Application Note
PSS 4000 EtherNet/IP communication with Allen-Bradley PLCs

Product
Type: PSSu H PLC1 FS SN SD (312070)
Name: PSS 4000, PAS4000, EtherNet/IP
Manufacturer: Pilz GmbH & Co. KG, Safe Automation

Document
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Release Date: 25 June 2013

Document Revision History

Release	Date	Changes	Chapter
0.1	2013-01-15	Creation with preview version R7.0c_23_ethernetip.PASB38	all
0.2	2013-01-18	Change version to R7.0d_248_ethernetip.PASB44 / R7.0d_95_ethernetip.RTSB4.86523.20130102	all
1.0	2013-06-25	Official release with PAS4000 version 1.8.0	all, remove chapter 5.4

Exclusion of liability

We have taken great care in compiling our application note. It contains information about our company and our products. All statements are made in accordance with the current status of technology and to the best of our knowledge and belief.
However, we cannot accept liability for the accuracy and entirety of the information provided, except in the case of gross negligence. In particular it should be noted that statements do not have the legal quality of assurances or assured properties.
We are grateful for any feedback on the contents.

June 2013

Support

Technical help round the clock!
Technical support is available from Pilz round the clock.
This service is provided free of charge beyond standard business hours.

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Contents

1. Useful documentation

Reading the documentation listed below is necessary for understanding this application note. The availability of the indicated tools and safe handling are also presupposed with the user.

1.1. Documentation from Pilz GmbH & Co. KG

No.	Description	Item No.
1	Pilz international homepage, download section	www.pilz.com
2	Operating Manual PSSu H PLC1 FS SN SD	21939-EN-xx
3	System Description Programmable safety and control system PSS 4000	1001467-EN-xx
4	Safety Manual Programmable safety and control system PSS 4000	1001468-EN-xx
5	PAS4000 online help Chapter: Hardware configuration > Configuration of the EtherNet/IP Adapter	Version 1.8.0 or higher
6		

1.2. Documentation from other sources of information

No.	Description	Item No.
1	Allen-Bradley portal (international) Internet-Link to "ab.rockwellautomation.com"	
2	Product catalogue of Allen-Bradley ControlLogix System (PLC) Internet-Link to product catalogue "ControlLogix System"	

2. Preface

This document provides a Step by Step example how to communicate between Allen-Bradley ControlLogix and PSS 4000 with EtherNet/IP connection.
The document is not intended as a technical documentation for general use of Allen-Bradley Automation Systems and Software “RSLogix 5000” of Rockwell Automation ControlLogix.
It may not be distributed to customers without a special note to its scope.

The EtherNet/IP-enabled PSS 4000 device from Pilz can be incorporated as an adapter in EtherNet/IP for **non-safety-related applications**.

- It supports:
  - Cyclical data exchange with an EtherNet/IP scanner
  - Acyclical data exchange as "Explicit Message Server"
- For more details please see:
  - Operation Manual of selected head module and
  - PAS4000 help, chapter: Hardware configuration > Configuration of the EtherNet/IP Adapter

3. Configuration

3.1. List of used hardware

- Allen-Bradley hardware

  This Application Note has been tested with the following hardware:
  - CPU 1756-L55/A ControlLogix5555 Controller, Revision 12.27
  - ETH-IP Scanner 1756-ENBT/A

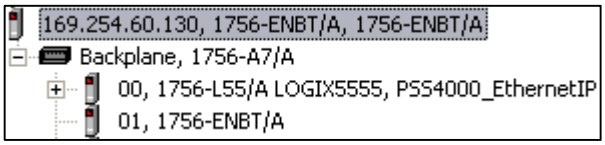


Fig. 1: RSLogix 5000 – Hardware Configuration Allen-Bradley ControlLogix PLC

- Pilz hardware

  This Application Note has been tested with the following hardware:
  - PSSu H PLC1 FS SN SD (order number 312070)
  - Firmware: R8.0d.RTSB147.89059
  - HW: 2

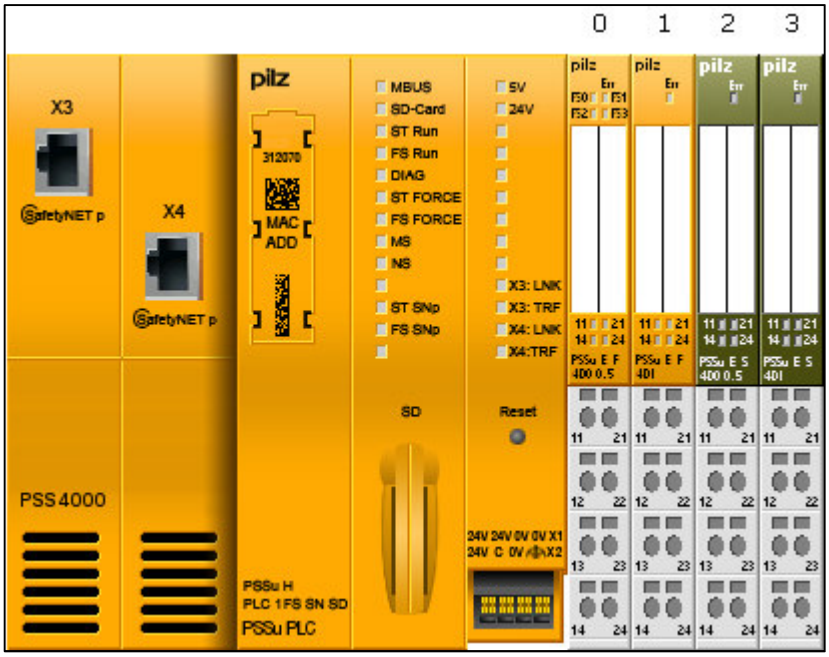


Fig. 2: PAS4000 – Hardware Configuration PSS 4000

Notice: The 4 failsafe outputs are directly wired to the 4 failsafe inputs in the same order.
The 4 standard outputs are directly wired to the 4 standard inputs in the same order.

3.2. List of supported Pilz hardware

- PSS 4000 head modules with order number:
  - PSSu H PLC1 FS SN SD 312070
  - PSSu H PLC1 FS SN SD-T 314070
  - PSSu H PLC1 FS SN SD-R 315070

3.3. List of used software

This Application Note has been tested with the following software:

- Allen-Bradley: RSLogix 5000, Version V12.06.00
- Pilz: PAS4000, Version R8.0d.PASB221

3.4. List of used IP addresses

The following IP addresses has been used in the example project:

- Computer (PAS4000, RSLogix 5000): 169.254.60.11
- Allen-Bradley ControlLogix PLC: 169.254.60.130
- Pilz PSS 4000 PLC: 169.254.60.110

Notice: For more information about setting IP address
» open in software “PAS4000” in menu “Help” the function "Contents and Index" and
» choose chapter "Hardware configuration" » “Create new device” » “Create PSSu system”

4. Application Task

Create a connection with EtherNet/IP and communicate between PSS 4000 and Allen-Bradley ControlLogix PLC.
The initial ControlLogix -Hardware configuration is not implemented in this “Application Note”.
You can get further details if you read the Allen-Bradley ControlLogix manuals, e.g.:

- Allen-Bradley User Manual “EtherNet/IP Network Configuration”
- Allen-Bradley Quick Start “Logix5000 Control Systems: Connect POINT I/O Modules Over an EtherNet/IP”

4.1. Steps before you can start

- Set IP address of your PC.
  In this example the IP address for the PC is 169.254.60.11.

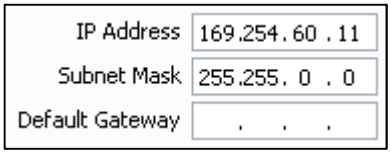


Fig. 3: PC – Set IP address

4.2. Steps for Allen-Bradley ControlLogix PLC

4.2.1. Prepare ControlLogix PLC with EtherNet/IP adapter

- Start software “RSLogix 5000”
- Select recent communication path to your ControlLogix PLC

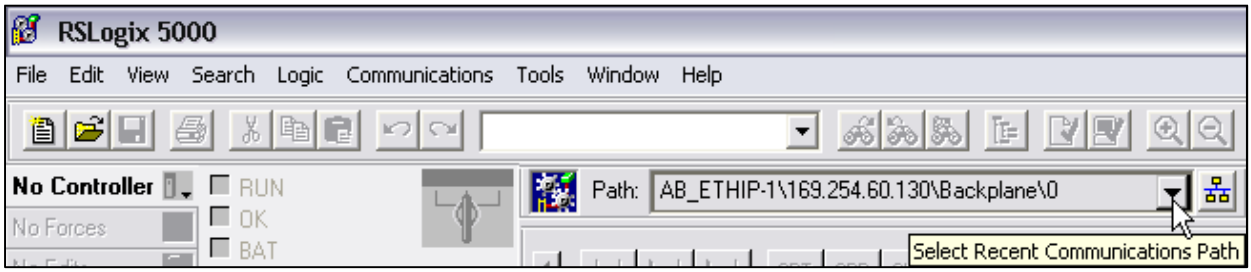


Fig. 4: RSLogix 5000 – Select recent communication path (1)

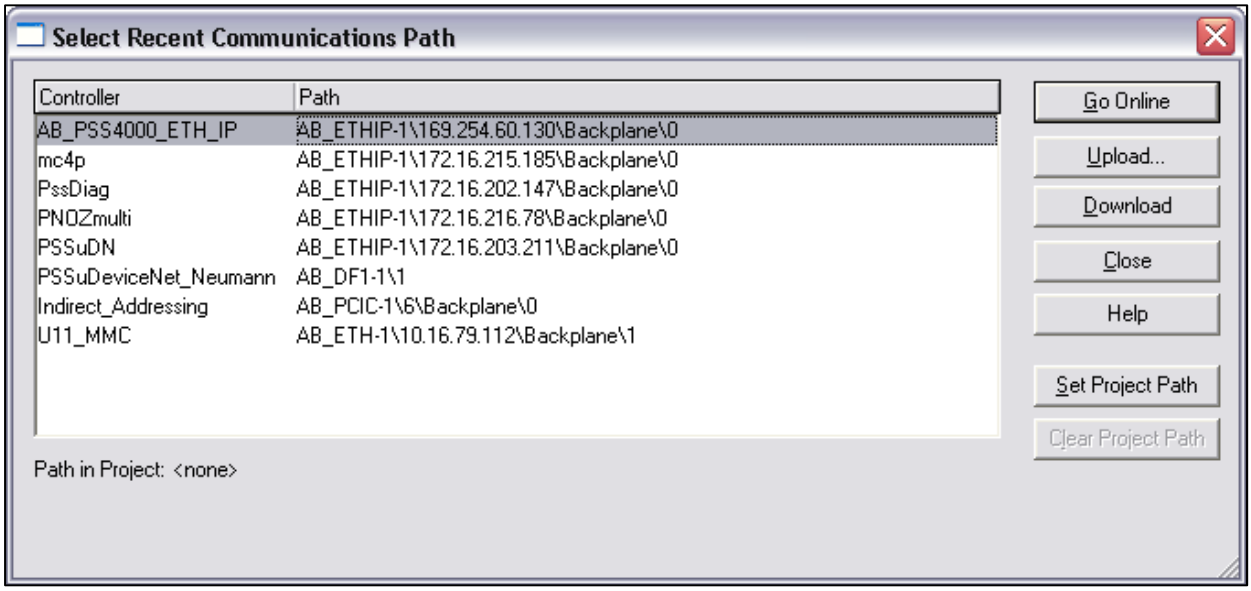


Fig. 5: RSLogix 5000 – Select recent communication path (2)

- Create a new project:

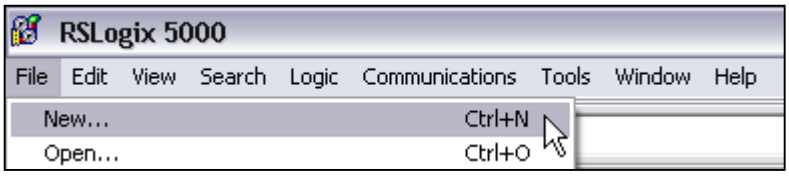


Fig. 6: RSLogix 5000 – Create new project (1)

- Create new controller:

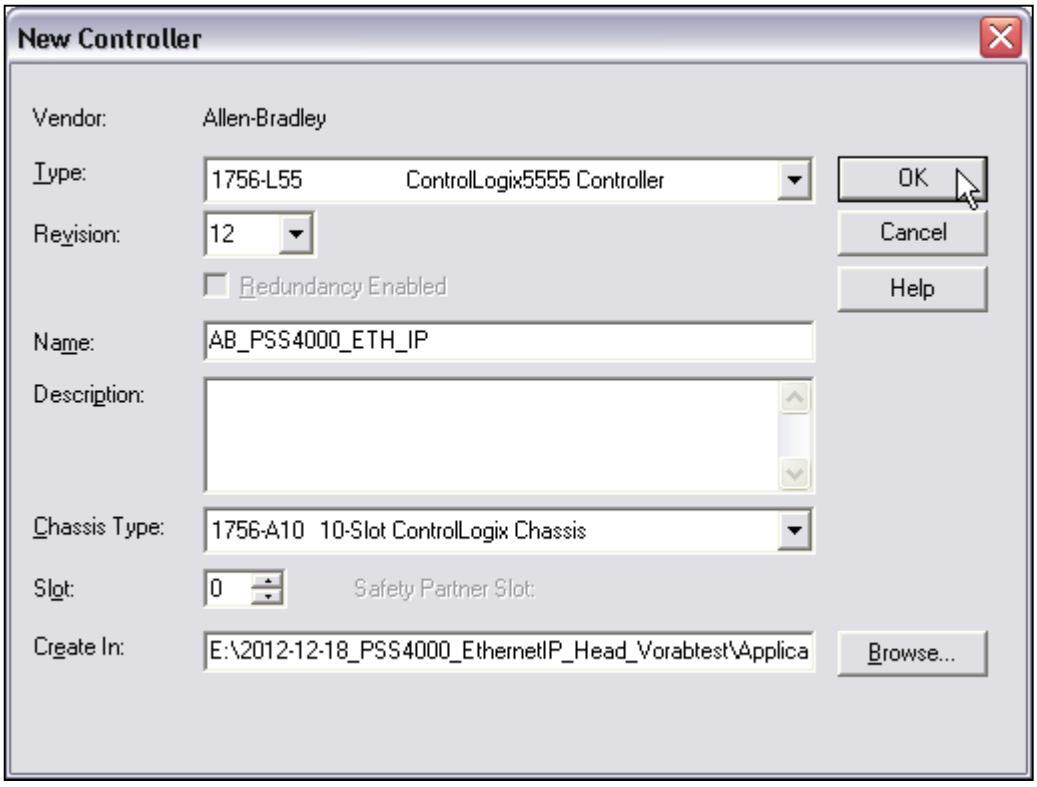


Fig. 7: RSLogix 5000 – Create new project (2)

- Create new Module Type (for EtherNet/IP Scanner):

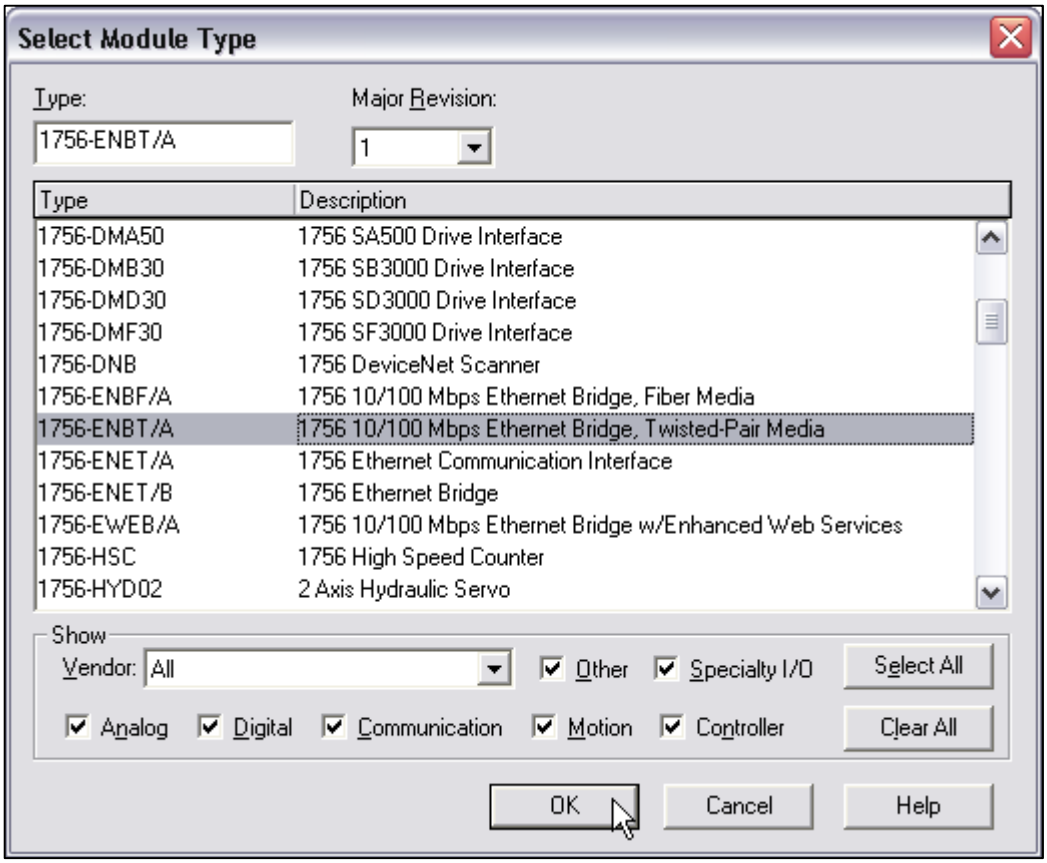


Fig. 8: RSLogix 5000 – Create new Module Type for EtherNet/IP Scanner (1)

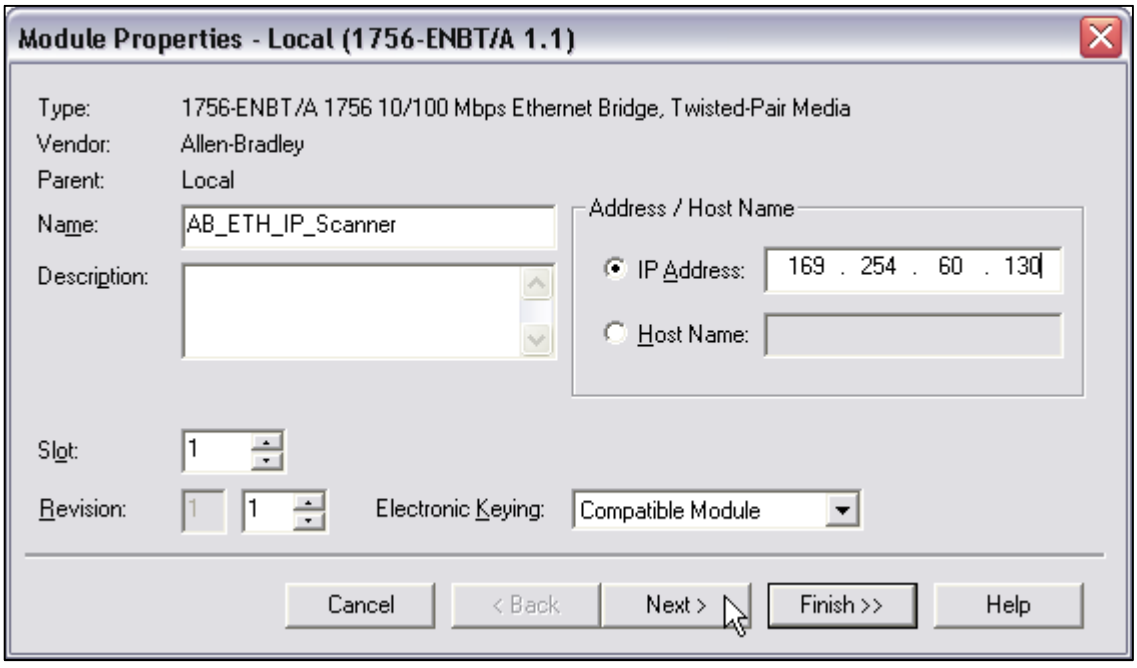


Fig. 9: RSLogix 5000 – Create new Module Type for EtherNet/IP Scanner (2)

- Create new Generic Ethernet Module:

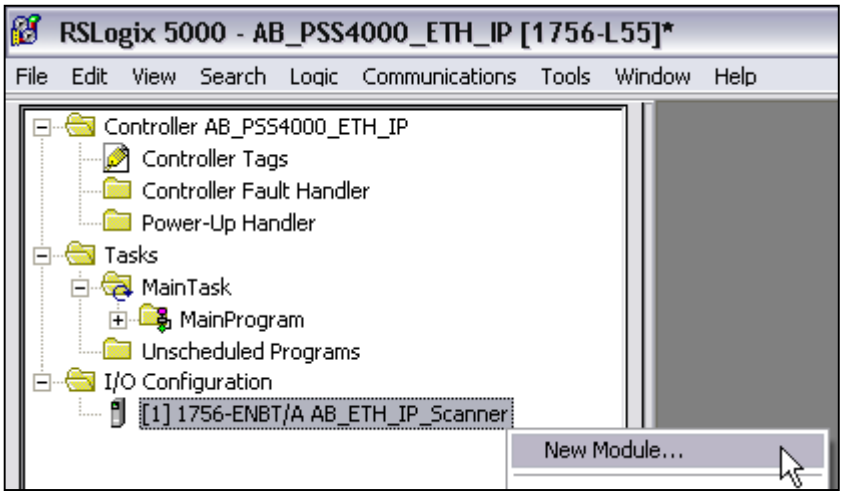


Fig. 10: RSLogix 5000 – Create new Generic Ethernet Module (1)

- Choose for 1756-ENET/A the standard “ETHERNET-MODULE – Generic Ethernet Module”:

Notice: Because of used version of RSLogix 5000 configuration file (EDS) is not supported, please use the standard module and configure the properties manually.
As of Version 20, RSLogix 5000 has a new EDS file manager “EDS Hardware Installation Tool”.
With the tool you can install, import, create, execute and delete EDS files.

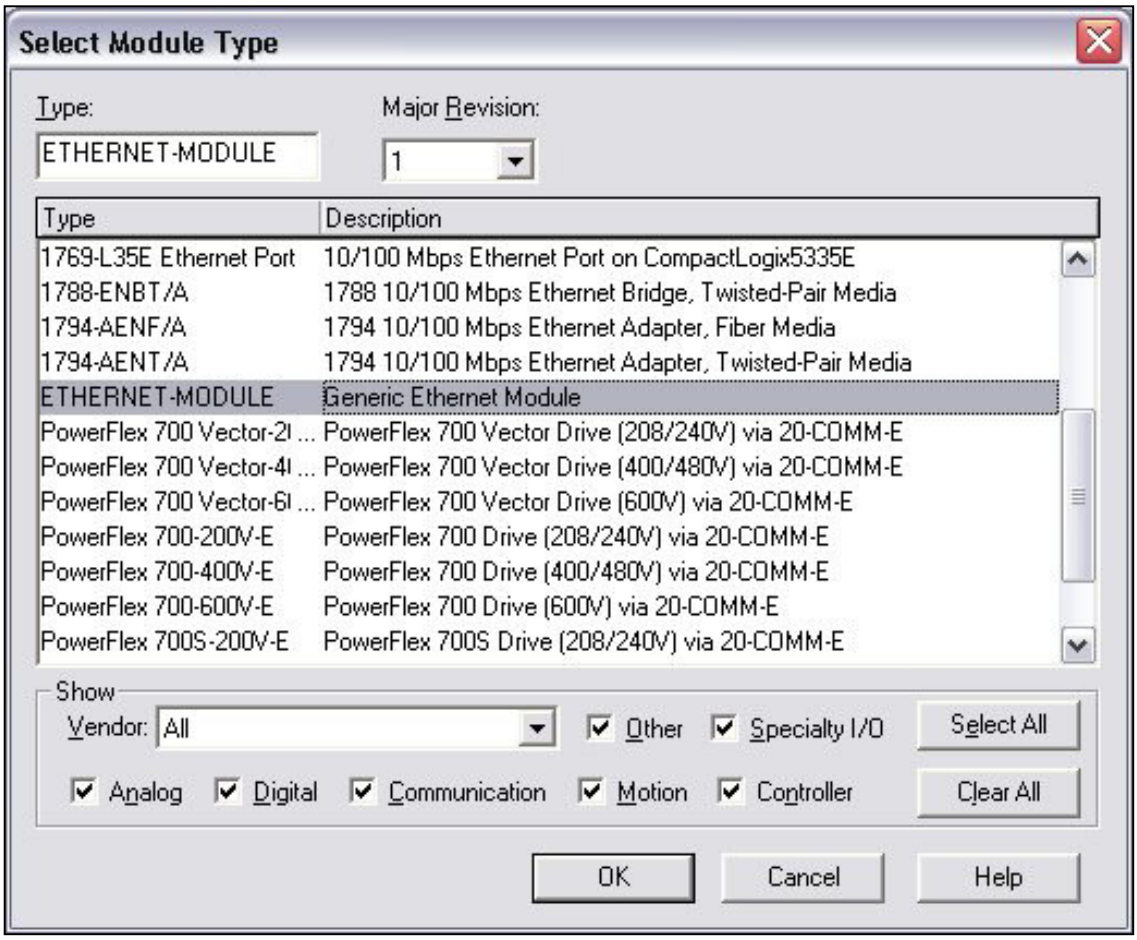


Fig. 11: RSLogix 5000 – Create new Generic Ethernet Module (2)

