MOTION LABORATORIES
ELECTRIC CHAIN HOIST CONTROL SYSTEMS MANUAL

Motion Laboratories is committed to Electrical Safety. As a manufacturer of Portable Power Distribution and Electric Chain Hoist Control products, Motion Laboratories is committed to safety and compliance to all National, State, Province and Local Codes. Our products are designed and manufactured to the highest standards for compliance and quality. Motion Laboratories uses ETL SEMKO, an OSHA recognized NRTL for its 3rd party listing and testing certification.

Low Voltage or Direct Control

There are two basic types of electric chain hoists commonly used in the entertainment industry today, low voltage control and direct control. Although the lifting capacities and electrical requirements are the same for both, the type of control system used to operate differs greatly. For this document we will focus on 3 phase hoists. In either low voltage control or direct control, the direction of the chain travel is determined by the phase rotation of the power supplied to the hoist.

Low voltage control hoists employ a phase reversing contactor built into the hoist itself. The coils of the contactor are controlled by contact closure provided by a switch of a pendant, or relays of a control system. The coils are additionally supervised by a set of limit switches that stop the hoist at a pre-determined point, preventing the chain from travelling thru the hoist. These are referred to as Upper and Lower limits which are adjustable, in some cases, by a trained technician. One important note to understand is that an improper phase rotation would result in the limit being bypassed. This would be evident by the hoist moving up while the control was indicating down or vice versa. It is therefore essential that in low voltage control, whenever a command is given to go up, the hoist moves in that direction, if not the user should stop and correct this condition. One advantage of low voltage control is the ability to use a “pickle” to control a single hoist.

Direct control hoists require that the control system reverses the phase rotation and thus direction. There are no reversing contactors in the hoist and more importantly, there are no limit switches. Direct control hoists use a mechanical chain stop system that is comprised of mechanical blocks fitted at the ends of the chain to prevent the chain from travelling thru the hoist. When the block comes in contact with the hoist body, the overload protection device activates and chain travel stops. One advantage of Direct Control is the total absence of power at the hoist unless it is operating.

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Regardless of the type of hoist being controlled, Motion Laboratories has a variety of form factors to provide control solutions.

Standard ATA Style Road Cases 1200 Series
Whether single-sided or double-sided construction, the ATA style road cases are an industry standard that provides durable protection and flexibility in product designs. The size of the case is dependent on the size of the controller (how many channels of hoist operation) plus any additional options that may be requested or required. The units are designed around our modular panel assemblies that are bolted together to form a complete dead front. In the case of the single sided system the controller is then mounted into its road case with a single-sided steel liner that provides full isolation and protection from any metal parts or the road case to any live parts inside the controller. Additionally with the double sided enclosures, a set of isolation rails provide the steel liner with a shock mount feature further increasing unit protection.

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19” Rack Mounted Equipment 1260 Series
A variety of control systems are available in 19” rack mounted chassis assemblies that are self contained and range in size from 3RU to 7RU depending on requirements. Rack mounted units allow the user to add 4 or 8 channel systems together in a rack and make the overall system larger or smaller as required. They can be mounted into any standard 19” rack case.

Stand Alone Units 1250 Series
Based on economics or size requirements, smaller standalone units are available in 4 to 6 channel sizes. These are generally self contained and are not expandable.

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Truss Mounted Controllers (Series TBD)
Truss mounted controllers are designed specifically for the application with flexibility and ease of deployment a priority.

Install Systems 1225 Series
A full range of install style systems are available and discussed in a separate document. These are generally custom designed around standard building blocks and incorporate options such as position and weight monitoring.

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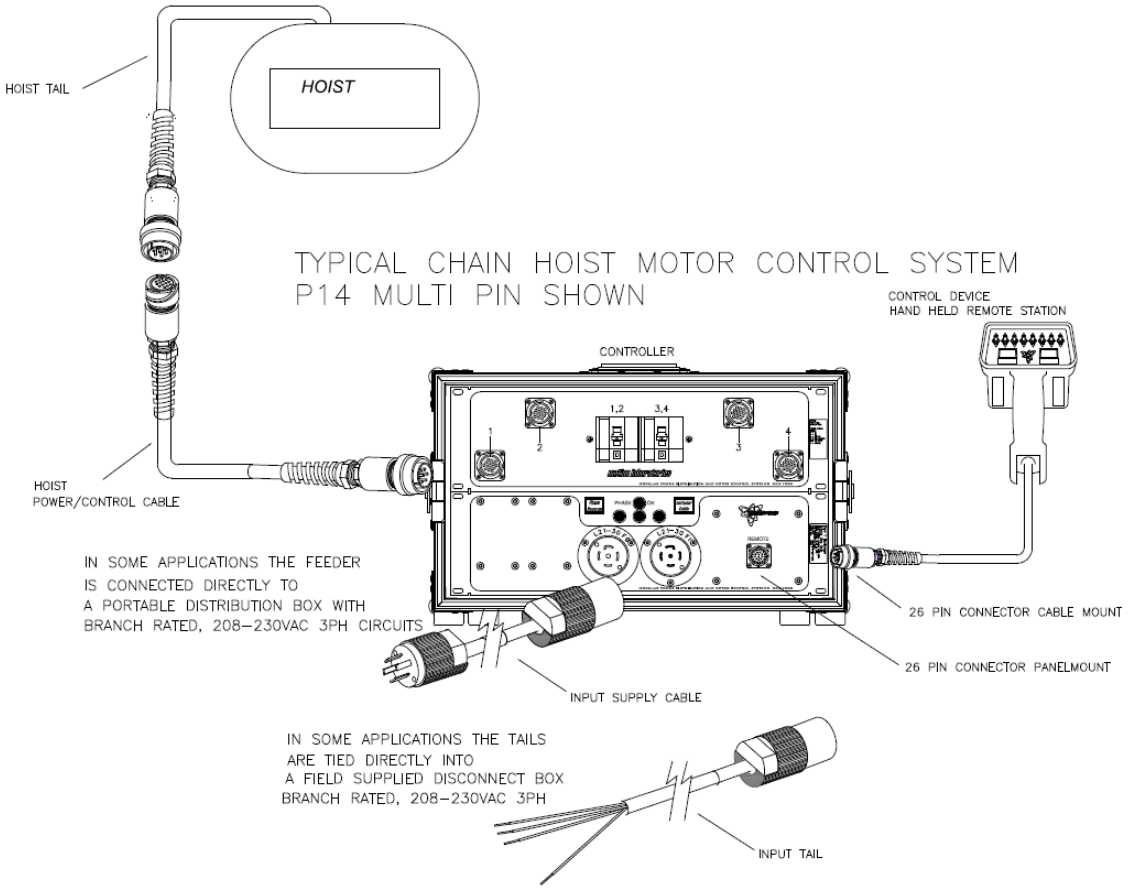
Typical Chain Hoist Control System Components



A typical system consists of the following components:

- Hoist Tail, An electric cable(s) that exit the hoist that allow for the connection of the hoist power/control cable.
- Hoist Power/Control Cable, The cable or cables that connect the hoist tail to the controller providing power or control or both power and control.
- Controller, a unit designed to allow for the operation of one or more hoists at a time, that (1) activates the power or control circuit of the hoist or both; and (2) allows for the removal of power from the hoist. It may be operated by a control device built-in or attached via an external connector.
- Control Device, The part of the system that is responsible for activation of a movement. It can be referred to as a human machine interface or man machine interface. It may control a single hoist (see pickle) or multiple hoists (see pendant and remote station).
- Input Power Supply Cable, Cables that feed power to the controller.

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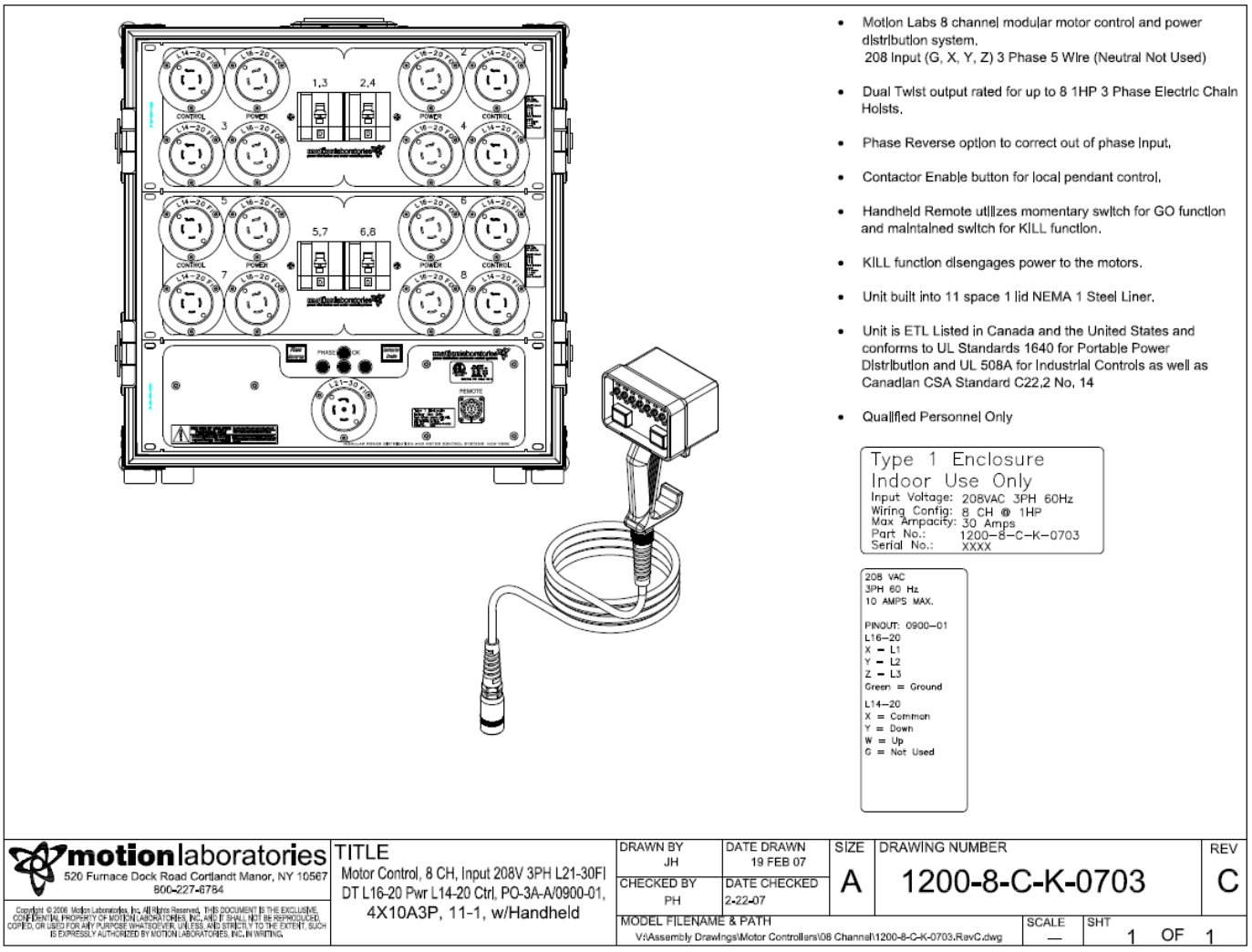
Controllers may be built with a variety of output connectors that provide the hoist with power, in the case of a direct control unit, or power and control, in the case of a low voltage control unit.

DUAL TWIST



motionlaboratories 520 Furnace Dock Road Cortlandt Manor, NY 10567 800-227-8784	TITLE: Motor Control, 8 CH, Input 208V 3PH L21-30FI DT L16-20 Pwr L14-20 Ctrl, PO-3A-A/0900-01, 4X10A3P, 11-1, w/Handheld	DRAWN BY: JH; DATE DRAWN: 19 FEB 07	SIZE: A	DRAWING NUMBER: 1200-8-C-K-0703	REV: C
		CHECKED BY: PH; DATE CHECKED: 2-22-07			
		MODEL FILENAME & PATH: V:\Assembly Drawings\Motor Controllers\08 Channel\1200-8-C-K-0703.RevC.dwg	SCALE: —	SHT: 1 OF 1	

Typical Dual Twist Controller, the hoist power/control cable utilizes two connectors, one for power and one for control. The cables may be either a single cable with the ends split, or two separate cables. In the instance where two separate cables are used they should be bundled.

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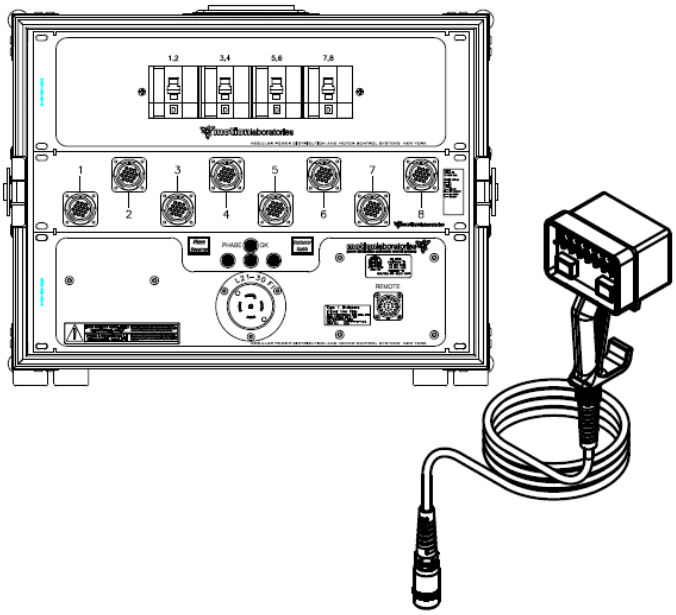
14 PIN



- Motion Labs 8 channel modular motor control and power distribution system.
  208 Input (G, X, Y, Z) 3 Phase 5 Wire (Neutral Not Used)
- P-14 output rated for up to 8 1HP 3 Phase Electric Chain Hoists,
- Phase Reverse option to correct out of phase input,
- Contactor Enable button for local pendant control,
- Handheld Remote utilizes momentary switch for GO function and maintained switch for KILL function.
- KILL function disengages power to the motors.
- Unit built into 8 space 1 lid NEMA 1 Steel Liner.
- Qualified Personnel Only

Type 1 Enclosure
Indoor Use Only
Input Voltage: 208VAC 3PH 60Hz
Wiring Config: 8 CH @ 1HP
Max Ampacity: 30 Amps
Part No.: 1200-8-C-K-1414
Serial No.: XXXX

208VAC
3PH 60 Hz
10 AMPS MAX.

