

# **P-VFD DUPLEX PUMP SYSTEM MANUAL**

**08-30-2015**

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### 1. SAFETY PRECAUTIONS

**To prevent injury and property damage, follow these instructions. Failure to adhere to installation/operation procedures and all applicable codes may result in hazards as indicated by warning codes below:**

The meaning of each symbol in this manual, and on your equipment, is as follows.



This is the safety alert symbol. Read and follow instructions carefully to avoid a dangerous situation.



This symbol alerts the user to the presence of “dangerous voltage” inside the product that might cause bodily harm or electric shock.

- This manual should be placed in a location where it can be accessed by users.
- This manual should be given to the person who actually operating the control panel and is responsible for its maintenance.

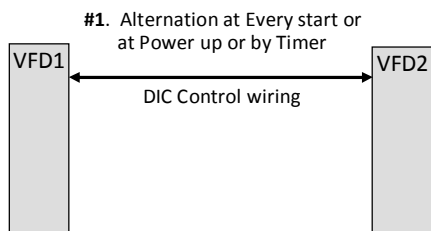


As with all electrical products, read manual thoroughly. Only qualified, expert personnel should perform installation and maintenance. Do not disassemble or repair unit unless described in this manual; death or injury to electrical shock or fire hazard may result. Specifications and manual data are subject to change. Consult factory for additional information.

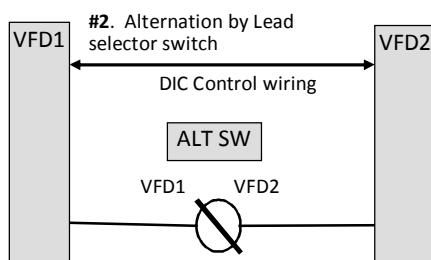
## 2. INTRODUCTION

The duplex pump control VFD system can be in configuration of two standalone VFDs, two standard enclosed VFD pump panels or one standard VDP (VFD Duplex Panel) control panel with two VFDs. Enclosed VFD packages are UL-508 listed panels which are designed to meet market requirements and provide reliable operation. Duplex system has different alternating modes and Lead-Lag control based on input signals from pressure transducers and VFDs status outputs. The communication between VFDs is based on digital inputs and outputs that makes VFD internal RS-485 communication (Modbus RTU) available for SCADA system, PLCs or other controllers. For two standalone VFDs there are option kits for alternation by VFD selector switch or by momentary pushbutton. For technical specifications and ratings refer to VFD manual for standalone VFDs or package specification for enclosed VFDs.

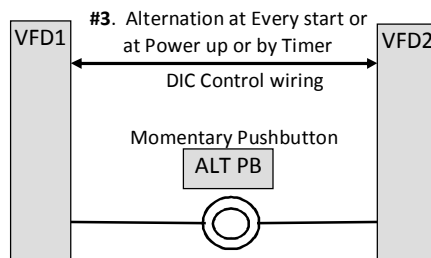
There are four duplex control configurations:



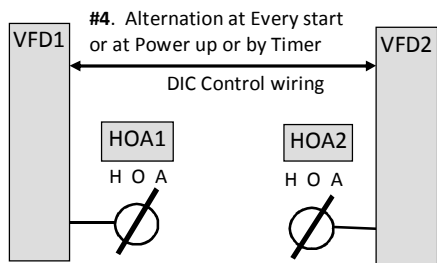
**Configuration #1** is for two VFDs with only control wiring between them. The alternation mode can be set to By Timer, At Power up or can be configured for alternation At Every Start.



**Configuration #2** is for two VFDs with control wiring between them and Lead VFD selector switch. The alternation mode should be set to Lead SW/FLT.



**Configuration #3** is for two VFDs with control wiring between them and one alternating momentary pushbutton. The alternation mode can be set to By Timer, At Power up or can be configured for alternation At Every start. The pushbutton acts as a manual alternator additional to selected alternation mode.



**Configuration #4** is for two enclosed VFDs with HOA switches and control wiring between them or VDP panel. The alternation mode can be set to By Timer, At Power up or can be configured for alternation At Every start.

If other type of alternation is required, please contact FCS tech support for assistance.