Notice: ▸ Maximum **data transfer rates** (from perspective of used RSLogix 5000 version 12.06.00)
» from Scanner (ControlLogix) to Adapter (PSS 4000): 496 Bytes (500 – 4 for Run/Idle Header)
» from Adapter (PSS 4000) to Scanner (ControlLogix): [A] 500 Bytes (498 process data + 2 status word)
[B] 500 Bytes pure process data without status word

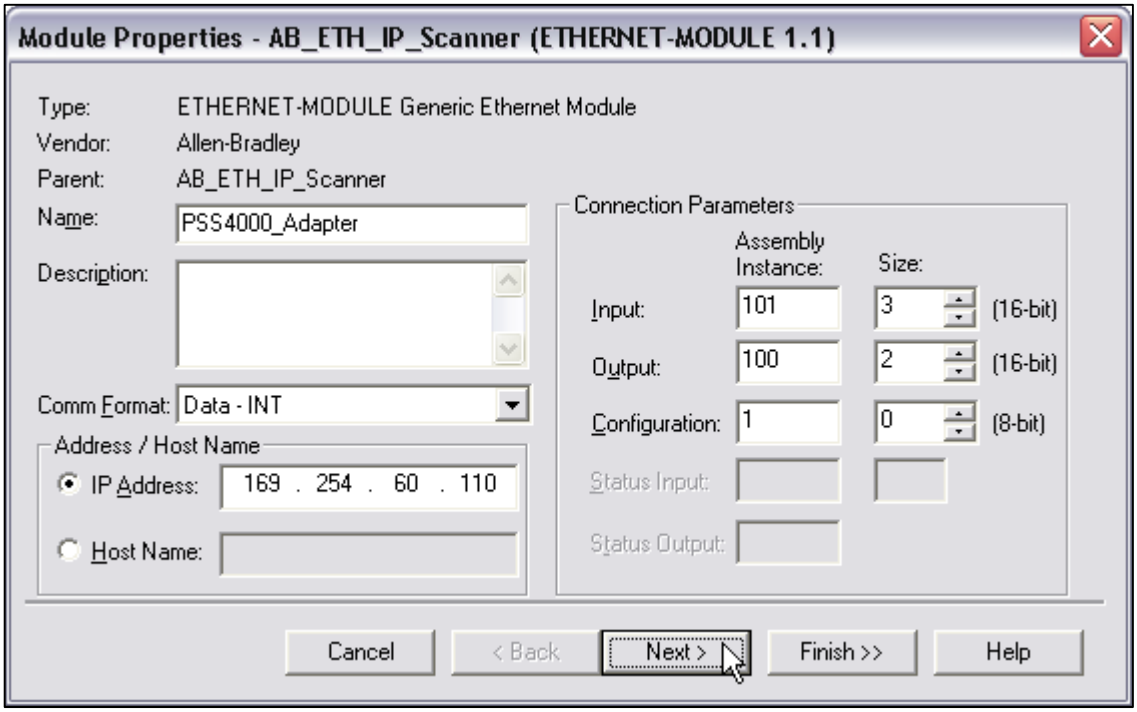


Fig. 12: RSLogix 5000 – Create new Generic Ethernet Module (3)

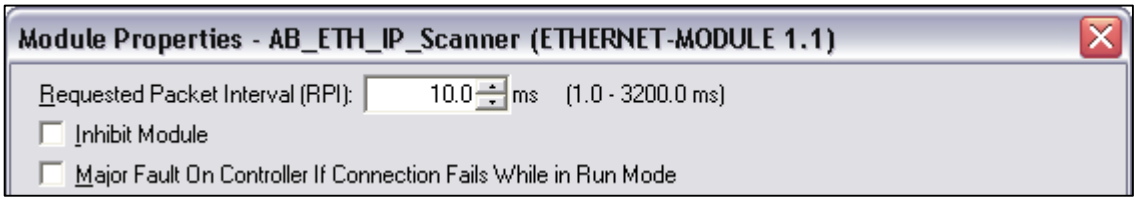


Fig. 13: RSLogix 5000 – Create new Generic Ethernet Module (4)

- You can check the correct data configuration with the function “Monitor (Controller) Tags”:

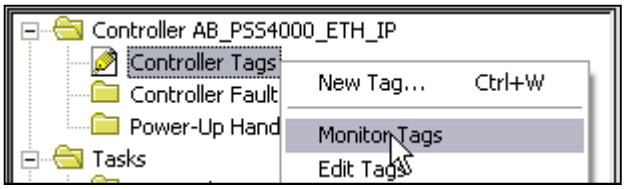


Fig. 14: RSLogix 5000 – Monitor Controller Tags (1)

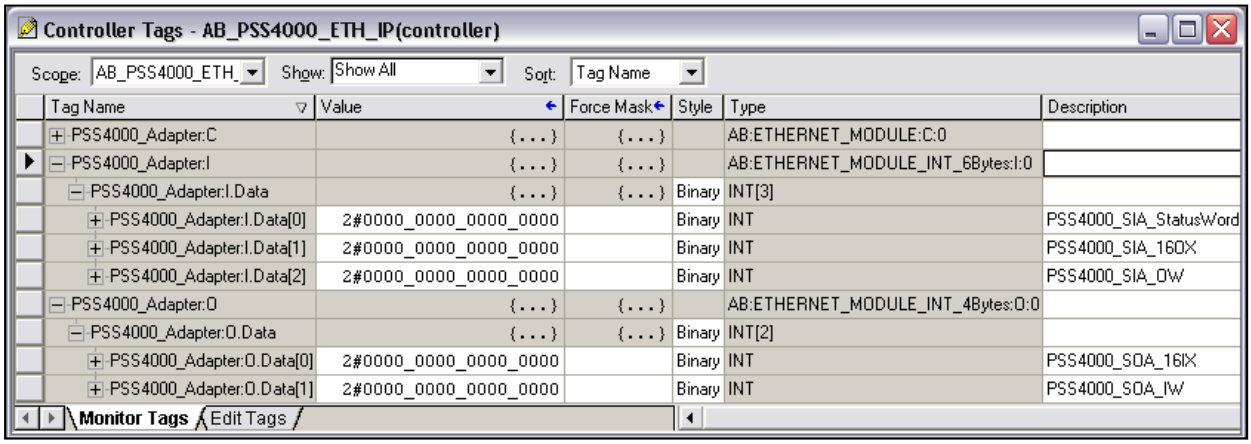


Fig. 15: RSLogix 5000 – Monitor Controller Tags (2)

4.2.2. Cyclical process data exchange on ControlLogix side

Cyclical process data are also referred as **Implicit Messaging** and is used for real-time I/O data exchange. For EtherNet/IP, Implicit Messaging uses UDP and can be multicast or unicast.

- Open ▸Tasks ▸MainTask ▸MainProgram ▸MainRoutine:

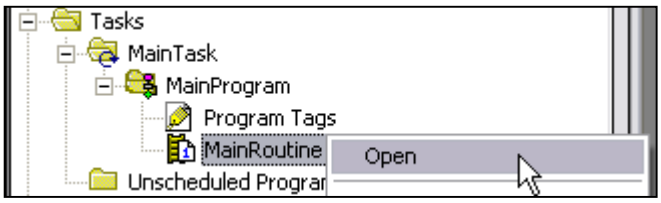


Fig. 16: RSLogix 5000 – Open MainRoutine

4.2.2.1. [A] RSLogix 5000-Program «– EtherNet/IP –» PI-Variables of PAS4000-Program

The process data is generated in the program code on PSS 4000 side, and then used on the Allen-Bradley side.

- PI variables of PSS 4000 program are mapped on data of “PSS4000_Adapter”:
  - PSS 4000 program data (POU_1) “ST_Input01/02” (PSS4000_SOA_16IX) to ...
    ... Assembly Object 100 – PSS4000_Adapter:O.Data[0] : Byte [0] of BOOL
  - PSS 4000 program data (POU_1) “ST_Input_WORD01” (PSS4000_SOA_16IW) to ...
    ... Assembly Object 100 – PSS4000_Adapter:I.Data[1] of WORD
  - PSS 4000 program data (POU_1) “ST_Output01/02” (PSS4000_SIA_16OX) to ...
    ... Assembly Object 101 – PSS4000_Adapter:I.Data[1] : Byte [0] of BOOL
  - PSS 4000 program data (POU_1) “ST_Output_WORD01” (PSS4000_SIA_16OW) to ...
    ... Assembly Object 101 – PSS4000_Adapter:I.Data[2] of WORD

Notice: ▸ Please see also
» Instruction part of PSS 4000 program for “POU_1” on Chapter 4.3.3.1
[A] PI-Variables of PAS4000-Program «– EtherNet/IP –» RSLogix 5000-Program, page 36ff and
» Fig. 55: PAS4000 – Assign I/Os of PI variables to I/O data of EtherNet/IP connection [A], page 40.
▸ Used Bits (data type BOOL) are controlled by the following function:
Fig. 18: RSLogix 5000 – Control I/O-data of PSS 4000 module bus with function ADD [B], page 17.

- A simple method to test dynamic data exchange of EtherNet/IP communication, it can:
  - move Word of Tag “PSS400_Adapter:I.Data[2]” of PI variables of PSS 4000 program to
  - Word of Tag “PSS400_Adapter:O.Data[1]” of PI variables of PSS 4000 program.

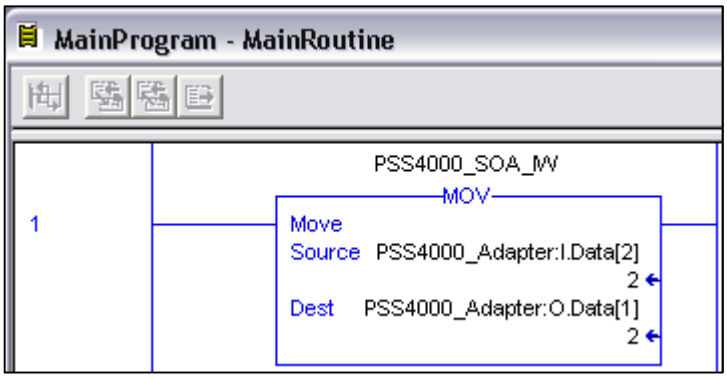


Fig. 17: RSLogix 5000 – Copy PI variables of PSS 4000 program with function MOV [A]

Notice: ▸ For the result on RUN mode please see also:
Fig. 66: PAS4000 – Cyclic change of process data, page 46.

4.2.2.2. [B] RSLogix 5000-Program «– EtherNet/IP –» PSS 4000-I/O data of Module bus

Here I/O data of the PSS 4000 system are read and write directly from Allen-Bradley side.
The outputs on PSS 4000 I/O modules are directly wired to its inputs of same type (FS and ST).

