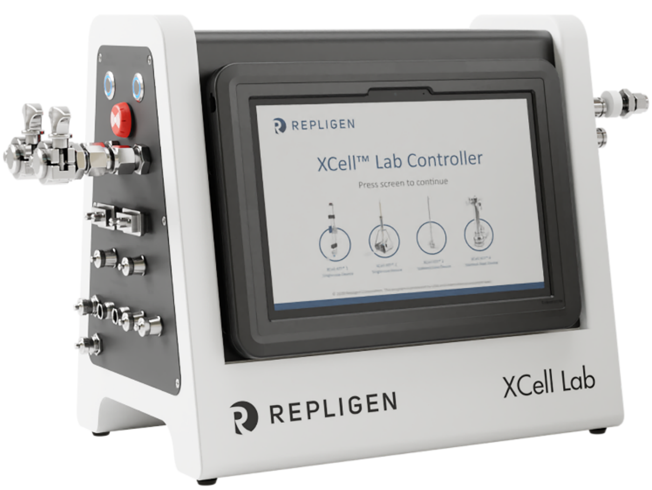
XCell®
Lab Controller

User Guide

For integration with DeltaV™ Systems



repligen.com

REPLIGEN

Document Number:UG-5255
Revision: 1
Effective Date: 7/30/2024
Legacy Document #: N/A

For further information, please contact Repligen Corporation at www.repligen.com.

Customer Support

customerserviceUS@repligen.com
781-250-0111

Repligen Corporation

41 Seyon Street
Building 1 Suite 100
Waltham, Massachusetts 02453
www.repligen.com

Contents

List of Tables

List of Figures

Abbreviations

ATF	Alternating tangential flow
ATF-A	XCell ATF Device A
ATF-B	XCell ATF Device B
ETH 1,2	Ethernet ports
HMI	Human machine interface
INT	Integer
I/O	Input/output
I/P	Internet protocol
LM	Landing Module
LPM	Liters per minute
OEM	Original equipment manufacturer
PLC	Programable logic controller
PCV	Process control valve
TCP	Transmission control protocol

1. Introduction

The purpose of this guide is to support the integration of the XCell® Lab Controller into a DeltaV™ System. This guide is specific to the XCell Lab Controller architecture powered with a Rockwell PLC.

This integration guide provides steps and examples to help plan integration. Actual configuration needs and the order in which these steps are performed may vary. Please refer to XCell Lab Controller User Guide for information on the XCell Lab Controller.

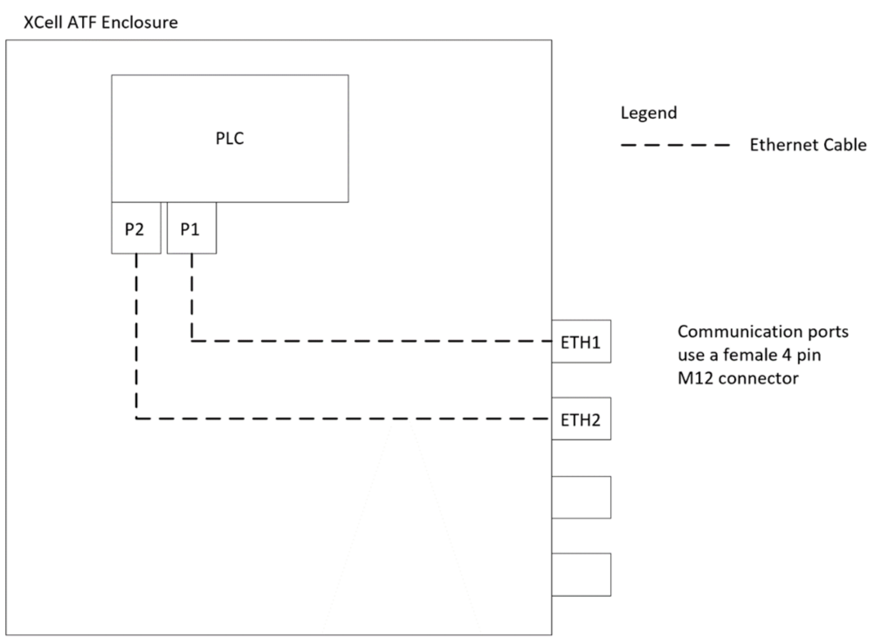
2. Controller Overview

The XCell Lab Controller use an active process that continuously senses diaphragm pressure, permeate pressure, and the flow between the bioreactor and the XCell ATF Device. Process parameters are adjusted in real-time to maintain the desired volume exchange and continuous perfusion. This system enables the XCell ATF Technology to provide consistent performance across a wide range of process fluids with differing viscosities, concentrations, and temperatures.

3. Controller Hardware

The XCell Lab Controller consist of a stainless-steel enclosure to house the PLC, Process Control Valve (PCV), and other necessary electrical components. The PLC is a CompactLogix L19ER from Allen-Bradley. The PCV is an Enfield SCEC-K-17000. The controller hardware supports connectivity to a variety of external control systems.

Figure 1. XCell Lab Controller Enclosure and Connectivity Options



4. Protocols

Ethernet I/P is an industrial network protocol that adapts the Common Industrial Protocol to Standard Ethernet (Section 15.1). It is widely used within the world of industrial automation. Within it are further selections, such as implicit vs. explicit messaging that define the nature of the communication between two devices.

There are pros and cons to using each protocol. Repligen has tested both with the XCell Lab Controller, providing sufficient communication for control.

5. XCell ATF Device PLC Tag Mapping

The PLC control logic drives the core XCell ATF Device operations. Communication occurs over Ethernet I/P protocols to enable supervisory control of the XCell ATF Device into external DeltaV Systems. ETH1 and ETH2 ports provide an ethernet connection to the PLC.

The protocol can be used to control the XCell ATF Device process, however only one of them can be in control at any given time. The PLC code contains separate data arrays for each protocol and uses a heartbeat solution to pick the active one (Section 6.3).

5.1 PLC Data Arrays

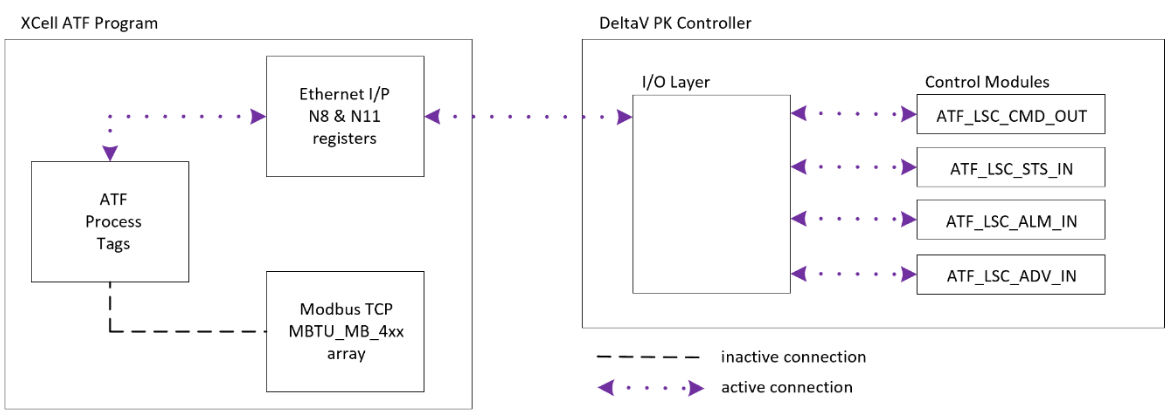
The PLC code contains one set of data arrays that can be connected to external DeltaV Systems to provide remote control: one to support Ethernet I/P communication. The information being exchanged is the same for both; communication simply occurs differently to serve the requirements of each protocol.

6. Operational Considerations

6.1 PLC Heartbeat

The PLC code uses a heartbeat solution to choose the controlling protocol. It does so by monitoring the heartbeat tag with each data array. When one of the heartbeat tags becomes dynamic by toggling between 0 and 1, the PLC gives remote control to the associated protocol and maintains it until the heartbeat is lost. For example, when Ethernet I/P is being used, the I/O data array in the DeltaV System will connect to the Ethernet I/P data array in the PLC code as shown in Figure 2.

Figure 2. PLC Program Tag Mapping



Because Ethernet I/P is the controlling protocol, the Ethernet I/P data array is mapped to the XCell Lab Controller process tags. This means that any changes to the Ethernet I/P data array are directly applied to the XCell ATF System process tags. This mapping provides a synchronous connection between the I/O in the DeltaV System and the Ethernet I/P data array in the PLC and is the foundation for how the PLC code can be controlled remotely. If a tag changes in the PLC, the matching tag will update in the DeltaV System. If a start bit is set from DeltaV, the PLC will read this change and use it to start the XCell ATF Device process.

7. DeltaV System Communication

The DeltaV Distributed Control System (DCS) provides process control networks and a variety of deployment options. This guide focuses on Ethernet I/P, which are relevant to the XCell Lab Controller.

7.1 DeltaV System Communication Overview

The DeltaV System platform includes several options for connecting over Ethernet I/P. With the traditional M and S series Controller, the VIM2 and the EIOC cards provide connections. These are installed in the DeltaV System rack adjacent to the controller. Another option from Emerson is the PK Controller which is a standalone option for skid control. The ethernet cable is plugged in directly and no additional communication card is necessary.

7.2 DeltaV System Communication Cards and Drivers

- M-series Virtual I/O Module 2 (M-VIM2) (Section 15.3)
- S-series Virtual I/O Module 2 (S-VIM2) (Section 15.4)
- Ethernet I/O Card (EIOC) (Section 15.5)
- PK Controller (Section 9.2)

Coupled with each hardware card is a device driver that defines the nature of the communication. The XCell ATF Device process can be controlled by any of the three cards using one of the approved device drivers.

Note: *For those drivers listed as supported, but without integration files, contact Repligen for integration support.*

Table 1. Device Drivers for the M-VIM2 and S-VIM2 Cards

Device Driver	Description	Supported by Repligen?	Integration Files Provided?
IOD-4112	Ethernet I/P Scanner Driver	Yes	No
IOD-4115	FMC722 Ethernet Protocol Driver	No	No
IOD-4116	ODVA Ethernet I/P Protocol Driver	Yes	Yes
IOD-4117	Profinet Protocol Driver	No	No

Table 2. Device Drivers for the Ethernet I/O Card (EIOC) (Section 15.5)

Device Driver	Description	Supported by Repligen?	Integration Files Provided?
VE4104	Ethernet I/P Control Tag Integration for Ethernet-connected I/O (EIOC)	Yes	No
VE4105	Ethernet I/P Interface for Ethernet connected I/O (EIOC)	Yes	No
VE4106	OPC-UA client for Ethernet connected I/O (EIOC)	No	No
VE4107	IEC 61850 MMS Interface for Ethernet connected I/O (EIOC)	No	No
VE4109Sxxx	Ethernet connected I/O (EIOC and PK): Physical Devices	No	No

The PK Controller system does not require purchasing separate communication drivers. It comes with native drivers to support Ethernet I/P. Both options are supported by the XCell ATF Device PLC. Currently Repligen provides the integration files for the Ethernet I/P integration (Section 15.5).

8. PLC Configuration

8.1 PLC IP Address Assignment

With any of the available integration options, it is necessary to fit the XCell ATF Device PLC into the existing DeltaV System network. This includes assigning it a new static IP address, following site IT guidance.

The PLC is a CompactLogix L19ER which is part of the Logix family from Allen-Bradley. It has a default IP address of 192.168.1.101.

8.1.1 Changing the IP Address

1. Download and install FactoryTalk Linx software (Section 15.6) onto a laptop.
2. Change the IP address of the laptop to 192.168.1.200 to match the PLC subnet.
3. Use an ethernet cable to connect the laptop to ETH1 or ETH2 on the XCell ATF Device enclosure.
4. Power up the XCell ATF enclosure.
5. Open FactoryTalk Linx and connect to the PLC.
6. Set the new PLC IP address.

The laptop will lose communication after the IP address is changed. This completes the configuration on the PLC side. All remaining configurations will happen within the DeltaV System and is dependent on the DeltaV System hardware, selected protocol, and communication driver.

