Class 6121 Frontline® DC Hoist Single Motor Controller

⚠ DANGER

HAZARDOUS VOLTAGE

Disconnect all power before working on equipment.

Electrical shock will result in death or serious injury.

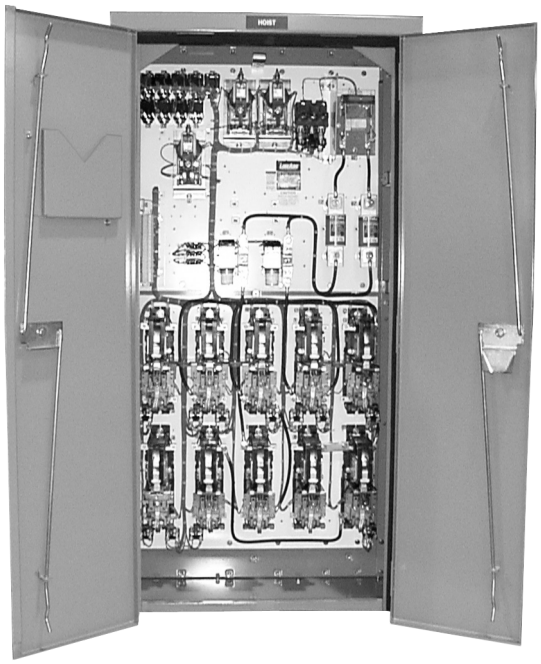

Figure 1: DC Hoist Single Motor Controller

INTRODUCTION

This bulletin describes Class 6121 DC dynamic lowering hoist controllers rated for use on 230 Vdc systems. Use these controllers with DC series wound motors on crane hoist drives without mechanical load brakes.

DESCRIPTION

The DC dynamic lowering hoist 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 for hoisting and lowering circuits (H, 1L, 2L, 3L)
- One single-pole spring-closed dynamic lowering contactor (DB)
- Four or five single-pole acceleration contactors (1A, 2A, 3A, 4A, 5A)
- Three or four static acceleration timers (1AR, 2AR, 3AR, 4AR)
- One undervoltage relay (UV)
- One voltage relay for acceleration lowering (VR)
- One limit switch relay (LSR)
- 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 wound brake
- One Class 6170 YOUNGSTOWN® power limit switch and resistor or a control circuit limit switch

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.

Electrical shock will result in death or serious injury.

Follow these precautions 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 proceed safely when performing troubleshooting and maintenance.

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

INSTALLATION

⚠ DANGER

HAZARDOUS VOLTAGE

Deenergize incoming line power to the controller before proceeding.

Electrical shock 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. Inspect all controller equipment. Make sure no parts are damaged. 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 master switch, acceleration resistors, and brake with resistor (if required).
5. Make sure that the main line knife switch (LSW) and control circuit knife switch (CSW) in the controller are open. Wire all external circuits to the controller in accordance with the wiring diagram. Observe the polarity shown in Figure 2 on page 6.

START-UP AND ADJUSTMENTS

⚠ DANGER

HAZARDOUS VOLTAGE

- Never open line knife switch when control knife switch is closed.
- Never close line knife switch if control knife switch is closed.

Electrical shock 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, Figure 2 on page 6. Make sure 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 in accordance with the manufacturer's instructions.
8. Manually operate the power or control limit switch. Check for free movement without binding.
9. Energize incoming line power to the controller.
10. With the main LSW open, close the CSW and make sure that the undervoltage relay is energized. Prior to shipping, the controller is checked at the factory. Check the controller again, however, to make sure there is no faulty external connection or shipping damage.
11. Open the CSW.
12. Move the master switch from the off position to the last speed-point hoist.
13. With the main LSW open, close the CSW and make sure that the coil of the undervoltage relay (UV) is not energized.
14. Move the master switch from the last speed point hoist to the off position. Make sure that the UV does not energize until the master switch is in the off position.
15. Move the master switch from the off position to the first speed point hoist. Make sure that the closed contactor power tips match those of the contactor sequence table in Figure 2 on page 6. Also make sure that the closed contactor power tips match those of the contactor sequence table in the other speed points both forward and reverse. An X in the contactor sequence table in Figure 2 denotes a closed contactor power tip.
16. If the controller sequences properly, open the control circuit knife switch (CSW).
17. Block the armature of the voltage relay (VR) in the energized position.
18. With the main LSW open, close the CSW.
19. Make sure that the closed contactor power tips match those of the contactor sequence diagram when the master switch is in the last point lower.
20. If the controller sequences properly, open the CSW.

