

Variable Frequency Drives

INDUSTRIAL MOTOR CONTROL



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By Cardinal Automation, LLC

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Table of Contents

TABLE OF CONTENTS.....	2
VARIABLE FREQUENCY DRIVES OVERVIEW	4
HOW DOES A VFD WORK?	4
VFD ELECTRICAL CIRCUIT	5
RECTIFIER.....	5
DC BUS	6
INVERTER	6
POWERFLEX 525 OVERVIEW	8
COMMON SPECIFICATIONS	9
DRIVE RATINGS	9
CATALOG NUMBER IDENTIFICATION	10
CATALOG NUMBER EXPLANATION	11
ANATOMY OF A POWERFLEX 525 DRIVE	12
MINIMUM MOUNTING CLEARANCES	12
GENERAL GROUNDING REQUIREMENTS.....	13
POWERFLEX 525 POWER MODULE	13
POWERFLEX 525 POWER MODULE TERMINAL BLOCK	14
POWERFLEX 525 CONTROL MODULE	15
POWERFLEX 525 CONTROL MODULE MAIN COMPONENTS.....	15
SEPARATING THE POWER MODULE AND THE CONTROL MODULE	16
CONNECTING THE POWER AND CONTROL MODULE	17
SEPARATING THE CONTROL MODULE COVER.....	18
POWERFLEX 525 CONTROL MODULE - I/O TERMINAL BLOCK.....	19
POWERFLEX 525 CONTROL MODULE – I/O BREAKDOWN	20
<i>Lab 01 - Wiring the VFD</i>	<i>22</i>
POWERFLEX 525 – CONTROL MODULE – DISPLAY AND CONTROL KEYS	25
POWERFLEX 525 PARAMETER CONFIGURATION	26
MODIFYING PARAMETERS USING THE HUMAN INTERFACE MODULE	26
POWERFLEX 525 PARAMETER ORGANIZATION	26
POWERFLEX 525 PARAMETER ORGANIZATION	27
VIEWING AND EDITING PARAMETERS	28
<i>Lab 02 – Reset the Powerflex to Defaults.....</i>	<i>29</i>
SMART STARTUP WITH BASIC PROGRAM GROUP PARAMETERS	31
<i>Lab 03 – Powerflex 525 - Smart Startup.....</i>	<i>33</i>
<i>Lab 04 – Basic VFD Keypad Operation</i>	<i>34</i>
ETHERNET COMMUNICATIONS FUNDAMENTALS	35
ESTABLISHING ETHERNET/IP COMMUNICATIONS.....	37
POWERFLEX 525 NETWORK STATUS INDICATORS	37
<i>Lab 05 – Communications - Configure the PowerFlex 525 Drive IP Address</i>	<i>38</i>



<i>Lab 06 – Communications - Establish the IP Address on the Computer</i>	39
RSLINX CLASSIC SOFTWARE	44
<i>Lab 07 – Communications - RSLinx Classic - Creating a Driver</i>	45
CONNECTED COMPONENTS WORKBENCH OVERVIEW	50
HARDWARE REQUIREMENTS	50
SOFTWARE REQUIREMENTS	50
ADDITIONAL SOFTWARE	51
INSTALLATION VERSIONS	51
STARTING CONNECTED COMPONENTS	51
CONNECTED COMPONENTS MAIN WINDOW	52
<i>Lab 08 – Connected Components Workbench - Creating a New Project</i>	53
MODIFYING DRIVE PARAMETERS	63
APPVIEW	64
CUSTOMVIEW	65
PROGRAM LOCK	66
LOCK PARAMETERS	66
POWERFLEX 525 STARTUP WIZARD	66
<i>Lab 09 – Connected Components Workbench – Commissioning a Powerflex 525 Drive</i>	67
<i>Lab 10 – Connected Components - VFD Wiring Configuration</i>	78
IDENTIFYING FAULTS	80
TYPES OF FAULTS	80
NON-FAULT CONDITIONS	81
KEY PARAMETERS TO HELP TROUBLESHOOT POWERFLEX 525 DRIVES	81
CLEARING FAULTS	83
CONNECTED COMPONENTS FAULTS/ALARMS	83
FIRMWARE	84
UPDATING THE POWERFLEX 525 DRIVE FIRMWARE	85
<i>Lab 11 – Connected Components Workbench – Creating a Trend</i>	92
NOTES	97
BIBLIOGRAPHY	98
CARDINAL AUTOMATION, LLC	99



Lab 02 – Reset the Powerflex to Defaults

Discussion:

When the PowerFlex 525 is powered up for the first time, all parameters are at the factory defaults. To prepare for configuring the drive, if it is unknown the last time the drive was used, make sure to reset the VFD back to factory defaults.

Below is a list of information related to the **Parameter P053 [Reset to Defaults]**.

P053 [Reset To Defaults]
 Stop drive before changing this parameter.
Resets all parameters to their factory default values. After a Reset command, the value of this parameter returns to zero.

Parameters that are NOT Reset when P053 = 1

Parameter	Parameter	Parameter
P030 [Language]	C138 [EN Gateway Cfg 2]	C159 [EN Data Out 3]
C121 [Comm Write Mode]	C139 [EN Gateway Cfg 3]	C160 [EN Data Out 4]
C122 [Cmd Stat Select]	C140 [EN Gateway Cfg 4]	C161 [Opt Data In 1]
C123 [RS485 Data Rate]	C141 [EN Rate Cfg]	C162 [Opt Data In 2]
C124 [RS485 Node Addr]	C143 [EN Comm Flt Actn]	C163 [Opt Data In 3]
C124 [Comm Loss Action]	C144 [EN Idle Flt Actn]	C164 [Opt Data In 4]
C126 [Comm Loss Time]	C145 [EN Flt Cfg Logic]	C165 [Opt Data Out 1]
C127 [RS485 Format]	C146 [EN Flt Cfg Ref]	C166 [Opt Data Out 2]
C128 [EN Addr Sel]	C147 [EN Flt Cfg DL 1]	C167 [Opt Data Out 3]
C129 [EN IP Addr Cfg 1]	C148 [EN Flt Cfg DL 2]	C168 [Opt Data Out 4]
C130 [EN IP Addr Cfg 2]	C149 [EN Flt Cfg DL 3]	C169 [MultiDrv Sel]
C131 [EN IP Addr Cfg 3]	C150 [EN Flt Cfg DL 4]	C171 [Drv 1 Addr]
C132 [EN IP Addr Cfg 4]	C153 [EN Data In 1]	C172 [Drv 2 Addr]
C133 [EN Subnet Cfg 1]	C154 [EN Data In 2]	C173 [Drv 3 Addr]
C134 [EN Subnet Cfg 2]	C155 [EN Data In 3]	C174 [Drv 4 Addr]
C135 [EN Subnet Cfg 3]	C156 [EN Data In 4]	C175 [DSI I/O Cfg]
C136 [EN Subnet Cfg 4]	C157 [EN Data Out 1]	GC [Parameters in Custom Group]
C137 [EN Gateway Cfg 1]	C158 [EN Data Out 2]	

Parameters that are Reset when P053 = 3

Parameter Name
P031 [Motor NP Volts]
P033 [Motor OL] Current
P034 [Motor NP FLA]
P035 [Motor NP Poles]
A435 [DC Brake Level]
A484 [Current Limit 1]
A485 [Current Limit 2]
A486 [Shear Pin1 Level]
A488 [Shear Pin2 Level]
A490 [Load Loss Level]
A496 [IR Voltage Drop]
A497 [Flux Current Ref]
A530 [Boost Select]
A531 [Start Boost]
A532 [Break Voltage]
A533 [Break Frequency]
A534 [Maximum] Voltage

0 "Ready/Idle" (Default)

1 "Param Reset" Does not reset custom groups, parameter P030 [Language], and communication parameters.

2 "Factory Rset" Restore drive to factory condition.

3 "Power Reset" Resets only power parameters. Can be used when swapping power modules.

4 "Module Reset"^{(1) (2)} Power cycle of the drive, **NO** parameters are reset.

⁽¹⁾ Setting is available in PowerFlex 525 FRN 5.xxxx and later.

⁽²⁾ Setting is available in PowerFlex 523 FRN 3.xxxx and later.

Objectives:

- Reset the Powerflex to Defaults

Situation: Restore a PowerFlex 525 Drive to Factory Defaults to prepare for startup.



