# Equipment Utilization Chart

The following Lab-Volt equipment is required to perform the exercises in this manual.

| EQUIPMENT | | EXERCISE | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| MODEL | DESCRIPTION | 1-1 | 1-2 | 1-3 | 1-4 | 1-5 | 1-6 | 2-1 | 2-2 |
| 3103-3 | Mobile Workstation | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 3112 | Switches | | | | | 2 | 2 | | |
| 3114 | Emergency Button | | | | | 1 | 1 | | |
| 3115-A | Pilot Lights | | | | 1 | | 1 | | |
| 3125-1 | Lockout Module | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 3126 | Manual Starter | | | | 1 | | | 1 | |
| 3130-2 | Control Relay | | | | | 1 | | | |
| 3138-3 | Control Transformer | | | | | 1 | | | |
| 3140-3 | Cam Switch | | | | | | | | 1 |
| 3147-1 | Inertia Wheel | | 1 | 1 | | 1 | | | |
| 3150-1 | Starting Resistors | | | | 1 | | | | 1 |
| 3165-1 | Power Diodes | | | | | | | | 1 |
| 3176-A | Brake Motor | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |
| 3179-2 | DC Motor | | | 1 | 1 | | | 1 | 1 |
| 3183 | AC Drive | 1 | 1 | 1 | 1 | 1 | 1 | | |
| 3184 | DC Drive | | 1 | 1 | | | | 1 | 1 |
| 3196 | AC Power Supply | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 8951-8 | Connection Leads | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 8951-E | Connection Leads | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 38503 | Magnetic Labels | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Option | Multimeter[1] | | 1 | 1 | | | | 1 | 1 |
| Option | Chronometer | | | 1 | | | | | |
| Option | Tachometer | | 1 | | | | | 1 | 1 |

[1] Voltmeter and DC ammeter

# Diagram Symbols

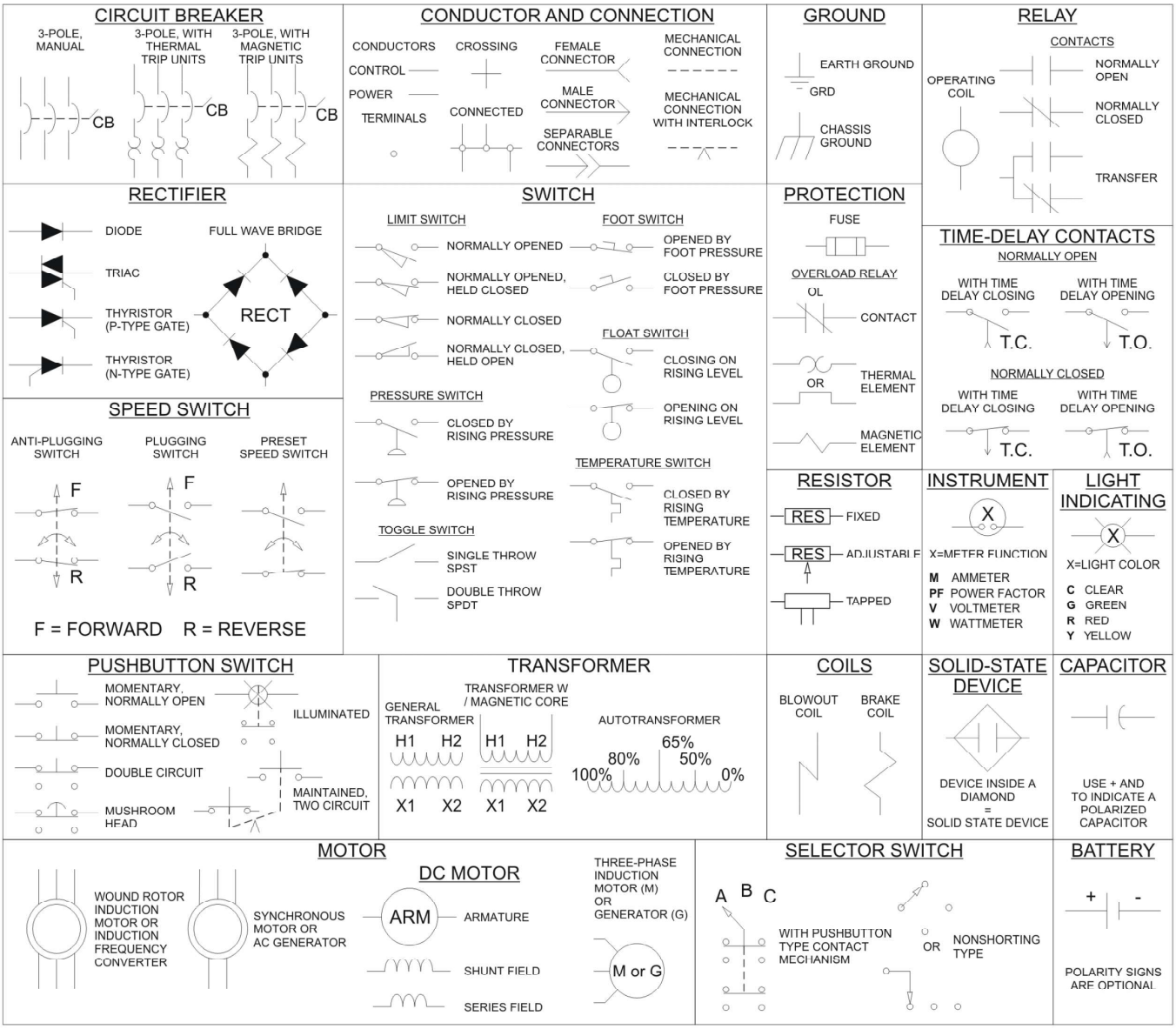



**Figure B-1. NEMA symbols.**

| FUNCTION OR DEVICE | DESIGNATION | FUNCTION OR DEVICE | DESIGNATION |
|---|---|---|---|
| Accelerating | A | Overload | OL |
| Ammeter | AM | Overvoltage | OV |
| Braking | B | Plugging or Potentiometer | P |
| Capacitor, Capacitance | C or CAP | Power Factor Meter | PFM |
| Circuit Breaker | CB | Pressure Switch | PS |
| Closing Coil | CC | Push Button | PB |
| Control Relay | CR | Reactor, Reactance | X |
| Current Transformer | CT | Rectifier | REC |
| Demand Meter | DM | Resistor, Resistance | R or RES |
| Diode | D | Reverse | R or REV |
| Disconnect Switch | DS or DISC | Rheostat | RH |
| Dynamic Braking | DB | Selector Switch | SS |
| Field Accelerating | FA | Silicon Controlled Rectifier | SCR |
| Field Contactor | FC | Solenoid Valve | SV |
| Field Decelerating | FD | Squirrel Cage | SC |
| Field-Loss | FL | Starting Contactor | S |
| Forward | F or FWD | Suppressor | SU |
| Frequency Meter | FM | Tachometer Generator | TACH |
| Fuse | FU | Terminal Block or Board | TB |
| Ground Protective | GP | Time-Delay Closing Contact | TC or TDC |
| Holding Coil | HC | Time-Delay Opening Contact | TO or TDO |
| Hoist | H | Time Relay | TR |
| Jog | J | Transformer | T |
| Latch Coil | LC | Transistor | Q |
| Limit Switch | LS | Trip Coil | TC |
| Lower | L | Unlatch Coil | ULC |
| Main Contactor | M | Undervoltage | UV |
| Master Control Relay | MCR | Voltmeter | VM |
| Master Switch | MS | Watthour Meter | WHM |
| Overcurrent | OC | Wattmeter | WM |