⚠ CAUTION

IMPROPER CONNECTION HAZARD

Ensure proper incoming line voltage and polarity.

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

21. Unblock the armature of the voltage relay (VR). Then block the armature of the limit switch relay (LSR) in the energized position.
22. With the LSW open, close the CSW.
23. With the master switch in the off position, make sure the UV coil is not energized. Also make sure that no relays or contactors operate when the master switch moves from the off position to another position.
24. If the controller sequences properly, open the CSW.
25. Unblock the armature of the LSR.
26. Close the main LSW; then close the CSW.
27. With no load on the hook, jog the master switch to check for proper motor rotation. If the motor rotates in the wrong direction, open the CSW first; then open the main LSW. Obtain proper motor rotation by interchanging armature connections A1 and A2 at the motor. Improper motor operation will result if connections are interchanged at the controller.
28. With no load on the hook, check the operation of the hoist drive with the master switch in each speed point hoist. Move the master switch rapidly from the off point to the last speed point hoist and make sure the acceleration is rapid without being jerky.
29. Refer to the limit switch service bulletin and make sure the switch operates properly. Make only motions at slow speed into the limit switch. Make sure the LSR operates properly when it is lowered out of the tripped limit switch. Refer to “Youngstown Power Limit Switch” on this page.
30. With no load on the hook, make sure the hoist drive operates properly in the lowering direction: Check for proper operation with the master switch in each speed point.
31. Open the CSW; then open the main LSW.

OPERATION

Class 6121 DC dynamic lowering hoist controllers for crane hoist service are supplied with either five or six speed points. Controllers rated up to 110 hp have five speed points; those with greater than 110 hp have six. The five-speed point controllers have four accelerating contactors; the six speed point controllers have five accelerating contactors.

The Class 6121 DC dynamic lowering hoist controller connects the DC series motor as a series motor in the hoisting direction and as a shunt motor in the lowering direction. Use this controller on crane hoist drives without mechanical load brakes.

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 a 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.

Voltage Relay

The voltage relay (VR) connects across the motor armature and prevents excessive current through the armature when the master switch is moved to the last point lower. This relay does not energize until the motor has accelerated sufficiently for the counter-emf voltage to be near 110 V on a 230 V controller. This level corresponds to around 70% of full load speed. If the motor has not accelerated to this speed when the master switch is moved to the last point lower, the voltage relay prevents the closing of 3L and the opening of 2L until the motor reaches 70% of full load speed.

Youngstown ® Power Limit Switch

Tripping the power limit switch (LS) removes power from the motor, causes the brake to set, and connects the motor in a dynamic braking circuit with the limit switch resistor (LS RES). The hoist will be brought to a stop through the combined effect of the series brake and the limit switch dynamic braking loop. If the operator moves the master switch to any lowering speed point at the instant of limit switch tripping, the motor will be plugged to lower as a series motor and the series brake will not set. If the hoist block travels into the limit switch at a significant speed, the plugging torque may not be sufficient to prevent the hook block from coasting into the hoist drum. To minimize the possibility of overhoisting, a limit switch relay (LSR) is included on the Class 6121 DC dynamic lowering hoist controller.

The limit switch relay is a voltage relay that is connected across the limit switch resistor. If the voltage drop across the limit switch resistor is 55 V or greater (on a 230 Vdc system), the limit switch relay will operate to de-energize the undervoltage relay (UV), removing power from the motor and allowing the series brake to set. If the hoist does not enter the limit switch at sufficient speed to energize the limit switch relay, the overhoisting possibility will be minimal. At reduced speed, the plugging torque should be sufficient to stop the hoist within a safe distance.

After the limit switch trips, the load cannot be moved further in the hoisting direction.

(This section continues on page 4.)

The motor is connected as a series motor and is driven down by applying lowering torque. No retarding torque is available until the limit switch resets. If the series motor goes to overspeed before the limit switch resets, or if the limit switch fails to reset, the limit switch relay will operate to de-energize the control and set the brake. To lower further, reset the control circuit by returning the master switch to the off position. The limit switch relay will continue to prevent overspeed until the limit switch resets and the dynamic lowering circuit is reestablished. The limit switch normally resets after a short movement of the load in the lowering direction; the motor will automatically reconnect as a shunt motor.

