PowerXL DG1 Redundant Drive Application

Introduction

The Power XL DG1 is capable of operating a redundant drive scheme when using the internal PID controller in the drive. This system will utilize two drives with one drive as the Master drive and a secondary drive as a backup. This scheme will use the RS485 communication bus to communicate between the two drives. If the master drive fails due to a fault or a motor interlock is removed, the secondary drive will be brought in and allow the system to keep running. Additional isolation can be built into the scheme to provide the ability to physically replace a drive if one has failed while allowing the other drive to operate the system.

System Configurations

The system setup for this redundant drive application will include two adjustable frequency drives of the same rating, appropriate input protection, input isolation contactors or disconnect devices, output contactors, and a single motor. The output of both drives will be wired into two output contactors and combined to feed to the motor. This setup will allow for either drive to supply power to the motor. By adding a disconnect before each drive, a failed drive can be replaced while having the backup drive continue to operate the system. This typical setup is detailed in Figure 1 below.

In most cases, this redundant drive setup will be used with two drives and a single motor as described above. However, the system could also be set up to utilize two drives each wired to its own motor. This system would utilize the same components as described above, except the output contactors would be wired to the respective motors and not combined to the same motor. This alternative setup is shown in Figure 2 below. This configuration provides redundancy for the drives as well as the motors.

For both system configurations, the output contactors for the master drive and backup drive will be tied to the Run relay output on the respective drives. This will set the drive software as the interlock. When the master drive is running and sees a fault, the motor interlock contactor will drop out. When this occurs, the system will check if the backup drive is able to run the motor. If it is able, the backup drive will close its Run relay thus closing the output contactor.

All main controls, inputs and outputs should be wired to both drives. This will allow either drive to properly operate the system if it becomes the active drive. Further details on the wiring and setup are given in the following sections.

