Introduction:

In the entirety of this experiment, you will setup, configure, program and operate a motor control system that utilizes a CompactLogix 1769-L32E Programmable Logic Controller (PLC) to control a pair of 3Φ Induction Motors, one by means of a PowerFlex 40 Variable Frequency Drive (VFD) and the other by means of a 3Φ contactor.

The entire experiment is split into five parts (A – E):

PLC-1A: CompactLogix-based Motor Control System – Overview (this document)

Part **A** introduces the **Motor Control System** that will be utilized during this experiment and provides setup instructions for the proper configuration of that equipment.

PLC-1B: PowerFlex 40 VFD – Configuration

Part **B** introduces the **PowerFlex 40 Variable Frequency Drive** that will be utilized by the motor control system to energize one of the 3Φ Induction Motors. Instructions are provided within part B for both the physical setup of the PF-40 and the configuration of the PF-40's operating parameters for proper integration into the motor control system.

PLC-1C: Communication Network – Configuration

Part **C** introduces the overall physical system that will be utilized during this experiment and provides setup instructions for the proper configuration of that equipment.

PLC-1D: RSLogix 5000 Software – Configuration, Programming, Downloading & Testing

Part **D** introduces various characteristics of the RSLogix software by stepping through the process required to create and test the operation of a simple ladder logic program.

PLC-1E: RSLogix 5000 Software II – Programming, Downloading & Testing

Part **E** is a continuation of Part D, but Part E focuses on the creation of a more complex ladder logic program that utilizes a wider variety of ladder logic instructions.

<u>Important Note – Order of Completion</u>

Although it is preferred that the parts of this experiment be completed in order, A⇨B⇨C⇨D⇨E, this may not be possible due to the limited amount of equipment available in the Q-215 laboratory.

Typically, only the motor control lab benches in the 4530 section of Q-215 will be setup with the equipment required for completion of this entire experiment. On the other hand, most of the computers in Q-215 have the RSLogix 5000 software required to complete the programming portion of this experiment (PLC-1D).

If you only have access to a lab bench with a computer that contains the RSLogix 5000 software, skip ahead to parts **D & E: RSLogix 5000 Software I and II** to complete the <u>programming</u> portions of this experiment. (Make sure that you save your completed programs on a memory stick.)

When you are able to access one of the physical systems, you can go back and complete parts **B & C** of this experiment, after which you can reload your saved programs into the RSLogix 5000 Software and complete the unfinished portions of parts D & E of this experiment.

CompactLogix-based Motor Control System:

System Description

The motor control system selected for this experiment utilizes a CompactLogix PLC to provide the operational logic required for the control of two 3Φ Induction Motors. The PLC contains both a 16-port (discrete-type, +24V$_{DC}$) input module and a 16-port (relay-type) output module, allowing for direct (wired) interaction with most of the system's other devices. Additionally, the PLC contains a communications port that will be connected to an Ethernet Switch, allowing for remote communications with other similarly-equipped devices via an Ethernet network.

The first Induction Motor will be energized by means of a contactor, the field-coil of which will be supplied directly by the PLC's output module. The second Induction Motor will be energized by means of a Variable Frequency Drive that also contains a communication port. The PLC will control the operation of the VFD remotely over the Ethernet network.

Operator control of the system will be provided by means of a NC "Stop" button and a NO "Start" button will respectively be connected to ports **0** and **1** of the PLC's input module.

Finally, a desktop computer will be utilized to both program, control, and monitor the operation of the PLC over the control system's Ethernet network.

Equipment List

To complete this entire experiment, access is required to one of the motor control lab benches in the Q-215 Electric Machines laboratory that contains all of the equipment following equipment:

> **1 – CompactLogix L32E Programmable Logic Controller (PLC)** with a 16-port **IQ16 Digital Input Module** and a 16-port **OW16 Relay Output Module**
> **1 – PowerFlex 40 (PF40) Variable Frequency Drive (VFD)** w/ Ethernet Module
> **1 – Personal Computer (PC)** with the following installed software packages: **RSLogix5000, RSLinx Classic, BootP, & Drive Explorer**.
> **2 – Combination (NO/NC) Pushbuttons**
> **1 – Indicator Lamp** (120V)
> **2 – Three-phase (3Φ) Induction Machines**
> **1 – Three-phase (3Φ) Contactor** with a 120V$_{AC}$ Field Coil
> **1 – Three-phase (3Φ) 120/208V LabVolt Power Supply**
> **1 – Ethernet Switch**

Physical Setup of the Motor Control System's Devices

The required **physical (wired) connections** between the various control system components that will be utilized during this experiment <u>should</u> already be complete.

A detailed description of the required connections is provided in the "Procedure" section of this handout and a **wiring diagram** is provided on the last page, both for informational purposes in case you need to troubleshoot and/or make repairs to the system.

