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**PLC5/ControlNet Redundant Driver
Programmable Serial Interface Card
Series 2**

USER MANUAL

March 2009

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1 INTRODUCTION

1.1 Scope

This document is the Design Document for the PLC5/ControlNet redundant communications driver firmware for the Emerson Process Management (EPM) DeltaV Control System. The driver will run in the DeltaV Series 2 Programmable Serial Interface Card (PSIC). The reader should be familiar with EPM’s DeltaV PSIC and connected PLC devices.

1.2 Document Format

This document is organized as follows:

Table 1

Introduction	Describes the scope and purpose of this document.
Theory of Operation	Provides a general functional overview of the ControlNet Driver.
Downloading Firmware	Describes downloading procedures for the ControlNet Driver firmware on to the DeltaV PSIC.
Configuration Information	Describes procedures and guidelines for configuring the DeltaV PSIC.
Operational Check	Provides tips and assistance to ensure PSIC is properly setup and configured.
DeltaV–Field Device Electrical Interface	Describes the electrical interface between DeltaV and the PLC5/ControlNet devices. Also describes the cable pin assignments for RS-232.
Technical Support	Describes who to call if you need assistance.
Example	Describes how to configure a device with input and output datasets.



1.3 System Specifications

The following table lists the minimum system requirements for the driver:

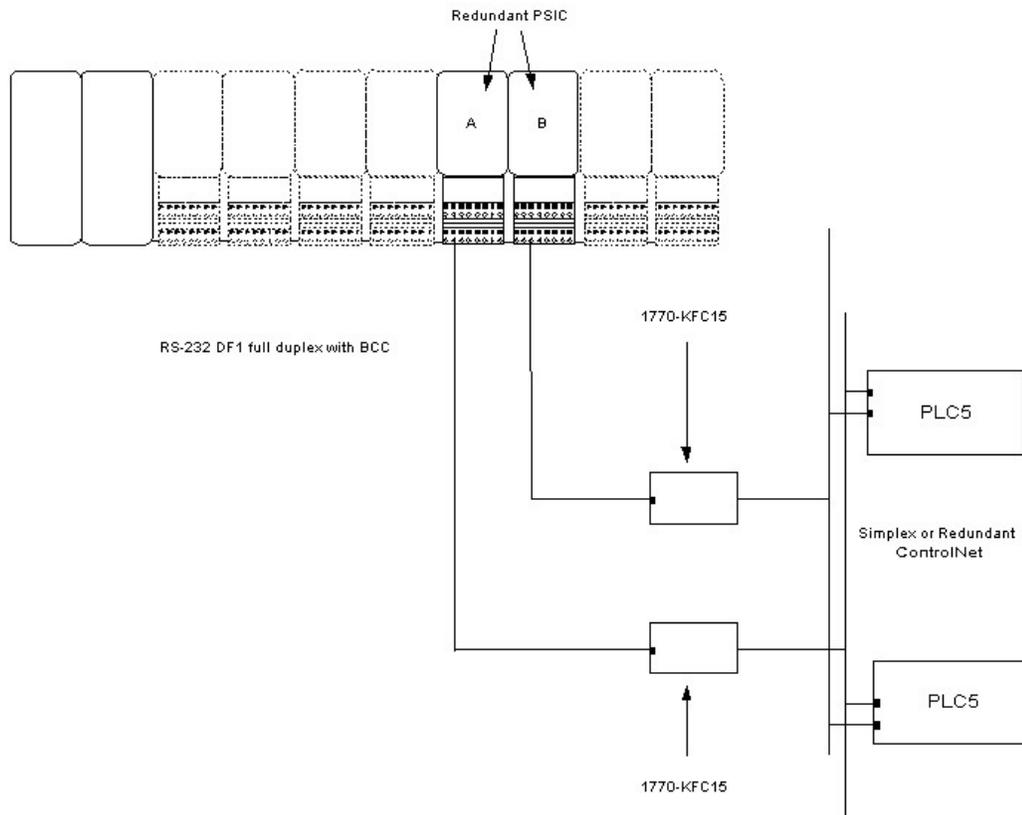
Protocol Compatibility and Reference documents	The communication protocol used will be Allen Bradley DF1 as documented in Rockwell Cat. No. 1770-6.5.16. PLC5/ControlNet Hot Backup User Manual, Rockwell Cat. No. 1785-CHBM.
Software Requirements	DeltaV System Software (Release 6.3.2 or later) installed on a hardware-appropriate Windows workstation configured as a ProfessionalPlus for DeltaV Serial Interface Port License (VE4102)
Minimum DeltaV Hardware Requirements	FRSI DeltaV Serial Interface Series 2, Hardware PN: 12P2506X022 FRSI DeltaV M3, M5, MD or MD+ Controller, Power Supply and 2 wide controller carrier FRSI 8 wide I/O card carrier



2 THEORY OF OPERATION

The Programmable Serial Interface Card (PSIC) has 2 ports which can be configured for RS-232, RS-422/RS-485 Half Duplex or RS-422/RS-485 Full Duplex communications with external devices.

For communications with PLC5/ControlNet devices, the PSIC will connect with 1770-KFC15 gateway modules. The driver will utilize only port 1 of the PSIC. Port 2 will be configured, but it will not be connected to any external device. The datasets of both port 1 and 2 (maximum available is 32, 16 under each port) will be considered as a single database. This is illustrated below.





The DeltaV Serial Card Driver functionality required is:

1. Serial card redundancy for the Railbus;
2. Hot backup management for the connected PLC5/ControlNet devices.

Serial card redundancy

Serial card redundancy shall comprise 2 DeltaV serial cards working together as primary and secondary. Switchover from primary to secondary (or side switch) shall be provided based on the following criteria:

1. User command from DeltaV Diagnostics;
2. Error response in Status file read from both PLC's;
3. Port Timeout/No Response from connected PLC's;
4. Port Timeout/No Response from KFC15 module; and
5. KFC15 cannot communicate with the PLC's.

As normal operation of the PSIC, the primary card will communicate with the currently selected/designated primary PLC via the KFC15. For a detailed description of normal primary PSIC communications, please see General Operation section.

The secondary card will continuously ping the KFC15 and Hot Backup PLC. Failure to communicate will cause the secondary PSIC to assert an error. This error will be visible in DeltaV diagnostics as Secondary Unavailable. In this state, side switchover will not be available.

Hot Backup Management

Background – DeltaV PSIC driver assumes that it is communicating to a single device with a unique station address. However, Allen Bradley redundant processors do not have the same station address. When a switchover occurs between PLC processors, the station address is not swapped. Consequently, the DeltaV PSIC driver must swap the PLC station address in its general data I/O communications. Otherwise, it will be communicating with the wrong PLC. This requires special handling in the PSIC driver, based on data read from the PLC Backup and Configuration Status File.

Each ControlNet processor of a redundant pair has a “ControlNet Backup Configuration and Status file” (see the Allen Bradley ControlNet PLC-5 Hot Backup System user manual, publication 1785-CHBM, January 2003). This is a 200-word integer file (see page 5-8 of the user manual). Word 3 of this file is the “backup state” of the PLC processor. The DeltaV PSIC driver must read the status file in both PLC processors. Based on values read, the PSIC must then select the “primary” PLC processor address for general data I/O communications.

