Industrial Maintenance

DC Motor Drive

Courseware Sample

38529-F0

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Safety and Common Symbols

The following safety and common symbols may be used in this manual and on the equipment:

Symbol	Description
DANGER	**DANGER** indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.
WARNING	**WARNING** indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
CAUTION	**CAUTION** indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
CAUTION	**CAUTION** used without the *Caution, risk of danger* sign ⚠, indicates a hazard with a potentially hazardous situation which, if not avoided, may result in property damage.
	Caution, risk of electric shock
	Caution, hot surface
	Caution, risk of danger
	Caution, lifting hazard
	Caution, hand entanglement hazard
	Notice, non-ionizing radiation
	Direct current
	Alternating current
	Both direct and alternating current
	Three-phase alternating current

Safety and Common Symbols

Symbol	Description
	Earth (ground) terminal
	Protective conductor terminal
	Frame or chassis terminal
	Equipotentiality
	On (supply)
	Off (supply)
	Equipment protected throughout by double insulation or reinforced insulation
	In position of a bi-stable push control
	Out position of a bi-stable push control

We invite readers of this manual to send us their tips, feedback, and suggestions for improving the book.

Please send these to did@de.festo.com.

The authors and Festo Didactic look forward to your comments.

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To the Instructor

- Before a student begins a work order, make sure that the equipment is in good condition and does not represent any risk when used.

- Whenever a lockout/tagout is required, make sure that each student working on the Industrial Wiring Training System has and installs a padlock on the safety switch handle of the system's three-phase power bus.

- Before a student begins a work order, make sure that he or she has read the relevant sections of the reference material and understands the objectives of the job to be done.

- This guide provides you with the list of points that should be checked to assess the student's work. The guide also provides notes that contain complementary information on how to perform the work order.

- Photographs in the work order show several electrical components used in DC motor drives as well as the construction of a DC motor drive at various stages. Most of these photographs were taken at the time the DC motor drive was designed. Although every effort is made to keep these pictures up to date, you may notice some differences between what is shown in the pictures and the components you received. This is normal and reflects Lab-Volt's commitment toward continuous product improvement.

Sample Work Order

Extracted from

DC Motor Drive

Installing a DC Motor Drive

Tasks: To assemble a DC motor drive and install it on the Mobile Workstation. To connect the DC motor drive to a 1/2-HP, permanent magnet DC motor. To verify the operation of the DC motor drive and make the proper adjustments.

PROCEDURE

☐ 1. Perform the basic safety procedures listed in Appendix C of this manual.

☐ 2. Familiarize yourself with the work to be done by carefully examining the schematic diagram, connection diagram, interconnection diagram, and riser diagram of the DC motor drive.

☐ 3. Identify the 1/2-HP, permanent magnet DC motor. A typical permanent magnet DC motor is shown in Figure 1-1. A motor is identified by reading the information on its nameplate.

Figure 1-1. A permanent magnet DC motor.

Note: *The description and Lab-Volt part number of each component required in this work order is provided in the Equipment Utilization Chart (Appendix A of this manual).*

☐ 4. Install the motor control enclosure (MCE) and the 1/2-HP, permanent magnet DC motor (M) on the Mobile Workstation as shown in Figure 1-2.

Note: *A transparent tubular shield must be installed in front of the DC motor to avoid accidental contact with the motor shaft.*

Figure 1-2. Motor control enclosure and 1/2-HP, permanent magnet DC motor installed on the Mobile Workstation.

☐ 5. Identify the single-pole safety switch. A typical single-pole safety switch is shown in Figure 1-3. This safety switch is of the rotary type and is designed to be mounted on a DIN rail. The switch handle is to be mounted on the door panel of the enclosure in which the safety switch is installed.

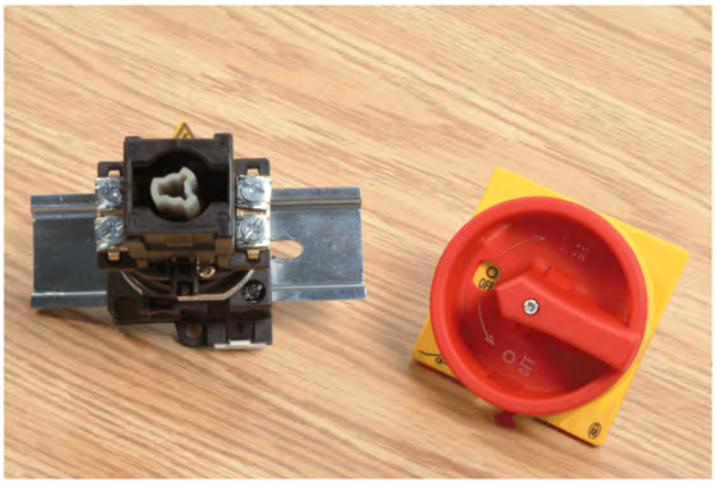

Figure 1-3. A single-pole safety switch designed to be mounted on a DIN rail, and its handle.

