Industrial Maintenance

AC Motor Drive

Courseware Sample

38528-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.

- When a student has to complete a setup that is partially mounted, ensure that the setup corresponds to the task requested in the work order.

- 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.

- For each work order, 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 the way of performing certain work orders.

- Photographs in the work orders show several electrical components used in manual starters and AC motor drives as well as the construction of a manual starter and an AC motor drive at various stages. Most of these photographs were taken at the time the manual starter and the AC motor drive were 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

AC Motor Drive

Replacing the Manual Starter with an AC Motor Drive

Tasks: To replace the manual starter built in the previous work order with an AC motor drive. To set the operating parameters of the AC motor drive. To verify the operation of the AC motor drive.

PROCEDURE

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

☐ 2. Determine the work to be done in this work order by carefully comparing the electrical drawings of the manual starter built in the previous work order with those of the AC motor drive.

☐ 3. Set the handle of the three-pole safety switch S1 to the O (off) position to remove power from the manual starter. Install a padlock on the safety switch handle to make sure that electric power cannot be reapplied while you are working on the manual starter.

☐ 4. Disconnect the manual starter from the three-pole safety switch S1 and the 1/2-HP, three-phase induction motor.

☐ 5. Replace the MCE with a new enclosure large enough to house the electrical components of the AC motor drive.

> **Note:** *This new enclosure is referred to as the new MCE in the rest of this work order.*

☐ 6. Identify the AC motor drive. A typical AC motor drive is shown in Figure 2-1. An AC motor drive is an electronic device housed in a compact-sized plastic enclosure. A label is usually applied on the enclosure to provide the AC motor drive's electrical specifications.

Figure 2-1. A typical AC motor drive.

☐ 7. Identify the overload relay. A typical overload relay is shown in Figure 2-2. An overload relay is recognized by its current setting knob, reset button, and terminals labeled L1 to L3 and T1 to T3. Most overload relays also have a test button.

Figure 2-2. A typical overload relay.

☐ 8. Identify the molded plastic terminal blocks. Figure 2-3 shows an example of a molded plastic terminal block. The figure also shows a dual jumper used to interconnect two adjacent terminal block elements.

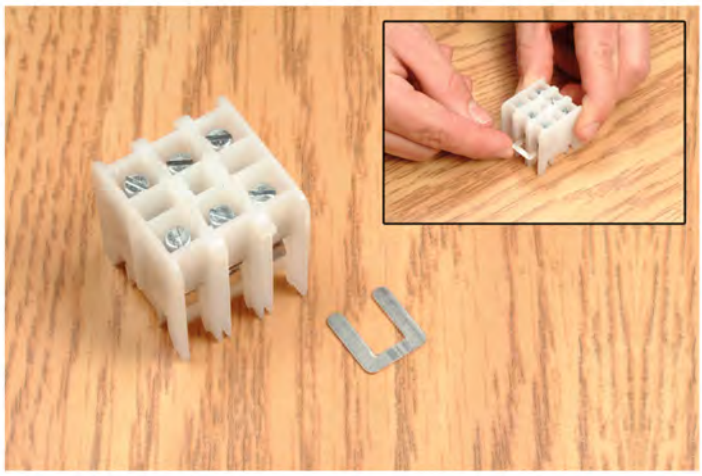

Figure 2-3. A molded plastic terminal block and a dual jumper used to interconnect two adjacent terminal block elements.

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

Wire the electrical components as indicated in the AC motor drive connection diagram, and in compliance with the National Electrical Code® (NEC®). Check all your connections.

☐ 10. Connect the conduits coming from the three-pole safety switch S1 and 1/2-HP, three-phase induction motor to the new MCE.

☐ 11. Using the information in the riser diagram and interconnection diagram of the AC motor drive, install any additional conductors required in the conduits that connect to the new MCE.

☐ 12. Install the mounting plate on which you wired the AC motor drive in the new MCE. Apply an identification label to the outside of the new MCE door panel.

☐ 13. Install the AC motor drive controls and pilot lights on the new MCE door panel as indicated in the AC motor drive connection diagram. Apply the required identification labels.

Figure 2-4 shows the components required to assemble a typical I/O push-button unit with a pilot light, and an assembled unit.

Figure 2-4. Components required to assemble a typical I/O push-button unit with a pilot light, and an assembled unit.

Figure 2-5 shows the components required to assemble a typical push button, and an assembled push button.