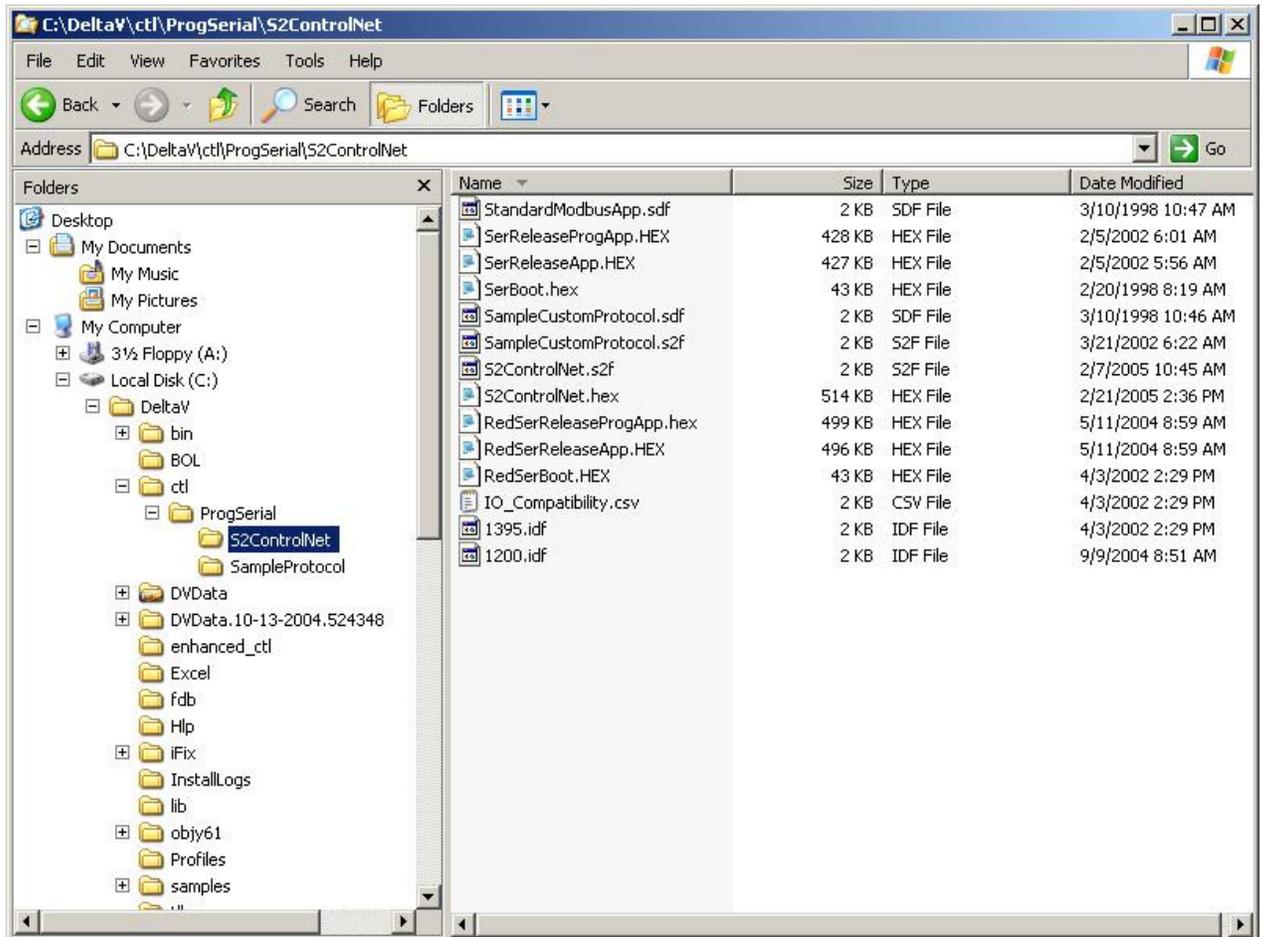


3 Downloading the firmware

The driver software distribution comprises 14 files, distributed on a CD. These files must be copied to the DeltaV directory on your ProPlus Workstation. The path is:

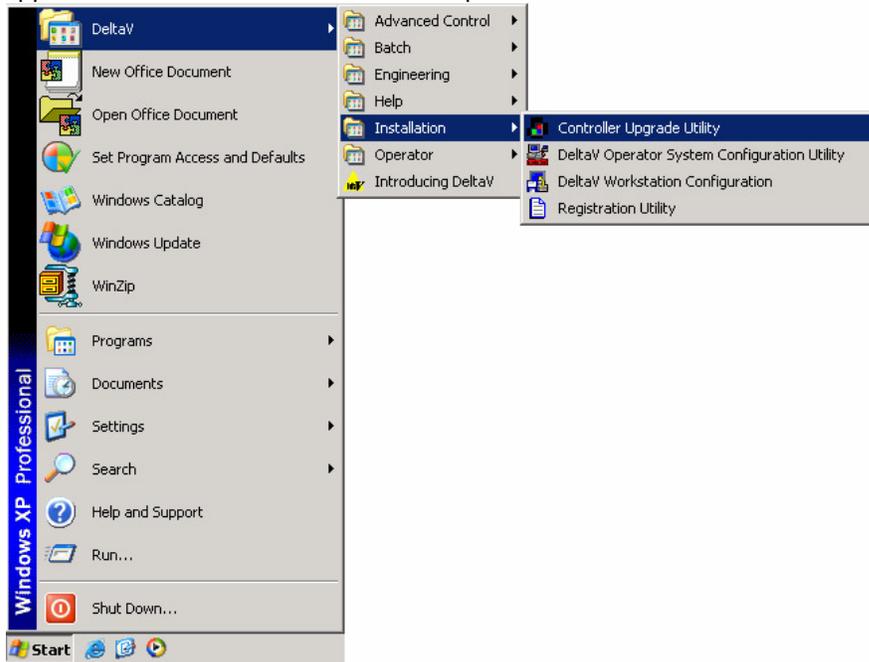
\DeltaV\ctl\ProgSerial\S2ControlNet

Note that you will have to create the \S2ControlNet subdirectory. The following files will be copied:

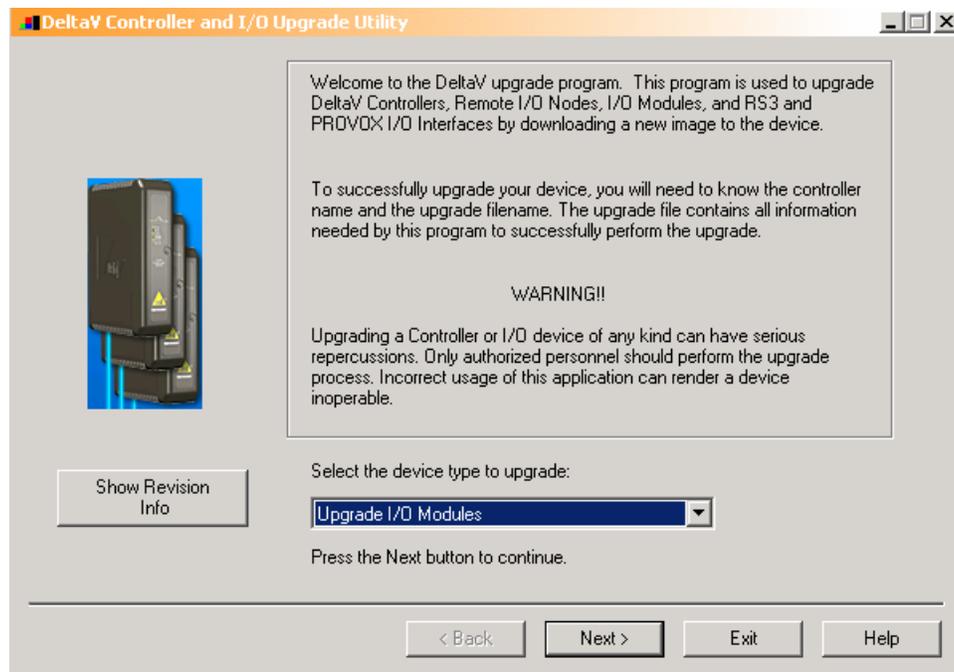




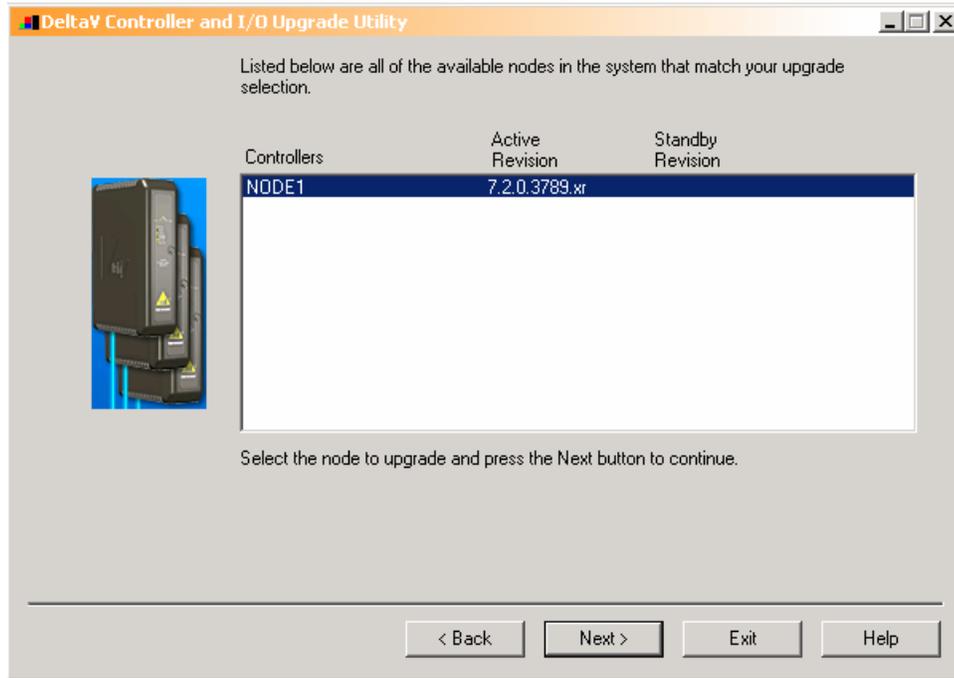
After copy completion, you are ready to program (or upgrade) the Programmable Serial Card with the supplied custom driver software. The steps are as follows:



1. Click on the Start button and select DeltaV-> Installation-> Controller Upgrade Utility as shown below, and the following dialog will appear:

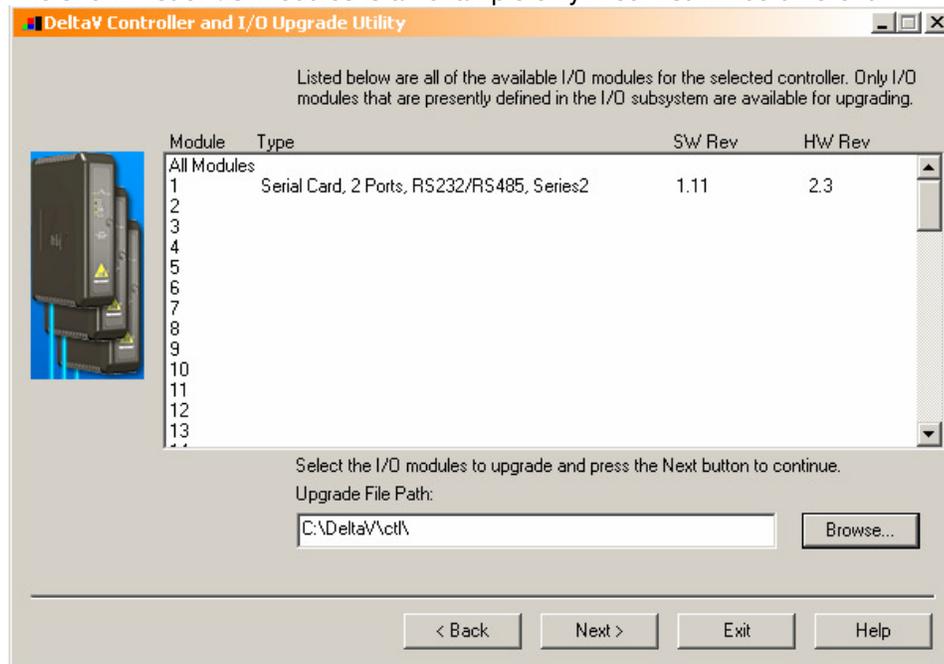


2. Choose Upgrade I/O Modules from the drop down menu and click Next.

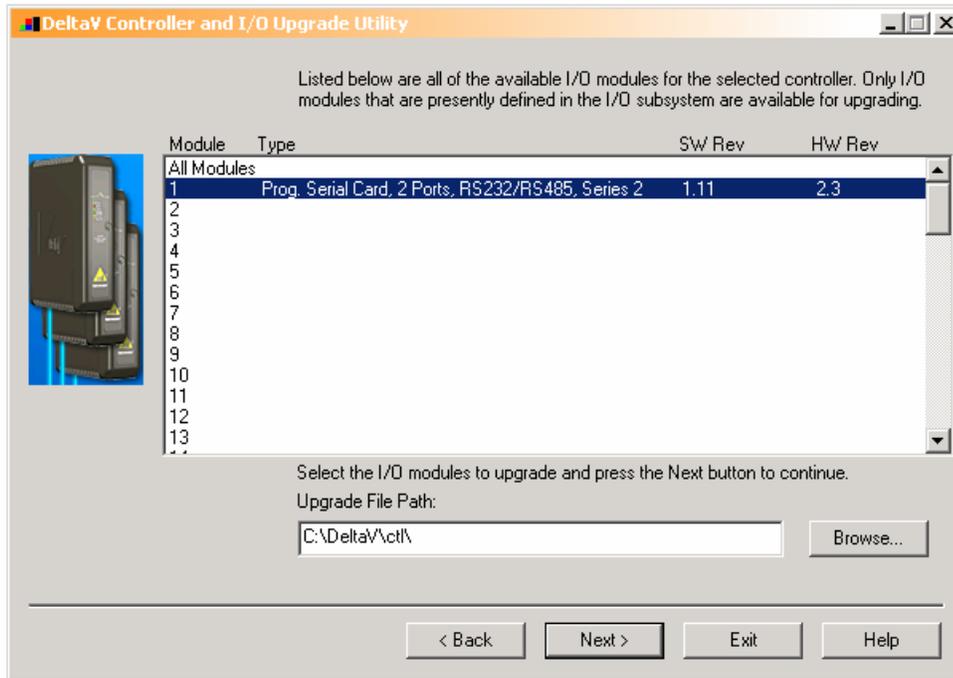


3. The above dialog will appear, listing all the available Controllers in your network. From this dialog, select the appropriate Controller and then Click Next.