**Figure B-2. Device designations.**

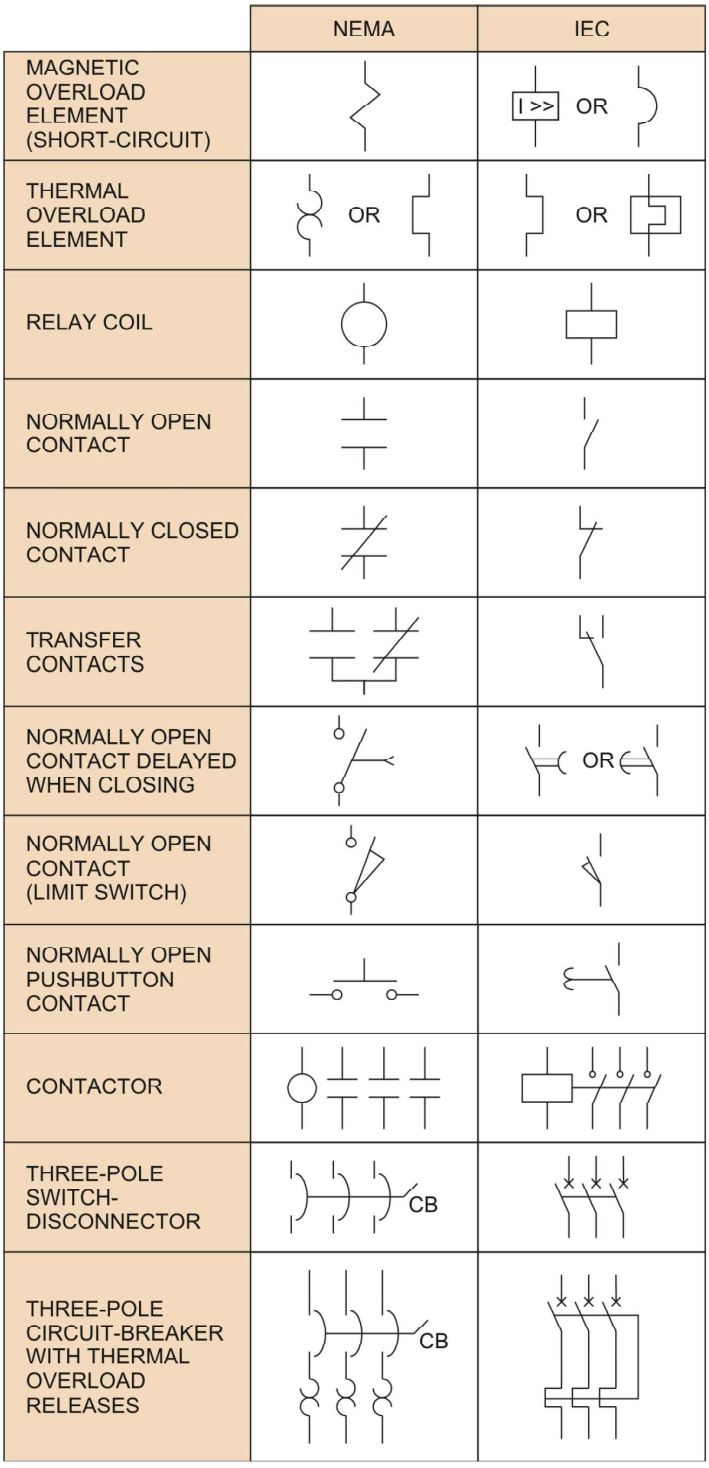



**Figure B-3. Comparison of NEMA and IEC symbols.**

# Basic Setup and Lockout/Tagout Procedures

This appendix contains the Basic Setup and Lockout/Tagout procedures specific to the Industrial Controls Training System from Lab-Volt. It is divided into four sections:

- Basic Setup procedure, explains the basic operations that must be performed at the beginning of the exercise procedures.
- Lockout/Tagout procedure (de-energizing procedure), describes the lockout/tagout procedure used to de-energize the training system before setting up a circuit.
- Energizing procedure, gives details on how to end a lockout/tagout procedure and energize the training system.
- Module identification, gives instructions on how to use the magnetic labels to identify the modules.

**Basic Setup procedure**

This procedure is recommended at the beginning of every experiment involving the modules of the training system. It ensures that the system is safe prior to cabling specific circuits.

Figure C-1 shows the AC Power Supply, Model 3196. Individual power switches are located on both faces of the module, for separate control of the power source.


**Figure C-1. AC Power Supply, Model 3196.**

☐ 1. Make sure that the power switch located on your side of the AC Power Supply is set to the O position.

**Note:** *The AC Power Supply should already be installed in the Mobile Workstation.*

☐ 2. Install the Lockout module into the Mobile Workstation.

**Note:** *Each time you install a module in the Mobile Workstation, make sure that the fault switches located behind the module faceplate are set to the O position as shown in Figure C-2.*

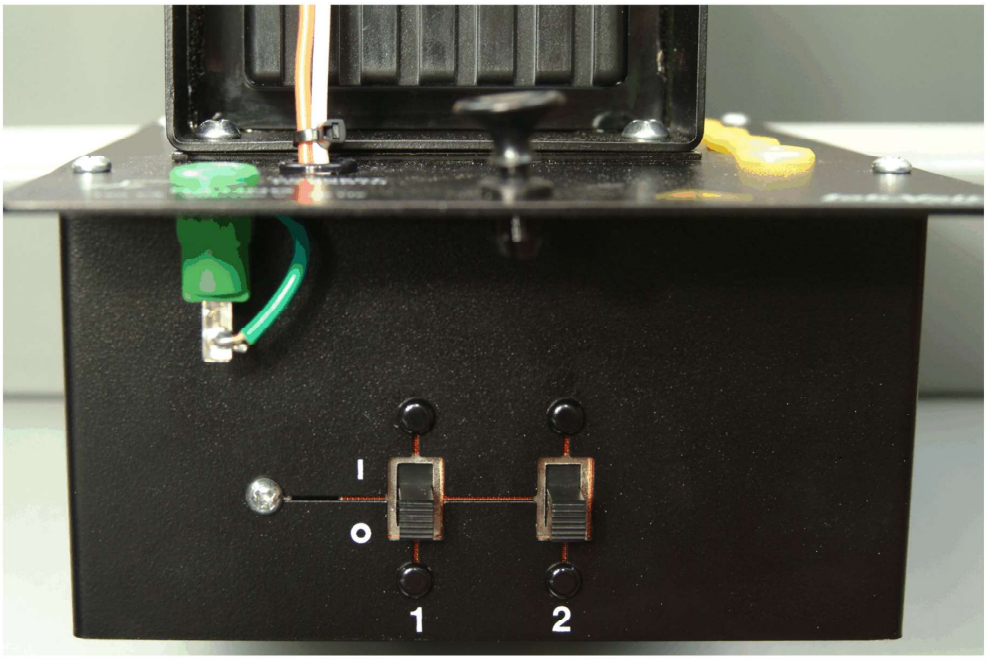



**Figure C-2. Make sure that the fault switches are set to the O position.**

☐ 3. Turn off the Lockout Module.

☐ 4. Connect the Lockout Module cables to the AC Power Supply module terminals, noting the phase sequence. See Figure C-3.


**Figure C-3. Lockout Module connected to the AC Power Supply module.**

### Lockout/Tagout procedure (de-energizing procedure)

☐ 5. Turn off the Lockout Module.

☐ 6. Install the lockout hasp and the student padlocks and tags on the Lockout Module. Ask the instructor to install the lab padlock and tag as well. Refer to Figure C-4 for details.

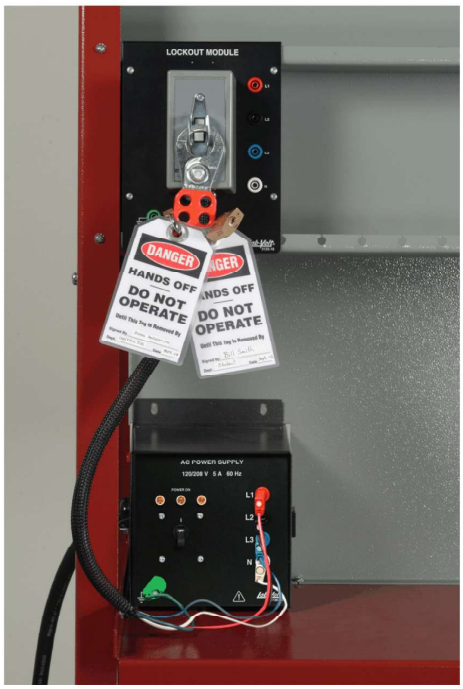



**Figure C-4. Installation of padlocks and hasps.**

☐ 7. Check that the Lockout Module switch cannot be opened. With a voltmeter, verify that no voltage is present between the Lockout Module output terminals to confirm that the circuit is de-energized. You may now set up your circuit.

### Energizing procedure

☐ 1. Interconnect the ground terminal (green) of all AC modules with the ground terminal of the Lockout Module.

**Note:** *DC modules do not incorporate ground terminals.*

☐ 2. Make sure the Security Guard is installed if you are using a motor.

☐ 3. Identify the modules with labels as described in the Module Identification section of this Appendix.

☐ 4. Once the connections have been made, ask for the instructor to check the circuit. When the circuit is correctly wired, notify all the people working around the Mobile Workstation that the system will be energized.

☐ 5. Remove the lockout hasp, padlocks and tags.