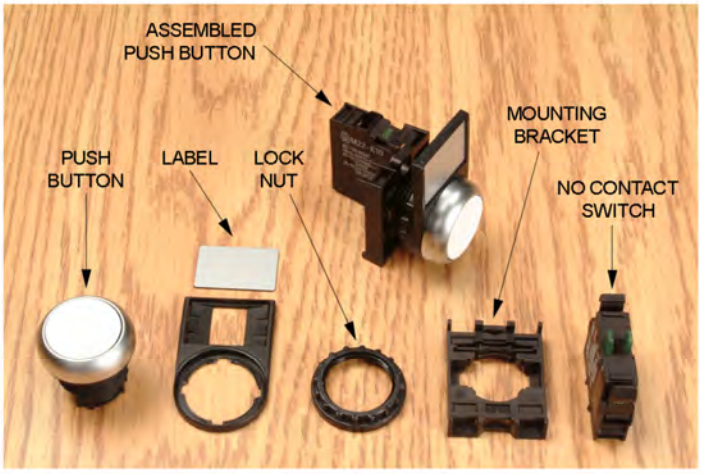

Figure 2-5. Components required to assemble a typical push button, and an assembled push button.

Figure 2-6 shows the components required to assemble a typical two-position (Forward/Reverse) selector, and an assembled selector.

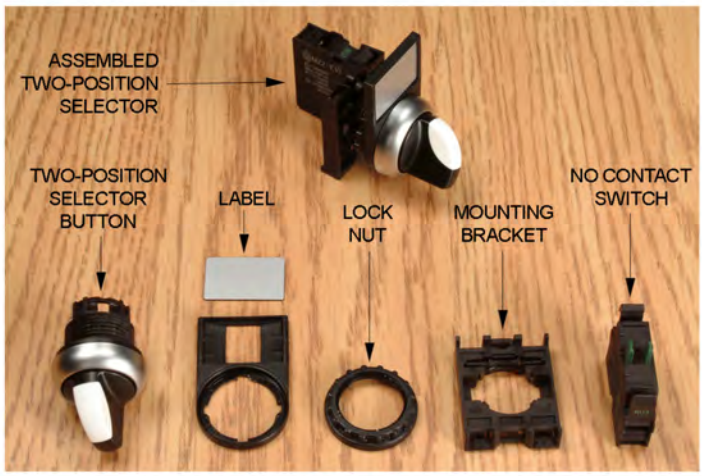

Figure 2-6. Components required to assemble a typical two-position (Forward/Reverse) selector, and an assembled selector.

Figure 2-7 shows the components required to assemble a typical pilot light, and an assembled pilot light.

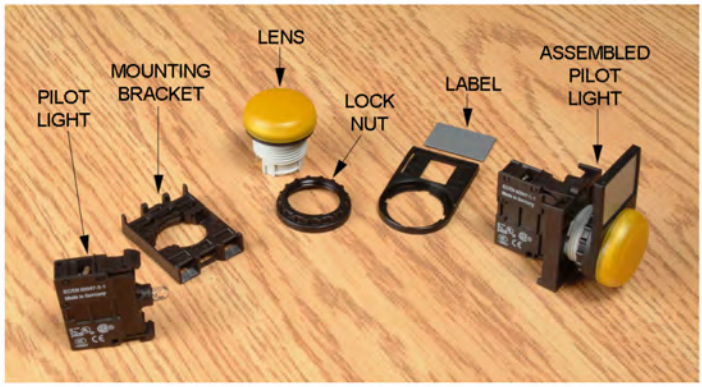

Figure 2-7. Components required to assemble a typical pilot light, and an assembled pilot light.

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

☐ 15. Connect the AC motor drive to the three-pole safety switch S1 and the 1/2-HP, three-phase induction motor as indicated in the AC motor drive interconnection diagram, and in compliance with the National Electrical Code® (NEC®). Check all your connections.

☐ 16. Apply power to the AC motor drive.

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.

Set the operating parameters of the AC motor drive as requested by your instructor. Refer to the instructions provided with the AC motor drive to learn how to change the operating parameters. Close the new MCE door when you have finished programming the AC motor drive.

☐ 17. Verify that the AC motor drive operates correctly. If so, go to step 19. Otherwise, go to the next step.

☐ 18. Perform the necessary checks and tests to identify the cause of the problem. Make the corrections required and go back to the previous step.