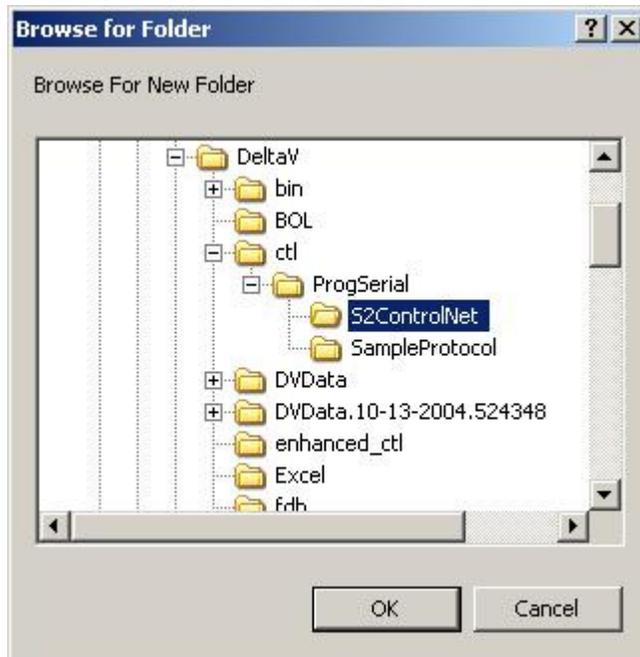
4. The following dialog will appear, listing all the I/O modules in your selected Controller. The shown list of I/O modules is an example only. Your list will be different.



Note: The first time a standard Serial card is upgraded to the ControlNet Driver, the dialog will be as shown below. When upgrading an existing Programmable Serial Card, skip Steps 4, 5 and 6, and go to Step 7.

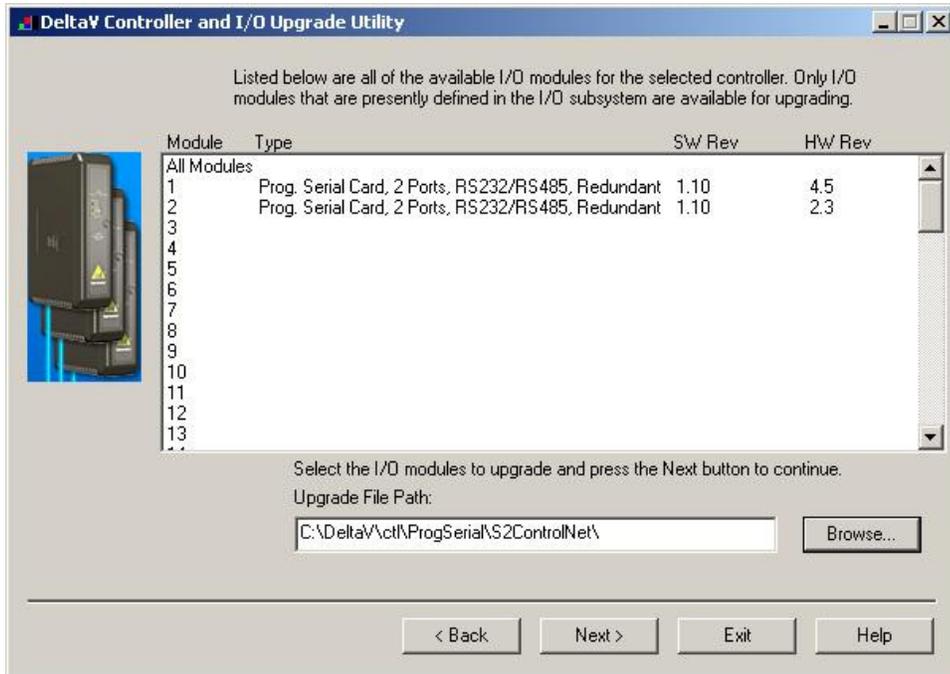


5. Click the Browse button and select the DeltaV path as shown below, and then click Ok. Note that the disk drive could be C or D.

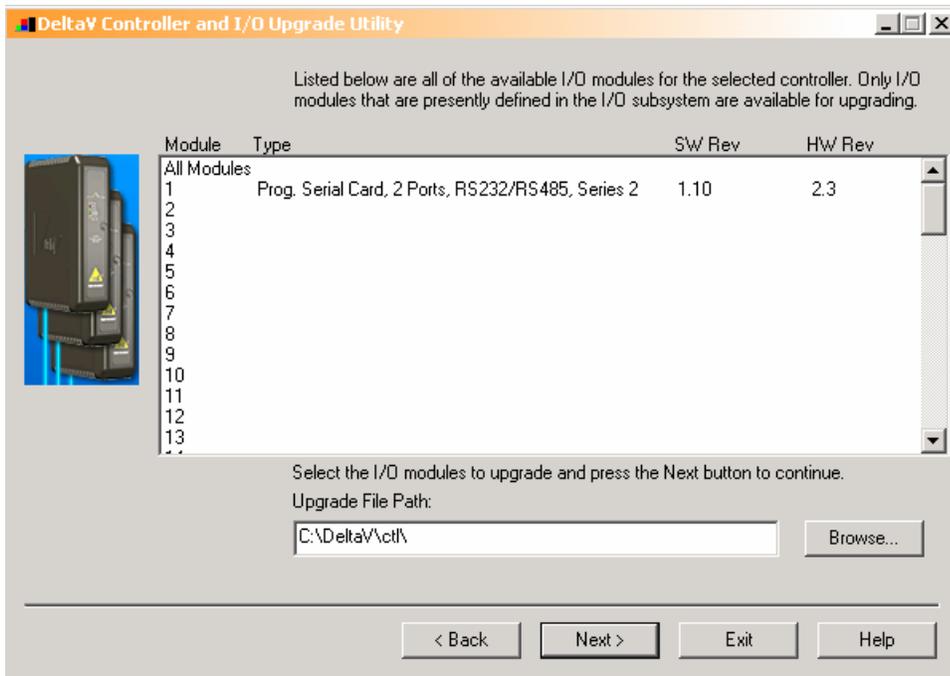




6. Select the I/O module again as shown below and then click Next. Go to Step 9.



7. If you are upgrading an existing Programmable Serial Card, the dialog will be as shown below. From this dialog, select the Programmable Serial Card I/O Module in the list.





