## Phoenix Contact's Axiocontroller(AXC) 1050



# & Axioline(AXL) F BK PN Manual v0.0.6 Alpha

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OBS: This manual was developed using PC Worx version 6.30 and AXC(version 3) and AXL(version 2)

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## Introduction:

Axiocontrollers and Axioline are a line of PLC's produced by Phoenix Contact. It is an Industrial Grade PLC, so it is extremely resistant to harsh enviornments and impacts but let's not take that as a challenge to break it, ok?

How does the AXC differ from the other PLC's already donated to the College, like the NanoPLC? The answer is that as the Arduino is less reliable or resistant to damage than the NanoPLC, The NanoPLC is less reliable or resistant to damage than the AXC line. In an Industrial environment, errors need to be close to 0, and having a device that can answer to a signal in milliseconds is extremely important. So if you want a durable controller, the AXC is the way to go!

#### Security:

If you already played around with a NanoPLC you know that you should use a USB cable to upload a project from NanoNavigator and instantly you get an answer from the device. The AXC line will not work that way. Multiple AXL machines can be connected to a single AXC, but for that to work, it uses Ethernet cables to do this communication. So lets start with the main topic: making the AXC and AXL work together.

PS: This setup requires "expertise" in networking and if you don't know what you are doing, that is totally fine, you should be a pro by the time you are finished reading this manual. If you still have questions after reading this, just contact your TA or ITS, they will be glad to help!

## First steps:

1- Connect the power cord to the AXC Trainer 1050 PN (as shown below), and turn the switch to the ON (|) mode.





2- Take a second to see the lights blinking and understand the connection between the modules. Check appendix A to see the legend.

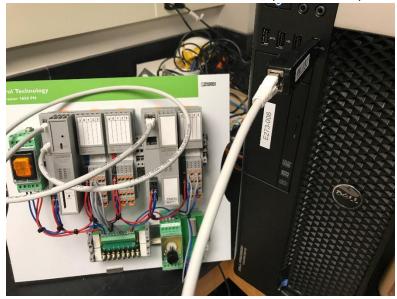
Now we have a functioning PLC, but without any code inside. To upload code, we will have to setup a connection between the AXC and your computer, and that's when things get a little tricky. If you have problems, contact the TA or ITS!

## On your computer:

1- Connect a USB-to-Ethernet adapter to the front of your computer, so that you can connect to the PLC.



2- Connect an Ethernet cable from the USB adapter to the X1 port of the AXC.



3- Go on the Control Panel on your computer, click on Network and Internet and click on Network and Sharing Center and check the network adapters. One of them should be Ethernet 2 or something like that. Double-click on it and click on Properties. Click on Internet Protocol Version 4 (TCP/IPv4). After selecting it, click in properties, select "Use the following IP address" and enter the value for IP address of 192.168.0.10, for subnet mask 255.255.255.0 and click ok and you can close the other windows.

Internet Protocol Version 4 (TCP/IPv4)	Properties	×
General		
You can get IP settings assigned autor this capability. Otherwise, you need to for the appropriate IP settings.		
○ <u>O</u> btain an IP address automatical ③ Use the following IP address:	ly	
IP address:	192.168.0.10	
Subnet mask:	255.255.255.0	
Default gateway:		
Obtain DNS server address auton	,	
Preferred DNS server:		
Alternate DNS server:		
Valjdate settings upon exit	Ad <u>v</u> anced	
	OK Cance	I

What's a subnet mask?

The subnet mask is in charge of separating the IP address into two components. It is called the subnet mask because it is used to identify the network address of an IP address by performing a bitwise AND on the netmask. This decimal address is 32 bits when converted to binary, and 255 translates to all 1's and 0 is of course, all 0's. This means that to be in the same range your device must match the IP address where the subnet is 1's (255 in decimal) and be different where the subnet is 0 (0 in the example).

Now we have the Adapter and the computer configured to the common range of devices that is the 192.168.0.XXX range. Be mindful that every device to be configured on this manual needs to be in the IP range between 192.168.0.2 and 192.168.0.254.

### PC Worx:

- 1- Open PC Worx on your computer. You can click the search box on the bottom of the screen and search for PC WORX and PC Worx 6.30.1668 should show up on the search. If it doesn't, contact your TA. It could be located within a Phoenix Contact folder.
- 2- Create a new project by clicking file  $\rightarrow$  New Project  $\rightarrow$  AXC 1050 Rev. > 01/2.10

New Project	×
General AXC 1xxx AXC 3xxx ILC 1xx ILC 2xx ILC 3xx P • •	OK Cancel
<ul> <li>▲XC 1050 Rev. &gt; 01/2.00</li> <li>▲XC 1050 Rev. &gt; 01/2.10</li> <li>▲XC 1050/XC Rev. &gt; 01/2.00</li> <li>▲XC 1050/XC Rev. &gt; 01/2.10</li> <li>▲XC CLOUD-PRO Rev. &gt; 01/1.00</li> </ul>	

3- To configure the Bus, click on Bus Configuration Workspace, on the Toolbar, click on the AXC 1050 192.168.0.2 that is inside the Bus Structure and click on IP Settings on the Device Details page.

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AXC 1050 192.168.0.2						
- R Resource	Project name	Value				
R STD_RES AXC1050_21	Project name	UNTITLED				
- Axioline	Creator	7WRNZF				
- ## PROFINET	Computer name at project creation	PXCSW-N0082				
- 🌞 # MODBUS_CLT	MULTIPROG version at project creation	5.51.8.0	_			
	PC WORX version at project creation	PC WORX 6.30.1503	_			
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	Last editor	7WRNZF	-			
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😑 🌆 UNTITLED	AXC 1050 192.168.0.2 \IP Settings\					
a- # AXC 1050 192.168.0.2	Name	Value				
E A Resource	D Vendor	Phoenix Contact	-			
R STD_RES AXC1050_21	Vendor     Designation	AXC 1050	-			
PROFINET	Designation     Functional description	Axioline Controller for Ethernet Networks	-			
	Punctional description     Device type	PLC	_			
Touch Display	Device type     Device family	AXC1xxx	-			
- Unconnected	Order number	2700988	-			
_	D Revision	01/2.10	-			
	Station Name	07,210	-			
	Device Name		-			
	D Module Equipment ID		-			
	DNS Name	axc-10501	1			
	MAC Address		1			
	D IP Address	192.168.0.2				
	🗅 Subnetmask	255.255.255.0				
<u> </u>	Default Gateway					
: Device Catalog 🕴 🔺 🔟						
Phoenix Contact						
🗄 🛅 Universal						
Enter search criteria						
1 A						
: Module Catalog 🕴 🔺 🖾						
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# Ethernet Topology: Displaying the network in tree topology						
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For Help, press F1						C: >2GB
i or new preserv						C. 7200

4- Check the IP Address defined to the AXC and the Subnet mask value and see how they reside inside the range of 192.168.0.XXX.