WARNING

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

☐ 19. **Optional Manipulation**: Assemble the blower (if available). Mechanically couple the 1/2-HP, three-phase induction motor to the blower. Refer to Appendix E of this manual to know how to perform these tasks.

Set the Foward/Reverse selector of the AC motor drive to the Reverse position so that the 1/2-HP, three-phase induction motor rotates counterclockwise. This direction of rotation is required when the induction motor is used with the blower.

☐ 20. Ask your instructor to check and approve your work.

☐ 21. Disassemble the AC motor drive following the directives of your instructor.

Name: _____ Date: _____

Instructor's approval: _____

Instructor Guide Sample

Work Order

Extracted from

AC Motor Drive

Replacing the Manual Starter with an AC Motor Drive

STUDENT ASSESSMENT

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

Step 2

☐ Ask the student questions to determine whether or not he or she correctly evaluates the work to be done in the work order. The following tasks should be mentioned by the student. These tasks should be performed in the order they are listed.

- Turn the power off by setting the handle of the three-pole safety switch S1 to the O (off) position. Install a padlock on the safety switch handle to make sure that electric power cannot be reapplied to the manual starter.
- Disconnect the manual starter from the three-pole safety switch S1 and the 1/2-HP, three-phase induction motor.
- Disconnect the conduits from the MCE.
- Remove the MCE from the Mobile Workstation and install a new enclosure large enough to house the electrical components of the AC motor drive.
- Identify the electrical components required to build the AC motor drive.
- Install the electrical components of the AC motor drive on the mounting plate of the new motor control enclosure (new MCE). Wire these electrical components as indicated in the connection diagram of the AC motor drive.
- Connect the conduits to the new MCE.
- Replace the grounded (green) conductor in the conduit that interconnects the three-pole safety switch S1 and the new MCE with a longer conductor of the same type and color, to allow connection to the equipment grounding terminal which is located in the lower left-hand corner of the new MCE mounting plate.
- Install the mounting plate (AC motor drive) in the new MCE.
- Install the controls and pilot lights of the AC motor drive on the new MCE door panel. Wire these controls and pilot lights as indicated in the connection diagram of the AC motor drive.
- Set the current setting of the overload relay to the value indicated in the legend of the AC motor drive schematic diagram.
- Connect the AC motor drive to the three-pole safety switch S1 and the 1/2-HP, three-phase induction motor as indicated in the AC motor drive interconnection diagram.
- Remove the padlock installed on the handle of the three-pole safety switch S1, and turn the power on by setting the switch handle to the I (on) position.
- Set the operating parameters of the AC motor drive.
- Verify the operation of the AC motor drive.

Step 3

☐ The student set the handle of the three-pole safety switch S1 to the O (off) position and installed a padlock on the safety switch handle to make sure that electric power cannot be reapplied while he or she is working on the manual starter.

Step 4

☐ The student disconnected the conductors from the manual starter and the ground terminal block installed in the MCE.

Step 5

☐ The MCE is removed from the Mobile Workstation.

☐ The 40" metal struts installed on the Mobile Workstation are positioned so as to allow installation of the new motor control enclosure (new MCE). See Figure 2-1.

☐ The new MCE is level and secured to two 40" metal struts with a fastener at each corner. Each fastener consists of a bolt, a lock washer, a large flat washer, and a spring nut. See Figure 2-1.

Figure 2-1. New MCE installed on the Mobile Workstation.

Step 9

☐ The electrical components of the AC motor drive are installed on the mounting plate of the new MCE at the locations shown in the AC motor drive connection diagram. See Figure 2-2.

