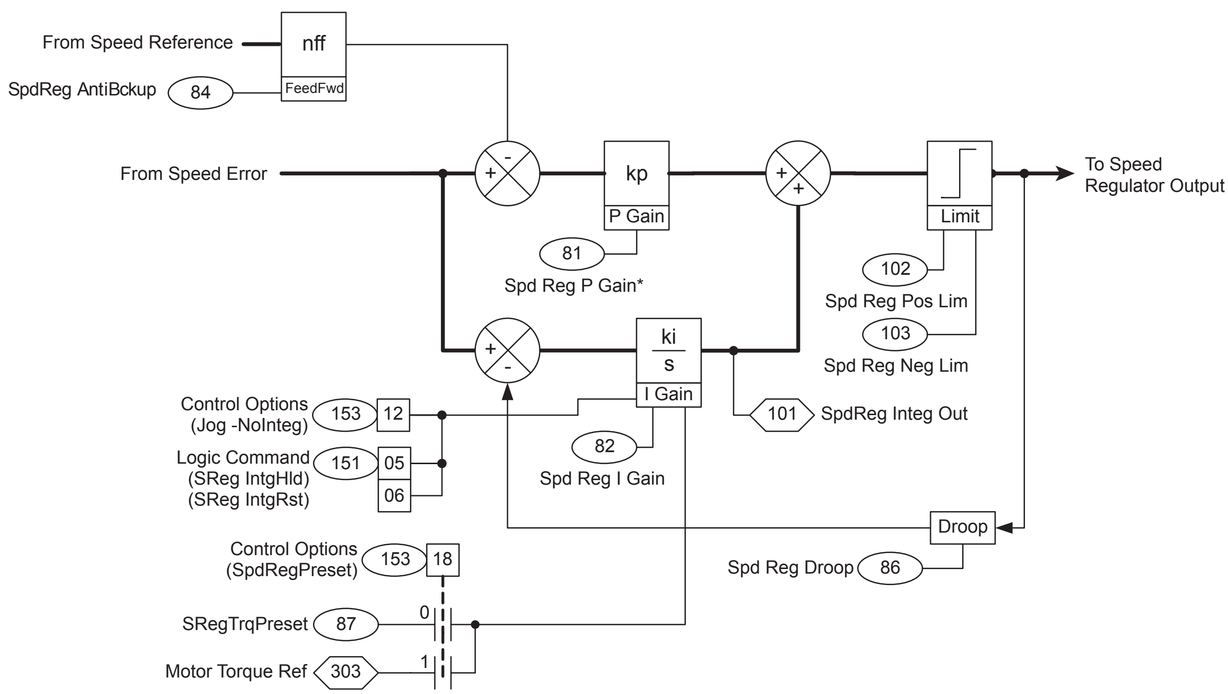
Servo lock is used for servo or positioning applications. The effect of Servo Lock is to increase stiffness of the speed response to a load disturbance. It behaves like a position regulator with velocity feed forward, but without the pulse accuracy of a true position regulator. The output of the servo lock block is summed with the filtered speed error.

Parameter 85 [Servo Lock Gain] sets the gain of an additional integrator in the speed regulator. The units of [Servo Lock Gain] are rad/sec. Gain should normally be set to less than 1/3 speed regulator bandwidth, or for the desired response. Set [Servo Lock Gain] to zero to disable Servo Lock.



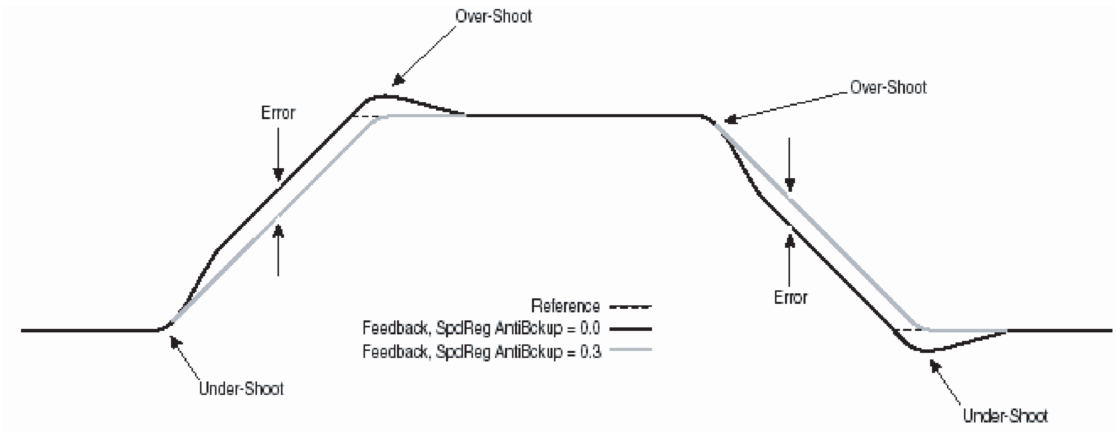
Speed Regulator Gains

The speed regulator gains determine the response of the speed regulator. See Basic Tuning with a Gear Box or Belt on page 2-125 for speed regulator tuning guidelines.



Speed Regulation Anti-Backup

Parameter 84 [SpdReg Anti Bckup] modifies the drive's response to the speed reference. With the value minimized, the drive will follow the reference very closely, minimizing error, which is desirable for typical process applications. However, it will exhibit some over-shoot and under-shoot. Increasing the value of this term decreases the over-shoot and under-shoot, which is desirable where back-up cannot be tolerated. However, this tends to increase the following error: This parameter has no affect on the drive's response to load changes. The recommended setting is 0.1 to 0.5. The following is an example of how the anti-backup affects the speed regulator's response.



Proportional Gain

The filtered speed error (after the servo lock is added and the anti-backup is subtracted) is sent to the proportional gain block. The proportional gain determines how much of a speed error occurs during a load transient.

Parameter 81 [Spd Reg P Gain] sets the proportional gain of the speed regulator. It's value is automatically calculated based on the bandwidth setting in parameter 90 [Spd Reg BW] and parameter 9 [Total Inertia]. Proportional gain may be manually adjusted by setting [Spd Reg BW] to a value of zero. Units are (per unit torque) / (per unit speed). For example, when parameter 81 [Spd Reg P Gain] is 20, the proportional gain block will output 20% motor rated torque for every 1% error of motor rated speed.

Integral Gain

The speed droop is subtracted from the filtered speed error (after the servo lock is added and the anti-backup is subtracted). This signal is then sent to the integral gain block. The integral gain block outputs a torque command relative to the error integrated over a period of time.

Parameter 82 [Spd Reg I Gain] sets the integral gain of the speed regulator. It's value is automatically calculated based on the bandwidth setting in [Spd Reg BW] and the inertia of the system in [Total Intertia]. Integral gain may be manually adjusted by setting [Spd Reg BW] to a value of zero. Units are (per unit torque/sec) / (per unit speed). For example, when [Spd Reg I Gain] is 50 and the speed error is 1%, the integral output will integrate from 0 to 50% motor rated torque in 1 second.

When parameter 153 [Control Options] bit 12 - "Jog-NoInteg" is turned on, this tells the speed regulator not to use the integral gain during jog commands.

When parameter 151 [Logic Command] bit 5 "SReg IntgHld" is turned on, the Integrator holds its output at the present level until the bit is turned off again.

When parameter 151 [Logic Command] bit 6 "SReg IntgRst" is turned on, the output of the integrator is set to 0. When the "Integ Reset" bit is turned back off, the integrator output starts integrating up again from 0.

When parameter 153 [Control Options] bit 18 "SpdRegPreset" is turned on, the value in parameter 303 [Motor Torque Ref] is added to the integrator output. When

"SpdRegPreset" is turned off, parameter 87 [SReg Torq Preset] (default of 0 per unit) is added to the integrator output.

Parameter 101 [SpdReg Integ Out] contains the value of the torque output from the integrator. This parameter is in per unit so that a value of 1 equals rated motor torque.

Droop

Droop is used to "shed" load and is usually used when a soft coupling of two motors is present in an application. For more information on droop, see Droop on page 2-29.

Speed Regulator Output Limits

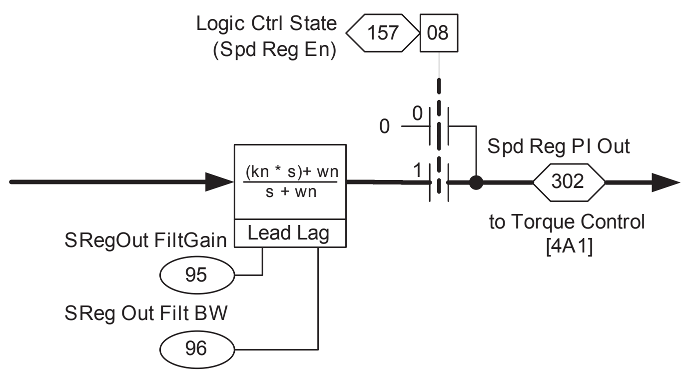
The outputs from the proportional block and integrator block are summed together, creating a torque reference. This torque reference is limited by parameter 102 [Spd Reg Pos Lim] and parameter 103 [Spd Reg Neg Lim].

Speed Regulator Output Filter

Now the torque reference goes through a lead/lag filter, tuned by parameter 95 [SregOut FiltGain] and 96 [Sreg Out Filt BW]. For more information on lead/lag filters refer to Lead-Lag Filter on page 2-33.

Parameter 157 [Logic Ctrl State] bit 8 - "Spd Reg En" indicates when the speed regulator is enabled. When "Spd Reg En" is on, this allows the speed regulator output to pass to the torque control loop.

Parameter 302 [Spd Reg PI Out] contains the filtered, limited torque reference that was generated by the speed regulator.



Speed Regulator Tuning

Basic Tuning with a Gear Box or Belt

This section provides guidelines for basic tuning of the speed loop when the motor is coupled to the load through a gear box.

1. Identify motor and system inertia (in seconds). The motor inertia can be determined by performing an inertia test with the motor uncoupled from the load, or the motor inertia in seconds can be calculated using the following formula:

$$J_{sec} = \frac{WK^2 \text{ x } RPM}{308 \text{ x } T_{acc}}$$

where WK^2 is the inertia in $lbft^2$, RPM is the base motor speed of the motor, and T_{acc} is the rated torque of the motor in lbft. T_{acc} can be calculated using the following formula:

$$T_{acc} = \frac{HP \text{ x } 5252}{RPM}$$

where HP is the nameplate horsepower of the motor and RPM is the base motor speed of the motor.

System Inertia (parameter 9) is determined by performing the inertia test with the load coupled, or the value (in seconds) can be calculated using the formulas above if WK^2 is known for the system.

2. Set the desired bandwidth in parameter 90 [Spd Reg BW]. Do not exceed the bandwidth limit of curve 1 (based on the ratio of motor inertia to system inertia).
3. Make parameter 89 [Spd Err Filt BW] = 5 * parameter 90 [Spd Reg BW].

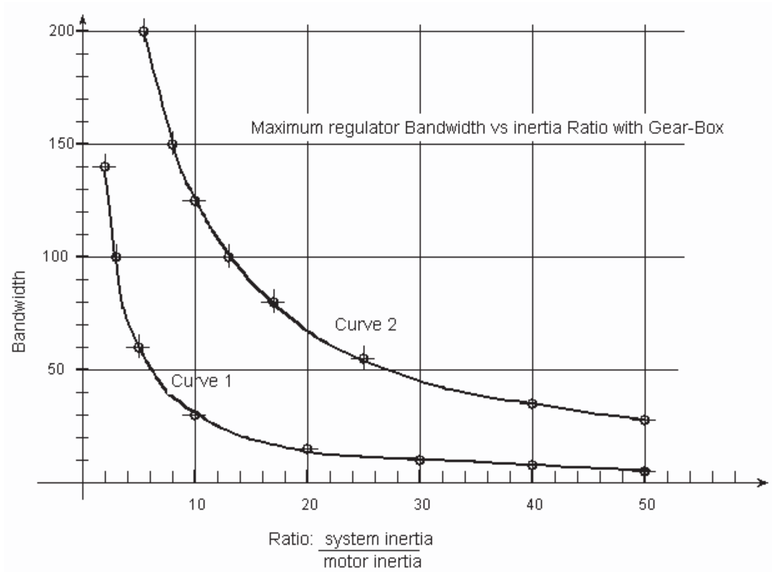
Note: For speed regulator bandwidths up to approximately 200 rad/sec, parameter 89 [Spd Err Filt BW] can be left at the factory default of 700 rad/sec starting with v2.003 firmware because of the addition of an FIR (finite infinite response) filter.