☐ 6. Turn on the AC Power Supply and Lockout Module, and return to your exercise.

**Module identification**

☐ 1. Once the setup is completed, identify all buttons, pilot lights, switches, etc, in accordance with the circuit schematic diagram. Place the magnetic labels on the module faceplates as shown in Figure C-5.

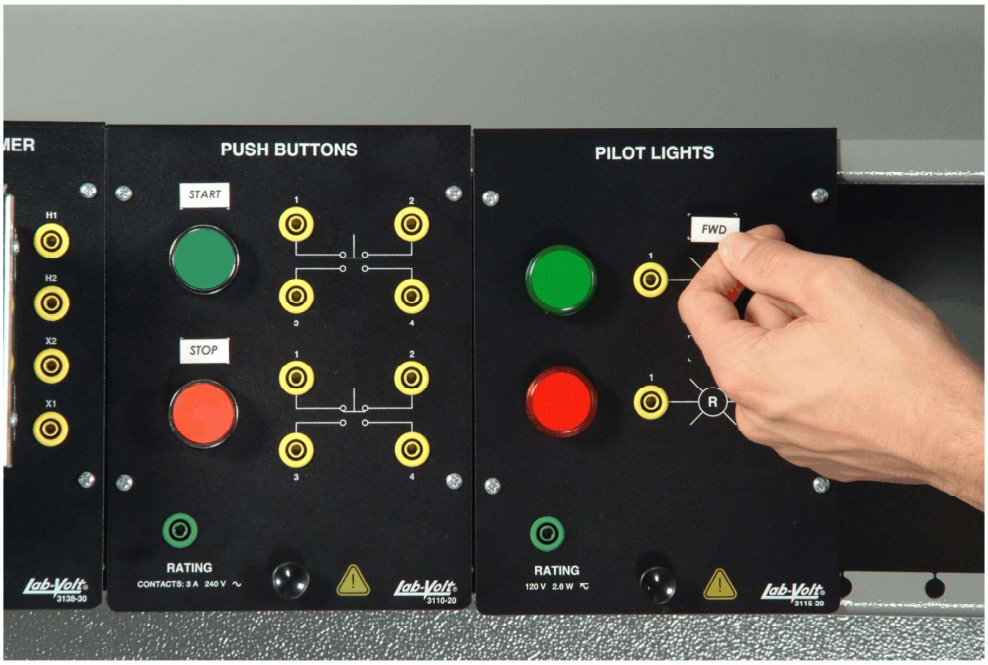



**Figure C-5. Module identification.**

**Note:** *For storing purposes, arrange the magnetic labels in alphabetic order on the vertical surface of the Mobile Workstation as shown in Figure C-6.*

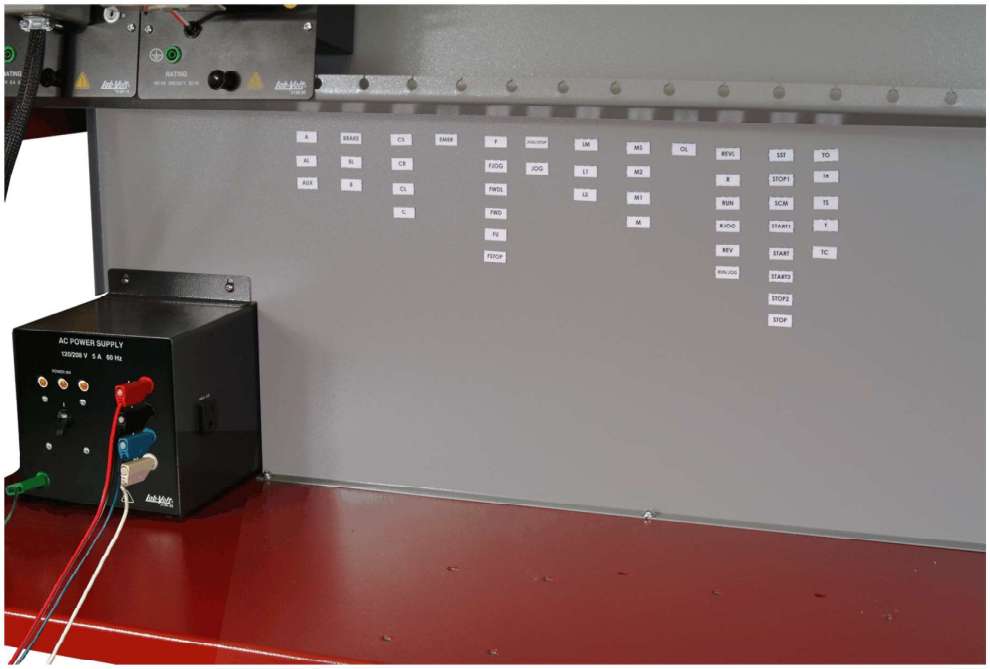



**Figure C-6. Store the magnetic labels on the vertical surface of the Mobile Workstation.**

# Coupling Motors

This procedure describes how to couple two motors on the Mobile Workstation.

**Note:** *To facilitate electrical connections, the Brake Motor should be installed at your left.*

- Fix the Brake Motor to the Mobile Workstation (See appendix E in the Basic Controls manual, part number 39163 if necessary).
- Remove the Inertia Wheel from the Brake Motor (when applicable).
- Slide a coupling half on the Brake Motor shaft taking care of aligning the coupling keyway with the key.
- Align the end of the coupling with the end of the shaft and tighten the set screw on the shaft key. See Figure D-1.

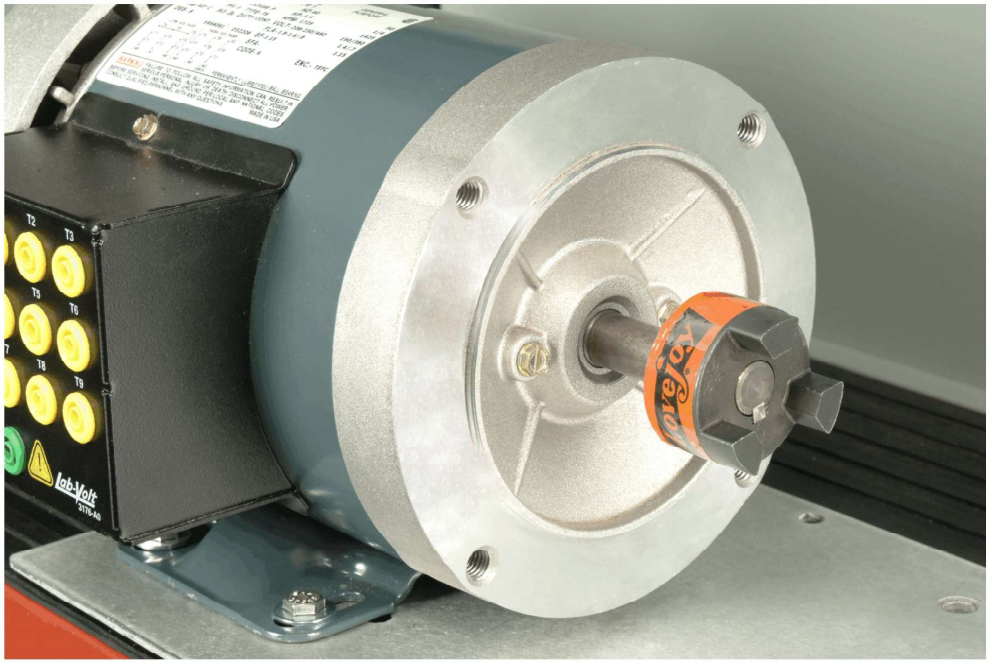



**Figure D-1. Installation of a coupling half on a motor shaft.**

- Install the insert in the coupling half.
- Slide a coupling half on the DC Motor taking care of aligning the coupling keyway with the key. Do not tighten the setscrew now.

- Position the DC Motor so the shafts of both motors are facing. Do not forget to insert the spacer plate between the motor base and the Mobile Workstation.
- Join the two coupling sections, allowing a 1.6 mm-gap (1/16 in) between the two halves sections, then tighten the setscrew.
- Align and fix the DC Motor to the Mobile Workstation surface using hexagonal head screws and knurled nuts.

> **Note:** *Misalignment will cause noise and vibration. Refer to Appendix E for basic information about alignment.*

- Install the Safety Guard.