- I/O-data of PSS 4000 modules are mapped on data of “PSS4000_Adapter”:
  - FS Outputs “O0(11)..O3(24)” of “0 : PSSu E F 4DO 0.5” (PSS4000_SIA_16OX) to ...
    ... Assembly Object 101 – PSS4000_Adapter:I.Data[1] : Byte [2] of BOOL
  - FS Inputs “I0(11)..I3(24)” of “0 : PSSu E F 4DI” (PSS4000_SOA_16IX) to ...
    ... Assembly Object 100 – PSS4000_Adapter:O.Data[0] : Byte [2] of BOOL
  - ST Outputs “O0(11)..O3(24)” of “2 : PSSu E S 4DO 0.5” (PSS4000_SIA_16OX) to ...
    ... Assembly Object 101 – PSS4000_Adapter:I.Data[1] : Byte [3] of BOOL
  - ST Inputs “I0(11)..I3(24)” of “3 : PSSu E S 4DI” (PSS4000_SOA_16IX) to ...
    ... Assembly Object 100 – PSS4000_Adapter:O.Data[0] : Byte [3] of BOOL

Notice: Please see also:
Fig. 58: PAS4000 – Assign I/O-data of module bus to I/O data of EtherNet/IP connect. [B], page 42.

- A simple method to test dynamic data exchange of EtherNet/IP communication, it can:
  - add a Bit muster 2#**0101 0101** 0000 0000
  - to 3rd and 4th Byte [2]/[3] of Tag “PSS400_Adapter:I.Data[1]” of the inputs and
  - set the result to 3rd and 4th Byte [2]/[3] of Tag “PSS400_Adapter:O.Data[0]” to the outputs.

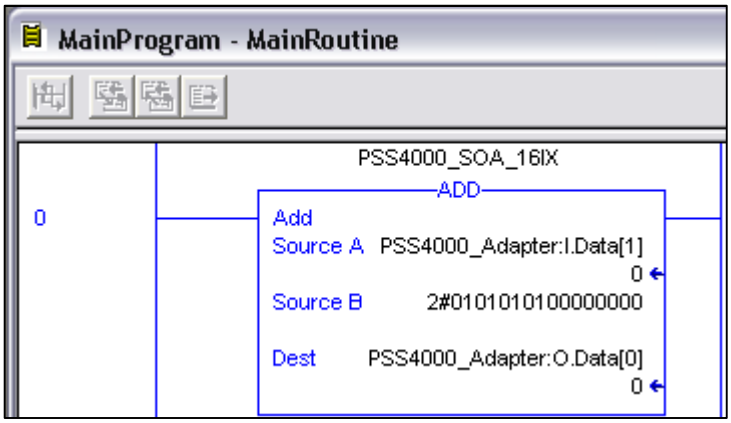


Fig. 18: RSLogix 5000 – Control I/O-data of PSS 4000 module bus with function ADD [B]

4.2.3. Acyclic data exchange on ControlLogix side

Acyclical process data are also referred as **Explicit Messaging** and are used for non time-critical data exchange. For EtherNet/IP, Explicit Messaging uses TCP as request/reply methods.

You can use the integrated functions and commands of tool RSLogix 5000 for supported CIP objects. CIP objects are divided into classes, instances and attributes.
PSS 4000 devices with EtherNet/IP Adapter system section support the object classes as Adapters (see 4.3.4 Acyclical data exchange on PSS 4000 side, page 43).

The diagnostic tools from Rockwell can be used to display the content of attributes.
Various Common Services are supported.

- For more details please see:
  - PAS4000 help,
    Chapter: Hardware configuration
    > Configuration of the EtherNet/IP Adapter
    > Basics on the EtherNet/IP Adapter
    > Supported EtherNet/IP objects and Common Services

4.2.3.1. Example of Explicit Messaging (Identity Object, Class ID 0x01)

- The Identity Object is available on each PSS 4000 device with EtherNet/IP Adapter system section (chapter 3.2 List of supported Pilz hardware, page 8). In this example, we want to be read out from Identity Object (Class **ID 0x01**) the following device data:
  - Attribute **ID 1**, Vendor ID **181** (0x00B5) 1
    This is the manufacturer identification from Pilz.
  - Attribute **ID 4**, Revision **1.8** 2
    This is the version of the product's PSS 4000 firmware [<Major-No>.<Minor-No>]

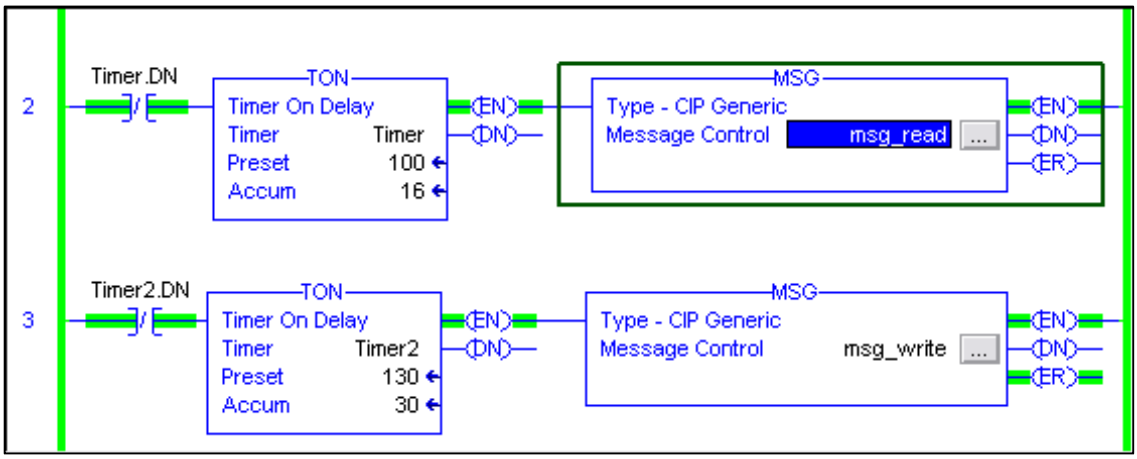


Fig. 19: RSLogix 5000 – Code with function MSG for Explicit Messaging of PSS 4000 object

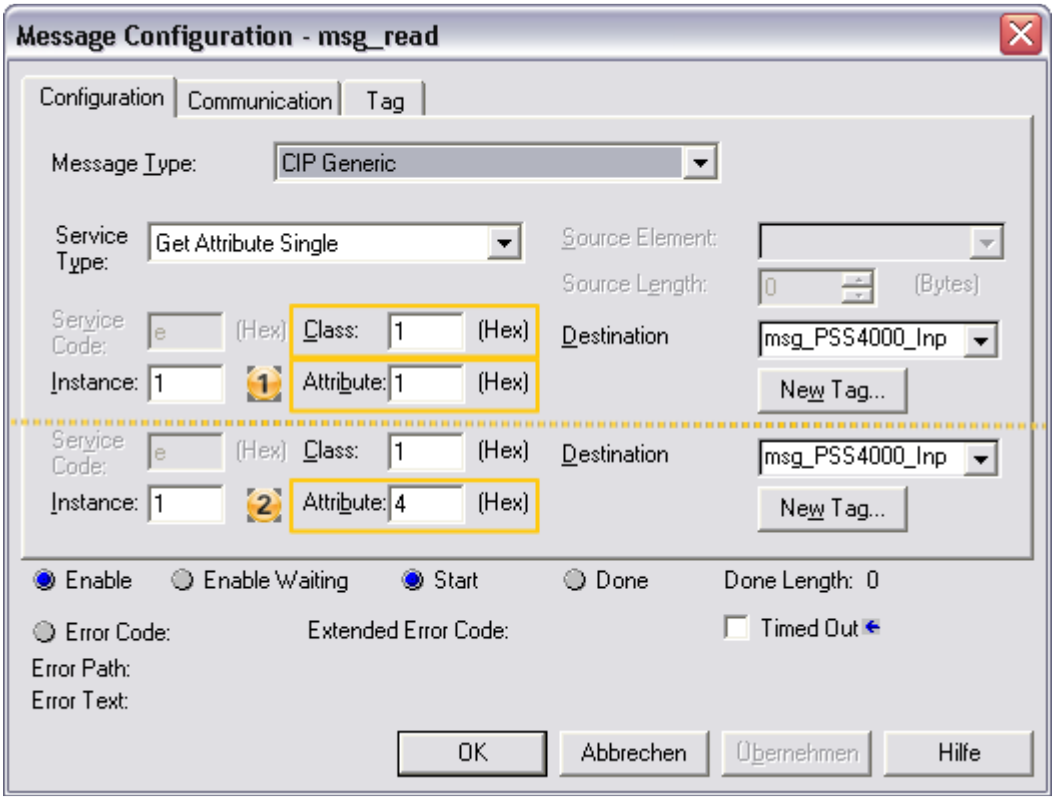


Fig. 20: RSLogix 5000 – Configuration of function MSG for Explicit Messaging

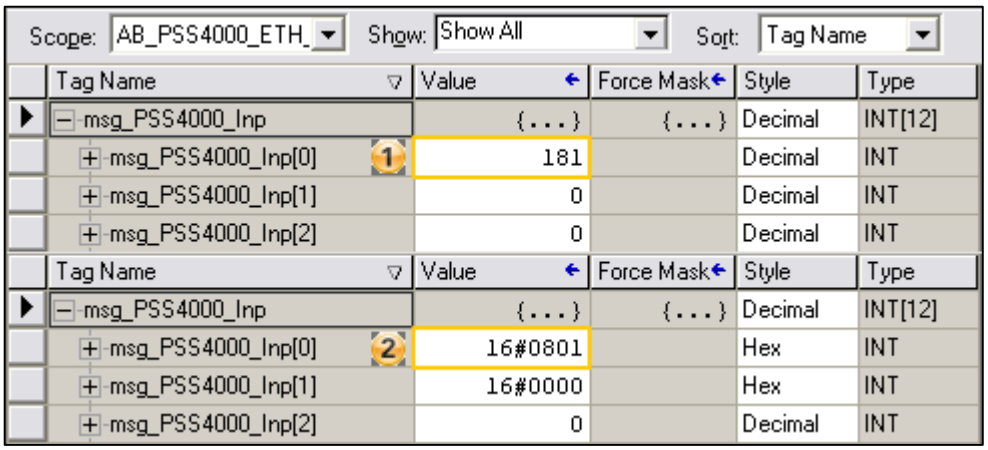


Fig. 21: RSLogix 5000 – Monitor Tags of Explicit Messaging of PSS 4000 objects

4.2.4. Save and download project to ControlLogix PLC

- Check before downloading that the correct communication path to ControlLogix PLC is set. Please see also Fig. 4: RSLogix 5000 – Select recent communication path (1), page 10.
- Save MainRoutine and start Download:

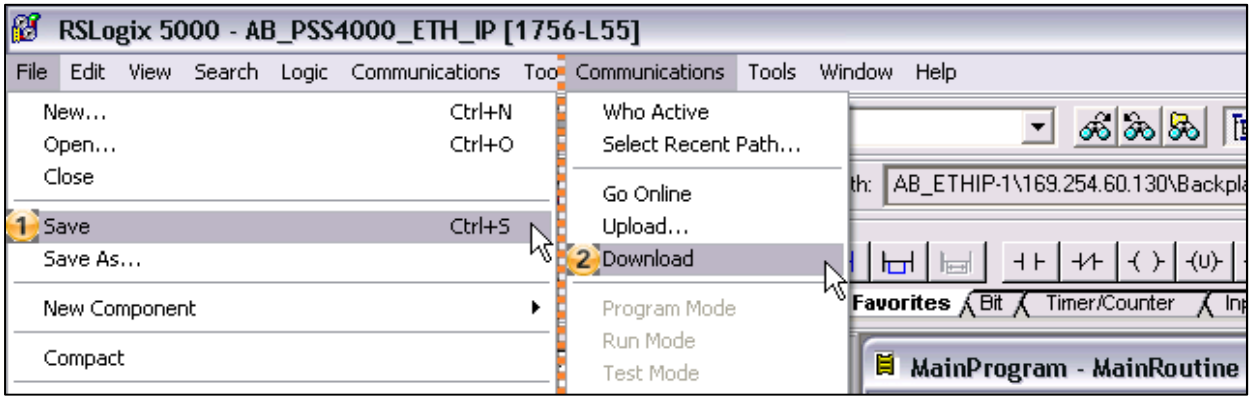
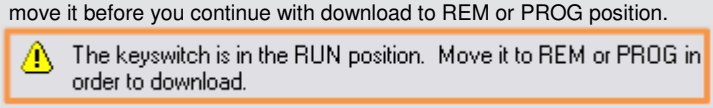


Fig. 22: RSLogix 5000 – Save MainRoutine and Start Download to ControlLogix PLC

Notice: If the > Key-Switch on Logix5555 Controller is in RUN position, move it before you continue with download to REM or PROG position.