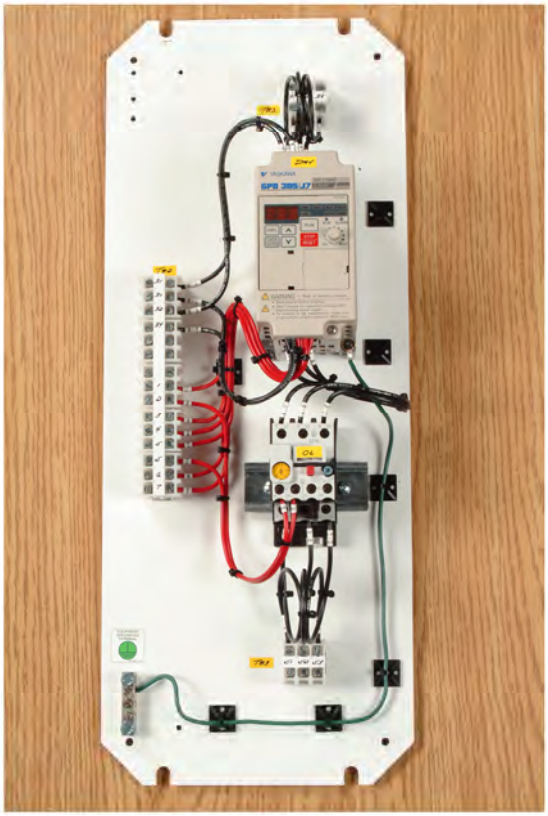

Figure 2-2. Assembled AC motor drive (new MCE mounting plate).

☐ All electrical components of the AC motor drive are securely fastened to the mounting plate of the new MCE.

☐ Labels applied to the AC motor drive and the overload relay identify these components as indicated in the AC motor drive connection diagram. See Figure 2-2.

☐ Labels applied to the mounting plate of the new MCE identify the terminal blocks as indicated in the AC motor drive connection diagram. See Figure 2-2.

☐ The terminals of each terminal block are identified as indicated in the AC motor drive connection diagram.

☐ A dual jumper is used to interconnect the two elements of terminal block TB2 that are numbered "5".

☐ A dual jumper is used to interconnect the two elements of terminal block TB2 that are numbered "31".

☐ A few terminal block elements are left unused on terminal block TB2 to have a physical separation between the power conductors (black insulation conductors) and the conductors used for control signals (red insulation conductors). See Figure 2-2.

☐ The electrical components are wired as indicated in the AC 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. 14 AWG, with black insulation, should be used for all connections that can carry current to the induction motor as well as the connections to terminals 31, 32, and 34 of terminal block TB2. See Figure 2-2.

☐ A conductor of type MTW and size no. 16 AWG, with green insulation, and a round lug should be used to connect the chassis of the AC motor drive to the equipment grounding terminal of the mounting plate. See Figure 2-2.

☐ Conductors of type MTW and size no. 16 AWG, with red insulation, should be used for all other connections of the AC motor drive (low-voltage control signal connections). See Figure 2-2.

☐ The conductors are routed so as to minimize the proximity between the power conductors (black insulation conductors) and control conductors (red insulation conductors). See Figure 2-2.

☐ 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 2-2.

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

☐ The current setting of the overload relay is set to the value indicated in the legend of the AC motor drive schematic diagram.

Note to the Instructor

- It is your choice to have the electrical components of the AC motor drive installed and wired by the students or by competent personnel in charge of the laboratory equipment. If you choose to have the AC 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 10

☐ The conduits coming from the three-pole safety switch S1 and 1/2-HP, three-phase induction motor are properly connected to the new MCE. See the previous work order for a list of the points to be checked when verifying conduit connections.

Note to the Instructor

- The conduit that interconnects the new MCE and the 1/2-HP, three-phase induction motor must be reduced in length slightly (about 6 to 8 inches) to allow proper installation, because the new MCE is larger than the original MCE. To reduce the length of this conduit without removing the conductors, the student can remove the electrical connections at the motor, disconnect the conduit from the motor, remove the fitting from the conduit, slightly pull the conductors at the new MCE (to temporarily enter the conductors into the conduit at the motor end), cut the conduit at the motor end, push the conductors at the MCE until the conductors protrude from the conduit at the motor end, put the fitting back on the conduit, reconnect the conduit to the motor, adjust (reduce) the length of the conductors at the motor, and redo the connections at the motor.

Step 11

Note to the Instructor

- Although no additional conductor is required in the conduits that connect to the new MCE, the grounded (green) conductor in the conduit that interconnects the three-pole safety switch S1 and the new MCE must be replaced with a longer conductor of the same type and color to allow connection to the equipment grounding terminal which is located in the lower left-hand corner of the new MCE mounting plate.

Step 12

☐ The mounting plate on which the student wired the AC motor drive is installed in the new MCE and securely fastened.

☐ An identification label marked "MCE" is applied to the outside of the new MCE door panel.

Step 13

☐ The AC motor drive controls and pilot lights are installed on the new MCE door panel at the locations shown in the AC motor drive connection diagram. See Figure 2-3.

Figure 2-3. AC motor drive controls and pilot lights installed on the new MCE door panel.

☐ All AC motor drive controls and pilot lights are securely fastened to the new MCE door panel.