SEQUENCE OF OPERATION

Tables 1 and 2 show the contactor operation sequence in the hoisting and lowering direction. These tables describe the master switch moving slowly through the indicated speed points. For more information on the sequence of operation, refer to the following:

- Figure 2 on page 6 shows the standard elementary wiring diagram .
- Table 7 on page 7 shows standard contactor sequences for five-speed point hoists.

Table 1: Hoist Acceleration [a]

Speed Point	Contactor Operation	Purpose
1	M and H close; DB opens	Motor connects as series motor in series with resistor section R1 - R5; takes up slack cable and hoists light loads
2	1A closes	Reduces amount of resistance in series with the motor; increases motor voltage and torque
3	After 1AR closes, 2A closes	Reduces amount of resistance in series with the motor; increases motor voltage, torque, and speed
4	After 2AR closes, 3A closes	Reduces amount of resistance in series with the motor; increases motor voltage, torque, and speed
5	After 3AR closes, 4A closes	Reduces amount of resistance in series with the motor; increases motor voltage, torque, and speed

[a] Moving master switch rapidly from the off point to the fifth speed point hoist closes H and M instantly. Without time delay, 1A closes next. The DB contactor opens; then contactors 2A, 3A, and 4A close in timed sequence under control of acceleration timers 1AR, 2AR, and 3AR, respectively.

Table 2: Hoist Deceleration [a]

Speed Point	Contactor Operation	Purpose
5th to 4th	4A opens	Decreases voltage applied to motor
4th to 3rd	3A opens	Decreases voltage applied to motor
3rd to 2nd	2A opens	Decreases voltage applied to motor
2nd to 1st	1A opens	Decreases voltage applied to motor
1st to off	H and M open; DB closes	Disconnects motor from line; sets service brake

[a] Moving master switch rapidly from the fifth speed point hoist to the off point causes each contactor operation to occur simultaneously.

Table 3: Lower Acceleration [a]

Speed Point	Contactor Operation	Purpose
1	M, 1L, 3A, and 4A close; DB remains closed	Provides line current for brake release; connects motor as shunt motor with limited driving down torque; provides dynamic braking if load is overhauling
2	After 1AR closes and before DB opens, 2L closes; after DB opens, 2A closes	Reduces but maintains dynamic braking; increases voltage to armature; increases lowering speed for all loads
3	3A and 4A open	Weakens field and reduces dynamic braking; increases lowering speed for all loads
4	2A opens	Weakens field and reduces dynamic braking; increases lowering speed for all loads
5	If motor CEMF (counter electromotive force) is 50% or more of applied voltage, voltage relay (VR) energizes; then 3L closes; after 3L closes, 2L opens	Voltage relay (VR) prevents excessive current through armature; weakens field further and reduces dynamic braking; increases voltage to armature; reaches maximum speed for all loads

[a] Moving the master switch rapidly from the off point to the fifth speed point lower closes M, 1L, and 4A instantly. Depending on the speed of master switch movement, 3A may also close and reopen. After static timer 1AR closes, 2L closes. A time delay allows series brake release. DB opens first; then 4A opens. Attaining sufficient speed from the motor energizes VR and permits closure of 3L. After 3L closes, 2L opens.

Table 4: Lower Deceleration [a]

Speed Point	Contactor Operation	Purpose
5th to 4th	Voltage relay (VR) de- energizes; 2L closes; then 3L opens; DB remains open	Maintains and strengthens dynamic braking
4th to 3rd	2A closes	Strengthens field; increases dynamic braking
3rd to 2nd	3A closes; then 4A closes	Strengthens field; increases dynamic braking
2nd to 1st	2L opens; DB closes; 2A opens	Maintains and increases dynamic braking
1st to off	M, 1L, 3A, and 4A open; DB remains closed	Maintains dynamic braking and brake sets

[a] Moving the master switch rapidly from the fifth speed point lower to the off point de-energizes VR, opens 3L, may close and reopen 3A and 4A, closes DB, and opens 1L and M in rapid sequence.

RESISTORS

Changing the ohmic values of the resistance steps affects hoist performance. Consider the effects that a change in these values may cause on the hoist and lower operations. Never change the ohmic 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.

Tables 5 and 6 list hoist performance characteristics as changing resistor values affect them.