4. Turn-off Lead Lag filters; parameter 93 [SregFB Filt Gain] =1, parameter 95 [SregOut FiltGain] = 1.
5. Run the drive and observe its performance, particularly gear noise (chatter)
6. If performance is smooth throughout the speed range, the tuning test is done. If gear noise or chatter is present continue with step 7.
7. Reduce parameter 90 [Spd Reg BW] or progressively turn on the "Lead Lag" filters A through D (below), with D being the most aggressive. Stop when the drive is sufficiently smooth.
   - **A.** Parameter 95 [SregOut FiltGain] = 0.7; parameter 96 [SregOut Filt BW] = 35
   - **B.** Parameter 95 [SregOut FiltGain] = 0.5; parameter 96 [SregOut Filt BW] = 20
   - **C.** Parameter 95 [SregOut FiltGain] and parameter 93 [SRegFB Filt Gain] = 0.7; parameter 94 [SReg FB Filt BW] and parameter 96 [SregOut Filt BW] = 35

D. Parameter 95 [SregOut FiltGain] and parameter 93 [SRegFB Filt Gain] = 0.5; parameter 94 [SReg FB Filt BW] and [SregOut Filt BW] = 20

8. If gear noise or chatter is still present after turning on the filters, repeat steps 2 through 7 with a lower speed regulator BW.

9. If the desired bandwidth cannot be achieved due to gear noise or chatter, follow the procedure for advanced tuning of the speed regulator with a gearbox.



Advanced Tuning for the Speed Regulator with Gearbox or Belt

When using a system with a gearbox or belts, the backlash or lost motion, can cause instability. To alleviate this, we have a feature called inertia adaptation, which compensates for lost motion. Follow the steps below to use inertia adaptation:

1. Identify motor and system inertia (in seconds).

The motor inertia can be determined by performing an inertia test with the motor uncoupled from the load, or the motor inertia in seconds can be calculated using the following formula:

$$J_{sec} = \frac{WK^2 \text{ x } RPM}{308 \text{ x } T_{acc}}$$

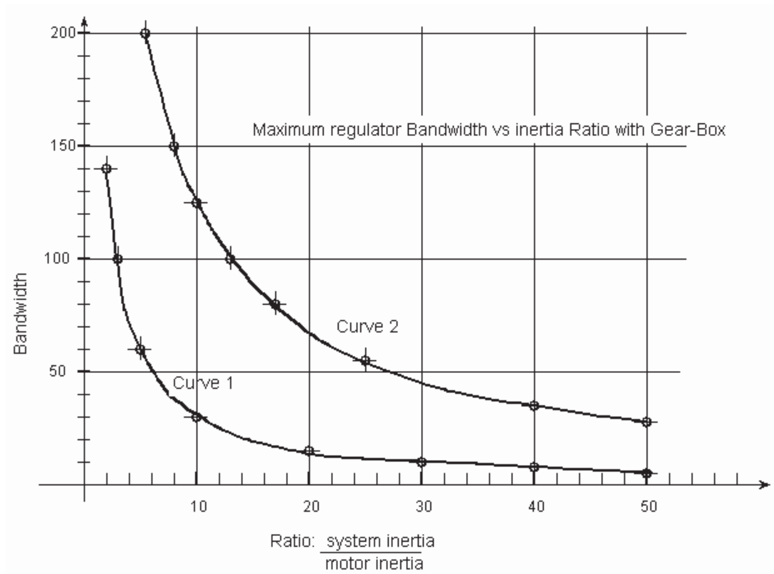
where WK^2 is the inertia in $lbft^2$, RPM is the base motor speed of the motor, and T_{acc} is the rated torque of the motor in lbft. T_{acc} can be calculated by the following:

$$T_{acc} = \frac{HP \text{ x } 5252}{RPM}$$

where HP is the nameplate horsepower of the motor and RPM is the base motor speed of the motor.

System Inertia (parameter 9) is determined by performing the inertia test with the load coupled, or the value (in seconds) can be calculated using the formulas above if WK^2 is known for the system.

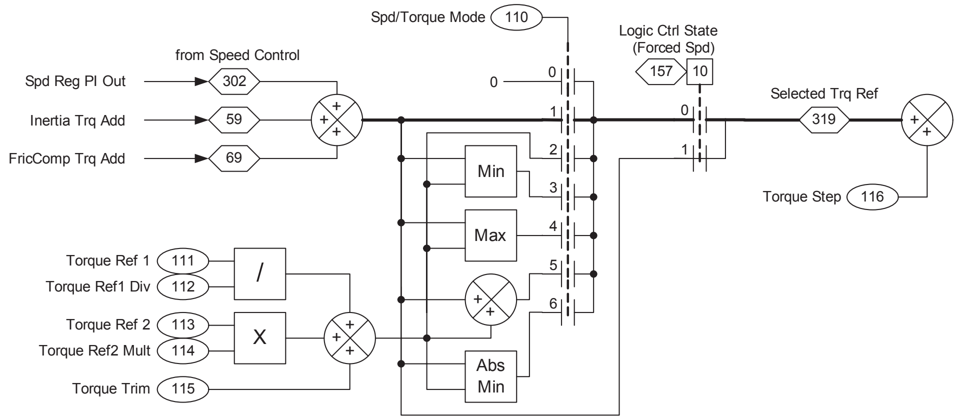
2. Set parameter 90 [Spd Reg BW]. Do not exceed the bandwidth limit of curve 2 below (based on the ratio of motor inertia to system inertia).
3. Set parameter 133 [Inert Adapt BW] = parameter 90 [Spd Reg BW].
4. Verify that the Lead Lag filters are off: parameter 93 [SRegFB Filt Gain] =1 and parameter 95 [SReg Out Filt Gain] =1 to disable the filters.
5. Enable inertia adaptation, parameter 132 [Inert Adapt Sel] bit 0 "Inertia Adapt" = 1.
6. Enable the drive and adjust the bandwidth (BW) for the application but do not exceed curve 2. When you adjust the BW, you must set parameter 90 and parameter 133 to the same BW.
7. You may hear an unusual high frequency sound which indicates adaptation is active.



Speed/Torque Mode Select

Parameter 110 [Speed/Torque Mode] is used to choose the operating mode for the drive. The drive can be programmed to operate as a velocity regulator, a torque regulator, or a combination of the two. Refer to the firmware flowchart shown in Figure 2.22.

Figure 2.22 Firmware Flowchart



As shown in Figure 2.22, parameter 110 [Spd/Trq Mode Sel], is used to select the mode of operation. Zero torque current is allowed when set to zero (0).

Set to a value of 1, the drive and motor are operated in speed mode. The torque command changes as needed to maintain the desired speed.

Set [Spd/Trq Mode Sel] to a value of two (2) for torque mode. In torque regulation mode, the drive controls the desired motor torque. The motor speed is the result of torque command and load present at the motor shaft.

Min and Max mode are selected by values 3 and 4, respectively. These modes offer a combination of speed and torque operation. The algebraic minimum or maximum of speed/torque will be the operating point for the Min and Max modes. The drive automatically switches from speed to torque mode (or from torque to speed) based on the dynamics of the motor/load.

The Min mode is typically used with positive torque and forward speed operation, the minimum of the two being closest to zero. The Max mode is opposite, typically used with reverse speed and negative torque, the maximum being the least negative (closest to zero).

Sum mode is selected when [Spd/Trq Mode Sel] is set to a value of 5. This mode allows an external torque command to be added to the speed regulator output when desired.

Speed Regulation Mode

Operating as a speed regulator is the most common and simplest mode to set up. Examples of speed regulated applications are blowers, conveyors, feeders, pumps, saws, and tools.

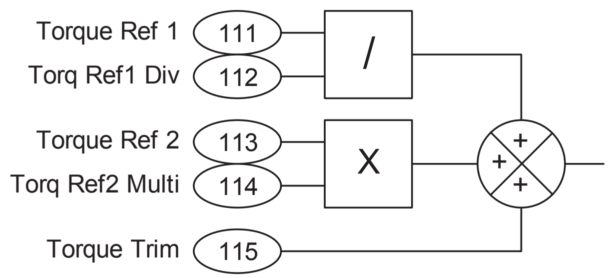
In a speed regulated application, the speed regulator output generates the torque reference. Note that under steady state conditions the speed feedback is steady while the torque reference is a constantly adjusting signal. This is required to maintain the desired speed. In a transient state, the torque reference changes dramatically to compensate for a speed change. A short duration change in speed is the result of increasing or decreasing the load very rapidly.

Note: Inertia Torque Add and Friction Compensation Torque Add are summed with the output of the speed regulator. See Inertia Compensation on page 2-54 and Friction Compensation on page 2-40.

Torque Regulation Mode

A torque regulated application can be described as any process requiring some tension control. An example is a winder or unwinder with material being "drawn" or pulled with a specific tension required. The process requires another element setting the speed. Configuring the drive for torque regulation requires [Spd/Trq Mode Sel] to be set to 2. In addition, a reference signal must be linked to the Torque Reference. For example, when Analog Input 1 is used for the reference, link parameter 111 [Torque Ref 1] to parameter 800 [Anlg In1 Data].

When operating in a torque mode, the motor current will be adjusted to achieve the desired torque. If the material being wound/unwound breaks, the load will decrease dramatically and the motor can potentially go into a "runaway" condition.



Torque Reference:

Parameter 111 [Torque Ref 1] is divided by parameter 112 [Torq Ref1 Div]

Parameter 113 [Torque Ref 2] is multiplied by parameter 114 [Torq Ref2 Mult]

Parameter 115 [Torque Trim] can be used to trim the torque. For example, [Torque Trim] can be linked to an analog input or to the Process PI output.

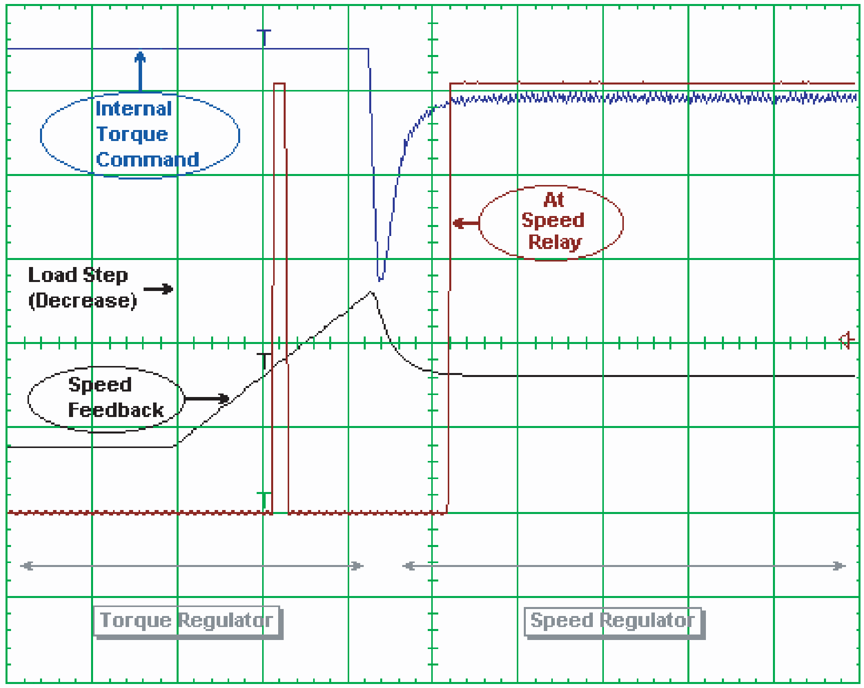
The final torque reference, in the Torque Mode, is the sum of scaled [Torque Ref 1], scaled [Torque Ref 2], and [Torque Trim].

Min Mode / Max Mode

This operating mode compares the speed and torque commands. The algebraically minimum value is used. This mode can be thought of as a Speed Limited Adjustable Torque operation. Instead of operating the drive as a pure torque regulator, the "runaway" condition can be avoided by limiting the speed. A winder is a good example for the application of the Min Spd/Trq operating mode. Max mode would be used if both speed and torque are negative.

Figure 2.23 illustrates how min. mode operates. The drive starts out operating as a torque regulator. The torque reference causes the motor to operate at 308rpm. The speed reference is 468rpm, so the minimum is to operate as a torque regulator. While operating in torque regulation, the load decreases and the motor speeds up. Notice the torque command has not changed. When the speed regulator comes out of saturation, it clamps the speed and now the drive operates as a speed regulator. The At Speed Relay then closes.