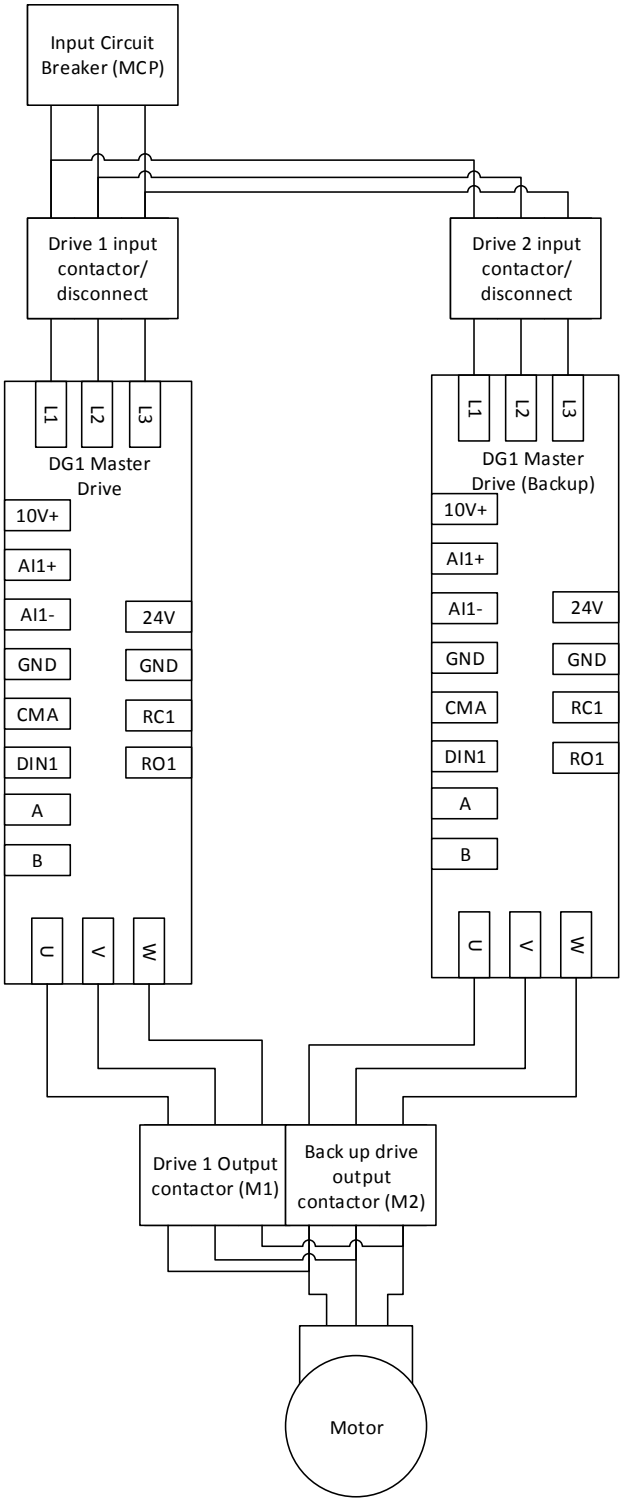


Figure 1: Redundant Drive Configuration with 2 Drives Controlling 1 Motor

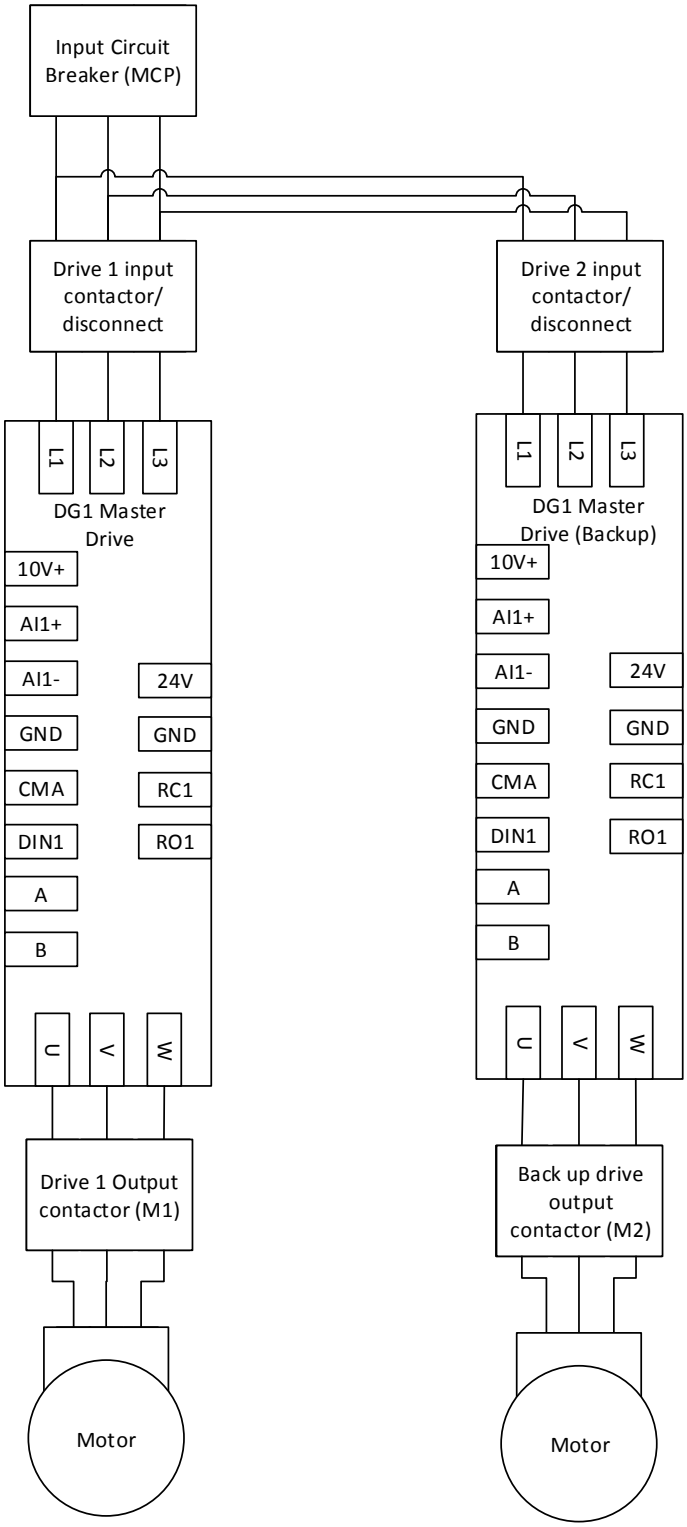


Figure 2: Redundant Drive Configuration with 2 Drives Controlling 2 Motors

Sample Control Schemes

Figures 3 – 5 below show basic control scheme layouts for three different types of transducer setups. The figures show the wiring of the analog signals, start commands, and the RS-485 communication bus between each drive. With this setup, the backup drive will always be capable of becoming the active drive in the event of a drive failure.

If Safe Torque Off (STO) is used, the inputs can be run in parallel to each drive or individually. If the backup drive's STO is connected individually from the Master drive and a fault is triggered, it can be sent back to the Master drive to stop the system. This is controlled by the P18.3.6 parameter setting and is explained in the later tables.