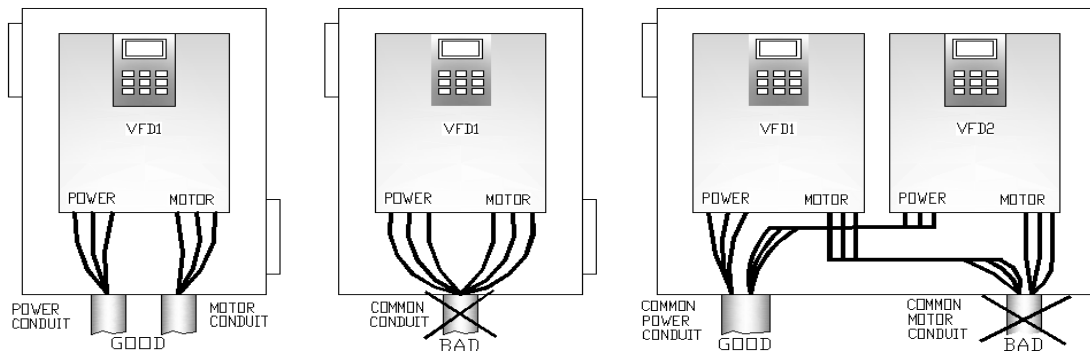
The duplex control system requires two pressure transducers (one for each VFD) for redundancy and reliable operation.

### 3. INSTALLATION AND WIRING



**Check if supply voltage matches the voltage rating on the provided drawing & VFD or manufacturer's control panel label before wiring and powering up the pump control panel!**

The duplex VFD control system should be installed in environment suitable for standalone VFDs or the enclosure UL type rating for enclosed VFDs. Refer to P-VFD manual for spacing for proper ventilation. Provide properly sized main disconnect and branch circuit protections where required. The gauge of the input power, motor and control wiring shall be selected based on the NEC and local law requirements. The power wiring and grounding shall be done by a licensed electrician at the points shown as dashed lines on the provided electrical diagrams. Do not combine input power and motor leads or motor leads from both VFDs in the same conduit.



Provide dedicated input power and motor ground wires to VFDs. Using metal construction or conduits as a grounding path could cause improper VFD ground fault protection operation.

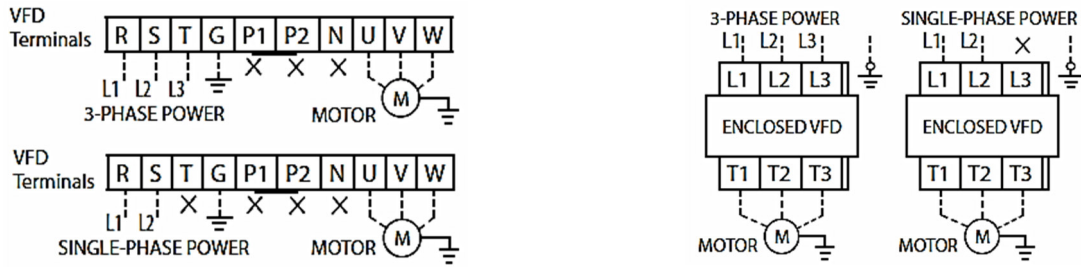
For the VFD protection and better power filtering it is recommended to install line reactors for each VFD if distance to the service transformer is greater than 50'.

For the motor winding protection for 480VAC and 575VAC systems it is recommended to install output reactor for 45' to 100' distance from VFD to a motor, dV/dt output filter from 100' to 1000' (800' for submersible pumps) and Sine-Wave filter for greater distances.

**Power wiring.** Wire input power, motor leads and ground wires based on the following drawings:

**Standalone VFD wiring**

**Enclose VFD wiring**



**Control wiring.** For DIC (Duplex Interconnection Cable) wiring between two VFDs or two enclosed VFD panels refer to the following diagrams (VDP panel prewired from the factory). The configurations shown on figures 2, 3 and 4 require extra wiring for optional alternating switch or alternating pushbutton or auxiliary N.C. contact for HOA switch Auto position. Use multi-wire shielded cable for control wiring with shield drain wire isolated on VFD-1 side and connected on VFD-2 to a ground. Put shrink tube or electrical tape to isolate bare shield drain wire to protect from shorting any VFD or panel terminals. Use shielded cable for pressure transducer wiring with shield drain wire connected to a ground point at VFD or enclosed VFD panel. Isolate bare shield drain wire with shrink tube or electrical tape and connect it to ground terminal.

