

# Instruction Bulletin

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## FRONTLINE® DC Reversing, Plugging, Single-Motor Controller Class 6121

### **⚠ DANGER**

#### HAZARDOUS VOLTAGE

Disconnect all power before working on equipment.

**Failure to follow this instruction will result in death or serious injury.**



**Figure 1: Single-Motor Controller**

### INTRODUCTION

This bulletin describes Class 6121 DC reversing, plugging controllers, rated for use on 230 Vdc systems. Use these controllers with DC series wound motors on crane bridge and trolley drives.

### DESCRIPTION

The controller contains the following equipment. Specific installations may require additional equipment.

- One double-pole, unfused main line knife switch with padlock clip (LSW)
- One double-pole, fused control circuit knife switch with padlock clip (CSW)
- One single-pole, negative line contactor (M)
- Four single-pole directional contactors with mechanical interlocks (1F, 2F, 1R, 2R)
- Four or five single-pole acceleration contactors including one for plugging (P, 1A, 2A, 3A, 4A)
- Three or four static acceleration timers (1AR, 2AR, 3AR, 4AR)
- One undervoltage relay (UV)
- One rectifier plugging relay (PR)
- Two magnetic overload relays: one instantaneous (1OL) and one inverse time (2OL)

Although the DC dynamic lowering hoist controller does *not* contain the following equipment, the controller requires this equipment for a complete set of control. Each is separate for mounting:

- One set of Class 6715 TAB-WELD® acceleration resistors
- One Class 9004 master switch
- One Class 5010 series or shunt wound brake with resistor (if required)

### PRECAUTIONS

**⚠ DANGER**

**HAZARDOUS VOLTAGE**

Disconnect power to controller before installing, adjusting, maintaining, or troubleshooting equipment. The metal parts of controller devices may be at line voltage.

**Failure to follow these instructions will result in death or serious injury.**

Follow the precautions below while installing, operating, and servicing equipment.

*NOTE: This bulletin contains servicing information for basic controllers. For controllers that vary from basic models, refer to the applicable controller drawings to determine how to perform troubleshooting and maintenance safely.*

1. Read this bulletin prior to installing or operating the equipment.
2. If you plan to store the reversing plugging controllers prior to installation, protect them from the weather and keep them free from condensation and dust.
3. Make sure that all contactor arc chutes are in place before operating the controller.
4. Permit *only* authorized personnel to operate or service the controllers.

### INSTALLATION

**⚠ DANGER**

**HAZARDOUS VOLTAGE**

- Disconnect the incoming line power to the controller before proceeding.
- Installation, startup, and maintenance should be performed only by a qualified electrician.

**Failure to follow these instructions will result in death or serious injury.**

To install the controller, follow these steps:

1. Unpack the controller carefully; check nameplate data to make sure equipment is correct.
2. Thoroughly inspect all controller equipment to ensure that there are no damaged parts. Remove shipping tape (if used).
3. Bolt the controller to the floor in a vertical position.
4. After verifying equipment is correct and undamaged, mount the master switch, acceleration resistors, and brake with resistor (if required).
5. Make sure that both the main line knife switch (LSW) and control circuit knife switch (CSW) in the controller are open. Wire all external circuits to the controller as shown in the wiring diagram. Figure 2 on page 5 shows the recommended polarity.

### START-UP AND ADJUSTMENTS

**⚠ DANGER**

**HAZARDOUS VOLTAGE**

- Disconnect the incoming line power to the controller before operating the knife switches.
- Never open the line knife switch when control knife switch is closed.
- Never close the line knife switch if the control knife switch is closed.

**Failure to follow these instructions will result in death or serious injury.**

To start or adjust the controller, follow these steps:

1. Make sure that both the main line knife switch (LSW) and control circuit knife switch (CSW) are open.
2. Refer to the wiring diagram shown in Figure 2 on page 5. Ensure that all external circuits and devices, such as the master switch and resistor, are properly wired to the controller.
3. Make sure that all parts of the controller are firmly attached and undamaged. Check to see if any wires or leads are broken, loose, or short-circuited as a result of shipment. Check all terminals for loose connections.
4. Make sure that the inverse time overload relay has oil in the dashpot.
5. Manually operate the contactors and relays. Check each device to make sure movement is free without binding.
6. Operate the master switch and check for easy movement without binding. Return the master switch to the off position.
7. Make sure that the brake has been properly installed and adjusted according to the manufacturer's instructions.
8. With the main LSW open, close the CSW, then energize the incoming line power to the controller and make sure that the undervoltage relay is energized. Prior to shipping, the controller is checked at the factory; however, check the controller again to ensure there are no faulty external connections or shipping damage.
9. Deenergize the line power to the controller, then open the CSW.
10. Move the master switch from the off position to the last speed point forward.
11. With the main LSW open, close the CSW, then energize the line power to the controller and make sure that the coil of the undervoltage relay (UV) is not energized.
12. Move the master switch from the last speed point forward to the off position. Make sure that the UV relay does not energize until the master switch is in the off position.
13. Move the master switch from the off position to the first speed point forward or reverse. Make sure that the closed contactor power tips match those in the

**⚠ CAUTION**

**IMPROPER CONNECTION HAZARD**

Ensure proper incoming line voltage and polarity.

