Name _____ **Lab Section** _____ **Date** _____

Introduction:

This experiment introduces the basic configuration and operational characteristics of an Allen-Bradley, **PowerFlex 40**, Variable Frequency Drive (VFD) that is being used to supply a three-phase, squirrel-cage, induction motor. The keypad provided on the faceplate of the drive will be used both to configure the drive and to control the operation of the induction motor. The Lab-Volt data acquisition system will be used to monitor the drive's output voltage and current waveforms as the speed of the motor is varied from start-up to near synchronous speed.

Procedure:

1. Configure the Lab-Volt system such that a Squirrel Cage Induction Motor is belted to the Dynamometer. Provide $24V_{AC}$ power to both the Data Acquisition Interface (DAI) and to the Dynamometer, and connect a USB cable between the DAI and the desktop computer.

2. Adjust the dynamometer to provide minimum torque load, and adjust the potentiometer on the front of the PF40 to its minimum (**CCW**) setting.

3. Start the LVDAM-EMS software.

4. Setup the DAI's instrumentation software to display all of the phase-voltage and line-current magnitudes (E1-E3 and I1-I3) using the digital meters, and to display all of the phase-voltage and line-current waveforms using the oscilloscope interface (**50 V/div, 0.5A/div** and **5ms/div**).

Connecting the PowerFlex 40 (PF40) VFD to the Lab-Volt Supply and the Induction Motor:

5. Connect the three "**blue**" leads attached to terminals **L1**, **L2**, and **L3** of the PF40 to terminals **1**,**2**, and **3** of the Lab-Volt, **constant 120/208V**, three-phase supply.

6. If available, **Do Not** connect the forth "**blue**" lead attached to the **Ground** terminal of the PF40 to the Ground terminal of the Lab-Volt supply. Again… **Do NOT Ground** the VFD.

7. Connect the three "**red**" leads attached to terminals **T1**, **T2**, and **T3** of the PF40 to terminals **1**,**2**, and **3** of a wye-connected Squirrel-Cage Induction Machine via the three ammeters of the DAI.

8. Connect/configure the three volt-meters of the DAI to measure the individual phase-voltages being supplied to the induction motor by the VFD.

9. Rotate the potentiometer on the front panel of the PF40 to its minimum (CCW) position.

10. **HAVE YOUR INSTRUCTOR CHECK YOUR WIRING BEFORE YOU ENERGIZE THE CIRCUIT.**

11. Turn **ON** the main Lab-Volt power supply to energize the PF40.

Resetting the PowerFlex 40 to its Default Operating Parameters:

The PowerFlex 40's operating parameters are determined by various values that are stored in its memory. The values are organized into two groups; the ***Basic Program Group*** **(P)** containing the most commonly used parameters that define the drive's basic operation, and the ***Advanced Group*** **(A)** containing parameters that may be accessed in order to modify the more technical aspects of the drive's operation.

Along with the program groups, a third set of memory registers is organized into ***Display Groups*** **(d)** that contain parameters pertaining to the operational state of the drive.

All of these parameters may be accessed from the keypad on the front panel of the drive.

12. Reset the VFD to its default configuration by accessing the ***Basic Program Group*** – **P041** and setting its value to **one** (**1**) using the following procedure:

a) Press the **Esc** button on the front panel of the ***PF40*** to display the last user-selected group parameter. The parameter number will flash.

b) Press the **Esc** button a second time to enter the group menu. The left-most character in the LED display will flash. (For example – "**d**" for ***Display Group***).

c) Press the ▲ or ▼ buttons to scroll through the available menu groups (**d**, **P** and **A**).

d) Choose group **P**, the ***Basic Program Group***, and press the ↵ (**Enter**) button or the **Sel** button to select that group. The parameter number will now flash.

e) Use the ▲ or ▼ button to change to program number to "**P041**". Once "**P041**" is displayed, press the **Enter** or the **Sel** button to view that parameter's value.

f) Press the **Enter** or the **Sel** button again to enter the program mode in order to edit the parameter's value. *(Note – if you don't want to edit the value, press **Esc** to return to the parameter number)*

g) Use the ▲ or ▼ button to change the parameter value from "**0**" to "**1**" and press **Enter** (↵). This will reset the ***PF40*** to default conditions.

h) The ***PF40's*** display should now be flashing the ***fault-code*** "**F048**". Fault code ***48*** occurs when the ***VFD's*** parameters are reset to their default values.

i) Press the red "**Stop**" button to acknowledge and clear the fault.