☐ Labels applied to the inner side of the new MCE door panel identify the AC motor drive controls and pilot lights as indicated in the AC motor drive connection diagram. See Figure 2-3.

Step 14

☐ The AC motor drive controls and pilot lights are wired as indicated in the AC 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. 14 AWG, with black insulation, should be used for the connections that supply power to the pilot lights. See Figure 2-4.

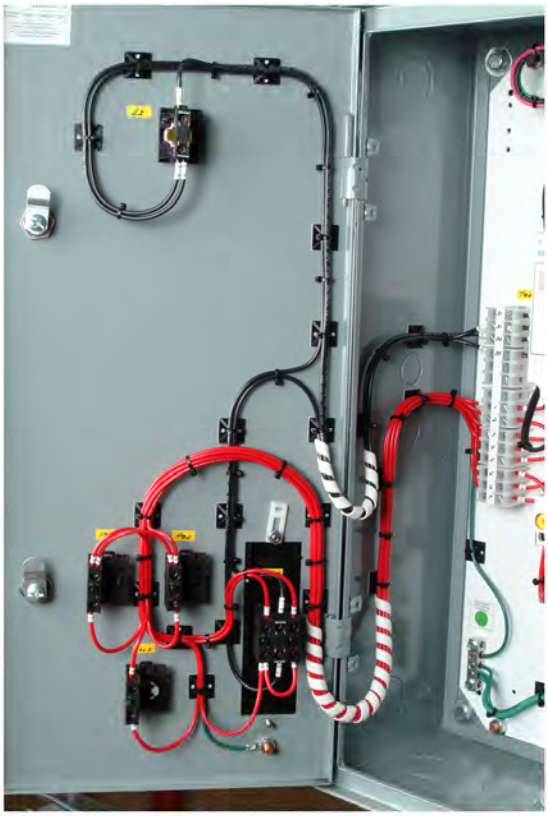

Figure 2-4. Connections of the AC motor drive controls and pilot lights.

☐ A conductor of type MTW and size no. 16 AWG, with green insulation, and a round lug must be used to connect the ground stud on the new MCE door panel to the equipment grounding terminal of the mounting plate. See Figure 2-4.

☐ Conductors of type MTW and size no. 16 AWG, with red insulation, should be used for the connections of the AC motor drive controls (low-voltage control signal conductors). See Figure 2-4.

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

☐ The conductors are routed so as to minimize the proximity between the power conductors (black insulation conductors) and control conductors (red insulation conductors). See Figure 2-4.

☐ The conductors are organized neatly and kept together using proper fasteners (e.g., cable ties, spiral wrap, etc). See Figure 2-4.

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

Note to the Instructor

- It is your choice to have the controls and pilot lights of the AC motor drive installed and wired by the students or by competent personnel in charge of the laboratory equipment. If you choose to have the AC 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.

- To avoid damages to the pilot lights installed on the new MCE door panel, instruct the student to apply reasonable torque when tightening the pressure terminal screws on these components.

Step 15

☐ The electrical components are wired as indicated in the AC motor drive interconnection diagram, and in compliance with Articles 110, 250, 300, 310, 312, and 430 of the National Electrical Code® (NEC®). See Figures 2-5 and 2-6.

☐ 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 2-5.

☐ The electrical connections at the 1/2-HP, three-phase induction motor should be made with #1 solderless connectors (setscrew type). See Figure 2-6.

☐ A grounded conductor (green insulation wire) should be securely fastened to the equipment grounding terminal of the MCE. See Figure 2-5.

☐ A grounded conductor (green insulation wire) should be securely fastened to the induction motor enclosure. See Figure 2-6.

Note to the Instructor

- To prolong the life of the induction 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.

- The connections to the three-phase induction motor changed (phase reversal of the winding connection) with respect to the previous installation. Make sure that the student noticed this change and made the correct connections at the three-phase induction motor.