PINOUT: P14-01
A = L1
B = L2
C = L3
D = MTR UP
E = MTR COMMON
F = MTR DOWN
N = GROUND

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		CHECKED BY: PH	DATE CHECKED: 2-22-07		
		MODEL FILENAME & PATH: V:\Assembly Drawings\Motor Controllers\08 Channel\1200-8-C-K-1414.RevC.dwg		SCALE: -	SHT: 1 OF 1

Typical 14 Pin Controller, the hoist power/control cable utilizes a ¼ turn bayonet style mil spec connector.

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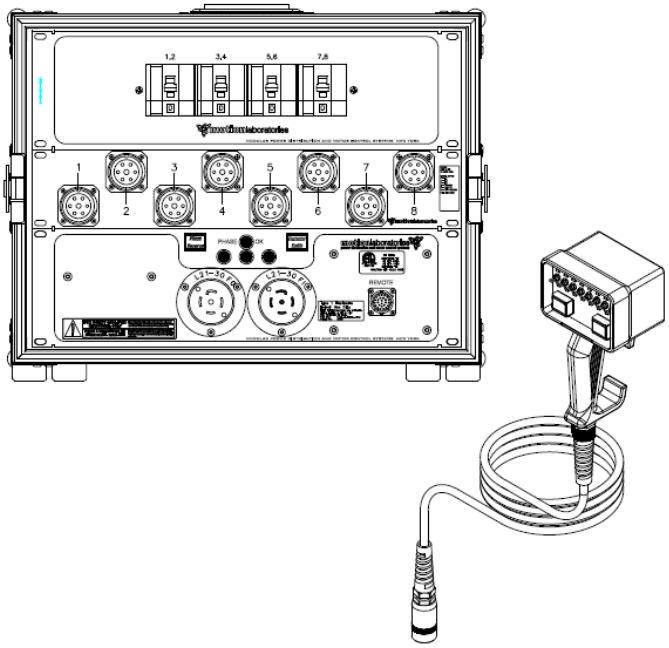
7PIN



- Motion Labs 8 channel modular motor control and power distribution system.
  120/208 Input (G,N, X, Y, Z) 3 Phase 5 Wire (For Pass Thru)
- Ceep 7 output rated for up to 8 1 HP 3 Phase Electric Chain Hoists.
- Phase Reverse option to correct out of phase input.
- Contactor Enable button for local pendant control.
- Handheld Remote utilizes momentary switch for GO function and maintained switch for KILL function.
- KILL function disengages power to the motors.
- Unit built into 8 space 1 lid NEMA 1 Steel Liner.
- Unit is ETL Listed in Canada and the United States and conforms to UL Standards 1640 for Portable Power Distribution and UL 508A for Industrial Controls as well as Canadian CSA Standard C22.2 No. 14
- Qualified Personnel Only

Type 1 Enclosure
Indoor Use Only
Input Voltage: 208VAC 3PH 60Hz
Wiring Config: 8 CH @ 1HP
Max Ampacity: 30 Amps
Part No.: 1200-8-F-KK-1313
Serial No.: XXXX

208VAC
3PH 60 Hz
10 AMPS MAX.

PINOUT: C7-30
1 = L1
2 = L2
3 = L3
4 = GROUND
5 = MTR UP
6 = MTR COMMON
7 = MTR DOWN

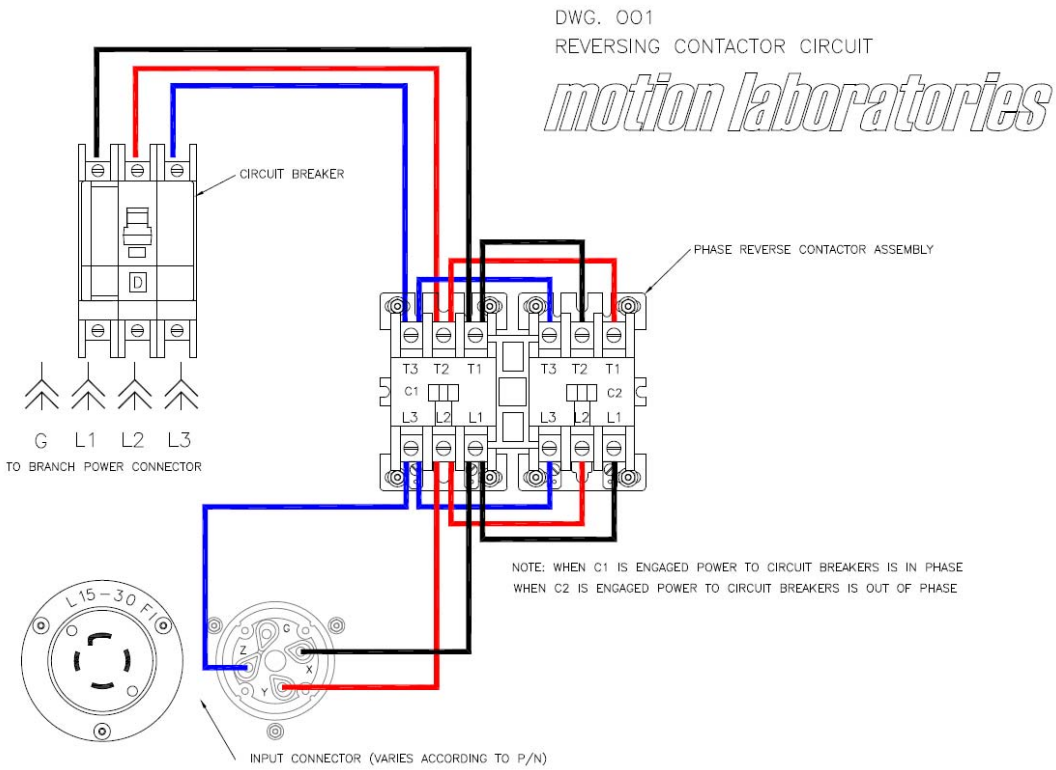
motionlaboratories 520 Furnace Dock Road Cortlandt Manor, NY 10567 800-227-6784	TITLE: *Motor Control, 8 CH, Input 208V 3PH L21-30FI/FO, C7, PO-5A-3/C7-30, 4X10A3P, 8-1, w/Handheld*	DRAWN BY PH / DATE DRAWN 2-21-07	SIZE A	DRAWING NUMBER 1200-8-F-KK-1313	REV -
		CHECKED BY PH / DATE CHECKED 2-22-07			
		MODEL FILENAME & PATH V:\Assembly Drawings\Motor Controllers\08 Channel\1200-8-F-KK-1313.dwg	SCALE -	SHT 1 OF 1	

Typical 7 Pin Controller, the hoist power/control cable utilizes a circular series connector.

All Motion Laboratories controllers share some common circuitry although these circuits may differ slightly from unit to unit; the basic concepts are the same throughout the product line.

Main Power Circuit

Each controller incorporates a main power circuit that begins at the input connector, runs thru a main phase reverse contactor assembly and then distributes thru branch rated circuit protection to each individual hoist.



The input connector is determined by a number of reasons including the size of the unit, customer preference and geographical location, and the power requirements of the system. In some applications a pass thru connector may be provided for convenience. When pass thru connectors are used, the pass-thru connector and all upstream components are subject to the total current load of all down stream components. Therefore, the system shall be designed so that the maximum capacity of the upstream cable or components are not exceeded. In applications where multiple controllers are to be run simultaneously, the pass thru connector ratings must be capable of handling the entire current load of the sum of all of the controllers or a separate feeder must be run to each controller.

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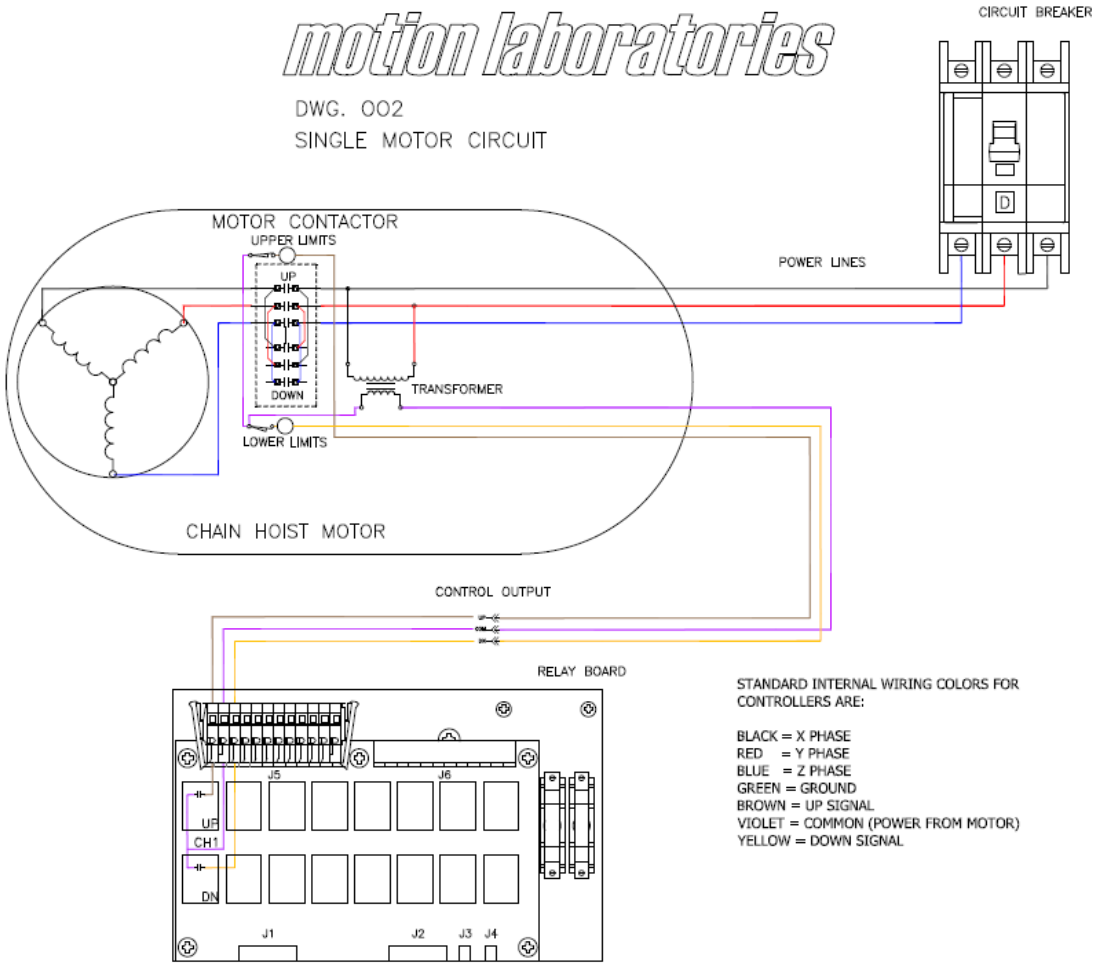
The phase reversing contactors serve a dual purpose; they are used to shut down the power to the hoists when the system is not attended, and they are used to change the phase rotation to the hoists in the event that the building or venue power is not phased in harmony with your system.
The branch circuit protection is a requirement of the standards by which our controllers are built. For systems operating hoists under 2 horsepower, one breaker may serve 2 hoists. For systems 2 horsepower and up, a separate breaker is required for each hoist.

Hoist Control Circuit
Control Circuit, Low Voltage Control Hoists
In Low Voltage Control Hoist applications, the reversing contactors are in the hoist are operated by a relay card in the controller. The relay card is part of a 12VDC control circuit. The important item to understand here is that the power for each individual hoist's control circuit comes from a transformer mounted in the hoist, is sent to the controller relay card and then depending on the operators selection, returns to the hoist to engage either the up or down contactor.



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The voltage for the hoist control circuit is dependent on the voltage of the hoist transformer and the designed control voltage, it may be 48VAC or 110VAC. The relay card in the controller is rated to handle either control voltage.

Control Circuit, Direct Control Hoists

In Direct Control Hoist applications, there is no hoist control circuit. 3 Phase power simply exits the controller and operates the hoist. All control functions are provided within the controller.

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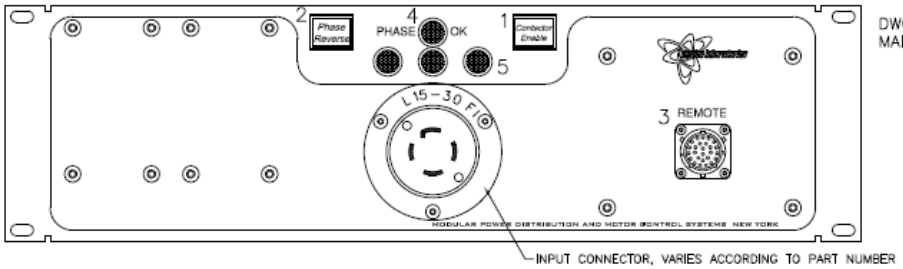
Main 40 Control Section

On ATA style modular construction controllers (1200 Series), the Main 40 is the input and control section panel. The main external components are indicated below:



DWG. 003
MAIN 40 FRONT VIEW

1 Contactor Enable — THE CONTACTOR ENABLE SWITCH LAMP IS LIT WHENEVER THE CONTACTOR IS ENGAGED. WHEN THE SWITCH IS PUSHED IN IT WILL ENGAGE THE MAIN CONTACTOR SENDING POWER TO THE BREAKERS.AT THE SAME TIME THIS SWITCH ALSO INTERRUPTS 12VDC+ CONTROL VOLTAGE AT THE 26PIN REMOTE CONNECTOR KILLING POWER TO THE REMOTE STATION. THIS IS TYPICALLY USED TO PICKLE MOTORS DURING SETUP.

2 Phase Reverse — THE PHASE REVERSE SWITCH LAMP IS LIT WHENEVER THE 12VDC POWER SUPPLY HAS POWER. THIS SWITCH WILL DETERMINE WETHER THE IN PHASE OR OUT PHASE CONTACTOR ENGAGES WHEN THE REMOTE STATION IS CONNECTED OR THE CONTACTOR ENABLE SWITCH IS PUSHED IN

3 REMOTE — THIS 26 PIN 1/4 TURN BAYONETT STYLE CONNECTOR IS USED TO CONNECT THE HAND HELD REMOTE STATION TO THE CONTROLLER. WHEN THE REMOTE STATION IS CONNECTED IT WILL RECIEVE POWER, LIGHT UP, AND ENEGERIZE THE MAIN CONTACTOR ASSEMBLY,PROVIDED THE CONTACTOR ENABLE SWITCH IS DISENGAGED.

PHASE 4 OK — THIS LAMP WILL LIGHT, AND THUS INDICATE, WHEN THE CORRECT PHASE ROTATION OF POWER IS AVAILABLE TO THE POWER OUTPUT CONNECTORS AS DETERMINED BY CUSTOMER SPECIFICATIONS.

5 — NEON POWER INDICATORS

The components shown on the Main 40 Panel exist on all other types of controllers although placement, form and function may vary slightly. The Main 40 panel is available with pass thru options and with a blank input for use with higher ampacity panels such as larger pin and sleeve devices or cam-lock panels.