The ***default configuration*** allows the VFD to receive **start**, **stop**, **forward** and **reverse** commands from its keyboard and its **speed reference** (output frequency) from the potentiometer on its front panel. See the attached parameter tables for a complete list of the default parameter values.

PowerFlex 40 Operation:

13. Using the keypad, set the PF40 to display the parameter in ***Display Group*** "**d002**". This parameter shows the "***Commanded Frequency***" for the drive.

14. Press the green "**Start**" button on keypad to **enable** the drive.

15. Using the potentiometer on the front of the PF40, raise the frequency of the drive's output to **10Hz** by slowing rotating the potentiometer in the **CW** direction. While raising the frequency, note the value displayed for parameter "**d002**" along with the operation of the motor.

16. Press **ESC** to once again display the current group number "**d002**" (*Commanded Frequency*).

17. Use the ▲ button to change to group "**d003**" and press **Enter**. This parameter shows the "***Output Current***" for the drive.

18. Similarly, change to group "**d004**" to display the "***Output (Line) Voltage***" of the drive.

19. Return the display to the "**d002**" setting.

20. Quickly raise the drive frequency from **10Hz** to **60Hz** (maximum) by quickly rotating the potentiometer to its CW-most position.

21. Watch the frequency displayed on the drive as the motor accelerates to its new steady-state operational speed.

22. Once the motor achieves steady-state operation, return the potentiometer back to the **10Hz** setting and adjust the drive to display the "**d001**" parameter. This parameter shows the "***Output Frequency***" for the drive.

23. Once again, quickly raise the frequency to **60Hz** and watch the displayed frequency. How is this different from the frequency displayed with the "**d002**" option?

24. Return the potentiometer back to the **10Hz** setting.

25. Using the Data Acquisition System, **record** the **phase voltage** and **line current** magnitudes along with the motor **speed** at the **10Hz** setting.

26. Raise the drive frequency from **10Hz** to **60Hz** in **10Hz** steps. **Record** the voltage, current and speed values at each frequency value.

27. Decrease the drive frequency back down to **10Hz** and adjust the dynamometer to provide a **6 lb·in load** to the motor.

28. Repeat the previous measurements over the same set of drive frequencies.

29. Reduce the dynamometer's load setting to **0 lb·in** and decrease the drive frequency to **0Hz**.

30. While slowly raising the drive frequency from **0Hz** to **60Hz**, view the output voltage waveforms from the drive using the oscilloscope interface of the DAI.

31. Decrease the output frequency back to **0Hz**.

32. Once again, while slowly raising the drive frequency from **0Hz** to **60Hz**, view the output current waveforms from the drive using the oscilloscope interface of the DAI.

33. Adjust the dynamometer for a load of **6 lb-in** repeat steps 29→31, viewing the output voltage and current waveforms as the drive frequency is slowly raised from **0Hz** to **60Hz**.

34. Reduce the dynamometer's load setting to **0 lb·in** and decrease the drive frequency to **0Hz**.

35. Adjust the drive to display group "**d001**", the "***Output Frequency***" of the drive.

36. Quickly increase the frequency of the drive from **0Hz** to **60Hz** and count how long it takes for the drive to reach an output frequency of **60Hz**.

37. Quickly decrease the frequency of the drive from **60Hz** to **0Hz** and count how long it takes for the drive to reach an output frequency of **0Hz**.

38. Raise the frequency of the drive back to **60Hz**.

39. Without adjusting the potentiometer, press the "**Stop**" button on the keypad and note the operation of the drive and the motor. Does the motor stop immediately?

40. Press the green "**Start**" button to re-enable the drive. Note that the drive accelerates back to **60Hz**.

41. Once the output reaches **60Hz**, press the ↔ "**Reverse**" button on the keypad and note the operation of the drive and the motor.

42. Adjust the frequency to **0Hz** and reset the drive for **Forward** operation (I.e. – press "Reverse" again).

43. Using the buttons on the keypad, change the parameters in Basic Program Groups **P039** and **P040** from "**10**" to "**3**".

44. Quickly adjust the frequency from **0Hz** to **60Hz** and note the operation of the drive and the motor.

45. Quickly adjust the frequency from **60Hz** to **0Hz** and note the operation of the drive and the motor.

46. What effect did changing parameters **P039** and **P040** both to "**3**" have on the drive's operation?

47. Press "**Stop**" to disable the drive and turn off the main Lab-Volt power supply.

48. Disconnect the drive from the Lab-Volt equipment.