	Details	
AXC 10	050 192.168.0.2 \IP Settings\	
	Name	Value
ß	Vendor	Phoenix Contact
ß	Designation	AXC 1050
ß	Functional description	Axioline Controller for Ethernet Networks
ß	Device type	PLC
ß	Device family	AXC1xxx
ß	Order number	2700988
ß	Revision	01/2.10
ß	Station Name	
ß	Device Name	
ß	Module Equipment ID	
ß	DNS Name	axc-10501
ß	MAC Address	
۲	IP Address	192.168.0.2
ß	Subnetmask	255.255.255.0
	Default Gateway	

As you can see, the AXC is within the previously mentioned range and it matches the subnet so we are good to go! 5- VERY IMPORTANT: check the side of your AXC and it should have a MAC address under a barcode. Enter on the defined area (above IP Address) this number on the device.



6- Now go to the IP Assignment Tab and it should display 2 devices: AXC and AXL. Click on the one that starts with AXC and click on Assign IP and click refresh to see if the IP Address has changed.

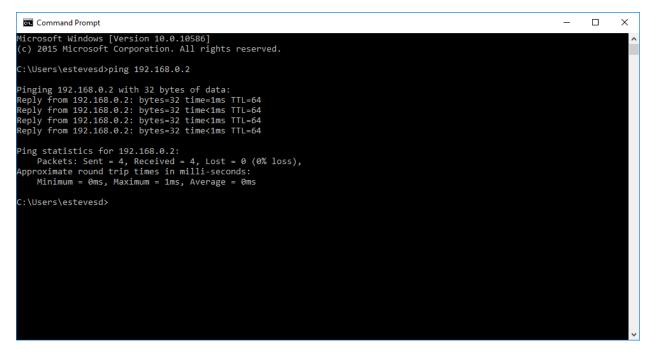
Read PROFINET					
Selected PROFINET IO					
Name: rfc-				IP Address: 192.168.0.2	
Device Type: RF0	C 470 PN 3TX			Subnet Mask: 🛛	255.255.255.0
				Default Gateway:	
Available on Network					
Name	Туре	MAC Address	IP Address	Subnet Mask	
axc-10501	[IOD]: AXC 1050	00:A0:45:41:BA:CB	192.168.0.10	255.255.255.0	
rfc-4701	[IOC]: RFC 470 PN 3TX	00:A0:45:20:3A:44	192.168.0.2	255.255.255.0	
Filter: 📃 unname	d 📃 not in Project				
Refresh	Flashing On	Insert			
	2 DCP /	devices reachable on the	network		
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					Help Close

NOTE: Make sure both filters, 'unnamed' and 'not in project' are unchecked! Otherwise your controller may not show up in the list.

- If the IP assignment tab doesn't show anything and the error indicates "no Ethernet adapter selected", click Extras->PROFINET Configuration and select the right adapter under Ethernet Network Board.
- If the IP assignment tab shows the error concerning WinPcap drivers, follow this link to reinstall them: <a href="https://www.winpcap.org/install/default.htm">https://www.winpcap.org/install/default.htm</a>. Ignore the error message during the installation.
- If you receive wht "DNS names do not match" error, ensure that you have the correct name in the 'Device Details' page so that you can connect to the AXC on the IP assignment page. Give the device whatever name the IP assignment pop-up gives it.
- 7- Restart your AXC to implement these changes!!!!
- 8- If the IP was successfully changed, let's go to the next step and we are going to take a break from PCWorx just for a second.

On your computer:

- 1- Press the Windows button on your keyboard and type "cmd" and click on Command Prompt.
- 2- Type without the quotes "ping 192.168.0.xxx". Substitute the xxx by the last digit of the IP address of the AXC. If it gives the following code (0% lost and all 4 packets received), you can go to the next step. If not, try rebooting the machine and redoing the steps inside PC Worx.

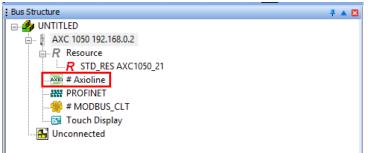


Back to PCWorx:

- 1- Go to the Communication Tab inside Bus Configuration Workspace.
- 2- Check that the Interface Type is Ethernet, the Connection name is Manual Input, the IP address is the same you used with the ping command above, the subnet mask is 255.255.255.0 and the gateway address is empty and unchecked use virtual LAN.

Sector Se	•	- 0	×
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AXC 1050 192.188.02.2      Resource      R STD_RESOURCE      R STD_RESOURCE      R PROFINIT      R PROFINIT      D RODBUS_CLT      D Unconnected	Interface Type AXC 1050 Communication Path Communication Path Station Name	Connection Name Manual Input   IP Address  255 . 255 . 0  Gatevay Address	
		Resource: STD_RES	
EPerke Catalog I A D	Te	Test Apply Help	
Mode Catalog	👼 IP Settings 🖪 Extended Settings	p 🖉 Communication 🕽 IP Assignment 🕞 CPU Service Editor 😫 Terminal Points 😕 Bus inter( - ) -	
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For Help, press F1		C;	>2GB

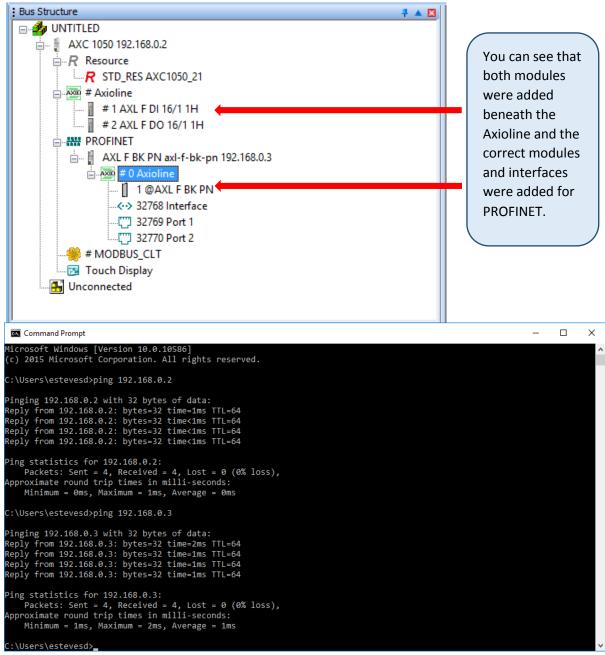
- 3- Click Test and it should display a text inside a green box saying" Host Type: AXC 1050".
- 4- If the above happened, kudos to you!! **If not,** ensure the DNS names are exactly the same and the correct interface is selected You did a good job! But it is not over yet...
- 5- Go on the Bus Structure (the top-left box) and right click on Axioline, Read Axioline, OK and you should see the Axioline expanded with #1 and #2.