It is highly recommended that you follow through the steps of this procedure in order to gain an understanding of the physical setup and to verify that the system is properly configured.

> **DO NOT disassemble** the control system components **or modify** any of the physical connections <u>unless</u> the system is <u>not</u> setup as described in the following procedure.

Procedure:

Programmable Logic Controller

L32E CPU & Power Supply

1. Energize the PLC's **power supply** by connecting a power cord from the **Power** socket on the front panel of the *A-B CompactLogix PLC* module to an AC **power-strip** on the workbench.

2. Connect the PLC to the control system's **Ethernet switch** via the **RJ-45 (net)** communications jack available on the front panel of the PLC module.

> *This will allow the PLC to communicate with any other devices that are connected to the control system's Ethernet network such as the VFD and the desktop computer.*

3. If not already in the proper position, turn the *key-switch* on the PLC's CPU to the "*REM*" position (vertical). (You can view the switch position through the clear plexiglass panel on the front on the *A-B CompactLogix PLC* module.

> *This will allow the PLC to be switched between "program" and "run" modes **rem**otely using the RSLogix software that is installed on the desktop computer.*

IQ16 Input Module

4. Connect the **negative terminal** of the PLC's $24V_{DC}$ source to the **Common** terminal of the **Input Module.** Note that both of these terminals are available on the PLC's front panel.

> *This provides the DC zero-volt reference for all of the PLC's inputs.*

5. Connect a **NC (Stop) Pushbutton** between the **positive terminal** of the PLC's $24V_{DC}$ **source** and **Input Port 0** of the PLC.

> *Since the PLC's inputs are triggered by $+24V_{DC}$, the NC pushbutton will hold Input Port 0 "true" unless the NC pushbutton is pressed.*

6. Connect a **NO (Start) Pushbutton** between the **positive terminal** of the $24V_{DC}$ **source** and **Input Port 1** of the PLC.

> *Since a NO pushbutton is connected to Input Port 1, the port will remain "false" unless the NO pushbutton is pressed.*

OW16 Output Module

7. Connect the **Common (V_{in})** terminal for **Ports 0-7** the **Output Module** to **Terminal 1** of the **constant 120/208V 3Φ supply**.

> *Since the output module is a relay-type module, whenever an output port (numbered 0-7) is energized, $120V_{AC}$ (with respect to the AC supply's neutral terminal) will be present at that port's terminal.*

8. Connect **Output Port 0** of the PLC to the **left terminal** of the contactor's **Field Coil**.

Connect and the **right terminal** of the **Field Coil** to the **Neutral (N) terminal** of the **constant 120/208V 3Φ supply**.

> *Whenever Output Port 0 is energized, the field coil will be supplied with $120V_{AC}$.*

9. Connect **Output Port 1** of the PLC to the **left terminal** of the **Indicator Lamp**.

Connect the **right terminal** of the **Indicator Lamp** to the supply's **Neutral** (**N**) **terminal**.

Whenever Output Port 1 is energized, the lamp will be supplied with 120V$_{AC}$.

Contactor – Main Contacts (Energizes / Deenergizes Motor #1)

10. Connect **terminals 1**, **2**, and **3** of the **constant 120/208V 3Φ supply** to **terminals 1**, **3**, and **5** of the "**red**" contactor's **NO contacts**.

Connect **terminals 2**, **4**, and **6** of the contactor's **NO contacts** to **terminals 1**, **2**, and **3** of the **left-hand** 3Φ Induction Motor's **stator windings**.

Connect **terminals 4**, **5**, and **6** of the **left-hand** 3Φ Induction Motor's **stator windings** together using two short (yellow) patch cables.

*When the field coil is energized, the NO contacts will close, energizing the first induction motor by connecting terminals **1**, **2**, and **3** of the 120/208V supply to terminals **1**, **2**, and **3** of the motor.*

PowerFlex 40 VFD (Variable Frequency Supply for Motor #2)

11. Connect the three "**blue**" **leads** attached to **terminals L1, L2**, and **L3** of the PF40 VFD to **terminals 1**, **2**, and **3** of the LabVolt constant **120/208V 3Φ Supply**.

This will provide the VFD with the supply voltage that is needs to operate.

12. Connect the three "**red**" **leads** attached to **terminals T1**, **T2**, and **T3** of the PF40 VFD to **stator terminals 1**, **2**, and **3** of the **right-hand** 3Φ Induction Motor.

Connect **terminals 4**, **5**, and **6** of the **right-hand** 3Φ Induction Motor's **stator windings** together using two short (yellow) patch cables.

*When the PF40 VFD is activated, the VFD will supply a variable-frequency AC voltage to terminals **1**, **2**, and **3** of the second motor's stator windings.*

13. Connect the **VFD's RJ-45 Ethernet Port** to the control system's **Ethernet Switch**.

This will allow the VFD to communicate with any other devices that are connected to the control-system's Ethernet network such as the PLC and the desktop computer.