Tasks:

1. Press the **STOP**  button to make sure the drive is stopped and to clear any faults from the drive.
2. Press the **ESC**  button until you see the **Parameter b001 (0.00Hz)** displayed on the keypad. 
3. Press the **SELECT**  button and use the **UP**  or **DOWN**  arrows until you see the **Basic Program group** on the HIM Display.
4. Press the **ENTER**  or **SELECT**  button to enter the Basic Program Group.
5. The **right digit** of the last viewed parameter in the group will flash.
6. Use the **UP**  or **DOWN**  arrows until you have **P053 [Reset to Defaults]** displayed. 
7. You can also press the **SELECT**  button to move from digit to digit. The digit that is being changed will flash. If you wait one second, the HIM display will scroll across reading **P053 – “Reset to Defaults”**.
8. Once **P053 – “Reset to Defaults”** is displayed, press the **ENTER**  button. You will see **0 – “Ready/Idle”** scroll across the HIM display. Press the **UP**  or **DOWN**  arrows until you see **2 - “Factory Reset”**.
9. Press the **ENTER**  button to confirm. The drive will fault with a scrolling message of **F048 – “Parameters Defaulted”**. 

No.	Fault	Type ⁽¹⁾	Description	Action
F048	Params Defaulted	1	The drive was commanded to write default values to EEPROM.	• Clear the fault or cycle power to the drive. • Program the drive parameters as needed.

10. Press the **STOP**  button to clear the fault from the drive.

Do NOT edit any further parameters at this time.



Lab 05 – Communications - Configure the PowerFlex 525 Drive IP Address

Assignment:

- Configure the PowerFlex 525 Drive IP Address

Situation: Configure the Communication Parameters Group to establish communication with the PowerFlex 525 Drive IP Address.

Tasks:

1. Connect an **ethernet cable** to the **EtherNet/IP port** on the PowerFlex 525.



2. Change the **Communications Group Parameters** to the following to establish an **IP address**:

Parameter	Description	Setting
C128	Enables the IP address, subnet mask, and gateway to be set with a BOOTP server or Parameters	1
C129	Sets the bytes in the IP Address – [EN IP Addr Cfg 1] – 4 th Octet	192
C130	Sets the bytes in the IP Address – [EN IP Addr Cfg 1] – 3 rd Octet	168
C131	Sets the bytes in the IP Address – [EN IP Addr Cfg 1] – 2 nd Octet	1
C132	Sets the bytes in the IP Address – [EN IP Addr Cfg 1] – 1 st Octet	2

Note: The first three octets for the IP address will be the same for the Computer, VFD, PLC or HMI.

Change the **Communication Group Parameters** to the following to establish a **Subnet Mask**:

Parameter	Description	Setting
C133	Sets the bytes of the subnet mask – [EN Subnet Cfg 1] – 4 th Octet	255
C134	Sets the bytes of the subnet mask – [EN Subnet Cfg 1] – 3 rd Octet	255
C135	Sets the bytes of the subnet mask – [EN Subnet Cfg 1] – 2 nd Octet	255
C136	Sets the bytes of the subnet mask – [EN Subnet Cfg 1] – 1 st Octet	0

3. The VFD must be power cycled. Turn off main power to the VFD. Allow enough time for a “power off” state. Turn power back on the VFD.



Lab 06 – Communications - Establish the IP Address on the Computer

Discussion:

For **Connected Components Workbench** software or **Studio 5000 Logix Designer** software to communicate with the **PowerFlex 525 drive**, we need to establish an IP Address on the computer within the same subnet as the drive.

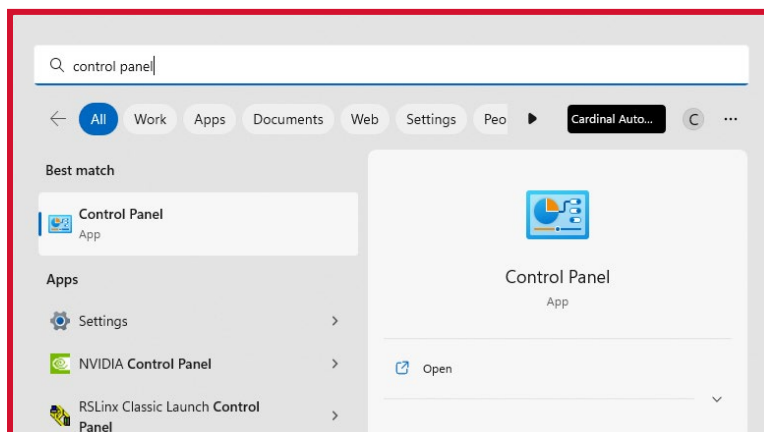
Assignment:

- Establish an IP Address on a computer.

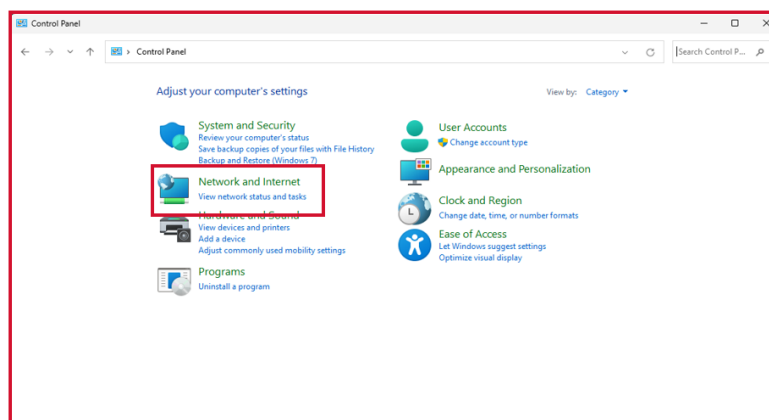
Situation: Need to establish communication settings on a personal computer.

Tasks:

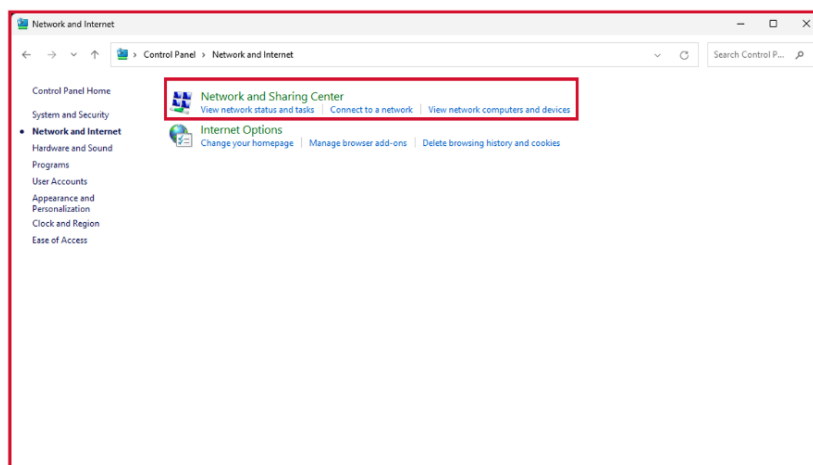
1. Open the **Control Panel** by using the Main Menu or Search Bar