6- Now right-click on PROFINET, Read PROFINET, click on the AXL, click insert, AXL F BK PN 01/1.01, click ok and close the window.

Selected PROFINET IO Contro Name: axc-1050 Device Type: AXC 1050					
	1				
Device Type: AXC 1050			IP Address:	192.168.0.2	
	D		Subnet Mask: Default Gateway:	255.255.255.0	
vailable on Network					
Name	Туре		MAC Address	IP Address	Subnet
axc-10501	[IOC]: AXC 105	0	00:A0:45:9D:67:93	192.168.0.2	255.255
axl-f-bk-pn	(IOD): AXL F BI	K PN	00:A0:45:9D:55:4F	192.168.0.3	255.255
<					>
Filter: 🗌 unnamed	not in Project				
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7- You should have everything connected. To make sure, click on the AXL under PROFINET, find its IP address and repeat the ping process that you did with the AXC IP address test.

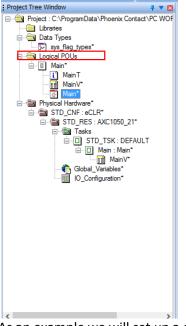


## Finally, Lets Code!!

1- Right next to the Bus Configuration Workspace button there is a button called IEC Programming Workspace. Click on it.

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Bus Structure 🕴 🔺 🛽	Device Details     IEC Programming Wo     # 0 Axioline \Axioline Settings\	rkspace	A 🗶 🛛	
🖃 🎒 UNTITLED	# 0 Axioline \Axioline Settings\			
⊨- ∦ AXC 1050 192.168.0.2 	Name	Value		
R STD RES AXC1050 21	D Vendor	Phoenix Contact		
- 🕬 # Axioline	Designation	AXL F BK PN		
# 1 AXL F DI 16/1 1H	Functional Description	PROFINET IO - Axioline Bus Coupler		
# 2 AXL F DO 16/1 1H	Device Type	Bus Coupler		
PROFINET	Device Family	AXL F		
AXL F BK PN axl-f-bk-pn 192.168.0.3	C Order number	2701815		
= 😳 # 0 Axioline	Revision: HW / Master FW (/COP FW)	01/1.01		
1 @AXL F BK PN	C Station Name			
	Device Name			
	Module Equipment ID			
	Number of connectable devices	63		
Touch Display	🗅 max. current output at UL	without boost terminal (2000 mA)		
Unconnected	D Node ID	38		
- onconnected				

2- On Project Tree Window, expand Logical POU's to find Main. Expand Main to find 3 different Main subcategories. Double-click on the plain Main (without T or V).



- 3- As an example we will set up a circuit that will turn an Output HIGH after the 2 Inputs remain HIGH for 7 seconds. The following steps will walk you through this process for the functional block diagram program.
- 4- On the right part of the window you will find multiple kinds of logic gates. We will use two for this example: 1 AND + 1 TON.

Edit Wizard		<b>₽</b> ▼
Group:		
<favorites></favorites>		
Name	Description	
🛨 ADD 🍐	Addition	
🖶 AND	Bitwise AND	
茸 CTD	Counter Down	
茸 CTU	Counter Up	
茸 CTUD	Counter Up/Down	
💶 DIV	Division	
💶 EQ	Equal: =	
茸 F_TRIG	Falling Edge Detection	
💶 GE	Greater Than Equal: >=	
💶 GT	Greater Than : >	
💶 LE	Less Than Equal: <=	
📲 LT	Less Than: <	
🛨 MOD	Modulo Division	
🖶 MOVE	Assigns Value	
🖶 MUL	Multiplication	
💶 NE	Not Equal: <>	
🖶 NOT	Complement	
📲 OR	Bitwise OR	
茸 R_TRIG	Rising Edge Detection	
🖶 ROL	Rotate Left	
📲 ROR	Rotate Right	
茸 RS	Reset Dominant	
🖅 SHL	Shift Left	
💶 SHR	Shift Right	
茸 SR	Set Dominant	
🖶 SUB	Subtraction	
茸 TOF	Timer Off-Delay	
茸 TON	Timer On-Delay	
茸 TP	Pulse	

5- Drag the AND gate and drop anywhere you want. Double-click one of the blue terminals. Rename it as "INPUT\_1" or something you like. Make sure the Usage is set to VAR\_GLOBAL and the data type to BOOL. Repeat that to the second blue terminal but change the name of it.

Variable Properties		×
Name: INPUT_1 Data Type: INT Usage: VAR_GLOBAL VIDE BETAIN Initial value: I/O address: Description:	Definition scope © Local © Global Local Variable Groups: @ Default ~ Global Variable Groups: @ Physical Hardware @ STD_CNF @ STD_CNF @ STD_CNF @ STD_CNF @ STD_CNF @ Default @ System Variables @ Main	OK Cancel Help
<u>PDD</u> OP <u>C</u> <u>H</u> idden <u>Initvalue as default</u> Redundant	✓ Sho <u>w</u> all variables of worksheets Sort by group name	

6- Now drag the TON gate to the right of the AND gate. Do not change anything on it, just click ok. Connect the output of the AND gate to the IN input of the TON gate. Double-click the blue terminal next to PT and name it T#7s. Double click the terminal next to ET and enter the name Actual\_Time (Data type: TIME). Double click Q and put the name of the variable you want. MAKE SURE ALL THE VARIABLES ARE IN USAGE MODE VAR\_GLOBAL!!! If you do not make them global

#### you will not be able to find them later!

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Project : C:\ProgramData\Phoenix Contact\PC WOF     Divaries     discrete State Types     discrete State Types			Group: <favorites> Name Description</favorites>	~
😑 🔄 Logical POUs		TON 1	a ADD Addition	
i⊟ Main ⊡tì Main T	AND	TON	AND Bitwise AND     ECTD Counter Down	
	INPUT 1	IN Q OUTPUT 1	ECTU Counter Up	
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Government STD_CNF: eCLR     Government STD_RES: AXC1050 21	INP01_2		EQ Equat =	
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			OR Bitwise OR     B TRIG Rising Edge Detection	
			ROL Rotate Left	
			ROR Rotate Right     RS Reset Dominant	
			SHL Shift Left	
			SHR Shift Right     SR Set Dominant	
		•	TSUB Subtraction	
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7- Let's link the variables to the PLC controller lights and switches. Press Process Data Workspace and a 4-window page is going to show up. On the top-left one click on STD\_RES:AXC1050\_21. This should display some variables on the bottom-left. On the Top-right one Click on the AXC 1050 192.168.0.xxx and some items should be displayed on the bottom-left window.