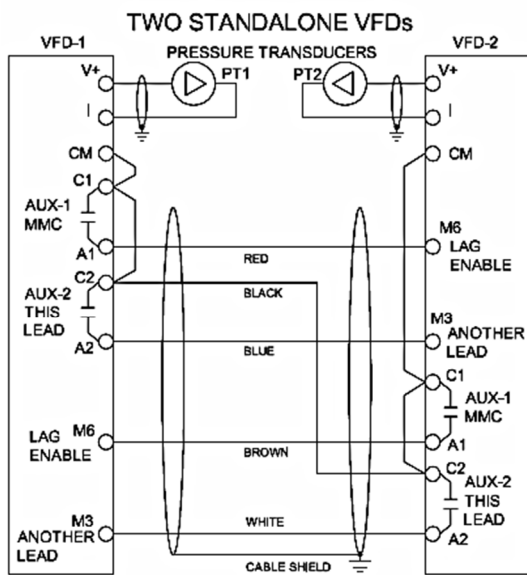


FIG. 1

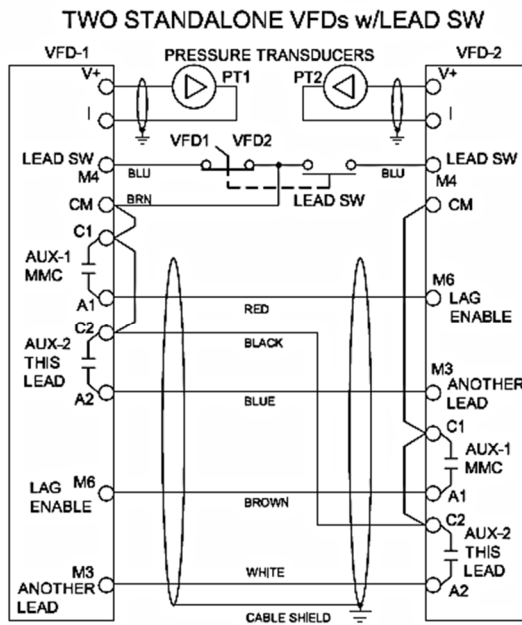


FIG. 2

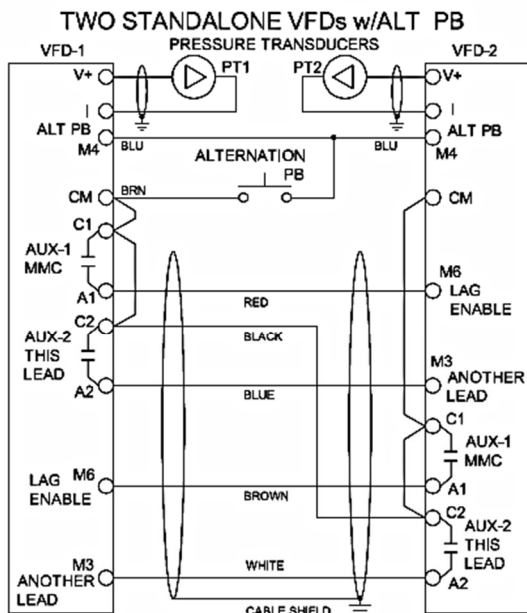


FIG. 3

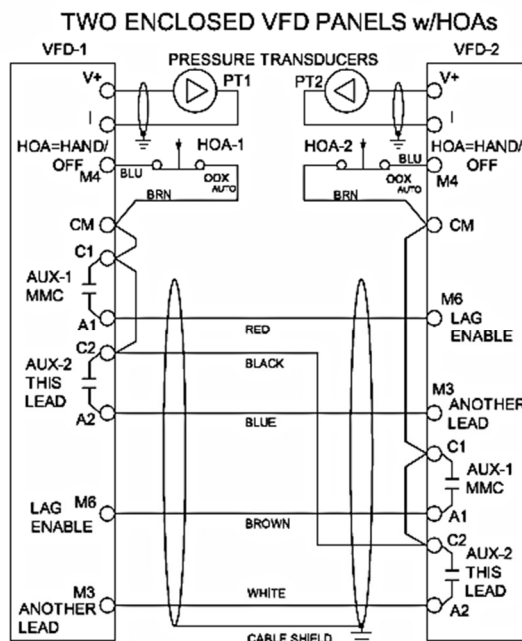


FIG. 4

#### 4. SETUP AND FEATURES

The standalone VFDs or VFDs in two enclosed VFD panels should be set to centrifugal or submersible pump application with all the necessary control and protection features based on provided QSG (quick start guide). Both VFDs' parameters should be set identically except VFD ID and Lead/Lag setting. It is recommended to set all the necessary parameters for VFD-1 then save changes to a keypad and use its keypad to program VFD-2. Set motor data parameters according to motor nameplate for proper system operation and motor protection. Then set all the necessary parameters for basic duplex control and additional parameters for configurations shown on figures 2, 3 and 4.

#### Basic Duplex Control Parameters

Par.#	Value/Selection	Description
SET-50	YES (MMC)	Multi-motor control (Lead-Lag)
SET-56	40.00Hz	Lag Stop Frequency. Set 1Hz above [SET-32] sleep frequency
SET-63	30.00Hz	Pump speed jump at Lag stop.
I/O-22	Another Lead	M3 input set to monitor if another VFD is Lead.
I/O-25	Lag Enable	When M6 input is activated by Lead VFD, the Lag VFD starts.
I/O-33	VFD1 or VFD2	Identification VFD-1 or VFD-2 for Duplex control
I/O-34	Timer/Flt or PowerUp/FLT	Alternating by Lead run time or at every power-up
I/O-35	Lead VFD or Lag VFD	Set VFD1 to Lead VFD and VFD2 to Lag VFD at initial start-up
I/O-36	168hrs (7-Days)	Alternating time setting in hours (Lead run time).
I/O-76	MMC	AUX-1 relay output set for MMC (Lag Start) output
I/O-77	This Lead	Lead VFD AUX-2 relay output is active.