8.2 Physical Connection

The integration of the XCell ATF System with DeltaV System requires a physical ethernet connection.

8.2.1 Creating the Physical Connection

1. Connect one end of an ethernet cable to ETH1 or ETH2 on the XCell Lab Controller enclosure and the other end to a port with DeltaV System connectivity. The XCell PLC should now be pingable from within the DeltaV System subnet.
2. Confirm a successful ping before proceeding to the next section.

9. DeltaV System Configuration

The DeltaV System must be configured to communicate correctly with the XCell ATF System PLC. The configuration is dependent on the existing DeltaV System communication hardware and software.

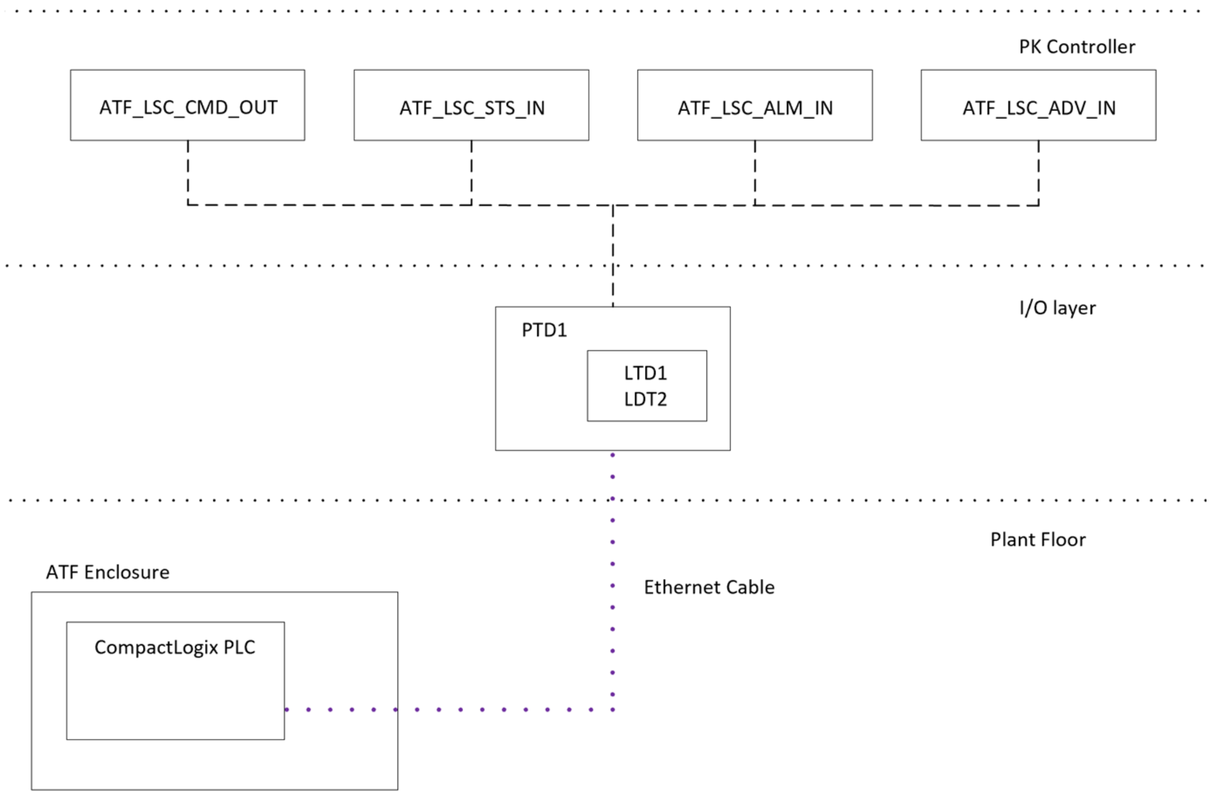
9.1 Software Architecture

Repligen has standardized a set of 4 control modules to aggregate and organize the I/O signals by their function. These control module classes are consistent across all the different integration solutions. While the classes are the same, the instantiated modules differ depending on which protocol has been selected. Each protocol will require a different I/O configuration to connect to the data arrays within the XCell ATF Device PLC. Repligen aims to facilitate integration by providing not just the classes but plant areas for each type of integration. This way, the I/O mapping is already complete, and the relevant files just need to be imported.

Table 3. Control Module Classes

Command	Description
ATF_LSC_CMD_OUT	Command Outputs
ATF_LSC_STS_IN	Status Feedback
ATF_LSC_ALM_IN	Alarms
ATF_LSC_ADV_IN	Advanced

Figure 3. DeltaV System Software Architecture – PK Controller Example



Repligen aims to provide all necessary DeltaV System software up to the control module layer. As of this time Repligen does not provide higher level code such as Equipment Modules or any HMI screens/faceplates.

9.2 PK Controller

The PK Controller is an increasingly popular option that is powerful enough to be standalone, but also flexible enough to integrate into larger DeltaV control systems. Unlike the M & S Series Controller, the PK comes with built-in ethernet ports that can be configured for Ethernet I/P. The ports are configurable with IP address and port numbers which makes it easy to match the subnet of the PLC IP address. For this integration, the XCell ATF Device can be connected directly to the ethernet port on the PK Controller.

9.2.1 PK Controller Ethernet I/P

Repligen has standardized on UCMM with Logix Tags communication to connect the PK Controller to the N8 and N11 PLC registers. Repligen provides all necessary software to complete the configuration steps.

Table 4. DeltaV Integration Files - PK Controller Ethernet I/P

File name	Description
PDT1_ETH.fhx	Ethernet Physical Device Configuration
ATF_LSC_ETH.fhx	A unit module containing 4 linked control modules
Repligen.fhx	Category in the Library containing 4 control module classes (shown below)
• ATF_LSC_ADV_IN	ATF LAB/LSC Advanced Statuses control module class
• ATF_LSC_ALM_IN	ATF LAB/LSC Alarms control module class
• ATF_LSC_CMD_OUT	ATF LAB/LSC Commands control module class
• ATF_LSC_STS_IN	ATF LAB/LSC Statuses control module class

The PDT1_ETH.fhx file contains the I/O configuration information to connect to the ATF PLC. It contains the Ethernet I/P Physical Device which contains 2 Ethernet I/P Logical Devices: LDT1 and LDT2. LDT1 is the input data array that connects to the N11 array in the CompactLogix and LDT2 is the output data array that connects to the N8 array.

ATF_LSC_ETH.fhx is a unit module containing instances of the 4 control module classes linked to the I/O defined in P01.fhx. The 4 control module classes are also included. Importing these files provides a quick and complete integration.

9.3 VIM2 Card

9.3.1 IOD-4116 ODVA Ethernet I/P

This section applies to DeltaV Systems that are running the IOD-4116 communication driver on a VIM2 card.

9.3.1.1 Class 3 Messaging

Explicit connected Class 3 messaging is used to connect DeltaV System to the PLC N8 and N11 data arrays.

There are three layers of DeltaV System configuration involved in this integration:

- Configuration of the VIM2 card to map to the N8 and N11 PLC registers
- Configuration of the DeltaV System I/O layer to match the VIM2 arrays
- Configuration of the DeltaV System modules that connect to the I/O layer

Repligen provides all necessary software to complete the configuration steps.

Table 5. VIM2 Ethernet I/P Integration Software Package

File Name	Description
ATF_LSC_4116_VIM.vio	VIMNet Explorer file
ATF_LSC_4116_DVIO.fhx	DeltaV System I/O configuration
ATF_LSC_ADV_IN	XCell LAB/LSC Controller Advanced Statuses control module class
ATF_LSC_ALM_IN	XCell LAB/LSC Controller Alarms control module class
ATF_LSC_CMD_OUT	XCell LAB/LSC Controller Commands control module class
ATF_LSC_STS_IN	XCell LAB/LSC Controller Statuses control module class

The VIM2 card is linked to the C57, C58, C59, and C60 cards in the I/O layer of the controller that it is serving. During internal testing, Repligen created DEV01 within Port 01 of C57 to communicate with the XCell ATF Controller. This device location is matched within the VIMNet Explorer file. It is not important which of the 4 cards and nested ports are utilized, but it is necessary to ensure a match between the DeltaV I/O configuration and the VIMNet configuration. It is also important to match the Device Address in each location.

Depending on the existing plant VIM2 I/O, the location of the XCell ATF System may need to move from the default of C57 Port 01. The ATF_LSC_4116_DVIO.fhx software is provided as an example of a working configuration and can either be imported directly or adjusted to better fit existing plant I/O configurations. It will only import C57 into the DeltaV I/O layer.

There are two configured data sets within DEV01 of the import file:
- DS01 connects to PLC tag array N11 to receive the XCell Lab Controller status information.
- DS02 connects to PLC tag array N8 to publish the XCell Lab Controller commands.

Table 6. VIM2 I/O Data Set Configurations

Location	DS01	DS02
General Tab		
Data direction	input	output
output mode	0	0, no readback
DeltaV Tab		
DeltaV data type	16-bit int w/status	16-bit int w/status
PLC Tab		
Device data type	0	0
Data start address	0	0
Number of values	88	40
Special Data Tab		
Special data 1	7	7
Special data 2	11	8
Special data 3	0	0
Special data 4	0	0
Special data 5	0	0

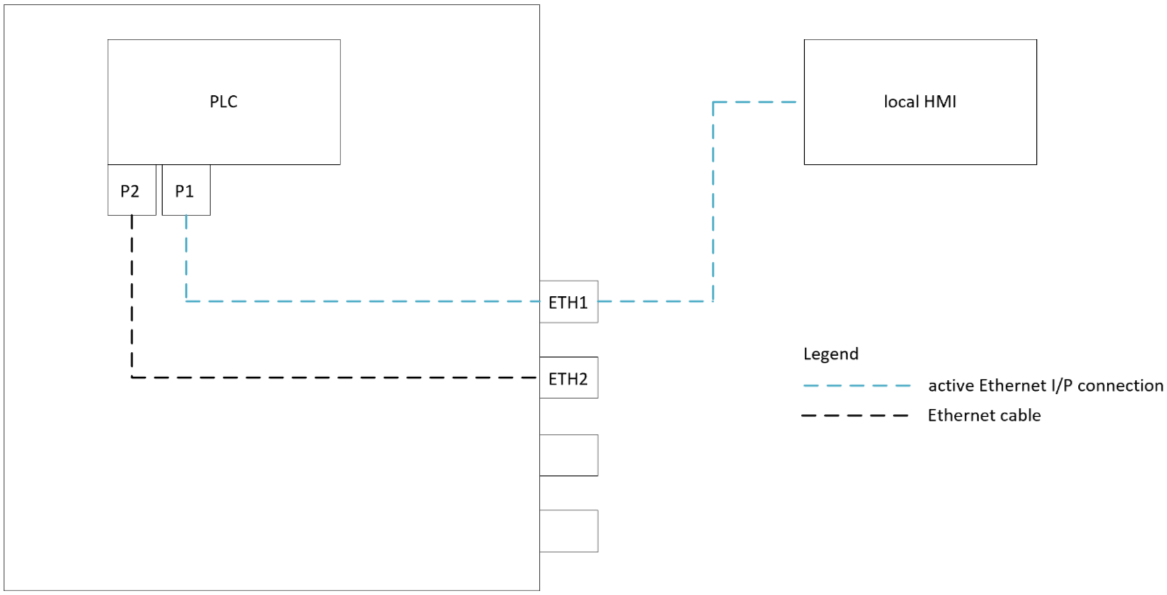
Configure the VIMNet:
The VIMNet configuration includes two connection definitions within the Serial Card Ethernet IP Definition Library.
- C3DF1_N:11/0-0 defines the VIM2 connection to N11 within the PLC
- C3DF1_N:8/0-0 defines the VIM2 connection to N8 within the PLC

1. Open the ATF_LSC_4116_VIM.vio file to view these connection definitions and see how they are deployed within the I/O Net layer.
2. Within DEV01, change the IP address to match the XCell ATF PLC address set in Section 8.1.
3. After the DeltaV System I/O and VIMNet configurations have been finalized, download the DeltaV System I/O.
4. Upload the VIMNet configuration to the VIM2 card.
5. This should provide the necessary communication between DeltaV System and the PLC. Run DeltaV System diagnostics to view the registers in the data sets.
6. Confirm a healthy and active connection between DeltaV System and the ATF PLC before proceeding.