> **Note:** *Ask your instructor to check your setup.*

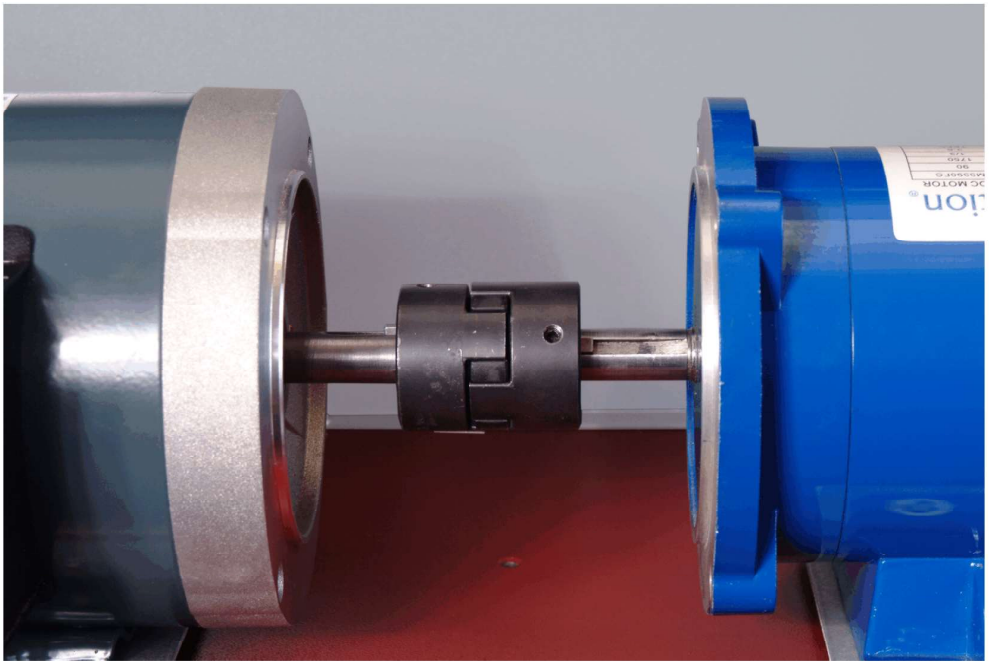


**Figure D-2. DC Motor coupled with the Brake Motor without Safety Guard.**

# Alignment

## Flexible couplings

Flexible shaft couplings are used for joining shafts of equal or different diameters. A flexible jaw coupling is shown in Figure E-1.

**Figure E-1. Flexible coupling.**

Flexible couplings can usually compensate for slight errors in shaft alignment. Improper shaft alignment can lead to premature failure of couplings and bearings, and may cause excessive vibration.

## Alignment

The two basic types of shaft misalignment are parallel and angular.

Parallel misalignment results when two shafts are parallel but not on the same plane, as shown in Figure E-2.


**Figure E-2. Parallel misalignment.**

Angular misalignment, also called axial misalignment, results when the shafts are at a different angle with the horizontal or vertical planes as shown in Figure E-3.


**Figure E-3. Angular misalignment.**

Both the vertical and horizontal planes must be checked to ensure a correct angular alignment.

### Alignment methods

Depending on the required precision, many alignment methods may be used. One of the simplest methods (low precision method) is as follows:

- Lay a straightedge (supplied with the training system) as shown in Figure E-4 to check the alignment of the shafts in the horizontal plane.

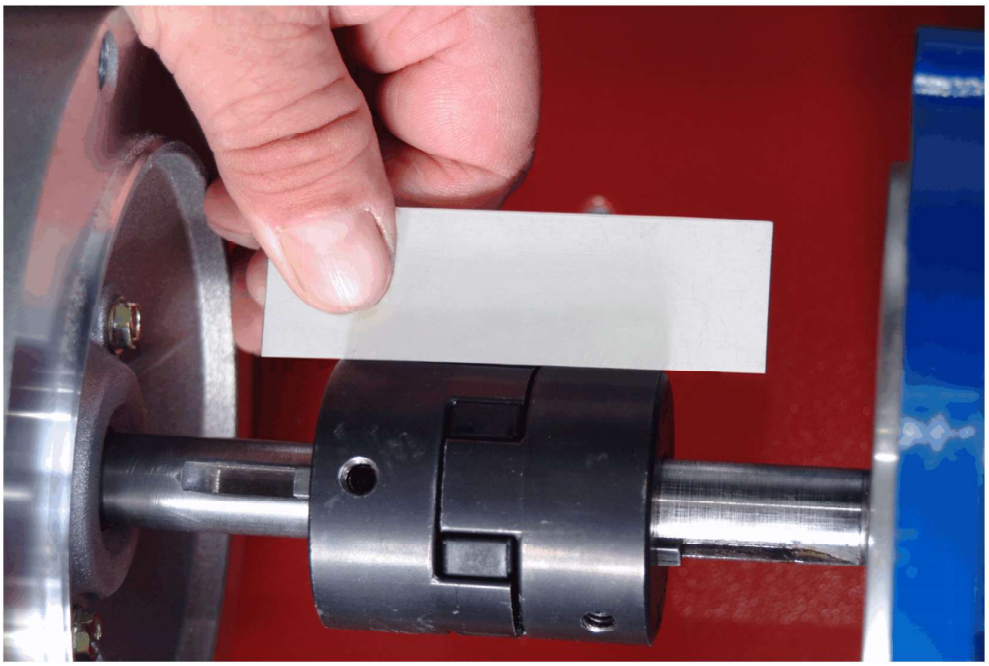


**Figure E-4. Alignment in the horizontal plane.**

- The horizontal alignment is correct when the straightedge is in contact with the two coupling halves at any point. Alignment is adjusted in the horizontal plane by moving one of the motors to the right or left.

**Note:** *Remove the labels on the coupling halves if necessary.*

- Once the alignment in the horizontal plane is completed, lay the straightedge as shown in Figure E-5 to align the shafts in the vertical plane.

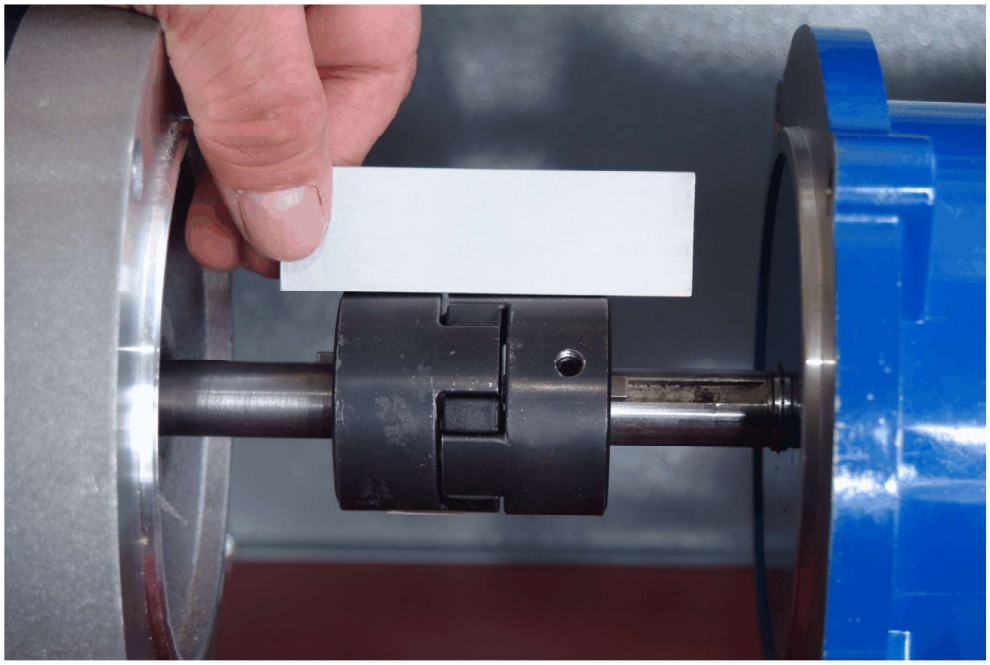


**Figure E-5. Alignment in the vertical plane.**

- Alignment is adjusted in the vertical plane by raising or lowering one of the motors with shims (supplied with the training system) as shown in Figure E-6.