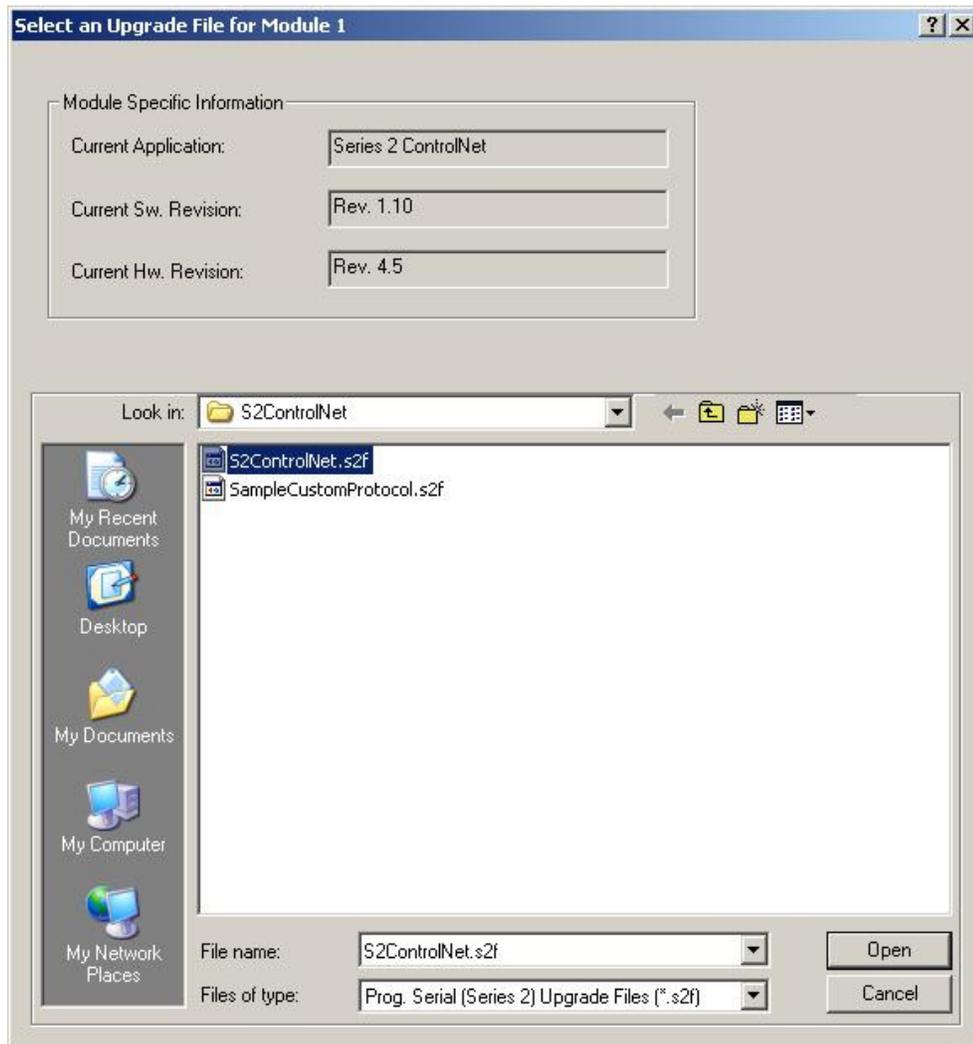
For example, we will select I/O Module 1. This will give you a dialog, from which you will select the file path to where the driver software is located. This path will be:

\Delta\ct\ProgSerial \S2ControlNet

Once you are in the specified directory, you will need to select the following file:

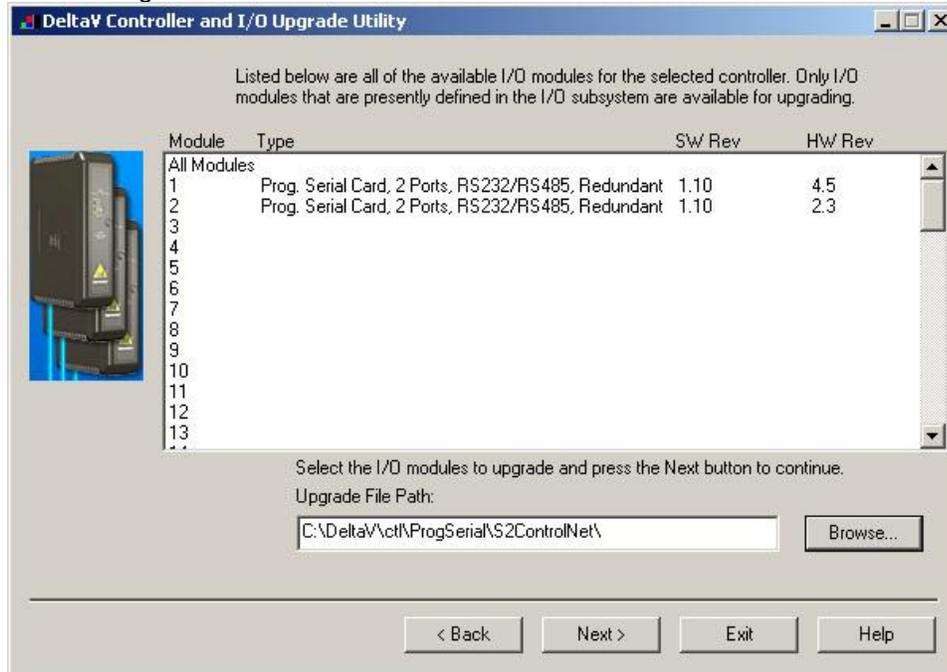
S2ControlNet.S2F

This is shown in the following dialog.