9.3.2 Summary

Once the I/O and control modules are in place, and the controller downloads are complete, the XCell Lab Controller is ready to be controlled remotely from DeltaV System. Section 10 describes how the available tags within DeltaV can be used to achieve the desired process control.

Figure 4. Local HMI Control Only



10. XCell ATF Device Input/Output List

10.1 I/O Overview

The XCell ATF Device I/O list is a consolidation of all input/output signals hosted in the control module layer. It contains 1 tab for each control module class. The filename is XCell ATF Device LSC IO List.xlsx.

This section illustrates a typical setup from initial configuration through running the more advanced features of the technology. The steps are provided as a guideline. The exact order and number of steps may vary, depending on your individual configuration. Throughout this section, the relevant I/O tags will be highlighted and explained.

It is recommended that you read and reference the XCell Lab Controller User Guide for details regarding the correct setup, configuration, and use of the system.

Table 7. Control Modules

Command	Description
ATF_LSC_CMD_OUT	Command outputs
ATF_LSC_STS_IN	Status feedback
ATF_LSC_ALM_IN	Alarms
ATF_LSC_ADV_IN	Advanced

Table 8. Heartbeat Tags

Tag name	Tab
SCADA_HB	ATF_LSC_CMD_OUT
MSTR_ETH	ATF_LSC_STS_IN
MSTR_MB	ATF_LSC_STS_IN
XCELL_HB	ATF_LSC_STS_IN

The ATF_LSC_CMD_OUT control module is responsible for toggling the SCADA_HB command. Once the designation is assigned, MSTR_ETH or MSTR_MB will transition from 0 to 1, depending on which protocol is sending the heartbeat. Within the PLC, this designation will map the active protocol tags to the XCell ATF Device process tags.

10.2 XCell ATF Device Configuration

The XCell ATF PLC code is written to support a variety of physical product configurations including XCell ATF 1, 2, and 4 Devices with the presence/absence of a permeate pressure monitor (P3), etc.

1. Verify the three XCell ATF Device sizes are available by confirming a 1 value in model availability tags. It is important for the XCell ATF Device size to be listed as available within the program.

Table 9. Model Availability Tags

Tag name	Tab
MODEL_ATF1	ATF_LSC_STS_IN
MODEL_ATF2	ATF_LSC_STS_IN
MODEL_ATF4	ATF_LSC_STS_IN

2. Set the XCell ATF Device A and B sizes in the program using the configuration tags to match the XCell ATF Devices connected to the XCell ATF Device enclosure and confirm the selections by monitoring the status tags.

Table 10. Device Size Configuration Tags

Tag name	Tab
FA_SIZE	ATF_LSC_CMD_OUT
FB_SIZE	ATF_LSC_CMD_OUT
FA_ACTIVE_SIZE	ATF_LSC_STS_IN
FB_ACTIVE_SIZE	ATF_LSC_STS_IN

There are two tags to communicate configuration errors back from the PLC.

Table 11. Configuration Error Tags

Tag name	Tab
CFG_LOCKED_ERR	ATF_LSC_ALM_IN
CFG_RANGE_ERR	ATF_LSC_ALM_IN

3. If the XCell ATF Device setup is using the permeate pressure monitoring option, activate this in the program and confirm the status change using the following tags.

Table 12. Permeate Pressure Monitoring Activation and Status Tags

Tag name	Tab
MODEL_TMP	ATF_LSC_STS_IN
FA_P3_ENABLE	ATF_LSC_CMD_OUT
FB_P3_ENABLE	ATF_LSC_CMD_OUT
FA_P3_ENABLED	ATF_LSC_STS_IN
FB_P3_ENABLED	ATF_LSC_STS_IN

4. Configure the total flow calculation method. Set the BOOLs to reflect the design of the product configuration.
5. Set restart options and confirm the status.

The PLC code supports the option to automatically restart the XCell ATF Device after power returns from an unanticipated power loss. Set the desired behavior and confirm the status using tags (Table 15).

Table 13. Restart Tags

Tag name	Tab
RESTART_ENABLE	ATF_LSC_CMD_OUT
RESTART_ENABLED	ATF_LSC_STS_IN

10.3 Manual Control of the Process Control Valve

The Process Control Valve (PCV) is responsible for controlling the pressure under the diaphragm (P2) in the XCell ATF Device housing. It receives the utility inputs for pressure and vacuum and controls to a pressure SP signal sent from the PLC. It has two outputs to cover XCell ATF Devices A and B. This section details how it can be manually controlled.

Table 14. PCV Manual Control Tags

Tag name	Tab
PCVA_ON_CMD	ATF_LSC_CMD_OUT
PCVA_SP	ATF_LSC_CMD_OUT
PCVA_CV	ATF_LSC_STS_IN
FA_P2_PV	ATF_LSC_STS_IN
PCVA_READY	ATF_LSC_STS_IN
PCVB_ON_CMD	ATF_LSC_CMD_OUT
PCVB_SP	ATF_LSC_CMD_OUT
PCVB_CV	ATF_LSC_STS_IN
FB_P2_PV	ATF_LSC_STS_IN
PCVB_READY	ATF_LSC_STS_IN

The PCVX_READY signals indicate the XCell ATF Device PCVs are ready to be manually controlled. The PCVX_ON_CMD commands will apply power to the PCV and cause it to control P2 pressure to the values in the PCVX_SP tags. The PCVX_SP tags accept between -95 and 100% which correlate to full vacuum and full pressure. The PCVX_CV tags are a reflection from the PCV of the PCVX_SP back to the PLC. The FX_P2_PV tags represent the actual sensed pressure.

For both XCell ATF Devices A and B, experiment with setting various percent values for the PCVX_SP and activating the PCV by setting the PCVX_ON_CMD to 1. Observe how the PCVX_CV and FX_P2_PV signals change in response to the changing setpoints. For single-use products, it is possible and helpful to watch the diaphragm within the device housing as it moves in response to the changing setpoints.

Set the PCVX_ON_CMD commands back to 0 to remove power from the PCV.

10.4 Starting in Wetting Mode

Wetting mode is a simplified control regime that does not adjust the process parameters in response to the observed flowrate. It simply runs the process with defined pressure and exhaust setpoints. This mode is commonly used at the beginning of the run to wet the XCell ATF Device with media before the cells are introduced into the bioreactor.

Table 15. Wetting Mode Tags

Tag Name	Tab
FA_WET_EXHST_SP	ATF_LSC_CMD_OUT
FA_FILTER_WET	ATF_LSC_CMD_OUT
FA_WET_PRESS_SP	ATF_LSC_CMD_OUT
FB_WET_EXHST_SP	ATF_LSC_CMD_OUT
FB_FILTER_WET	ATF_LSC_CMD_OUT
FB_WET_PRESS_SP	ATF_LSC_CMD_OUT

Repligen recommends that this procedure be conducted separately for XCell ATF Devices A and B.

1. Use FX_WET_PRESS_SP and FX_WET_EXHST_SP to define the pressure and exhaust setpoints the ATF will cycle between as it runs in the wetting mode.
2. Choose two setpoints within the full range and activate wetting mode by setting FX_FILTER_WET to 1. FX_FILTER_WET is a sustained tag that needs to remain at 1 for wetting mode to operate.
3. Observe the P2 value over time as the process runs. Trending P2 will visualize the pressure curve over time which is the fundamental force that is driving the XCell ATF Device process.
4. Return FX_FILTER_WET to 0 to stop the XCell ATF Device.

11. XCell ATF Device Input/Output List

11.1 I/O Overview

The XCell ATF Device I/O list is a consolidation of all input/output signals hosted in the control module layer. It contains 1 tab for each control module class. The filename is XCell ATF Device LSC IO List.xlsx.

This section illustrates a typical setup from initial configuration through running the more advanced features of the technology. The steps are provided as a guideline. The exact order and number of steps may vary, depending on your individual configuration. Throughout this section, the relevant I/O tags will be highlighted and explained.

It is recommended that you read and reference the XCell Lab Controller User Guide for details regarding the correct setup, configuration, and use of the system.

Table 16. Control Modules

Command	Description
ATF_LSC_CMD_OUT	Command outputs
ATF_LSC_STS_IN	Status feedback
ATF_LSC_ALM_IN	Alarms
ATF_LSC_ADV_IN	Advanced

Table 17. Heartbeat Tags

Tag Name	Tab
SCADA_HB	ATF_LSC_CMD_OUT
MSTR_ETH	ATF_LSC_STS_IN
MSTR_MB	ATF_LSC_STS_IN
XCELL_HB	ATF_LSC_STS_IN

The ATF_LSC_CMD_OUT control module is responsible for toggling the SCADA_HB command. Once the designation is assigned, MSTR_ETH or MSTR_MB will transition from 0 to 1, depending on which protocol is sending the heartbeat. Within the PLC, this designation will map the active protocol tags to the XCell ATF Device process tags.

11.2 XCell ATF Device Configuration

The XCell ATF PLC code is written to support a variety of physical product configurations including XCell ATF 1, 2, and 4 Devices with the presence/absence of a permeate pressure monitor (P3), etc.

6. Verify the three XCell ATF Device sizes are available by confirming a 1 value in model availability tags. It is important for the XCell ATF Device size to be listed as available within the program.

Table 18. Model Availability Tags

Tag Name	Tab
MODEL_ATF1	ATF_LSC_STS_IN
MODEL_ATF2	ATF_LSC_STS_IN
MODEL_ATF4	ATF_LSC_STS_IN

7. Set the XCell ATF Device A and B sizes in the program using the configuration tags to match the XCell ATF Devices connected to the XCell ATF Device enclosure and confirm the selections by monitoring the status tags.

Table 19. Device Size Configuration Tags

Tag Name	Tab
FA_SIZE	ATF_LSC_CMD_OUT
FB_SIZE	ATF_LSC_CMD_OUT
FA_ACTIVE_SIZE	ATF_LSC_STS_IN
FB_ACTIVE_SIZE	ATF_LSC_STS_IN

There are two tags to communicate configuration errors back from the PLC.

Table 20. Configuration Error Tags

Tag Name	Tab
CFG_LOCKED_ERR	ATF_LSC_ALM_IN
CFG_RANGE_ERR	ATF_LSC_ALM_IN

8. If the XCell ATF Device setup is using the permeate pressure monitoring option, activate this in the program and confirm the status change using the following tags.

Table 21. Permeate Pressure Monitoring Activation and Status Tags

Tag Name	Tab
MODEL_TMP	ATF_LSC_STS_IN
FA_P3_ENABLE	ATF_LSC_CMD_OUT
FB_P3_ENABLE	ATF_LSC_CMD_OUT
FA_P3_ENABLED	ATF_LSC_STS_IN
FB_P3_ENABLED	ATF_LSC_STS_IN

9. Configure the total flow calculation method. Set the BOOLs to reflect the design of the product configuration.
10. Set restart options and confirm the status.

The PLC code supports the option to automatically restart the XCell ATF Device after power returns from an unanticipated power loss. Set the desired behavior and confirm the status using tags (Table 24).

Table 22. Restart Tags

Tag name	Tab
RESTART_ENABLE	ATF_LSC_CMD_OUT
RESTART_ENABLED	ATF_LSC_STS_IN

11.3 Manual Control of the Process Control Valve

The Process Control Valve (PCV) is responsible for controlling the pressure under the diaphragm (P2) in the XCell ATF Device housing. It receives the utility inputs for pressure and vacuum and controls to a pressure SP signal sent from the PLC. It has two outputs to cover XCell ATF Devices A and B. This section details how it can be manually controlled.