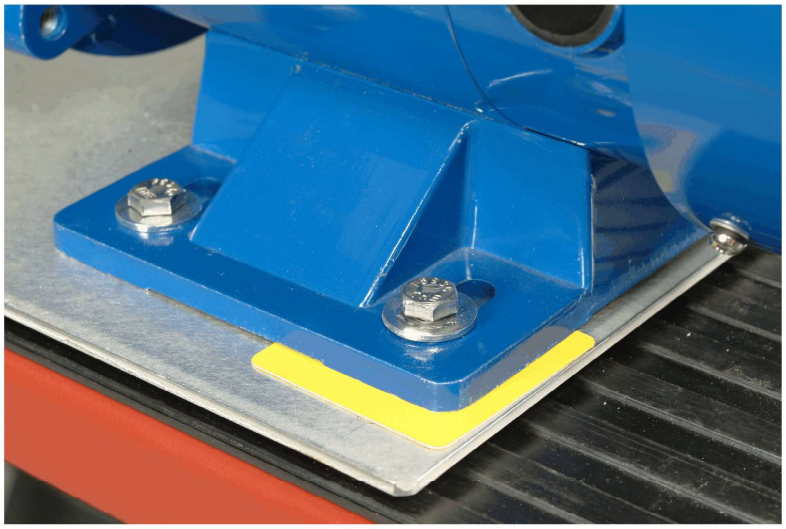
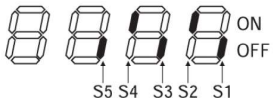
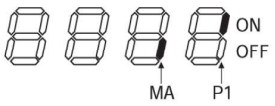


**Figure E-6. Insert shims to align the shafts in the vertical plane.**

# AC Drive – Error Codes and Parameter Numbers

| ERROR CODES | |
|---|---|
| **DISPLAY** | **CAUSE** |
| E01 | Inverter overcurrent in static operation |
| E02 | Inverter overcurrent during deceleration |
| E03 | Inverter overcurrent during acceleration |
| E05 | Overload |
| E07 | Overvoltage |
| E08 | EEPROM fault |
| E09 | Undervoltage |
| E11 | Processor malfunction |
| E12 | External fault message |
| E14 | Ground fault |
| E15 | Mains overvoltage |
| E21 | Overtemperature |
| E35 | Thermistor fault signal |
| E60 | Communication fault |

## Monitor Mode (d□□□) / Basic Function Mode (F□□□)

| Parameter No. | Name | Monitor or data range (Digital Operator) | Default setting | Changes during operation | Unit | Set value |
|---|---|---|---|---|---|---|
| d001 | Output frequency monitor | 0.0 to 400.0 | — | — | Hz | |
| d002 | Output current monitor | 0.0 to 999.9 | — | — | A | |
| d003 | Rotation direction monitor | F: Forward<br>o: Stop<br>r: Reverse | — | — | — | |
| d004 | PID feedback value monitor | 0.00 to 99.99<br>100.0 to 999.9<br>1000. to 9999.<br>(Enabled when the PID function is selected) | — | — | — | |
| d005 | Multi-function input monitor |  Example)<br>Terminal<br>S4, S2: ON<br>Terminal<br>S5, S3, S1: OFF | — | — | — | |
| d006 | Multi-function output monitor |  Example)<br>Terminal P1: ON<br>Terminal MA: OFF | — | — | — | |
| d007 | Output frequency monitor (after conversion) | 0.00 to 99.99<br>100.0 to 999.9<br>1000. to 9999.<br>1000 to 3996 (10000 to 39960)<br>(Output frequency × Conversion factor of b086) | — | — | — | |
| d013 | Output voltage monitor | 0. to 600. | — | — | V | |
| d016 | Total RUN Time | 0. to 9999.<br>1000 to 9999<br>⌈100 to ⌈999[h] | — | — | h | |
| d017 | Power ON time monitor | 0. to 9999.<br>1000 to 9999<br>⌈100 to ⌈999[h] | — | — | h | |
| d018 | Fin temperature monitor | 0.0 to 200.0 | | | °C | |
| d080 | Fault frequency monitor | 0. to 9999. | — | — | — | |
| d081 | Fault monitor 1 (Latest) | Error code (condition of occurrence) → Output frequency [Hz] → Output current [A] → Internal DC voltage [V] → RUN time [h] → ON time [h] | — | — | | |
| d082 | Fault monitor 2 | | | | | |
| d083 | Fault monitor 3 | | | | | |

| Parameter No. | Name | Monitor or data range (Digital Operator) | Default setting | Changes during operation | Unit | Set value |
|---|---|---|---|---|---|---|
| d102 | DC voltage monitor | 0.0 to 999.9 | — | — | V | |
| d104 | Electronic thermal monitor | 0.0 to 100.0 | — | — | % | |
| F001 | Output frequency setting/monitor | Starting frequency to 1st or 2nd max. frequency | — | Yes | Hz | |
| F002 | Acceleration time 1 | 0.01 to 99.99<br>100.0 to 999.9<br>1000. to 3000. | 10.0 | Yes | s | |
| F202 | *2nd acceleration time 1 | 0.01 to 99.99<br>100.0 to 999.9<br>1000. to 3000. | 10.0 | Yes | s | |
| F003 | Deceleration time 1 | 0.01 to 99.99<br>100.0 to 999.9<br>1000. to 3000. | 10.0 | Yes | s | |
| F203 | *2nd deceleration time 1 | 0.01 to 99.99<br>100.0 to 999.9<br>1000. to 3000. | 10.0 | Yes | s | |
| F004 | Operator rotation direction selection | 00: Forward<br>01: Reverse | 00 | No | — | |

* 2nd function is displayed when SET(08) is allocated to one of from C001 to C005.

## Extended function mode

| Parameter No. | | Function name | Monitor or data range (Digital Operator) | Default setting | Changes during operation | Unit | Set value |
|---|---|---|---|---|---|---|---|
| Basic setting | A001 | Frequency reference selection | 00: Digital Operator (FREQ adjuster)<br>01: Terminal<br>02: Digital Operator (F001)<br>03: ModBus communication<br>10: Frequency operation result | 00 | No | — | |
| | A201 | *2nd frequency reference selection | | 00 | No | — | |
| | A002 | RUN command selection | 01: Terminal<br>02: Digital Operator<br>03: ModBus communication | 02 | No | — | |
| | A202 | *2nd RUN command selection | | 02 | No | — | |
| | A003 | Base frequency | 30. to Max. frequency [A004] | 60. | No | Hz | |
| | A203 | *2nd base frequency | 30. to Max. frequency [A204] | 60. | | | |
| | A004 | Maximum frequency | 30. to 400. | 60. | No | Hz | |
| | A204 | *2nd maximum frequency | | 60. | | | |

* 2nd control is displayed when SET (08) is allocated to one of from C001 to C005.

| Parameter No. | | Function name | Monitor or data range (Digital Operator) | Default setting | Changes during operation | Unit | Set value |
|---|---|---|---|---|---|---|---|
| Analog input | A005 | FV/FI selection | 02: Switches between FV/FREQ adjuster via terminal AT<br>03: Switches between FI/FREQ adjuster via terminal AT<br>04: FV input only<br>05: FI input only | 02 | No | — | |
| | A011 | FV start frequency | 0.0 to Max. frequency | 0.0 | No | Hz | |
| | A012 | FV end frequency | 0.0 to Max. frequency | 0.0 | No | Hz | |
| | A013 | FV start ratio | 0. to 100. | 0. | No | % | |
| | A014 | FV end ratio | 0. to 100. | 100. | No | % | |
| | A015 | FV start selection | 00: External start frequency (A011 set value)<br>01: 0 Hz | 01 | No | — | |
| | A016 | FV, FI sampling | 1. to 17. | 8. | No | — | |
| Multi-step speed, Jogging | A020 | Multi-step speed reference 0 | 0.0/Starting frequency to Max. frequency | 6.0 | Yes | Hz | |
| | A220 | *2nd multi-step speed reference 0 | 0.0/Starting frequency to 2nd max. frequency | 6.0 | Yes | Hz | |

* 2nd control is displayed when SET (08) is allocated to one of from C001 to C005.

| Parameter No. | | Function name | Monitor or data range (Digital Operator) | Default setting | Changes during operation | Unit | Set value |
|---|---|---|---|---|---|---|---|
| Multi-step speed, Jogging | A021 | Multi-step speed reference 1 | 0.0/Starting frequency to Max. frequency | 0.0 | Yes | Hz | |
| | A022 | Multi-step speed reference 2 | | 0.0 | | | |
| | A023 | Multi-step speed reference 3 | | 0.0 | | | |
| | A024 | Multi-step speed reference 4 | | 0.0 | | | |
| | A025 | Multi-step speed reference 5 | | 0.0 | | | |
| | A026 | Multi-step speed reference 6 | | 0.0 | | | |
| | A027 | Multi-step speed reference 7 | | 0.0 | | | |
| | A028 | Multi-step speed reference 8 | | 0.0 | | | |
| | A029 | Multi-step speed reference 9 | | 0.0 | | | |
| | A030 | Multi-step speed reference 10 | | 0.0 | | | |
| | A031 | Multi-step speed reference 11 | | 0.0 | | | |
| | A032 | Multi-step speed reference 12 | | 0.0 | | | |
| | A033 | Multi-step speed reference 13 | | 0.0 | | | |
| | A034 | Multi-step speed reference 14 | | 0.0 | | | |
| | A035 | Multi-step speed reference 15 | | 0.0 | | | |
| | A038 | Jogging frequency | 0.00/Starting frequency to 9.99 | 6.00 | Yes | Hz | |
| | A039 | Jogging stop selection | 00: Free-run stop<br>01: Deceleration stop<br>02: DC injection braking stop | 00 | No | — | |