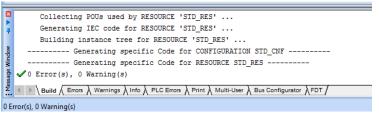
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Process Data Assignment					_							• E
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Symbol/Variable	Data Type	Process Data Item	Device	Process Data Item	I/Q	Data Type	Byte.Bit	A	Symbol/Variable	1	Function 1	ext
			1 @AXL F BK PN	~PNIO_DATA_STATE	1	BYTE	0.0					
			1 @AXL F BK PN	PNIO_IS_PRIMARY	1	BOOL	0.0					
			1 @AXL F BK PN	PNIO_DATA_VALID	1	BOOL	0.2					
			1 @AXL F BK PN	PNIO_APPL_RUN	1	BOOL	0.4					
			1 @AXL F BK PN	PNIO_NO_DIAG	1	BOOL	0.5					

									-
<u>File Edit View Project Bu</u>									
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Process Data Assignment			· · · · ·						
Symbols/Variables			# 2 AXL F	DO 16/1 1H					
			PROFINET						
STD_RES : AXC10	50_21			PN axl-f-bk-pn 192.168.0.3					
			🚊 🟧 # 0 Ax						
👔 System Variab				0AXL F BK PN 768 Interface					
B- STD_TSK : DEF				769 Port 1					
👜 🔲 Main : Ma	in			770 Port 2					
				LT					
			🔂 Touch Displa	/					
Symbol/Variable	Data Type	Process Data Item	Device	Process Data Item	VQ	Data Type	Byte.Bit	A Symbol/Variable	
INPUT_1	INT		1 @AXL F BK PN	~PNIO_DATA_STATE		BYTE	0.0		
INPUT_2 OUTPUT_1	INT BOOL		1 @AXL F BK PN 1 @AXL F BK PN	PNIO_IS_PRIMARY PNIO_DATA_VALID	1	BOOL BOOL	0.0		
OUIPULI	BUUL		1 @AXL F BK PN 1 @AXL F BK PN	PNIO_DATA_VALID PNIO_APPL_RUN		BOOL	0.2		
			1 @AXL F BK PN	PNIO_NO_DIAG	1	BOOL	0.5		
PC WORX - Untitled									_
<u>Eile Edit View Project Bu</u>	ild Online Extras 1								
Process Data Assignment Symbols/Variables STD_CNF : eCLR 	0_21		P Ca UNTITLED → AXC 1050 192.168. → P Resource	2					
Symbols/Variables	les AULT			16/1 1H O 16/1 1H V axl-f-bk-pn 192.168.0.3	,				
Symbols/Variables STD_CNF: eCLR STD_RES: AXC105 System Variab System Variab System Variab	les AULT			116/11H 016/11H axd-f-bk-pn 192.168.0.3 line XLF EK PN	,				
Symbols/Variables Symbols/Variables STD_CNF: eCLR Gradient Structure Graduet G	les AULT n		•         ●         Calculation to a load           •         ●         Permute           •         ●         Permute           •         ●         Permute           ●         ●         ■         1Ax10           ●         ●         ■         1Ax10           □         ■         ■         1Ax10           □         ■         ■         ■           ●         ●         ■         ■           ●         ■         ■         ■           ●         ●         ■         ■           ●         ●         ■         ●           ●         ●         ●         ●           ●         ●         ●         ●           ●         ●         ●         ●           ●         ●         ●         ●           ●         ●         ●         ●           ●         ●         ●         ●           ●         ●         ●         ●	1 16/1 1H 0 16/1 1H 1 adi-f-bit-pn 192.168.0.3 line XLF BK PN 8 Interface					
Symbole/Variables	les AULT n Data Type	Process Data Item		1 16/1 1H 0 16/1 1H line WLL F BK PN 8 Interface Process Data Item	να	Data Type Pool	Byte.Bit	A. Symbol/Variable	
Symbol/Vanable  Symbol/Vanable  Symbol/Vanable  Name Symbol/Vanable  Symbol/Vanable  Name Symbol/Vanable  Symbol/Vanable	les AULT n	Process Data Item	•         ●         Calculation to a load           •         ●         Permute           •         ●         Permute           •         ●         Permute           ●         ●         ■         1Ax10           ●         ●         ■         1Ax10           □         ■         ■         1Ax10           □         ■         ■         ■           ●         ●         ■         ■           ●         ■         ■         ■           ●         ●         ■         ■           ●         ●         ■         ●           ●         ●         ●         ●           ●         ●         ●         ●           ●         ●         ●         ●           ●         ●         ●         ●           ●         ●         ●         ●           ●         ●         ●         ●           ●         ●         ●         ●	1 16/1 1H 0 16/1 1H 1 adi-f-bit-pn 192.168.0.3 line XLF BK PN 8 Interface		Data Type BOOL BOOL	Byte.Bit 0.0 0.1	A Symbol/Variable	
Symbole/Variables	les AULT n Data Type INT	Process Data Item		16/1 1H 0 16/1 1H 1 ad-6-bk-pn 192.168.0.3 line ALF EK PN Bintefface Process Data Item IN00 IN01 IN02		BOOL BOOL BOOL	0.0 0.1 0.2	A Symbol/Variable	
Symbol/Variable Symbol/Variable Symbol/Variable NPUT_1 NPUT_2	les AULT n Data Type INT INT	Process Data Item		16/11H 016/11H 4ad-Fakepn 192.168.0.3 line Process Data Item IN00 IN01 IN02 IN03		BOOL BOOL BOOL BOOL	0.0 0.1 0.2 0.3	A Symbol/Variable	