Table 23. PCV Manual Control Tags

Tag Name	Tab
PCVA_ON_CMD	ATF_LSC_CMD_OUT
PCVA_SP	ATF_LSC_CMD_OUT
PCVA_CV	ATF_LSC_STS_IN
FA_P2_PV	ATF_LSC_STS_IN
PCVA_READY	ATF_LSC_STS_IN
PCVB_ON_CMD	ATF_LSC_CMD_OUT
PCVB_SP	ATF_LSC_CMD_OUT
PCVB_CV	ATF_LSC_STS_IN
FB_P2_PV	ATF_LSC_STS_IN
PCVB_READY	ATF_LSC_STS_IN

The PCVX_READY signals indicate the XCell ATF Device PCVs are ready to be manually controlled. The PCVX_ON_CMD commands will apply power to the PCV and cause it to control P2 pressure to the values in the PCVX_SP tags. The PCVX_SP tags accept between -95 and 100% which correlate to full vacuum and full pressure. The PCVX_CV tags are a reflection from the PCV of the PCVX_SP back to the PLC. The FX_P2_PV tags represent the actual sensed pressure.

For both XCell ATF Devices A and B, experiment with setting various percent values for the PCVX_SP and activating the PCV by setting the PCVX_ON_CMD to 1. Observe how the PCVX_CV and FX_P2_PV signals change in response to the changing setpoints. For single-use products, it is possible and helpful to watch the diaphragm within the device housing as it moves in response to the changing setpoints.

Set the PCVX_ON_CMD commands back to 0 to remove power from the PCV.

11.4 Starting in Wetting Mode

Wetting mode is a simplified control regime that does not adjust the process parameters in response to the observed flowrate. It simply runs the process with defined pressure and exhaust setpoints. This mode is commonly used at the beginning of the run to wet the XCell ATF Device with media before the cells are introduced into the bioreactor.

Table 24. Wetting Mode Tags

Tag Name	Tab
FA_WET_EXHST_SP	ATF_LSC_CMD_OUT
FA_FILTER_WET	ATF_LSC_CMD_OUT
FA_WET_PRESS_SP	ATF_LSC_CMD_OUT
FB_WET_EXHST_SP	ATF_LSC_CMD_OUT
FB_FILTER_WET	ATF_LSC_CMD_OUT
FB_WET_PRESS_SP	ATF_LSC_CMD_OUT

Repligen recommends that this procedure be conducted separately for XCell ATF Devices A and B.

5. Use FX_WET_PRESS_SP and FX_WET_EXHST_SP to define the pressure and exhaust setpoints the ATF will cycle between as it runs in the wetting mode.

6. Choose two setpoints within the full range and activate wetting mode by setting FX_FILTER_WET to 1. FX_FILTER_WET is a sustained tag that needs to remain at 1 for wetting mode to operate.
7. Observe the P2 value over time as the process runs. Trending P2 will visualize the pressure curve over time which is the fundamental force that is driving the XCell ATF Device process.
8. Return FX_FILTER_WET to 0 to stop the XCell ATF Device.

11.5 Start ATF

This procedure starts normal operation of a single, independent XCell ATF Device. The XCell ATF Device will step through its initialization procedure before transitioning into running. The process is started with a flowrate SP and will adjust its process parameters over time to seek the desired performance. It also includes several operational modes than can be activated as needed by the operator. Consult the XCell Lab User Guide for descriptions of these modes and how they can be used to adjust to changing process conditions.

Table 25. Individual XCell ATF Device Control Tags

Tag Name	Tab
FA_FLOW	ATF_LSC_CMD_OUT
FA_PAUSE_CMD	ATF_LSC_CMD_OUT
FA_START_CMD	ATF_LSC_CMD_OUT
FA_STOP_CMD	ATF_LSC_CMD_OUT
FA_OPN_LOOP	ATF_LSC_CMD_OUT
FA_AVG_DIS	ATF_LSC_CMD_OUT
FA_RPD_RSP_EN	ATF_LSC_CMD_OUT
FA_HEADPRESS *	ATF_LSC_CMD_OUT
FB_FLOW	ATF_LSC_CMD_OUT
FB_PAUSE_CMD	ATF_LSC_CMD_OUT
FB_START_CMD	ATF_LSC_CMD_OUT
FB_STOP_CMD	ATF_LSC_CMD_OUT
FB_OPN_LOOP	ATF_LSC_CMD_OUT
FB_AVG_DIS	ATF_LSC_CMD_OUT
FB_RPD_RSP_EN	ATF_LSC_CMD_OUT
FB_HEADPRESS *	ATF_LSC_CMD_OUT

1. * These parameters do not influence initialization sequence and are listed as is place holders for future functionality. (Use the FX_HEADPRESS commands provide the initialization sequence with an estimated head pressure.)
2. For both XCell ATF Devices A and B, input the desired flowrate into FX_FLOW and set FX_START_CMD to 1 to start the ATF Process.
3. Reference the status tags in ATF_LSC_STS_IN for an understanding of where the XCell ATF Device is in its process. These tags include detail on the steps of the initialization process that occur when the ATF is first started.
4. Once the ATF is running, use the FX_OPN_LOOP tag to change it to open loop mode. Average Mode can be disabled using FX_AVG_DIS, and Rapid Response Mode can be enabled using FX_RPD_RSP_EN.
5. The ATF can be paused using the FX_PAUSE_CMD tag and stopped using the FX_STOP_CMD tag.
6. Stop the ATF by setting the FX_STOP_CMD tag to 1.

FX_START_CMD, FX_PAUSE_CMD, and FX_STOP_CMD are all momentary tags in the PLC which means they are returned to 0 in DeltaV System after the action has been observed in the ATF Process. The reset is done automatically by the ATF_LSC_CMD_OUT control module.

ATF_LSC_STS_IN contains feedback tags that give insight into how the ATF Process is performing. P2 and F1 give instantaneous signals for diaphragm pressure and retentate flow rate. These signals are averaged in the PLC and included in the feedback tags as well as information on average percentage dwell and cycle counters.

11.6 Running In Dual Mode

This section discusses how to run XCell ATF Devices A and B together in dual mode. The devices can be configured to run in phase, out of phase or independently. Running the XCell ATF Devices out of phase is the most common approach as it minimizes the change in working volume in the bioreactor.

Table 26. Dual XCell ATF Device Control Tags

Tag Name	Tab
DX_IN_PHASE_CMD	ATF_LSC_CMD_OUT
DX_OUT_PHASE_CMD	ATF_LSC_CMD_OUT
DUAL_ERR	ATF_LSC_ALM_IN
DX_IN_PHASE	ATF_LSC_STS_IN
DX_OUT_PHASE	ATF_LSC_STS_IN
MODEL_DUAL	ATF_LSC_STS_IN

ATF_LSC_CMD_OUTUT lists all the necessary dual command and status tags. These can be used in accordance with the recommendations for the similar tags for single devices, except that they apply to running both XCell ATF Devices simultaneously.

1. Using the Dual tags, assign the XCell ATF Device size.
2. Set the devices to run in phase, out of phase, or in independent mode.Independent mode is achieved by setting both DX_IN_PHASE_CMD and DX_OUT_PHASE_CMD to 0.
3. Set a desired flowrate.
4. Start the XCell ATF Devices together using DX_START_CMD. The XCell ATF Devices will run through their initialization phases and start run mode together.
5. Stop the XCell ATF Devices by setting DX_STOP_CMD tag to 1.

DX_START_CMD, DX_PAUSE_CMD, and DX_STOP_CMD are all momentary tags in the PLC which means they need to be returned to 0 in DeltaV System after the action has been observed in the process.

11.7 Alarms and Advanced Statuses

ATF_LSC_ALM_IN contains XCell ATF System alarms. These alarms are calculated in the PLC code and can be used for troubleshooting. If desired, these alarms can be included into an alarm notification system within DeltaV System to alert operators of any operational issues. The ALARM_RESET_CMD tag in ATF_LSC_CMD_OUT is used to reset the alarms by setting it to 1 and then returning it to 0.

ATF_LSC_ADV_IN contains advanced status information that describes how the process is functioning. This includes details on the observed endpoints of the P2 curve, the quality of data exchange between the PLC and the flowmeters, the active mode, and event counters that track the events calculated within the XCell ATF System algorithm. This information is read-only and not necessary for basic control of the process.

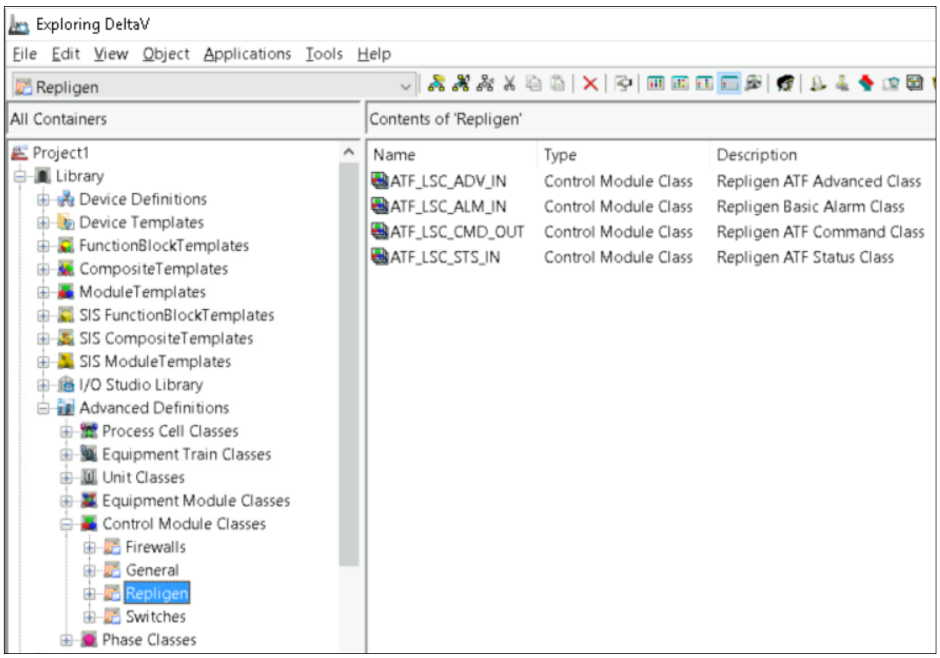
12. Detailed Example Instructions for Importing Ethernet Landing Module

This section provides detailed instructions to import and prepare an integration for a DeltaV PK Controller systems. The following example assumes that the DeltaV PK Controller is named "PKCTLR". If the PK Controller has a different name than the references to PKCTLR in each of the following files must be Replaced with the new name of the PK Controller. The Notepad text editor can be used to open the .fhx files and perform the Replace function on the files. Additionally, the XCell Controller IP address may need to be changed prior to performing this procedure based on customer Network addressing strategy.

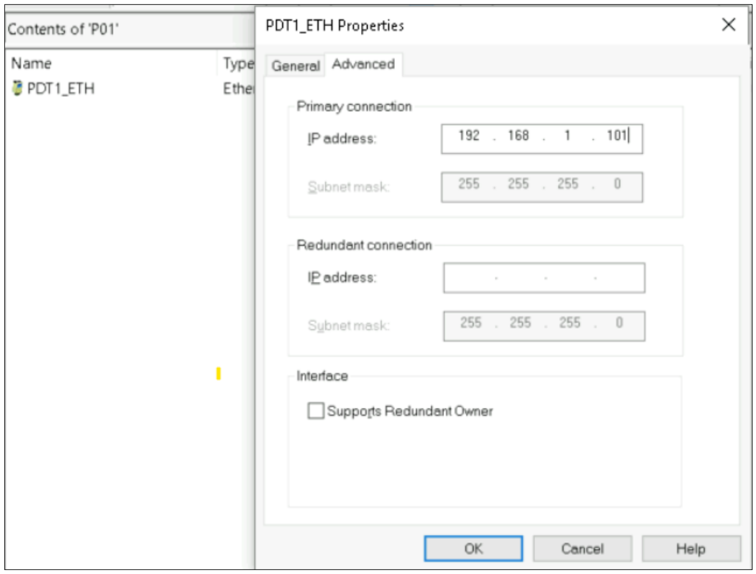
12.1 Importing the First XCell ATF System

Obtain the Landing module .fhx files listed below.