☐ 6. Identify the single-pole fuse holder. A typical single-pole fuse holder is shown in Figure 1-4. This fuse holder has a flip-type fuse drawer and is designed to be mounted on a DIN rail. Connections are made through terminal blocks integrated to the unit.

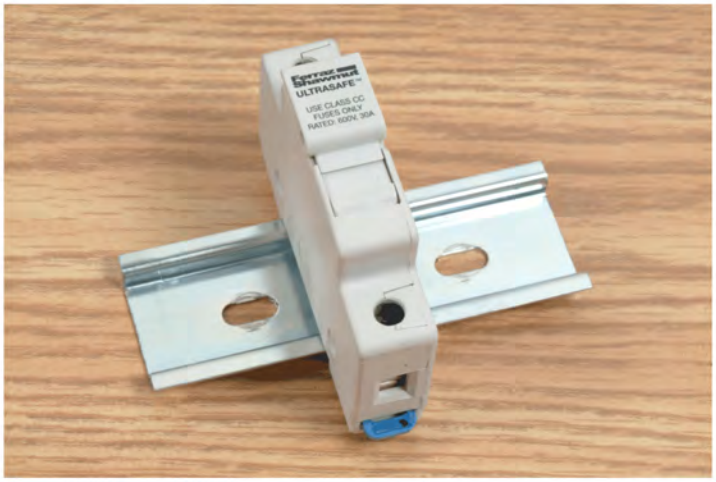

Figure 1-4. A single-pole fuse holder designed to be mounted on a DIN rail.

☐ 7. Identify the DC motor drive. Figure 1-5 shows a typical DC motor drive. This DC motor drive consists of numerous electronic components mounted on a printed circuit board (pcb). This pcb is designed to be installed on the MCE mounting plate.

Figure 1-5. A DC motor drive.

☐ 8. Install the electrical components of the DC motor drive on the MCE mounting plate as indicated in the DC motor drive connection diagram. Apply the required identification labels.

Wire the components according to the DC motor drive connection diagram and in compliance with the National Electrical Code® (NEC®). Install the required fuses. Check all your connections.

Set the trim potentiometers (trimpots) of the DC motor drive as indicated in the supplied installation instructions.

☐ 9. Using the information in the riser diagram and interconnection diagram of the DC motor drive, install the conduits (except the one going to the wiring trough) required to interconnect the various elements of the DC motor drive.

☐ 10. Using the information in the riser diagram and interconnection diagram of the DC motor drive, install the conductors required in the various conduits.

> **Note:** *The conductors going to the wiring trough (WT) of the system's three-phase power bus will be installed later in the work order.*

☐ 11. Install the assembled DC motor drive in the MCE. Apply an identification label to the outside of the MCE door panel. Apply the required fuse identification label to the inner side of the MCE door panel.

☐ 12. Install the safety switch handle on the MCE door panel. An extension shaft is required to link the safety switch handle to the safety switch on the MCE mounting plate. Figure 1-6 shows an extension shaft. If necessary, refer to the installation instructions provided with the safety switch.

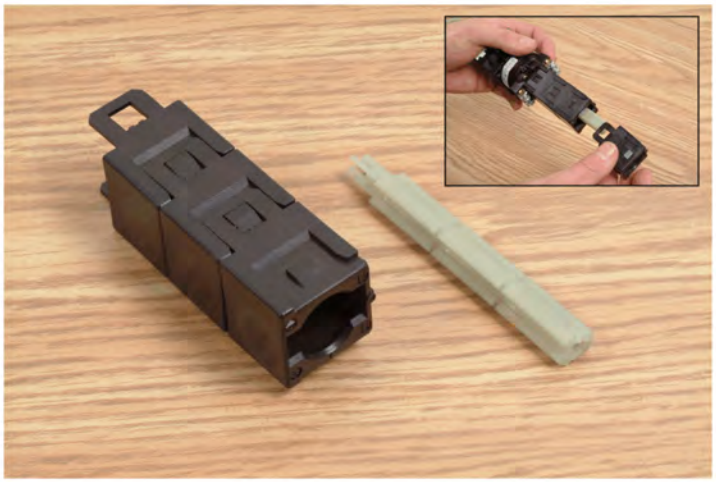

Figure 1-6. An extension shaft for a safety switch.

☐ 13. Install the DC motor drive controls on the MCE door panel as indicated in the DC motor drive connection diagram. Apply the required identification labels.

Figure 1-7 shows the components required to assemble a typical potentiometer (variable resistor), and an assembled unit.

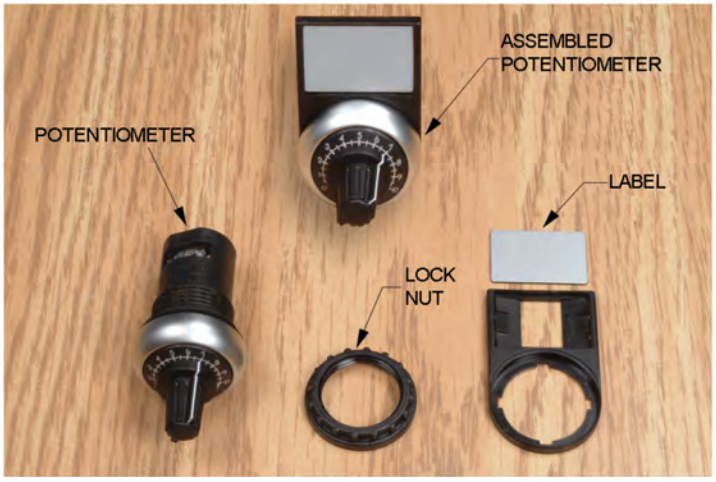

Figure 1-7. Components required to assemble a typical potentiometer, and an assembled potentiometer.