If multiple motors are used, it would be advised to use Motor interlocks to be sure the motor is OK to run prior to operating. In the case where a single motor is used, the interlock would be disabled or fed back to both drives. When the motor interlock is used, it will not allow the system to run with a single motor.

The last drive in the network should have the RS485 Termination resistor enabled on the control board. This resistor identifies the last device on the communication network.

Please see the figures and associated notes on the following pages.

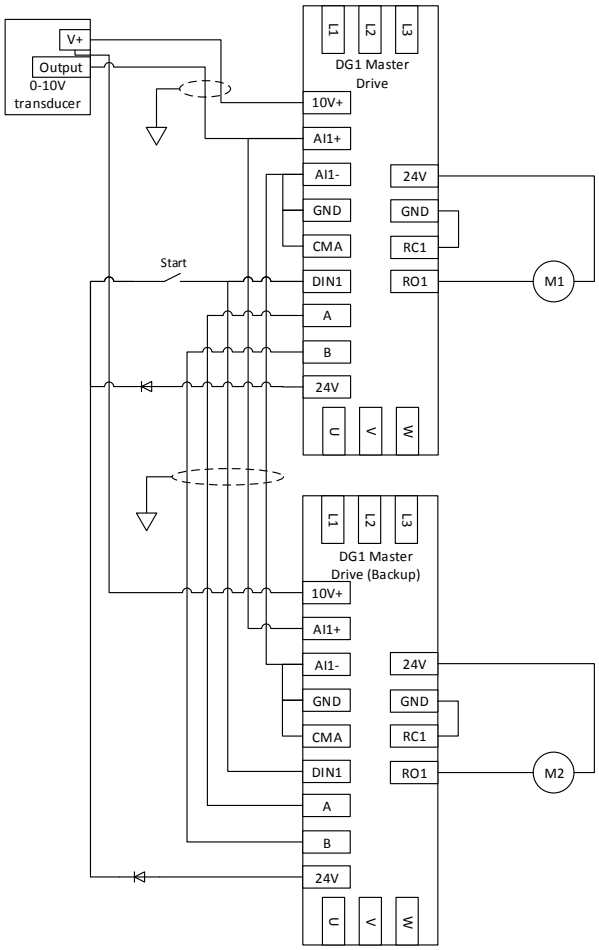
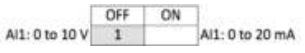
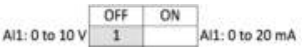
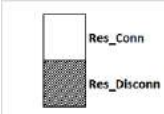
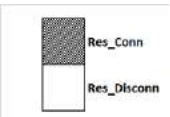


Figure 3: Control scheme with 10V supply and 0-10V transducer

For the control scheme in Figure 3, please note the following:

- The 10V+/24V+ supplies along with Grounds for each drive should be connected together. When connecting multiple power supplies together, it is advised to use a feedback diode to prevent power supplies back feeding on themselves.
- The Run commands need to be wired into each drive.