1. Copy the following files to the \DeltaV\DVData\Import-Export folder.
   Repligen.fhx
   ATF_LSC_ETH.fhx
   PDT1_ETH.fhx
2. From DeltaV Explorer select File-Import (use Standard DeltaV Format…) In the Import Dialogue window select the Repligen.fhx file and click the Open button. When the import is complete a new Category called Repligen should be found under the Library\Advanced Definitions\Control Module Classes containing four Control Module Classes.

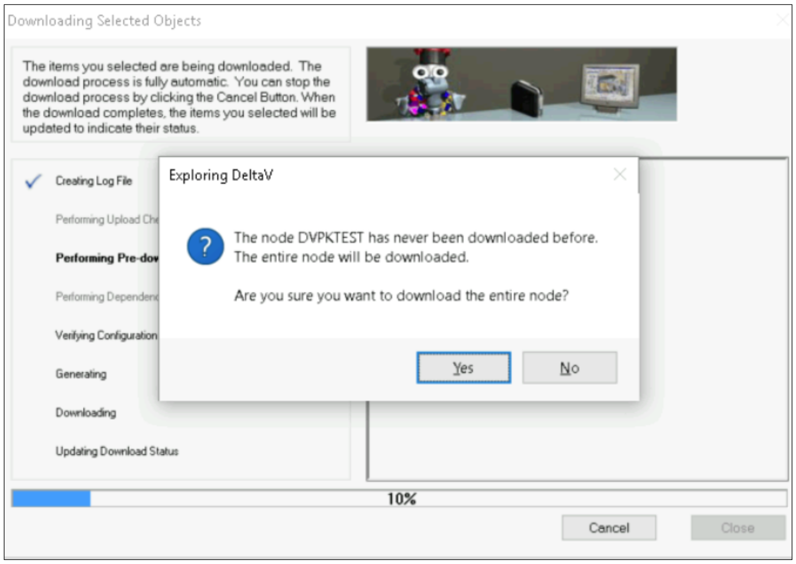


3. Import the PDT1_ETH.fhx. When the import is complete a new Ethernet I/O Physical Device will have been created under port P01 of the PK Controller. Change the IP address of PDT1_ETH to match the ATF Device under the Properties | Advanced tab. *Note: Factory Default IP address of XCell ATF Controller is 192.168.1.101. Consult user guide (XC-Lab-UG) to change the IP address of the PLC prior to this step if needed.*



4. Download the Ethernet I/O Port P01.

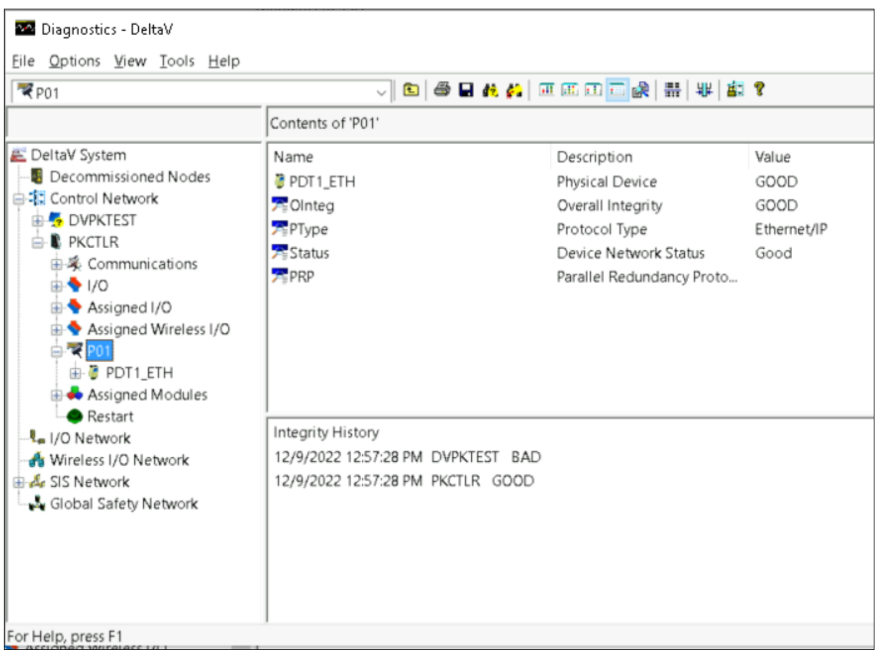
Note: *In new DeltaV PK controller installations, the following messages may be presented.*



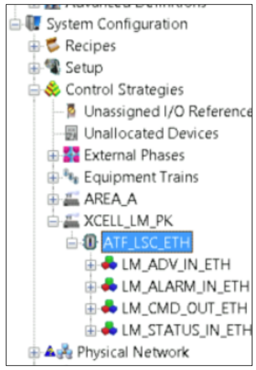
Select Yes to the entire node download.

Note: *The IP address should be in the same range/network address as Port P01 of the PK Controller under Ethernet I/O Port Properties | Advanced tab, i.e., 192.168.1.xxx.*

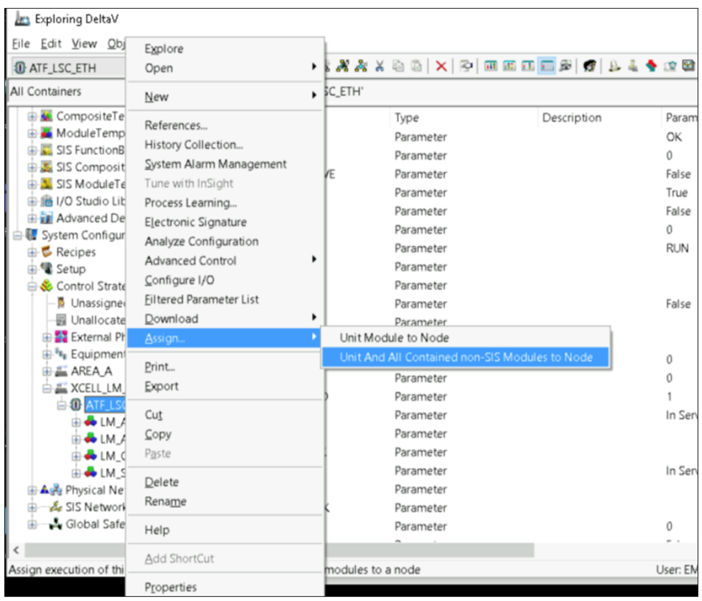
Check the communications using the DeltaV Diagnostics application.

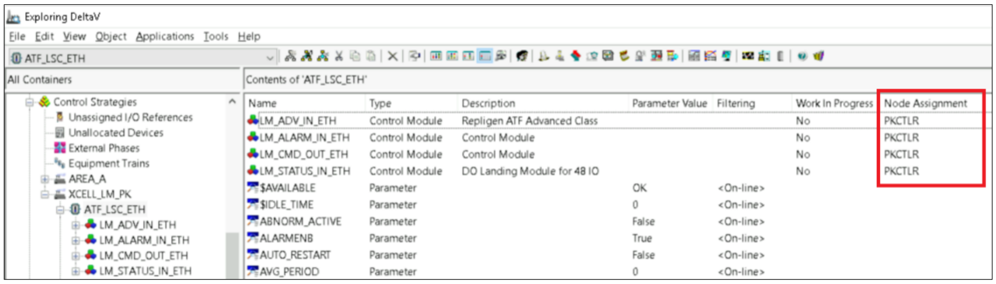


5. Import ATF_LSC_ETH.fhx as described in Step 2 above. When completed, a new Area (under System Configuration\Control Strategies\ is created) called XCELL_LM_PK an d one new Unit Module called ATF_LSC_ETH, containing four Control Modules, is created under the XCELL_LM_PK Area. As shown below.

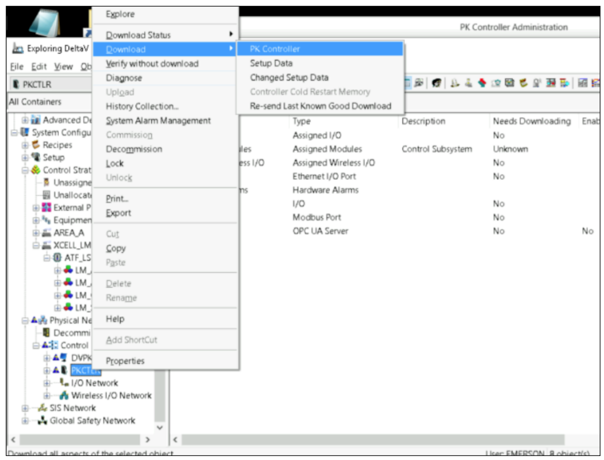


6. If needed, assign all Control Modules in the ATF_LSC_ETH Unit Module to the PK Controller by right clicking the Unit module, selecting Assign, then Unit, and All Contained non-SIS Modules to Node.
    a. Answer yes to prompts.
    b. Select PKCTLR
    c. Answer yes and OK.

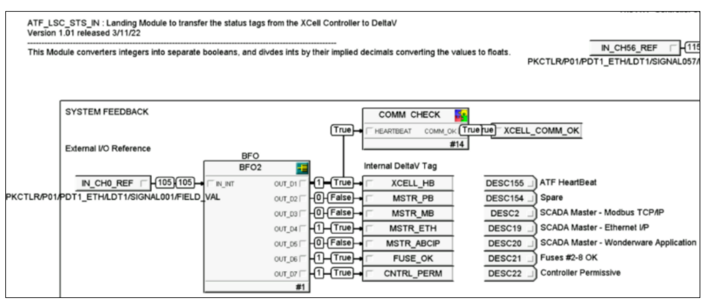




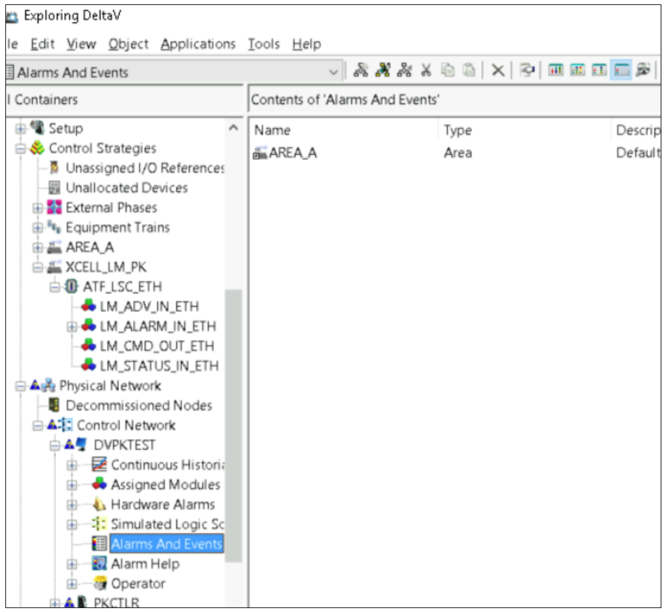
7. Download the PK Controller.



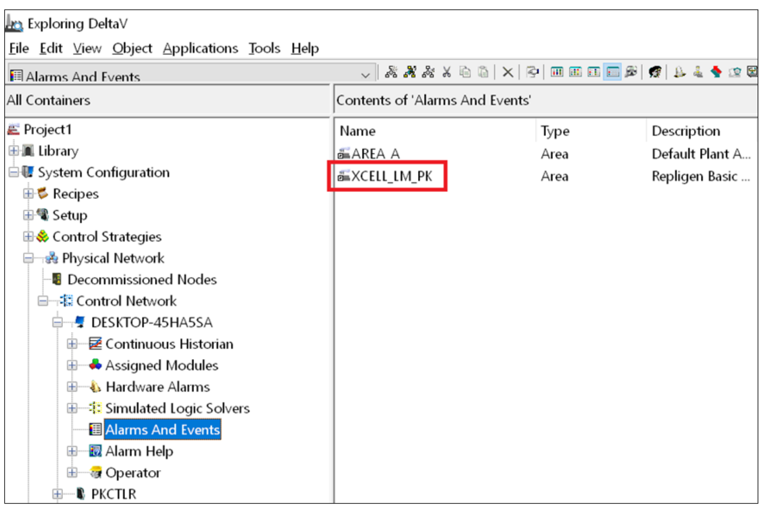
8. With the Repligen XCell ATF controller connected to the network open the LM_STATUS_IN_ETH Control Module Online in Control Studio and confirm the HeartBeat parameter, XCELL_HB, switch between 0 (False) and 1 (True, as shown below).