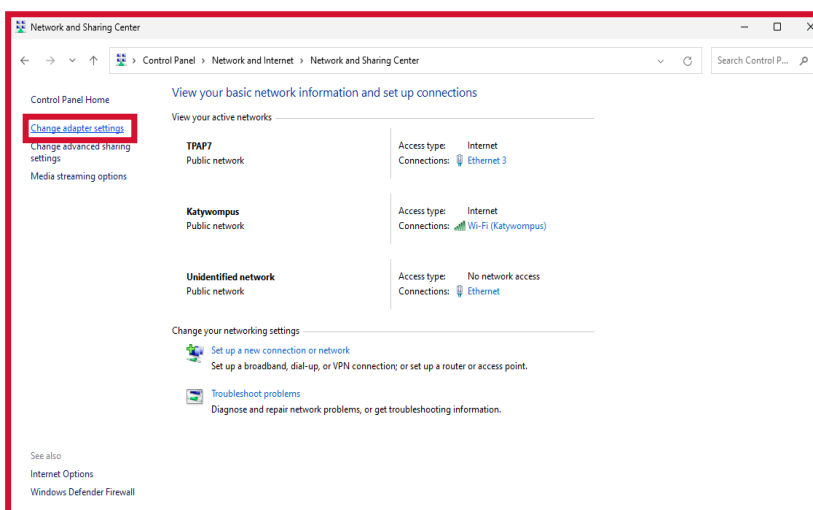
2. Click **Network and Internet**



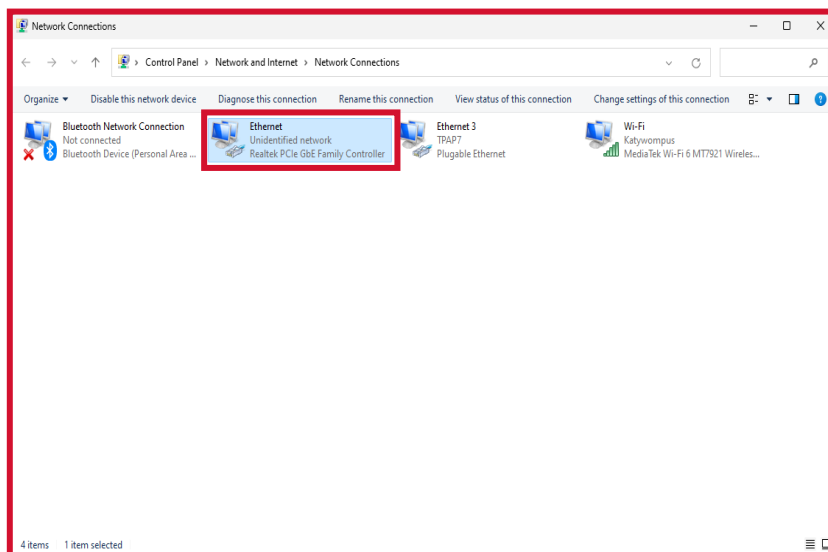
3. Click **Network and Sharing Center**



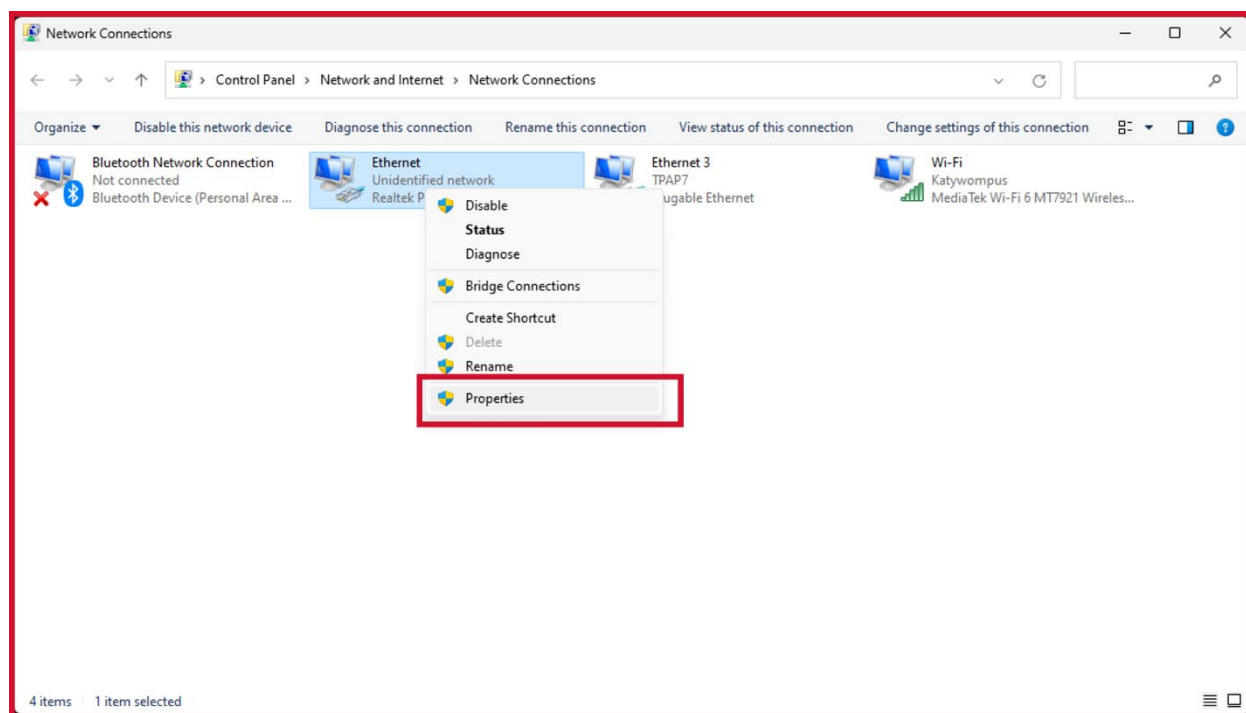
4. Click **Change adapter settings** in the left pane.



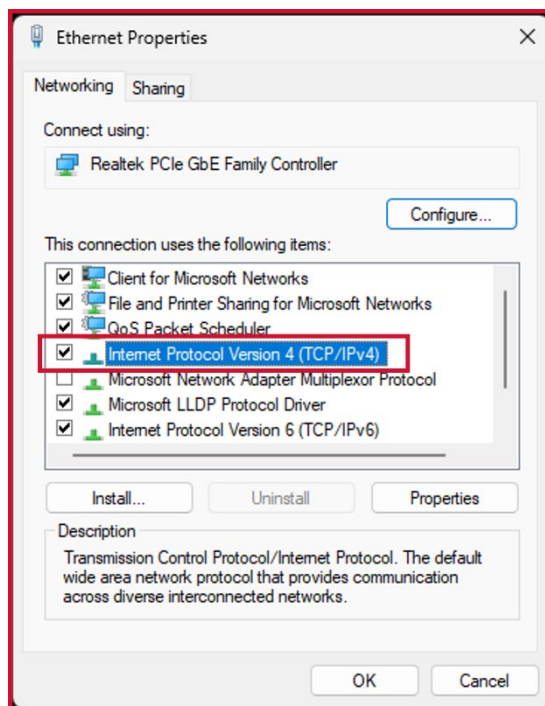
5. On this computer, the adapter with the name **Ethernet** indicates Unidentified Network.



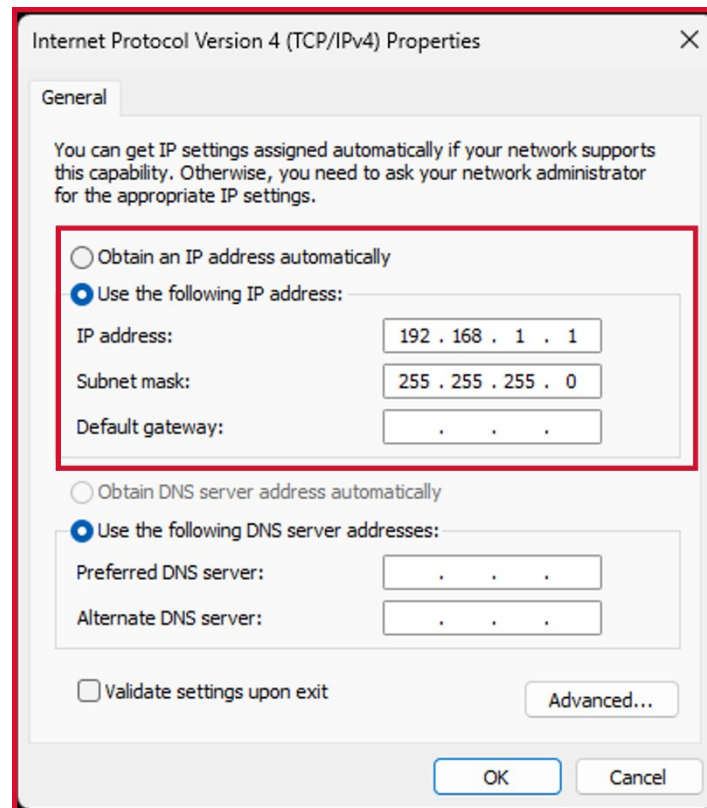
6. Right-click on Ethernet and select **Properties**.



7. To configure the IP address, double-click **Internet Protocol Version 4**.

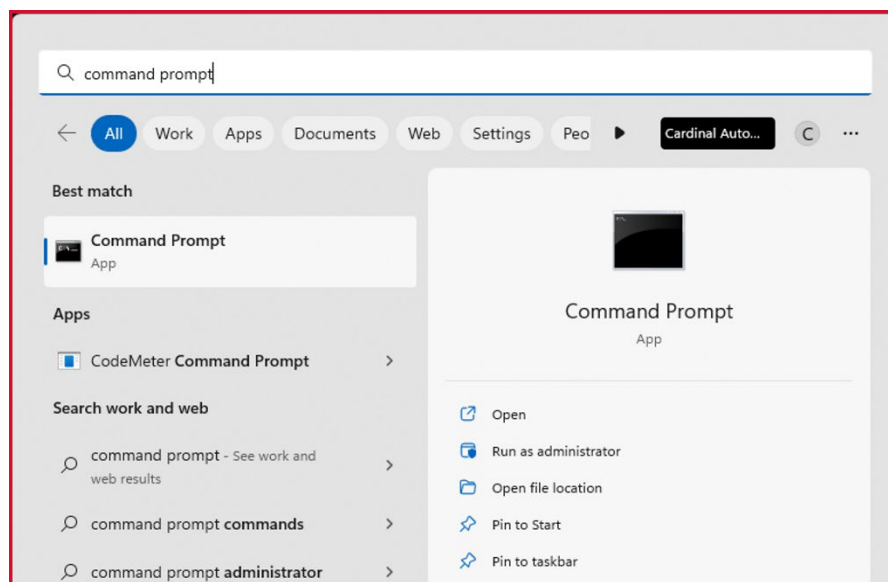


8. On the General tab, the default setting is typically set to Obtain an IP address automatically. **Select Use the Following IP address.** Set the host IP address.