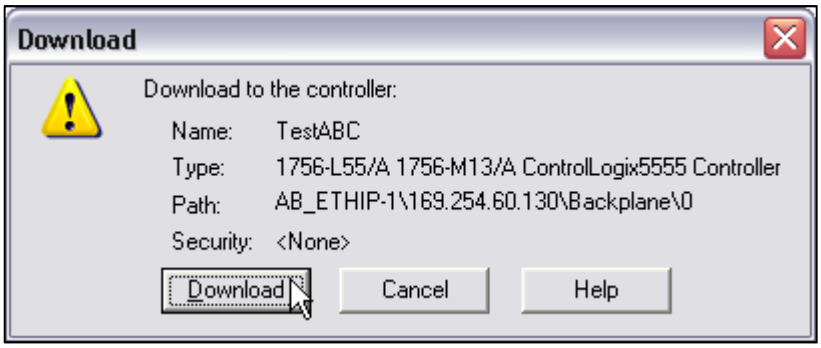


Fig. 23: RSLogix 5000 – Continue download to ControlLogix PLC

Notice: After download move > Key-Switch on Logix5555 Controller back to RUN position!

4.3. Steps for PSS 4000

4.3.1. Prepare PSS 4000 system for EtherNet/IP communication

- Start software “PAS4000”.
- Click at “New” to create a new project.

Fig. 24: PAS4000 – Create new project (1)

- Enter the project name and continue with “OK”. The new project will be created.

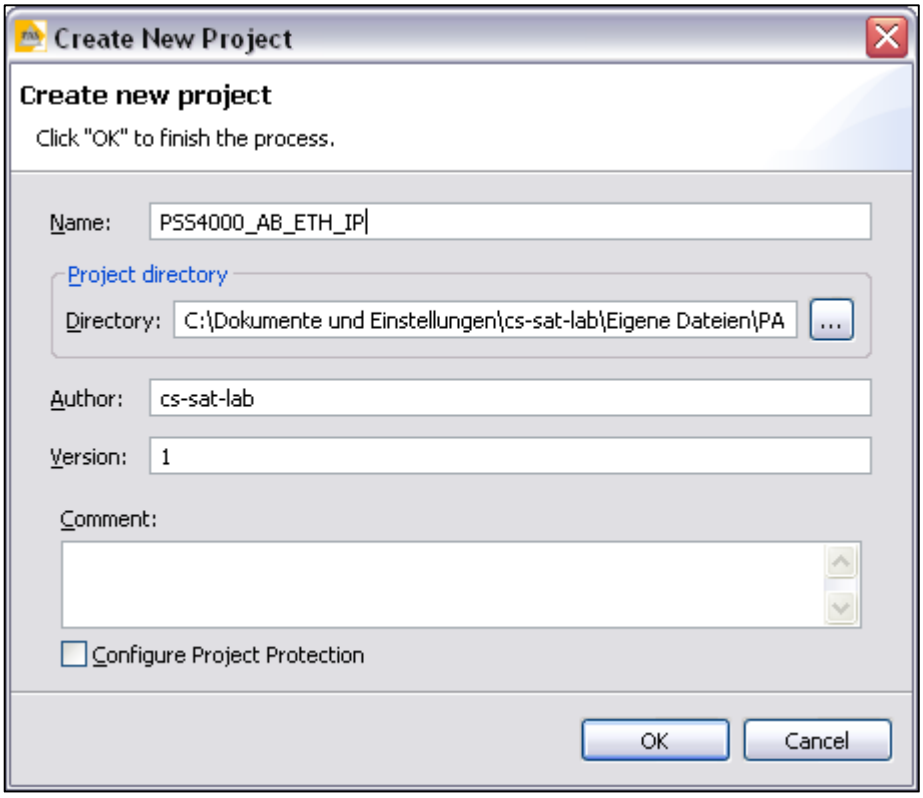


Fig. 25: PAS4000 – Create new project (2)

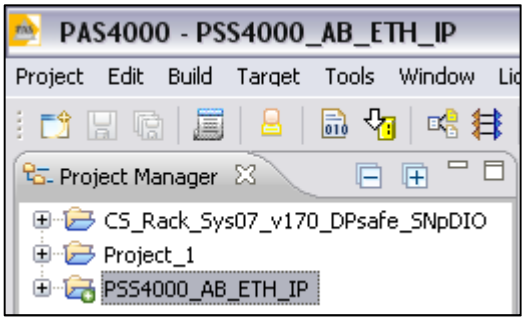


Fig. 26: PAS4000 – New project created

- Click at “Online Network Editor”.

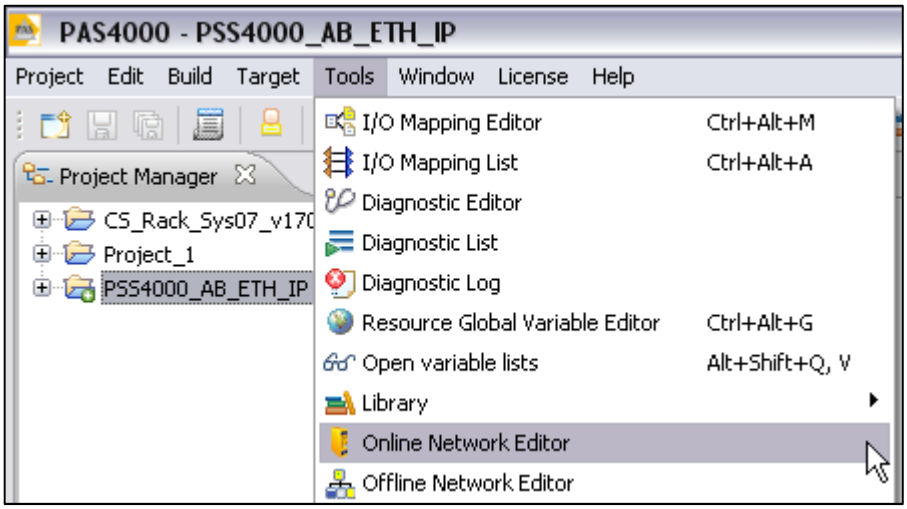


Fig. 27: PAS4000 – Open Online Network Editor

- Click at “Scan Network”.

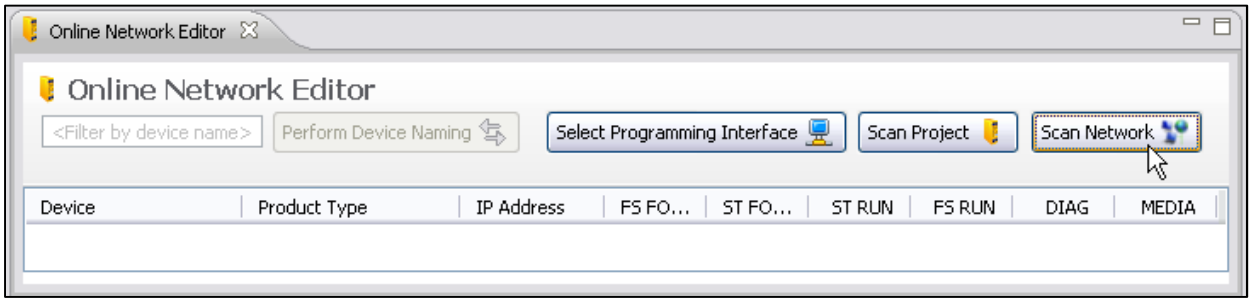


Fig. 28: PAS4000 – Scan Network (1)

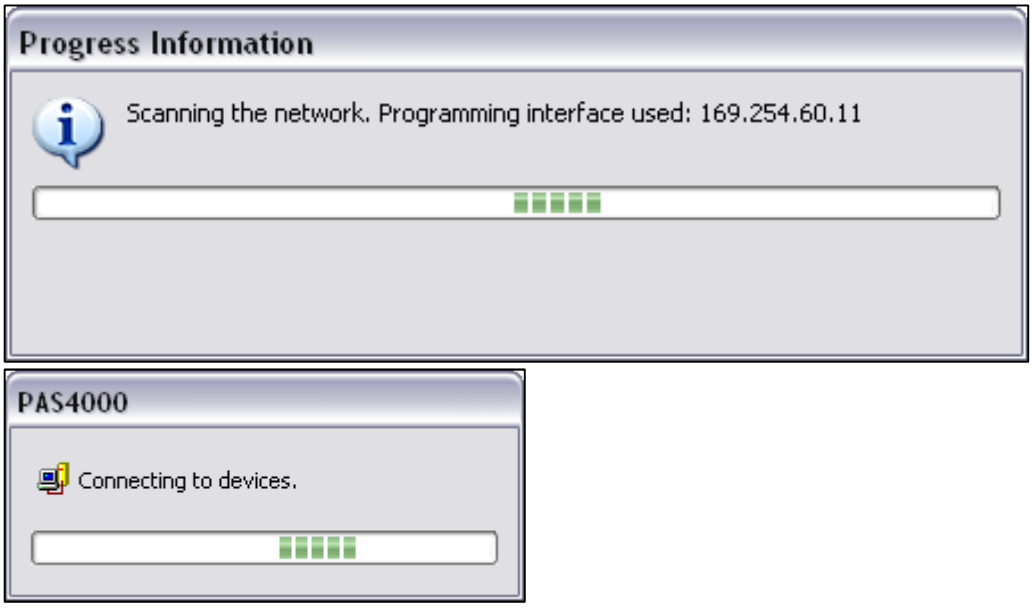


Fig. 29: PAS4000 – Scan Network (2)

- Click with the right mouse button on your device and choose “Change Naming Data”.

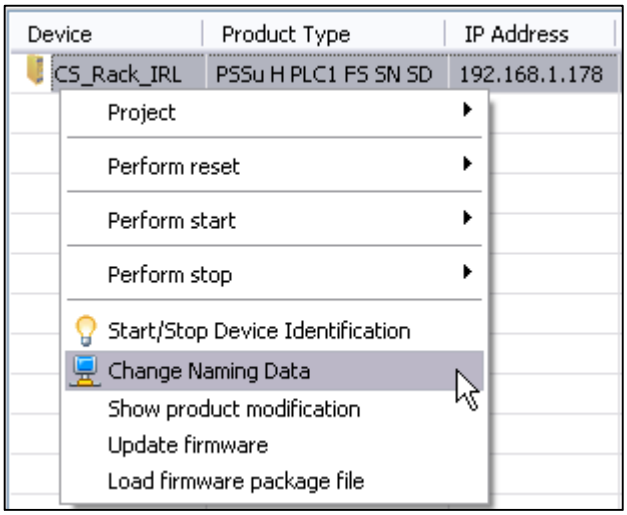


Fig. 30: PAS4000 – Change Naming Data (1)

- Enter the IP address of the PSS 4000 and the Device name.
  In the example the IP address is “169.254.60.110” and the Device name “Ethernet_IP_1”.
- Continue with “OK”.

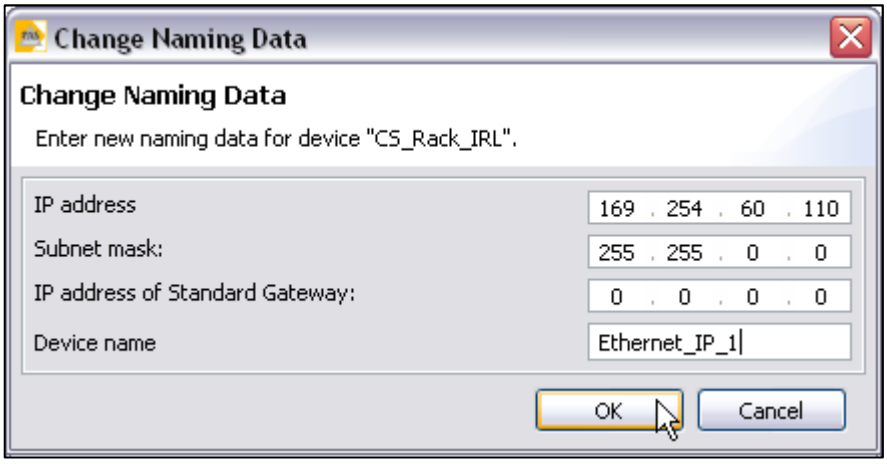


Fig. 31: PAS4000 – Change IP address and Device name

- Continue with “OK”. It can take some minutes to change the settings.