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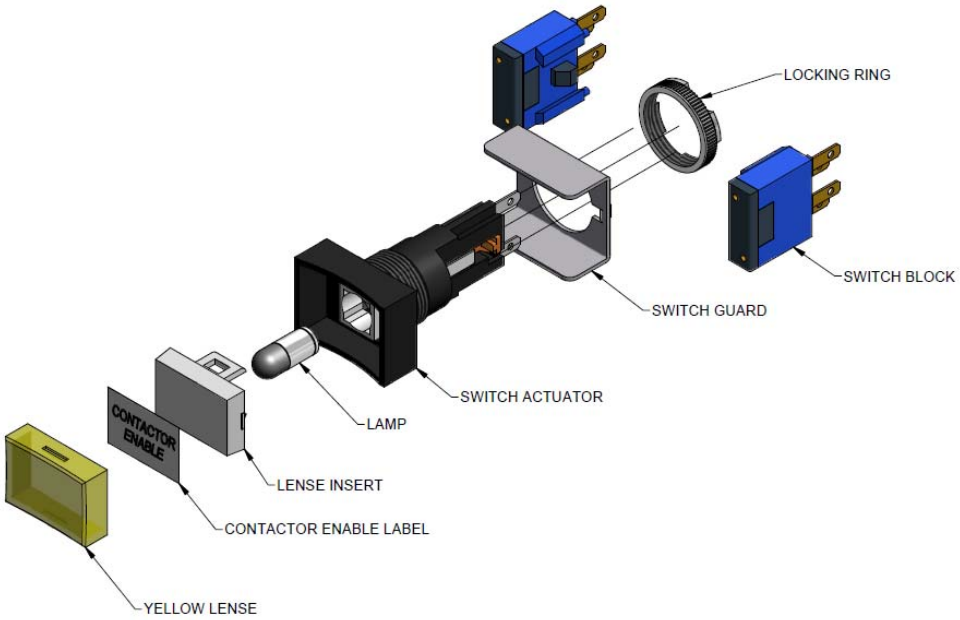
Contactor Enable Switch



The contactor enable switch is a maintained T&H switch. It has a yellow lens that is backlit by a replaceable lamp. The switch lamp is paralled off the contactor drive relay and as such will light whenever the main phase reverse contractor is energized.

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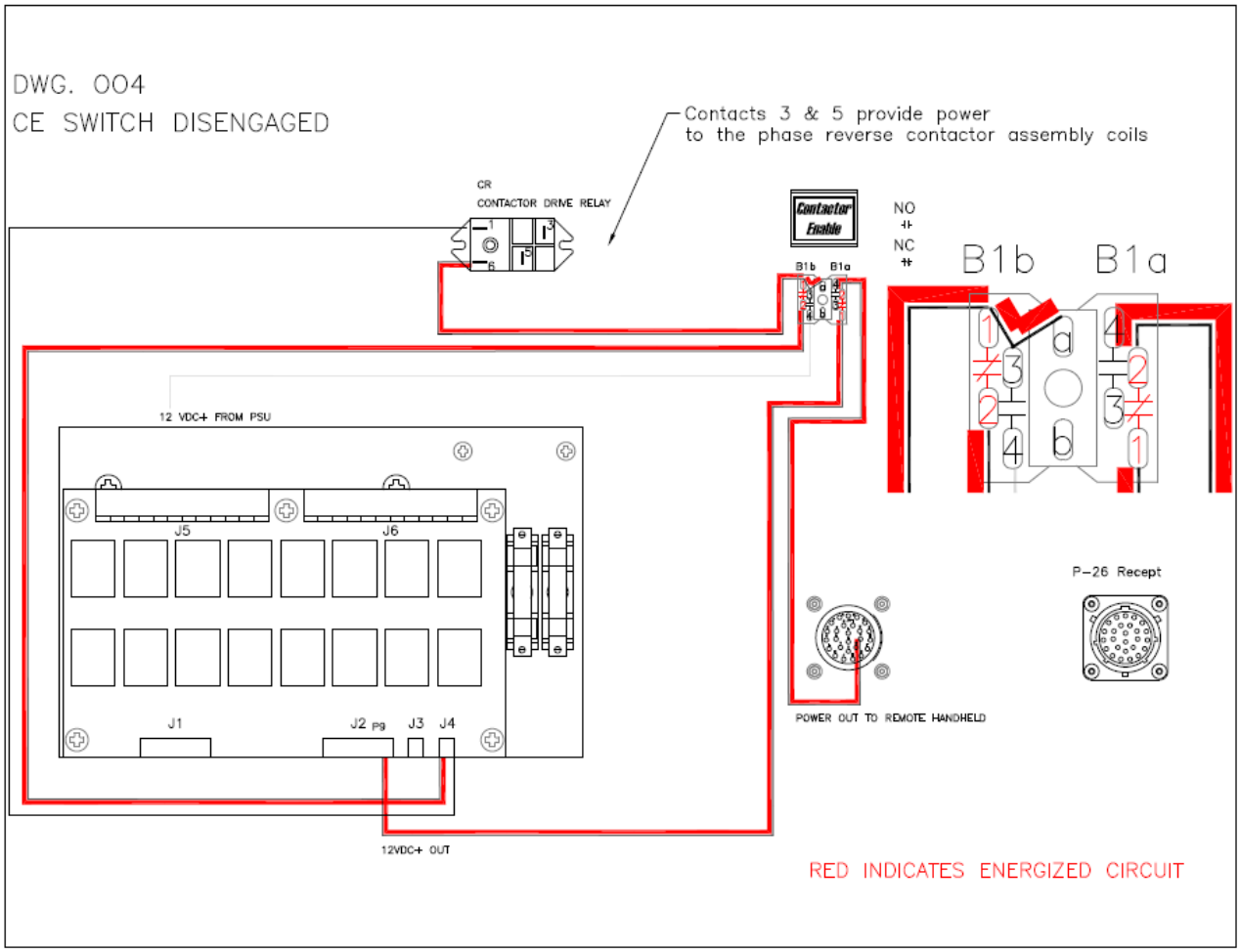
When the switch is disengaged it allows, via switch block B1a pins 1&2, +12VDC from the relay board Panduit connector J2 pin 9 to exit the controller on the 26 pin connector pin V providing power to the Hand Held Remote Station. Switch block B1b pins 1&2 allows power from J4 to energize the contactor drive relay.



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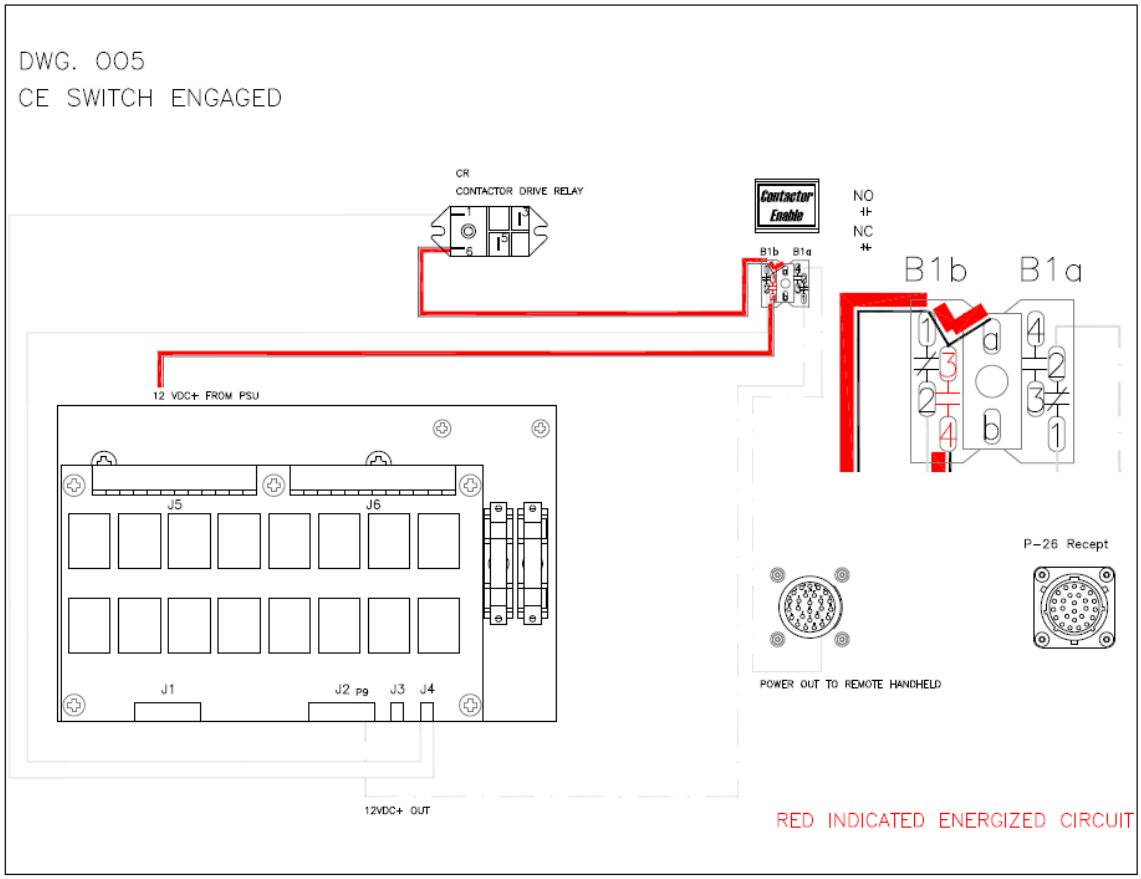
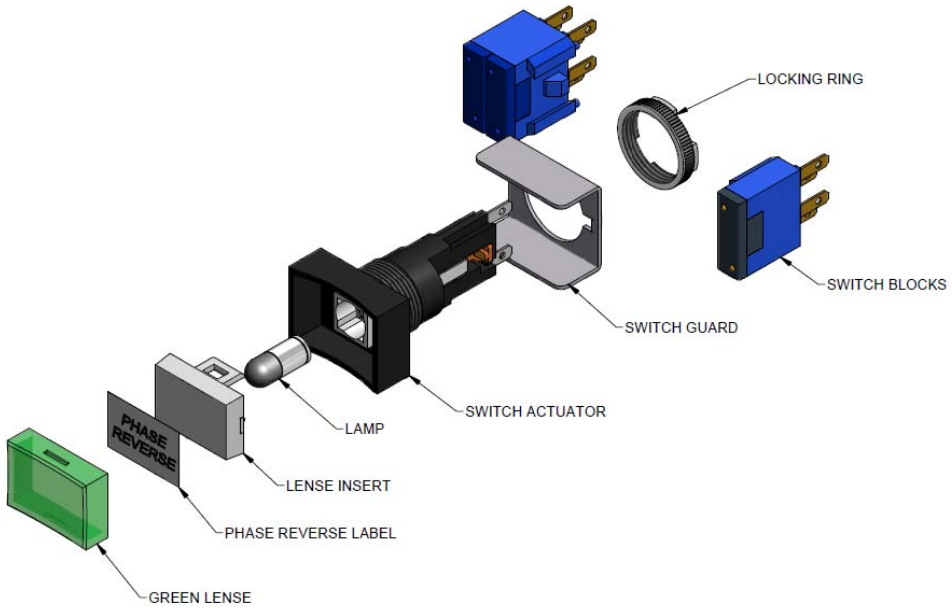
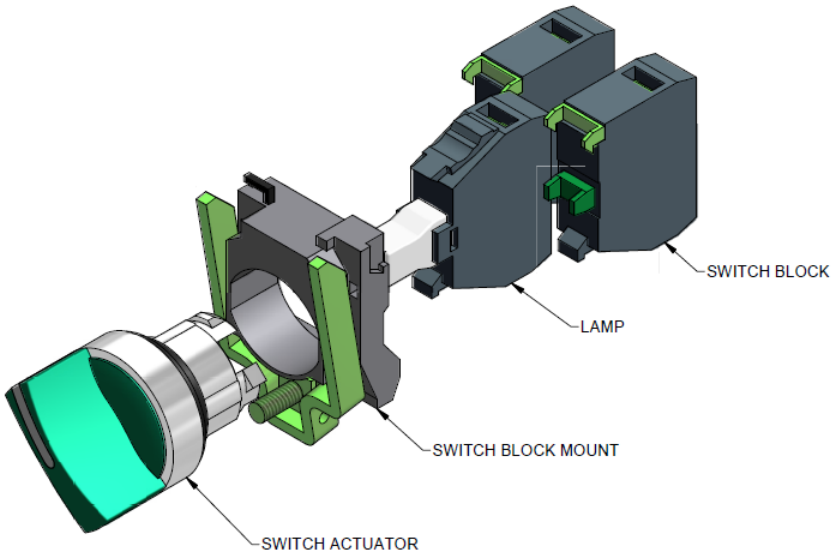
When the switch is engaged it shuts off power to the Hand Held Remote Station via pin V and applies +12VDC from the power supply directly to the Contactor Drive Relay via switch block B1b pins 3&4.