Figure 2.23 Min Mode Operation



Sum Mode

Configuring the drive in this mode allows an external torque input to be summed with the torque command generated by the speed regulator. This mode requires both a speed reference and a torque reference to be linked. This mode can be used for applications that have precise speed changes with critical time constraints. If the torque requirement and timing is known for a given speed change, then the external torque input can be used to preload the integrator. The timing of the speed change and the application of an external torque command change must be coordinated for this mode to be useful. The sum mode will then work as a feed forward to the torque regulator.

Zero Torque Mode

Operation in zero torque mode allows the motor to be fully fluxed and ready to rotate when a speed command or torque command is given. This mode can be used for a cyclical application where through put is a high priority. The control logic can select zero torque during the "rest" portion of a machine cycle instead of stopping the drive. When the cycle start occurs, instead of issuing a start to the drive, a speed regulate mode can be selected. The drive will then immediately accelerate the motor without the need for "flux up" time.

Important: Zero Torque may excessively heat the motor if operated in this mode for extended periods of time. No load or flux current is still present when the drive is operating in zero torque mode. A motor with an extended speed range or separate cooling methods (blower) may be required.

Absolute Min Mode

Absolute Min Mode selects the smallest absolute algebraic value to regulate to when the torque reference and torque generated from the speed regulator are compared.

Start Inhibits

This section covers Start Inhibits, parameter 156 [Run Inhibit Stat]. This parameter indicates the cause of no response to a start request.

Bit 0	Description
0	Drive is Faulted
1	No Enable signal present
2	Software Ramp Stop request present
3	Software Coast Stop request present
4	Software Current Limit Stop request present
5	Power Loss
6	Power EE prom error
7	Flash upgrade in progress
8	Start request present
9	Jog request present
10	Encoder PPR error
11	Bus Precharge not complete
12	Digital input configuration error
13	Motion Shtdwn
14	Permanent Magnet motor Feedback Error
15	Position feedback selection
16	Gate shutdown
17	Safe-Off enabled
18	MC Config - Drive is loading firmware for motor control

Start/Stop Modes

Technical Information

The start and stop mode refers to how you want to control the drive's start and stop functions. There are two basic modes of start and stop control: 3-wire and 2-wire.

3-wire control indicates that the start and stop are momentary inputs. 3-wire control also indicates that there is one input for the start command, and one input for the stop command. The term "3-wire" comes from the fact that when using this type of control with digital inputs, one wire is used for the start input, one wire is used for the stop input, and one wire is used for the common.

2-wire control indicates that the start and stop are combined as one maintained input. The input must be on to start and to remain running. Then the same input is turned off to stop. The term "2-wire" comes from the fact then when using this type of control with digital inputs, one wire is used for the combined start/stop input, and one wire is used for the common.

For the stop command, there are three different types of stopping that can be performed: coast stop, ramp stop, and current limit stop.

1. Coast Stop - when in coast stop, the drive acknowledges the stop command by shutting off the output transistors and releasing control of the motor. The load/ motor will coast or free spin until the mechanical energy is dissipated.
2. Ramp Stop - when in ramp stop, the drive acknowledges the stop command by ramping down the motor speed reference using the programmed parameter 33 [Decel Time], maintaining control of the motor until the drive output reaches zero. The output transistors are then shut off.
3. Current Limit Stop - when in current limit stop, the drive acknowledges the stop command by setting the motor speed reference to zero, causing the drive to bring the motor down to zero speed as fast as the power limits, torque limits and current limits will allow. When the drive output reaches zero, the output transistors are shut off.

When different stop types are commanded at the same time, the priority from highest priority to lowest is coast stop, current limit stop, and then ramp stop.

The remainder of this section describes how to configure the drive for the different start and stop modes.

Configuring the Start and Stop for 3-Wire Control (Momentary Start and Stop)

To configure the drive for 3-wire control with a ramp stop:

For parameter 153 [Control Options], set bit 8 “3WireControl” = 1.

To control from digital inputs:

1. Set one of the parameters 825-830 [DigInx Sel] = 4 "Normal Stop - CF" or = 14 "Normal Stop". "Normal Stop-CF" indicates that the same digital input is used as a stop and a clear fault.
2. Set a second parameter 825-830 [DigInx Sel] = 5 "Start".

To control from a communication network (20-COMM module):

1. Toggle bit 1 "Start" in the logic command word on and then off to perform a start.
2. Toggle bit 0 "Stop" in the logic command word on and then off to perform a ramp stop.

To configure the drive for 3-wire control with a coast stop:

For parameter 153 [Control Options], set bit 8 “3WireControl” = 1.

To control from digital inputs:

1. Set one of the parameters 825-830 [DigInx Sel] = 19 "Coast Stop".
2. Set a second parameter 825-830 [DigInx Sel] = 5 "Start".

To control from a communication network (20-COMM module):

1. Toggle bit 1 "Start" in the logic command word on and then off to perform a start.
2. Toggle bit 9 "CoastStop" in the logic command word on and then off to perform a coast stop.

To configure the drive for 3-wire control with a current limit stop:

For parameter 153 [Control Options], set bit 8 “3WireControl” = 1.

To control from digital inputs:

1. Set one of the parameters 825-830 [DigInx Sel] = 18 "CurLim Stop".
2. Set a second parameter 825-830 [DigInx Sel] = 5 "Start".

To control from a communication network (20-COMM module):

1. Toggle bit 1 "Start" in the logic command word on and then off to perform a start.
2. Toggle bit 8 "CurrLimStop" in the logic command word on and then off to perform a current limit stop.

   Note: In 3-wire mode, all stops commanded by pressing the HIM Stop button are ramp stops.

Configuring the Start and Stop for 2-Wire Control (Maintained Start and Stop)

To configure the drive for 2-wire control with a ramp stop:

"Set parameter 153 [Control Options] bit 8 "3WireControl" = 0.

To control from digital inputs:

– Set one of the parameters 825-830 [DigInx Sel] = 7 "Run"

To control from a communication network (20-COMM module):

1. Turn on bit 1 "Start" in the logic command word to run.
2. Turn off bit 1 "Start" in the logic command word to perform a ramp stop.

To configure the drive for 2-wire control with a coast stop:

"Set parameter 153 [Control Options] bit 8 "3WireControl" = 0.

To control from digital inputs:

– Set one of the parameters 825-830 [DigInx Sel] = 7 "Run"

To control from a communication network (20-COMM module):

1. Turn on bit 1 "Start" in the logic command word to run.
2. Toggle bit 9 "CoastStop" in the logic command word on and then off to perform a coast stop. Bit 1 "Start" in the logic command word must be turned off and back on to run again (therefore, technically, there is no 2-Wire control with a coast stop on a network because two bits must be controlled).

To configure the drive for 2-wire control with a current limit stop:

"Set parameter 153 [Control Options] bit 8 "3WireControl" = 0.

To control from digital inputs:

– Set one of the parameters 825-830 [DigInx Sel] = 7 "Run"

To control from a communication network (20-COMM module):

1. Turn on bit 1 "Start" in the logic command word to run.
2. Toggle bit 8 "CurrLimStop" in the logic command word on and then off to perform a current limit stop. Bit 1 "Start" in the logic command word must be turned off and back on to run again (therefore, technically, there is no 2-Wire control with a coast stop on a network because two bits must be controlled).

Note: In 2 wire mode (parameter 153 [Control Options] bit 8 "3WireControl" = 0), the HIM Start button is not functional.

Start-Up

Refer to Autotune - Start-Up Menu on page 2-4 for Start-Up information.

Stop Modes

Refer to Start/Stop Modes on page 2-131.

SynchLink™

This section contains information specific to PowerFlex® 700S SynchLink™ parameters and gives an example of setting up the PowerFlex 700S SynchLink using DriveExecutive™. Please refer to the *SynchLink System Design Guide,* publication 1756-TD008, for PowerFlex 700S SynchLink topologies, hardware and wiring details.

SynchLink Configuration

Parameter 904 [SL Node Cnfg] contains the following four bits:

- Bit 0- “Time Keeper” - This bit is turned on in the SynchLink master. Only one node in a SynchLink network can be the time keeper.
- Bit 1 - “Reserved” - Not used.
- Bit 2- “Synch Now” - This bit is turned on and all other bits off in the SynchLink Followers.
- Bit 3 - "Reset SL" - This bit can be turned on to reset SynchLink after a SynchLink configuration change instead of cycling power on the drive.

SynchLink data is transmitted as a combination of direct and buffered data. Parameters 905 [SL Rx CommFormat] and 910 [SL Tx CommFormat] set the format for the receive and transmit data. The following tables show the different formats for transmit and receive data and the respective SynchLink fiber update rates for the direct and buffered data.

Table 2.T Receive Data

Parameter 905 [SL Rx CommFormat]	# of Direct Words	Direct Word Update	# of Buffered Words	Buffered Word Update
7	2	50 µSec	18	0.5 ms
9	4	50 µSec	8	0.5 ms
17	4	50 µSec	18	1 ms

Note: Selections 6 and 16 for parameter 905 [SL RX CommFormat] are not shown in the table above and are not functional at the time of publication.

Table 2.U Transmit Data

Parameter 910 [SL Tx CommFormat]	# of Direct Words	Direct Word Update	# of Buffered Words	Buffered Word Update
7	2	50 μSec	18	0.5 ms
9	4	50 μSec	8	0.5 ms
17	4	50 μSec	18	1 ms

SynchLink™ Direct Data

Direct Data Receive Parameters (Follower)

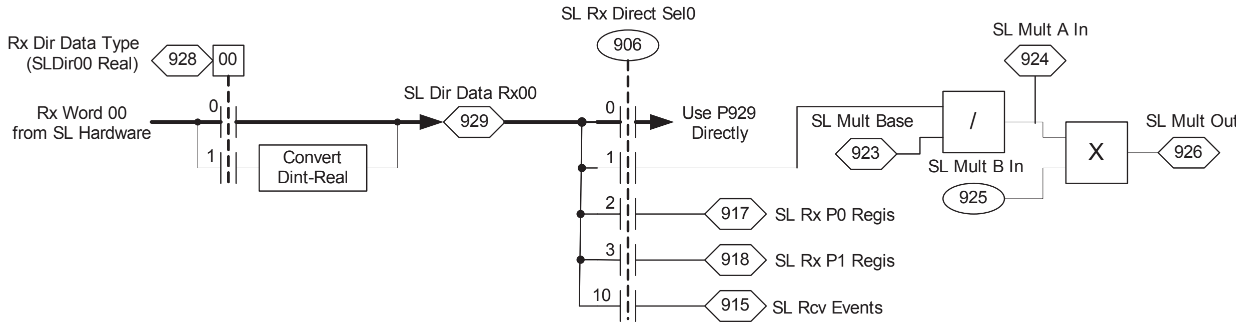
Parameters 906 [SL Rx DirectSel0] through 909 [SL Rx DirectSel3] select what you want to do with direct received data. The available settings for these parameters are:

- 0 “No Data” - SynchLink received data is passed straight through. Parameters 929 [SL Dir Data Rx00] through 932 [SL Dir Data Rx03] contain the values for direct data received from SynchLink. When “No Data” is selected a destination parameter can be linked directly to the corresponding direct data receive parameter (parameters 929 through 932).
- 1 "SL Multiply" - See details on Multiply Block on page 2-137.
- 2 "Event P0" - Parameter 917 [SL Rx P0 Regis] receives value from Registration Latch 0 of transmitter.
- 3 "Event P1" - Parameter 918 [SL Rx P1 Regis] receives value from Registration Latch 1 of transmitter. Event P1 is not functional over SynchLink at the time of publication.
- 10 "Event Status" - Parameter 915 [SL Rcv Events] receives registration found bits for Registration Latch 0/1 from registration of transmitter. Bit 0 is for Registration Latch 0 and Bit 1 is for Registration Latch 1.

Important: The clear bit in parameter 916 [SL Clr Events] of the receiving drive must be toggled to clear the corresponding found bit in parameter 915 before the receiving drive can receive a new value for the Registration Latch P0 or P1.

Parameter 928 [Rx Dir Data Type] bits 0 through 3 select whether the direct data words received over SynchLink will be DInt (double integer) or real (floating point) data. When the bit is turned off, the received data will be DInt data. When the bit is turned on, the received data will be floating point data. The default is all DInt words.