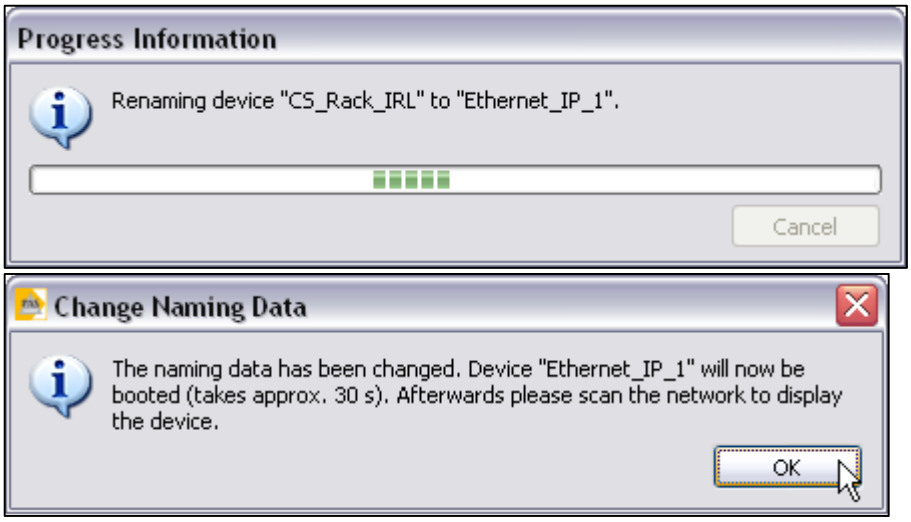


Fig. 32: PAS4000 – Change Naming Data (2)

- Scan the network again to display saved changes:

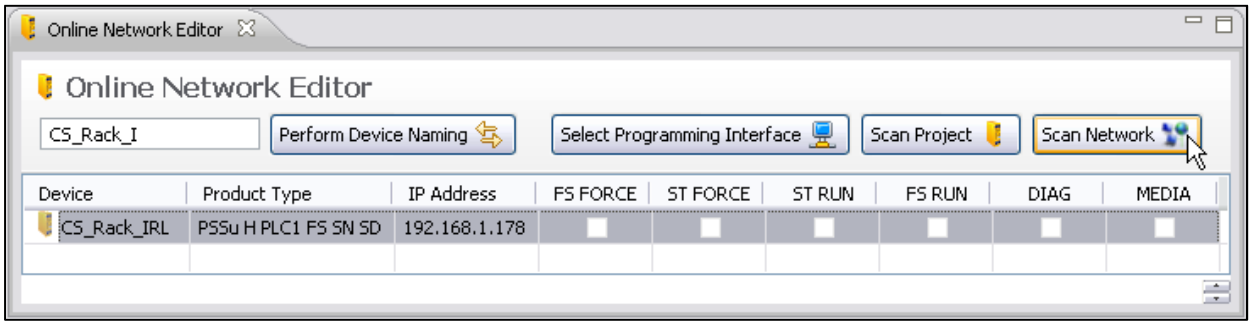


Fig. 33: PAS4000 – Scan Network (3)

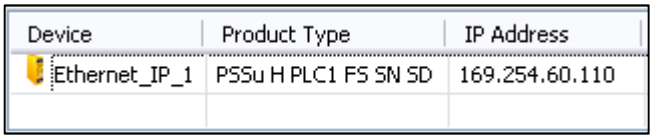


Fig. 34: PAS4000 – Changed device IP address and Device name

- Now you have to insert a new device in your PAS4000 project:
  - Click with right mouse button on “Hardware configuration” and
  - Choose “New” and click on “Device”.

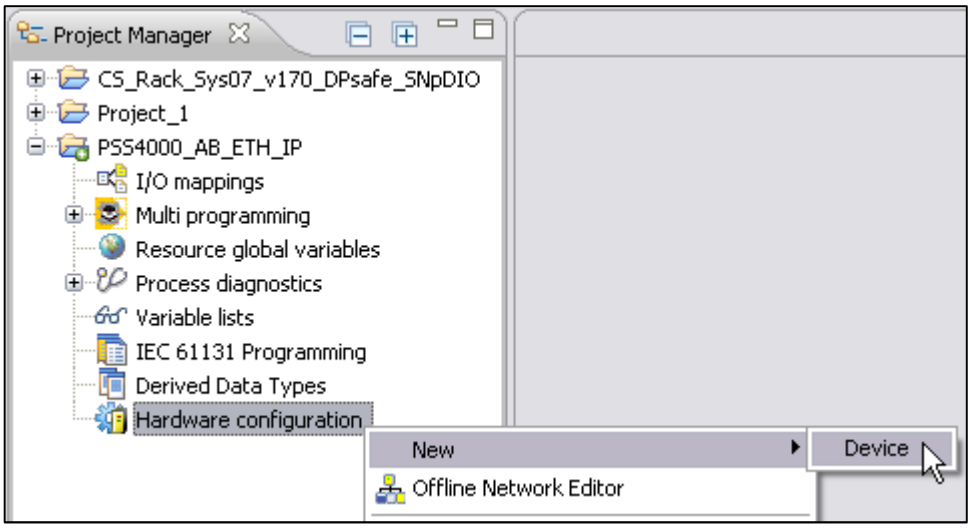


Fig. 35: PAS4000 – Create new device

- Choose the “Filter” and “Product type”.
  The Pilz hardware used in this example is described in Ch. 3.1, page 7.

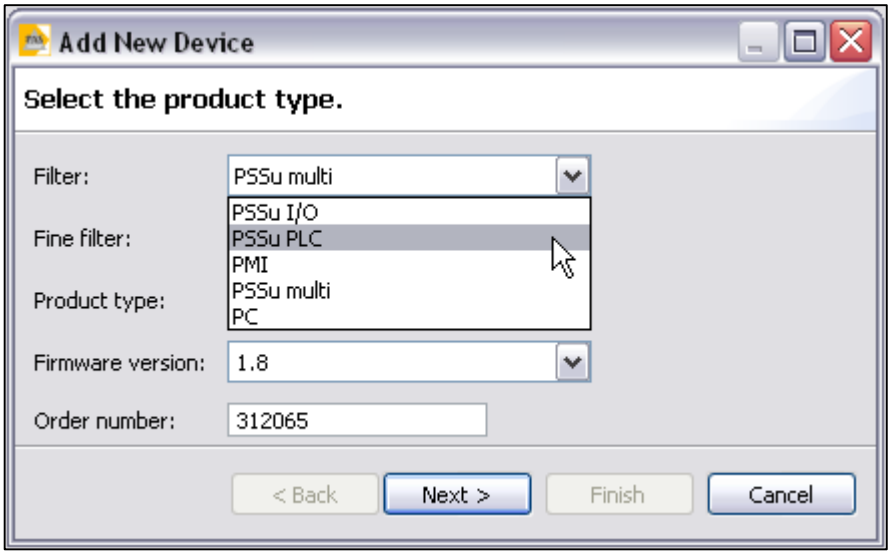


Fig. 36: PAS4000 – Filter setting

- Choose “PSSu PLC” as filter and “PSSu H PLC1 FS SN SD” as product type.

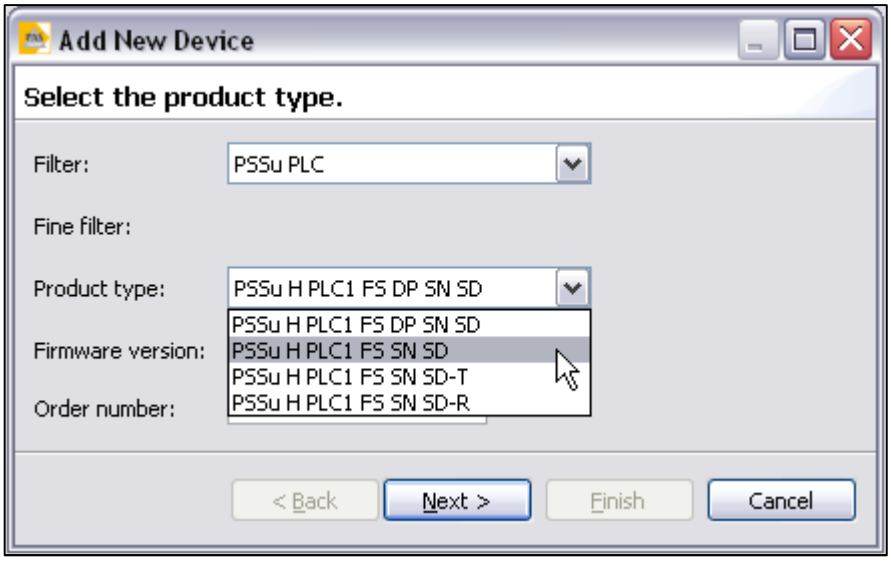


Fig. 37: PAS4000 – Product type setting

- The firmware version used in this example is “1.8”.
  Continue with “Next”.

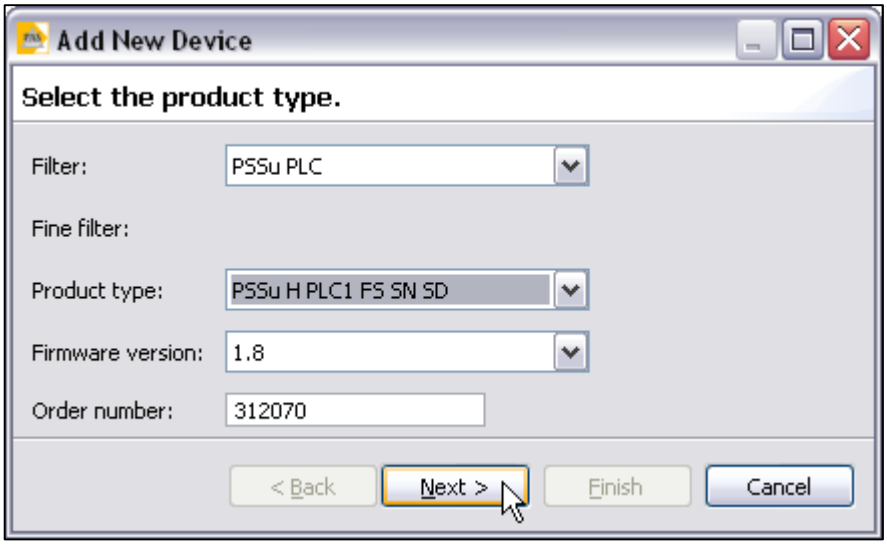


Fig. 38: PAS4000 – Add New Device

- Enter the IP address and the device name of the PSS 4000 system. In this example:
  - IP address of PSS 4000 head module is “169.254.060.110”.
  - Device name is “PSS_PLC”.
- Continue with “Finish”. The new head module will be generated.

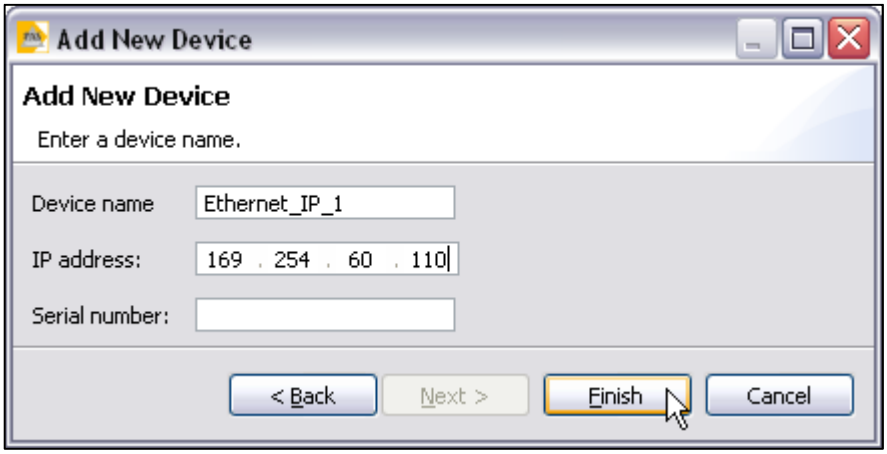


Fig. 39: PAS4000 – Finish device setting

- The “PSSu Module Editor” opens automatically now:
  Add electronic modules like Fig. 2: PAS4000 – Hardware Configuration PSS 4000, page7.
- Save your hardware configuration and continue with configuration of EtherNet/IP Adapter.