Phase Reverse Switch

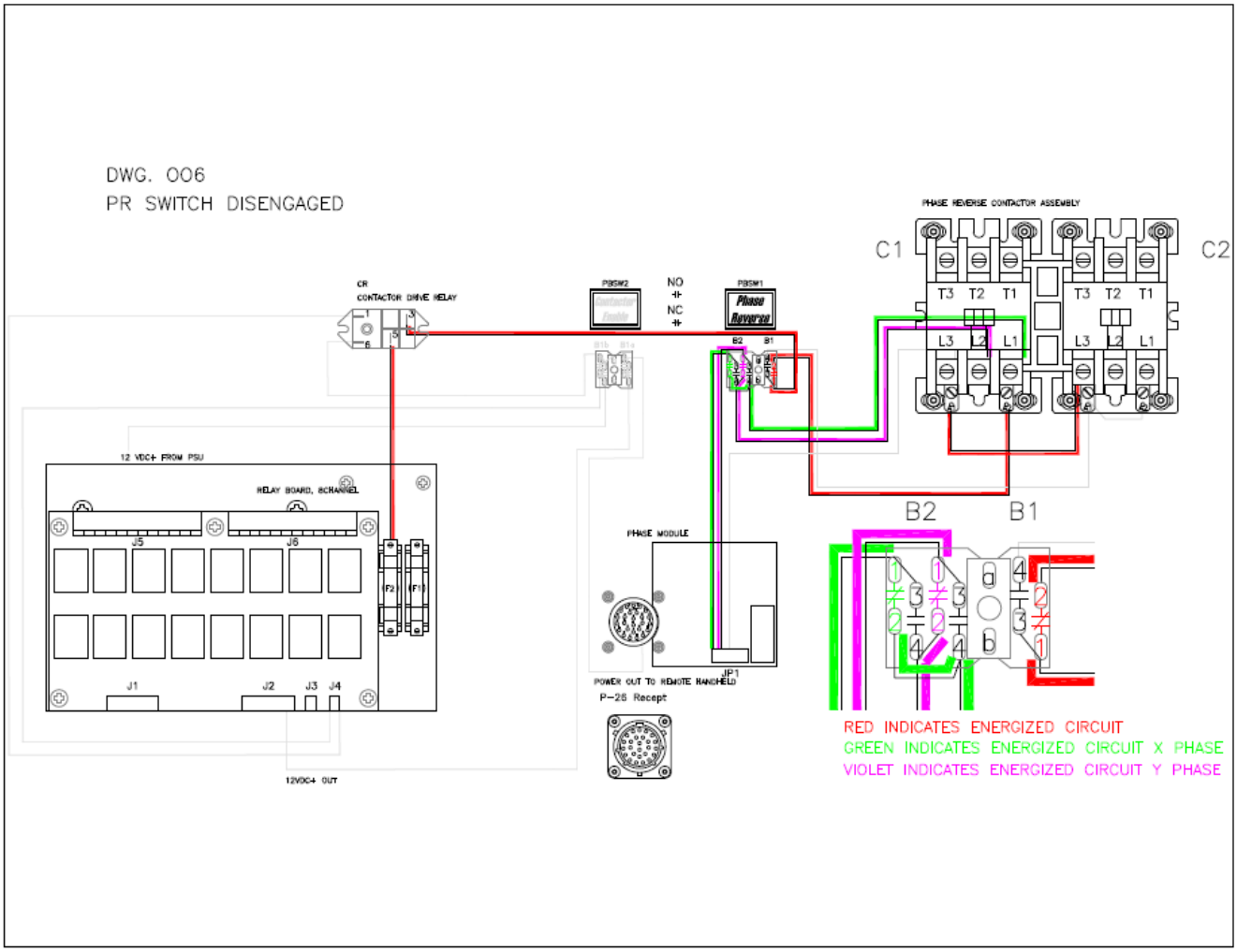


The Phase Reverse Switch is a maintained T&H switch. It has a green lens that is backlit by a replaceable lamp. The switch lamp is wired directly to the Relay Power Supply so it will be lit whenever the controller is powered.

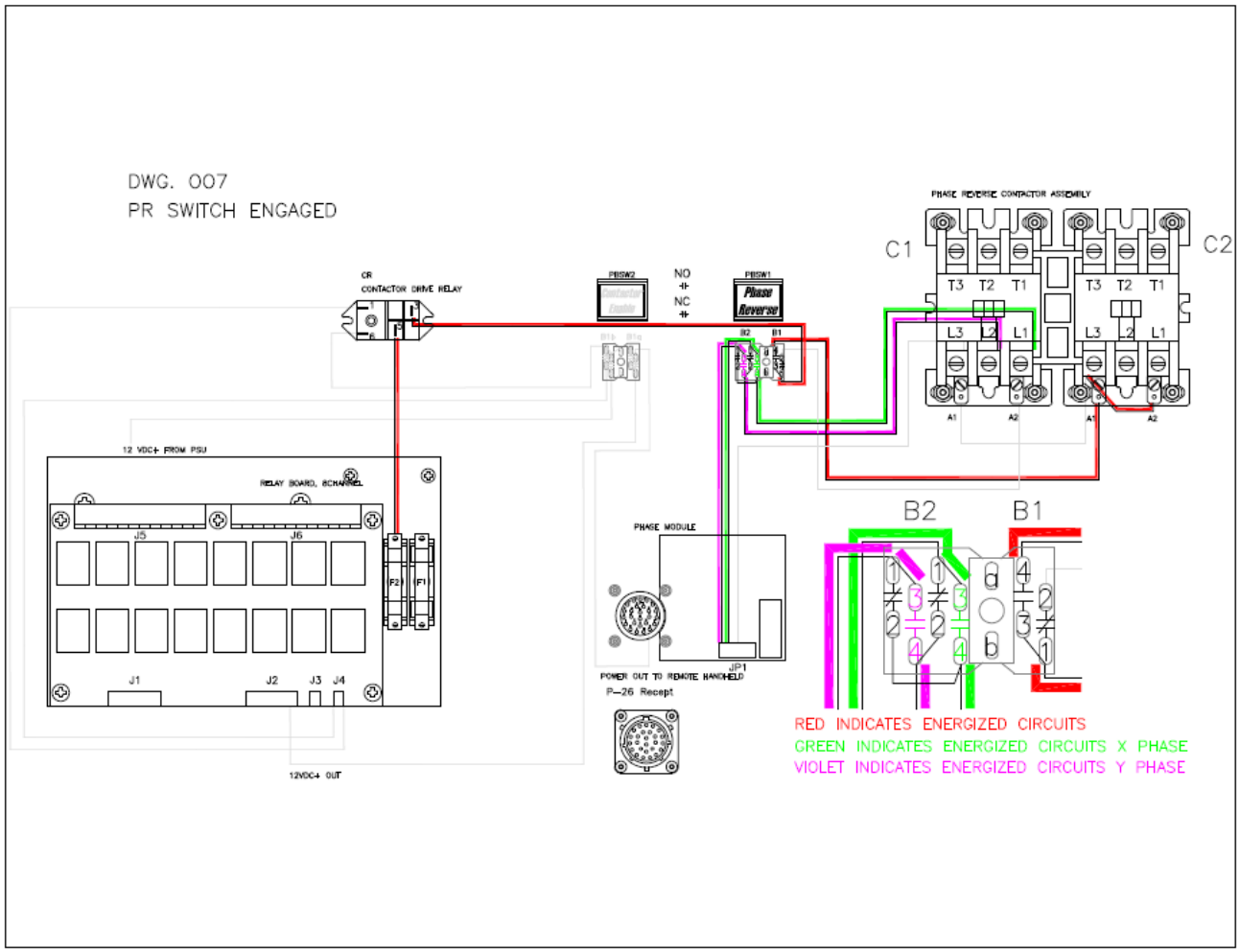


On the 19” rack mounted units, the Phase Reverse Switch is a XB4 style switch assembly. The lamp is powered thru the phase module and only lights when phase is correct.

When the phase reverse switch is disengaged the phases of power that are connected to the X and Y legs are routed via switch block B2 to the X and Y pins of the phase module respectively. This allows the phase OK lamp to become lit if the power is in the correct phase rotation. At the same time, switch block B1 routes control power from the contactor drive relay to the C1 or in phase contactor coil.



If the input power were reversed at the point of connection, the phase module would sense incorrect phase rotation and thus prevent the Phase OK Lamp from lighting. Correct this condition by engaging the Phase Reverse Switch.
When the switch is engaged, the X leg input is routed via the switch block B2 to the Y pin of the phase module and the Y leg is routed to the X pin of the phase module. At the same time, switch block B1 routes the control power from the contactor drive relay to the C2 or out of phase contactor. This allows the Phase OK Lamp to illuminate and the phase rotation to be corrected.



Take note that in 19” rack mounted units, the phase module simply senses the power at the output side of the main reversing contactor.

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26 Pin Remote Connector

The remote connector is a ¼ turn bayonet style connector used to connect the control device (Hand Held Remote Station) to the controller.

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P26 REMOTE STATION CABLE PINOUT

PIN #	COLOR	FUNCTION	PANDUIT POSITION
A	PINK	CH 1 UP	J1 P1
B	TAN	CH 1 DOWN	J1 P2
C	RED/GREEN	CH 2 UP	J1 P3
D	RED/YELLOW	CH 2 DOWN	J1 P4
E	RED/BLACK	CH 3 UP	J1 P5
F	WHITE/BLACK	CH 3 DOWN	J1 P6
G	WHITE/RED	CH 4 UP	J1 P7
H	WHITE/GREEN	CH 4 DOWN	J1 P8
J	WHITE/YELLOW	CH 5 UP	J1 P9
K	WHITE/BLUE	CH 5 DOWN	J1 P10
L	YELLOW	CH 6 UP	J2 P1
M	VOILET	CH 6 DOWN	J2 P2
N	GRAY	CH 7 UP	J2 P3
P	ORANGE	CH 7 DOWN	J2 P4
R	BLUE	CH 8 UP	J2 P5
S	BROWN	CH 8 DOWN	J2 P6
T	RED	KILL	J2 P7
U	BLACK	GO	J2 P8
V	WHITE	12VDC+	J2 P9
W	GREEN	GROUND	J2 P10
X	WHITE/BROWN	RESERVED FOR FUTURE USE	
Y	WHITE/ORANGE		
Z	WHITE/GRAY		
a	WHITE/VIOLET		
b	WHITE/BLACK/RED	Jumper to c	
c	WHITE/GLACK/GREEN	Jumper to b	

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Control Devices

The Hand Held Remote Station is designed to operate hoists singly or in groups. Individual direction switches are provided for each channel as well as LED direction indicators that light when the switch position is moved. The green LED will light when the UP direction is selected, yellow when the Down direction is selected. Once selected, the hoists will move in the direction indicated when and as long as the GO button is depressed. The Remotes are available as 4, 6, and 8 channel units in the small frame enclosure.

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Larger units, up to 40 channels are available in a large frame format.

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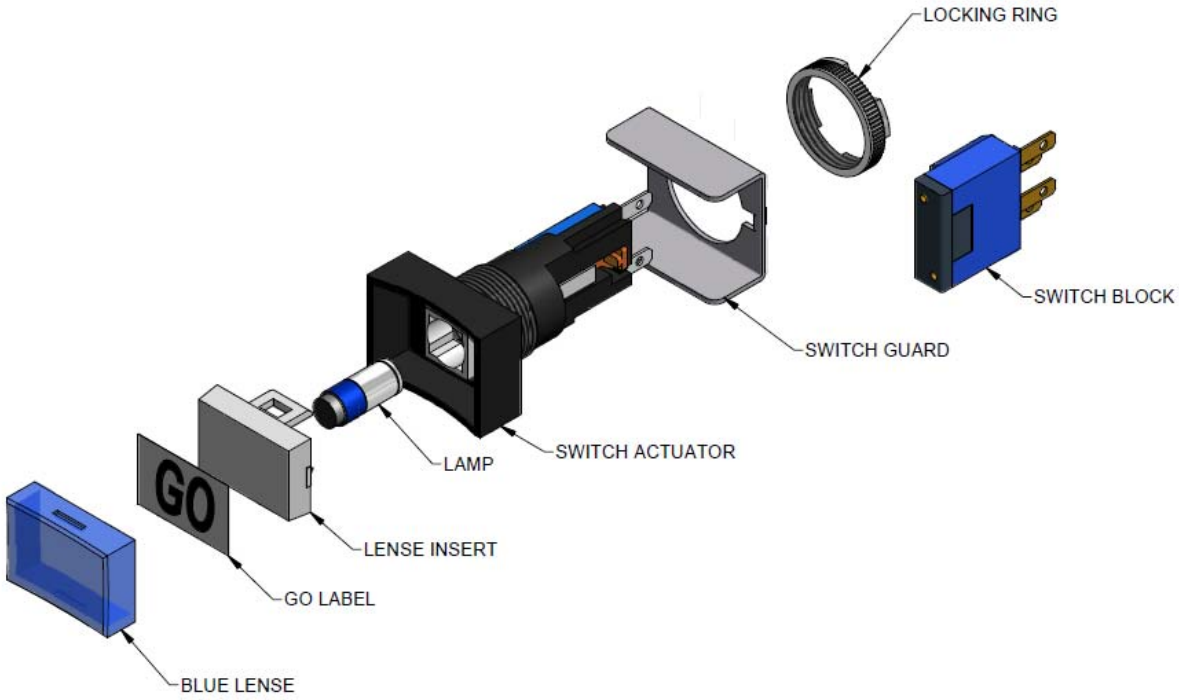
GO Switch



The Go Switch is a momentary T&H switch. It has a blue lens that is backlit by a replaceable lamp.. Operation of this switch will provide the selected direction switches with a path to ground allowing relay closure and thus hoist operation. The lamp shuts off when the switch is depressed.

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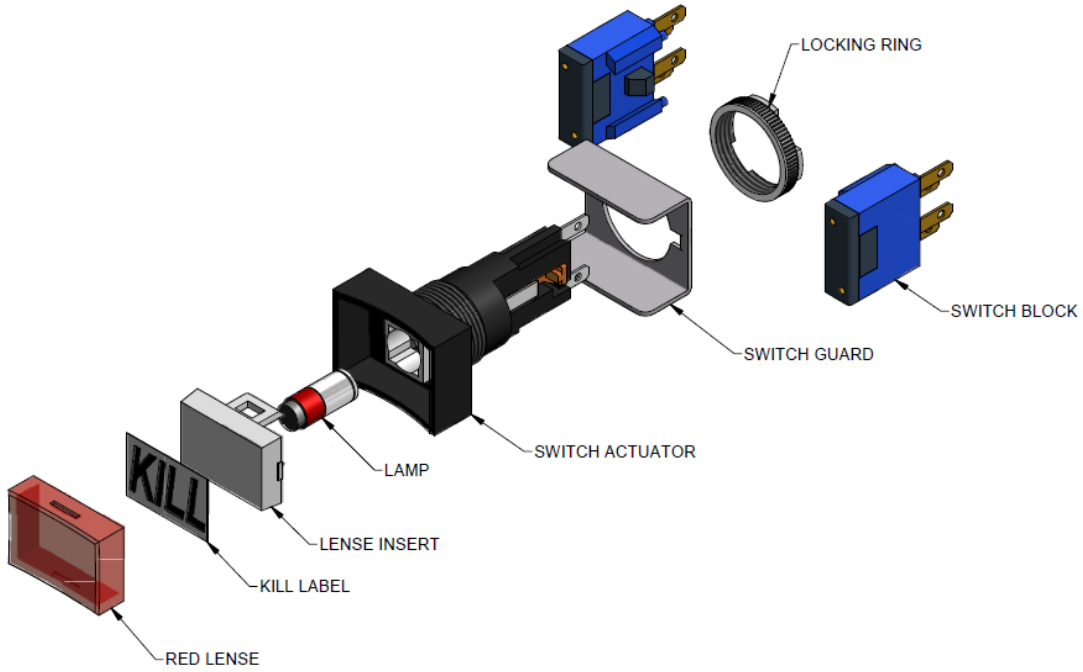
Kill Switch



The Kill Switch is a maintained T&H switch. It has a red lens that is backlit by a replaceable lamp.
Operation of this switch de-energized the Phase Reverse Contactor Assembly interrupting power to all hoists. When depressed, the lamp shuts off as well as the lamp in the GO switch. The direction switches and their associated LED's will remain functional, even operating relays in the controller if the go switch is depressed. Although the relays are operational, power is interrupted to the hoists preventing movement.