#### Lead Switch Option Parameters (Fig.2)

Par. #	Value/Selection	Description
I/O-23	LEAD Switch	Input for two-position Lead selector switch
I/O-34	Lead SW/FLT	Alternating Mode set to Lead Selector Switch

#### Alternating Momentary Pushbutton Option Parameters (Fig.3)

Par. #	Value/Selection	Description
I/O-23	ALT Input	Input for momentary N.O. alternating pushbutton
I/O-34	Timer/Flt or PowerUp/FLT	Alternating by Lead run time or at every power-up

#### Hand-Off-Auto Switch Option Parameters (Fig.4)

Par. #	Value/Selection	Description
I/O-23	HOA Hand/OFF (Not in Auto)	M4 Input for N.C. HOA switch contact in Auto position
I/O-34	Timer/Flt or PowerUp/FLT	Alternating by Lead run time or at every power-up

The standard VDP packages will come from the factory pre-programmed for duplex control and will only require programming for motor data parameters and setting of some specific protection and control features for the application.

#### VDP Duplex Control Parameters

Par.#	Value/Selection	Description
SET-50	YES (MMC)	Multi-motor control (Lead-Lag)
SET-56	40.00Hz	Lag Stop Frequency. Set 1Hz above [SET-32] sleep frequency
SET-63	30.00Hz	Pump speed jump at Lag stop
I/O-22	Another Lead	M3 input set to monitor if another VFD is Lead
I/O-23	HOA Hand/OFF (Not in Auto)	M4 Input for N.C. HOA switch contact in Auto position
I/O-25	Lag Enable	When M6 input is activated by Lead VFD, the Lag VFD starts
I/O-33	VFD1 or VFD2	Identification VFD-1 or VFD-2 required for Duplex control
I/O-34	Timer/Flt	Alternating by Lead run time
I/O-35	Lead VFD or Lag VFD	Set VFD1 to Lead and VFD2 to Lag at initial start-up
I/O-36	168 hrs	Alternating time set to 7 days (Lead run time)
I/O-76	MMC	AUX-1 relay output set for MMC (Lag Start) output
I/O-77	This Lead	Lead VFD AUX-2 relay output is active.