Figure 1-8 shows the components required to assemble a typical Start/Stop switch (rotary type), and an assembled switch.

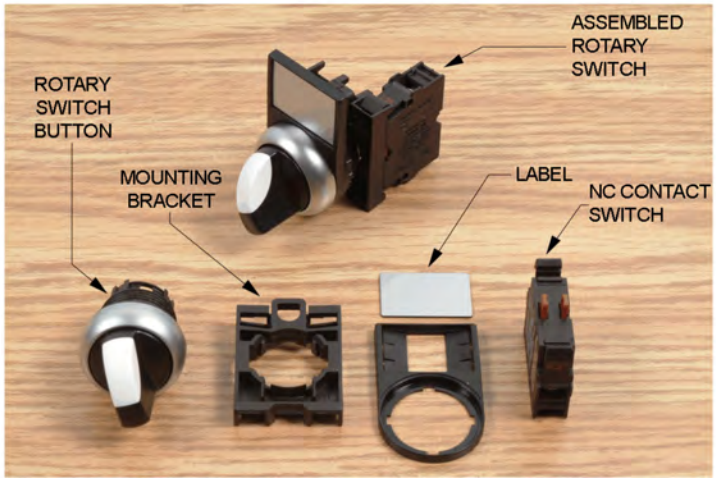

Figure 1-8. Components required to assemble a typical Start/Stop switch (rotary type), and an assembled switch.

☐ 14. Wire the controls installed on the MCE door panel as indicated in the DC motor drive connection diagram, and in compliance with the National Electrical Code® (NEC®). Check all your connections.

> **Note:** *To avoid damages to the potentiometer installed on the MCE door panel, do not apply too much torque when tightening the pressure terminal screws on this component.*

☐ 15. Wire the DC motor drive and the 1/2-HP, permanent magnet DC motor as indicated in the DC motor drive interconnection diagram, and in compliance with the National Electrical Code® (NEC®). Check all your connections.

☐ 16. Perform a lockout/tagout to de-energize the Industrial Wiring Training System. The lockout/tagout procedure specific to the Industrial Wiring Training System is provided in Appendix D of this manual.

Before you perform the next step, ask your instructor to check that the Industrial Wiring Training System is de-energized and the lockout/tagout procedure has been performed correctly.

WARNING

To avoid electric shock hazards, do not continue this work order as long as your instructor has not confirmed that the Industrial Wiring Training System is de-energized and the lockout/tagout procedure has been performed correctly.

☐ 17. Using the information in the riser diagram and interconnection diagram of the DC motor drive, install the conduit required to mechanically interconnect the MCE and the wiring trough, install the required conductors in the conduit, and make the electrical connections required in the MCE and the

wiring trough to connect the power lines and the grounded conductor to the DC motor drive.

☐ 18. Re-energize the Industrial Wiring Training System. The specific procedure to be followed to re-energize the Industrial Wiring Training System is provided in Appendix D of this manual.

WARNING

High voltage is now present in the Industrial Wiring Training System! Be careful and follow all usual safety rules as you perform the following manipulations.

☐ 19. Make sure that the Start/Stop switch on the MCE door is set to the Stop position. Set the safety switch handle on the MCE door to the I (on) position.

☐ 20. Verify that the DC motor drive operates correctly. If so, go to step 22. Otherwise, go to step 21.

☐ 21. Perform the necessary checks and tests to identify the cause of the problem. Make the corrections required and go back to step 20 of this work order.

WARNING

If certain checks and tests require the DC motor drive to be energized, be very careful and follow all usual safety rules to avoid electric shock hazards.

☐ 22. Install the transparent protective cover on the DC motor drive. Ask your instructor to check and approve your work.

☐ 23. Disassemble the DC motor drive following the directives of your instructor.

Name: _____ Date: _____

Instructor's Approval: _____

Instructor Guide Sample

Work Order

Extracted from

DC Motor Drive

Installing a DC Motor Drive

Student Assessment

The following points should be checked to assess the student's work:

Step 4

- ☐ The motor control enclosure (MCE) and the 1/2-HP, permanent magnet DC motor are positioned as shown in Figure 1-2 of the student manual.
- ☐ The metal strut required to install the MCE is approximately 40" long, level, and properly secured to the Mobile Workstation with fasteners at both ends. Each fastener consists of a bolt, a lock washer, a large flat washer, and a spring nut.
- ☐ The MCE is level and secured to the 40" metal strut and the upper horizontal rail of the Mobile Workstation with a fastener at each corner. Each fastener consists of a bolt, a lock washer, a large flat washer, and a spring nut.
- ☐ The 1/2-HP, permanent magnet DC motor is installed on two 12" long metal struts secured to the lower horizontal rails of the Mobile Workstation with fasteners (bolt, lock washer, large flat washer, and spring nut) at both ends. The motor base is secured to the metal struts with a fastener (bolt, lock washer, large flat washer, and lock nut) at each corner.
- ☐ To prevent accidental contact with the motor shaft, a transparent tubular shield is installed in front of the 1/2-HP, permanent magnet DC motor as shown in Figure 1-1. The metal bracket that holds the tubular shield is secured to a 12" metal strut with two fasteners (bolt, lock washer, large flat washer, and spring nut). The 12" metal strut is secured to the lower horizontal rails of the Mobile Workstation with a fastener at each end (bolt, lock washer, large flat washer, and spring nut).
- ☐ The bolts, screws, and nuts of all fasteners are tightened firmly.

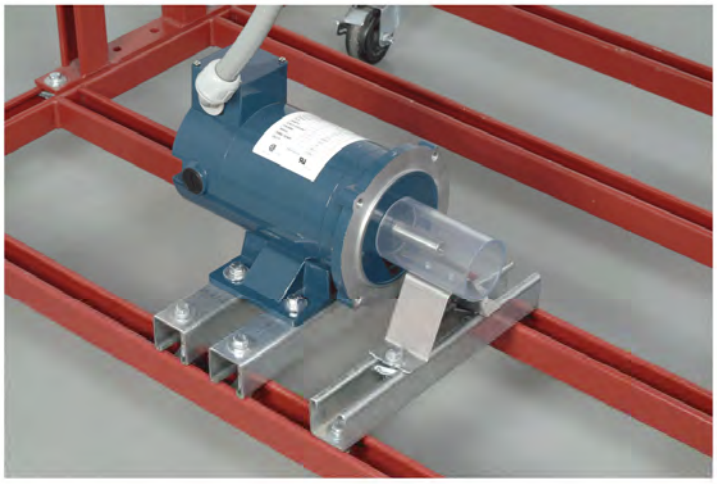

Figure 1-1. A transparent tubular shield installed in front of the 1/2-HP, permanent magnet DC motor prevents accidental contact with the motor shaft.

Step 8

- ☐ The electrical components of the DC motor drive (fuse holder, safety switch, printed circuit board of the DC motor drive, and terminal blocks) are installed on the mounting plate of the MCE at the locations shown in the DC motor drive connection diagram. See Figure 1-2.
- ☐ All electrical components of the DC motor drive are securely fastened to the MCE mounting plate.
- ☐ Labels applied to the MCE mounting plate identify the power line input terminals (L and N) as indicated in the DC motor drive connection diagram. See Figure 1-2.
- ☐ Labels applied to the MCE mounting plate identify the single-pole fuse holder (F1), single-pole safety switch (S1), and DC motor drive (DRV) as indicated in the DC motor drive connection diagram. See Figure 1-2.
- ☐ Labels applied to the MCE mounting plate identify the terminal blocks as indicated in the DC motor drive connection diagram. See Figure 1-2.
- ☐ A label applied to the printed circuit board (pcb) of the DC motor drive identifies the fuse holder (F2) as indicated in the DC motor drive connection diagram. See Figure 1-2.
- ☐ The terminals of each terminal block are identified as indicated in the DC motor drive connection diagram.
- ☐ The electrical components are wired as indicated in the DC motor drive connection diagram and in compliance with Articles 110, 250, 310, 312, and 430 of the National Electrical Code® (NEC®).

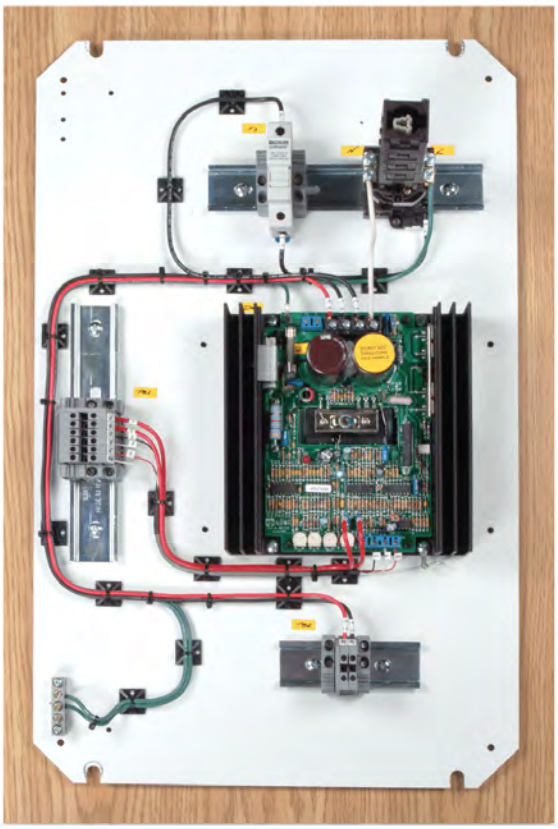

Figure 1-2. Assembled DC motor drive (MCE mounting plate).