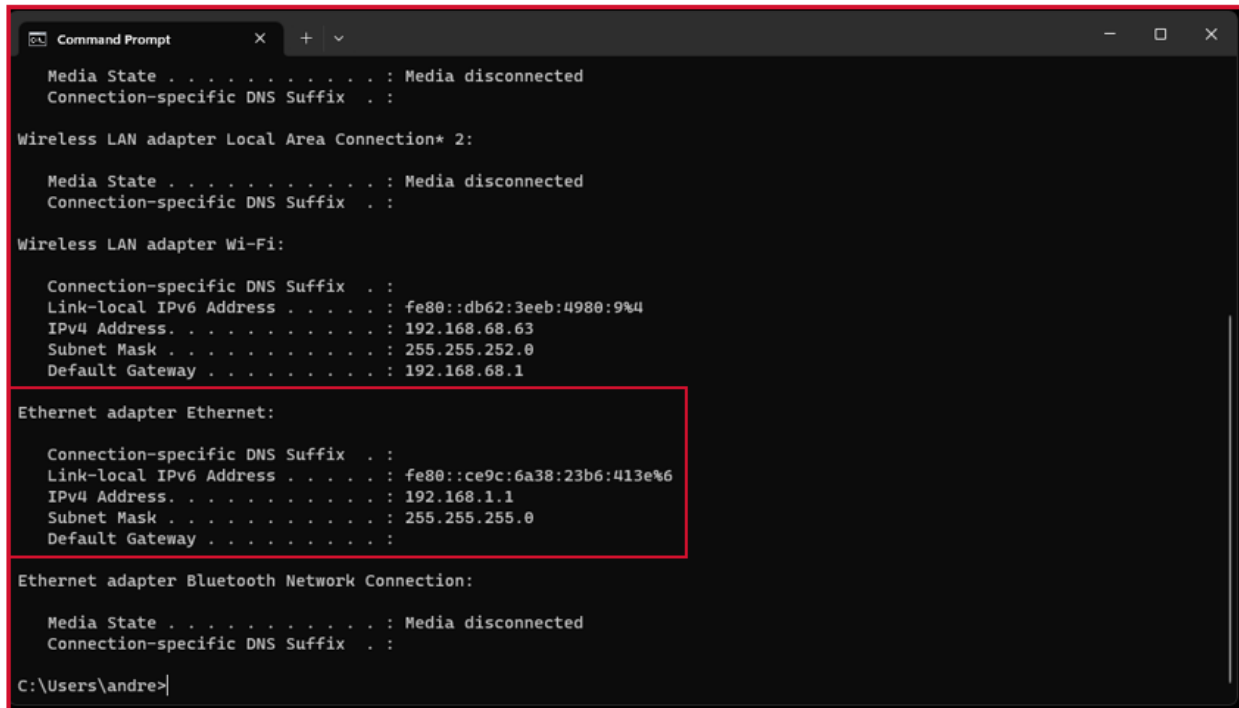


Note: Verify with the Instructor for the correct IP address to use for the computer.

9. **Verify** the IP Address of the computer. In the **Start Menu** or **Search Bar**, type and select **Command Prompt**.



10. Type **ipconfig** – verify the IP address is correct. The IP address that was set in the previous step, should appear under Ethernet adapter.



```
Command Prompt
Media State . . . . . : Media disconnected
Connection-specific DNS Suffix . :

Wireless LAN adapter Local Area Connection* 2:

Media State . . . . . : Media disconnected
Connection-specific DNS Suffix . :

Wireless LAN adapter Wi-Fi:

Connection-specific DNS Suffix . :
Link-local IPv6 Address . . . . . : fe80::db62:3eeb:4980:9%4
IPv4 Address. . . . . : 192.168.68.63
Subnet Mask . . . . . : 255.255.252.0
Default Gateway . . . . . : 192.168.68.1

Ethernet adapter Ethernet:

Connection-specific DNS Suffix . :
Link-local IPv6 Address . . . . . : fe80::ce9c:6a38:23b6:413e%6
IPv4 Address. . . . . : 192.168.1.1
Subnet Mask . . . . . : 255.255.255.0
Default Gateway . . . . . :

Ethernet adapter Bluetooth Network Connection:

Media State . . . . . : Media disconnected
Connection-specific DNS Suffix . :

C:\Users\andre>
```



RSLinx Classic Software



RSLinx Classic Software is a communication server package that provides plant-floor device connectivity for a wide variety of applications. It acts as a powerful communication bridge, enabling data exchange between Rockwell Automation devices such as programmable logic controllers (PLCs), human-machine interfaces (HMIs), Variable Frequency Drives (VFDs) and other systems.

One of the primary functions of RSLinx Classic is to configure the **communication drivers** needed between a programming device and industrial devices. **Configuring drivers allow networks to browse for industrial devices to establish reliable connections with those devices and facilitate data exchange.** It enables bi-directional

communication, allowing devices to send and receive data seamlessly.

By providing support for multiple communication protocols like **DF1**, **DH485**, and **Ethernet/IP**, RSLinx Classic allows for interoperability and integration of diverse devices and systems.

When it comes to the **EtherNet/IP protocol**, the user has two options:

- Ethernet devices
- EtherNet/IP Driver

The “**Ethernet devices**” driver allows the user to enter the IP address of each device that you’re looking to communicate with. The advantage of this method is that you’re limiting yourself to only the devices that you have specified. This is a much more controlled method of communication and helps to eliminate user mistakes.

The “**EtherNet/IP Driver**” driver allows the user to send an **Address Resolution Protocol (ARP)** message. ARP broadcasts a request packet to all the machines on the **Local Area Network (LAN)** and asks if any of the machines are using a **particular IP address**. This will go to the entire **subnet** and map all the devices onto the driver.

This method is easier to execute on a large network, but it is easy to connect to the wrong device from a list of many and to make unwanted changes to the device.

Both can be created from the “**Configure Drivers**” prompt within RSLinx. However, their setup and interface are different and would need to be set up differently.

Once each device is specified, the driver will start pinging those devices only. A **ping (Packet Internet or Inter-Network Groper)** is a computer network administration utility that allows a user to test and verify the reachability of a host on a network. This will check if a particular destination IP address exists and can accept requests in the network.



Lab 07 – Communications - RSLinx Classic - Creating a Driver

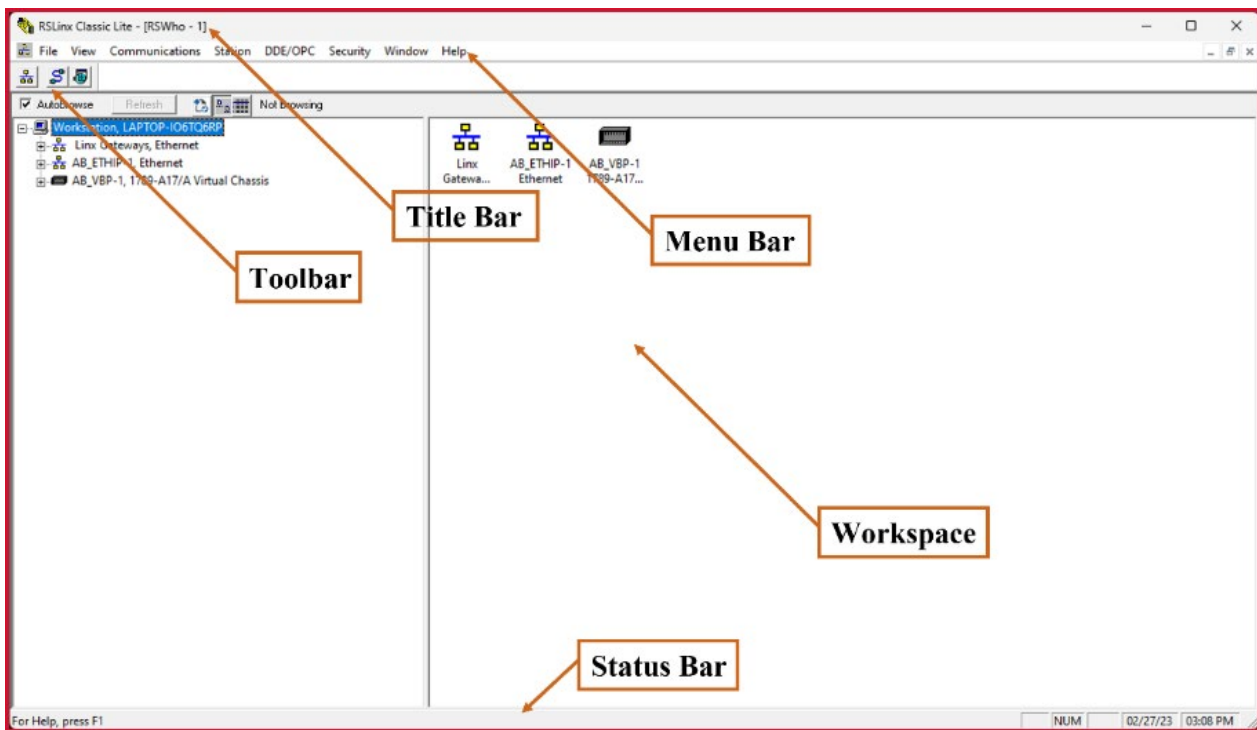
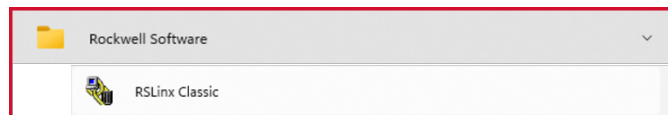
Assignment:

- Create/Delete a Driver in RSLinx Classic Software

Situation: Create a driver to establish communications for various devices. For this demonstration, we will be using the “EtherNet/IP Driver”. EtherNet/IP is an internet protocol that has been altered for the data collection of manufacturing applications, such as configuration, controls, information, motion, safety, and synchronization.

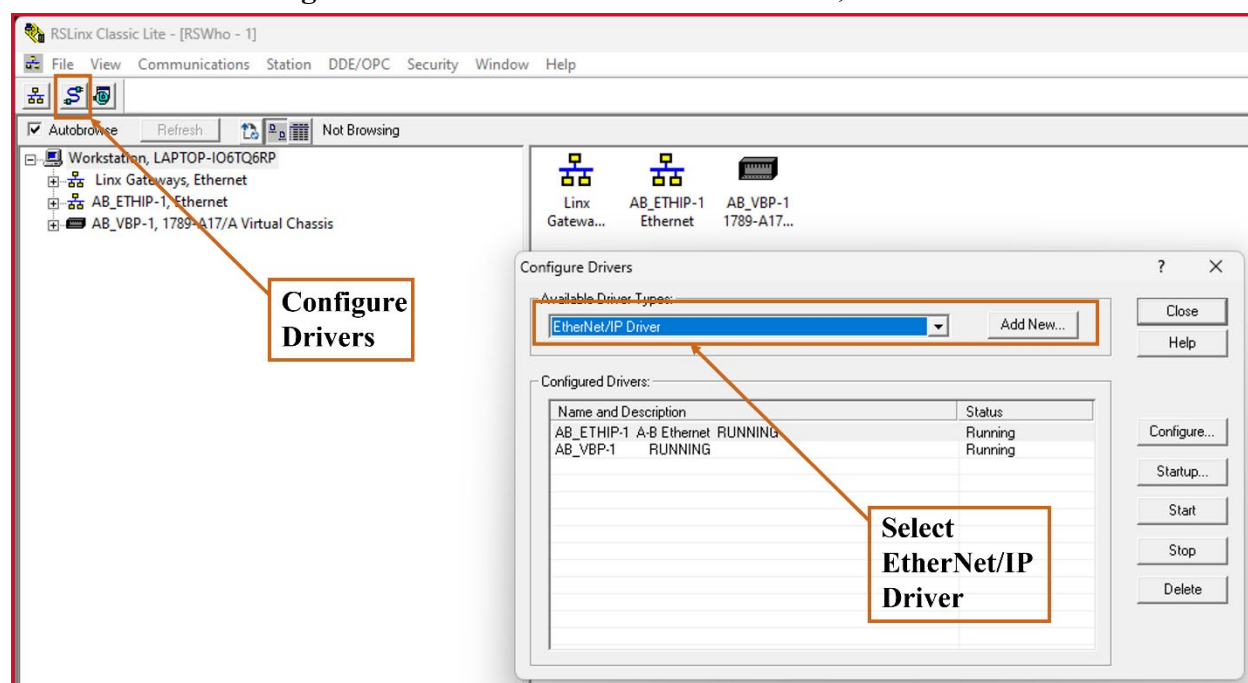
Tasks:

1. Click on **All Programs** and under the folder **Rockwell Software**, select **RSLinx Classic**.
2. When you start RSLinx Classic, the **Rockwell Software RSLinx Classic application window** appears.

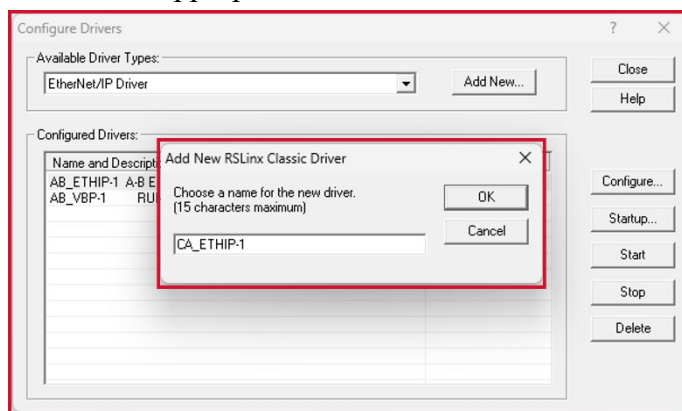


Component	Description
Title Bar	The title bar contains the RSLinx Classic icon, the name of the software, the RSWho instance number and the Minimize, Maximize, and Close button.
Menu Bar	The RSLinx Classic menu bar contains the following menu items: File, Edit, View, Communications, Station, DDE/OPC, Security, Window and Help
Toolbar	The toolbar contains shortcuts to several commonly used RSLinx Classic functions: RSWho, Configure Drivers, and Driver Diagnostics.
Workspace	The Application Workspace shows the open windows, such as the RSWho and RSLinx Classic dialog boxes.
Status Bar	The status bar at the bottom of the RSLinx Classic screen provides information about the current status of your system.

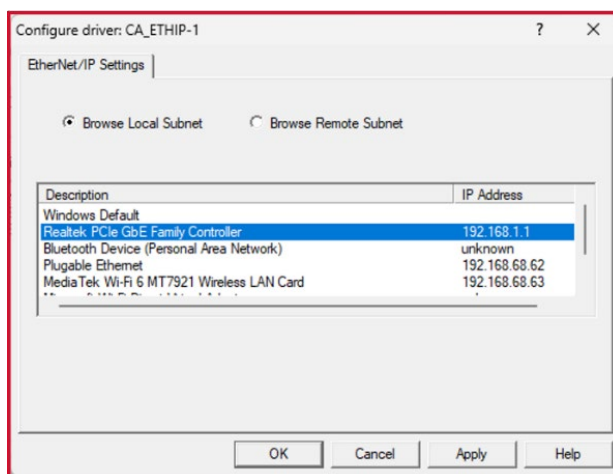
3. Click on **Configure Drivers**. From the Pull-Down Menu, select **EtherNet/IP Driver**.