Figure 2.24 Diagram of Direct Receive Data (Word 00)



Direct Data Transmit Parameters

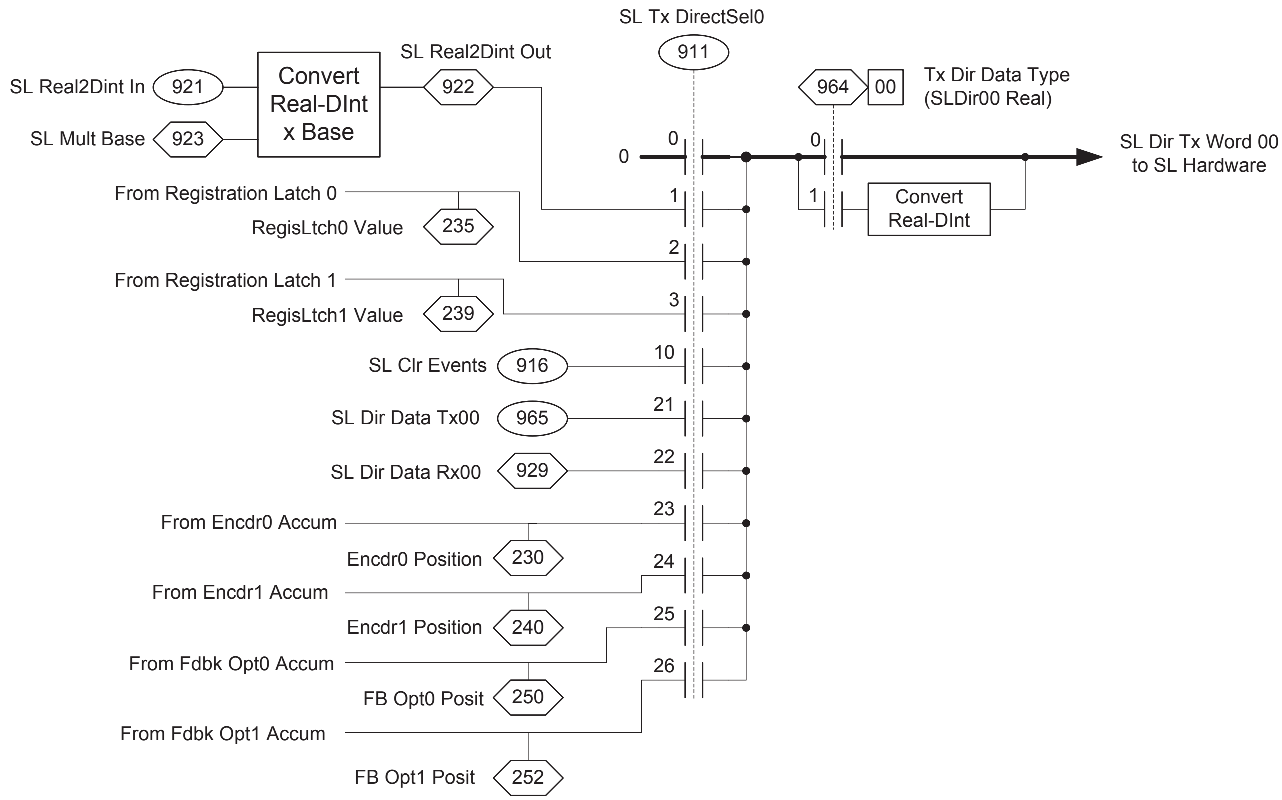
Parameters 911 [SL Tx DirectSel0] through 914 [SL Tx DirectSel3] select what direct transmit data you want to send. The most common settings for these parameters are:

- 0 "No Data" - No data is selected for that transmit word.
- 1 "SL Multiply" - See details on Multiply Block on page 2-137.
- 2 "Event P0" - Transmits registration value from Registration Latch 0.
- 3 "Event P1" - Transmits registration value from Registration Latch 1. Event P1 is not functional over SynchLink at the time of publication.
- 10 "Event Status" - Transmits the found bits for Registration Latch 0/1 status.
- 21 "Dir Tx Data" - Use this selection to transmit a parameter. Parameters 965 [SL Dir Data Tx00] through 968 [SL Dir Data Tx03] contain the values for direct data transmitted to SynchLink™. When 21 "Dir Tx Data" is selected the corresponding direct transmit parameter (parameters 965 through 968) parameters can be linked to source parameters.
- 22 "Dir Rx Data" - Use this selection to transmit data that was received on SynchLink straight through.
- 23 "E0 Accum" - Use this selection to transmit Encoder 0 counts directly through before they enter the feedback control loop. This eliminates the update delay of the feedback control loop.
- 24 "E1 Accum" - Use this selection to transmit Encoder 1 counts directly through before they enter the feedback control loop. This eliminates the update delay of the feedback control loop.
- 25 "Opt0 Accum" - Use this selection to transmit feedback option 0 counts directly through before they enter the feedback control loop. This eliminates the update delay of the feedback control loop.
- 26 "Opt1 Accum" - Use this selection to transmit feedback option 1 counts directly through before they enter the feedback control loop. This eliminates the update delay of the feedback control loop.

Parameter 964 [Tx Dir Data Type] bits 0 through 3 select whether the direct data words transmitted over SynchLink will be DInt (double integer) or real (floating point) data. When the bit is turned off, it means the data transmitted will be DInt.

When the bit is turned on, it means the data transmitted will be floating point. The default is all DInt words.

Figure 2.25 Diagram of Direct Transmit Data (Word 00)



Multiply Block

SynchLink™ has the ability to take one of the direct data words and multiply it by a constant or parameter value for features such as draw control. Parameters for the multiply block must be setup in the Master as well as the Follower.

Parameter 927 [SL Mult State] contains overflow bits if the data for the multiply block is too large. It contains the following bits:

- Bit 0 - "Local Ovflow" - The result of the multiply function is too large.
- Bit 1 - "Rx Ovflow"- The data received from SynchLink is too large.
- Bit 2 - Not used.
- Bit 3 - "FtoI Ovflow" - In the master, the data converted from floating point to integer is too large.

Multiply Block Receive Parameters (Follower)

Select the direct word on which to use the multiply block by setting one of the parameters, 906 [SL Rx DirectSel0] through 909 [SL Rx DirectSel3] to 1 “SL Multiply". Note that the receive parameter selected to use the multiply block in the follower must correspond to the transmit parameter selected to use the multiply block in the master.

- Parameter 924 [SL Mult A In] contains the value received from SynchLink™, after it was divided by parameter 923 [SL Mult Base].
- Parameter 925 [SL Mult B In] contains the multiply scale factor to multiply by the value received from SynchLink. Note that parameter 925 can be a constant or can be linked to a source parameter.
- Parameter 923 [SL Mult Base] contains the base to convert integer data received from SynchLink back to real data. Usually, parameter 923 [SL Mult Base] will be set the same in the master and follower.
- Parameter 926 [SL Mult Out] contains the result of the multiply block. A floating point destination parameter can be linked to parameter 926 [SL Mult Out].

For example, to receive a speed reference from the master and scale it by 0.5, set parameter 906 [SL Rx DirectSel 0] to 1 "SL Multiply". Set parameter 925 [SL Mult B In] to 0.5. Set parameter 923 [SL Mult Base] to 10,000. Link parameter 10 [Speed Ref 1] to parameter 926 [SL Mult Out].

Multiply Block Transmit Parameters (Master)

SynchLink sends across the multiply data as an integer. Therefore, floating point values are converted to DInt (double integer) before sent as multiply data.

- Parameter 923 [SL Mult Base] sets the value to multiply parameter 921 [SL Real2DInt In] to convert the floating point parameter to DInt. Make sure [SL Mult Base] is set appropriately so that the DInt value sent across SynchLink has enough resolution.
- Parameter 921 [SL Real2DInt In] is linked to the parameter that you want to multiply and must be a floating point parameter.
- Parameter 922 [SL Real2DInt Out] contains the integer value sent over SynchLink. One of the SynchLink Transmit Direct Selects (parameter 911 through 914) must be set to 1 "SL Multiply" to send the value over SynchLink.

For example, to use the multiply block to scale the ramped speed reference and send it over SynchLink, link parameter 921 [SL Real2DInt In] to parameter 43 [Ramped Spd Ref]. Set parameter 923 [SL Mult Base] to 10,000. Then set parameter 911 [SL Tx DirectSel0] = 1 "SL Multiply" to send the result in parameter 922 [SL Real2DInt Out] over SynchLink.

Buffered Data

Buffered Data Receive Parameters (Follower)

Parameters 934 [SL Buf Data Rx00] through 951 [SL Buf Data Rx17] contain values that you receive from SynchLink as buffered data. Destination parameters can be linked to this buffered data.

Parameter 933 [Rx Buf Data Type], bits 0 through 17, select whether each word of buffered data that is transmitted is DInt (double integer) or real (floating point). When the bit is turned off, it means the data received will be DInt. When the bit is turned on, it means the data received will be floating point. The default is all DInt words.

Buffered Data Transmit Parameters (Master)

Parameters 970 [SL Buf Data Tx00] through 987 [SL Buf Data Tx17] can be linked to source parameters that you want to send out SynchLink™ as buffered data.

Parameter 969 [Tx Buf Data Type], bits 0 through 17, select whether each word of buffered data that is transmitted is DInt (double integer) or real (floating point). When the bit is turned off, it means the data transmitted will be DInt. When the bit is turned on, it means the data transmitted will be floating point. The default is all DInt words.

SynchLink Diagnostics:

Parameters 894 [SL CRC Err Accum] through 903 [SL Error History] provide diagnostic information for SynchLink.

Parameter 894 [SL CRC Err Accum] displays the total accumulated number of CRC (Cycle Redundancy Check) errors. Clearing a fault resets this accumulator. This data is visible on the SynchLink diagnostics tab of the Peer Communication window.

Parameter 895 [SL CRC Error] displays the number of CRC errors that occurred during the last test (last 8 mS). This data is visible on the SynchLink diagnostics tab of the Peer Communication window.

Parameter 896 [SL BOF Err Accum] displays the total accumulated number of BOF (Beginning of Frame) errors. Clearing a fault resets this accumulator. This data is visible on the SynchLink diagnostics tab of the Peer Communication window.

Parameter 897 [SL BOF Error] displays the number of BOF errors that occurred during the last test (last 8 mS). This data is visible on the SynchLink diagnostics tab of the Peer Communication window.

Parameter 898 [SL CRC Err Limit] identifies the number of CRC errors per test (per 8 mS) allowed before the drive declares a SynchLink CRC Error exception event. Set this limit on the SynchLink diagnostics tab of the Peer Communication window.

Parameter 899 [SL BOF Err Limit] identifies the number of BOF errors per test (per 8 mS) allowed before the drive declares a SynchLink BOF Error exception event. Set this limit on the SynchLink diagnostics tab of the Peer Communication window.

Parameter 900 [SynchLink Rev] indicates the current revision of the local SynchLink Programmable Logic firmware.

Parameter 901 [SL System Rev] indicates the system revision of the SynchLink network. To be compatible on the network, all nodes must have the same major revision.

Parameter 902 [SL Error Status] and parameter 903 [SL Error History] indicates the presence of SynchLink™ faults. This data is visible on the SynchLink diagnostics tab of the Peer Communication window.

- Bit 0 “Sync Loss” indicates SynchLink communication has failed, after it had been established
- Bit 1 “Rx Loss” indicates the receive port is not receiving data, and the receive port configuration is set to receive data
- Bit 2 “Many BOF Err” indicates the number of Beginning Of Frame (BOF) errors exceeds limit set by Par 899 [SL BOF Err Limit]
- Bit 3 “Many CRC Err” indicates the number of Cyclic Redundancy Check (CRC) errors exceeds limit set by Par 898 [SL CRC Err Limit]
- Bit 4 “Pckg Msg Err” indicates the received package sequence number has not matched for 1.0S
- Bit 5 “CommForm Err” indicates the format of received data does not match the configuration of the receive port
- Bit 6 “Sys Rev Err” indicates the system revision in the received data does not match the value of Par 900 [SynchLink Rev]
- Bit 7 “Mult TimeKpr” indicates more than one node on the SynchLink system is configured as a time keeper.