9. Ensure that the XCELL_LM_PK Area is assigned to the DeltaV ProPlus's Alarms And Events sub-system, as shown below, by dragging and dropping it into the Contents of 'Alarms And Events' window pane.
   a. First Select Alarms and Events as shown below:



b. Click on XCELL_LM_PK and drag it under AREA_A
c. Answer yes to both prompts. When complete, the Alarms and Events contains XCELL_LM_PK.



10. Download (Changed Setup Data) to the ProPlus workstation, DVPKTEST.
11. Test all 4 LM classes by opening each new Control Module Online with Control Studio; and confirm each is communicating with the controller. In this test, Control modules are listed in (a, b, c, &d) and tested in (e, f, g, & h):
    a. LM_ADV_IN_ETH (tested in step h)
    b. LM_ALARM_IN_ETH (tested in step g)
    c. LM_CMD_OUT_ETH (tested in steps e, g, & h)
    d. LM_STATUS_IN_ETH (tested in step f)
    e. In LM_CMD_OUT_ETH Confirm SCADA_HB and OUT_CH0_REF both switch between 0 and 1.
    f. After the controller recognizes that ethernet connection is in charge, In LM_STATUS_IN_ETH confirm MSTR_ETH is TRUE.
    g. In LM_CMD_OUT_ETH, with DX_OUT_PHASE_CMD set to TRUE, Confirm in LM_ALARM_IN_ETH that DUAL_ERR is TRUE. Then, reset DX_OUT_PHASE_CMD to FALSE, in LM_CMD_OUT_ETH and confirm in LM_ALARM_IN_ETH that DUAL_ERR is FALSE.

h. In LM_CMD_OUT_ETH, with FA_OPN_LOOP set to FALSE, Confirm in LM_ADV_IN_ETH that FA_OPNLPMD_ON is FALSE. Then, set FA_OPN_LOOP to TRUE, in LM_CMD_OUT_ETH and confirm in LM_ADV_IN_ETH that FA_OPNLPMD_ON is TRUE. (Be sure to reset FA_OPN_LOOP back to FALSE before proceeding with additional commissioning or testing)

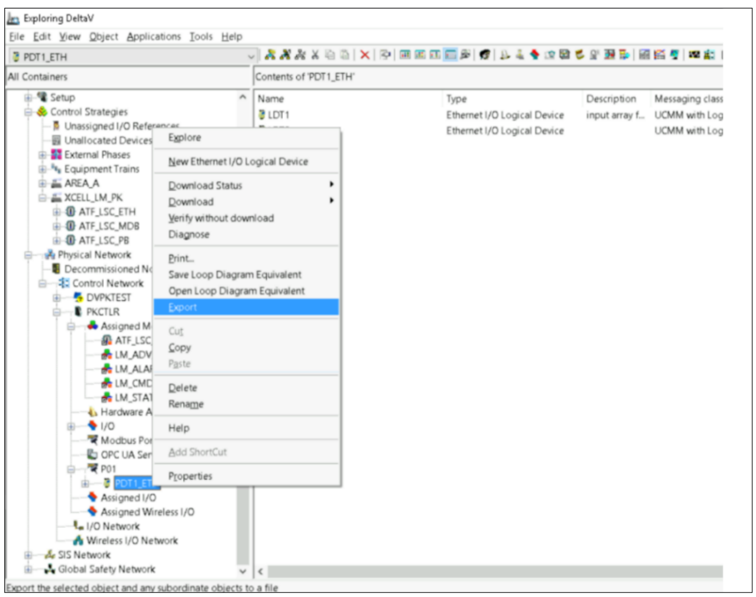
12.2 Add Second, Third, or …nth XCell ATF Physical Device Tag to Current PK Controller

Note: *nth current limit is based on PK controller size/type: PK controllers limit the number of devices possible based on their size: PK100=16 devices, PK300=32 devices, PK750=64 devices, PK1500=128 devices.*

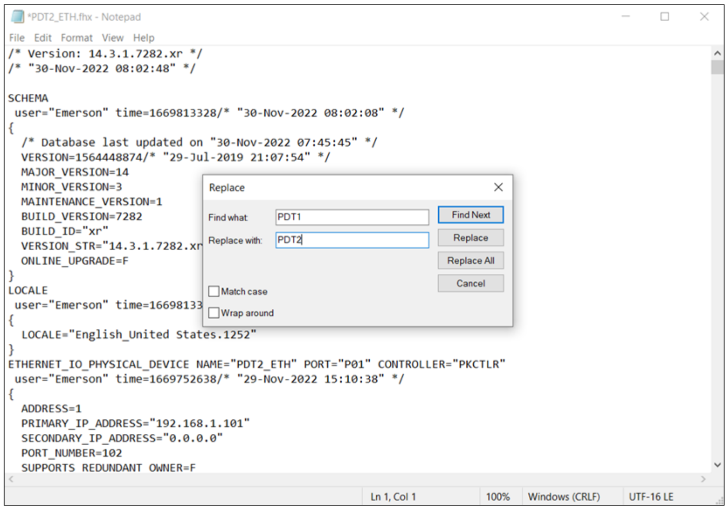
For this section, the following is needed:

a. A current communicating single XCell ATF Controller has been verified by the Step 11, above.
b. The new IP address in the same range as the existing XCell ATF Controller, i.e. 192.168.1.xxx.
c. Computer will use Microsoft Notepad (to search and replace text.)

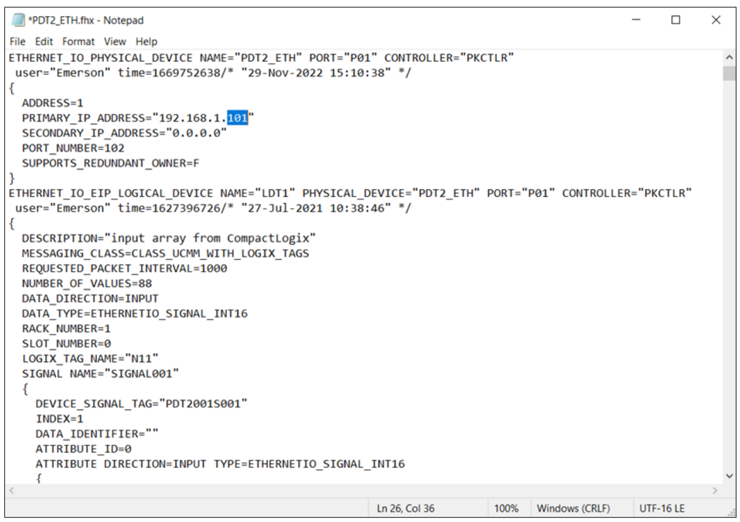
1. Open DeltaV Explorer and navigate to PKCTRL/P01/PDT1_ETH, highlight, right-click, and select Export.



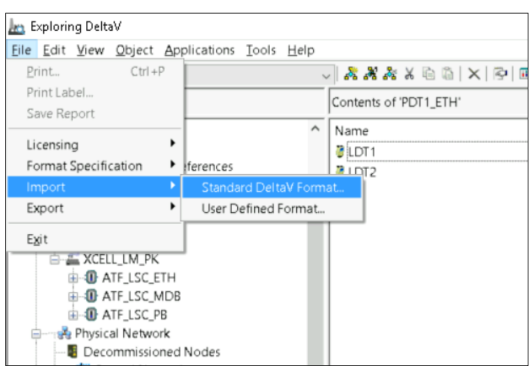
2. In the Export Dialogue window rename the file from PDT1_ETH.fhx to PDT2_ETH.fhx and save the file to the default \Import-Export folder.
3. Open the \Import-Export folder, right click the PDT2_ETH.fhx file, and open it in Notepad.exe.
4. Perform a Replace All on PDT1 to PDT2, as shown below, and Save the file.



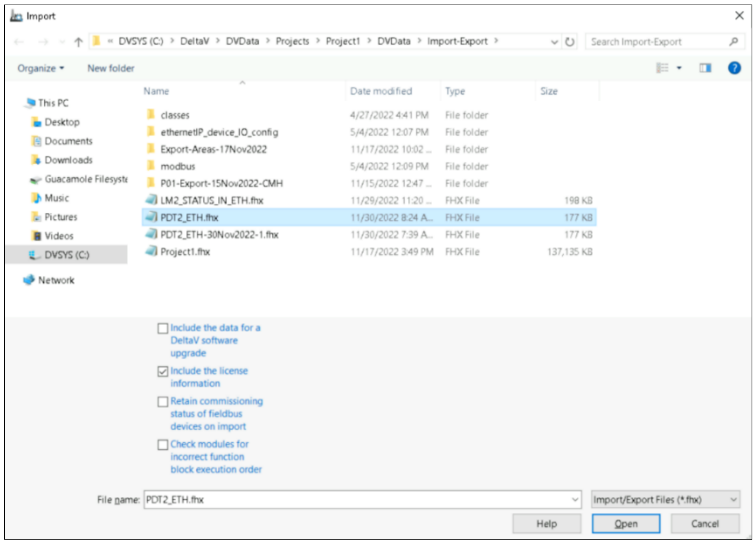
5. Change the IP address to reflect the IP of the new ATF Device, i.e. 192.168.1.102, as shown below, and Save the File.



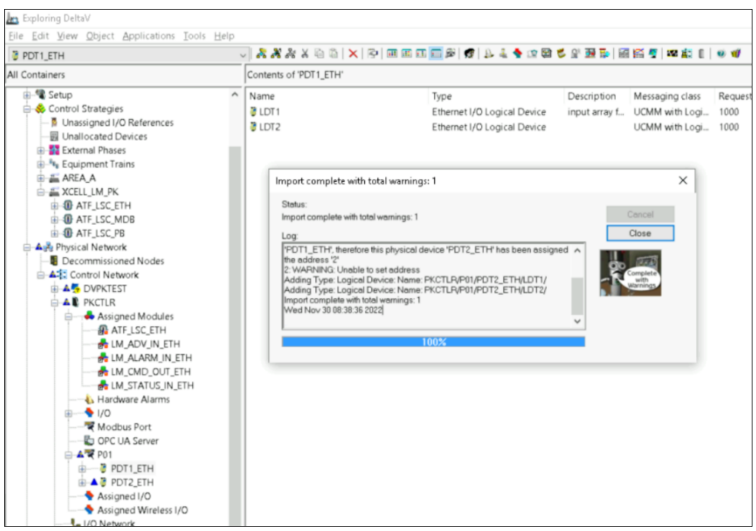
6. In DeltaV Explorer, select File-Import (Standard DeltaV Format).



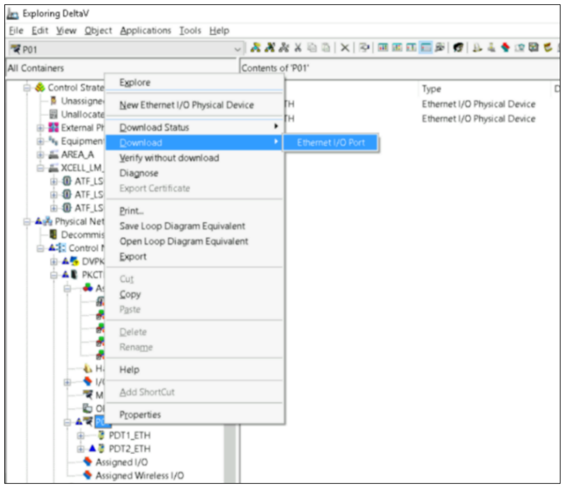
7. Select the newly modified PDT2_ETH.fhx file and click the Open button.