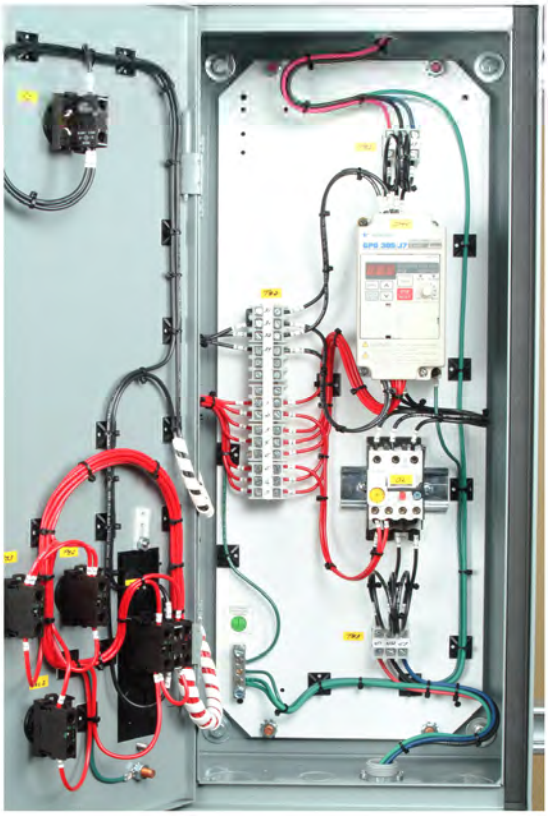

Figure 2-5. Connections in the new MCE.

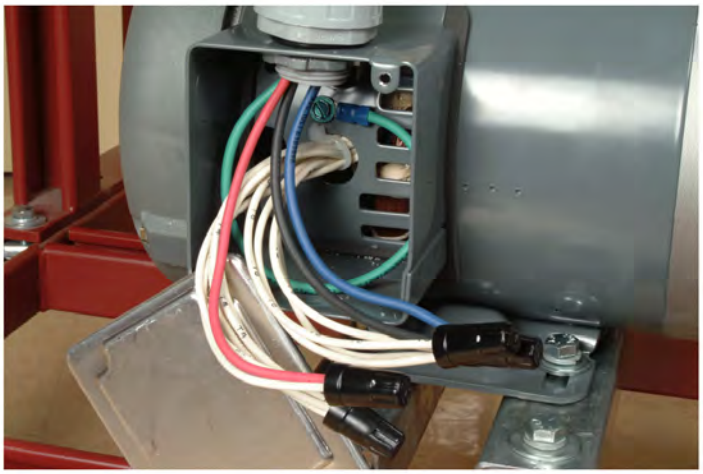

Figure 2-6. Connections at the 1/2-HP, three-phase induction motor.

Step 16

☐ The operating parameters of the AC motor drive are set as indicated in the *Note to the Instructor* below.

Note to the Instructor

- The AC motor drive operation depends on numerous parameters. These parameters have default values set at the factory. The values of some parameters (see tables below) must be changed so that the AC motor drive operates correctly in the present application.

  Make sure that the AC motor drive parameters are all set to the default values, then instruct the student to change the values of the operating parameters as indicated in the table corresponding to the model of AC motor drive installed.

  Refer to the instructions provided with the AC motor drive to learn how to change the operating parameters.

PARAMETER NUMBER	PARAMETER DESCRIPTION	PARAMETER VALUE
n03	Reference Selection	0 (digital operator pot.)
n10	Voltage - Max.	208 V
n12	Frequency- Midpoint	30 Hz
n13	Voltage - Midpoint	36 V
n15	Voltage - Min.	8 V
n32	Motor Rated Current	2.3 A
n33	Electronic Thermal Overload Protection	2 (disabled)
n37	Multi-Function Input Selection 3 (Terminal S3)	0 (Fwd/Rev command, 3-wire control)
n39	Multi-Function Input Selection 5 (Terminal S5)	34 (Up/Down command)

Table 2-1. AC motor drive parameters to be changed (Yaskawa J7).

PARAMETER NUMBER	PARAMETER DESCRIPTION	PARAMETER VALUE
E1-01	Input Voltage Setting	208 V
E1-05	Max Output Voltage	208 V
E1-07	Mid Output Frequency	30 Hz
E1-08	Mid Output Frequency Voltage	36 V
E1-10	Minimum Output Freq. Voltage	8 V
E2-01	Motor Rated Current	2.3 A
E2-05	Motor Line-to-Line Resistance	9.8 Ω
H1-03	Multi-Function Digital Input Terminal S3 Function Selection	0 (3-Wire Sequence)
H1-04	Multi-Function Digital Input Terminal S4 Function Selection	10 (Up Command)
H1-05	Multi-Function Digital Input Terminal S5 Function Selection	11 (Down Command)
H2-01	Terminal MA, MB, and MC Function Selection (Relay)	0 (During Run)
L1-01	Motor Overload Protection Selection	0 (Disabled)

Table 2-2. AC motor drive parameters to be changed (Yaskawa J1000).