Options	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Mult TimeKpr	Sys Rev Err	Comm Frmt Er	Pckg Msg Err	Many CRC Err	Many BOF Err	Rx Loss	Sync Loss
Default	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

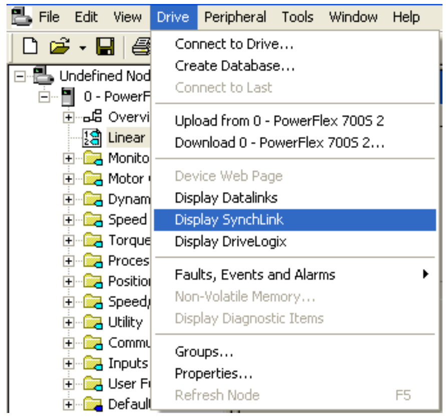
0 = False
1 = True

Speed Synchronization Example:

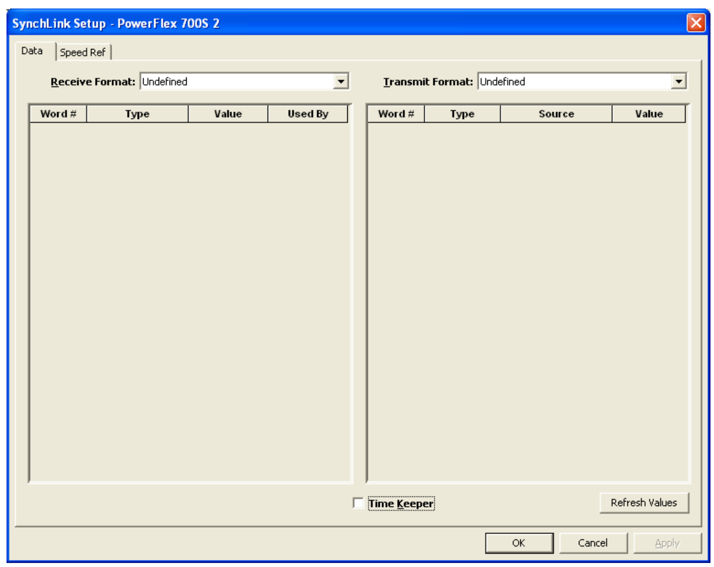
This example describes how to setup SynchLink to synchronize the ramped speed reference for two PowerFlex® 700S Phase II drives using DriveExecutive™. DriveExecutive must be v3.01 with v3.03 patch installed or later (To check if the patch is installed in DriveExecutive click Help > Details to check component versions. RADrvSynchLink.dll must be version 3.3 or later).

Note that the “SynchLink Setup” dialog box in DriveExecutive configures the appropriate SynchLink parameters for you as you go through the setup.

Once connected to the drive, in DriveExecutive, select **Drive** > **Display SynchLink**.



The SynchLink Setup dialog box displays (as shown below). This is the dialog box used to setup SynchLink™.



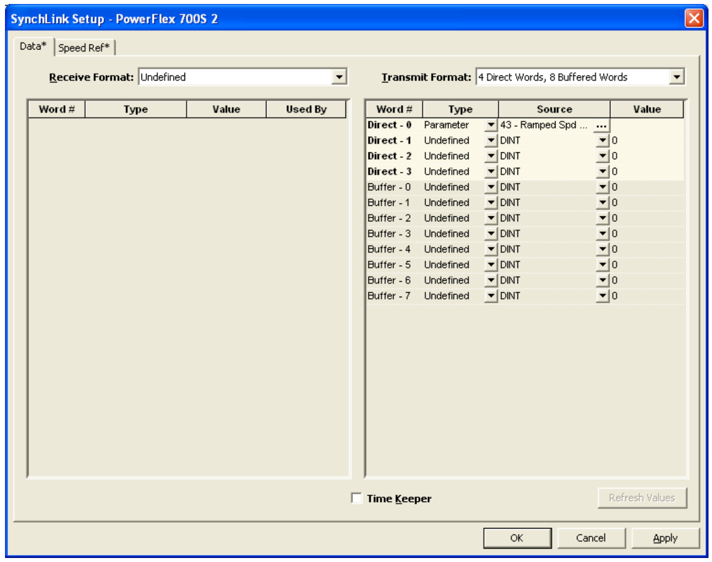
Master PowerFlex® 700S Drive Setup (Transmitting Drive)

1. In the master, or transmitting drive, select the desired transmittal format in the **Transmit Format** field. For this example, select “4 Direct Words, 8 Buffered Words”.

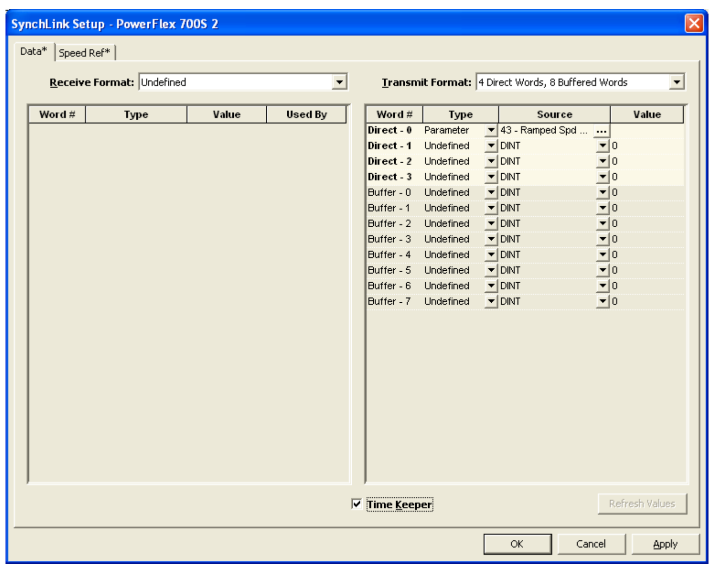
2. Below the **Transmit Format** field, for **Direct Word 0**, do the following:

   a. Click the arrow next to the **Type** field and select “Parameter”.

b. Click the ... button to the right of the **Source** field and select "43 - Ramped Spd Ref". This setting is to transmit the ramped speed from the master.



3. Check the **Time Keeper** box. The master will be the time keeper for SynchLink.



4. Click **OK** to apply the settings and close the SynchLink dialog.

5. To synchronize the speed references, you must add a time delay to the S-Curve Speed Reference of the master by linking parameter 37 [Spd Ref Bypass] to parameter 45 [Delayed Spd Ref].

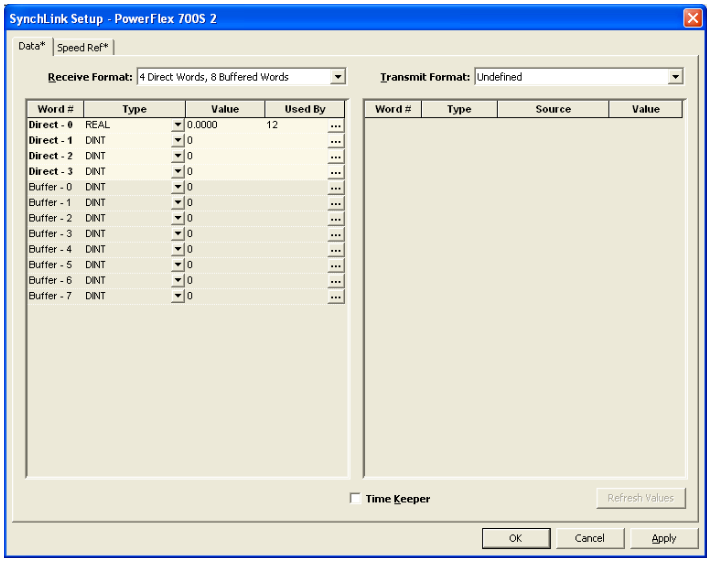
Follower PowerFlex® 700S Setup (Receiving Drive)

1. In the follower, or receiving drive, select the receiving format in the **Receive Format** field to match the size of the data transmitted from the master drive. For this example, select "4 Direct Words, 8 Buffered Words".

2. Below the **Receive Format** field, for **Direct Word 0**, do the following:

   a. Click the arrow next to the **Type** field and select "Real".

   b. Click the ... button to the right of the **Used By** field and select "12 [Speed Ref 2]". This means that parameter 12 will be linked to Direct Word 0 from SynchLink™.



3. Click OK to close the SynchLink Setup dialog box.

4. To set the follower to use Speed Reference 2, set parameter 27 [Speed Ref A Sel] = 2 "Speed Ref 2".

Note that Speed Reference 2 in the follower will contain the ramped speed from the master drive. Because the speed reference is already ramped, the ramp in the follower can be disabled by setting parameter 151 [Logic Command] bit 0 "SpdRamp Disable" = 1.

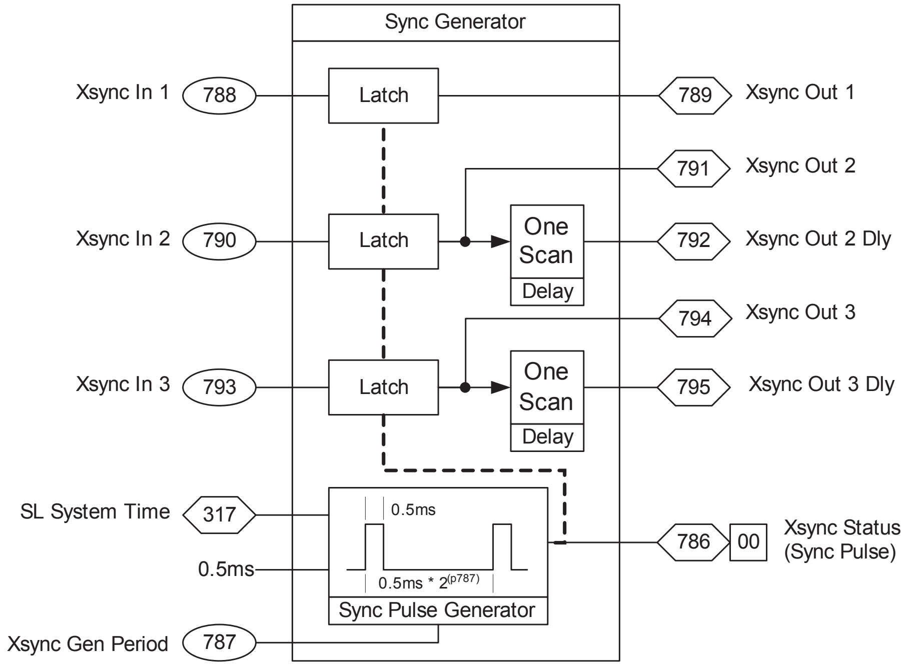
Reset SynchLink™

After setting up the configuration SynchLink must be reset on both drives in one of the following ways:

- Set parameter 904 [SL Node Cnfg] bit 3 "Reset SL" = 1 on the drives. This bit will automatically transition back to 0 after SynchLink is reset.
  OR
- Perform a reset on the drives. This can be done via the HIM by navigating from the Main Menu to Diagnostics > Faults > Reset Device.
  OR
- Cycle power on the drives.

Sync Generator

The synch generator can be used to synchronize a parameter and delay it one scan. This can be used in conjunction with SynchLink (Refer to SynchLink™ on page 2-134 for more information).



Configuration:

- Parameters 788 [Xsync In 1] and 789 [Xsync Out 1] can be used to synchronize a DInt parameter.
- Parameters 790 [Xsync In2] through 792 [Xsynch Out 2 Dly] can be used to synchronize a DInt parameter and delay it one scan.
- Parameters 793 [Xsync In3] through 795 [Xsynch Out 3 Dly] can be used to synchronize a floating point parameter and delay it one scan.
- Parameter 787 [Xsync Gen Period] sets the scan time of the synch generator. The following options are available:

0 =	0.5 mSec
1 =	1 mSec
2 =	2 mSec
3 =	4 mSec
4 =	8 mSec

The default setting is 1 = "1 mSec".

Task Time

Task Times are adjustable for the 3 Tasks in the drive.

- Task 1 includes the Speed Regulator, Speed/Position Feedback, Torque Control, Current Control, Analog I/O and Digital I/O
- Task 2 includes the Speed Reference Control, Position Control and Process PI Control
- Task 3 includes User Functions

The times are set by parameter 146 [FW TaskTime Sel] as listed below:

Parameter 146	Task 1 Time	Task 2 Time	Task 3 Time
0	0.5 mSec	2 mSec	8 mSec
1	0.5 mSec	1 mSec	8 mSec
2	0.25 mSec	1 mSec	8 mSec

After changing the Task Time in parameter 146 [FW TaskTime Sel] a drive reset must be performed (via the HIM navigate from the Main Menu to Diagnostics > Faults > Reset Device) or drive power must be cycled before the change will be active. Parameter 148 [FW TaskTime Actl] will then display the actual Task Time.

Test Points

Test points are used to monitor values in the drive for diagnostic information.

[xxxx TP Sel] selects a value to monitor for diagnostics.

[xxxx TP Data] shows the value selected by [xxxx TP Sel].