Parameter/Setting	Main Drive Setting	Backup Drive Setting
P2.1 – AI1 Mode	0-10V	0-10V
P2.2 – AI1 Signal Range	0-100%	0-100%
Jumper		
RS485 Terminating Resistor		

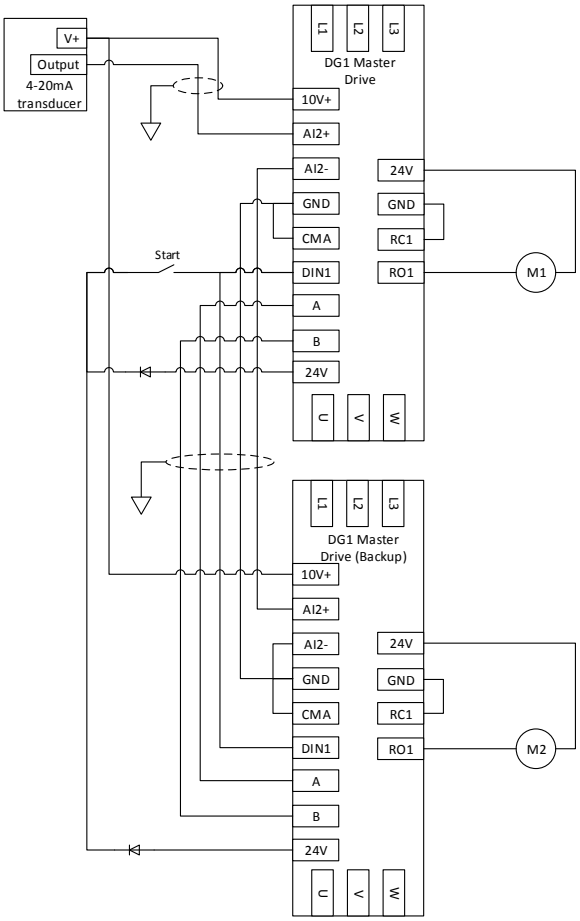
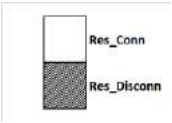
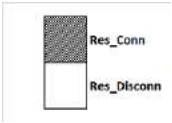


Figure 4: Control Scheme with 10V supply and 4-20mA Transducer

For the control scheme in Figure 4, please note the following:

- The 10V+/24V+ supplies along with Grounds for each drive should be connected. When connecting multiple power supplies together, it is advised to use a feedback diode to prevent power supplies back feeding on themselves.
- The Run commands need to be wired into each drive.

Parameter/Setting	Main Drive Setting	Backup Drive Setting
P2.11 – AI2 Mode	0-20mA	0-20mA
P2.12 – AI2 Signal Range	20-100%	20-100%
Jumper		
RS485 Terminating Resistor		