Step 17

The AC motor drive should operate as follows:

- ☐ The Power On pilot light lights up when electric power is applied to the AC motor drive, i.e., when the handle of the three-pole safety switch S1 is set to the I (on) position.
- ☐ The Forward/Reverse selector and the Speed-Up and Speed-Down push buttons are not operational when the Motor Run pilot light is off.
- ☐ When the Motor Run I (on) push button is depressed momentarily, the Motor Run pilot light lights up.
- ☐ The 1/2-HP, three-phase induction motor rotates clockwise when the Forward/Reverse selector is set to the Forward position. The motor rotates counterclockwise when the Forward/Reverse selector is set to the Reverse position.
- ☐ The motor speed increases when the Speed-Up push button is depressed. The maximum speed depends on the maximum frequency parameter of the AC motor drive.
- ☐ The motor speed decreases when the Speed-Down push button is depressed. The minimum speed depends on the minimum frequency parameter of the AC motor drive.

☐ When the Motor Run O (off) push button is depressed momentarily, the motor speed decreases slowly until the induction motor stops rotating, then the Motor Run pilot light goes out.

☐ The Power On pilot light goes out when electric power is removed from the AC motor drive, i.e., when the handle of the three-pole safety switch S1 is set to the O (off) position.

Note to the Instructor

- Once the AC motor drive is operational, you can ask the student to use a power quality analyzer (if available) to measure the active power and displacement power factor at the AC motor drive input when the motor is running at full speed (without load), and note the results. You can ask the student to compare these results with those obtained with the manual starter in the same situation. The student should observe that the active power is approximately the same in both cases. The student should also observe that the displacement power factor obtained with the AC motor drive is much better than that obtained with the manual starter. This is a major gain since capacitor banks are not required to correct the displacement power factor (i.e., set the displacement power factor near unity).

- Once the AC motor drive is operational, you can ask the student to use a power quality analyzer (if available) to measure the harmonics on the line current at the input of the AC motor drive. The student should observe that there are a lot of harmonics on the line current. These harmonics are produced by the AC motor drive. This is a disadvantage of using an AC motor drive.

- If necessary, instruct the student to refer to the user manual provided with the power quality analyzer to learn how to use this instrument.

Step 19

☐ The blower is assembled as indicated in the Blower Application Assembly diagram.

☐ The blower housing is secured to the lower horizontal rails of the Mobile Workstation with four fasteners (bolt, lock washer, large flat washer, and spring nut), as indicated in the Blower Application Assembly diagram. See Figure 2-7.

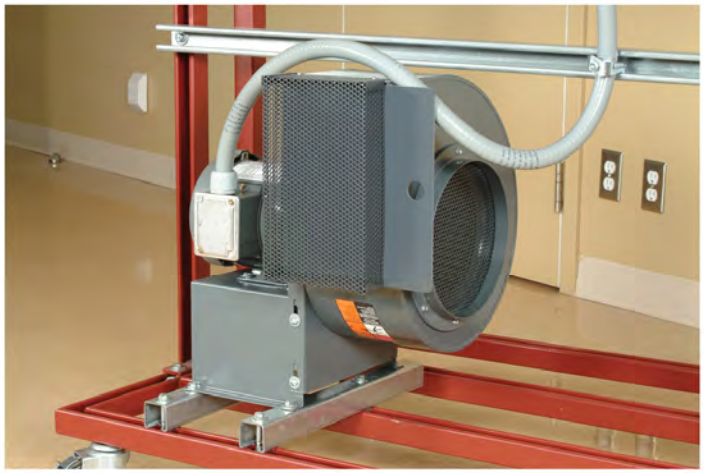

Figure 2-7. Blower installed on the lower horizontal rails of the Mobile Workstation.

☐ The 1/2-HP, three-phase induction motor is installed on the blower housing as indicated in the Blower Application Assembly diagram. The motor base is secured to this housing with a fastener (bolt, lock washer, large flat washer, and nut) at each corner. See Figure 2-7.

☐ The setscrews on the blower wheel are tightened firmly.

☐ The Forward/Reverse selector of the AC motor drive is set to the Reverse position.