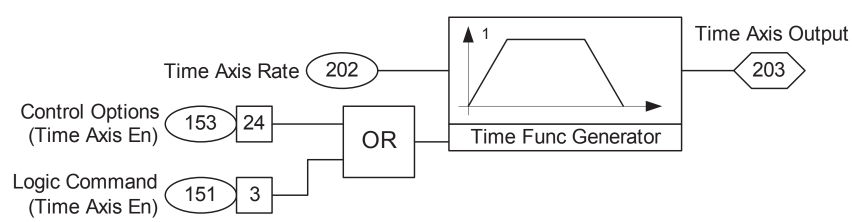
Thermal Regulator

Refer to Drive Overload on page 2-27.

Time Function Generator

The Time Function Generator ramps the output of the function generator at the rate in parameter 202 [Time Axis Rate].

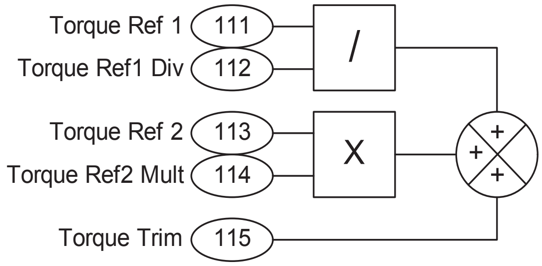
- When parameter 153 [Control Options] bit 24 "Time Axis En" or parameter 151 [Logic Command] bit 3 "Time Axis En" =1 the output ramps from 0.0000 to 1.0000 at the Time Axis Rate set in parameter 202.
- When parameter 153 [Control Options] bit 24 "Time Axis En" or parameter 151 [Logic Command] bit 3 "Time Axis En" = 0 the output ramps from 1.0000 to 0.0000 at the Time Axis Rate set in parameter 202.



Torque Reference

When the PowerFlex® 700S is operated in Torque mode, an external signal is used for a Torque reference. Refer to Figure 2.26 for the firmware diagram.

Figure 2.26 Torque Reference Firmware Diagram



Torque Reference Input

Parameter 111 [Torque Ref 1] is used to supply an external reference for desired torque. The scaling of this parameter is a per unit type, where a value of 1.0 is equal to the rated motor torque.

[Torque Ref 1] is then divided by parameter 112 [Torq Ref1 Div]. This defines the scaled [Torque Ref 1].

Parameter 113 [Torque Ref 2] is used to supply an external reference for desired torque. The scaling of this parameter is a per unit type, where a value of 1.0 is equal to the rated motor torque.

[Torque Ref 2] is then multiplied by parameter 114 [Torq Ref2 Mult]. This defines the scaled [Torque Ref 2].

The torque reference can be utilized when a master/slave multi-drive system is configured. The torque reference into the "slave" can be scaled to create the proper torque output. Keep in mind that the motors may be different ratings and this function is used to help the "system" share the load.

Parameter 115 [Torque Trim] can be used to trim the torque.For example, [Torque Trim] can be limited to an analog input or to the Process PI output.

Once the scaling is complete on both [Torque Ref 1] and [Torque Ref 2], the output is summed with the output of the [Torque Trim].

Trending

Trending can be used to trend up to 4 parameters with 1023 samples for each parameter at a rate between 0.2 mSec and 1 Sec per sample.

Configuration:

1. Set the trend rate in parameter 559 [Trend Rate] between 0.2 mSec and 1000 mSec (1 Second). There are a total of 1024 samples that will be taken at this rate.

2. For the trigger, two values can be compared or you can look at a single bit. To compare two DInt parameters for the trigger, use parameters 560 [Trend TrigA DInt] and 562 [Trend TrigB DInt]. To compare two floating point parameters for the trigger, use parameters 561 [Trend TrigA Real] and 563 [Trend TrigB Real]. To trigger on a single bit, link parameter 564 [Trend Trig Data] to the parameter that will be watched and set parameter 565 [Trend Trig Bit] to the bit that you want to watch in parameter 564.
3. Up to four different parameters can be trended. Link parameters 570 [Trend In1 DInt] or 571 [Trend In1 Real], 574 [Trend In2 DInt] or 575 [Trend In2 Real], 578 [Trend In3 DInt] or 579 [Trend In3 Real], and 582 [Trend In4 DInt] or 583 [Trend In4 Real], depending on the data type, to the parameters you would like to trend.
4. Set parameter 556 [Trend Control] bits 1 "In 1 Real" through 4 "In 4 Real" to correspond to the data type for the parameters you are trending. When the corresponding bit is off, the parameter will be DInt. When the corresponding bit is on, the parameter will be Real.
5. Set parameter 566 [Trend PreSamples] to the number of data points to store prior to the trend trigger (pre-trigger data). This can be set between 0 and 1022 samples.
6. Set parameter 556 [Trend Control] bit 0 "Enbl Collect" to enable the trend. When the trend is triggered, parameter 557 [Trend Status] bit 1 "Triggered" will be set. When the trend has completed parameter 557 [Trend Status] bit 2 "Complete" will be set.
7. To play back the data, you can monitor parameters 572 [Trend Out1 DInt] or 573 [Trend Out1 Real], 576 [Trend Out2 DInt] or 577 [Trend Out2 Real], 580 [Trend Out3 DInt] or 581 [Trend Out3 Real], and 584 [Trend Out4 DInt] or 585 [Trend Out4 Real], depending on the data type. The output parameters can be monitored in DriveObserver™, or you can link analog outputs to the output parameters and monitor the analog output with a chart recorder or oscilloscope. Then set parameter 556 [Trend Control] bit 15 "Auto Output" to automatically play back the output trend data at the rate entered in parameter 559 [Trend Rate]. Note that data can be played back at a slower rate than it was recorded by changing [Trend Rate] before turning on [Trend Control] bit 15 “Auto Output.”

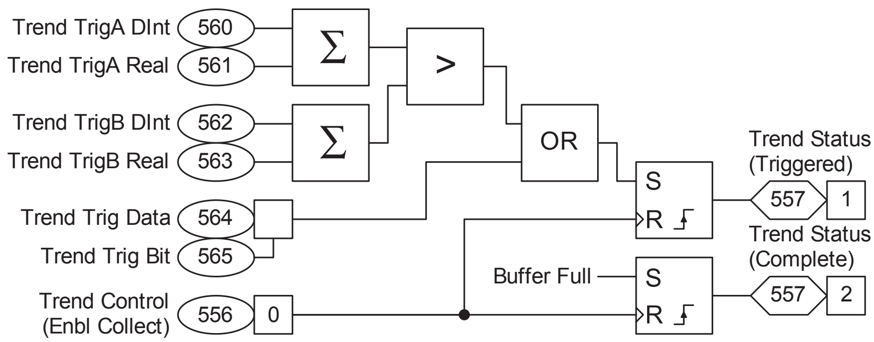
Additional Trend Parameters:

Parameter 567 [Trend Mark DInt] marks the start of data for trend buffers that are using integer data. The Trend Marker can be used to provide a scope trigger signal for the Auto Output function.

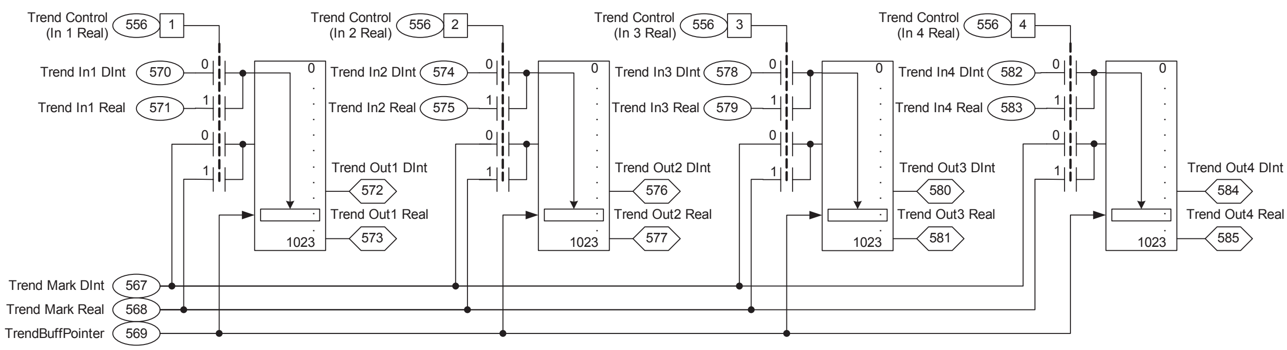
Parameter 568 [Trend Mark Real] marks the start of data for trend buffers that are using real data. The Trend Marker can be used to provide a scope trigger signal for the Auto Output function.

Parameter 569 [TrendBuffPointer] selects the trend buffer element to be displayed in the Trend Output Parameters when the trend function is inactive (not collecting data samples). A zero value points to the element that corresponds to the trigger event. Negative values point to pre-trigger data. Positive values point to post-trigger data.When the Auto Output function is running, this parameter will automatically sequence through it's full range, at a rate set by Parameter 559 [Trend Rate].

Trend Control:



Trend Data:



Unbalanced or Ungrounded Distribution Systems

Unbalanced Distribution Systems

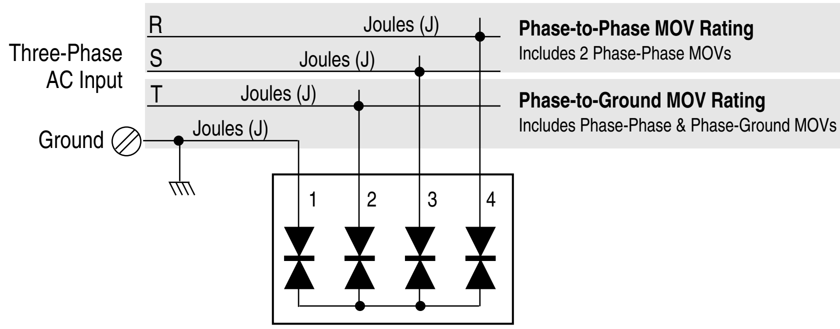
This drive is designed to operate on three-phase supply systems whose line voltages are symmetrical. Surge suppression devices are included to protect the drive from lightning induced overvoltages between line and ground. Where the potential exists for abnormally high phase-to-ground voltages (in excess of 125% of nominal), or where the supply ground is tied to another system or equipment that could cause the ground potential to vary with operation, suitable isolation is required for the drive. Where this potential exists, an isolation transformer is strongly recommended.

Ungrounded Distribution Systems

All drives are equipped with an MOV (Metal Oxide Varistor) that provides voltage surge protection and phase-to-phase plus phase-to-ground protection which is designed to meet IEEE 587. The MOV circuit is designed for surge suppression only (transient line protection), not continuous operation.

With ungrounded distribution systems, the phase-to-ground MOV connection could become a continuous current path to ground. Energy ratings are listed below. Exceeding the published phase-to-phase or phase-to-ground energy ratings may cause physical damage to the MOV.

PowerFlex drives contain protective MOVs and common mode capacitors that are referenced to ground. To guard against drive damage, these devices should be disconnected if the drive is installed on an ungrounded distribution system where the line-to-ground voltages on any phase could exceed 125% of the nominal



Device Rating (V AC)	240	480/600	240/480	600	240/480	600
Phase-Phase Total	160J	320J	280J	320J	280J	300J
Phase-Ground Total	220J	380J	360J	410J	360J	370J

line-to-line voltage. Refer to your *PowerFlex® 700S User Manual*, publication 20D-UM006, for details.

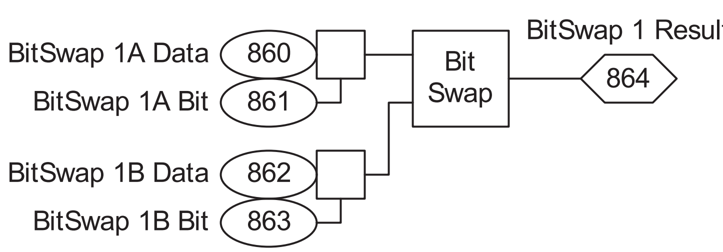
User Functions

There are several user functions available in the drive for custom control.

- Parameter 1000 [UserFunct Enable] is used to enable or disable user functions in the drive. The drive does not require a drive reset for a change to take affect.
  - Bit 0 "User Params" - enables use of user DInt and floating point parameters 1002 through 1021.
  - Bit 1 "Sel Switches" - enables a 16 selection switch, a DInt switch and a Real switch.
  - Bit 2 "Converts" - enables converters for Real to DInt or DInt to Real data.
  - Bit 3 "Logic Functs" - enables blocks that can be configured as (AND / NAND / OR / NOR/XOR / NXOR) and enables the compare functions.
  - Bit 4 "Multi/Div Math" - enables multiply/divide functions.
  - Bit 17 "MOP" - enables the MOP (motor operated potentiometer).
- Parameter 1001 [UserFunct Actual] will show the actual user functions enabled.