Desktop Computer

14. **Unplug** the (blue) cable that connects the computer's **Ethernet Port** to the **campus network**.

*The computer **must be disconnected from the campus network** because the control system requires the use of the program BootP, which functions as a DHCP Server that can assign IP addresses to computers or other devices attached to the network. IT Policy does not allow individual users to operate DHCP Server software while connected to the campus network.*

15. Connect the computer's **Ethernet Port** to the **control system's Ethernet Switch**.

LabVolt 3Φ Power Supply

16. Do NOT energize the main LabVolt power supply at this time. You will be instructed when to do so in the next part of this lab.

> **REMINDER**
> **TURN-OFF** the main power supply **immediately** if any **unexpected operation** occurs while the supply is energized (**ON**).
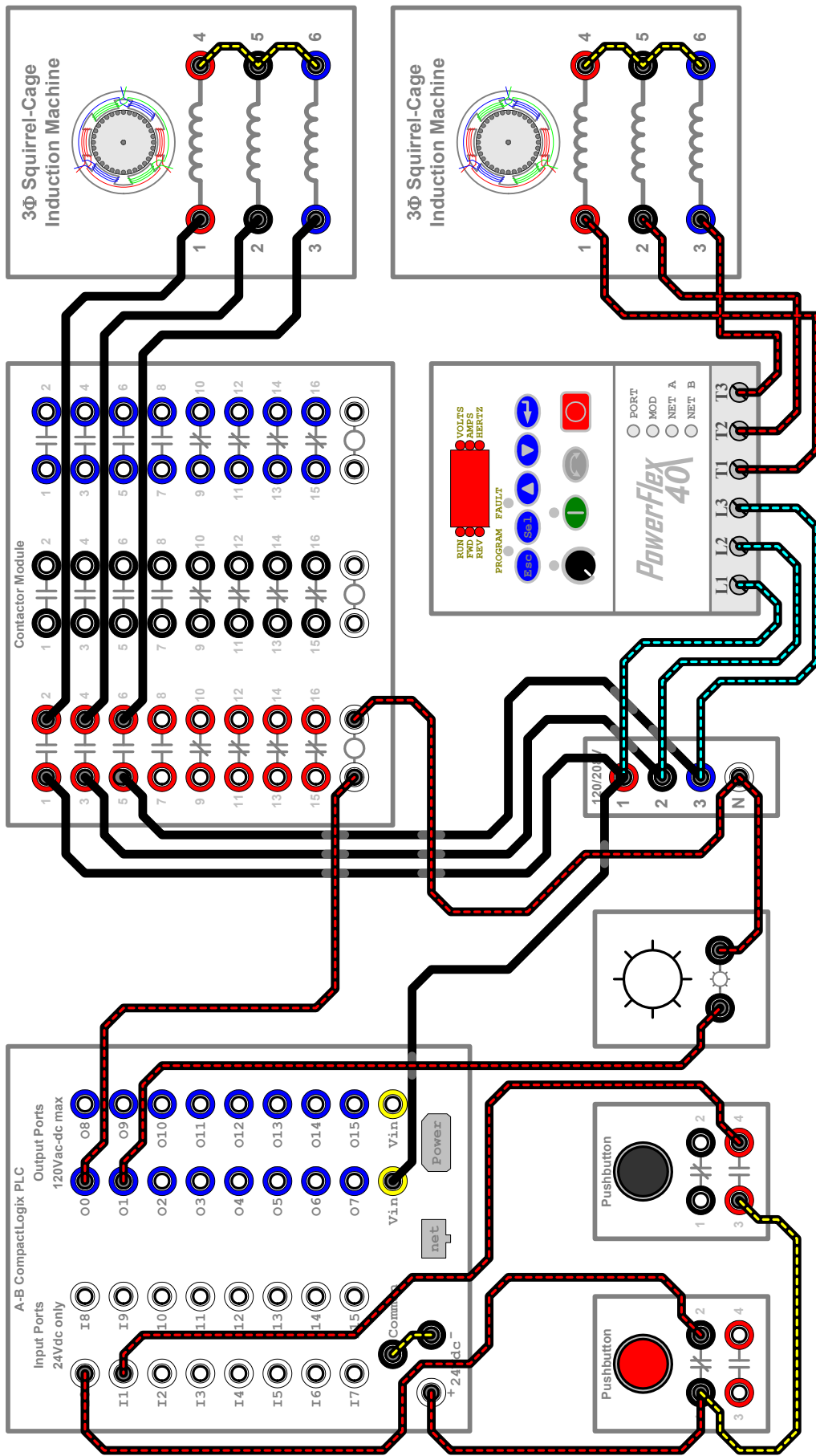
Figure A-1 – Wiring Diagram for CompactLogix-based Motor Control System