Table 5: Hoisting

Speed Point	Step	Increasing Ohm Value	Decreasing Ohm Value
5 6	R1 - R5 R1 - R6	Reduces first point current, torque, speed; reduces size of load that can be hoisted on first point; if increased too much, brake releases too slowly	Increases first point current, torque, and speed; increases size of load that can be hoisted on first point
5 6	R2 - R5 R2 - R6	Reduces second point current, torque, and speed; reduces size of load that can be hoisted on second point; increasing the value of any section reduces the current, torque, and speed for any point with that section in the circuit	Increases second point current, torque, and speed; increases size of load that can be hoisted on second point; decreasing the value of any section increases the current, torque, and speed for any point having that section in the circuit
5 or 6	L.S. Res.	Reduces dynamic braking torque and current when limit switch is tripped	Increases dynamic braking torque and current when limit switch is tripped

Table 6: Lowering

Speed Point	Step	Increasing Ohm Value	Decreasing Ohm Value
5 or 6	R1 - R2	Reduces first point speed and inrush current	Increases first point speed and inrush current
5 or 6	R1 - R11	Reduces speed of all points but last; increases speed of last point	Increases speed of all points but last; decreases speed of last point
5 6	R11 - R5 R11 - R6	Increasing any of these sections increases the speed for all points that have the increased section effective in the field branch	Decreasing any of these sections decreases the speed for all points that have the decreased section effective in the field branch
5 or 6	R7 - R8	Decreases speed and line current of non-overhauling loads on last point; increases speed of overhauling loads on last point	Increases speed and line current of non-overhauling loads on last point; decreases speed of overhauling loads on last point
5 or 6	R7 - R9	Decreases speeds of non-overhauling loads and increases speeds of overhauling loads on the intermediate points; moving R9 toward R10 increases current interrupted by DB contactor upon transfer from first to second point	Increases speeds of non-overhauling loads and decreases speeds of overhauling loads on the intermediate points; moving R9 toward R8 decreases current interrupted by DB contactor upon transfer from first to second point
5 or 6	R7 - R10	Reduces torque and speed of non-overhauling loads and increases speed of overhauling loads on first point; moving master switch from lower to off reduces dynamic braking torque and current	Increases torque and speed of non-overhauling loads and decreases speed of overhauling loads on first point; moving master switch from lower to off increases dynamic braking torque and current
5 or 6	Moving R11	Toward R1: Increases speeds and starting torques of intermediate points; increases current interrupted by DB contactor upon transfer from first to second point	Toward R2: Reduces speed and starting torques of intermediate points; decreases current interrupted by DB contactor upon transfer from first to second point