Bit Swap

The bit swap allows you to compare word A with word B and replace the selected bit from word A with the selected bit of word B.



Example of Using a Bit Swap and Digital Input for Custom Control

This example uses a bit swap to enable and disable the S-curve using digital input 3.

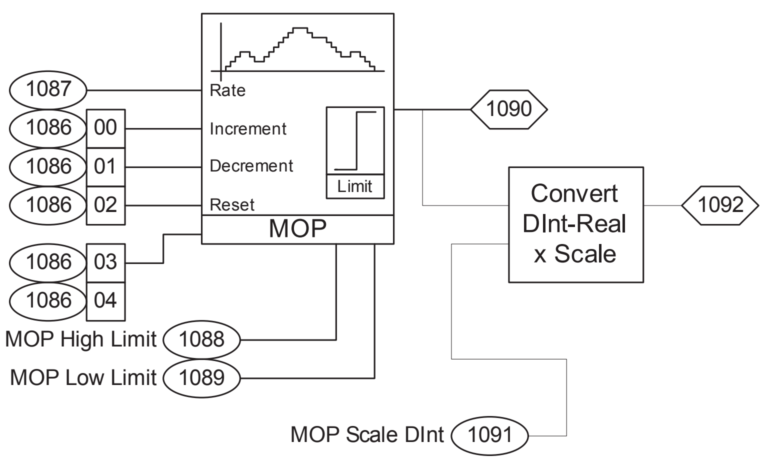
- Set parameter 860 [BitSwap 1A Data] to 0. This parameter sets up any data you would like to pass through to the result.
- Set parameter 861 [BitSwap 1A Bit] = 1. This parameter sets the bit that you would like to turn on in the result, and is set to bit 1 because we want to use bit swap 1 to turn on bit 1 "Spd S Crv En" of parameter 151 [Logic Command].
- Link parameter 862 [Bit Swap 1B Data] to parameter 824 [Local I/O Status]. Parameter 862 [Bit Swap 1B Data] sets the data that you would like to compare.
- Set parameter 863 [BitSwap 1B Bit] = 3. This parameter indicates that bit 3 of parameter 824 is used. Bit 3 of parameter 824 [Local I/O Status] indicates that digital input 3 has turned on.
- Link parameter 151 [Logic Command] to parameter 864 [BitSwap 1 Result]. The result of bit swap 1 will control parameter 151.

The overall function of BitSwap 1 is that when digital input 3 turns on, we turn on bit 1 "Spd S Crv En" of parameter 151 [Logic Command].

For another example using multiple bitswaps and the 16 position selector switch to control the point to point position with Digital Inputs see Position Loop - Point to Point on page 2-74.

MOP

The Motor Operated Potentiometer (MOP) allows the user to increase and decrease a DInt (double integer) or floating point value using two inputs. The inputs can come from Digital Inputs, a network, or DriveLogix™.



Configuration:

- Parameter 1086 [MOP Control] Motor Operated Potentiometer control and configuration. The bits are as follows:
  - Bit 0 “Increase”, if set, increments the MOP level (output) from parameter 1087 [MOP Rate] to parameter 1088 [MOP High Limit].
  - Bit 1 “Decrease”, if set, decrements the MOP level (output) from parameter 1087 [MOP Rate] to parameter 1088 [MOP Low Limit].
  - Bit 2 “Reset”, if set, resets the MOP level (output) to zero and Bit 0 “Increment” and Bit 1 “Decrement” are inhibited.
  - Bit 3 “Reset @ Stop”, if set, resets the MOP level (output) to zero when stop is set.
  - Bit 4 “Reset @ PwrLs”, if set, resets the MOP level (output) to zero when power is lost.

  Note: If either Bit 3 or Bit 4 is not set, the MOP level (output) will be saved until Bit 2 “Reset” is set.
- Parameter 1087 [MOP Rate] sets the rate of change (increment or decrement) for the MOP. The setting 0.1/sec will equate to an increment or decrement of 0.1 for every second active. If this is used for the speed reference, that equals 10% of base speed every second for a total of 10 seconds to reach base speed reference.
- Parameter 1088 [MOP High Limit} sets the upper limit for the MOP output. The MOP cannot be incremented above this level.
- Parameter 1089 [MOP Low Limit] sets the lower limit for the MOP output. The MOP cannot be decremented below this level.
- Parameter 1090 [MOP Level Real] or parameter 1092 [MOP Level DInt] can be linked to the parameter that you wish to control via the MOP function. For example, link parameter 10 [Speed Ref 1] to parameter 1090 [MOP Level Real] to control the value of speed reference 1.
- Parameter 1091 [MOP Scale DInt] set this value for scaling of the DInt MOP output. The MOP is calculated and controlled as a REAL value MOP. Use this scale to adjust for an integer value. Use this parameter to scale the conversion from Par 1090 to Par 1092.
- Parameter 1092 [MOP Level DInt] is the actual output value of the MOP as a DInt number. This value is scaled by parameter 1091 [MOP Scale DInt].

Controlling the MOP from Digital Inputs:

Program one of the digital inputs, parameters 825 [Dig In1 Sel] through 830 [Dig In6 Sel], to 23 "MOP Inc". Turn on the digital input to increase the MOP level at the rate programmed.

Program a second digital input, parameters 825 [Dig In1 Sel] through 830 [Dig In6 Sel], to 24 "MOP Dec". Turn on the digital input to decrease the MOP level at the rate programmed.

A digital input can also be programmed to 25 "MOP Reset". Turning on this digital input resets the MOP level to 0.

Controlling the MOP from a Network or DriveLogix™

Turn on parameter 1086 [MOP Control] bit 0 "Increase" to increase the MOP level at the rate programmed. Turn on parameter 1086 [MOP Control] bit 1 "Decrease" to decrease the MOP level at the rate programmed. Parameter 1086 [MOP Control] bit 2 "Reset" can be toggled to reset the MOP level.

Parameter 1086 can be controlled from a network by using a Datalink. Refer to Datalinks on page 2-20 for details on using Datalinks.

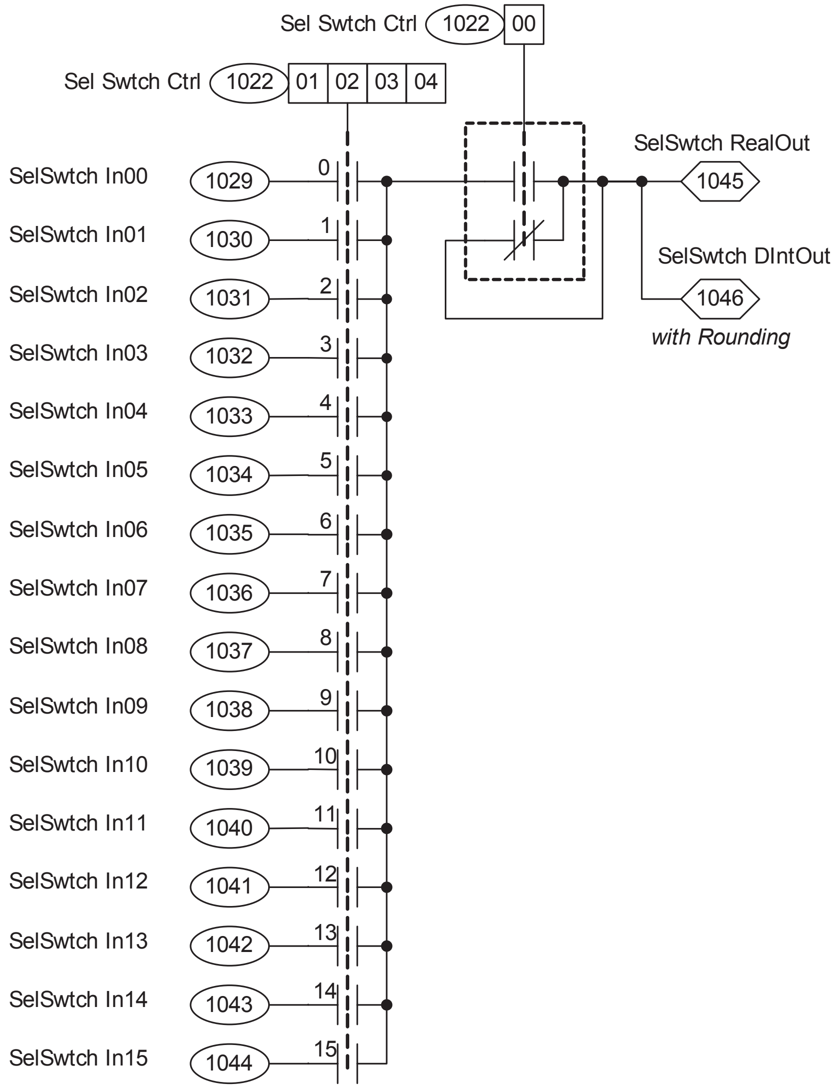
Parameter 1086 can be controlled from DriveLogix by linking it to one of the FromDriveLogix words (parameters 602 to 622). Refer to the *DriveLogix™ 5730 Controller User Manual*, publication 20D-UM003, for more details on setting up DriveLogix.

Selector Switches

There are three different selector switches available:

1. A switch that selects between up to 16 floating point values. The result is available as a DInt (double integer) and floating point.
2. A switch that selects between 2 floating point values. The result is floating point.
3. A switch that selects between 2 DInt values. The result is DInt.

16 Position Selector Switch:



Configuration:

- Parameter 1022 [Sel Switch Ctrl] is the control parameter for the switches and selector switch user functions. 16 Input Selector switches use bits 0-4.
  - Bit 0 “SSW DataPass” updates the output. If bit 0 is low, the output is NOT updated with the selected input.
  - Bit 1 “Sel Swtch 00” - Bit 4 “Sel Switch 04” are the BCD selection of the 16 inputs to the switch. Bit 1 is the LSB. (See parameters 1029 - 1046)
- Parameter 1029 [Sel Swtch In00] to 1044 [Sel Swtch In15] are the inputs to the selector switch. All inputs are entered as Real values. You may use the output of the selector switch as either Real or DInt. A conversion is done to create the DInt value.
- Parameter 1045 [SelSwtch RealOut] is the result of the selector switch. The output is loaded with the selected input based on parameter 1022 [Sel Switch Ctrl] bits 1-4 and bit 0. The output is only updated when parameter 1022 bit 0 is high. If parameter 1022 bit 0 is not high the output will not be updated to the

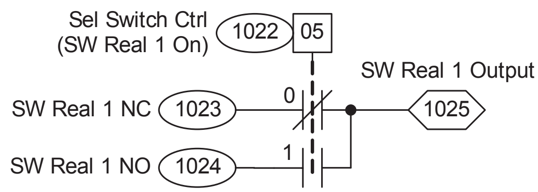
selected input. If this parameter does not update, check the setting of parameter 1000 [UserFunct Enable] bit 1.

- Parameter 1046 [SelSwtch DIntOut] is the value of parameter 1045 [SelSwtch RealOut] converted to a DInt value. Use this value for point to point positioning values.

Example:

For an example using multiple bitswaps and the 16 position selector switch to control the point to point position with Digital Inputs refer to Position Loop - Point to Point on page 2-74.

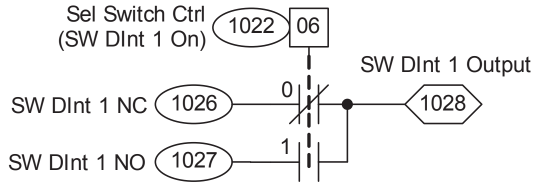
2 Position Floating Point Switch



Configuration:

- Parameter 1022 [Sel Switch Ctrl] bit 5 "Sel Sw Real 1 On" activates the switch.
- Parameter 1023 [Swtch Real 1 NC] is the Normally Closed input to the Real switch. When parameter 1022 [Sel Switch Ctrl] bit 5 is low, this input is updated to parameter 1025 [Swtch Real 1 Output].
- Parameter 1024 [Swtch Real 1 NO] is the Normally Open input to the Real switch. When parameter 1022 [Sel Switch Ctrl] bit 5 is high, this input is updated to parameter 1025 [Swtch Real 1 Output].
- Parameter 1025 [Swtch Real 1 Out] is the result of the switch. The output is loaded with the selected input based on parameter 1022 [Sel Switch Ctrl] bit 5. If this parameter does not update, check the setting of parameter 1000 [UserFunct Enable] bit 1.