**Failure to follow this instruction can result in injury or equipment damage.**

Contact Sequence Diagram, Table 4 on page 5. Also make sure that the closed contactor power tips match those of the contactor sequence diagram in the other speed points, both forward and reverse. An X in the contactor sequence diagram in Table 4 on page 5 denotes a closed contactor power tip.

14. If the controller sequences properly, deenergize the line power to the controller and then open the CSW.
15. Close the LSW, the CSW, and the enclosure door, then energize the line power to the controller.
16. With no load on the crane, check for proper motor rotation by jogging the master switch. If the motor rotates in the wrong direction, first deenergize the line power to the controller, open the CSW, then open the LSW. Obtain proper motor rotation by interchanging armature connections A1 and A2.
17. With no load on the crane, verify operation in the forward direction for each speed point forward of the master switch. Also move the master switch rapidly from the off point to the last speed point forward. Make sure that acceleration is rapid but not jerky. Ensure that there is no wheel slippage.
18. With no load on the crane, verify operation in the reverse direction for each speed point forward of the master switch. Also move the master switch rapidly from the off point to the last speed point reverse. Make sure that acceleration is rapid but not jerky and that there is no wheel slippage.
19. Deenergize the line power to the controller, open the CSW, then open the LSW.

## OPERATION

Class 6121 DC reversing, plugging controllers have either five or six speed points. Controllers rated up to 110 hp have five speed points; those rated above 110 hp have six. The five-speed point controllers have four accelerating contactors; the six-speed point controllers have five accelerating contactors.

The controller connects the DC series motor as a series motor in both the forward and reverse directions.

### Static Acceleration Timers

Class 7001 Type ST-1 static acceleration timers for acceleration control are standard on the controller. The static acceleration timers, wired in series with the acceleration contactor coils, appear as normally open, timed closed contacts. Voltage applied across terminals 1 (+) to 3 (-) initiates a 0.6 second time delay; voltage applied across terminals 2 (+) to 3 (-) initiates 1.2 second time delay. For a 3 second time delay, clip the jumper on top of the ST-1 timer. Terminal 3 is always connected to power supply negative. After completing the timing cycle, the device appears as a contact closure and allows the contactor coil to be energized.

### Plugging Relay

Moving the master switch rapidly from any speed point of one direction to any speed point of the opposite direction effects a form of retardation referred to as plugging. Plugging occurs when reverse power is applied to a rotating motor. The plugging system used on Class 6121 DC reversing plugging controllers includes a single coil relay with a rectifier in series with the operating coil. The voltage rating of the relay coil is one-half the rated line voltage. The plugging relay coil and rectifier are connected across the motor armature (see Figure 2 on page 5). Moving the master switch rapidly from the fifth speed point forward to the fifth speed point reverse, all contactors de-energize and then contactors M, 1R, and 2R close. Voltage generated at the motor terminals energizes the plugging relay (PR). Rotation of the motor causes this counter electromotive force (CEMF) voltage. The voltage is approximately proportional to the motor speed at the instant of plugging. When energized, the plugging relay prevents energization of the plugging contactor. As the CEMF decreases and the motor speed approaches standstill, the plugging relay de-energizes. This process energizes the plugging contactor and allows normal acceleration of the relay.

## SEQUENCE OF OPERATION

Contactor operation sequence for the standard five-speed point reversing plugging controller is basically the same in both the forward and reverse directions. Table 1 on this page and Table 2 on page 4 show the contactor operation sequence when controller is accelerated or decelerated. Regardless of how the master switch is operated, these operation descriptions apply to the controller.

**Table 1: Controller Acceleration**

Speed Point	Contactor Operation	Purpose
1	M, 1F, and 2F close or M, 1R, and 2R close	Motor connects as series motor; speed slows with all circuit resistance
2	P closes	Amount of series resistance decreases with the motor; motor voltage, torque, and speed increases
3	After 1AR closes, 1A closes	Amount of series resistance decreases with the motor; motor voltage, torque, and speed increases
4	After 2AR closes, 2A closes	Amount of series resistance decreases with the motor; motor voltage, torque, and speed increases
5	After 3AR closes, 3A closes	Amount of series resistance decreases with the motor; motor voltage, torque, and speed increases