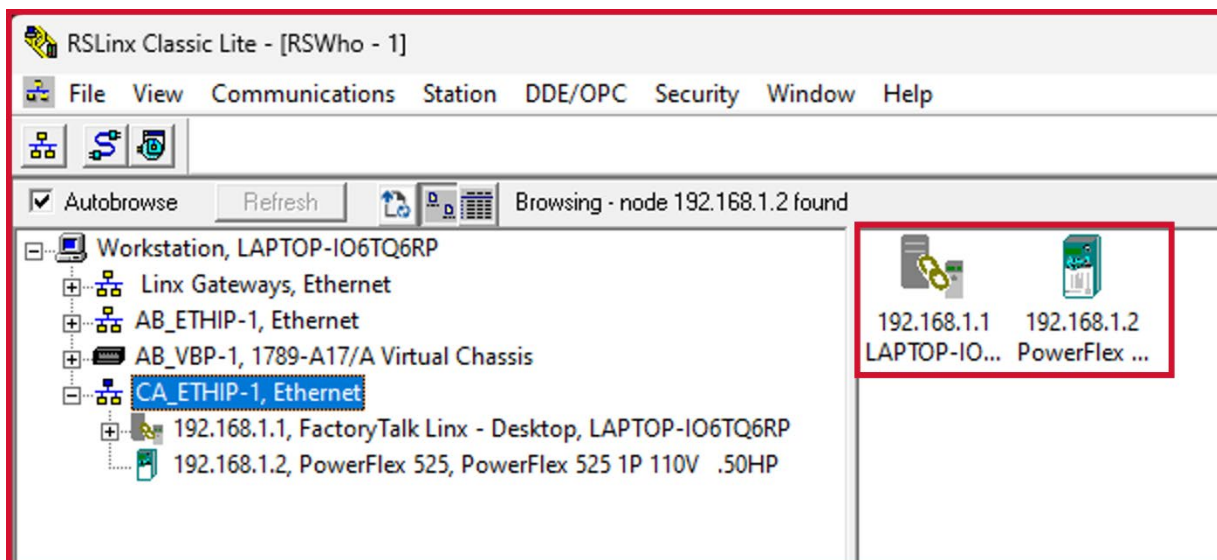
4. Click **Add New**. Enter an appropriate name for the EtherNet/IP Driver. Click **OK**.



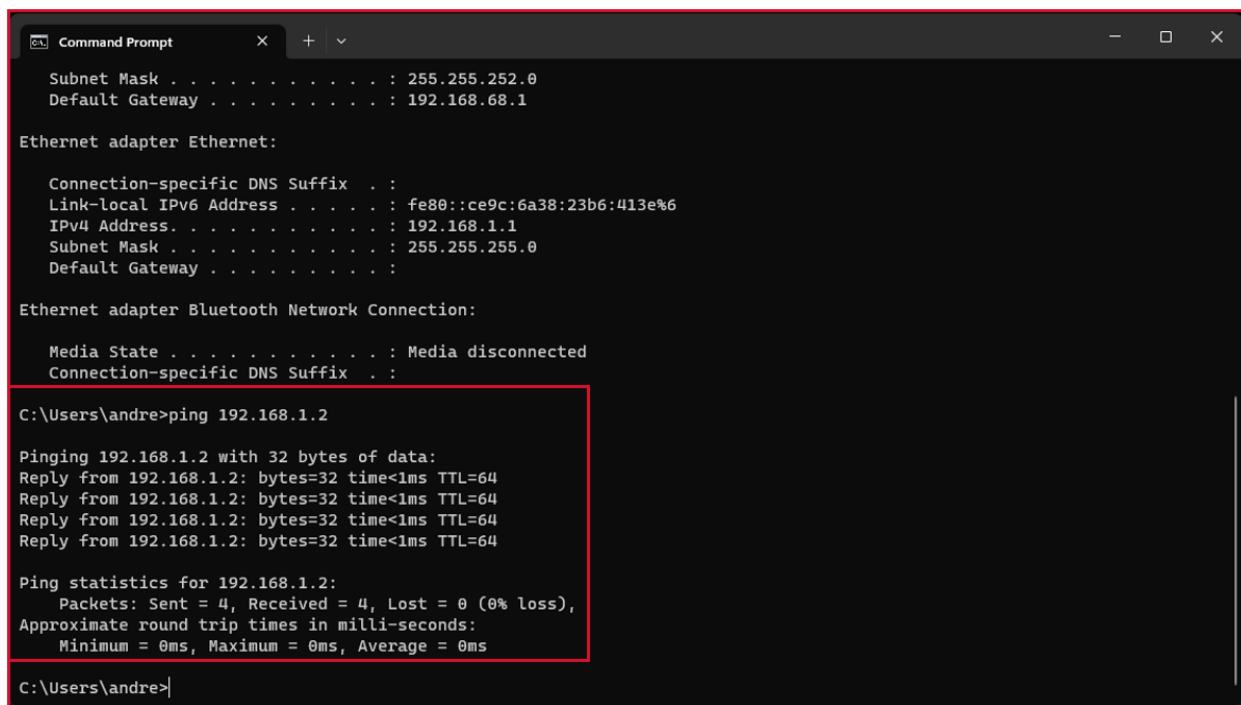
5. Select the **IP Address** of your computer. Click “**Apply**” and “**OK**”.



6. Select the + **sign** next to the newly created driver. All the devices currently connected to your network will appear.



7. **Ping** the Powerflex 525 Drive by using Command Prompt to verify communication. Type ping followed by the IP address of the drive, [**ping 192.168.1.2**]. This will check if the particular destination IP address exists and can accept requests in the network.



```
Command Prompt
Subnet Mask . . . . . : 255.255.252.0
Default Gateway . . . . . : 192.168.68.1

Ethernet adapter Ethernet:

    Connection-specific DNS Suffix  . : 
    Link-local IPv6 Address . . . . . : fe80::ce9c:6a38:23b6:413e%6
    IPv4 Address. . . . . : 192.168.1.1
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 

Ethernet adapter Bluetooth Network Connection:

    Media State . . . . . : Media disconnected
    Connection-specific DNS Suffix  . : 

C:\Users\andre>ping 192.168.1.2

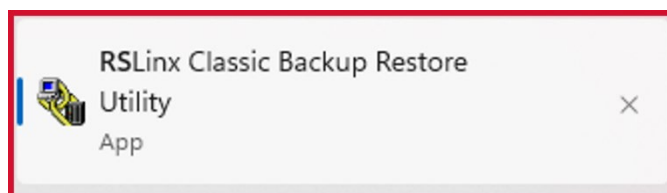
Pinging 192.168.1.2 with 32 bytes of data:
Reply from 192.168.1.2: bytes=32 time<1ms TTL=64
Reply from 192.168.1.2: bytes=32 time<1ms TTL=64
Reply from 192.168.1.2: bytes=32 time<1ms TTL=64
Reply from 192.168.1.2: bytes=32 time<1ms TTL=64

Ping statistics for 192.168.1.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\Users\andre>
```

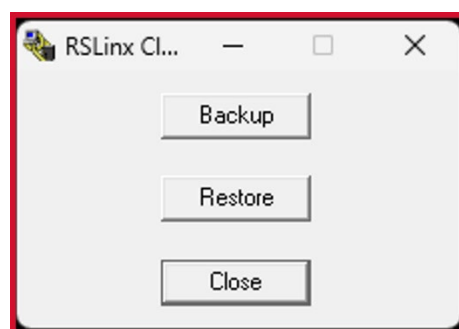


8. RSLinx Classic Software includes a Backup/Restore utility which is accessible from the Start menu. In the **Windows Start Menu** or **Search bar**, type in **RSLinx Classic Backup Restore Utility**.



There are two options to use in the RSLinx Classic Backup Restore Utility:

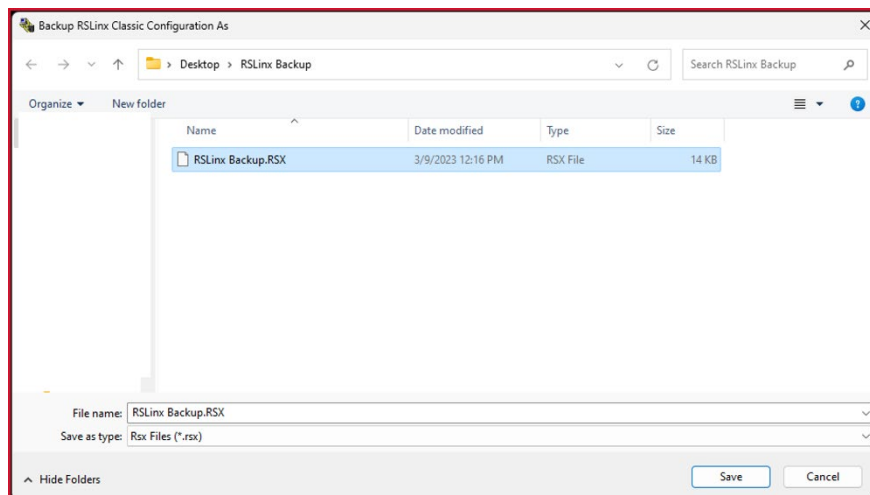
- **Backup:** Which will allow the user to **backup** the following:
 - Configured drivers
 - DDE/OPC topics
 - Configuration settings
 - Network shortcuts
 - CIP Options
 - Interchange port mappings
 - Associated registry entries.



The Backup will create a .RSX file. Backup files can be archived on a network server and retrieved during a restore operation.

- **Restore:** Which will allow the user to restore .RSX file, the application configurations, in case of a hardware failure, a deleted driver, or even assign the configuration to another PC.