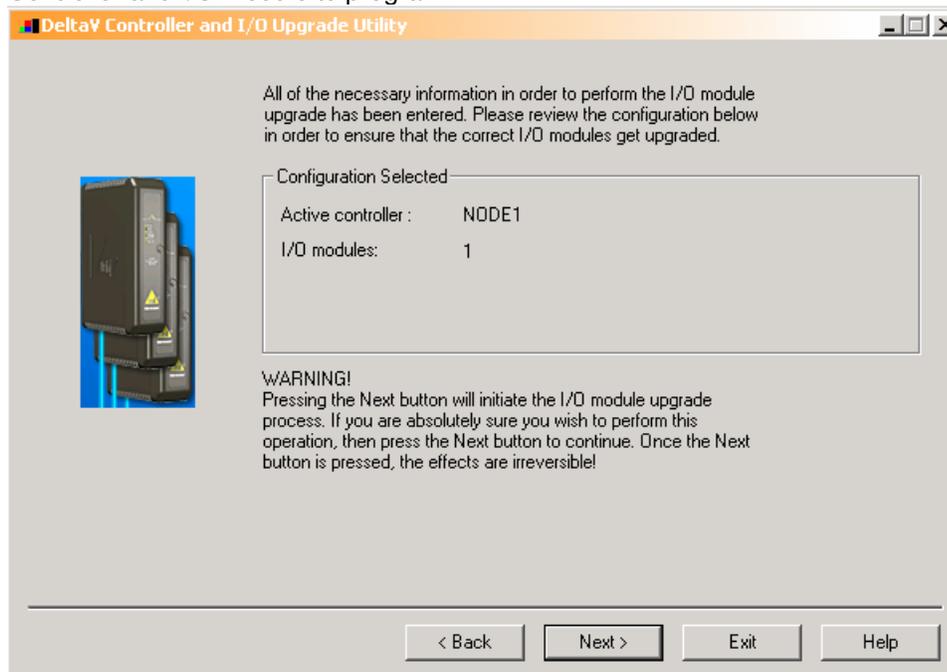




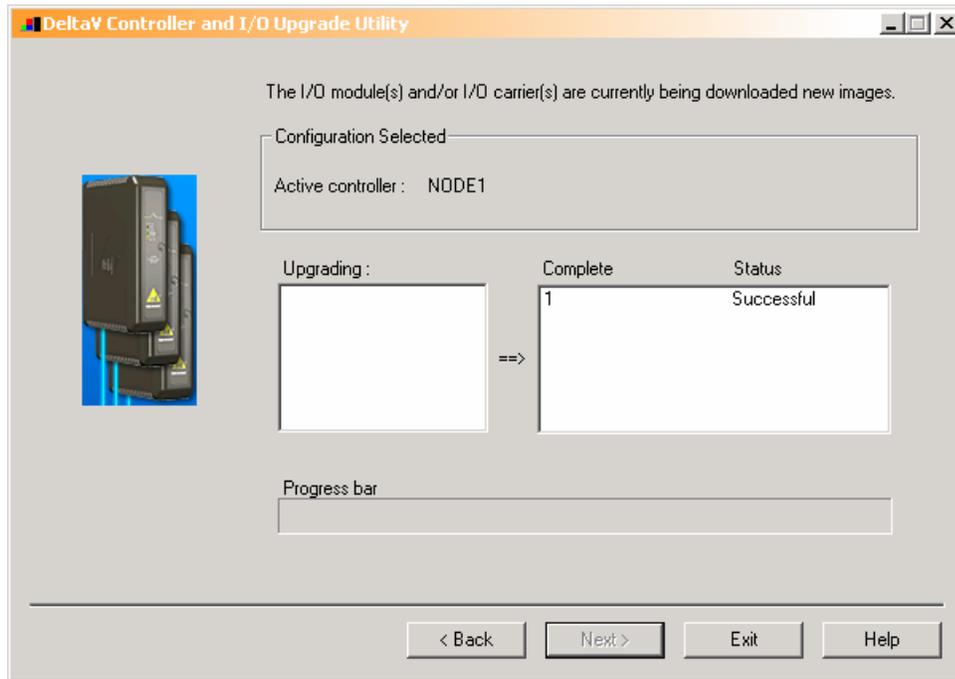
8. After selecting the .S2F file, Click on Open. This dialog will close and you will be back to the following:



9. In this dialog, Click Next again. You will get the following dialog, confirming the Controller and I/O Module to program.



10. Click Next and the I/O Module upgrade process will begin. After completion, you will receive the following dialog, indicating success.



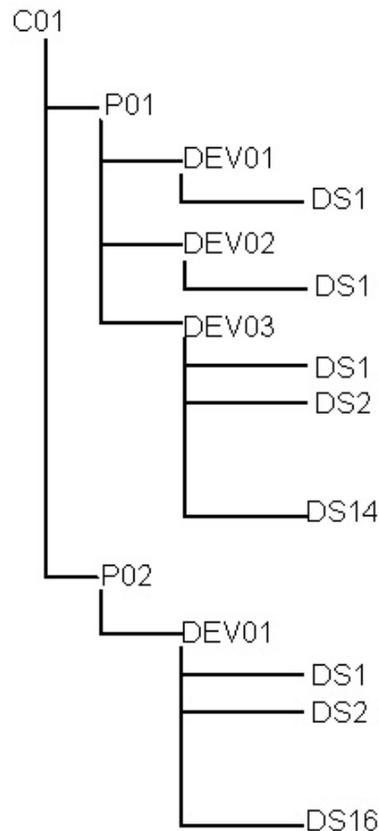
11. This completes the I/O Module upgrade process.



4 CONFIGURATION INFORMATION

Under each port, there exist 16 datasets. Dataset 1 and 2 of port 1 are used as special control datasets. The remaining 14 datasets are available for general data communications. All 16 available datasets under port 2 are used for general data communications. If port 2 datasets are not required, they can be left un-configured and the port disabled.

The primary PSIC continuously polls the configured datasets in order, starting with dataset 1. Upon reaching the highest configured dataset, the PSIC returns to dataset 1 and repeats the polling sequence again. This polling repeats indefinitely. The DeltaV card configuration will be as shown below:



Under port P01, device DEV01 shall be configured with the (odd) address of the target PLC. The dataset under DEV01 shall be configured to read the PLC Status file. The dataset shall have 31 16-bit UINT word registers. Out of the 31 registers read, only words 3, 7, 12 and 31 shall be used. The remaining registers are informational only.

Under port P01, device DEV02 shall be configured with the (even) address of the target PLC. The dataset under DEV01 shall be configured to read the PLC Status file. The dataset shall have 31 16-bit UINT word registers. Out of the 31 registers read, only words 3, 7, 12 and 31 shall be used. The remaining registers are informational only.



Status file word 3 has the following values:

0	Invalid
1	No Control
2	Primary
4	Secondary

Status file word 7 has the following values:

0	No Partner found
1	Partner available

Status file word 12 has the following values:

0	No designated Primary (default)
1	PLC with odd address is the designated primary

The status data read for datasets 1 and 2 will allow the PSIC to choose the station address of the currently designated primary PLC. The PSIC chooses the appropriate PLC address for general data I/O communications. The PSIC shall choose the PLC address after the poll of dataset 2 and before the poll of dataset 3.

This continuous reading of the PLC Status files by the primary PSIC shall comprise the "ping".

The Secondary PSIC shall send the PLC Diagnostic command to the PLC's. The response will allow the PSIC to verify PLC availability. If the secondary PSIC fails to communicate with the PLC's, DeltaV shall assert the "Standby Unavailable" error.

Choosing the PLC address:

The device address assigned under DEV03 under P01 and DEV01 under P02 will be ignored by the serial card. Only DEV01 and DEV02 under P01 will be used to select the primary PLC address.

The following cases shall be examined to select the PLC address.

Case 1:

**IF ((DEV01.DS1.R3 = 2) AND ((DEV02.DS1.R3 <> 2) OR (DEV02.DS1 has Fault))) THEN
The PLC address configured in DEV01 is selected**

Case 2:

**IF ((DEV02.DS1.R3 = 2) AND ((DEV01.DS1.R3 <> 2) OR (DEV01.DS1 has Fault))) THEN
The PLC address configured in DEV02 is selected**

Case 3:

**IF (((DEV01.DS1.R3 = 2) AND (DEV02.DS1.R3 = 2)) OR ((DEV01.DS1.R3 = 4) AND (DEV02.DS1.R3 = 4))) THEN
IF ((DEV01.DS1.R12 = 1) OR (DEV02.DS1.R12 = 1)) THEN
The PLC with the odd configured address is selected**



Case 4:
IF ((DEV01.DS1 has Fault) AND (DEV02.DS1 has Fault)) THEN
No Field Communications – Do Switchover

Failure to Choose a PLC address:

If a PLC address cannot be chosen because the register values are in an indeterminable state, then the PSIC can optionally force a new Primary PLC. This will be done by first examining register 7 and 12 of the status file. If register 7 indicates Partner Available and register 12 indicates No Designated Partner, the PSIC will write a non-zero value to register 31 of the Status file. This will force a switchover to a new Primary PLC, triggering Status registers to update.

The PSIC then aborts the current polling sequence and resume polling with DEV01, dataset 1. This polling mechanism continues until a PLC address is chosen.

NOTE: "ABORT THE POLL SEQUENCE" MEANS THE PSIC RESTARTS THE POLL SEQUENCE AT BLOCK 1 AND POLLS ONLY DEV01/DS1 AND DEV02/DS1 UNTIL ONE AND ONLY ONE OF THESE TWO BLOCKS INDICATE 'PRIMARY'.

4.1 Port Configuration

All communications will take place through port 1 only. If additional datasets are required outside of the 16 available under port 1, port 2 may be enabled. If port 2 is enabled, all configured port 2 datasets will use port 1 for communications. No data will be transmitted using port 2.

4.2 Device Configuration

Specify devices, as shown above. For port 1 there should be 3 devices defined. If port 2 is used only 1 device should be defined. As shown above, the device address will be chosen from Device 1 or Device 2 based on the status words. The device address selected in Device 3 and Device 1 on port 2 are ignored by the driver.