*NOTE: Moving the master switch rapidly from the off point to the fifth speed point closes the directionals and M instantly. P closes next without any time delay. Contactors 1A, 2A, and 3A close in timed sequence under control of the acceleration timers 1AR, 2AR, and 3AR.*

**Table 2: Controller Deceleration**

Speed Point	Contactor Operation	Purpose
5th to 4th	3A opens	Decreases voltage applied to motor
4th to 3rd	2A opens	Decreases voltage applied to motor
3rd to 2nd	1A opens	Decreases voltage applied to motor
2nd to 1st	P opens	Decreases voltage applied to motor
1st to off	Directionals and M open	Motor disconnects from line

*NOTE: Moving the master switch rapidly from the fifth speed point to the off point causes each contactor operation to occur simultaneously.*

## RESISTORS

Changing the ohmic values of the resistance steps affects bridge and trolley performance. Consider the effects that a change in these values may cause on the acceleration and plugging operations. Never change the ohm values of any step(s) by more than 10% of the original design values. If operation requires greater ohmic changes than these, consult your local Square D field office.

Table 3 lists bridge and trolley performance characteristics as changing resistor values affect them.

**Table 3: Bridge and Trolley Performance**

Speed Point	Step	Increasing Ohm Value	Decreasing Ohm Value
5 6	R1 - R5 R1 - R6	Decreases first point current, torque, speed; decreases plugging torque, and current	Increases first point current, torque, and speed; increases plugging torque and current; too much decrease in ohm value may cause wheel slippage
5 6	R2 - R5 R2 - R6	Decreases second point current, torque, and speed; increasing the value of any section decreases the current, torque, and speed for any point with that section in the circuit	Increases second point current, torque, and speed; decreases the value of any section; increases the current, torque, and speed for any point with that section in the circuit

**⚠ DANGER**

**HAZARDOUS VOLTAGE**

- Disconnect the incoming line power to the controller before operating the knife switches.
- Never open the line knife switch when the control knife switch is closed.
- Never close the line knife switch when the control knife switch is closed.

**Failure to follow these instructions will result in death or serious injury.**

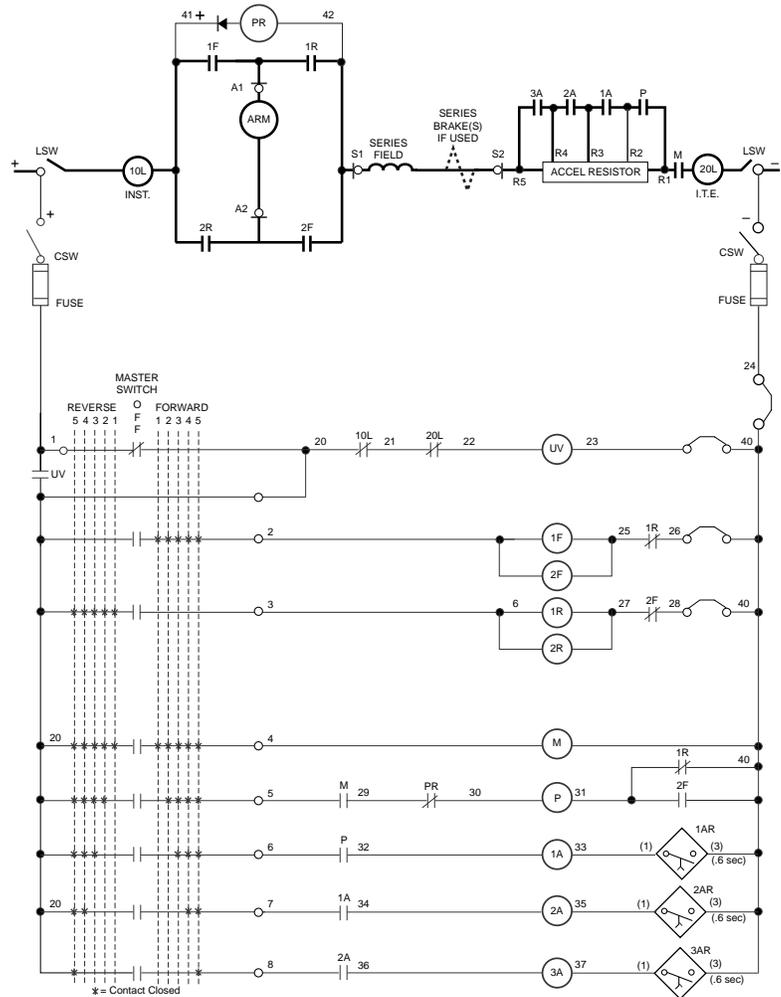


Figure 2: Wiring Diagram

Table 4: Contactor Sequence Diagram (X = Closed Power Tips)

Device	Hoist					Off	Lower				
	5	4	3	2	1		1	2	3	4	5
1F							X	X	X	X	X
2F							X	X	X	X	X
1R	X	X	X	X	X						
2R	X	X	X	X	X						
M	X	X	X	X	X		X	X	X	X	X
P	X	X	X	X				X	X	X	X
1A	X	X	X						X	X	X
2A	X	X								X	X
3A	X										X

NOTE: Contactors 1F and 1R; 1R and 2F; and 2F and 2R are mechanically interlocked.