9. Click on “**Backup**”, select an appropriate directory to save your .RSX file.



Lab 11 – Connected Components Workbench – Creating a Trend

Assignment:

- Create a Trend in Connected Components Workbench

Situation: Create a Trend to analyze and collect data for maintenance and troubleshooting.

Tasks:

1. Create a Trend
2. View Trend Properties and Add Traces
3. Set Sampling Size
4. Set Triggers
5. Run a Trend
6. Export Trend Data

Trending Overview

When working with Powerflex drives, creating a Trending can be a very useful and powerful tool to help maintenance personnel investigate and locate the cause of a system problem.

Trends can help visualize historical data about your drive.

Keep the following points in mind when using trends:

- Trending gives the ability to plot parameter values over time.
- Multiple parameter values can be plotted at the same time.
- A trend can be set up to trigger based on drive status.

Some key parameters to trend include Commanded Frequency, DC Bus Voltage, Output Frequency, Output Current, and Output RPM.

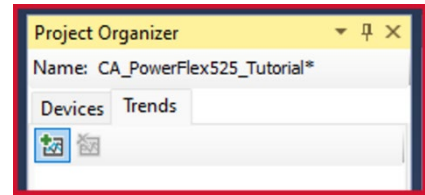
Important: Before you can trend parameter values, the drive must first be added to the Connected Components Workbench project.



1 - Creating a Trend

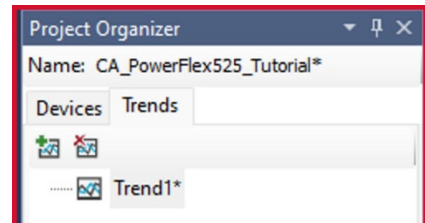
Once the drive has been added to the software project, you will want to first access the **Trends Tab** and the select **Add Trends** button.

This will start the trend creation project.



After creating a new trend, you will see the trend appear in the **Project Organizer**.

Trends can be renamed.



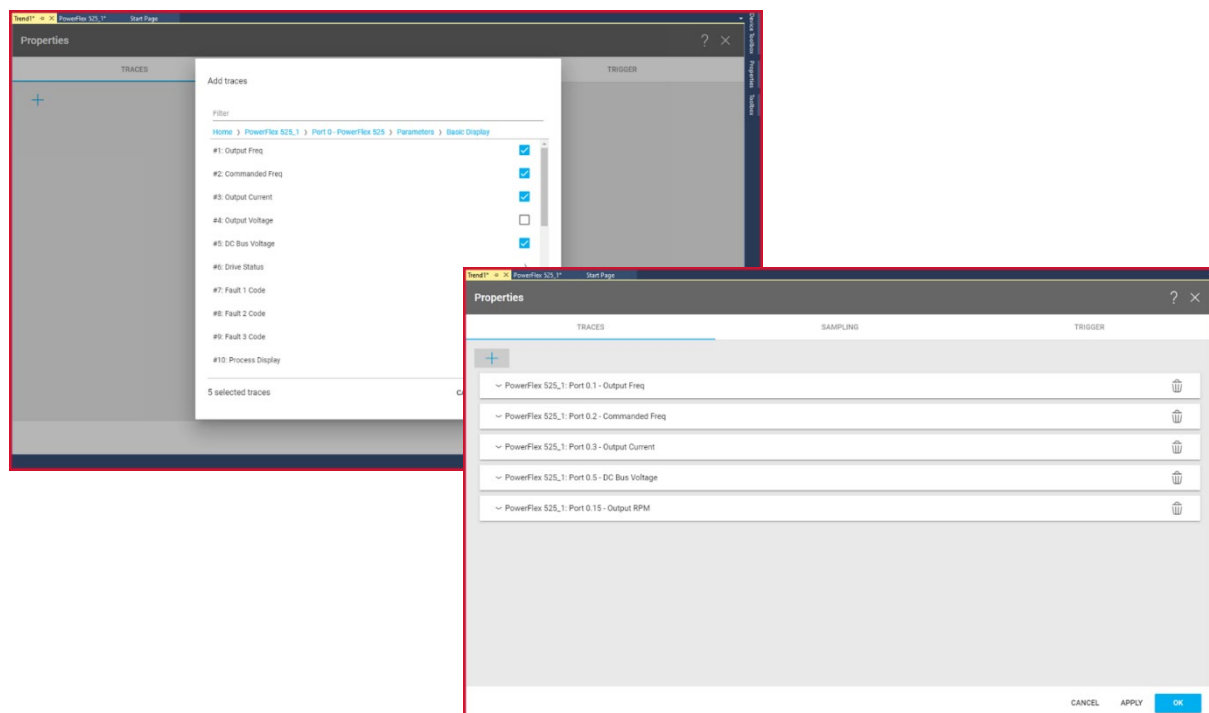
2 – View Trend Properties and Add Traces

Open the **Trend** and view the **Properties** window, click the **plus sign** to add traces.

You have multiple options to choose from when adding traces to a trend.

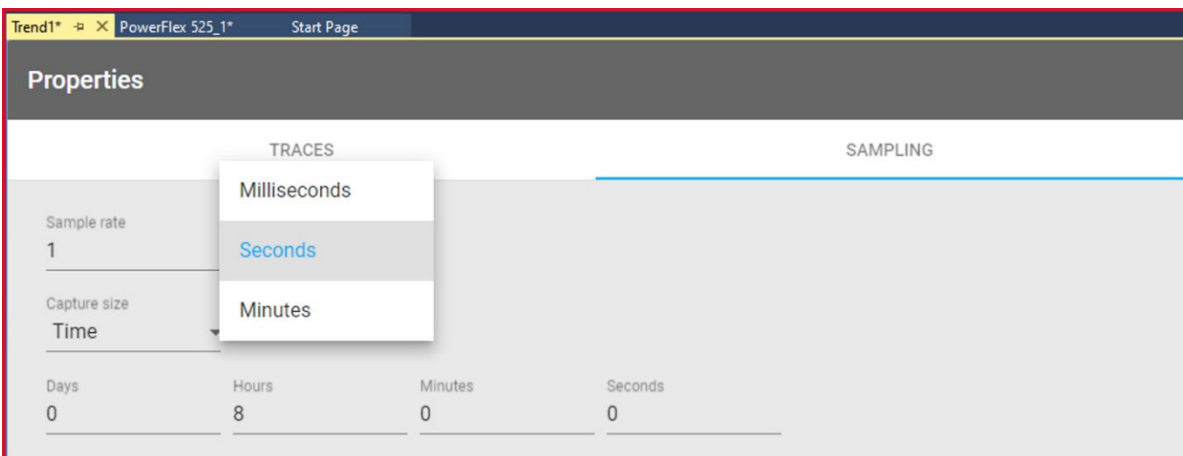
- Search the larger parameters list, which are displayed according to how parameters are organized in the drive.
- Filter the list using all or part of a parameter name.

In the example above, the **Output Freq**, **Commanded Freq**, **Output Current**, **DC Bus Voltage**, and **Output RPM (not shown)** are the traces that have been added to the trend.



3 – Set Sampling Size

Once traces have been added, you can use the **Sampling Tab** of the Properties box to define the sample rate and the size of the capture. **Capture Size** can be specified by time, or the number of samples collected.



Sample rates can be limited by the speed of the EtherNet/IP network that you are using.

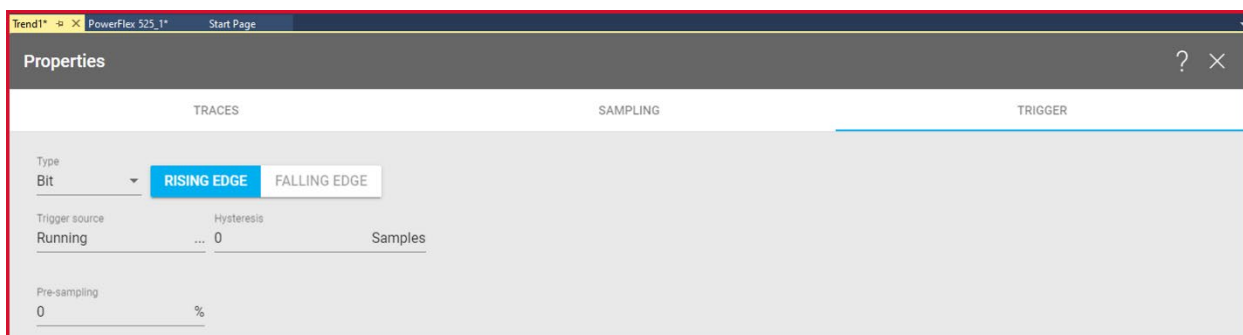
4 – Set Triggers

On **Triggers Tab** of the Properties box, Trends can be configured to start by four different options:

- Manually
- Analog Signal
- Bit
- Time

Select the appropriate trigger based on the needs of your application.