Symbol/Variable Symbol/Variable Symbol/Variable NPUT_1 NPUT_2	les AULT n Data Type INT INT	Process Data Item		16/11H 016/11H Vaul-Febro p192.168.0.3 line Val. F & K N N S Interface Process Data Item IN00 IN01 IN02 IN03 IN04 IN04 IN04		BOOL BOOL BOOL BOOL BOOL	0.0 0.1 0.2 0.3 0.4	A Symbol/Variable	
Symbol/Variable Symbol/Variable Symbol/Variable NPUT_1 NPUT_2	les AULT n Data Type INT INT	Process Data Item		16/11H 016/11H 4ad-Fakepn 192.168.0.3 line Process Data Item IN00 IN01 IN02 IN03		BOOL BOOL BOOL BOOL	0.0 0.1 0.2 0.3	A Symbol/Variable	
Symbol/Variable Symbol/Variable Symbol/Variable NPUT_1 NPUT_2	les AULT n Data Type INT INT	Proces: Data Item	■         ●	16/11H 216/11H Val-Febro 192.168.0.3 line VXL FBK N IN00 IN01 IN02 IN02 IN02 IN03 IN04 IN04 IN05 IN05 IN05 IN04 IN0		BOOL BOOL BOOL BOOL BOOL BOOL BOOL BOOL	0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7	A Symbol/Variable	
Symbol/Variable Symbol/Variable Symbol/Variable NPUT_1 NPUT_2	les AULT n Data Type INT INT	Process Data Item	↓         ↓	16/11H 0 16/11H 1au/1-bit/pn 192.168.0.3 line VLI F BK PN 8 Interface Process Data Item N00 N00 N00 N00 N00 N00 N00 N0		800L 800L 800L 800L 800L 800L 800L 800L	0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 1.0	A Symbol/Variable	
Symbol/Variable Symbol/Variable Symbol/Variable NPUT_1 NPUT_2	les AULT n Data Type INT INT	Process Data Item	■         ●	16/11H 216/11H Val-Febro 192.168.0.3 line VXL FBK N IN00 IN01 IN02 IN02 IN02 IN02 IN03 IN04 IN0		BOOL BOOL BOOL BOOL BOOL BOOL BOOL BOOL	0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7	A Symbol/Variable	
Symbol/Variable Symbol/Variable Symbol/Variable NPUT_1 NPUT_2	les AULT n Data Type INT INT	Process Data Item	↓         ↓	16/11H 016/11H Val-Febren 192.168.0.3 line VALF BK N Information IN00 I		800L 800L 800L 800L 800L 800L 800L 800L	0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 1.0 1.1	A Symbol/Variable	
Symbol/Variable Symbol/Variable Symbol/Variable NPUT_1 NPUT_2	les AULT n Data Type INT INT	Process Data Item	■         ■	16/11H 21 ad-Febro 192.168.0.3 inte 22 task-febro 192.168.0.3 28 interface Process Data Item 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1011 101		BOOL BOOL BOOL BOOL BOOL BOOL BOOL BOOL	0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 1.0 1.1 1.2 1.3 1.4	A Symbol/Variable	
Symbol/Variable Symbol/Variable Symbol/Variable NPUT_1 NPUT_2	les AULT n Data Type INT INT	Process Data Item	■         ■	16/1 1H 0 16/1 1H 1 4ul-f-bb(pn 192:168.0.3 Inve VXL F BK PN VXL F BK PN Process Data Item IN00 IN01 IN02 IN03 IN04 IN05 IN05 IN05 IN05 IN05 IN06 IN07 IN07 IN07 IN07 IN08 IN09 IN09 IN09 IN09 IN09 IN09 IN09 IN01 IN01 IN02 IN02 IN03 IN04 IN05		800L 800L 800L 800L 800L 800L 800L 800L	0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 1.0 1.1 1.2 1.3 1.4 1.5	A Symbol/Variable	
Symbol/Variable Symbol/Variable Symbol/Variable NPUT_1 NPUT_2	les AULT n Data Type INT INT	Process Data Item	■         ■	16/11H 21 ad-Febro 192.168.0.3 inte 22 task-febro 192.168.0.3 28 interface Process Data Item 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1011 101		BOOL BOOL BOOL BOOL BOOL BOOL BOOL BOOL	0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 1.0 1.1 1.2 1.3 1.4	A. Symbol/Variable	
Symbol/Variable Symbol/Variable Symbol/Variable NPUT_1 NPUT_2	les AULT n Data Type INT INT	Process Data Item	■         ●	116/1 1H 1 16/1 1H 1 4al-f-bk-pn 192.168.0.3 Ike Ike Ike Ike Ike Ike Ike Ike	VQ 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L	0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 0.0	A Symbol/Variable	
Symbol/Variable Symbol/Variable Symbol/Variable NPUT_1 NPUT_2	les AULT n Data Type INT INT	Process Data Item	Personal     Personal	16/11H 0 16/11H 1 all-fb4/ps192168.0.3 ine VLI F8 K N 2015 fb4/s 1 N00 1 A/U, F0116/11H :N04 1 N05 1 N00 1 N11 1 N11 1 N13 1 N14 1 N14 1 N15 1 N15	VQ 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L	0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 0.0 0.0	A Symbol/Variable	
Symbol/Variable Symbol/Variable Symbol/Variable NPUT_1 NPUT_2	les AULT n Data Type INT INT	Process Data Item	■         ●	116/1 1H 1 16/1 1H 1 4al-f-bk-pn 192.168.0.3 Ike Ike Ike Ike Ike Ike Ike Ike	VQ 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L 800L	0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 0.0	A. Symbol/Variable	

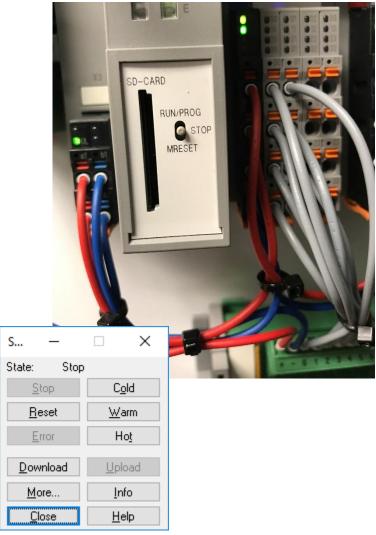
8- Take a look at how the Device separates the matrixes into I(inputs) Q(Outputs). The tables correspond to the same notation on the device. So grab the input you want and drag and drop into the variable. That simple! Repeat that to the second input and for the output but don't use an Input as an output variable, of course.