* 2nd control is displayed when SET (08) is allocated to one of from C001 to C005.

| Parameter No. | | Function name | Monitor or data range (Digital Operator) | Default setting | Changes during operation | Unit | Set value |
|---|---|---|---|---|---|---|---|
| Characteristics, Torque boost | A041 | Torque boost selection | 00: Manual torque boost only<br>01: Automatic (simple) torque boost | 00 | No | - | |
| | A241 | *2nd torque boost selection | | 00 | | | |
| | A042 | Manual torque boost voltage | 0.0 to 20.0 | 5.0 | Yes | % | |
| | A242 | *2nd manual torque boost voltage | | 0.0 | | | |
| | A043 | Manual torque boost frequency | 0.0 to 50.0 | 2.5 | Yes | % | |
| | A243 | *2nd manual torque boost frequency | | 0.0 | | | |
| | A044 | V/f characteristics selection | 00: Constant torque characteristics (VC)<br>01: Reduced torque characteristics (VP 1.7th power)<br>06: Special reduced torque characteristics (Special VP) | 00 | No | - | |
| | A244 | *2nd V/f characteristics selection | | 00 | | | |
| | A045 | Output voltage gain | 20. to 100. | 100. | Yes | % | |
| | A245 | *2nd output voltage gain | | 100. | | | |
| DC injection braking | A051 | DC injection braking selection | 00: Disabled<br>01: Enabled<br>02: Frequency control [A052 set value] | 00 | No | — | |
| | A052 | DC injection braking frequency | 0.0 to 60.0 | 0.5 | No | Hz | |
| | A053 | DC injection braking delay time | 0.0 to 5.0 | 0.0 | No | s | |
| | A054 | DC injection braking power | 0. to 100. | 50 | No | % | |
| | A055 | DC injection braking time | 0.0 to 60.0 | 0.5 | No | s | |
| | A056 | DC injection braking method selection | 00: Edge operation<br>01: Level operation | 01 | No | — | |

* 2nd control is displayed when SET (08) is allocated to one of from C001 to C005.

| Parameter No. | | Function name | Monitor or data range (Digital Operator) | Default setting | Changes during operation | Unit | Set value |
|---|---|---|---|---|---|---|---|
| Upper/Lower limit, Jump | A061 | Frequency upper limit | 0.0/Frequency lower limit to Max. frequency | 0.0 | No | Hz | |
| | A261 | *2nd frequency upper limit | 0.0/Frequency lower limit to 2nd Max. frequency | 0.0 | | | |
| | A062 | Frequency lower limit | 0.0/Starting frequency to Frequency upper limit | 0.0 | No | Hz | |
| | A262 | *2nd frequency lower limit | 0.0/Starting frequency to 2nd frequency upper limit | 0.0 | | | |
| | A063 | Jump frequency 1 | Jump frequency: 0.0 to 400.0<br>Jump frequency width: 0.0 to 10.0 | 0.0 | No | Hz | |
| | A064 | Jump frequency width 1 | | 0.5 | | | |
| | A065 | Jump frequency 2 | | 0.0 | | | |
| | A066 | Jump frequency width 2 | | 0.5 | | | |
| | A067 | Jump frequency 3 | | 0.0 | | | |
| | A068 | Jump frequency width 3 | | 0.5 | | | |
| PID control | A071 | PID selection | 00: Disabled<br>01: Enabled | 00 | No | — | |
| | A072 | PID P gain | 0.2 to 5.0 | 1.0 | Yes | — | |
| | A073 | PID I gain | 0.0 to 150.0 | 1.0 | Yes | s | |
| | A074 | PID D gain | 0.00 to 100.0 | 0.0 | Yes | s | |
| | A075 | PID scale | 0.01 to 99.99 | 1.00 | No | Time | |
| | A076 | PID feedback selection | 00: FI<br>01: FV<br>02: RS485 communication<br>10: Operation function output | 00 | No | — | |
| | A077 | Reverse PID function | 00: OFF (Deviation = Target value - Feedback value)<br>01: ON (Deviation = Feedback value - Target value) | 00 | No | — | |
| | A078 | PID output limit function | 0.00 to 100.0 | 0.0 | No | % | |
| AVR | A081 | AVR selection | 00: Always ON<br>01: Always OFF<br>02: OFF during deceleration | 02 | No | — | |
| | A082 | AVR voltage selection | 200-V class: 200/215/220/230/240<br>400-V class: 380/400/415/440/460/480 | 200/ 400 | No | V | |

* 2nd control is displayed when SET (08) is allocated to one of from C001 to C005.

| Parameter No. | | Function name | Monitor or data range (Digital Operator) | Default setting | Changes during operation | Unit | Set value |
|---|---|---|---|---|---|---|---|
| RUN mode, Acceleration/Deceleration functions | A085 | RUN mode selection | 00: Normal operation<br>01: Energy-saving operation | 00 | No | - | |
| | A086 | Energy-saving response/ accuracy adjustment | 0 to 100 | 50 | No | % | |
| | A092 | Acceleration time 2 | 0.01 to 99.99<br>100.0 to 999.9<br>1000. to 3000. | 15.00 | Yes | s | |
| | A292 | *2nd acceleration time 2 | | 15.00 | | | |
| | A093 | Deceleration time 2 | 0.01 to 99.99<br>100.0 to 999.9<br>1000. to 3000. | 15.00 | Yes | s | |
| | A293 | *2nd deceleration time 2 | | 15.00 | | | |
| | A094 | 2-step acceleration/ deceleration selection | 00: Switched via multi-function input 09 (2CH)<br>01: Switched by setting | 00 | No | — | |
| | A294 | *2nd 2-step acceleration/ deceleration selection | | 00 | | | |
| | A095 | 2-step acceleration frequency | 0.0 to 400.0 | 0.0 | No | Hz | |
| | A295 | *2nd 2-step acceleration frequency | | 0.0 | | | |
| | A096 | 2-step deceleration frequency | 0.0 to 400.0 | 0.0 | No | Hz | |
| | A296 | *2nd 2-step deceleration frequency | | 0.0 | | | |
| | A097 | Acceleration pattern selection | 00: Line<br>01: S-shape curve | 00 | No | — | |
| | A098 | Deceleration pattern selection | 00: Line<br>01: S-shape curve | 00 | No | — | |

* 2nd control is displayed when SET (08) is allocated to one of from C001 to C005.

| Parameter No. | | Function name | Monitor or data range (Digital Operator) | Default setting | Changes during operation | Unit | Set value |
|---|---|---|---|---|---|---|---|
| External frequency adjustment | A101 | FI start frequency | 0.0 to 400.0 | 0.0 | No | Hz | |
| | A102 | FI end frequency | 0.0 to 400.0 | 0.0 | No | Hz | |
| | A103 | FI start ratio | 0. to 100. | 0. | No | % | |
| | A104 | FI end ratio | 0. to 100. | 100. | No | % | |
| | A105 | FI start selection | 00: Use FI start frequency [A101]<br>01: 0 Hz start | 01 | No | — | |
| Operation frequency | A141 | Operation frequency input A setting | 00: Digital Operator (F001)<br>01: Digital Operator (FREQ adjuster)<br>02: Input FV<br>03: Input FI<br>04: RS485 communication | 01 | No | — | |
| | A142 | Operation frequency input B setting | | 02 | No | — | |
| | A143 | Operator selection | 00: Addition (A + B)<br>01: Subtraction (A - B)<br>02: Multiplication (A × B) | 00 | No | — | |
| Frequency addition | A145 | Frequency addition amount | 0.0 to 400.0 | 0.0 | Yes | Hz | |
| | A146 | Frequency addition direction | 00: Adds A145 value to output frequency<br>01: Subtract A145 value from output frequency | 00 | No | — | |
| VR adjustment | A151 | VR start frequency | 0.0 to 400.0 | 0.0 | No | Hz | |
| | A152 | VR end frequency | 0.0 to 400.0 | 0.0 | No | Hz | |
| | A153 | VR start ratio | 0. to 100. | 0. | No | % | |
| | A154 | VR end ratio | 0. to 100. | 100. | No | % | |
| | A155 | VR start selection | 00: Use VR start frequency [A151]<br>01: 0 Hz start | 01 | No | — | |