4.3 Dataset Configuration

Channel Attributes Block

For the PSIC configuration, there is one channel attributes block per Dataset. There can be up to 16 Datasets configured per port for a total of 32 Channel Attribute Blocks per Serial Card. Each Channel Attribute Block contains all the configuration information for a single configured PSIC Dataset.

The four following attributes are unique to the Allen-Bradley Data Highway serial card. All other values are as per the standard serial interface card. Information for the standard serial interface card can be found in *DeltaV Books Online*, under the title "Using Serial Data Control Strategies".



Attribute	Defined Values
<i>DeviceDataType</i>	0 = PLC-5 Typed (Logical ASCII Addressing) 1 = PLC-5 Ranged (Logical ASCII Addressing) 2 = Diagnostic 3 = PLC-5 Read-Mod-Write (Logical ASCII Addressing) 4 = PLC-5 Typed (Logical Binary Addressing) 5 = PLC-5 Ranged (Logical Binary Addressing) 6 = PLC-5 Read-Mod-Write (Logical Binary Addressing)
<i>SpecialData1</i> <i>(PLC-5 File Type)</i>	This Field is "Don't Care" for DeviceDataType 0-3, and 6 0 = Output File Type, O 1 = Input File Type, I 2 = Status File Type, S 3 = Binary File Type, B 4 = Timer File Type, T 5 = Counter File Type, C 6 = Control File Type, R 7 = Integer File Type, N 8 = Floating File Type, F
<i>SpecialData2</i> <i>(PLC-5 File Number)</i>	0 – 65535 file number 0 - 8 are reserved to match with file types in SpecialData1
<i>SpecialData3</i>	Specify 0 for DF1 with Full Duplex and BCC Specify 1 for DF1 with Half Duplex and CRC



4.3.1 Data Direction:

The dataset under Device 1 and Device 2 should always be defined as input. The others are user-defined.

4.3.2 Output Mode and Readback:

Two output modes are available in the driver: block output (0) and single output (1). In typed or ranged transaction (DeviceDataType 0,1,4, and 5), the block output mode writes the entire data block for every output data value change. Therefore, it is undesirable to contain any foreign-device-controlled (device other than DeltaV) values within the block. For example, if a PLC-5 memory N7:5 is written by a PLC-2, and user defines a Dataset with a range of N7:0 to N7:10 in block output mode, an output operation will overwrite the N7:5 with the value in the DeltaV database.

Single output mode allows individual value to be sent out, leaving other values in the Dataset unaffected. In the binary file type, word value is treated as a single value. It does not allow user to write a specific bit within a word. Therefore, the entire 16 bit will be written when a single discrete output value changes. When communication with a PLC-5, writing single bit values in a multi-bit Dataset can be achieved with Read-Modify-Write (RMW) transaction (DeviceDataType 3 and 6). The RMW is used only with binary file type and single output mode. Each bit can be set or reset within a binary file without affecting other bits in the same word.

4.3.3 DeltaV Data Type:

This attribute defines how data will be stored in the DeltaV dataset.

PLC Data Type	Available DeltaV Data Types	Access	Restrictions
O – Table B - Table	Boolean with Status Discrete with Status	R/W	a. 16-bit aligned dataset Start Address. For example: 0, 16, 32, etc. b. Number of values is multiple of 16, and refers to bits. Maximum 96 registers. Each dataset register is a bit.
	16-bit Int with Status 16-bit Uint with Status	R/W	Maximum registers are 100. Starting address is any 16-bit word.
I – Table	Boolean with Status Discrete with Status	R	a. 16-bit aligned dataset Start Address. For example: 0, 16, 32, etc. b. Number of values is multiple of 16, and refers to bits. Maximum 96 registers. Each dataset register is a bit.
	16-bit Int with Status 16-bit Uint with Status	R	Maximum registers are 100. Starting address is any 16-bit word.
N-Table	16-bit Int with Status 16-bit Uint with Status	R/W	Maximum registers are 100. Starting address is any 16-bit word.
F-Table	Floating Point with Status	R/W	Maximum registers are 50. Starting address is any floating point register.

4.3.4 DeviceDataType

This attribute defines what type of transaction will be performed for the Dataset between the PSIC and the Allen-Bradley device. Values from 0 to 11 are listed in the above table. They are briefly described below:

Types 0 (Typed Transaction with ASCII addressing) and 4 (Typed Transaction with binary addressing):

The typed transactions treat each data type as an element and automatically adjust the memory address to accommodate the defined element type. Therefore, the starting address points to different memory location depending on the data type. It points to the word address for integer data and double word address for floating point data.

For Binary data type, it points to the word, not the bit, address within the Binary file. The number of element denotes the number of bits to be included in the Dataset starting at the specified word address. The bit position is relative to the starting word address. Therefore, every seventeenth bit will start at the next word. For example, a starting address of 8 with 32 elements means the Dataset starts at the eighth word in the binary file and contains 32 bits. The seventeenth bit will start at the ninth word. The bit position in the PLC is specified by a slash (/) after the word address. Therefore, the first bit in the above Dataset has an address of B3:8/0. Although each Dataset can contain 100 elements, it is recommended that the maximum number to be 96 to ensure the Dataset ends on a word address boundary.

Both single and block output modes are supported for integer, binary, and floating point file type.

Types 1 (Ranged Transaction with ASCII addressing) and 5 (Ranged Transaction with binary addressing):

Unlike Typed operations that automatically adjust the memory address to accommodate the defined element type, the Ranged operations use word address exclusively. It performs consecutive memory word read and write. The driver takes care of address adjustment for floating point file type, making it transparent to the user and DeltaV. Therefore, the Ranged operation on integer, binary, and floating point file types are the same as the Typed operation.

Both single and block output modes are supported for integer, binary, and floating point file type.

Unlike the Typed read which only accesses the accumulator or position attribute, the Ranged read always starts at the first attribute and includes all three attributes in the data file.

Types 3 (Read-Modify-Write with ASCII addressing) and 6 (Read-Modify-Write with binary addressing):

When communicating with a PLC-5, Read-Modify-Write (RMW) is used to set/reset a single bit in the binary file. User can set any bit in the Dataset. It is different from writing to the binary file with Typed write. The Typed write will write all 16 bits in the word. The RMW let user write a single bit in any word, leaving other bit unaffected. The block output mode is not supported in RMW. Therefore, single output mode (1) must be used with RMW.

RMW is for output only. The data direction parameter in the Dataset configuration must be "output". Configuring RMW as input or checking the "Output Read Back" box in output mode will cause an error and undesirable results.



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Notes:

- DeviceDataTypes 3 and 6 are only valid with file type 3 and output mode 1.
- Output Modes : 0- block output; 1- single data output
- PLC 5/XX Binary File Types only work in output mode 0, block outputs. To write single bit values in a multi-bit dataset use DeviceDataType 3 or 6 with output mode 1.
- Floating Point file types, 32-bit Integer, and 32-bit unsigned Integer require 2 16-bit registers per value, thus reducing the registers per dataset to 50 (maximum 16-bit registers per dataset is 100).
- When addressing registers, DeltaV PSIC register numbers are 1 based, whereas PLC-5 registers are 0 based.



4 Operational Check

5.1 Scope

The following sections provide some assistance to ensure the interface is working properly.