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General Switch Information

All T&H Switch actuators are capable of being operated in a momentary or maintained mode:

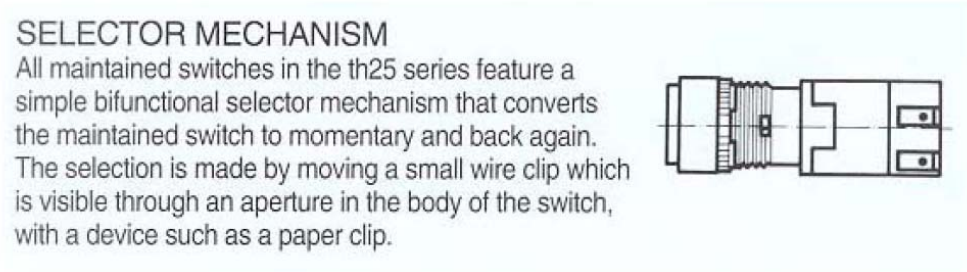


Figure 1

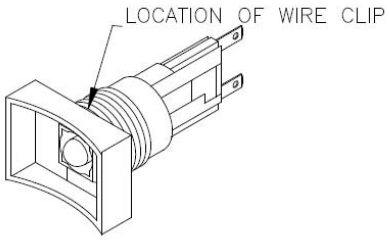
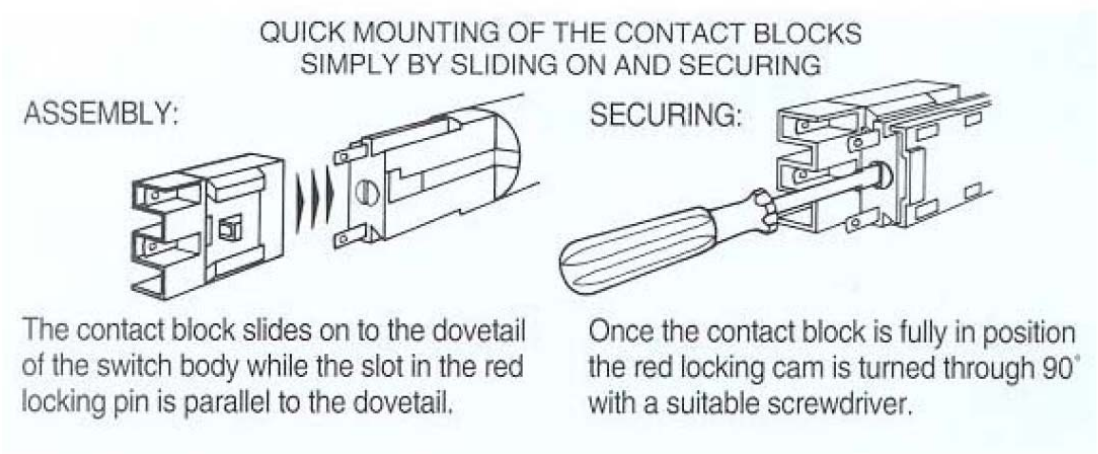


Figure 2

Installation and removal of switch blocks:



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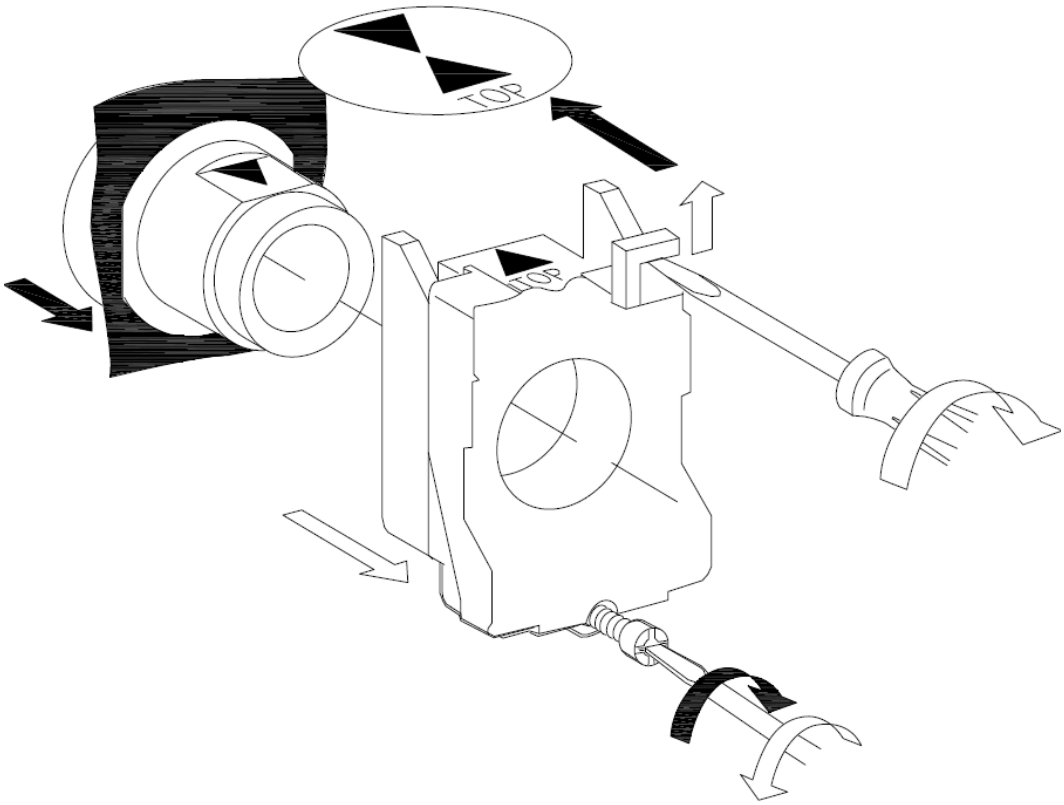
ZB4 Style Switch assembly



The ZB4 switch assemblies are used in a variety of applications in 19” Rack Mounted units. The lamp and switch modules snap into place on the back of the switch block mount after installation into the panel.

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General Control Device Information

REVISION HISTORY				
ZONE	REV	DESCRIPTION	DATE	APPROVED
-	A	ORIGINAL ISSUE. DH	1/5/2011	-

INSTALLATION NOTES:
UNLESS OTHERWISE SPECIFIED

1. THIS DOCUMENT DETAILS THE REPLACEMENT OF BI-DIRECTIONAL INCANDESCENT TYPE T1 AND BI-DIRECTIONAL LED TYPE T1 BULBS WITH MONO-DIRECTIONAL LED TYPE T1 BULBS IN SWITCH ASSEMBLIES ON HAND HELD REMOTE FACEPLATES.

2. REMOVE FACEPLATE FROM HAND HELD ENCLOSURE AND DISCONNECT PANDUITS FROM SWITCH CARD.

3. PRY OFF 'GO' SWITCH LENS WITH A SMALL SLOT HEAD SCREW DRIVER AS SHOWN. WORK LENS FREE GRADUALLY, ALTERNATING TOP AND BOTTOM SO AS NOT TO BREAK PLASTIC. PRESS IN SLIGHTLY TO RELEASE THE TABS.

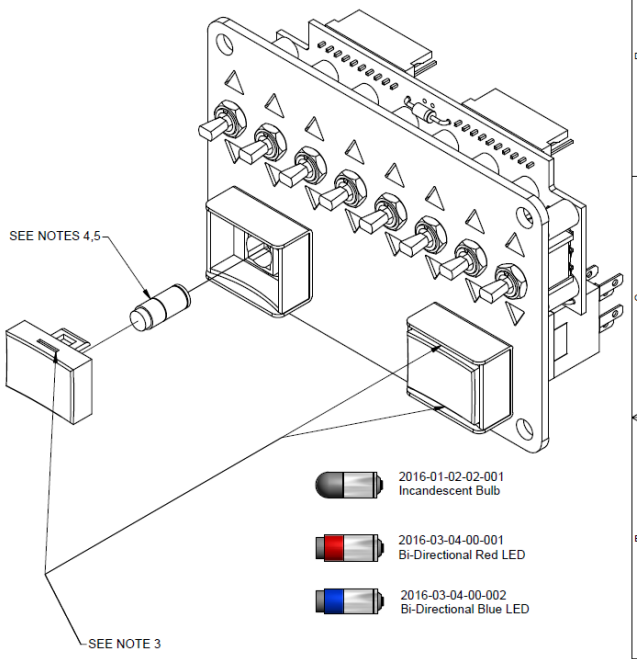
4. PULL INCANDESCENT BULB OUT OF SWITCH USING NEEDLE NOSE PLIERS, GENTLY GRIPPING THE SIDE OF THE BULB. BE CAREFUL NOT TO BREAK THE GLASS.

5. SNAP IN THE BLUE LED REPLACEMENT BULB WITH THE LED FACING TOWARDS THE LENS.

6. SNAP THE LENS BACK IN WITH THE LABEL IN THE PROPER ORIENTATION.

7. REPEAT NOTES 3 - 6 WITH THE 'KILL' SWITCH, REPLACING WITH THE RED LED.

8. MAKE SURE WIRING FOR WHITE AND GRAY WIRES FROM SWITCH CARD TO SWITCH BLOCKS MATCHES THAT SHOWN ON SHEET 2. CORRECT IF NECESSARY BY MOVING CRIMPED TERMINALS TO APPROPRIATE SWITCH BLOCK CONTACTS. REF. SHEET 2.



2016-01-02-02-001
Incandescent Bulb

2016-03-04-00-001
Bi-Directional Red LED

2016-03-04-00-002
Bi-Directional Blue LED

2016-03-04-00-005
Mono Directional Red LED (NEW)

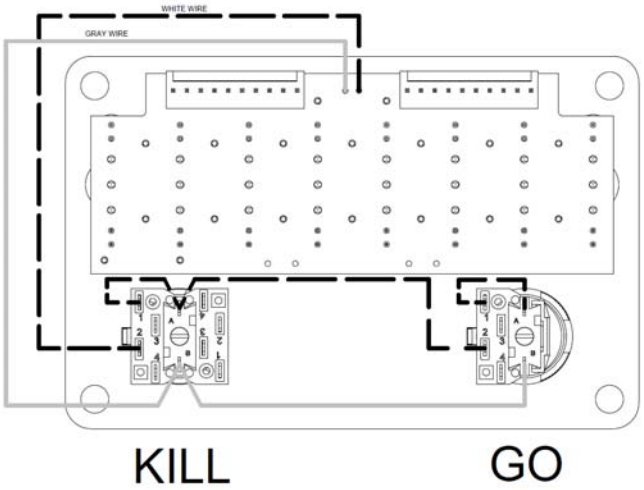
2016-03-04-00-006
Mono Directional Blue LED (NEW)

HISTORY

Since its inception, the Motion Laboratories Hand Held Remote has utilized an incandescent bulb in the "GO" and "KILL" Switches for illumination.
In 2006 Motion Laboratories began using a bi-directional LED replacement to improve bulb life.
As we have tried to minimize the impact to the end user, the use of the bi-directional element required no changes to wiring.

Starting in 2011, due to rising costs, we have switched to a mono directional LED.
The new LED, upon installation, requires that the wiring for the light circuit matches the attached wiring diagram (SEE SHEET 2). All new remotes will be wired this way and the new wiring will not affect either the old incandescent or the older style bi-directional LED.

motionlaboratories 520 Furnace Dock Road Cortlandt Manor, NY 10567	TITLE: Face Plate Assembly, Remote, Switch Card, Wiring Instructions for LED Lamps	DRAWN BY: DH	DATE DRAWN: 1/5/2011	CHECKED BY	DATE CHECKED: 1/6/2011	SIZE: C	DRAWING NUMBER: INST-II-0400	REV: A
		MODEL FILENAME & PATH: V:\Products\Installation Instructions\INSTALLATION DRAWINGS\INST-II-0400.drw				SCALE: 2:1	SHT: 1 OF 2	



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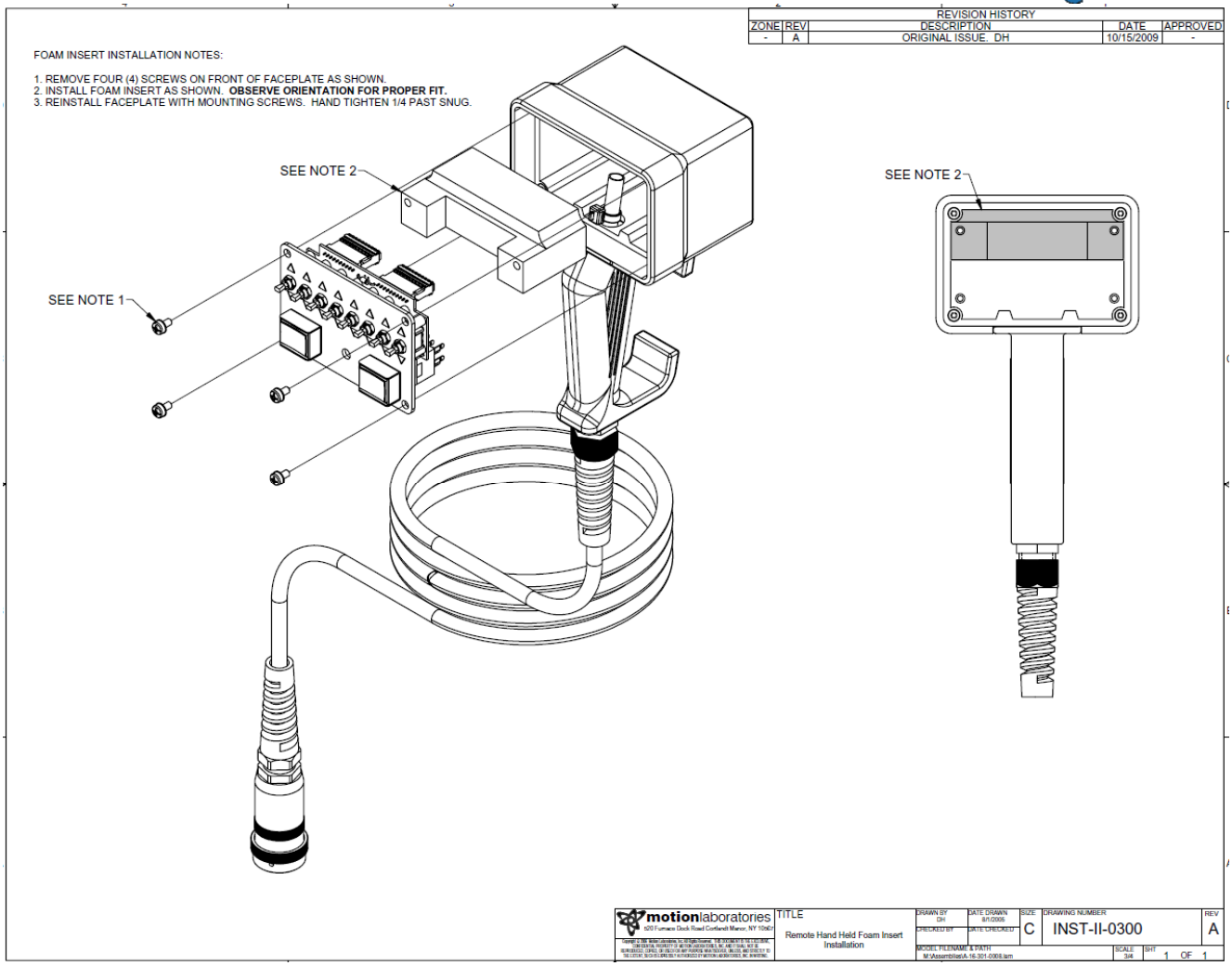

Foam Inserts were designed to prevent the J1 and J2 Panduit connectors from coming off when the remote is dropped.