2 Position DInt Switch



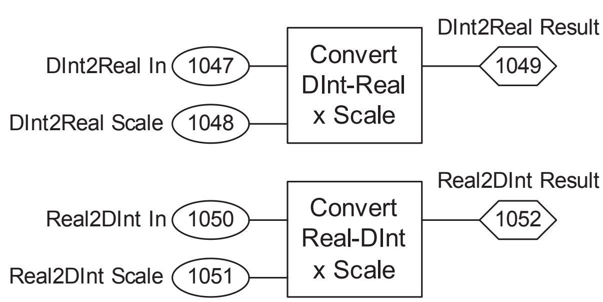
Configuration:

- Parameter 1022 [Sel Switch Ctrl] bit 6 "Sel Sw DInt 1 On" activates the switch.
- Parameter 1026 [Swtch DInt 1 NC] is the Normally Closed input to the DInt switch. When parameter 1022 [Sel Switch Ctrl] bit 6 is low, this input is updated to Par 1028 [Swtch DInt 1 Output].
- Parameter 1027 [Swtch DInt 1 NO] is the Normally Open input to the Real switch. When parameter 1022 [Sel Switch Ctrl] bit 6 is high, this input is updated to Par 1028 [Swtch DInt 1 Output].
- Parameter 1028 [Swtch DInt 1 Out] is the result of the switch. The output is loaded with the selected input based on parameter 1022 [Sel Switch Ctrl] bit 6. If this parameter does not update, check the setting of parameter 1000 [UserFunct Enable] bit 1.

DInt to Real and Real to DInt Converters

The DInt to Real converter is used to convert a double integer parameter to a floating point value. The resulting floating point value can then be linked to a floating point parameter.

The Real to DInt converter is used to convert a floating point parameter to a double integer value. The resulting double integer value can then be linked to a floating point parameter.



Configuration:

- Parameter 1047 [DInt2Real In] is the input value for DInt to Real value conversion.
- Parameter 1048 [DInt2Real Scale] is the input value to scale the conversion from DInt to Real. This is a multiplication to the input value after conversion to a Real value.
- Parameter 1049 [DInt2Real Result] is the resultant output of the conversion form a DInt value to a Real value after scaling.
- Parameter 1050 [Real2DInt In] is the input value for Real to DInt value conversion.
- Parameter 1051 [Real2DInt Scale] is the input value to scale the conversion from Real to DInt. This is a multiplication to the input value after conversion to a DInt value.
- Parameter 1052 [Real2DInt Result] is the resultant output of the conversion form a Real value to a DInt value after scaling.

Logic Blocks

The logic block is used to perform the logical operations AND, NAND, OR, NOR, XOR, and NXOR on user-specified bits of user-specified parameters.

Description of Logic operations:

AND - When all bits compared are on, the result will be true (1). When one of the bits compared is off, the result will be false (0).

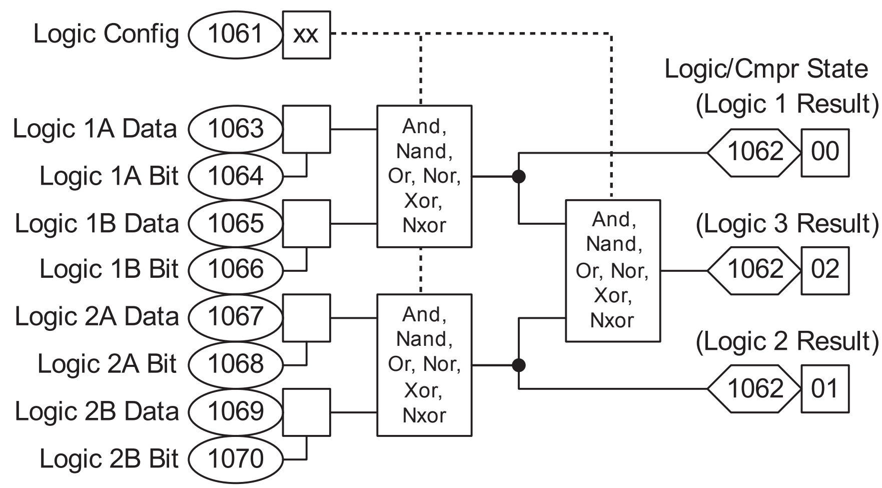
NAND - When all bits compared are off, the result will be false (0). When one of the bits compared is off, the result will be true (1).

OR - When one or all of the bits compared are on, the result will be true (1). When all of the bits compared are off, the result will be false (0).

NOR - When one or all of the bits compared are on, the result will be false (0). When all of the bits compared are off, the result will be true (1).

XOR (exclusive OR) - When one of the bits compared is on, the result will be true (1). When all of the bits are on or all of the bits are off, the result will be false (0).

NXOR - When one of the bits compared is on, the result will be false (0). When all of the bits are on or all of the bits are off, the result will be true (1).

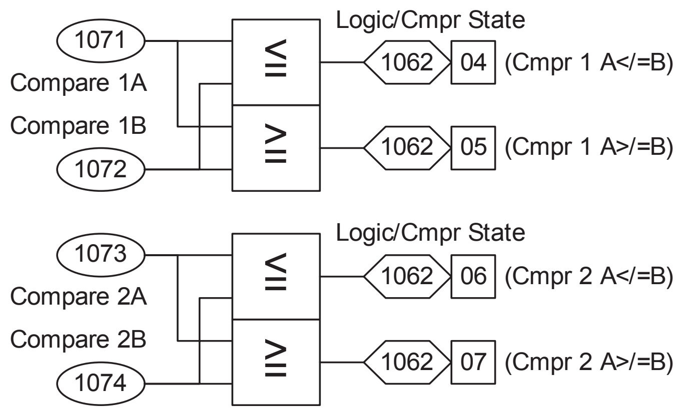


Configuration:

- Parameter 1061 [Logic Config] set this parameter to configure the logic routine in parameters 1063 [Logic 1A Data] - 1070 [Logic 2B Bit]. The result of this logic routine is displayed in parameter 1062 [Logic/Cmpr State]. There are three configurable logic blocks as displayed above. Each block can be configured as (AND / NAND / OR / NOR / XOR / NXOR). Select the functions as desired. Multiple operation selection for one block will result in the first selection (LSB) being the active mode.
- Parameter 1062 [Logic/Cmpr State] bits 0 "Logic 1 Rslt," 1 "Logic 2 Rslt" and 2 "Logic 3 Rslt" display the logical states of the Logic routine (parameters 1063 - 1070). A value of 0 = False and 1 = True.
- Parameter 1063 [Logic 1A Data] selects the data word for the first input to Logic Block 1. See parameter 1062 [Logic Config].
- Parameter 1064 [Logic 1A Bit] selects the bit of Par 1063 for the first input to Logic Block 1. Note: To invert the selected input enter the desired bit as negative. Use -32 to invert bit 0.
- Parameter 1065 [Logic 1B Data] selects the data word for the second input to Logic Block 1. See parameter 1062 [Logic Config].
- Parameter 1066 [Logic 1B Bit] selects the bit of parameter 1065[Logic 1B Data] for the second input to Logic Block 1. Note: To invert the selected input enter the desired bit as negative. Use -32 to invert bit 0.
- Parameter 1067 [Logic 2A Data] selects the data word for the first input to Logic Block 2. See parameter 1062 [Logic Config].
- Parameter 1068 [Logic 2A Bit] selects the bit of parameter 1067 [Logic 2A Data] for the first input to Logic Block 2. Note: To invert the selected input enter the desired bit as negative. Use -32 to invert bit 0.
- Parameter 1069 [Logic 2B Data] selects the data word for the second input to Logic Block 2. See parameter 1062 [Logic Config].
- Parameter 1070 [Logic 2B Bit] selects the bit of parameter 1069 [Logic 2B Data] for the second input to Logic Block 2. Note: To invert the selected input enter the desired bit as negative. Use -32 to invert bit 0.

Compare Blocks

The compare block are used to compare two floating point values and indicate which value is larger. It is possible to use the DInt to Real converter to convert one double integer parameter to a floating point value and use that value as an input to a compare block.



Configuration:

- Parameter 1062 [Logic/Cmpr State] bits 4 “Cmpr 1 A</=B” through 7 “Cmpr 2 A>/=B” display the logical states of the compare functions (parameters 1071 [Compare 1A] - 1074 [Compare 2B]. A value of 0 = False and 1 = True.”
- Parameter 1071 [Compare 1A] sets input A for the Compare 1. The results of the compare are displayed in parameter 1062 [Logic/Cmpr State].

  Available functions are (A </= B , A >/= B).
- Parameter 1072 [Compare 1B] sets input B for the Compare 1. The results of the compare are displayed in parameter 1062 [Logic/Cmpr State].

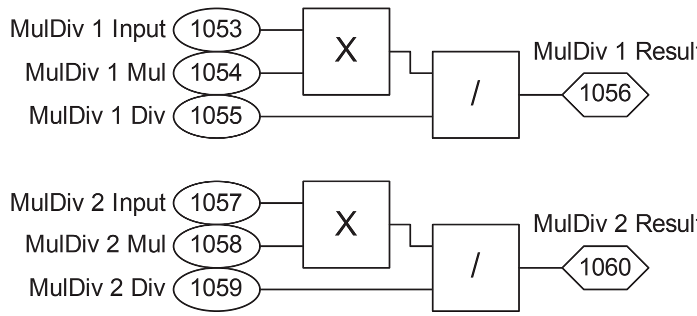
  Available functions are (A </= B , A >/= B).
- Parameter 1073 [Compare 2A] sets input A for the Compare 2. The results of the compare are displayed in Par 1062 [Logic/Cmpr State].

  Available functions are (A </= B , A >/= B).
- Parameter 1074 [Compare 2B] sets input B for the Compare 2. The results of the compare are displayed in Par 1062 [Logic/Cmpr State].

  Available functions are (A </= B , A >/= B).

Multiply/Divide Blocks

The multiply/divide blocks are used to multiply and divide floating point parameters. It is possible to use the DInt to Real converter to convert one double-integer parameter to a floating point value and use that value as an input to a multiply/divide block.



Configuration:

- Parameter 1053 [MulDiv 1 Input] is the input value to be scaled as need with the Multiplication and Division function. This input will be multiplied by parameter 1054 [MulDiv 1 Mul] and then divided by parameter 1055 [MulDiv 1 Div]. The result will be loaded to parameter 1056 [MulDiv 1 Result].

  Equation: (Par 1053 * Par 1054) / Par 1055 = Par 1056

- Parameter 1057 [MulDiv 2 Input] the input value to be scaled as need with the Multiplication and Division function. This input will be multiplied by parameter 1058 [MulDiv 2 Mul] and then divided by parameter 1059 [MulDiv 2 Div]. The result will be loaded to parameter 1060 [MulDiv 2 Result].

  Equation: (Par 1057 * Par 1058) / Par 1059 = Par 1060

Voltage Class

PowerFlex drives are sometimes referred to by voltage “class.” This class identifies the general input voltage to the drive. This general voltage includes a range of actual voltages. For example, a 400 Volt Class drive will have an input voltage range of 380-480VAC. While the hardware remains the same for each class, other variables, such as factory defaults and power unit ratings will change. In most cases, all drives within a voltage class can be reprogrammed to another drive in the class by using parameter 403 [Voltage Class] to reset a drive to a different setup within the voltage class range.

As an example, consider a 480 volt drive. This drive comes with factory default values for 480V, 60 Hz with motor data defaulted for U.S. motors (HP rated, 1750 RPM, etc.) By setting the [Voltage Class] parameter to “Low Voltage” (this represents 400V in this case) the defaults are changed to 400V, 50 Hz settings with motor data for European motors (kW rated, 1500 RPM, etc.).

Watts Loss

The following table lists watts loss data for PowerFlex® 700S drives running at full load, full speed, and factory default PWM frequency of 4kHz.

Table 2.V 480V Watts Loss at Full Load/Speed, 4kHz[1]

Drive ND HP @ 480V AC	Total Watt Loss
0.5	92
1	103
2	117
3	135
5	210
7.5	243
10	271
15	389
20	467
25	519
30	543
40	708
50	[2]
60	[2]
75	[2]
100	[2]
125	[2]
150	[2]

[1] Includes HIM

[2] Information not available at time of publication

A

B

C

F

G

H

I

J

L

R

V

W

X

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation, Vorstlaan/Boulevard du Souverain 36, 1170 Brussels, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

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