5.2 Verify Hardware and Software Version Number

The user can verify that the ControlNet driver has been installed using the DeltaV Diagnostics tool. The Diagnostics tool will show the Hardware Revision No. (HwRev) and the Software Revision No. (SwRev).

To begin the DeltaV Diagnostic tool select Start-> DeltaV-> Operator-> Diagnostics. In the Diagnostics tool expand the Controller, I/O and then double click on the Programmable Serial Interface Card that has the driver installed.

The following information will be displayed:

:	:	:
HwRev	Hardware Revision	1.10 (or later)
SwRev	Software Revision	2.3 (or later)

5.3 Verify Configuration

- Verify port configuration: The serial port must be enabled. User needs to make sure communication settings such as baud rate, parity, and number of data bits match the Allen-Bradley device settings.
- Verify device configuration: User must check for the proper device address is entered. The Allen-Bradley device address is an octal-based number. This number must be converted to a decimal number.
- Verify Dataset configuration: The RMW operations are output-only commands. Do not configure input Dataset with RMW. The DeltaV data type also needs to match with Allen-Bradley data types. For example, user should not match a DeltaV 16-bit unsigned integer with a PLC-5 floating point file data. Unpredictable results will occur if there is a mismatch between the two data types. The starting address should always be an even number to ensure proper word boundary is assigned. For Special Data 2, number 0 through 8 must match the default Allen-Bradley file types.



5.4 Verify I/O Communication With Control Studio

- User can create I/O modules in the control studio to verify correct values are read and written between the foreign device into the PSIC. For input data, the values should be changed in the foreign device and verified that the new data are correctly reported. For output data, change the values in the controller and then verify that the values are transferred to the foreign device.
- To assign a Dataset and a register in the Dataset to an I/O module, follow these steps:
 1. Double click the IO_IN/IO_OUT parameter for the module. This brings up the IO_IN/IO_OUT Property window.
 2. Click on the Browse button. This brings up the Browse window.
 3. Click on the Object_Type drop down list, select All. This displays all the Dataset tags.
 4. Double click on the desired Dataset tag. This assigns the tag to the module and closes the Browse window.
 5. Choose the desired register in the Parameter drop down list.
 6. Click the OK button.
- For output modules, user also needs to change the MODE parameter to Manual for Normal Mode and Target.

5.5 Using Diagnostics

- Verify PSIC communication: Select the PSIC on Diagnostics and press the right mouse button. Select Display Real -Time Statistics from the drop down menu. If the Programmable Serial Interface Card is functioning then the user will see the Valid Responses counter and the Async and/or Sync Transactions counters incrementing. There will not be any error counting up.
- Verify port statistics: Select the Port on the Programmable Serial Interface Card and press the right mouse button. Then select Display Port Statistics form the drop down menu. Verify that the port communications statistics are being displayed properly and are counting as expected for the protocol's functionality.
- Verify dataset values: Select a dataset and press the right mouse button. Select View Dataset Registers from the Drop down window. Verify that the dataset values are displayed as expected.

5.6 LED Indication

The Yellow LED for the port should be on solid when all communications on that port are valid. The Yellow LED should be blinking if there is some valid communications and some communications with errors on that port. The Yellow LED should be OFF if there are no valid communications on that port.



6 DeltaV–Field Device Electrical Interface

The electrical interface between DeltaV and field devices conforms to the RS-232 and RS-422/485 standards.

Each PSIC has 2 ports, In the ControlNet driver Port 2 performs no communications operations. Only Port 1 should be wired to the field. The distance between the serial card and the field device can be as much as 5000 feet, per the RS-422/485 standard. When using RS-232, the distance is limited to 50 feet. Section 6.1 shows the pin assignments for the PSIC serial terminal block.

6.1 Pin Assignments for DeltaV PSIC

RS-232 Standard

Table 6

Terminal Number	Signal Description
1	Port 1 - Isolated Ground (GND)
2	Unused
3	Port 1 – Transmit Data (TxD)
4	Unused
5	Port 1 – Receive Data (RxD)
6	Unused
7	Port 1 – Data Terminal Ready (DTR)
8	Port 1 – Data Set Ready (DSR)
9	Port 2 - Isolated Ground (GND)
10	Unused
11	Port 2 – Transmit Data (TxD)
12	Unused
13	Port 2 – Receive Data (RxD)
14	Unused
15	Port 2 – Data Terminal Ready (DTR)
16	Port 1 – Data Set Ready (DSR)



RS-422/485 Half Duplex Standard

Table 7

Terminal Number	Signal Description
1	Port 1 – Isolated Ground (GND)
2	Port 1 - Data +
3	Unused
4	Port 1 - Data -
5	Unused
6	Unused
7	Unused
8	Unused
9	Port 2 – Isolated Ground (GND)
10	Port 2 – Data +
11	Unused
12	Port 2 - Data -
13	Unused
14	Unused
15	Unused
16	Unused

RS-422/485 Full Duplex Standard

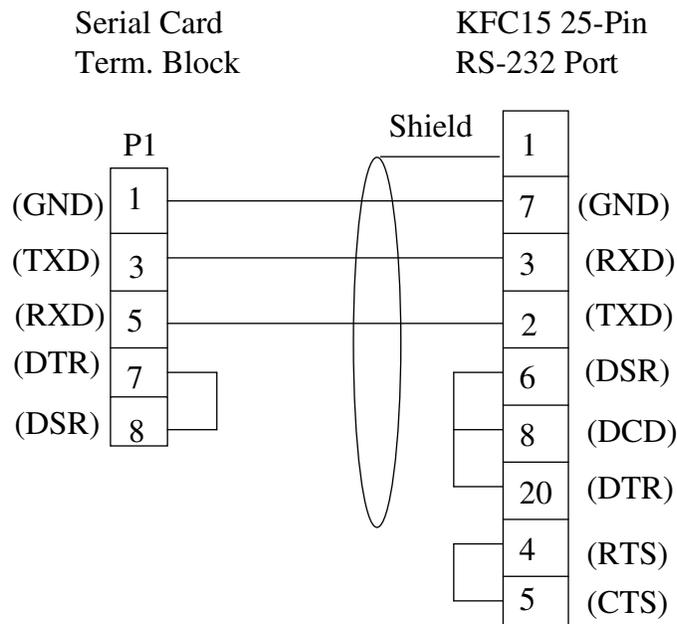
Table 8

Terminal Number	Signal Description
1	Port 1 – Isolated Ground (GND)
2	Port 1 – TxD +
3	Unused
4	Port 1 – TxD -
5	Unused
6	Port 1 – RxD +
7	Unused
8	Port 1 – RxD -
9	Port 2 – Isolated Ground (GND)
10	Port 2 – TxD +
11	Unused
12	Port 2 – TxD -
13	Unused
14	Port 2 – RxD +
15	Unused
16	Port 2 – RxD -



6.2 Wiring Connections

The figure below shows the connections between the 1770-KF15 module RS-232 port and the serial card I/O termination block. On the redundant serial termination block, only the Port1 connections will be used. Port2 connections will not be used. Connect Port1, left side, of the redundant serial termination block to one KFC15. Connect Port1, right side, of the redundant serial termination block to a second KFC15.





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7 Technical Support

For technical support or to report a defect, please give Mynah Technologies a call at (636) 681-1555. If a defect is discovered, please document it in as much detail as possible and then fax your report to us at (636) 681-1660.

You can also send us your questions via e-mail. Our address is:

support@mynah.com

Thank you for using DeltaV.