4.3.2. Configure of EtherNet/IP properties of PSS 4000 adapter

- Continue with the setup of EtherNet/IP configuration:
  - Double-Click at “EtherNet/IP Adapter”.

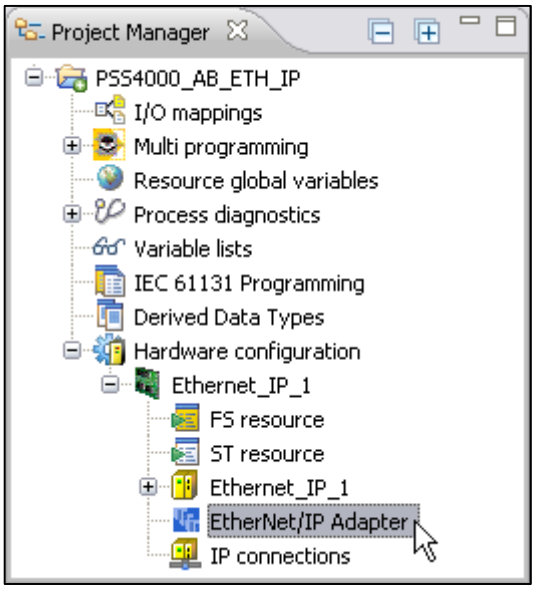


Fig. 40: PAS4000 – Open EtherNet/IP Adapter configuration

- Then you get this default setup:

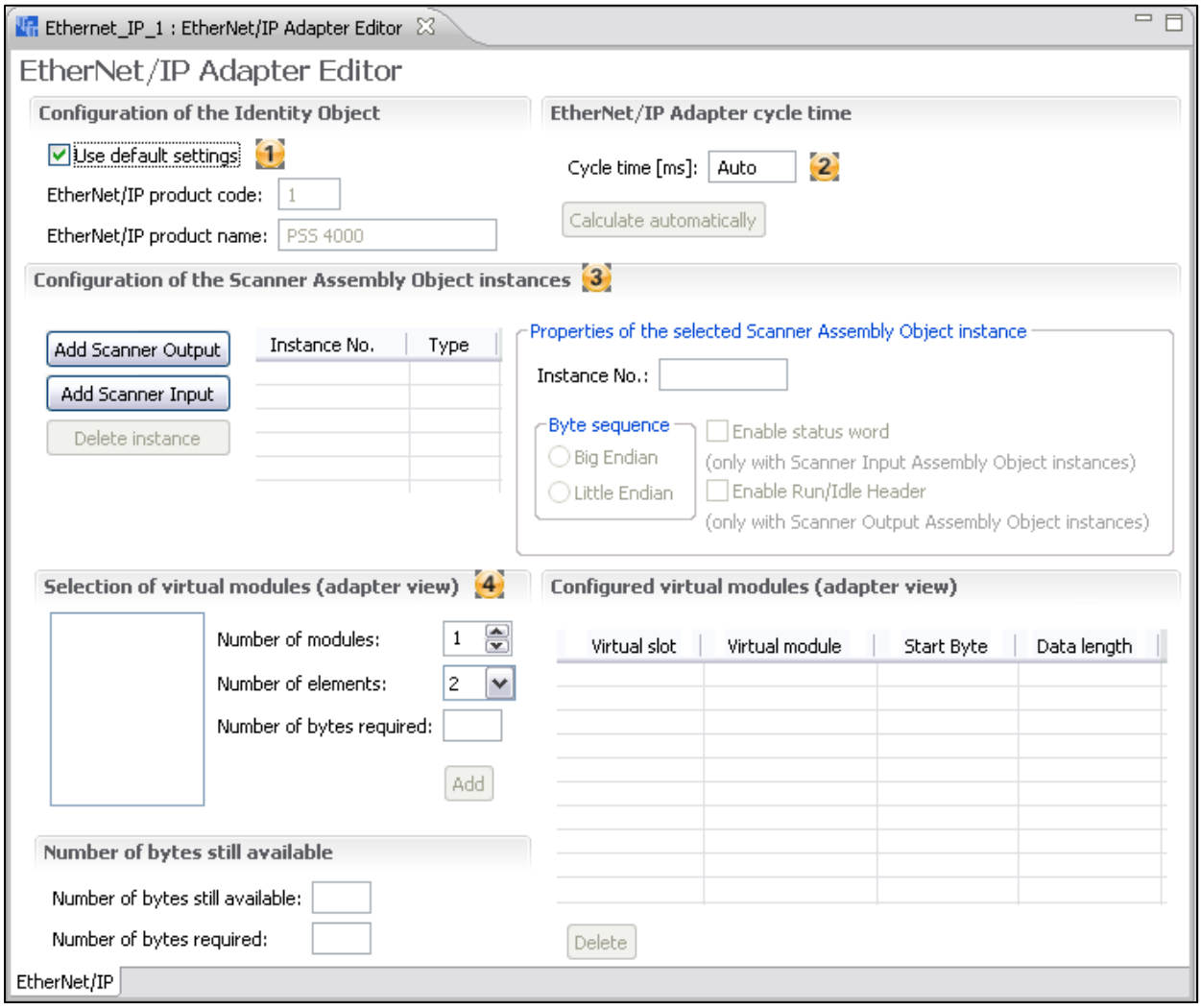


Fig. 41: PAS4000 – Default setup on “EtherNet/IP Adapter Editor”

- Block **Configuration of the Identity Object** 1
  - If the checkbox “Use default settings” is set (default setup), then:
    » Parameter “EtherNet/IP product code” has value “1” and
    » Parameter “EtherNet/IP product name” has string “PSS 4000”.
  - If the checkbox “Use default settings” is not set, then two following parameters have the values according to used actual head module. In this example:
    » Parameter “EtherNet/IP product code” has value “2070” (short for order number “312070”) and
    » Parameter “EtherNet/IP product name” has string “PSSu H PLC1 FS SN SD”.

Fig. 42: PAS4000 – Project-specific naming of “Configuration of the Identity Object”

Notice: Please use normally the **default name**!
- The **project-specific naming** is not recommended for future use in the tool RSLogix 5000, because in version lower than 20.xx.xx an EDS-file can be updated only for existing devices. Therefore you have to select for PSS 4000 adapter the standard “ETHERNET-MODULE – Generic Ethernet Module” (see also Fig. 11: RSLogix 5000 – Create new Generic Ethernet Module (2), page 13).

- Block **EtherNet/IP Adapter cycle time** 2
  - The default setup of “Cycle time [ms]” has string “Auto”.
  - You can also edit this value. In this example:
    » Parameter “Cycle time [ms]” has value “10” ms.

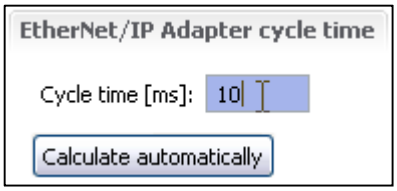


Fig. 43: PAS4000 – Project-specific value of parameter “Cycle time [ms]”

Notice: Please use normally the **automatic calculation**, then the calculation of this communication cycle time runs automatically with every build process and corresponding to the other cycle times.
- If you want to **set** this **cycle time manual**, please set also a value in field “Cycle time [ms]”.
  For additional information please see on PAS4000 Online-help:
  Chapter “Design guidelines for PSS 4000” > “Reaction times”.

- Block **Configuration of the Scanner Assembly Object instances** 3
  - Press button "**Add Scanner Output**":

    and
    in table instance "100 – Scanner Output Assembly Object instance" will be created.
  - For this instance:
    » Checkbox "Enable status word ..." is automatically deactivated and
    » Checkbox "Enable Run/Idle Header ..." is automatically activated.

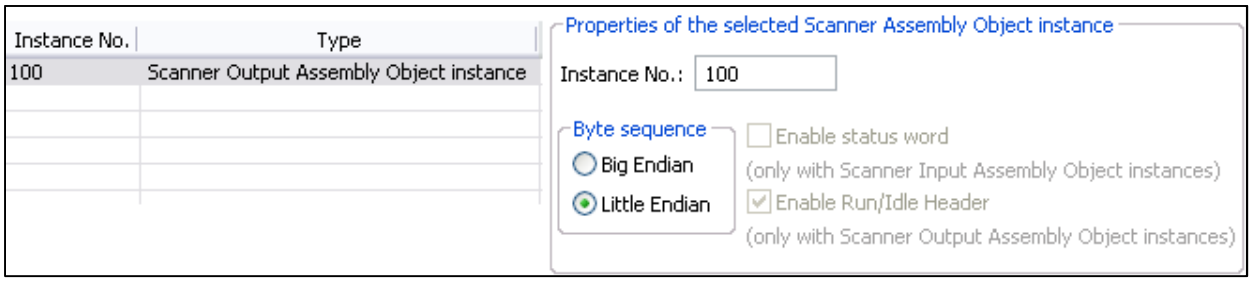


Fig. 44: PAS4000 – Function "Add Scanner Output" Object Instance

Notice:
- It is only **one instance** of Scanner Output allowed.
- For more information about Byte-order with parameter "Byte sequence" please see Chapter 5.2 Parameter "Byte sequence", page 48.
- For instance "100 – Scanner Output Assembly Object instance"
  » automatically activated checkbox "Enable Run/Idle Header..." used **4 "Configured Bytes"**
  » Result: maximum of 504 (of 508) Bytes for "Scanner Output Assembly Object instance" available:

- Press button “**Add Scanner Input**”

and
in table instance “101 – Scanner Input Assembly Object instance” will be created.
- For this instance:
  » Checkbox “Enable status word ...” is automatically activated and
  » Checkbox “Enable Run/Idle Header ...” is automatically deactivated.

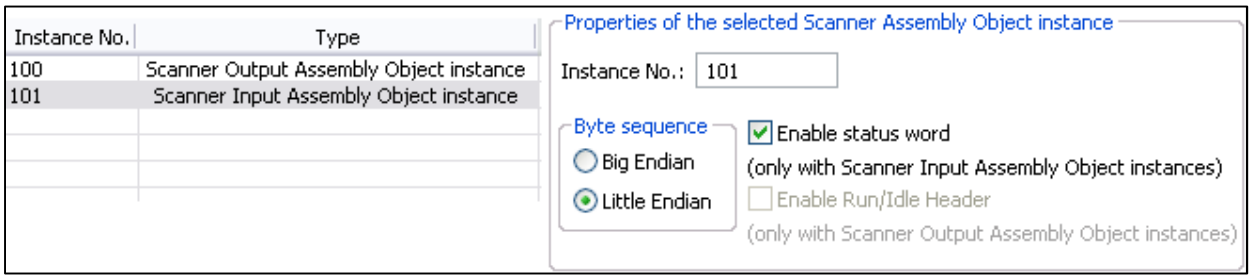
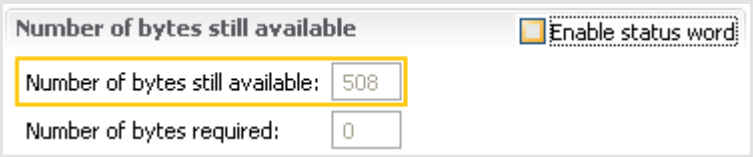


Fig. 45: PAS4000 – Function “Add Scanner Input” Object instance

Notice:
- It is only **one instance** of Scanner Input allowed.
- For more information about Byte-order with parameter “Byte sequence” please see Chapter 5.2 Parameter “Byte sequence”, page 48.
- For instance “101 – Scanner Input Assembly Object instance”
  » automatically activated checkbox “Enable status word...” **2 “Configured Bytes”**
  » Result: maximum of 506 (of 508) Bytes for “Scanner Input Assembly Object instance“ are available:

  » manually **de**activated checkbox “Enable status word...” used **0 “Configured Bytes”**
  » Result: maximum of 508 (of 508) Bytes for “Scanner Input Assembly Object instance “ are available:



Notice:
- If you want to use **several EtherNet/IP adapters** as PSS 4000 system for one scanner, you must change for the second and the following adapters the default values of **“Instance No.”** of every Object instance:
  » 1st Adapter: Scanner Output Assembly [100] and Scanner Input Assembly [101]
  » 2nd Adapter: Scanner Output Assembly [102] and Scanner Input Assembly [103]
  » 3rd Adapter: Scanner Output Assembly [104] and Scanner Input Assembly [105]
  ...
  » last possible combination: Scanner Output Assembly [197] and Scanner Input Assembly [198]