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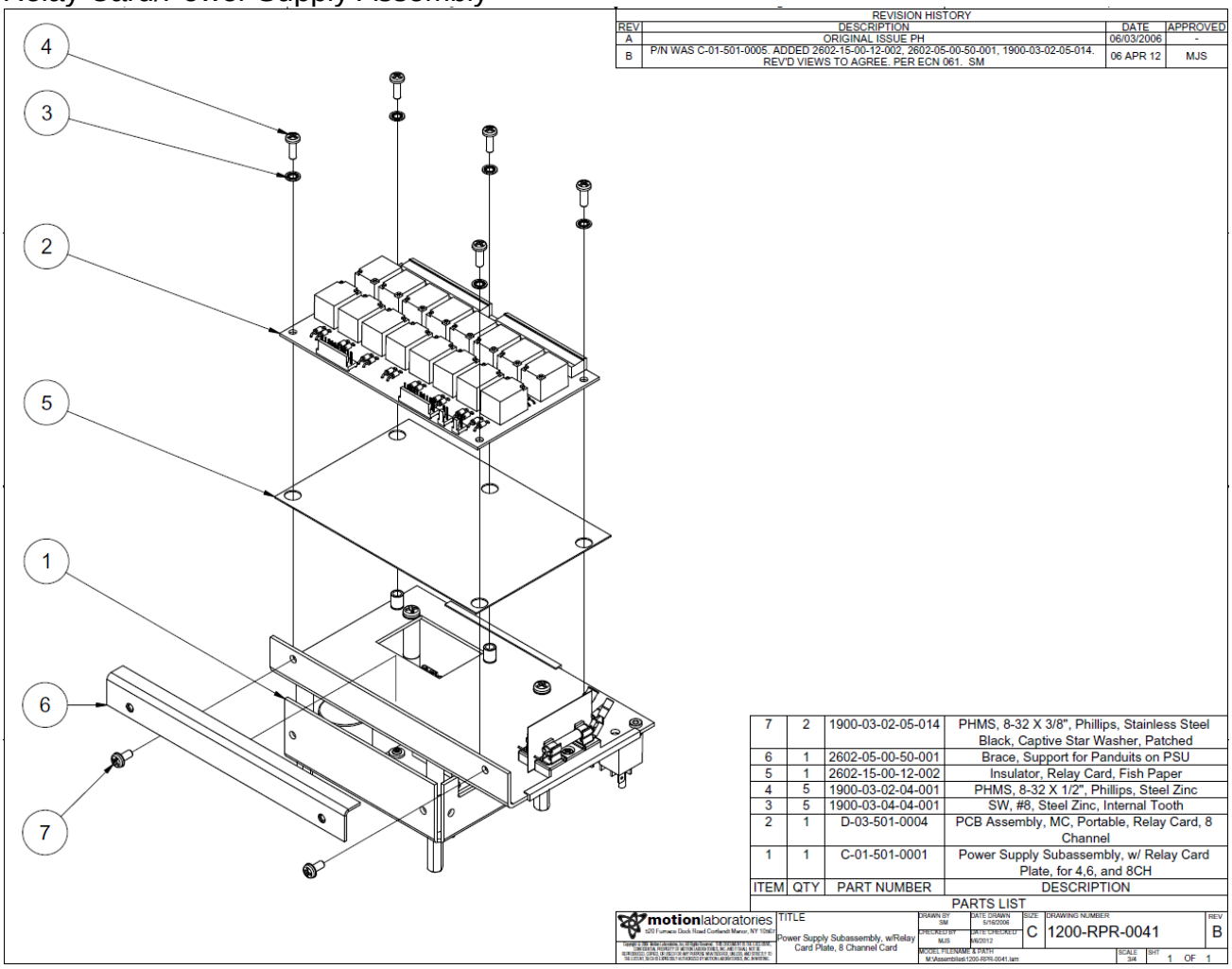
Relay Card/Power Supply Assembly



REVISION HISTORY

REV	DESCRIPTION	DATE	APPROVED
A	ORIGINAL ISSUE PH	06/03/2006	-
B	P/N WAS C-01-501-0005. ADDED 2602-15-00-12-002, 2602-05-00-50-001, 1900-03-02-05-014. REV'D VIEWS TO AGREE. PER ECN 061. SM	06 APR 12	MJS

ITEM	QTY	PART NUMBER	DESCRIPTION
7	2	1900-03-02-05-014	PHMS, 8-32 X 3/8", Phillips, Stainless Steel Black, Captive Star Washer, Patched
6	1	2602-05-00-50-001	Brace, Support for Panduits on PSU
5	1	2602-15-00-12-002	Insulator, Relay Card, Fish Paper
4	5	1900-03-02-04-001	PHMS, 8-32 X 1/2", Phillips, Steel Zinc
3	5	1900-03-04-04-001	SW, #8, Steel Zinc, Internal Tooth
2	1	D-03-501-0004	PCB Assembly, MC, Portable, Relay Card, 8 Channel
1	1	C-01-501-0001	Power Supply Subassembly, w/ Relay Card Plate, for 4,6, and 8CH

PARTS LIST

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TITLE: Power Supply Subassembly, w/Relay Card Plate, 8 Channel Card

DRAWN BY: SM | DATE DRAWN: 5/16/2006 | SIZE: C | DRAWING NUMBER: 1200-RPR-0041 | REV: B

CHECKED BY: MJS | DATE CHECKED: 06/20/12

MODEL FILENAME & PATH: M:\Assemblies\1200-RPR-0041.iam | SCALE: 3/4 | SHT 1 OF 1

Shown is a Typical 8 channel assembly.

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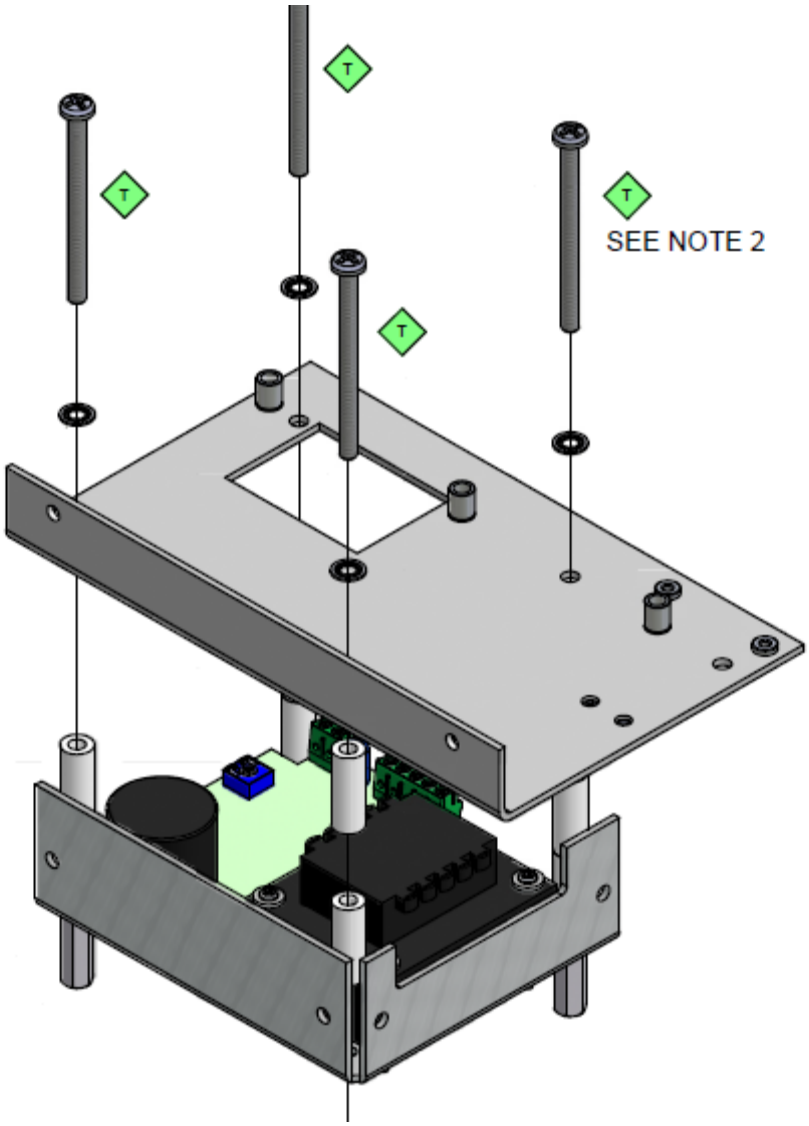
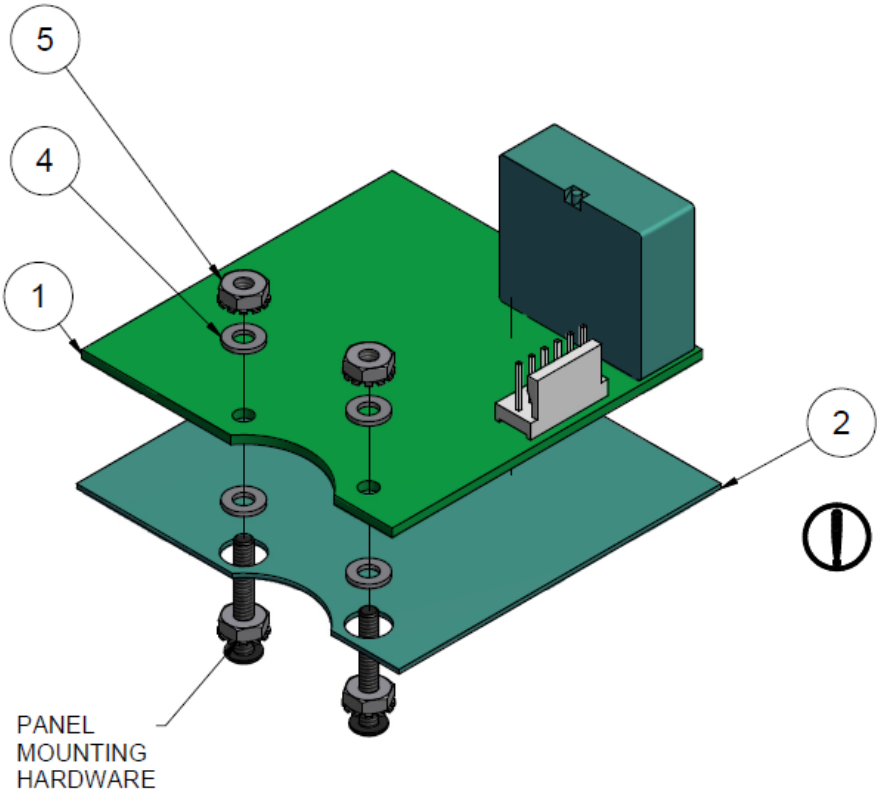


To insure that units operate correctly with long cable runs the power supplies are factory set at 14.1 VDC nominal. The adjustment pot is shown above in blue, access can be had by removing the relay card. Turn clockwise to increase.

Phase Module.
In older units, the phase module was an in-house piece. It was mounted adjacent to the 26 Pin connector on the Main 40 panel. Newer units have switched to a Zeilo Phase module which is now incorporated in the mounting of the Phase reverse contactor assembly. The operation and function of the unit remains the same.



Important!

The Insulator (ITEM 2) must be installed under the Under the Phase Module (ITEM 1)

Installation Notes:
1.Make sure unit is de-energized.
2.Remove old Phase Module, save hardware.
3.Install insulator onto panel mounting hardware.
4. Install first set of flat washers (ITEM 4)
5. Install Phase module
6. Install second set of flat washers
7. Secure with Hex Nuts (ITEM 5)

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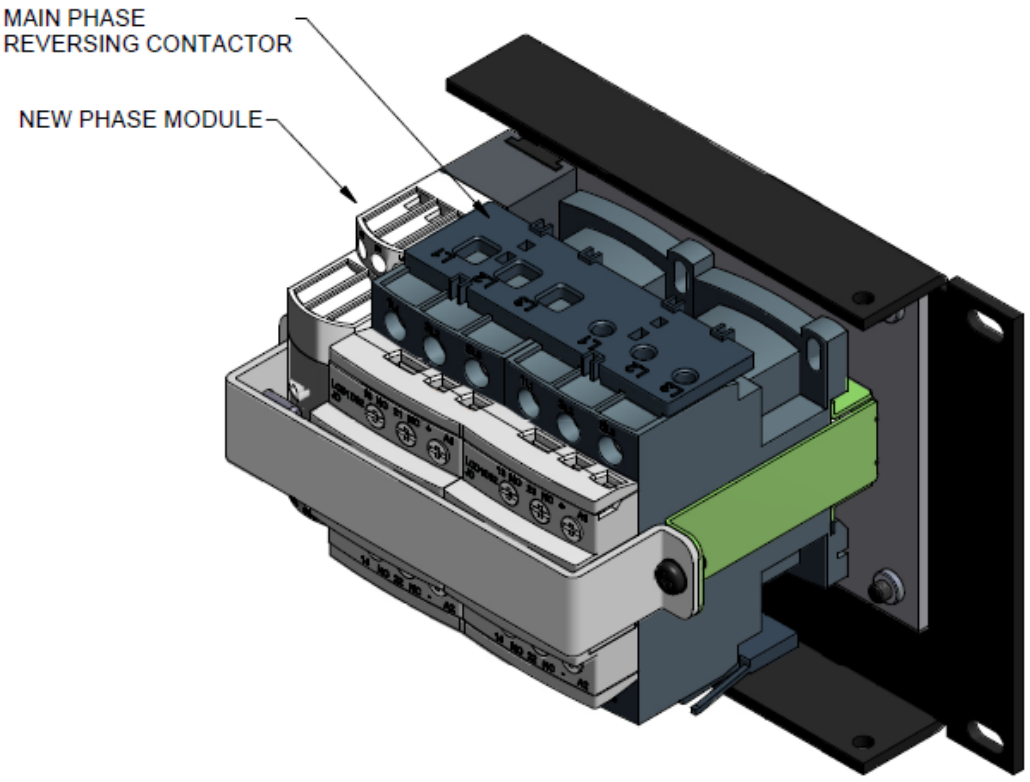

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SYSTEM OPERATION
General Information
Power
Prior to power up, verify that the supply voltage matches the voltage requirement for the controller and hoists.
The power supplying the system shall be of adequate capacity to operate the intended number of hoists and the input power supply cable shall be of adequate size. Low supply voltage can cause unreliable hoist operation and must be corrected. In addition improperly sized input power supply cable runs will compound the problem.