## 5. PRINCIPLE OF OPERATION

**Basic duplex control.** When power and start signals are applied to both VFDs, the Lead VFD will start and it will activate “This Lead” AUX-2 relay output. Another VFD will receive that signal on “Another Lead” M3 input and it will switch control to Lag mode. The Lag VFD will start when it receives “Lag Enable” signal on M6 input from Lead VFD AUX-1 MMC relay.

The Lag VFD will try to maintain pressure in the system by varying pump speed. If demand exceeds the Lead pump capacity and system pressure is still below a set-point, Lead VFD will provide AUX-1 “MMC” relay output to start Lag VFD. Both VFDs will maintain pressure until demand decreases below one pump capacity. In this case both VFDs will run at minimum speed and Lead VFD will stop Lag VFD by deactivating AUX-1 relay. If there is no demand, Lead VFD will switch to sleep mode.

If Lead VFD trips on fault or loses power, the Lag VFD will lose signal on M3 input and after short time delay it will switch control to Lead mode and it will start.

The VFD will keep Lead or Lag control mode when it is not powered. If at any point both VFDs become Lead or Lag, the VFD set in I/O-33 to VFD-1 will take a priority and it will become Lead VFD and VFD-2 will become Lag VFD.

**Alternation Mode Selections.** Alternation function for basic duplex control can be set in parameter I/O-34 to “Timer/FLT” or “PowerUp/FLT”.

When it is set to “Timer/FLT”, VFDs will alternate when Lead VFD run time exceeds the alternating timer value set in parameter I/O-36. If Lead VFD mode is changed to Lag, its alternating timer will be reset. In order to make alternation function test easier, set parameter MAK-55 to I/O-36 value minus one minute and VFDs will alternate in next two minute.

When it set to “PowerUp/FLT”, VFDs will run in the same Lead-Lag sequence until the system power cycle, which will activate an alternation. If only Lag VFD power is cycled, duplex system will not alternate. If Lead VFD power is cycled, duplex system will alternate on Lead VFD fault.

**Lead switch control option.** Lead switch option will not work with VFD packages with installed HOA switches. Two position Lead switch provides signal to M4 input on VFD-1 or VFD-2 corresponding to switch current position. The VFD that receives signal on M4 input switches to Lead control mode and another VFD to Lag mode. If Lead switch position is changed from VFD-1 to VFD-2, VFD-1 becomes Lag VFD and stops and VFD-2 becomes Lead VFD and starts. If Lead VFD-2 trips on fault or loses power, Lag VFD-1 will become Lead VFD and it will start. When VFD-2 is powered again or fault is reset, VFD2 will become Lead again and it will start after VFD-1 is stopped.

**Alternation pushbutton control option.** Alternation pushbutton can be combined with alternating by Timer or at Power-up modes. This option will not work with VFD packages with installed HOA switches. Momentary pushbutton provides pulse signal to M4 input on both VFDs simultaneously to activate alternation. The alternating timer of Lead VFD will be reset during alternation. The Lag VFD that receives signal on M4 input switches to Lead control mode and starts its alternating timer. If VFD-1 is Lead and it trips on fault, VFD-2 will become Lead and it will start. When VFD-1 fault is rest, it will become Lag VFD.

**HOA switch control option.** HOA switch option will not work with Lead switch and Alternation Pushbutton options. N.C. contact on Auto position of each HOA provides signal to “HOA Hand/Off” M4 input on each VFD when HOA is in Auto position. If Lead VFD HOA position is changed from Auto to Off or Hand, VFD will become Lag and another VFD with HOA in Auto position will be Lead. If both HOAs are in Off position and then VFD-2 HOA is switched to Auto, VFD-2 will become Lead.