☐ A conductor of type MTW and size no. 14 AWG, with white insulation, should be used for the neutral conductor that goes from the single-pole safety switch to the DC motor drive. See Figure 1-2.

☐ Conductors of type MTW and size no. 14 AWG, with black insulation, should be used for the live conductors (L) that go from the single-pole safety switch to the fuse holder F1, and from the fuse holder F1 to the DC motor drive. See Figure 1-2.

☐ A conductor of type MTW and size no. 14 AWG, with green insulation, should be used for the grounded conductor that goes from the single-pole safety switch to the equipment grounding terminal. See Figure 1-2.

☐ A conductor of type MTW and size no. 16 AWG, with green insulation, should be used for the grounded conductor that goes from the DC motor drive to the equipment grounding terminal. A crimped round lug must be used at one end of this conductor for the connection to the DC motor drive. See Figure 1-2.

☐ Conductors of type MTW and size no. 16 AWG, with red insulation, should be used for control wires 1 and 2. Crimped lugs must be used at one end of these conductors for the connections to the DC motor drive. See Figure 1-2.

☐ A conductor of type MTW and size no. 16 AWG, with red insulation, should be used for conductor 33 (armature, positive). See Figure 1-2.

☐ A conductor of type MTW and size no. 16 AWG, with black insulation, should be used for conductor 34 (armature, negative). See Figure 1-2.

☐ A shielded cable with at least three conductors of size no. 22 AWG should be used for control wires 3 to 5. The insulation of the conductors used can be of any color except green. Any extra conductor in the cable must be cut at both ends of the cable. A heat-shrinkable insulating sleeve should be installed at both ends of the cable. See Figure 1-3.

☐ One end of the cable shield must be connected to the chassis of the DC motor drive and the other end must be connected to terminal block TB1. An insulating sleeve should be installed on both ends of the cable shield. The cable shield has to be soldered to a round lug for the connection to the DC motor drive. See Figure 1-3.

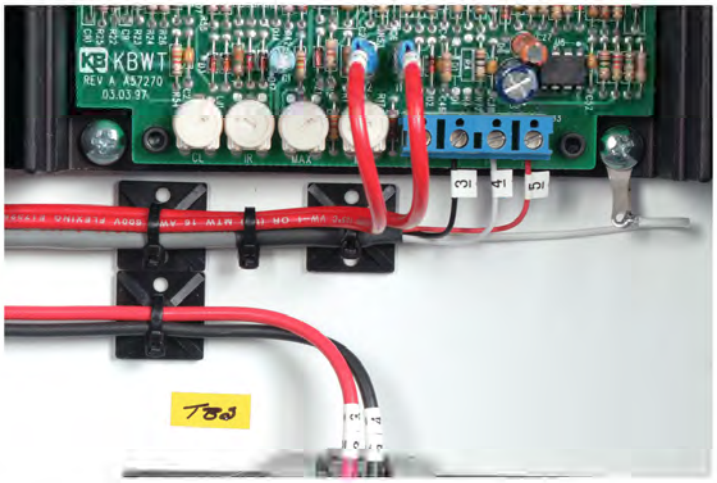

Figure 1-3. Connections of the shielded cable at the DC motor drive.

☐ The setscrews on the pressure terminals are fastened tightly to ensure solid connections of all conductors.

☐ The conductors are organized neatly and kept together using proper fasteners (e.g., cable ties). See Figure 1-2.

☐ All conductors except the neutral and grounded conductors are identified at each end using wire marking tapes, as indicated in the DC motor drive connection diagram.

☐ The required fuse (see legend in the DC motor drive schematic diagram for the type of fuse required) is installed in the fuse holder F1.

☐ The required fuse (see legend in the DC motor drive schematic diagram for the type of fuse required) is installed in the fuse holder F2 located on the DC motor drive pcb.

☐ The trim potentiometers (trimpots) of the DC motor drive are set as indicated in the supplied installation instructions.

Note to the Instructor

- It is your choice to have the electrical components of the DC motor drive installed and wired by the students or by competent personnel in charge of the laboratory equipment. If you choose to have the DC motor drive pre-wired by competent personnel (to avoid wear of or damages to the electrical components), instruct the students to skip this step of the work order.

- Completion of this step of the work order should require about two to three lab sessions (3 hours per session) depending on the student's skills.

Step 9

☐ The MCE and the 1/2-HP, permanent magnet DC motor are mechanically interconnected with 1/2" liquidtight flexible nonmetallic conduit (LFNC) as indicated in the DC motor drive riser diagram. See Figure 1-4.

☐ A fitting for LFNC is used for each conduit-to-enclosure (or conduit-to-box) connection.

☐ The threaded collar of each fitting is tightened firmly.

☐ Each fitting is secured tightly to the enclosure or box wall using a lock nut.

☐ All conduit bends are made in accordance with the guidelines of Article 356 of the National Electrical Code® (NEC®).

☐ The piece of 1/2" LFNC that mechanically interconnects the MCE and the permanent magnet DC motor should be securely fastened with a clamp to a 40" metal strut installed horizontally on the Mobile Workstation.