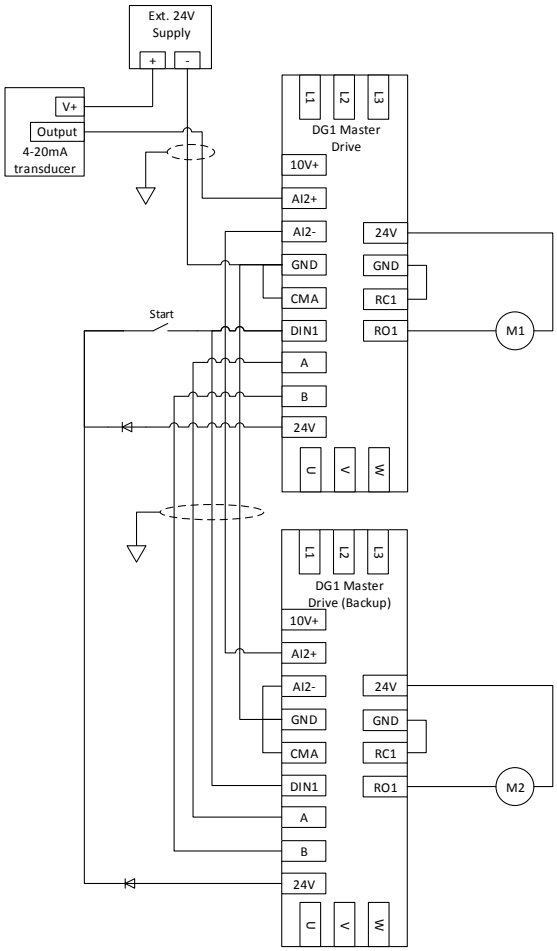
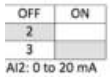
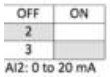
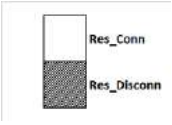
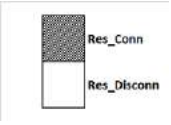


Figure 5: Control Scheme with External Supply and a 4-20mA transducer

For the control scheme in Figure 5, please note the following:

- The 24V+ supplies along with Grounds for each drive should be connected. When connecting multiple power supplies together, it is advised to use a feedback diode to prevent power supplies back feeding on themselves.
- The Run commands need to be wired into each drive.

Parameter	First Drive Setting	Backup/Last Drive Setting
P2.11 – AI2 Mode	0-20mA	0-20mA
P2.12 – AI2 Signal Range	20-100%	20-100%
Jumper		
RS485 Terminating Resistor		

Parameters

The table below shows the setup parameters. This menu is visible in both Single and Multi drive modes.

Panel Code	Parameter	Default	Range	Modbus ID	Description
P18.3.1	Multi-pump mode	0	0-1	2279	0 = Disable 1 = Single Drive 2 = Multi Drive (multi-follower)
P18.3.2	Drive ID	0	0-5	2278	Each drive in multi drive system has to have a unique, and non-zero number. If a drive has a zero ID, it will be regard as isolated single drive. And for multi drive system, the lower number drive has higher priority to compete for master.
P18.3.3	Number of Motors	1	0-5	342	Total number of motors/pumps connected to this drive in single drive mode. When in multi-drive, this limits the amount of active drives running at a time.
P18.3.4	Regulation Source	0	0-1	2284	0 = Network 1 = Feedback For drives that have been connected with both start/stop signal and PID feedback can be set as “Feedback”, so they will have ability to be master.
P18.3.5	Recovery Method	0	0-1	2285	0 = Automatic 1 = Stop This parameter is for slaves when multi drive system lost master, slave drive can continue run if it is set to be “Automatic”, however the slave drive will stop immediately if it is set to be “Stop”.
P18.3.6	Callback Source	0	0-1	2286	0 = No Action 1 = Safety Torque Off Sometimes some information needs to be called back from slave to master and affect the whole system; if the slave drive has a callback source as STO, when it suffers STO fault, master drive will answer this callback and shut down the whole system.
P18.3.7	Add/Remove Pump Rule	0	0-1	2311	0 = Drive ID 1 = Run Time In default, MPFC system will add/remove pump according to their drive ID, from small to large; and the order can also depend on each slave drive’s running time: add the drive has shortest running time and remove the drive has longest running time first.
P18.3.8	PID Bandwidth			343	The same as Single Drive mode
P18.3.9	Staging Frequency	P1.2	P1.1 - 400	2315	Master drive can only add pump when output frequency is over staging frequency and feedback is out of bandwidth.
P18.3.10	De-Staging Frequency	P1.1	0 - P1.2	2316	Master drive can only reduce pump when output frequency is below de-staging frequency and feedback is out of bandwidth.
P18.3.11	Add/Remove Delay			344	The same as Single Drive mode
P18.3.12	Interlock Enable			350	The same as Single Drive mode But in Multi Drive mode, system only detect Interlock 1
P18.3.13	Include Freq Converter			346	Not available for Multi Drive mode
P18.3.14	Auto-Change Enable			345	Not available for Multi Drive mode
P18.3.15	Auto-Change Interval			347	Not available for Multi Drive mode
P18.3.16	Auto-Change Freq Limit			349	Not available for Multi Drive mode
P18.3.17	Auto-Change Motor Limit			348	Not available for Multi Drive mode
P18.3.18	Run Time Enable	0	0-1	2280	The run time counter will start counting only if this parameter is enabled.
P18.3.19	Run Time Limit	0.0	0.0-300000.0	2281	If drive run time is over this limit, its network status will be “Need Alternation”. Limit equals 0 means run time counter disabled.
P18.3.20	Run Time Reset	0	0-1	2283	One-time parameter, when to “1” it will clear the run time counter.