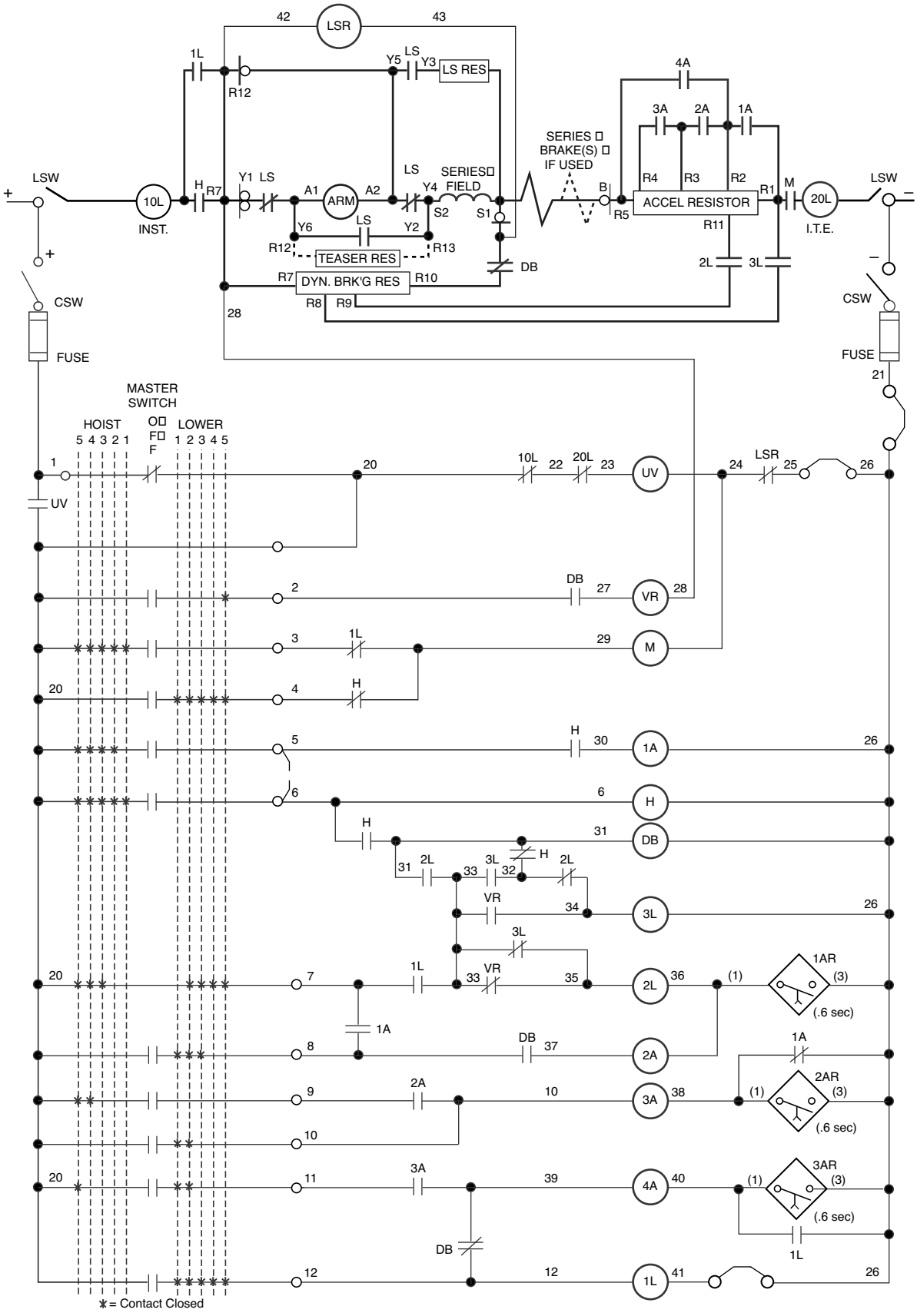

Figure 2: Wiring Diagram for Five Speed Point DC Dynamic Lowering Controller

Table 7: Contactor Sequence (X = Closed Power Tips) [a]

Device	Hoist					Off	Lower				
	5	4	3	2	1		1	2	3	4	5
M	X	X	X	X	X		X	X	X	X	X
H	X	X	X	X	X						
DB						X	X				
1L							X	X	X	X	X
2L								X	X	X	
3L											X
1A	X	X	X	X							
2A	X	X	X					X	X		
3A	X	X					X	X			
4A	X						X	X			

[a] Contactors 1R and 1L, 3L and H, H and 2L are mechanically interlocked.

TROUBLESHOOTING

⚠ DANGER

HAZARDOUS VOLTAGE

- Never open line knife switch when control knife switch is closed.
- Never close line knife switch if control knife switch is closed.

Electrical shock will result in death or serious injury.

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 drive can be operated, observe the problem.
3. Locate the operational problem in Table 8. Follow the troubleshooting instructions in sequence from left to right; perform all steps described in each instruction.

If Table 8 does not list the operational problem, check the equipment as outlined in “Start-Up and Adjustments” on page 2.

Table 8: Troubleshooting

Operation Problem	Troubleshooting Instructions				
1: Drive will not move in either direction	A	B	G		
2: Drive travels in wrong direction	A	B	E	G	
3: Jumpy operation	A	B	C	D	G
4: Sluggish Operation	A	B	C	D	G
5: Overloads tripping	A	B	C	D	G
6: Brake setting during operation	B	F	G		

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 and close the control circuit knife switch (CSW). 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, 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, 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 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. Open the CSW and remove the acceleration timer jumper wire.

(Instructions continue on page 8)

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.
3. 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. Open the control circuit knife switch (CSW). Check equipment as outlined in Steps 17 - 19 of “Start-Up and Adjustment” on page 2 of this bulletin.
   a. If the controller sequences properly, open the CSW and unblock the armature of the voltage relay (VR).
   b. If the contactor does not sequence properly, open the CSW and unblock the armature of the VR. Refer to **A**2 of this “Troubleshooting” section.
2. Close the main line knife switch (LSW); then close the CSW.
3. With the master switch in the last point lower, make sure the VR does not energize until the hook has accelerated to approximately 70% of full-load hoisting speed: Place a voltmeter across the coil of the voltage relay and see if the relay pickup voltage is approximately 110 Vdc.
4. Open the CSW; then open the main LSW.

E

1. Check the equipment as outlined in Steps 26 - 27 of “Start-up and Adjustment” on page 2 of this bulletin.
2. Open the control circuit knife switch (CSW); then open the main line knife switch (LSW).

F

Make sure that motor is loaded to at least 10% of its full-load current value.

G

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

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