* 2nd control is displayed when SET (08) is allocated to one of from C001 to C005.

| Parameter No. | | Function name | Monitor or data range (Digital Operator) | Default setting | Changes during operation | Unit | Set value |
|---|---|---|---|---|---|---|---|
| Restart during momentary power interruption | b001 | Retry selection | 00: Alarm<br>01: 0 Hz start<br>02: Frequency matching start<br>03: Trip after frequency matching deceleration stop | 00 | No | — | |
| | b002 | Allowable momentary power interruption time | 0.3 to 25.0 | 1.0 | No | s | |
| | b003 | Retry wait time | 0.3 to 100.0 | 1.0 | No | s | |
| | b004 | Momentary power interruption/ undervoltage trip during stop selection | 00: Disabled<br>01: Enabled | 00 | No | — | |
| | b005 | Momentary power interruption retry time selection | 00: 16 times<br>01: No limit | 00 | No | — | |
| | b011 | Starting frequency at frequency pull-in restart | 00: Frequency at interruption<br>01: Max. frequency<br>02: Set frequency | 00 | No | — | |
| Electronic thermal | b012 | Electronic thermal level | 0.2 × Rated current to 1.0 × Rated current | Rated current | No | A | |
| | b212 | *2nd electronic thermal level | | Rated current | | | |
| | b013 | Electronic thermal characteristics selection | 00: Reduced torque characteristics 1<br>01: Constant torque characteristics<br>02: Reduced torque characteristics 2 | 00 | No | — | |
| | b213 | *2nd electronic thermal characteristics selection | | 00 | | | |

* 2nd control is displayed when SET (08) is allocated to one of from C001 to C005.

| Parameter No. | | Function name | Monitor or data range (Digital Operator) | Default setting | Changes during operation | Unit | Set value |
|---|---|---|---|---|---|---|---|
| Overload limit | b021 | Overload limit selection | 00: Disabled<br>01: Enabled in acceleration/constant speed operation<br>02: Enabled in constant speed operation | 01 | No | — | |
| | b221 | *2nd overload limit selection | | 01 | | | |
| | b022 | Overload limit level | 0..1 × Rated current to 1.5 × Rated current | 1.5 × Rated current | No | A | |
| | b222 | *2nd overload limit level | | 1.5 × Rated current | | | |
| | b023 | Overload limit parameter | 0.1 to 3000.0 | 1.0 | No | s | |
| | b223 | *2nd overload limit parameter | | 1.0 | | | |
| | b028 | Overload limit source selection | 00: b022, b222 set values<br>01: Input terminal FV | 00 | No | — | |
| | b228 | *2nd overload limit source selection | | 00 | | | |
| Frequency pull-in | b029 | Deceleration rate constant at frequency pull-in restart | 0.1 to 3000.0 | 0.5 | No | s | |
| | b030 | Frequency pull-in restart level | 0.2 × Rated current to 2.0 × Rated current | Rated current | No | A | |
| Lock | b031 | Soft lock selection | 00: Data other than b031 cannot be changed when terminal SFT is ON.<br>01: Data other than b031 and the specified frequency parameter cannot be changed when terminal SFT is ON.<br>02: Data other than b031 cannot be changed.<br>03: Data other than b031 and the specified frequency parameter cannot be changed.<br>10: Data other than parameters changeable during operation cannot be changed. | 01 | No | — | |

* 2nd control is displayed when SET (08) is allocated to one of from C001 to C005.

| Parameter No. | | Function name | Monitor or data range (Digital Operator) | Default setting | Changes during operation | Unit | Set value |
|---|---|---|---|---|---|---|---|
| Non-stop function at momentary power interruption | b050 | Selection of non-stop function at momentary power interruption | 00: Disabled<br>01: Enabled (Stop)<br>02: Enabled (Restart) | 00 | No | | |
| | b051 | Starting voltage of non-stop function at momentary power interruption | 0.0 to 1000. | 0.0 | No | V | |
| | b052 | Stop deceleration level of non-stop function at momentary power interruption | 0.0 to 1000. | 0.0 | No | V | |
| | b053 | Deceleration time of non-stop function at momentary power interruption | 0.01 to 99.99<br>100.0 to 999.9<br>1000 to 3000 | 1.0 | No | s | |
| | b054 | Deceleration starting width of non-stop function at momentary power interruption | 0.0 to 10.0 | 0.0 | No | Hz | |
| Others | b055 | Overvoltage protection proportional gain during deceleration | 0.2 to 5.0 | 0.2 | Yes | — | |
| | b056 | Overvoltage protection integral time during deceleration | 0.0 to 150.0 | 0.2 | Yes | s | |
| | b080 | AM adjustment | 0. to 255.<br>(Shared with C086 for AM offset adjustment) | 100. | Yes | — | |
| | b082 | Starting frequency | 0.5 to 9.9 | 1.5 | No | Hz | |
| | b083 | Carrier frequency | 2.0 to 12.0 | 3.0 | No | kHz | |
| Initialization | b084 | Initialization selection | 00: Clears the trip monitor<br>01: Initializes data<br>02: Clears the trip monitor and initializes data | 00 | No | — | |
| | b085 | Initialization parameter selection | 00<br>* Do not change. | 00 | No | — | |

* 2nd control is displayed when SET (08) is allocated to one of from C001 to C005.

| Parameter No. | | Function name | Monitor or data range (Digital Operator) | Default setting | Changes during operation | Unit | Set value |
|---|---|---|---|---|---|---|---|
| Others | b086 | Frequency conversion coefficient | 0.1 to 99.9 | 1.0 | Yes | — | |
| | b087 | STOP key selection | 00: Enabled<br>01: Disabled | 00 | No | — | |
| | b088 | Free-run stop selection | 00: 0 Hz start<br>01: Frequency pull-in restart | 00 | No | — | |
| | b089 | Monitor display selection | 01: Output frequency monitor<br>02: Output current monitor<br>03: Rotation direction monitor<br>04: PID feedback value monitor<br>05: Multi-function input monitor<br>06: Multi-function output monitor<br>07: Frequency conversion monitor | 01 | Yes | — | |
| | b091 | Stop selection | 00: Deceleration → Stop<br>01: Free-run stop | 00 | No | — | |
| | b092 | Cooling fan control | 00: Always ON<br>01: ON during RUN<br>02: Depends on the fin temperature | 01 | No | — | |
| | b130 | Overvoltage LAD stop function | 00: Disabled<br>01: Enabled | 00 | No | — | |
| | b131 | Overvoltage LAD stop function level setting | 200-V class: 330. to 395.<br>400-V class: 660. to 790. | 380/ 760 | Yes | V | |
| | b133 | Overvoltage protection function selection during deceleration | 00: Disabled<br>01: Enabled | 00 | No | — | |
| | b134 | Overvoltage protection level setting during deceleration | 200-V class: 330. to 395.<br>400-V class: 660. to 790. | 380/ 760 | No | V | |
| | b140 | Overcurrent suppression function | 00: Disabled<br>01: Enabled | 01 | No | — | |
| | b150 | Automatic carrier reduction | 00: Disabled<br>01: Enabled | 00 | No | — | |
| | b151 | Ready function selection | 00: Disabled<br>01: Enabled | 00 | No | — | |

* 2nd control is displayed when SET (08) is allocated to one of from C001 to C005.