P18.3.21	Damper Start			483	Not available for Multi Drive mode
P18.3.22	Damper Time Out			484	Not available for Multi Drive mode
P18.3.23	Damper Delay			485	Not available for Multi Drive mode

The table below shows the status parameters. This menu is visible only in multi drive mode.

Panel Code	Parameter	Default	Range	Modbus ID	Description
P18.1.1.x	Operation Mode	0	0-2		0 = Offline (For single drive mode or slave drive which has lost master in multi drive mode) 1 = Slave Drive (Operate as an auxiliary drive in multi drive mode) 1 = Master (Operate as the regulating drive of the Multi drive system)
P18.1.2.x	Multi-pump Status	5	0-5		0 = Stopped (For master or single drive which is stopped) 1 = Sleep (For master or single drive which is asleep) 2 = Regulating (For master or single drive which is running) 3 = Wait for CMD (For slave drive which is stopped) 4 = Following (For slave drive which is running) 5 = Unknown (Status for disconnected drives showing on other drives' menu)
P18.1.3.x	Network Status	0	0-4		0 = Disconnected (For disconnected slave drive or single drive) 1 = Fault (For drives that suffer fault) 2 = Pump Lost (For drives that lose interlock signal) 3 = Need Alternation (For drives that run time is over limit) 4 = No Error

The table below shows the measurement parameters. This menu is visible only for Master drives.

Panel Code	Parameter	Default	Range	Modbus ID	Description
P18.2.1.x	Latest Fault Code				These measurement parameters of all drives within multi drive system can be seen from master drive's menu.
P18.2.2.x	Output Frequency				
P18.2.3.x	Motor Voltage				
P18.2.4.x	Motor Current				
P18.2.5.x	Motor Torque				
P18.2.6.x	Motor Power				
P18.2.7.x	Motor Speed				
P18.2.8.x	Run Time				

Installation Settings

The steps below detail the process for setting up the redundant drive system.

1. Make all hardwire connections between the two drives.
    a. Terminal A/B for RS485 – connect the two drives together.
    b. Power Supply – connect the two drives with feedback diodes if using both drives supplies (with ext. supply this is not required) to prevent back feeding on individual Master devices.
    c. GND – connect the Control GND terminals on both drives to keep a common control level.
    d. Digital Inputs – connect any desired Digital inputs to both drives.
    e. Analog Inputs – connect analog feedback and set point values to both drives.
    f. Safe Torque Off (STO) – connect to the STO terminals on both drives in series.
2. On the keypad or PC tool, set both drives to the Multi-Pump application (P21.1.2 Application).
3. Go through the Start Up wizard to set up the motor parameters and control places. (Either Local or Remote Reference parameters should be set for PID Control 1 to follow PID control loop operation.)
4. Set the Baud rate (P20.2.3) and communication mode (P20.2.1) to the desired com speed and Modbus-RTU. The Slave address (P20.2.2) for each drive should be different.
5. Set up any additional control functions required.
6. Set Drive ID's (P18.3.2) to different ID's.
7. Set the maximum amount of motors (P18.3.3) to "1" so that only one drive will be active at a time. Both drives should have the Start/Stop signal and PID feedback connected to them and the PID Feedback connection regulation source (P18.3.4) set to "PID Controller 1".
8. Select the functions for the other Multi-drive functions if the defaults are not desired. With the default values, the system can safely operate. The table on the following page shows the default values.
    a. Recovery Method (P18.3.5)
    b. Callback Source (P18.3.6)
    c. Add/Remove Drive Selection (P18.3.7)
    d. PID Bandwidth (P18.3.8)
    e. Interlock (P18.3.12)
9. Once set, copy the parameters to the keypad (P21.1.4) to back up the parameters for both drives.
10. With the drives connected, the Master drive should see the additional drive and the setup is done. The system can now be started.