☐ Both ends of the piece of LFNC are cut neatly.

☐ Both ends of the piece of LFNC are properly seated in the fittings.

Figure 1-4. The DC motor drive with all conduits installed except the one that goes to the wiring trough of the system's three-phase power bus.

Note to the Instructor

- Each conduit-to-enclosure (or conduit-to-box) connection has to be dismantled carefully to check the last two items in the above list.
- Other types of conduit (e.g., EMT, FMC, etc.) can be used to mechanically interconnect the MCE and the permanent magnet DC motor, as long as they respect the applicable NEC® requirements.

Step 10

☐ The number of conductors in the conduit that interconnects the MCE and the permanent magnet DC motor is as indicated in the DC motor drive riser diagram. Conductors of type XHHW should be used.

- ☐ The size of the conductors installed in the conduit is as indicated in the DC motor drive riser diagram.
- ☐ The conductor to be connected to ground must have green insulation.
- ☐ The conductors numbered 33 and 34 that carry current to the 1/2-HP, permanent magnet DC motor should have red and black insulation, respectively.
- ☐ The length of free conductors at each enclosure or box is as stated in Article 300 of the National Electrical Code® (NEC®).
- ☐ A fish tape, wire grip (e.g., a basket grip), and wire lubrication compound are used when pulling the conductors into the conduit. A pull line may be required to pull conductors into the conduit.

Step 11

- ☐ The mounting plate on which the DC motor drive is mounted is installed in the MCE and securely fastened.
- ☐ An identification label marked "MCE" is applied to the door of the motor control enclosure.
- ☐ A label applied to the inner side of the MCE door panel clearly identifies the different types of fuses required in the DC motor drive (see legend in the DC motor drive schematic diagram for types of fuses required).

Step 12

- ☐ The safety switch handle is positioned on the MCE door panel so that it aligns with the extension shaft of the single-pole safety switch.
- ☐ The safety switch handle is securely fastened to the MCE door panel with the provided screws.
- ☐ The safety switch is actuated (switched on or off) when the handle is set to either the ON (I) or OFF (O) position.
- ☐ The MCE door can be opened only when the handle is set to the OFF (O) position.

Step 13

☐ The DC motor drive controls are installed on the MCE door panel at the locations shown in the DC motor drive connection diagram. See Figure 1-5.

Figure 1-5. DC motor drive controls installed on the MCE door panel.

☐ All DC motor drive controls are securely fastened to the MCE door panel.

☐ Labels applied to the inner side of the MCE door panel identify the DC motor drive controls as indicated in the DC motor drive connection diagram. See Figure 1-5.

Note to the Instructor

- Installing the safety switch handle and the DC motor drive controls onto the MCE door panel requires some skill and accuracy. If you choose to have these components installed by competent personnel, instruct the students to skip these steps of the work order.

Step 14

☐ The DC motor drive controls are wired as indicated in the DC motor drive connection diagram, and in compliance with Articles 110, 250, 310, 312, and 430 of the National Electrical Code® (NEC®).

☐ Conductors of type MTW and size no. 16 AWG, with red insulation, should be used for control wires 1 and 2. See Figure 1-6.

Figure 1-6. Connections of the DC motor drive controls.

☐ A shielded cable with at least three conductors of size no. 22 AWG should be used for control wires 3 to 5. The insulation of the conductors used can be of any color except green. Any extra conductor in the cable must be cut at both ends of the cable. A heat-shrinkable insulating sleeve should be installed at both ends of the cable. See Figure 1-6.

☐ One end of the cable shield must be connected to the terminal block TB1. An insulating sleeve should be installed on this end of the cable shield. The cable shield at the other end of the cable must be cut. See Figure 1-6.

☐ A conductor of type MTW and size no. 16 AWG, with green insulation, and a crimped round lug must be used to connect the ground stud on the MCE door panel to the equipment grounding terminal of the mounting plate. See Figure 1-6.

☐ The setscrews on the pressure terminals are fastened tightly to ensure solid connections of all conductors.

☐ The conductors are organized neatly and kept together using proper fasteners (e.g., cable ties, spiral wrap, etc). See Figure 1-6.

☐ All conductors except the grounded conductor are identified at each end using wire marking tapes, as indicated in the DC motor drive connection diagram.

Note to the Instructor

- It is your choice to have the DC motor drive controls installed and wired by the students or by competent personnel in charge of the laboratory equipment. If you choose to have the DC motor drive controls pre-wired by competent personnel (to avoid wear of or damages to the electrical components), instruct the students to skip this step of the work order.

- To avoid damages to the potentiometer installed on the MCE door panel, instruct the student to apply reasonable torque when tightening the pressure terminal screws on this component.

Step 15

☐ The DC motor drive and the 1/2-HP, permanent magnet DC motor are wired as indicated in the DC motor drive interconnection diagram, and in compliance with Articles 110, 250, 300, 310, 312, and 430 of the National Electrical Code® (NEC®). See Figures 1-7 and 1-8.