The VFD that receives signal on M4 input switches to Lead control mode and another VFD to Lag mode. If Lead switch position is changed from VFD-1 to VFD-2, VFD1 becomes Lag VFD and stops and VFD-2 becomes Lead VFD and starts. If Lead VFD-2 trips on fault or loses power, Lag VFD-1 will become Lead VFD and it will start. When VFD-2 is powered again or fault is reset, VFD-2 will become Lead again and it will start after VFD1 is stopped.

**Alternation at every start.** Alternation at start can be combined with Basic Duplex configuration or HOA

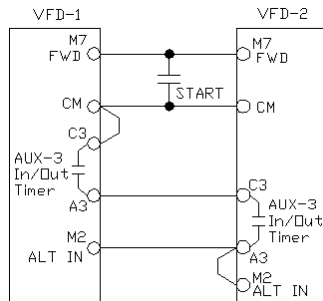


FIG. 5

switch control option. This mode requires common start signal for both VFDs and extra wiring shown on figure #5. When start contact is closed, both VFDs will close their AUX-3 relay outputs for two seconds and alternation mode will be activated during Run Time Delay. Then newly assigned Lead VFD will start.

If run command is present during power-up, VFDs will alternate. If VFD-1 is Lead and it trips on fault, VFD-2 will become Lead and it will start. When VFD-1 fault is rest, it will become Lag VFD.

See below a parameter list for alternation at start setup.

### Duplex Control with Alternation at Start Parameters

Par.#	Value/Selection	Description
I/O-21	ALT Input	Alternation input for momentary pushbutton
I/O-45	M7 (Default)	In-Out Timer Input Selection
I/O-46	ONE Pulse	Timer mode selection
I/O-47	2 sec.	Timer time setting
I/O-48	Normal Open (Default)	In-Out timer input selection N.O. or N.C.
I/O-78	In-Out Timer	AUX-3 relay output

## 6. SYSTEM START-UP

Power-up both VFDs and check the rotation of each pump in Hand or Local mode. If rotation is incorrect, swap any two motor wires coming for the pump. Return control to Remote or Auto mode.

Adjust desired system pressure set-point (PSI) in each VFD parameter DRV-00 or SET-26. Run system at maximum demand. Lead VFD should increase frequency to maximum and then Lag VFD should start. Both VFDs should maintain system pressure set-point. Then close demand and VFDs should decrease frequency to minimum and Lag pump will stop. After Sleep mode time delay VFD will increase pump speed to reach a boost pressure set-point. When system pressure is greater than boost pressure or boost timer is expired, Lead VFD will go to sleep mode. Open lowest demand line and when pressure drops below wake-up level, Lead VFD will start and it should maintain pressure set-point (Lag VFD in stop mode). Close line (no demand) and wait until VFD decreases speed and after pressure boost goes to sleep mode. Open maximum demand and when Lead VFD starts turn its power off. Lag VFD should start as Lead VFD and run at full speed. Turn the power on to another VFD and after approximately 15 seconds it should start and both VFDs will maintain a pressure set-point. Close demand, both VFDs should decrease frequency to minimum, Lag VFD will stop and then Lead VFD will go to sleep mode.

This manual is applicable to all FCS (Cerus) VFDs and Enclosed VFD panels shipped after July 1<sup>st</sup>, 2015.



**Disconnect and lock out all power before installing or servicing equipment.  
This equipment may require locking out multiple power sources prior to service.**

### **Warranty Information**

FCS provides 5-year warranty for all FCS brand electrical components excluding thermal protection devices. All other brand name devices installed in FCS control panels will carry original manufacturer warranties.

<p><b>Warranty period is 60 months after date of invoice. Detailed warranty terms and conditions are available from FCS or can be found at <a href="http://www.cerusind.com">www.cerusind.com</a></b></p>
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- **Warranty service information**
  - If standalone VFDs or enclosed VFD packages do not operate properly because of any defective component under normal and proper use within the warranty term, contact an authorized FCS distributor or FCS technical support.
  
- **Warranty is void if damage to the unit was caused by any of the following:**
  - Misuse, negligence or accident.
  - Abnormal supplied power voltage.
  - Improper repair or altering by other than a FCS authorized distributor or service center.
  - Earthquake, fire, flooding, lightning, or other natural calamities
  - When the warranty period has expired