Note: When the keypad is used as the set point source, changes are not communicated to other drive. If the set point is changed on one drive, it is required to manually change the set point on the other drive. This will allow the system to keep the desired set point when it switches to the backup drive.

Parameter	Parameter Name	Drive Setting (Both Drives)
P21.1.2	Application	Multi-Pump
P20.2.1	Communication Mode	Modbus RTU
P20.2.2	Slave Address	Varies
P20.2.3	Baud Rate	9600
P1.11	Remote Control Place	I/O terminal
P1.14	Remote Reference	PID Control 1
P3.37	Motor Interlock 1	Varies – single motor not used, multiple motors set up ID
P10.11	PID1 Keypad Set point 1	Varies
P10.14	PID1 Set point Source	Keypad or AI or Fieldbus
P10.32	Feedback Source 1	AI2 or AI2
P18.3.2	Drive ID	Varies
P18.3.3	Number of Motors	1
P18.3.4	Regulation Source	PID Controller 1
P18.3.5	Recovery Method	Automatic
P18.3.6	Callback Source	No Action if STO's are in wired in parallel, Safety Torque Off if the STO's are individually wired
P18.3.7	Add/Remove Pump Rule	Drive ID
P18.3.8	PID Bandwidth	10
P18.3.12	Interlock Enabled	Disabled – with single motor, Enable – with multiple motors
P18.3.13	Include Frequency Converter	Enabled

Application Specifics

Master Handover
When a drive is setup as the Master drive, it will maintain the master functionality as long as it does not meet the following status.

1. A Fault occurs except for STO. (If Master drive has STO fault, the whole system will be shut down and it will remain in the Master position).
2. The interlock signal is lost (when using the interlock function).
3. The regulation source (P18.3.4) changes from feedback to network.

In the event the Master drive meets one of the criteria above, the system will switch to the backup drive if the following conditions exist:

1. The drive is within the Multi-Pump and Fan control network and communication is OK.
2. Regulation source (P18.3.4) is set at feedback.
3. No active faults and interlock signal is present (if enabled).

Master Lost
If there is a communication loss between the Master and backup drive for over 5 seconds, there will be a new Master generated from the backup master. If neither Master is able to run, the system will stay stopped.

Slave Callback
If using the Safe Torque Off feature and the inputs are not wired in series between the two drives, it is possible to shut down both drives when a Safe Torque Fault occurs to the backup drive. By setting parameter P18.3.6 Callback Source Setting to “Safety Torque Off”, the main drive will shut down if an STO fault is seen by the backup drive.

Fire Mode
If using Fire Mode via a digital input, it is necessary to wire the input into both drives and set the Fire Mode frequency in both drives. This will allow the active drive (Master or backup) to begin operating at the Fire Mode frequency when activated.

Keypad Stop button
By default, the keypad is always active for stopping the drive based off the Keypad Stop (P7.5) parameter. When the Master drive keypad Stop button is pressed, the operation will shut down the whole system regardless of where the control source is coming from. If a backup drive receives the keypad Stop operation, it will not affect the Master drive.

Additional Help

In the US or Canada: please contact the Technical Resource Center at 1-877-ETN-CARE or 1-877-386-2273 option 2, option 6.

All other supporting documentation is located on the Eaton web site at www.eaton.com/Drives

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