☐ The conductors installed in the conduit that connects the MCE to the 1/2-HP, permanent magnet DC motor are identified as indicated in the DC motor drive interconnection diagram. Each conductor should be identified at both ends. See Figures 1-7 and 1-8.

☐ The setscrews on the pressure terminals are fastened tightly to ensure solid connections of all conductors.

☐ The conductors are organized neatly and kept together using proper fasteners (e.g., cable ties). See Figure 1-7.

☐ The electrical connections at the 1/2-HP, permanent magnet DC motor should be made with #1 solderless connectors (setscrew type). See Figure 1-8.

☐ A grounding wire (green insulation conductor) should be securely fastened to the DC motor enclosure. See Figure 1-8.

Note to the Instructor

- To prolong the life of the DC motor wires, it is important to apply solder to the end of these wires. Also, use #1 solderless connectors (setscrew type) when making connections to these wires.

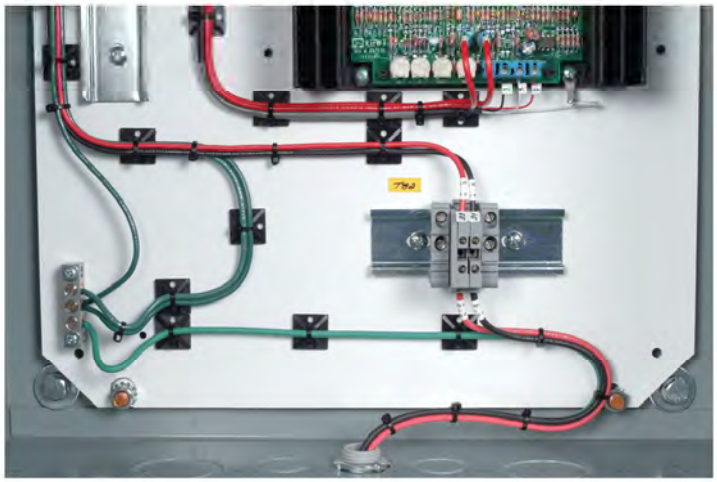

Figure 1-7. Connections on terminal block TB2 of the MCE.

Figure 1-8. Connections at the 1/2-HP, permanent magnet DC motor.

Step 16

Note to the Instructor

- **WARNING!** To avoid electric shock hazards, it is important that you check that the Industrial Wiring Training System is de-energized and the main disconnect switch is locked out and tagged out properly before the student begins the connection of the DC motor drive to the power lines.

- It is suggested that you also install your own padlock and tag on the safety switch handle of the system's three-phase power bus. This will allow you to make sure that everything is safe before the students re-energize the Industrial Wiring Training System later in the work order.

Step 17

☐ The motor control enclosure (MCE) is mechanically connected to the wiring trough (WT) of the system's three-phase power bus with 1/2" flexible metal conduit (FMC).

☐ Fittings for FMC are used for the connections to the MCE and wiring trough. The setscrew on each fitting is tightened firmly. Each fitting is oriented so that the setscrew head is easily accessible. Each fitting is secured tightly to the MCE (or trough) wall using a lock nut.

☐ Both ends of the piece of FMC are cut neatly and properly seated in the fittings. Insulating bushings are inserted at both ends of the piece of FMC.

☐ The bends in the piece of FMC are made in accordance with the guidelines of Article 348 of the National Electrical Code® (NEC®).

☐ The piece of FMC should be securely fastened with a clamp to the upper horizontal metal strut of the Mobile Workstation.

☐ The number of conductors in the piece of FMC is as indicated in the DC motor drive riser diagram. Conductors of type XHHW should be used.

☐ The size of the conductors installed in the piece of FMC is as indicated in the DC motor drive riser diagram.

☐ The length of free conductors at the MCE is as stated in Article 300 of the National Electrical Code® (NEC®).

☐ A fish tape, wire grip (e.g., basket grip), and wire lubrication compound are used when pulling the conductors into the piece of FMC. A pull line should not be required.

☐ The conductors connected to terminals L and N of the DC motor drive (i.e., the power lines) must have black and white insulation, respectively. See Figure 1-9.