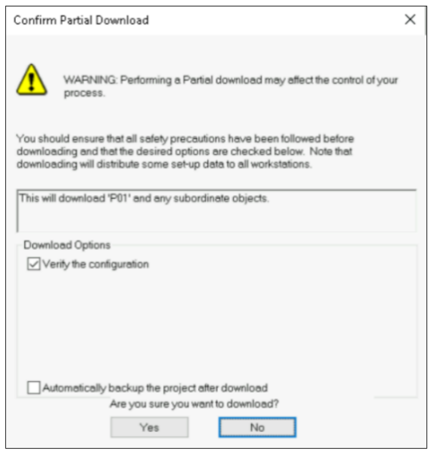
8. The resulting import should display the following:



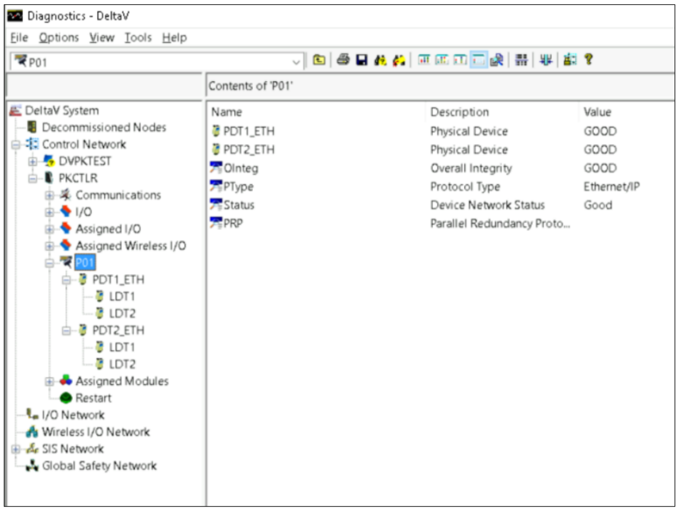
9. Disregard the Warnings about Address 1 and select Close.
10. Right click the port P01 under the PKCTLR controller and select Download (Ethernet I/O Port).



11. In the Confirm Partial Download Dialogue box click Yes.



12. Next check the communication status in DeltaV Diagnostics – by confirming GOOD values in PDT1_ETH and PDT2_ETH.

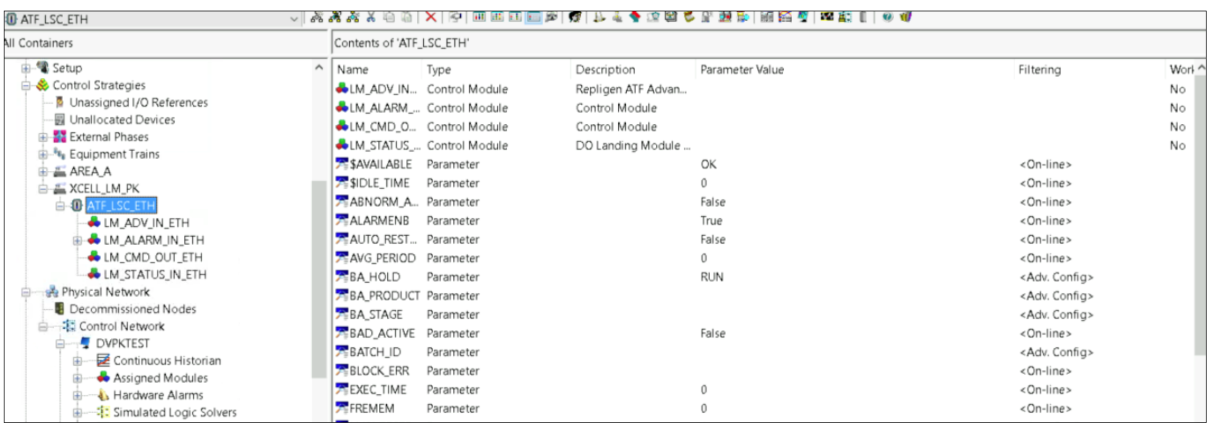


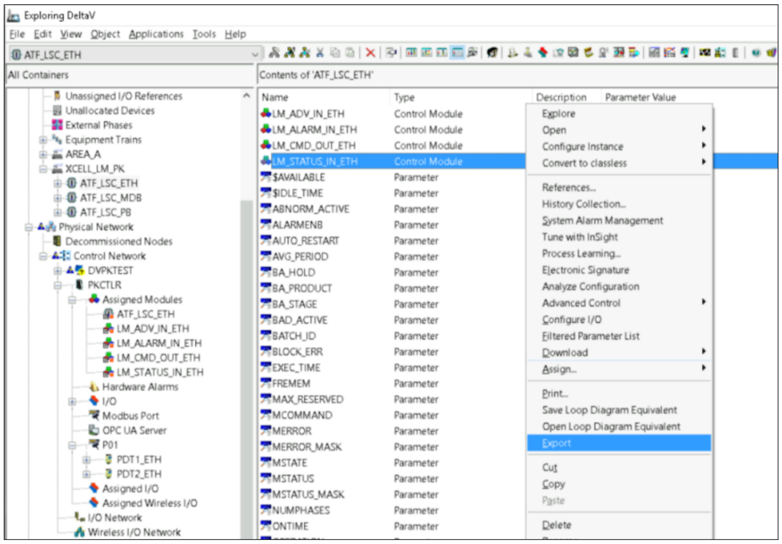
12.3 Add Second, Third, or …nth XCell ATF System to Current PK Controller

For this section, the following is needed:

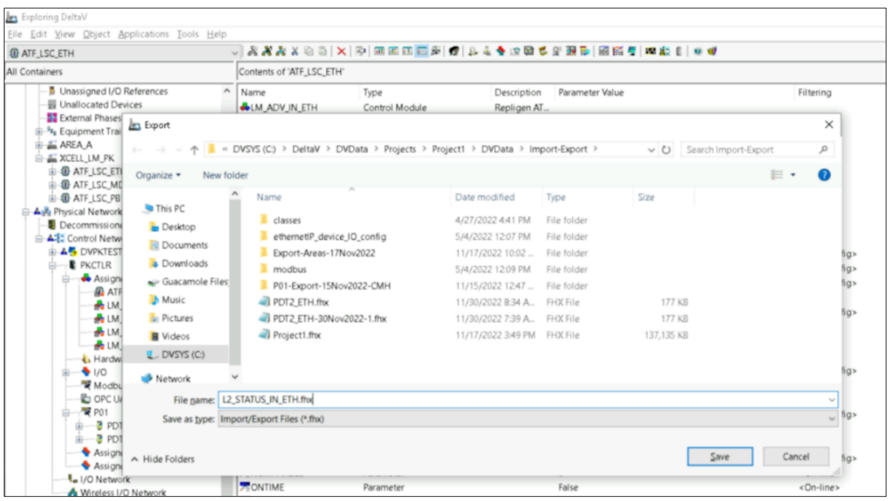
a. A currently communicating single XCell ATF Controller which has been verified by the Step 12, above.
b. Existing, functioning Landing Modules are loaded on the PK controller.
c. A computer which can use Microsoft Notepad (to search and replace text.)

1. From DeltaV Explorer select the Landing Module from the ATF_LSC_ETH Unit Module; highlight, right-click, and select Export.

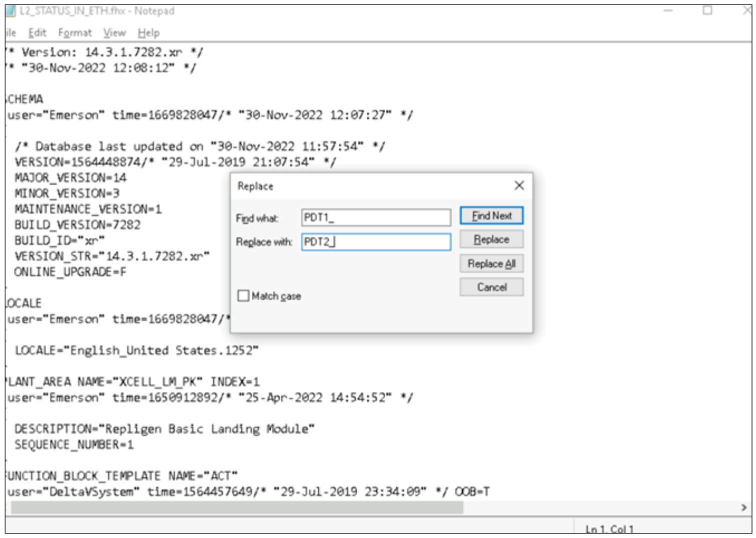




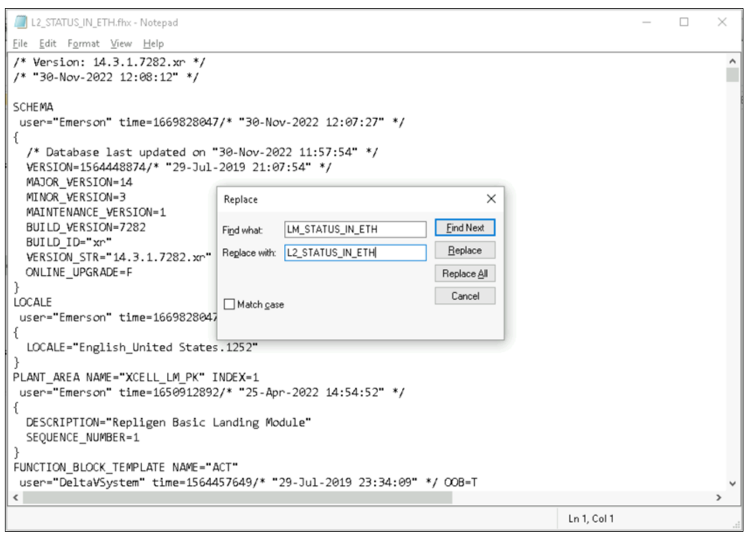
1. Close the dialog box after exporting.
2. In the Export Dialogue window rename the .fhx (module names have a 16-character limit), and Save.
    a. L2_STATUS_IN_ETH.fhx



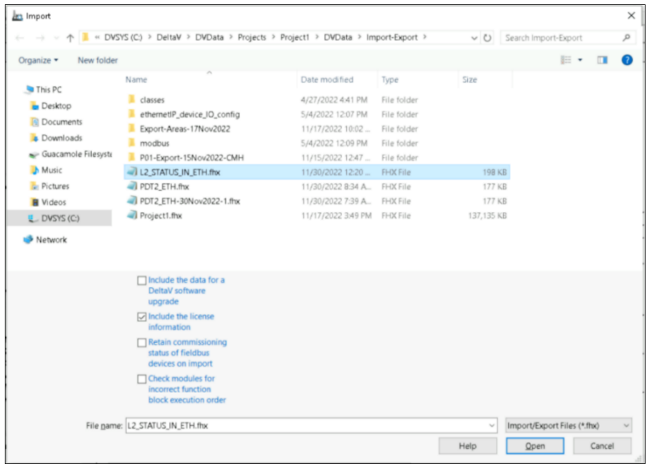
3. Open the \Import-Export folder where the file was saved, right-click, and open the file in Notepad.
    a. Perform a Replace All on PDT1_ to PDT2_ , as shown below. (Ctrl-H)



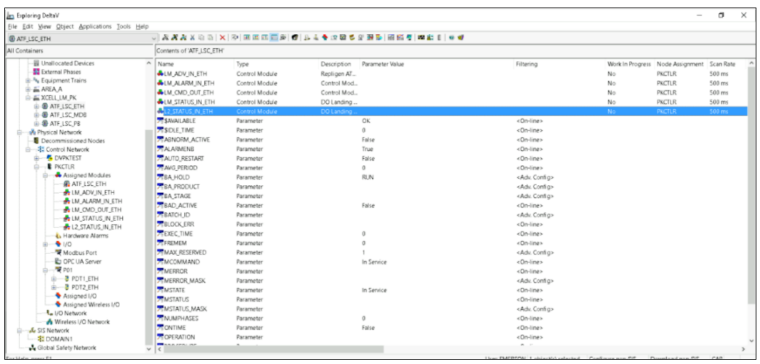
b. Replace All of LM_STATUS_IN_ETH to L2_STATUS_IN_ETH , Save the file and close it.