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Process Data Assignment				• • • • • • • • • •		~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~							
Symbols/Variables				□- 4 UNTITLED									
Good and a state of the second state of the s													
iymbol/Variable	Data Type	Process Data Item	_	Device	Process Data Item		D/Q	Data Type	Byte.Bit	A	Symbol/Variable	Funct	ion Te
NPUT_1	BOOL	# 1 AXL F DI 16/1 1H \ IN00	$\rightarrow$	# 1 AXL F DI 16/1 1H	IN00		1	BOOL	0.0		STD. CNF STD. RES \ INPUT. 1		
INPUT 2	BOOL	# 1 AXL F DI 16/1 1H \ IN01		# 1 AXL F DI 16/1 1H	IN01		1	BOOL	0.1		STD_CNF STD_RES \ INPUT_2		
OUTPUT_1	BOOL	# 2 AXL F DO 16/1 1H \ OUT0		# 1 AXL F DI 16/1 1H	IN02		1	BOOL	0.2				
				# 1 AXL F DI 16/1 1H	IN03		1	BOOL	0.3				
				# 1 AXL F DI 16/1 1H	IN04		1	BOOL	0.4				
				# 1 AXL F DI 16/1 1H	IN05		1	BOOL	0.5				
				# 1 AXL F DI 16/1 1H	IN05			BOOL	0.6				
				# 1 AXL F DI 16/1 1H	IN07		1	BOOL	0.7				
				# 1 AXL F DI 16/1 1H	INOS			BOOL	1.0				
				# 1 AXL F DI 16/1 1H	IN09			BOOL	1.1				
				# 1 AXL F DI 16/1 1H	IN10			BOOL	1.2				
				# 1 AXL F DI 16/1 1H	IN11			BOOL	1.3				
				# 1 AXL F DI 16/1 1H	IN12			BOOL	1.4				
				# 1 AXL F DI 16/1 1H	IN12 IN13			BOOL	1.5				
				# 1 AXL F DI 16/1 1H	IN13			BOOL	1.5				
				# 1 AXL F DI 16/1 1H	IN15			BOOL	1.7				
				# 1 AXL F DI 16/1 1H	~IN			WORD	0.0				
			-	# 2 AXL F DO 16/1 1H	OUTO		Q	BOOL	0.0		STD_CNF STD_RES \ OUTPUT_1		
				# 2 AXL F DO 16/1 1H	OUT1		Q	BOOL	0.1				
				# 2 AXL F DO 16/1 1H	OUT2		Q	BOOL	0.2				
				TABLE FRANKLING	ALC: NO.			20.01					

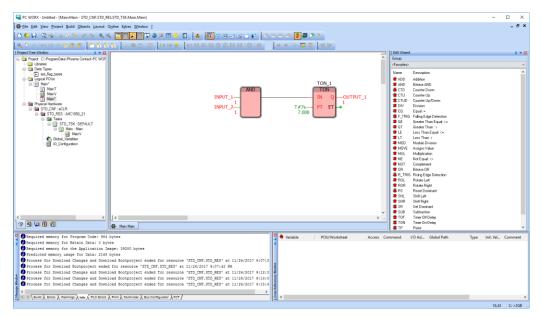
9- That should be it! Go on Build→Rebuild Project and some comments should show up on the bottom of the page. If you forgot something about the Data Types or Variables that you didn't initialize, it will yell at you.



10- Make sure the device is in the STOP mode by switching it to STOP physically and click Project Control Dialog and click on Download. Just click ok is any problems come up. Allow the PLC to run for a minute.



11- Now switch the device to RUN/PROG and flip the switches that you indicated in the previous steps as input. You can turn on the Debug on/off button and watch everything happening virtually including time counters.



You just finished programming for an Industrial-Grade PLC with functional blocks. Way to go!

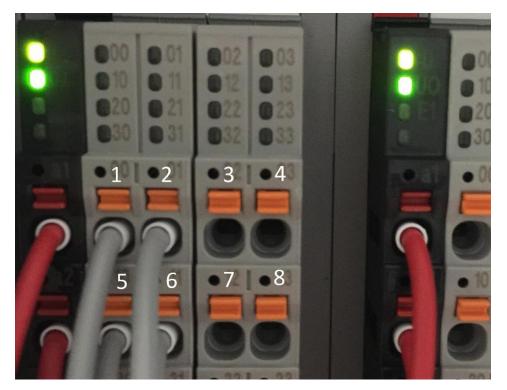


For video tutorials on the previous instructions, visit the Phoenix Contact website: <u>https://www.phoenixcontact.com/online/portal/us?1dmy&urile=wcm%3apath%3a/usen/web/mai</u> <u>n/products/subcategory\_pages/classic\_plc\_p-21-01/f4d50537-69ae-4bb1-b626-</u> <u>ac6829ecd452/f4d50537-69ae-4bb1-b626-ac6829ecd452</u>

## To go further:

Rewire the input to make the programming more intuitive:

This should be the order of the input switches. Press the orange button with a screwdriver to be able to pull out the wire or to plug in the wire.



## Implement Ladder Logic:

As illustrated on the picture below, ladder logic consists of contacts (GRP1M1), which is a condition to be met. When two contacts are in series it acts like an AND condition, and when two contacts are in parallel it acts like an OR condition. When the contact condition is true, the action is a coil (Group1), which is essentially an output that is set to true or false (false if crossed).



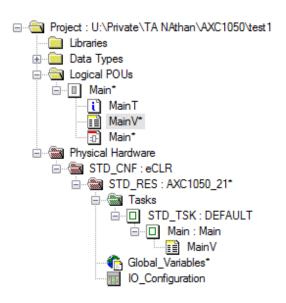
Below are the tools (available in the navigation bar) to create a program in ladder logic. For PC work, create a new rung by clicking the network option (left most).



#### Variable Management:

- Under the Process Data Workspace, if you cannot see a variable from your program, right click and choose Refresh View.
- Under IEC Programming Workspace, you can delete variables that you don't want anymore (See below). To do so, click MainV and delete the row containing the variable that you don't want anymore. MainV can also be used to make sure than the variables that are used as an input or an output have the Usage set to VAR\_EXTERNAL. To delete a global variable (what all your variables should be), click Global\_Variables and delete the unwanted variables from the list that appears.

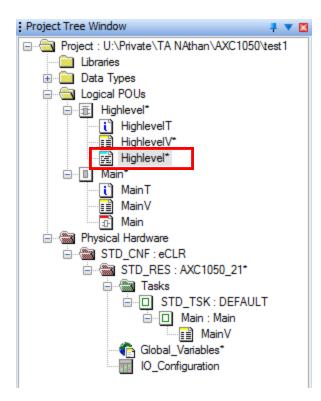
To use an output from ladder logic as an input for FBD, use the same variable name.