Since power requirements are based on the intended number of hoists to be run simultaneously, a careful analysis of system will be required in order to determine the maximum current load before specifying the power requirements. When the intended number of hoists to be used is unknown; the system power requirements shall be based on the maximum capacity of the controller.

The supply voltage shall be within the values indicated below.

- For a single phase 120 VAC (HN) system, shall not be below 110 VAC or above 126 VAC.
- For a single phase 240 VAC (HH) system, shall not be below 220 VAC or above 252 VAC.
- For a three phase 208 VAC (HHH) system, shall not be below 191 VAC or above 218 VAC.
- For a three phase 208 Y/120 (HHHN) system, shall not be below 191 Y/110 VAC or above 218 Y/128 VAC.
- For a three phase 480 VAC (HHH) system, shall not be below 440 VAC or above 504 VAC.

Verify that the power and control cables are the correct wire gauge for length of cable run as applies to voltage drop. The hoist manufacturer's recommendations shall be followed. Where the recommendations are not available, reference tables are provided in Annex A.

Apply power to the controller. With the Control Device disconnected, and the Contactor Enable Switch disengaged, the three power Neon's should light.
On units with a T&H style Phase Reverse Switch, this should also light indicating that the power supply is functional. In addition, if the phase rotation is correct, the Phase OK Lamp will light. Toggling the Phase Reverse Switch will result in the Phase OK Lamp going on and off depending on the state of the existing power.
The Contactor Enable Switch will light whenever the Main Phase Reverse Contactors are engaged. Engage the CE switch and you should hear the contactors pull in. At this point, power will be available to the hoists if the Circuit breakers are turned on. This is typically used to allow a "pickle" to operate individual hoists during setup.
Toggling the Phase Reverse Switch with the CE switch engaged will result in the Phase Reverse Contactor Assembly switching contactors. This can be heard as a audible engagement sound. Doing this should toggle the Phase OK Lamp as well depending on the original condition.

Disengage the CE switch and connect the Control Device. The contactors should re-engage. Depress the Kill switch and the contactors should shut down. Note that if the CE switch is engaged while the Control Device is attached, the control device will be non functional.

Prior to operation under load, verify that all hoists move in the direction selected on the control device. This can be accomplished by bumping each hoist connected in both the up and down direction. Bumping is a momentary tap of the Go Switch with a direction selected.
The operator should familiarize themselves with all of the operating controls.

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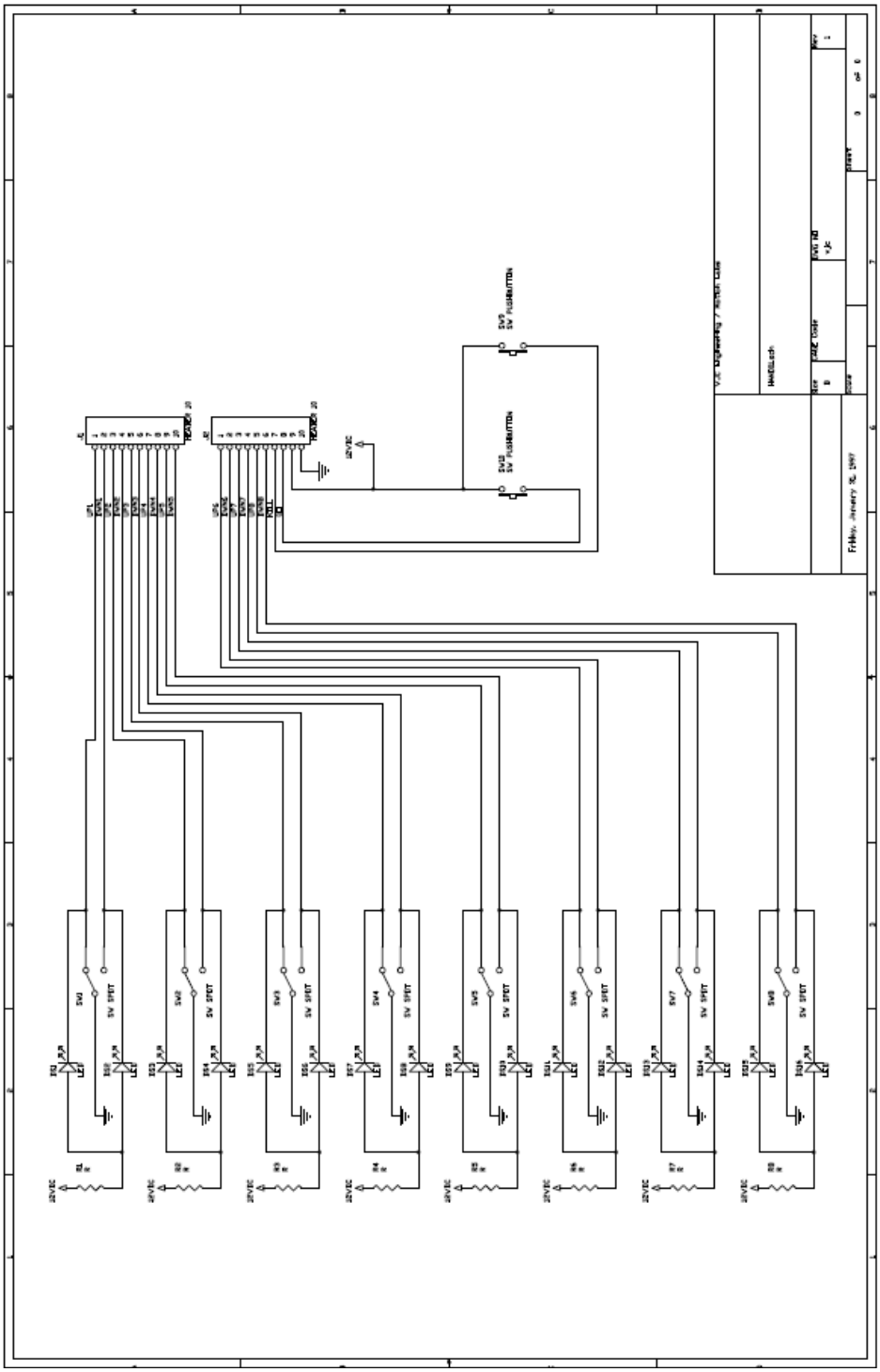
SCHEMATICS

Hand Held Remote Schematic



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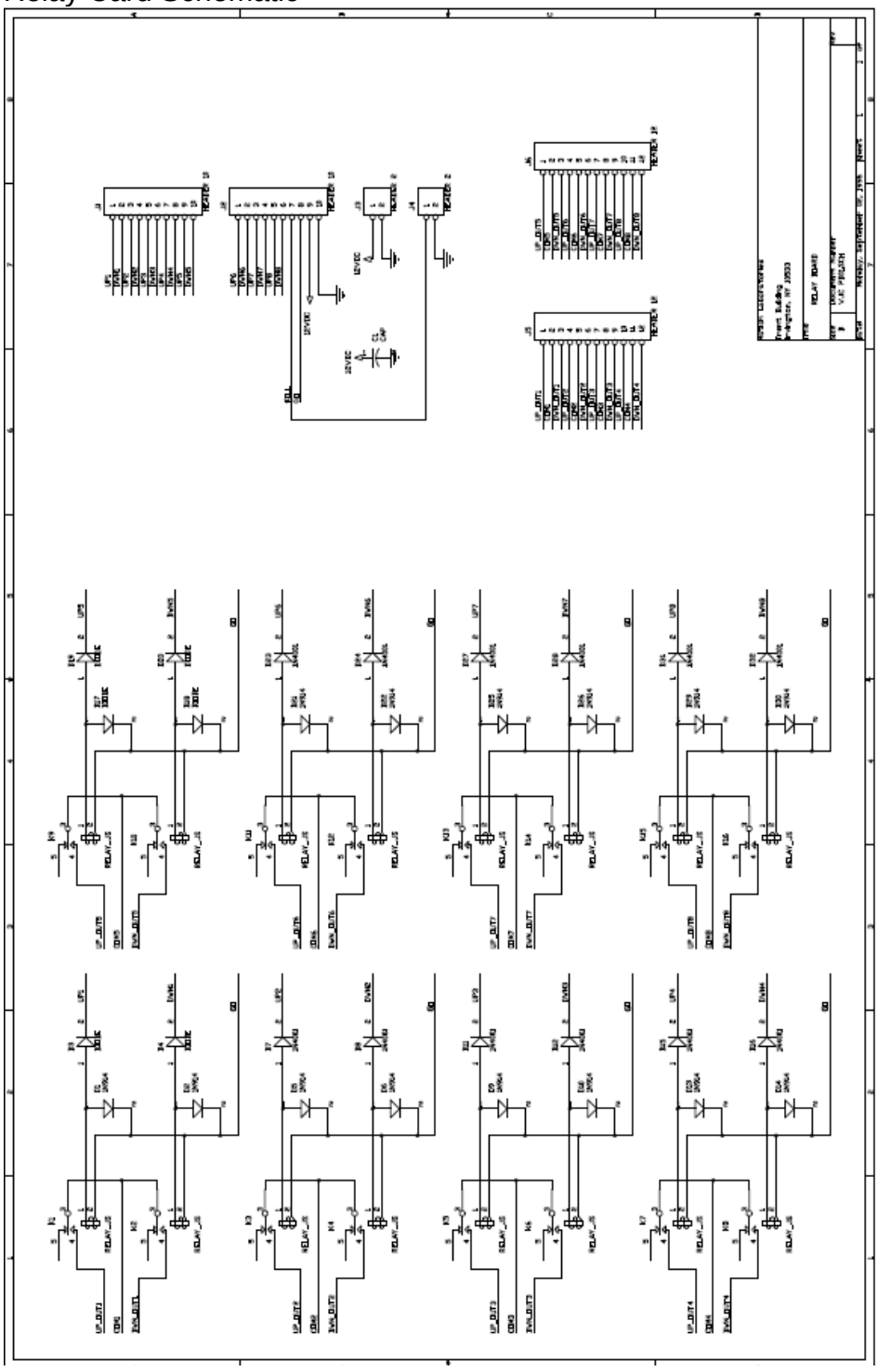
Relay Card Schematic



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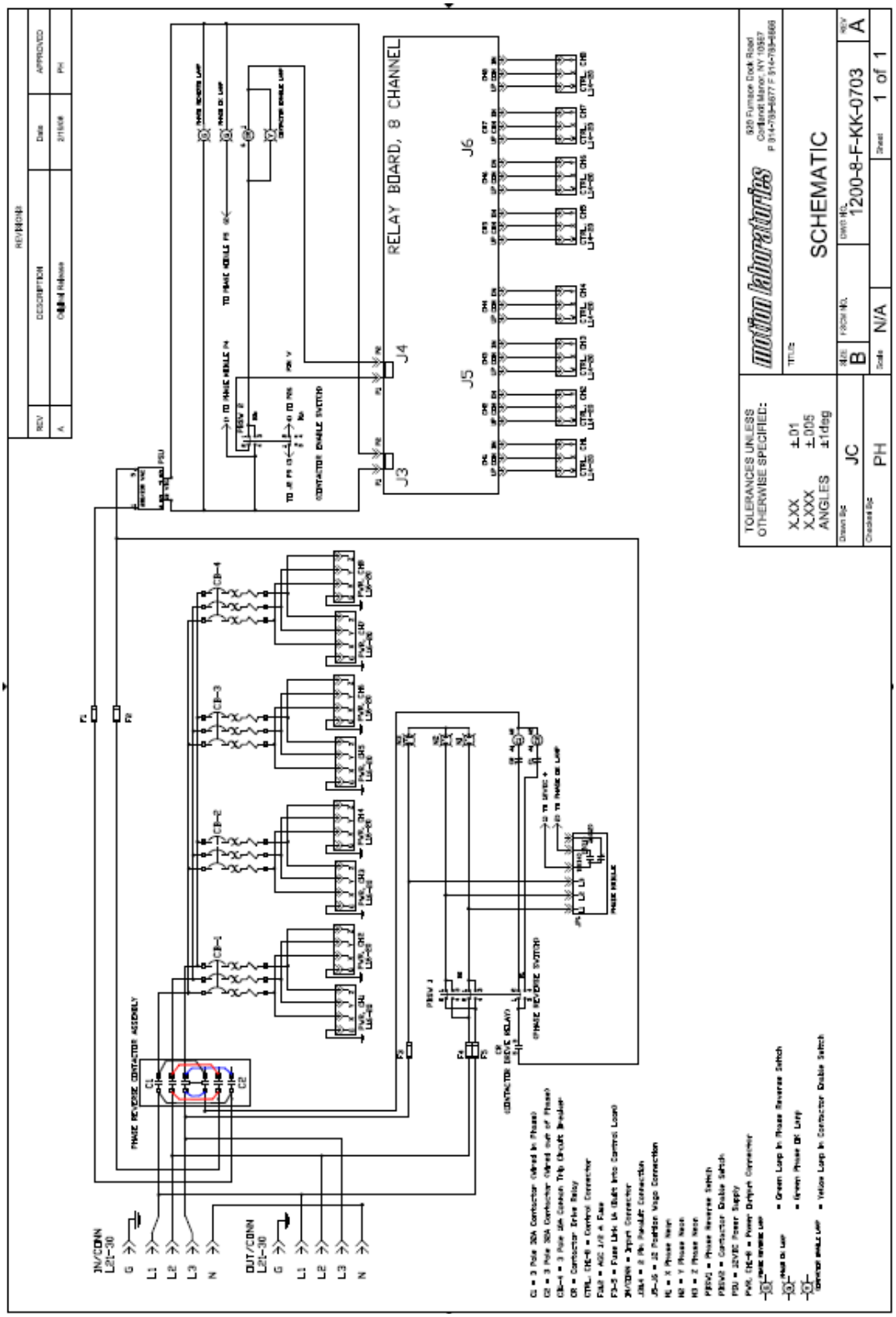

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ANNEX A

ANNEX A
VOLTAGE DROP AND CABLE SELECTION

A.1 The total voltage drop from the point of power supply shall not exceed 5%. That may be divided between the power supply cable and the hoist power/control cable. The installer should plan on a 2% drop for one and a 3% drop for the other. Be aware that the point of supply is considered to be at the service entrance and the design of the permanently installed feeder may have already included voltage drop calculations.