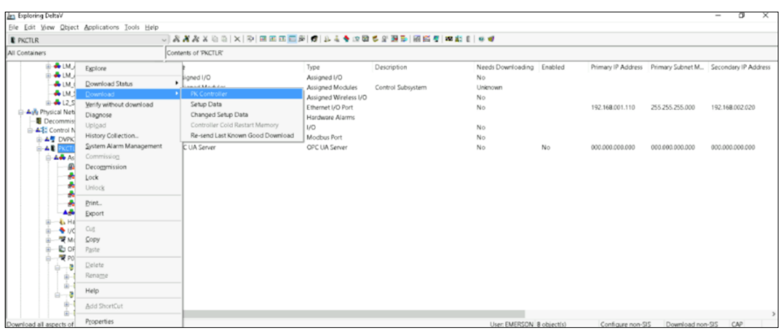
4. In DeltaV Explorer, select File-Import (Standard DeltaV Format). Then select the .fhx file that was just modified and click Open.



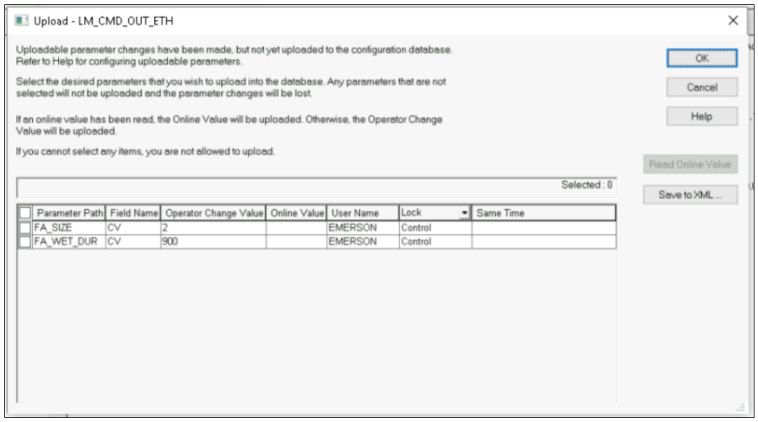
5. The new Landing Module should appear in the ATF_LSC_ETH Unit Module.



6. Download the controller.

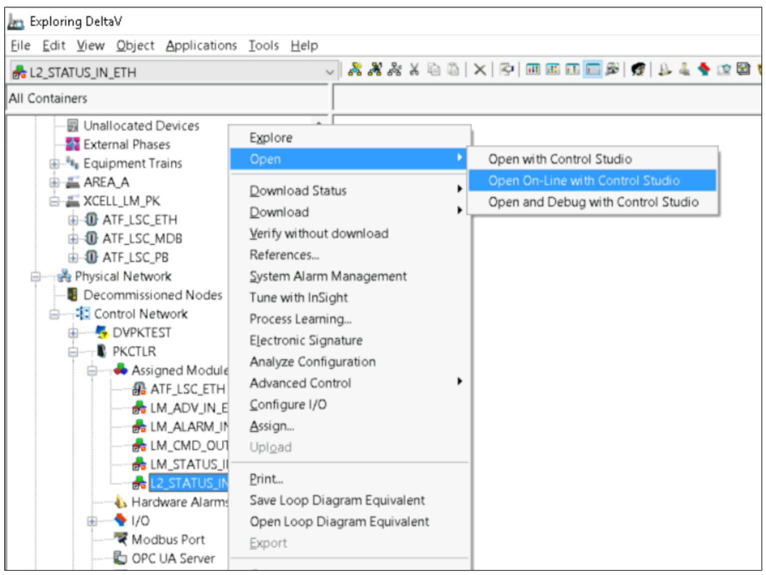


   a. If an upload pop-up is displayed, select cancel button, and the close button.

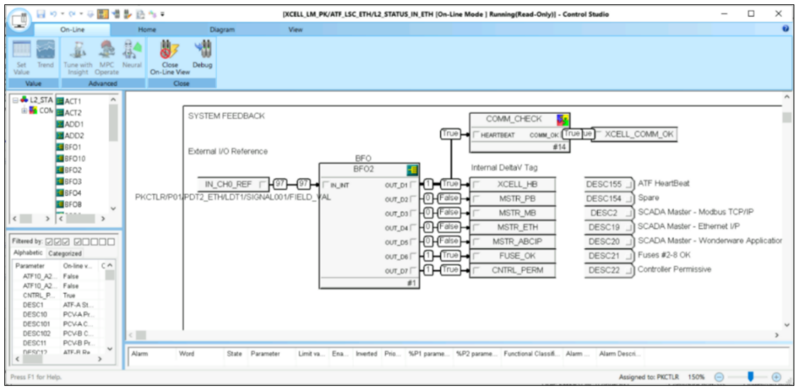


b. Then select Yes to confirm total download.

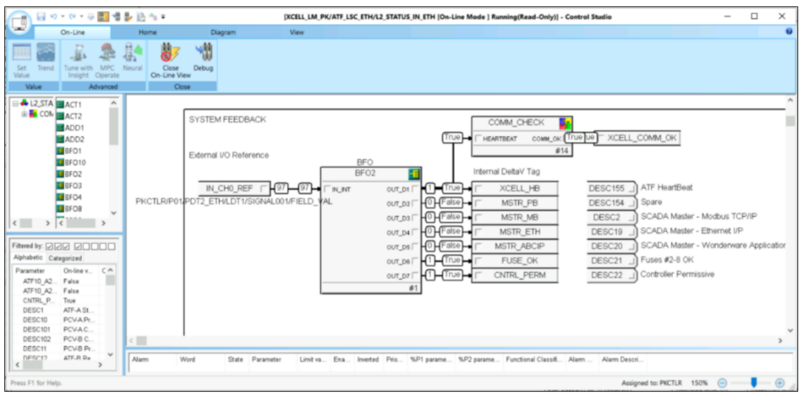
7. Open the newly downloaded Control Module Online with Control Studio by right-clicking on it and select Open (Open On-Line with Control Studio).



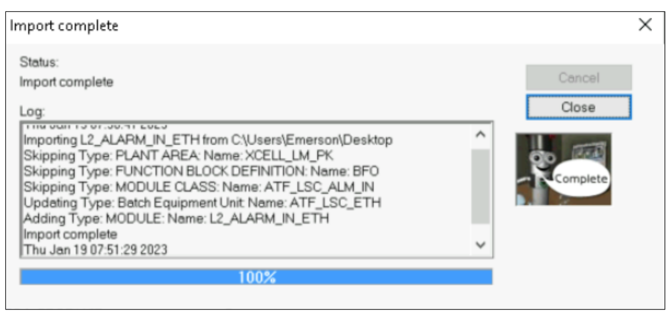
Verify the Heartbeat function. (Value switches between 0 and 1).



8. Repeat (steps 1-7) for other 3 landing modules.
    a. Select yes to all if prompted to update the existing object ATF_LSC_ETH



    b. Import complete message appears.

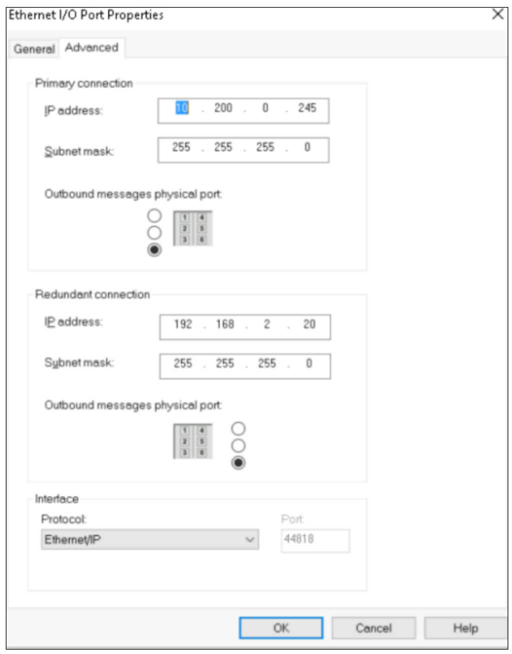


9. Download (Changed Setup Data) to the ProPlus workstation, DVPKTEST.
10. Test each new controller LM classes by opening each new Control Module Online with Control Studio; and confirm each is communicating with the controller. In this test, Control modules are listed in (a, b, c, &d) and tested in (e, f, g, & h):
    a. L2_ADV_IN_ETH (tested in step h)
    b. L2_ALARM_IN_ETH (tested in step g)
    c. L2_CMD_OUT_ETH (tested in steps e, g, & h)
    d. L2_STATUS_IN_ETH (tested in step f)
    e. In L2_CMD_OUT_ETH Confirm SCADA_HB and OUT_CH0_REF both switch between 0 and 1.
    f. After the controller recognizes that ethernet connection is in charge, In L2_STATUS_IN_ETH confirm MSTR_ETH is TRUE.

g. In L2_CMD_OUT_ETH, with DX_OUT_PHASE_CMD set to TRUE, Confirm in L2_ALARM_IN_ETH that DUAL_ERR is TRUE. Then, reset DX_OUT_PHASE_CMD to FALSE, in L2_CMD_OUT_ETH and confirm in L2_ALARM_IN_ETH that DUAL_ERR is FALSE.
h. In L2_CMD_OUT_ETH, with FA_OPN_LOOP set to FALSE, Confirm in L2_ADV_IN_ETH that FA_OPNLPMD_ON is FALSE. Then, set FA_OPN_LOOP to TRUE, in L2_CMD_OUT_ETH and confirm in L2_ADV_IN_ETH that FA_OPNLPMD_ON is TRUE. (Be sure to reset FA_OPN_LOOP back to FALSE before proceeding with additional commissioning or testing).

13. Changing IP Addresses for XCell ATF Systems on Current PK Controller

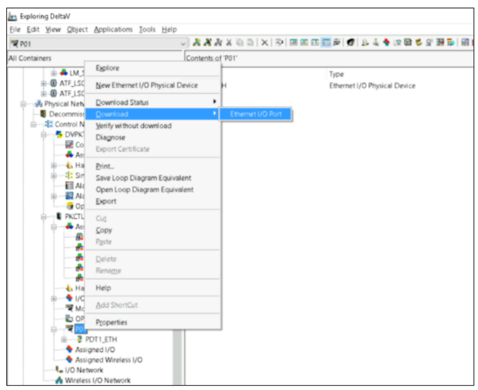
1. In DeltaV Explorer right-click on the P01under the PK Controller and select Properties, then select the Advanced tab.



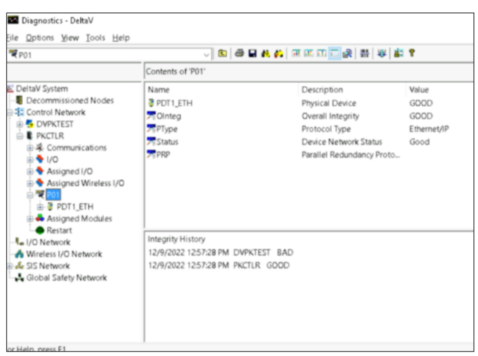
2. Change the Primary Connection IP Address to an unused address on the network.
3. Right-click on the Physical Device Tag, PDT1_ETH, and select Properties, then click the Advanced tab. Change the Primary Connection IP Address to the ATF IP address in the same range.

Note: *XCell ATF Devices do not currently support a Redundant Connection.*

4. Right-click the PK Controller’s P01 Port and select Download (Ethernet I/O Port).



5. Check the communications using the DeltaV Diagnostics application.



14. Recommendations for HMI Development

HMI design is specific to the standards and preferences of the end-user DeltaV System. Repligen recommends using this integration guide as a starting point for the HMI development, with I/O list and the tag descriptions as the primary input for interface development.

In addition to this integration guide, The XCell Lab Controllers User Guide includes screenshots for the Repligen Wonderware-based local HMI.

15. References

15.1 EtherNet/IP

15.2 DeltaV™ PK Controller

15.3 M-series Virtual I/O Module 2

15.4 S-series Virtual I/O Module 2

15.5 Ethernet I/O Card (EIOC)

15.6 FactoryTalk Linx

16. Index

Customer Service

Repligen Corporation
41 Seyon Street
Waltham, MA, USA 02453

customerserviceUS@repligen.com

(781) 250-0111

Document Number:UG-5255
Revision: 1
Effective Date: 7/30/2024
Legacy Document #: N/A