In the example below, the trigger source is **Running**, based on a **Rising Edge**, and the remaining values are set to default.

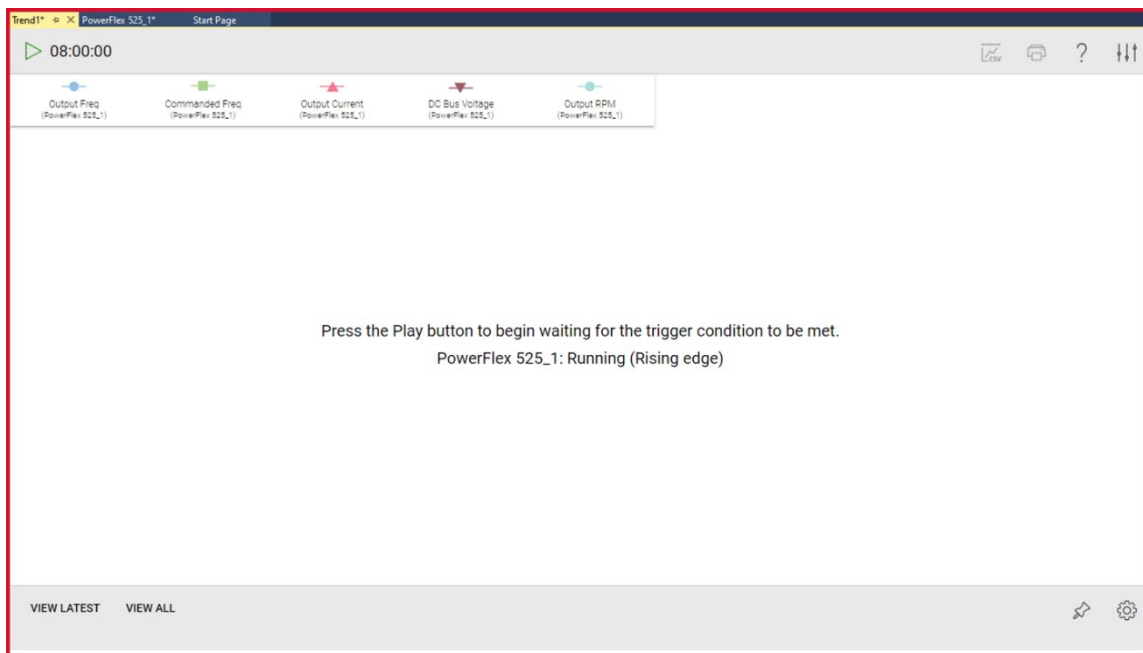


Once you have set up the **Properties** of the Trend, **click OK**.



5 – Run the Trend

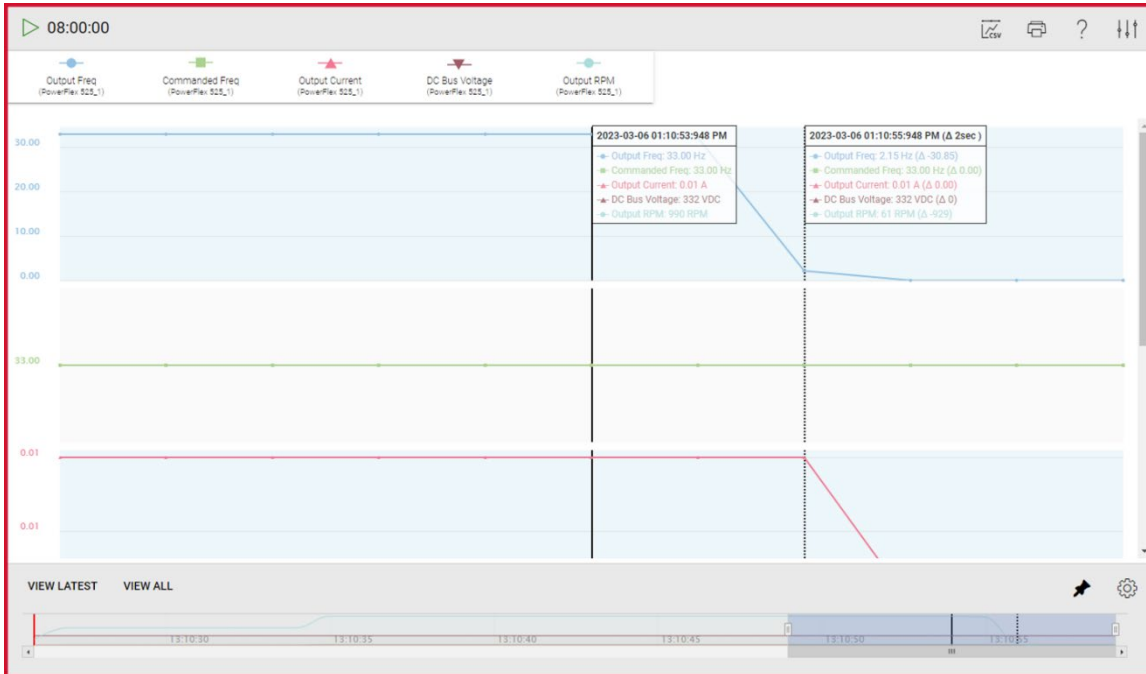
The Trend will now wait until the **Play Button** has been clicked, and the **trigger condition is met**.



Once the trigger condition has been met, the traces that have been added will start **collecting data**.



You can stop the Trend and click a moment in time of the trend to review the data collected.



6 – Export Trend Data

You can export the data collected to a **CSV file**, that can be opened for further review, by clicking on the **CSV Button** on the **Trends Window**.

A	B	C	D	E	F	G	H
1	Sample Rate	Value	Units				
2			1 Seconds				
3	Capture Size	28800					
4	Trigger	Trigger Type	Parameter	Parameter Value	Operator	Hysteresis	Pre-sampling
5		Bit	PowerFlex 525_1 Port 0: 6-Running 0	1 Equal		0	0
6	Time	PowerFlex 525_1 Port 0: 1-Output Freq	PowerFlex 525_1 Port 0: 2-Commanded Freq	PowerFlex 525_1 Port 0: 3-Output Current	PowerFlex 525_1 Port 0: 5-DC Bus Voltage	PowerFlex 525_1 Port 0: 15-Output RPM	
7	10:25.9	6.9	20	0.04	332	209	
8	10:26.9	20	20	0.01	332	600	
9	10:27.9	20	20	0.01	332	600	
10	10:28.9	20	20	0.01	332	600	
11	10:29.9	20	20	0.01	332	600	
12	10:30.9	20	20	0.01	332	600	
13	10:31.9	20	20	0.01	332	600	
14	10:32.9	20	20	0.01	332	600	
15	10:33.9	20	20	0.01	332	600	
16	10:34.9	33	33	0.01	332	990	
17	10:35.9	33	33	0.01	332	990	
18	10:36.9	33	33	0.01	332	990	
19	10:37.9	33	33	0.01	332	990	
20	10:38.9	33	33	0.01	332	990	
21	10:39.9	33	33	0.01	332	990	
22	10:40.9	33	33	0.01	332	990	
23	10:41.9	33	33	0.01	332	990	
24	10:42.9	33	33	0.01	332	990	
25	10:43.9	33	33	0.01	332	990	
26	10:44.9	33	33	0.01	332	990	
27	10:45.9	33	33	0.01	332	990	
28	10:46.9	33	33	0.01	332	990	
29	10:47.9	33	33	0.01	332	990	
30	10:48.9	33	33	0.01	332	990	
31	10:49.9	33	33	0.01	332	990	
32	10:50.9	33	33	0.01	332	990	
33	10:51.9	33	33	0.01	332	990	
34	10:52.9	33	33	0.01	332	990	
35	10:53.9	33	33	0.01	332	990	
36	10:54.9	32.15	33	0.01	333	961	
37	10:55.9	2.15	33	0.01	332	61	



Notes



Cardinal Automation, LLC

**About Us**

Cardinal Automation, LLC was created by former university instructors and industry professionals to provide custom automation training and equipment to meet the needs of your program.

Cardinal Automation, LLC is committed to providing a quality training platform to those looking to expand their knowledge in industrial automation.

- Our courses offer a concise curriculum taught online and in-person through step-by-step guides to teach real-world industrial equipment.
- We provide custom training options to assist the employees in your facility.
- The automation trainers we build are constructed with industrial grade components that will bridge the gap to industry.

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