Table A1-1

2% Voltage Drop		
Voltage	Allowable Voltage Drop	Resulting Voltage
120 VAC	2.4 Volts	117.6 VAC
208 VAC	4.16 Volts	203.84 VAC
230 VAC	4.6 Volts	225.4 VAC
440 VAC	8.8 Volts	431.2 VAC
480 VAC	9.6 Volts	470.4 VAC

Table A1-2

3% Voltage Drop		
Voltage	Allowable Voltage Drop	Resulting Voltage
120 VAC	3.6 Volts	116.4 VAC
208 VAC	6.24 Volts	201.76 VAC
230 VAC	6.9 Volts	223.1 VAC
440 VAC	13.2 Volts	426.8 VAC
480 VAC	14.4 Volts	465.6 VAC

Table A1-3
Maximum Voltage Drop

Voltage	5%
120 VAC	114 VAC
208 VAC	198 VAC
230 VAC	218 VAC
440 VAC	418 VAC
480 VAC	456 VAC

A.2 For Hoist Power/Control Cable, Choose the appropriate table based on the operating voltage and cross reference the length of the cable against the current draw to determine the gauge (AWG) of wire.

Table A2-1, 208 VAC 3PHASE 2% DROP

DISTANCE IN FEET		10	25	50	75	100	125	150	175	200	225	250	300
CURRENT DRAW	0.6	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG
	1.1	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG
	1.4	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG
	1.9	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG
	2	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG
	2.3	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	14AWG
	2.8	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	14AWG	14AWG	12AWG
	3.8	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	14AWG	12AWG	12AWG	12AWG
	4.6	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	12AWG	12AWG	12AWG	12AWG	10AWG
	4.7	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	12AWG	12AWG	12AWG	12AWG	10AWG
	4.9	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	14AWG	12AWG	12AWG	12AWG	10AWG	10AWG
	5.2	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	12AWG	12AWG	12AWG	12AWG	10AWG	10AWG
	7.6	16AWG	16AWG	16AWG	14AWG	14AWG	12AWG	12AWG	10AWG	10AWG	10AWG	10AWG	8AWG
	8.6	16AWG	16AWG	16AWG	14AWG	12AWG	12AWG	10AWG	10AWG	10AWG	10AWG	8AWG	8AWG
	15.4	12AWG	12AWG	12AWG	12AWG	10AWG	10AWG	8AWG	8AWG	8AWG	N/R	N/R	N/R

Table A2-2, 230 VAC 3PHASE 2% DROP

DISTANCE IN FEET		10	25	50	75	100	125	150	175	200	225	250	300
CURRENT DRAW	0.6	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG
	1.1	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG
	1.4	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG
	1.9	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG
	2	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG
	2.3	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG
	2.8	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	14AWG	14AWG
	3.8	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	14AWG	12AWG	12AWG	12AWG
	4.6	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	14AWG	12AWG	12AWG	12AWG	10AWG
	4.7	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	14AWG	12AWG	12AWG	12AWG	10AWG
	4.9	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	12AWG	12AWG	12AWG	12AWG	10AWG
	5.2	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	12AWG	12AWG	12AWG	12AWG	10AWG
	7.6	16AWG	16AWG	16AWG	14AWG	14AWG	12AWG	12AWG	12AWG	10AWG	10AWG	10AWG	8AWG
	8.6	16AWG	16AWG	16AWG	14AWG	12AWG	12AWG	12AWG	10AWG	10AWG	10AWG	8AWG	8AWG
	15.4	12AWG	12AWG	12AWG	12AWG	10AWG	10AWG	8AWG	8AWG	8AWG	N/R	N/R	N/R

Table A2-3, 480 VAC 3PHASE 2% DROP

DISTANCE IN FEET		10	25	50	75	100	125	150	175	200	225	250	300
CURRENT DRAW	0.6	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG
	1.1	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG

	1.4	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG
	1.9	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG
	2	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG
	2.3	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG
	2.8	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG
	3.8	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG
	4.6	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG
	4.7	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG
	4.9	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG
	5.2	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	14AWG
	7.6	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	14AWG	14AWG	12AWG	12AWG
	8.6	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	14AWG	12AWG	12AWG	12AWG
	15.4	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	10AWG	10AWG	10AWG	8AWG

Table A2-4, 120VAC SINGLE PHASE 2% DROP

DISTANCE IN FEET		10	25	50	75	100	125	150	175	200	225	250	300
CURRENT DRAW	0.6	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG
	1.1	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	14AWG
	1.4	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	14AWG	14AWG	12AWG
	1.9	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	14AWG	12AWG	12AWG	12AWG
	2	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	14AWG	12AWG	12AWG	12AWG	12AWG
	2.3	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	12AWG	12AWG	12AWG	12AWG	10AWG
	2.8	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	12AWG	12AWG	12AWG	10AWG	10AWG	10AWG
	3.8	16AWG	16AWG	16AWG	14AWG	14AWG	12AWG	12AWG	10AWG	10AWG	10AWG	10AWG	8AWG
	4.6	16AWG	16AWG	16AWG	14AWG	12AWG	12AWG	10AWG	10AWG	10AWG	8AWG	8AWG	8AWG
	4.7	16AWG	16AWG	16AWG	14AWG	12AWG	12AWG	10AWG	10AWG	10AWG	8AWG	8AWG	8AWG
	4.9	16AWG	16AWG	14AWG	14AWG	12AWG	10AWG	10AWG	10AWG	8AWG	8AWG	8AWG	8AWG
	5.2	16AWG	16AWG	14AWG	12AWG	12AWG	10AWG	10AWG	10AWG	8AWG	8AWG	8AWG	N/R
	7.6	16AWG	16AWG	14AWG	12AWG	10AWG	10AWG	8AWG	8AWG	8AWG	N/R	N/R	N/R
	8.6	16AWG	16AWG	12AWG	10AWG	10AWG	8AWG	8AWG	8AWG	N/R	N/R	N/R	N/R
	15.4	12AWG	12AWG	10AWG	8AWG	8AWG	N/R	N/R	N/R	N/R	N/R	N/R	N/R

Table A2-5, 220VAC SINGLE PHASE 2% DROP

DISTANCE IN FEET		10	25	50	75	100	125	150	175	200	225	250	300
CURRENT DRAW	0.6	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG
	1.1	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG
	1.4	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG
	1.9	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG
	2	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG
	2.3	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	14AWG	14AWG
	2.8	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	14AWG	14AWG	12AWG
	3.8	16AWG	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	14AWG	12AWG	12AWG	12AWG	10AWG

	4.6	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	14AWG	12AWG	12AWG	12AWG	10AWG	10AWG
	4.7	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	14AWG	12AWG	12AWG	12AWG	10AWG	10AWG
	4.9	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	12AWG	12AWG	12AWG	12AWG	10AWG	10AWG
	5.2	16AWG	16AWG	16AWG	16AWG	14AWG	14AWG	12AWG	12AWG	12AWG	10AWG	10AWG	10AWG
	7.6	16AWG	16AWG	16AWG	14AWG	12AWG	12AWG	10AWG	10AWG	10AWG	10AWG	8AWG	8AWG
	8.6	16AWG	16AWG	16AWG	14AWG	12AWG	12AWG	10AWG	10AWG	10AWG	8AWG	8AWG	8AWG
	15.4	12AWG	12AWG	12AWG	10AWG	10AWG	8AWG	8AWG	8AWG	N/R	N/R	N/R	N/R

A.3 For power input cables, determine the total current draw of the maximum number of hoists to be run simultaneously then using the appropriate table based on the operating voltage; cross reference the length of the cable against the current draw to determine the gauge (AWG) of wire.

Table A3-1, 208 VAC 3PHASE 3% DROP

DISTANCE IN FEET		10	25	50	75	100	125	150	175	200	225	250	300
CURRENT DRAW	10	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	10AWG	10AWG	10AWG	8AWG
	15	12AWG	12AWG	12AWG	12AWG	12AWG	10AWG	10AWG	10AWG	8AWG	8AWG	8AWG	8AWG
	20	12AWG	12AWG	12AWG	12AWG	10AWG	10AWG	8AWG	8AWG	8AWG	8AWG	6AWG	6AWG
	25	10AWG	10AWG	10AWG	10AWG	10AWG	8AWG	8AWG	8AWG	6AWG	6AWG	6AWG	4AWG
	30	10AWG	10AWG	10AWG	10AWG	8AWG	8AWG	8AWG	6AWG	6AWG	6AWG	4AWG	4AWG
	35	8AWG	8AWG	8AWG	8AWG	8AWG	8AWG	6AWG	6AWG	6AWG	4AWG	4AWG	4AWG
	40	8AWG	8AWG	8AWG	8AWG	8AWG	6AWG	6AWG	6AWG	4AWG	4AWG	4AWG	2AWG
	45	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	4AWG	4AWG	4AWG	4AWG	2AWG
	50	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	4AWG	4AWG	4AWG	4AWG	2AWG	2AWG
	55	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	4AWG	4AWG	4AWG	2AWG	2AWG	2AWG
	60	4AWG	4AWG	4AWG	4AWG	4AWG	4AWG	4AWG	4AWG	2AWG	2AWG	2AWG	2AWG
	70	4AWG	4AWG	4AWG	4AWG	4AWG	4AWG	4AWG	2AWG	2AWG	2AWG	2AWG	2/0
	80	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2/0	2/0
	90	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2/0	2/0	2/0
	100	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2/0	2/0	2/0	2/0
	110	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2/0	2/0	2/0	2/0	2/0
	120	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2/0	2/0	2/0	2/0	2/0
	130	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2/0	2/0	2/0	2/0	2/0	4/0
	140	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2/0	2/0	2/0	2/0	2/0	4/0
	150	2AWG	2AWG	2AWG	2AWG	2AWG	2/0	2/0	2/0	2/0	2/0	4/0	4/0
	160	2AWG	2AWG	2AWG	2AWG	2AWG	2/0	2/0	2/0	2/0	2/0	4/0	4/0
	170	2AWG	2AWG	2AWG	2AWG	2AWG	2/0	2/0	2/0	2/0	4/0	4/0	4/0
	180	2AWG	2AWG	2AWG	2AWG	2AWG	2/0	2/0	2/0	2/0	4/0	4/0	4/0
	190	2AWG	2AWG	2AWG	2AWG	2/0	2/0	2/0	2/0	4/0	4/0	4/0	4/0
	200	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	4/0	4/0	4/0	500MCM
	210	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	4/0	4/0	4/0	500MCM
	220	2/0	2/0	2/0	2/0	2/0	2/0	2/0	4/0	4/0	4/0	4/0	500MCM
	230	2/0	2/0	2/0	2/0	2/0	2/0	2/0	4/0	4/0	4/0	4/0	500MCM

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DISTANCE IN FEET		10	25	50	75	100	125	150	175	200	225	250	300
CURRENT DRAW	240	2/0	2/0	2/0	2/0	2/0	2/0	2/0	4/0	4/0	4/0	500MCM	500MCM
	250	2/0	2/0	2/0	2/0	2/0	2/0	4/0	4/0	4/0	4/0	500MCM	500MCM
	260	2/0	2/0	2/0	2/0	2/0	2/0	4/0	4/0	4/0	4/0	500MCM	500MCM
	270	2/0	2/0	2/0	2/0	2/0	2/0	4/0	4/0	4/0	500MCM	500MCM	500MCM
	280	2/0	2/0	2/0	2/0	2/0	2/0	4/0	4/0	4/0	500MCM	500MCM	500MCM
	290	2/0	2/0	2/0	2/0	2/0	2/0	4/0	4/0	4/0	500MCM	500MCM	500MCM
	300	2/0	2/0	2/0	2/0	2/0	4/0	4/0	4/0	500MCM	500MCM	500MCM	500MCM
	310	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	500MCM	500MCM	500MCM	500MCM
	320	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	500MCM	500MCM	500MCM	500MCM
	330	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	500MCM	500MCM	500MCM	500MCM
	340	4/0	4/0	4/0	4/0	4/0	4/0	4/0	500MCM	500MCM	500MCM	500MCM	500MCM
	350	4/0	4/0	4/0	4/0	4/0	4/0	4/0	500MCM	500MCM	500MCM	500MCM	500MCM
	360	4/0	4/0	4/0	4/0	4/0	4/0	4/0	500MCM	500MCM	500MCM	500MCM	500MCM
	370	4/0	4/0	4/0	4/0	4/0	4/0	4/0	500MCM	500MCM	500MCM	500MCM	500MCM
	380	4/0	4/0	4/0	4/0	4/0	4/0	4/0	500MCM	500MCM	500MCM	500MCM	500MCM
	390	4/0	4/0	4/0	4/0	4/0	4/0	4/0	500MCM	500MCM	500MCM	500MCM	500MCM
	400	4/0	4/0	4/0	4/0	4/0	4/0	500MCM	500MCM	500MCM	500MCM	500MCM	500MCM

NOTE: For the purposes of this document, parallel 4/0 may be substituted for 500MCM.

Table A3-2, 480 VAC 3PHASE 3% DROP

DISTANCE IN FEET		10	25	50	75	100	125	150	175	200	225	250	300
CURRENT DRAW	10	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG
	15	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	10AWG
	20	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	12AWG	10AWG	10AWG	10AWG
	25	10AWG	10AWG	10AWG	10AWG	10AWG	10AWG	10AWG	10AWG	10AWG	10AWG	10AWG	8AWG
	30	10AWG	10AWG	10AWG	10AWG	10AWG	10AWG	10AWG	10AWG	10AWG	8AWG	8AWG	8AWG
	35	8AWG	8AWG	8AWG	8AWG	8AWG	8AWG	8AWG	8AWG	8AWG	8AWG	8AWG	8AWG
	40	8AWG	8AWG	8AWG	8AWG	8AWG	8AWG	8AWG	8AWG	8AWG	8AWG	8AWG	6AWG
	45	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG
	50	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG
	55	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG	6AWG
	60	4AWG	4AWG	4AWG	4AWG	4AWG	4AWG	4AWG	4AWG	4AWG	4AWG	4AWG	4AWG
	70	4AWG	4AWG	4AWG	4AWG	4AWG	4AWG	4AWG	4AWG	4AWG	4AWG	4AWG	4AWG
	80	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG
	90	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG
	100	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG
	110	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG
	120	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG
	130	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG
	140	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG

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DISTANCE IN FEET		10	25	50	75	100	125	150	175	200	225	250	300
CURRENT DRAW	150	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2/0
	160	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2/0
	170	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2/0
	180	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2/0	2/0
	190	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2AWG	2/0	2/0
	200	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0
	210	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0
	220	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0
	230	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0
	240	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0
	250	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0
	260	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0
	270	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0
	280	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0
	290	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	4/0
	300	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	2/0	4/0
	310	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0
	320	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0
	330	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0
	340	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0
	350	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0
	360	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0
	370	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0
	380	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0
	390	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0
	400	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0

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