## **Implement Structured Text:**

Creating a Structure Text function block:

- Under IEC Programming Workspace tab, right click "Logical POU" (under Project Tree Window) and click Insert->Function Block
- Type your code under the third folder when expanding the function block (Highlevel\*)

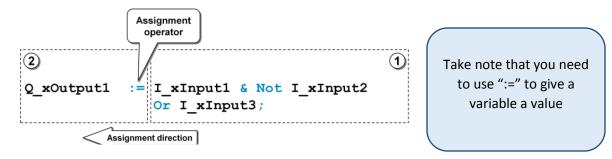


• Then, click at the Main window, and drag HighLevel\* from the project tree Window to the Main programming space, you should obtain the following:



Coding in Structured Text:

- WARNING: PC WORKS USES SLIGHTLY DIFFERENT SYNTAX THAN THE IEC 61131 STANDARDS
- If there is anything you need for the lab that is missing from this tutorial, check PC Worx tutorial: <u>http://axhelp.ru/files/pcworx/documentation/PC\_WORX\_6\_IEC\_61131\_Programming.pdf</u>
- To declare variables, open the section with "HighlevelV". Right-click the chart, then click "insert variables" and specify type



- The PLC will loop through the program so **DO NOT** initialize an I/O variable or it will change back to the initialized state at each loop
- To use AND-conditions use '&'. To use OR-conditions, use 'Or'

## **Operation Hierarchy**

	Operation	Symbol	Data type group
t	Brackets	(Ausdruck)	ANY
	Function evaluation	Funktion (Argumente)	*
	Potentialization	iZahl1 <b>**</b> iZahl2 <b>*</b>	NUM
	Negation Complement	-iZahl <b>NOT</b> wCode	BIT
Z	Multiplication Division Modulo	iZahl1 * iZahl2* rZahl1 / rZahl2* iZahl1 MOD iZahl2	NUM
Priority	Addition Subtraction	iZahl1 + iZahl2 * rZahl1 - rZahl2 *	
^	Comparison	diA > diB WC < WD iE >= iF iG <= iH	
	Equality Inequality	iZahl1 = iZahl2 * rZahl1 <> rZahl2 *	ANY
	Boolean AND	xVar1 <b>&amp;</b> xVar2 wCode1 <b>AND</b> wCode2	
	Boolean exclusive OR	xVar1 XOR xVar2	BIT
	Boolean OR	bVar1 OR bVar2	

Here is a diagram explaining the operation hierarchy

Assignments, Operators   

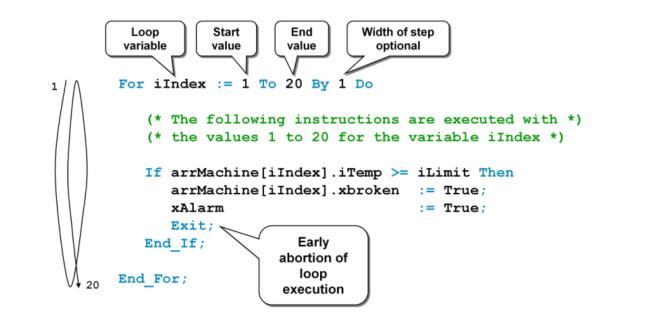
$$\begin{bmatrix}
Q_xOutput1 := False; \\
Q_xOutput2 := I_xInput2 & Not I_xInput4;
\end{bmatrix}$$
Requests   

$$\begin{bmatrix}
If I_xInput1 & I_xInput2 & Then \\
Q_xOutput1 := True; \\
ElsIf I_xInput2 & I_xInput3 & Then \\
Q_xOutput2 := True; \\
End_If;
\end{bmatrix}$$
FU calls and arguments   

$$\begin{bmatrix}
CTU_Output (CU := xPulse, \\
PV := iMaxValue, \\
RESET := xStop); \\
iValue := CTU_Output.QV; \\
xFul1 := CTU_Output.Q;
\end{bmatrix}$$
  

$$\begin{bmatrix}
Repeat \\
iLoops \\
\end{bmatrix}$$
Repeat;   

$$\begin{bmatrix}
Repeat; \\
ION \\
I$$



The image above shows the syntax for a for loop.

## Assigning inputs and outputs in Structured Text:

- Remember, declare variables under the HighlevelV file
- Before doing the next step, make sure to clear all the Default variables in the Global\_Variables file that have the name you want to assign to make sure the variable that you will assign to global comes from highlevelV
- Then, highlight an I/O variable that you use in the code and right-click, then click "Variable...". In the window that pops up, change the usage to VAR\_GLOBAL

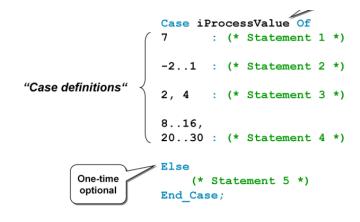
1 2	<pre>TON_1(IN:=True, PT:=T#5s);</pre>					
3	If TON_1.Q = True Then					
4	output1 := True	;				
5	Else					
6	output1 := False	e;				
7	End_If;					
8	1	얼	<u>V</u> ariable	F5		
			Open Varia <u>b</u> les Worksheets			
		5	<u>U</u> ndo	Ctrl+Z		
		<b>N</b>	<u>R</u> edo	Ctrl+Y		
		*	Cu <u>t</u>	Ctrl+X		
		<b>₽</b>	<u>C</u> opy	Ctrl+C		

#### Using timers in Structured Text:

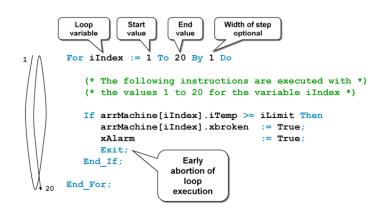
• The code below turns on a light if the switch is on for 5 seconds. Use the same syntax for your code

```
1
     (*enable/disable timer based on input*)
2
3
4
    If input1 Then
        TON 1(IN :=True, PT:=T#5s); (*first argument IN enable timers, second argument PT indicates timer preset*)
    Else
5
6
         TON 1(IN :=False); (*Set the enabling bit to False*)
    End If;
                                                                                    Take note of the
7
                                                                                    comment syntax:
8
9
     (*Check if timer is elapsed*)
                                                                                 (*Here is a comment in
     If TON 1.Q = True Then (*Q indicates if the timer is elapsed*)
                                                                                           ST*)
10
        output1 := True; (*If timer is elapsed enable the output*)
11
   Else
12
        output1 := False; (*Else, disable the output*)
13
   End If;
14
```

#### How to code a case switch in ST



```
How to code a For Loop in ST
```



## While Loops in ST

"Repeat ... until ..."
"
"
Repeat
iIndex := iIndex + 10;
Until
iIndex >= iLimit
"
Do
iIndex := iIndex + 10;
Foot-controlled
"
"
Aslong as..., do..."