| Parameter No. | | Function name | Monitor or data range (Digital Operator) | Default setting | Changes during operation | Unit | Set value |
|---|---|---|---|---|---|---|---|
| Multi-function input terminals | C001 | Multi-function input 1 selection | 00: FW (forward)<br>01: RV (reverse)<br>02: CF1 (multi-step speed setting binary 1)<br>03: CF2 (multi-step speed setting binary 2)<br>04: CF3 (multi-step speed setting binary 3)<br>05: CF4 (multi-step speed setting binary 4)<br>06: JG (jogging)<br>07: DB (external DC injection braking)<br>08: SET (2nd control)<br>09: 2CH (2-step acceleration/deceleration)<br>11: FRS (free-run stop)<br>12: EXT (external trip)<br>13: USP (USP function)<br>15: SFT (soft lock)<br>16: AT (analog input switching)<br>18: RS (reset)<br>19: PTC (thermistor input)<br>20: STA (3-wire start)<br>21: STP (3-wire stop)<br>22: F/R (3-wire forward/reverse)<br>23: PID (PID enabled/disabled)<br>24: PIDC (PID integral reset)<br>27: UP (UP/DWN function accelerated)<br>28: DWN (UP/DWN function decelerated)<br>29: UDC (UP/DWN function data clear)<br>31: OPE (forced operator)<br>50: ADD (frequency addition)<br>51: F-TM (forced terminal block)<br>52: RDY (ready function)<br>53: SP-SET (special 2nd function)<br>64: EMR (emergency shutoff *1)<br>255: No function<br>*1. The EMR is set forcibly with switch S8, not with parameters. | 00 | No | — | |
| | C201 | *2nd multi-function input 1 selection | | 00 | | | |
| | C002 | Multi-function input 2 selection | | 01 | | | |
| | C202 | *2nd multi-function input 2 selection | | 01 | | | |
| | C003 | Multi-function input 3 selection | | 18 | | | |
| | C203 | *2nd multi-function input 3 selection | | 18 | | | |
| | C004 | Multi-function input 4 selection | | 12 | | | |
| | C204 | *2nd multi-function input 4 selection | | 12 | | | |
| | C005 | Multi-function input 5 selection | | 02 | | | |
| | C205 | *2nd multi-function input 5 selection | | 02 | | | |
| | C011 | Multi-function input 1 operation selection | 00: NO<br>01: NC | 00 | No | — | |
| | C012 | Multi-function input 2 operation selection | | 00 | | | |
| | C013 | Multi-function input 3 operation selection | | 00 | | | |
| | C014 | Multi-function input 4 operation selection | | 00 | | | |
| | C015 | Multi-function input 5 operation selection | | 00 | | | |

* 2nd control is displayed when SET (08) is allocated to one of from C001 to C005.

| Parameter No. | | Function name | Monitor or data range (Digital Operator) | Default setting | Changes during operation | Unit | Set value |
|---|---|---|---|---|---|---|---|
| Multi-function output setting | C021 | Multi-function output terminal P1 selection | 00: RUN (signal during RUN)<br>01: FA1 (constant speed arrival signal)<br>02: FA2 (over set frequency arrival signal)<br>03: OL (overload warning)<br>04: OD (excessive PID deviation)<br>05: AL (alarm output)<br>06: Dc (disconnection detection)<br>07: FBV (PID FB status output)<br>08: NDc (network error)<br>09: LOG(logic operation output)<br>10: ODc (Do not use.)<br>43: LOC (light load detection signal) | 00 | No | — | |
| | C026 | Relay output (MA, MB) function selection | | 05 | | | |
| | C028 | AM selection | 00: Output frequency<br>01: Output current | 00 | No | — | |
| | C031 | Multi-function output terminal P1 contact selection | 00: NO contact at MA; NC contact at MB<br>01: NC contact at MA; NO contact at MB | 00 | No | — | |
| | C036 | Relay output (MA, MB) contact selection | | 01 | | | |
| | C038 | Light load signal output mode | 00: Enabled during acceleration/deceleration/ constant speed<br>01: Enabled only during constant speed | 01 | No | — | |
| | C039 | Light load detection level | 0.0 to 2.0 × Rated current (0.0 setting: Function disable) | Rated current | No | — | |
| Level output status setting | C041 | Overload warning level | 0.0: Does not operate<br>0.1 × Rated current to 2.0 × Rated current | Rated current | No | A | |
| | C241 | *2nd overload warning level | | Rated current | | | |
| | C042 | Arrival frequency during acceleration | 0.0 to 400.0 | 0.0 | No | Hz | |
| | C043 | Arrival frequency during deceleration | 0.0 to 400.0 | 0.0 | No | Hz | |
| | C044 | PID deviation excessive level | 0.0 to 100.0 | 3.0 | No | % | |
| | C052 | PID FB upper limit | 0.0 to 100.0 | 100 | No | % | |
| | C053 | PID FB lower limit | | 0.0 | | | |

* 2nd control is displayed when SET (08) is allocated to one of from C001 to C005.

| Parameter No. | | Function name | Monitor or data range (Digital Operator) | Default setting | Changes during operation | Unit | Set value |
|---|---|---|---|---|---|---|---|
| Communication function adjustment | C070 | Operator/ModBus selection | 02: Digital Operator<br>03: ModBus | 02 | No | — | |
| | C071 | Communication speed selection (Baud rate selection) | 04: 4800 bps<br>05: 9600 bps<br>06: 19200 bps | 04 | No | — | |
| | C072 | Communication station No. selection | 1. to 32. | 1. | No | — | |
| | C074 | Communication parity selection | 00: No parity<br>01: Even<br>02: Odd | 00 | No | — | |
| | C075 | Communication stop bit selection | 1: 1-bit<br>2: 2-bit | 1 | No | — | |
| | C076 | Communication error selection | 00: Trip<br>01: Trip after deceleration stop<br>02: Ignore<br>03: Free run<br>04: Deceleration stop | 02 | No | — | |
| | C077 | Communication error timeout | 0.00 to 99.99 | 0.00 | No | s | |
| | C078 | Communication wait time | 0. to 1000. | 0. | No | ms | |
| Various adjustment | C081 | FV adjustment | 0.0 to 200.0 | 100.0 | Yes | % | |
| | C082 | FI adjustment | 0.0 to 200.0 | 100.0 | Yes | % | |

* 2nd control is displayed when SET (08) is allocated to one of from C001 to C005.

| Parameter No. | | Function name | Monitor or data range (Digital Operator) | Default setting | Changes during operation | Unit | Set value |
|---|---|---|---|---|---|---|---|
| Others | C086 | AM offset adjustment | 0.0 to 10.0 | 0.0 | Yes | V | |
| | C091 | Not used | Use "00".<br>*Do not change. | 00 | — | — | |
| | C101 | UP/DWN selection | 00: Do not store the frequency data<br>01: Store the frequency data | 00 | No | — | |
| | C102 | Reset selection | 00: Trip reset at power-on<br>01: Trip reset when the power is OFF<br>02: Enabled only during trip (Reset when the power is ON.) | 00 | No | — | |
| | C141 | Logic operation function A input | 00: RUN (signal during RUN)<br>01: FA1 (constant speed arrival signal)<br>02: FA2 (over set frequency arrival signal)<br>03: OL (overload warning)<br>04: OD (excessive PID deviation)<br>05: AL (alarm output)<br>06: Dc (disconnection detected)<br>07: FBV (PID FB status output)<br>08: NDc (network error)<br>10: ODc (Do not use.)<br>43: LOC (light load detection signal) | 00 | No | — | |
| | C142 | Logic operation function B input | | 01 | No | — | |
| | C143 | Logic operator selection | 00: AND<br>01: OR<br>02: XOR | 00 | No | — | |
| | C144 | Output terminal P1 ON delay | 0.0 to 100.0 | 0.0 | No | s | |
| | C145 | Output terminal P1 OFF delay | 0.0 to 100.0 | 0.0 | No | s | |
| | C148 | Relay output ON delay | 0.0 to 100.0 | 0.0 | No | s | |
| | C149 | Relay output OFF delay | 0.0 to 100.0 | 0.0 | No | s | |
| Control parameter | H003 | Motor capacity selection | 200-V class<br>0.2/0.4/0.75/1.5/2.2/3.7/5.5/7.5<br>400-V class<br>0.4/0.75/1.5/2.2/3.7/5.5/7.5 | Factory default | No | kW | |
| | H203 | *2nd motor capacity selection | | Factory default | | | |
| | H004 | Motor pole number selection | 2<br>4<br>6<br>8 | 4 | No | Pole | |
| | H204 | *2nd motor pole number selection | | 4 | | | |
| | H006 | Stabilization parameter | 0. to 255. | 100 | Yes | % | |
| | H206 | *2nd stabilization parameter | | 100 | Yes | % | |

* 2nd control is displayed when SET (08) is allocated to one of from C001 to C005.

# DC Motor Characteristics

The characteristics of the DC Motor are:

| RATINGS | 120 V | 220 V | 240 V |
|---|---|---|---|
| Power rating (hp) | 1/3 | 1/3 | |
| Full-load current (A) | 3.6 | 1.8 | |
| Armature DC volts | 90 | 180 | |
| Enclosure type | TEFC | | |
| Duty rating | CONT. | | |
| Maximum ambient temperature [°C (°F)] | 40 (104) | | |
| Rotation speed (r/min) | 1750 | | |
| Torque | 1.52 n•m (13.5 lb•in) | | |
| Insulation class | F | | |