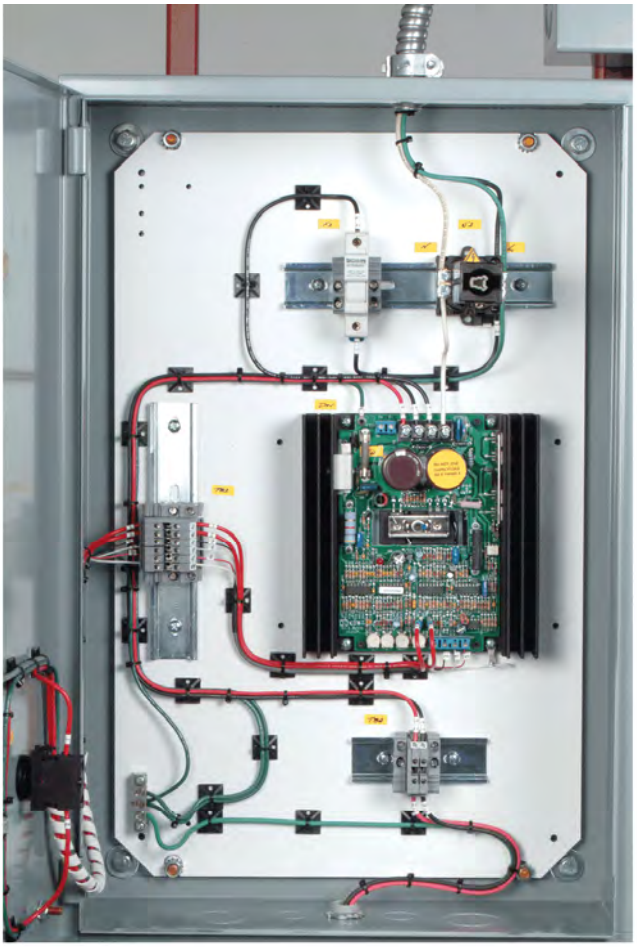

Figure 1-9. Connections in the MCE.

☐ The grounded conductor connected to the single-pole safety switch of the DC motor drive must have green insulation. See Figure 1-9.

☐ The length of free conductors at the wiring trough is sufficient to allow easy electrical connections.

☐ The electrical connections in the wiring trough are made with insulated wiring connectors similar to those shown in Figure 1-10.

Figure 1-10. Type of connector commonly used to make electrical connections in wiring troughs.

- ☐ The setscrews on the pressure terminals are fastened tightly to ensure solid connections of all conductors.
- ☐ The conductors are organized neatly and kept together using proper fasteners (e.g., cable ties). See Figure 1-9.

Note to the Instructor

- The FMC connections have to be dismantled carefully to check the third item in the above list.
- Other types of conduit (e.g., EMT, LFNC, etc.) can be used to mechanically interconnect the MCE and the wiring trough of the system's three-phase power bus, as long as they respect the applicable NEC® requirements.

Step 20
The DC motor drive should operate as follows:

- ☐ When the Start/Stop switch is set to the Stop position, the 1/2-HP, permanent magnet DC motor does not rotate no matter what the setting of the Speed control knob is.
- ☐ When the Start/Stop switch is set to the Start position, the 1/2-HP DC motor rotates clockwise at a speed that depends on the setting of the Speed control knob.
- ☐ The speed is zero or close to zero when the Speed control knob is turned fully counterclockwise. The speed increases when the Speed control knob is rotated clockwise.
- ☐ The 1/2-HP DC motor stops rotating when the Start/Stop switch is returned to the Stop position.

Note to the Instructor

- The DC motor may rotate at low speed when the Speed control knob is set fully counterclockwise. The motor speed may be zeroed by adjusting the minimum speed (MIN) trim potentiometer of the DC motor drive until the DC motor stops rotating. To make this adjustment, the student should set the safety switch handle on the MCE to the O (off) position, open the MCE door panel, set the single-pole safety switch to the I (on) position using a flat blade screwdriver, adjust the MIN trim potentiometer of the DC motor drive so that the motor stops rotating, set the single-pole safety switch to the O (off) position using a flat blade screwdriver, and close the MCE door panel.

Step 22

☐ The transparent protective cover is placed over the DC motor drive and securely fastened to the MCE mounting plate with four screws. Threaded holes have to be made in the MCE mounting plate for these screws.

Step 23

Note to the Instructor

- Before the student begins to disassemble the DC motor drive, tell him or her which elements of the equipment setup do not need to be disassembled (e.g., the DC motor drive assembled on the MCE mounting plate, the controls mounted on the MCE door panel, the permanent magnet DC motor installed on the Mobile Workstation, etc), if any.

- When the student has finished disassembling the DC motor drive, close the holes in the MCE with knockout snap-in blanks (see Figure 1-11). This will allow the MCE to be reused by another student. Knockout snap-in blanks are easily installed in enclosure holes using a nylon head hammer.

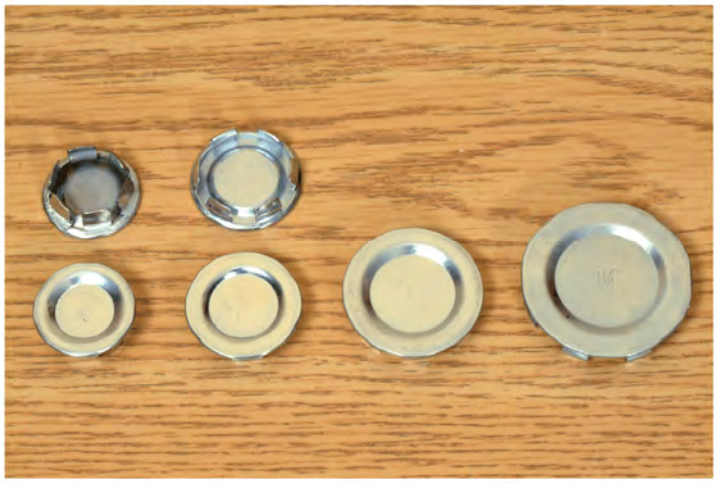

Figure 1-11. Knockout snap-in blanks of various sizes.