You are now a PLC expert!



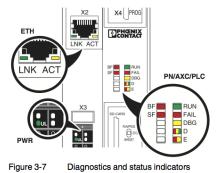
## Appendix:

A) Lights legend

#### Description of the AXC 1050 (XC)

#### 3.5 Diagnostics and status indicators

The diagnostics and status indicators are used for quick local error diagnostics.



**3** 

Table 3-1 Diagnostics and status indicators of the controller

Desig- nation	Color	Meaning	State	Description
PN: PROF	INET contr	oller/device function	on	
	Status of		AXC 1050 (XC) as a PROFINET controller	
			Off	The AXC 1050 (XC) has established an active communication connection to each configured PROFINET device.
			On	No link status at the Ethernet interfaces and/or no 100-Mbit transmission and/or no full-duplex operation.
		Status of PROFINET com-	Flashing (1 Hz)	Link status present, at least one configured PROFINET device has no communication connection.
BF	Red	munication/com-		AXC 1050 (XC) as a PROFINET device
		munication errors	s A PROFINET controller has established a tion connection to the AXC 1050 (XC) (PF	A PROFINET controller has established an active communica- tion connection to the AXC 1050 (XC) (PROFINET device) or the function of the PROFINET device is switched off.
		On terfaces). Flashing Link status pr	No PROFINET communication (no link status at the Ethernet in- terfaces).	
			· ·	Link status present, no communication connection to the PROFINET controller.

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#### AXC 1050 (XC)

Table 3-1	Diagno	stics and status indic	ators of the co	ontroller
Desig- nation	Color	Meaning	State	Description
			AXC 1050	(XC) concurrently operates as a PROFINET controller and device
BF	Red	Status of PROFINET com- munication/com-	Off	The AXC 1050 (XC) (PROFINET controller) has established an active communication connection to each configured PROFINET device and a PROFINET controller has established an active communication connection to the AXC 1050 (XC) (PROFINET device).
		munication errors	On	No link status at the Ethernet interfaces and/or no 100-Mbit transmission and/or no full-duplex operation.
			Flashing (1 Hz)	Link status present, at least one configured PROFINET device has no communication connection or the PROFINET controller has no communication connection.
		Group error	Off	PROFINET diagnostics not present.
SF	Red	(PROFINET)	On	PROFINET diagnostics present.
PLC: con	troller diag	nostics		
			Off	IEC 61131 runtime system not ready to operate.
		PLIN status of the	Flashing (0.5 Hz)	IEC 61131 runtime system successfully initialized. Control function is in the READY/STOP state, program not pro- cessed.
RUN	Green	RUN status of the controller	Flashing (2 Hz)	Controller reset to default state (see Section "Reset button (concealed)" on page 30).
			On	IEC 61131 runtime system successfully initialized and a pro- gram is running. Control function is in the RUN state.
			On	A runtime error has occurred in the IEC 61131 runtime system program.
FAIL	Red	Failure	Off	No runtime error has occurred in the IEC 61131 runtime system program.
			Flashing (0.5 Hz)	The hardware watchdog of the controller has been triggered.
			On	The IEC 61131 runtime system/controller is in debug mode, i.e., debug mode has been activated in PC Worx (breakpoint(s) set and/or variable(s) forced).
DBG	Yellow	Debug mode		The state of the RUN LED is not affected.
		(troubleshooting)	Flashing (2 Hz)	Boot phase of the controller (from sending the BootP request to assigning the IP address settings) if the MAC address of the controller has been entered in the PC Worx software. Other- wise, flashing stops after three failed boot requests.

 Table 3-1
 Diagnostics and status indicators of the controller

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Description of the AXC 1050 (XC)

Desig- nation	Color	Meaning	State	Description	
AXC: Axi	oline F diag	nostics			
			Green on	Run: The Axioline F station is ready for operation; communication within the Axioline F station is OK. All data is valid. There is no error.	
				Flashing green	Active: The Axioline F station is ready for operation; communication within the Axioline F station is OK. The data is <b>not</b> valid. Valid data from the controller is not available. There is no malfunction in the device.
			Yellow on	Ready: The Axioline F station is ready for operation; no data is being exchanged.	
			Flashing yellow	Access from Startup+ in I/O check mode	
		bus communica-	Flashing yellow/red	Local bus error during active I/O check	
				Local bus error during startup	
				Possible causes:	
D	Red/yel- low/green		Flashing	<ul> <li>Configuration cannot be generated, information is missir from a device</li> </ul>	
		tion	red	<ul> <li>Chip version of a device is &lt; V 1.1</li> </ul>	
				<ul> <li>Deviation between actual and required configuration</li> </ul>	
				<ul> <li>No local bus device connected</li> </ul>	
				<ul> <li>The maximum number of local bus devices has been exceeded</li> </ul>	
				Bus error in RUN state	
				The Axioline F station is ready for operation but has lost con- nection to at least one device.	
				Possible causes:	
			Red on	<ul> <li>Communication error</li> </ul>	
				<ul> <li>A local bus device has been removed or a configured de vice is missing</li> </ul>	
				<ul> <li>Reset from a local bus device</li> </ul>	
				<ul> <li>Serious device error at a local bus device (local bus device can no longer be reached)</li> </ul>	
			Off	Power down: Device is in (power) reset.	
Е	Yel-	Error/warning	Yellow on	I/O warning at an Axioline F device	
•	low/red	Error/warning	Red on	Peripheral fault at an Axioline F device	

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#### AXC 1050 (XC)

Table 3-1 Diagnostics and status indicators of the controller Desig-Color Meaning State Description nation PWR: supply voltage (communications power UL) Off 24 V communications power feed-in not present or too low. UL Green ULogic On 24 V communications power feed-in present. ETH: Ethernet interfaces Off Connection not established successfully Connection established successfully (link): the controller is On LNK Link status Green able to contact another network device. Flashing PROFINET device identification "flashing" (0.5 Hz) Off Data transmission inactive ACT Yellow Activity status Data transmission active (activity): the Ethernet interface is On/flashing sending or receiving data



#### Exception: updates

During an update using FTP or an SD card, the RUN and DBG LEDs flash in alternation. For information about performing updates, please refer to Section "Performing updates" on page 150.



#### Exception: update using an SD card

Once an update using an SD card is successfully completed, the BF, SF, RUN und FAIL LEDs all flash concurrently at a frequency of 1 Hz.

For information about performing updates using an SD card, please refer to Section "Performing updates via an SD card" on page 150.

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