Note to the Instructor

- Once the blower is installed and the AC motor drive is programmed as indicated in this work order (variable torque operation), you can ask the student to use a power quality analyzer (if available) to measure the active power and displacement power factor at the AC motor drive input when the motor is running at full speed, 2/3 of full speed, and 1/3 of full speed (AC motor drive frequencies of 60, 40, and 20 Hz, respectively) with the blower air outlet fully open, and note the results.

- Following the previous optional manipulation, you can ask the student to modify the operating parameters of the AC motor drive for constant torque operation (see tables below), use the power quality analyzer to measure the active power and displacement power factor at the AC motor drive input when the motor is running at full speed, 2/3 of full speed, and 1/3 of full speed (AC motor drive frequencies of 60, 40, and 20 Hz, respectively) with the blower air outlet fully open, and note the results.

PARAMETER NUMBER	PARAMETER DESCRIPTION	PARAMETER VALUE
n12	Frequency- Midpoint	1.5 Hz
n13	Voltage - Midpoint	11 V
n15	Voltage - Min.	11 V

Table 2-3. AC motor drive parameters to be changed for constant torque operation (Yaskawa J7).

PARAMETER NUMBER	PARAMETER DESCRIPTION	PARAMETER VALUE
E1-07	Mid Output Frequency	1.5 Hz
E1-08	Mid Output Frequency Voltage	11 V
E1-10	Minimum Output Freq. Voltage	11 V

Table 2-4. AC motor drive parameters to be changed for constant torque operation (Yaskawa J1000).

- Once the two previous optional manipulations are done, you can ask the student to compare the active power and displacement power factor obtained with the two operation modes of the AC motor drive. The student should observe that when the motor rotates at less than full speed, the active power measured at the AC motor drive input is lower with the variable torque operation than with the constant torque operation. This is because the variable torque operation is perfectly suited to the blower application which is a mechanical load with a variable torque characteristic (i.e., the load torque decreases as the speed decreases). The student should also observe that the operation mode of the AC motor drive has no effect on the displacement power factor.

  You can also ask the student to compare the active power drawn by the 1/2-HP three-phase induction motor when it is controlled by the manual starter and running at full speed with the blower air outlet fully closed, to the active power at the AC motor drive input when the motor is running at 2/3 of full speed (AC motor drive frequency of 40 Hz) with the blower air outlet fully open. The student should observe that the active power is approximately the same in both cases. However, there is no air flow when the manual starter is used whereas the air flow is 2/3 of maximum when the AC motor drive is used. This means that when an AC motor drive is used to control the air flow, less active power is required to produce medium to low air flow rates. This results in a significant power economy.

- If necessary, instruct the student to refer to the user manual provided with the power quality analyzer to learn how to use this instrument.

Step 21

Note to the Instructor

- Before the student begins to disassemble the AC motor drive, tell him or her which elements of the equipment setup do not need to be disassembled (e.g., the AC motor drive on the new MCE mounting plate, the controls and pilot lights on the new MCE door panel, the three-phase induction motor installed on the Mobile Workstation, etc.), if any.

- When the student has finished disassembling the AC motor drive, close the holes in the original MCE and new MCE with knockout snap-in blanks (see Figure 2-8). This will allow these enclosures to be reused by another student. Knockout snap-in blanks are easily installed in enclosure holes using a nylon head hammer.

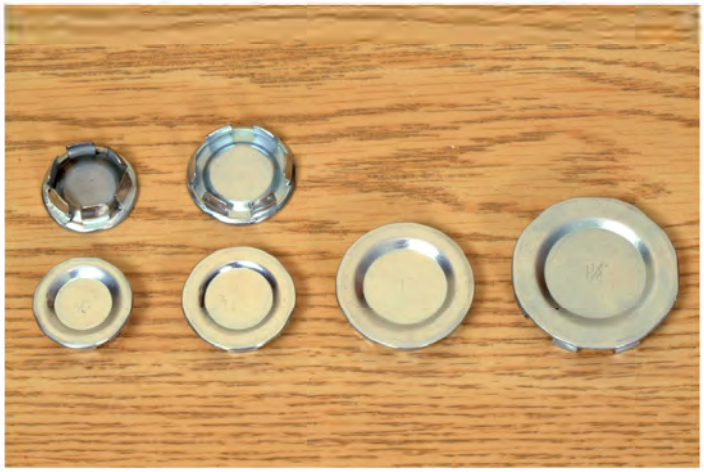

Figure 2-8. Knockout snap-in blanks of various sizes.