## TROUBLESHOOTING

The following list provides the most efficient way to locate trouble in a controller:

1. Check with the operator; reported symptoms may not be accurate.
2. If the drive can be operated, observe the problem.
3. Locate the operational problem in Table 5. Follow the troubleshooting instructions in sequence from left to right; perform all steps described in each instruction.

If Table 5 does not list the operational problem, check the equipment as outlined in "Start-Up and Adjustments" on page 2.

**Table 5: Troubleshooting**

Operation Problem	Troubleshooting Instructions				
1: Drive will not move in either direction	A	B	F		
2: Drive will move only in one direction	A	F			
3: Drive travels in wrong direction	A	E	F		
4: Jumpy operation	A	B	C	F	
5: Sluggish operation	A	B	C	F	
6: Overload devices trip	A	B	C	D	F

*NOTE: Follow the "Troubleshooting Steps" on page 6 to locate trouble most efficiently in a controller.*

## Troubleshooting Steps

### A.

1. Check equipment as outlined in "Start-Up and Adjustments" on page 2.
2. If the problem can be isolated to a contactor not operating in a specific speed point or speed points, connect a voltmeter across the contactor coil, close the control circuit knife switch (CSW), and then energize the incoming line power. Check the voltage across the coil of the contactor in that (those) speed point(s).
  - a. If the voltage across the coil is the same as the line voltage, deenergize the incoming line power, open the control circuit knife switch (CSW) and refer to the "Troubleshooting" section in the contactor service bulletin.
  - b. If the voltage across the coil is less than the line voltage, deenergize the incoming line power, and then open the CSW.
    1. Visually check all electrical interlocks and any static acceleration timer in series with the coil for burned or broken parts, connectors, or wires.
    2. Visually inspect any master switch contact in series with the coil and check for proper operation in that (those) speed point(s).
  3. If the visual check does not isolate the problem, place a jumper wire across the terminals of any static acceleration timer in series with the contactor coil. Close the CSW, energize the incoming line power, and check the contactor operation in the various speed points.
    - a. If the contactor operates properly, replace the static acceleration timer.
    - b. If the contactor fails to operate and the voltage across the coil is the same as the line voltage, refer to the "Troubleshooting" section in the contactor service bulletin.
    - c. If the contactor fails to operate and the voltage across the coil is less than the line voltage, look for discontinuity in the circuit by checking the voltage from the coil through each device in the circuit (in sequence). Replace any inoperable wiring, connections, or devices.
  4. Deenergize the incoming line power. Open the CSW and remove the acceleration timer jumper wire.

### B.

1. With the main line knife switch (LSW) and control circuit knife switch (CSW) open, visually inspect the acceleration resistors. Replace any burned or broken connectors, wires, or resistor sections.
2. Using an ohmmeter, check resistor units for continuity and proper ohmic value. If necessary, adjust the resistance values in the circuit by moving the taps on the resistor units. Refer to "Operation" on page 3.

### C.

1. With the control circuit knife switch (CSW) open, disconnect the wire from terminal 3 on each static acceleration timer. Connect meter negative input to timer terminal 3 and meter positive input to timer terminal 1 or 2. Make sure the resistance across each timer is at least 20 K ohms. If the resistance is less, replace the static acceleration timer.
2. Change the timing period of the static acceleration timer by changing the connection. Refer to "Operation" on page 3.

### D.

1. Close the main line knife switch (LSW). Close the control circuit knife switch (CSW). Then energize the incoming line power
2. With the master switch in the last point forward, quickly move the master switch to the last point reverse. Make sure the plugging relay (PR) is energized and that it remains energized until the drive approaches zero speed. Check the energization by placing a voltmeter across the coil of the plugging relay and making sure the relay deenergizes at near zero volts.

*NOTE: The plugging relay (PR) is polarity sensitive . Therefore, connect the (+) lead as shown in Figure 2 on page 5.*

3. Deenergize the incoming line power. Open the CSW, then open the LSW.

**E.**

1. Check the equipment as outlined in Steps 15-16 of "Start-up and Adjustment" on page 2 of this bulletin.
2. Deenergize the incoming line power. Open the control circuit knife switch (CSW). Then open the main line knife switch (LSW).

**F.**

If steps **A - E** do not isolate the problem, the trouble is not in the controller. Check the integrity of all external circuits, connectors, wiring, and devices.