- **Example** for 2nd Adapter:

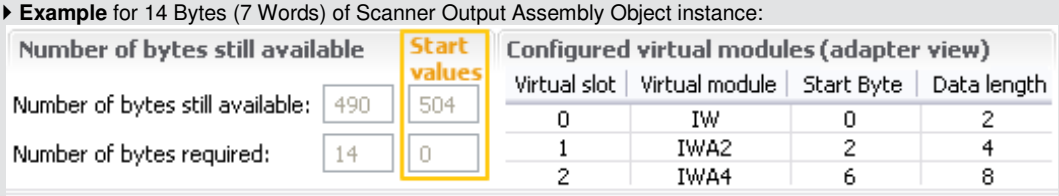
- Block **Selection of virtual modules (adapter view)** 4 for:
  - "**100 – Scanner Output Assembly Object instance**"
    from Scanner (ControlLogix) to Adapter (PSS 4000):
    - » **16IX**: adjustable numbers of modules of fixed 16 Input Bits
    - » **IBAn**: adjustable numbers of modules of selectable Input Bytes
    - » **IW**: adjustable numbers of modules of fixed Input Words
    - » **IWAn**: adjustable numbers of modules of selectable Input Words
    - » **ID**: adjustable numbers of modules of fixed Input Double-Words

Virtual module	Data type	Application
16IX	ARRAY [0..15] OF BOOL	Virtual EtherNet/IP Bit module To receive an array with 16 elements of data type BOOL
IBAn	ARRAY [0..(n-1)] OF BYTE	Virtual EtherNet/IP Byte module To receive an array with n elements of data type BYTE n = 2, 4, 8, 16, 32 or 64
IW	WORD	Virtual EtherNet/IP Word module To receive data of data type WORD
IWAn	ARRAY [0..(n-1)] OF WORD	Virtual EtherNet/IP Word module To receive an array with n elements of data type WORD n = 2, 4, 8, 16, 32 or 64
ID	DWORD	Virtual EtherNet/IP Double-Word module To receive data of data type DWORD

  - "**101 – Scanner Input Assembly Object instance**"
    from Adapter (PSS 4000) to Scanner (ControlLogix):
    - » **16OX**: adjustable numbers of modules of fixed 16 Output Bits
    - » **OBAn**: adjustable numbers of modules of selectable Output Bytes
    - » **OW**: adjustable numbers of modules of fixed Output Words
    - » **OWAn**: adjustable numbers of modules of selectable Output Words
    - » **OD**: adjustable numbers of modules of fixed Output Double-Words

Virtual module	Data type	Application
16OX	ARRAY [0..15] OF BOOL	Virtual EtherNet/IP Bit module To send an array with 16 elements of data type BOOL
OBAn	ARRAY [0..(n-1)] OF BYTE	Virtual EtherNet/IP Byte module To send an array with n elements of data type BYTE n = 2, 4, 8, 16, 32 or 64
OW	WORD	Virtual EtherNet/IP Byte module To send data of data type WORD
OWAn	ARRAY [0..(n-1)] OF WORD	Virtual EtherNet/IP Word module To send an array with n elements of data type WORD n = 2, 4, 8, 16, 32 or 64
OD	DWORD	Virtual EtherNet/IP Double-Word module To send data of data type DWORD

Notice:
- Parameter "**Number of modules**" is the adjustable number of the selected virtual module type.
  This is available for all virtual modules Adapter types.
- Parameter "**Number of elements**" is the selectable number of elements for selected virtual module type
  This is available only for: IBAn, IWAn, OBAn, OWAn
  - » If you select another type, then this parameter is not available (light grey) and the value is not correct!
- Parameter "**Number of bytes required**" is the calculated number of Bytes for selected virtual module type.
- **Example** for 14 Bytes (7 Words) of Scanner Output Assembly Object instance:



- Maximum **data transfer rates** (from perspective of used PAS4000 version 1.8.0)
  - » from Scanner (ControlLogix) to Adapter (PSS 4000): 508 Bytes (504 process data + 4 for Run/Idle Header)
  - » from Adapter (PSS 4000) to Scanner (ControlLogix): [A] 508 Bytes (506 process data + 2 statuswWord)
    [B] 508 Bytes pure process data without status word

IMPORTANT: From perspective of used RSLogix 5000 version 12.06.00
the ControlLogix EtherNet/IP Scanner can transmit less data!
(for details please see Ch. 4.2.1 Prepare ControlLogix PLC with EtherNet/IP adapter, page 10ff)

4.3.3. Cyclical process data exchange on PSS 4000 side (Implicit messages)

- Setup for PAS4000 program
  - **Scanner Output Assembly Object instance**:
    - Instance Number: 100
    - Byte-Order: Little Endian
    - Run/Idle-Header: Enabled (4x Byte)
    - 16 Input Bits: 1x 16IX (2x Byte)
    - 1 Input Word: 1x IW (2x Byte)
    - Configured Bytes: **8 Bytes** (“4 Bytes” is displayed)

Notice: On RSLogix 5000 configuration you must set **only 4 Bytes** for process data.
Here there are the 4 Bytes for Run/Idle Header always included.

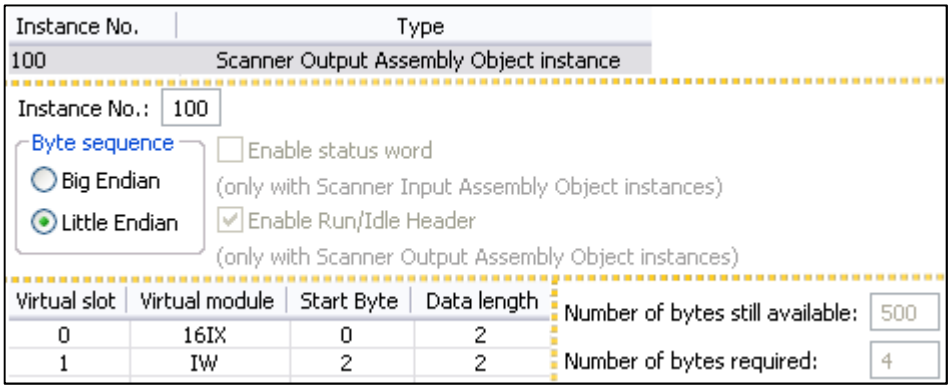


Fig. 46: PAS4000 – Setup for Scanner Output Assembly on “EtherNet/IP Adapter Editor”

- **Scanner Input Assembly Object instance**:
  - Instance Number: 101
  - Byte-Order: Little Endian
  - Status word: Enabled
  - 16 Output Bits: 1x 16OX
  - 1 Output Word: 1x OW
  - Configured Bytes: **6 Bytes**

Notice: On RSLogix 5000 configuration you must set all **6 Bytes**, 4 Bytes for process data and 2 Bytes for status word

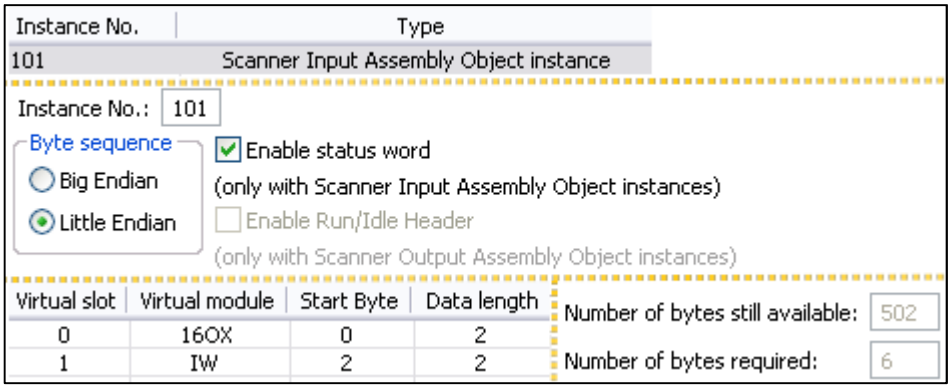


Fig. 47: PAS4000 – Setup for Scanner Input Assembly on “EtherNet/IP Adapter Editor”

- Save all editors:

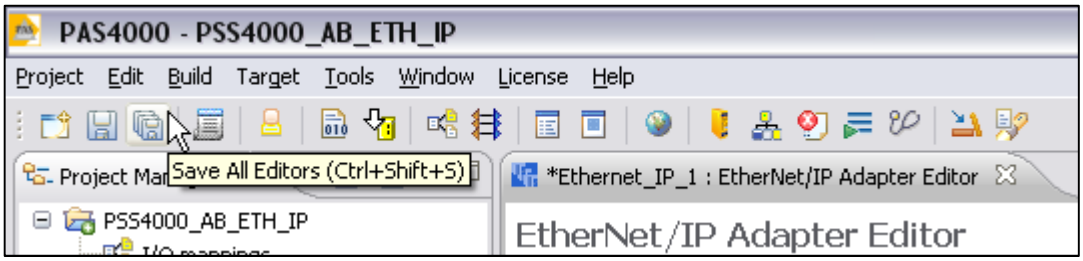


Fig. 48: PAS4000 – Save all Editors (1)

4.3.3.1. [A] PI-Variables of PAS4000-Program «– EtherNet/IP –» RSLogix 5000-Program

Here the process data is generated in the program code (Pre-processing on PSS 4000 side), and then used on the Allen-Bradley side.

- Create a new “POU”:
  - Click with right mouse button on “IEC 61131 Programming”.
  - Click at “New” and choose “POU”.

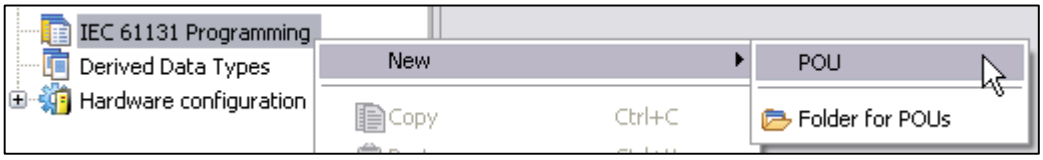


Fig. 49: PAS4000 – Create new POU

- Set the properties of this POU
  - Choose a name. In this example the Name is “POU_1”.
  - Set the Programming language to “IL: Instruction List” and
  - the Type to “Program”.
- Continue with “OK”.

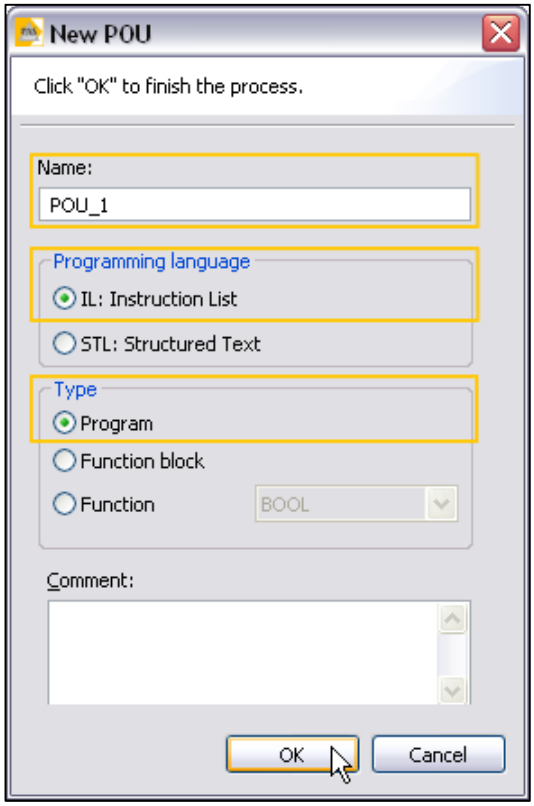


Fig. 50: PAS4000 – Settings of new POU

- Enter the program code for “POU_1” as shown in the following figure:
- Declaration part

```
001 PROGRAM POU_1
002 VAR
003   ST_Output01 AT %q*: BOOL;
004   ST_Output02 AT %q*: BOOL;
005   ST_Input01 AT %i*: BOOL;
006   ST_Input02 AT %i*: BOOL;
007
008   ST_Output_WORD01 AT %q* : WORD;
009   ST_Input_WORD01 AT %i* : WORD;
010   ST_ROR_IN1 : WORD :=WORD#2#0001;
011   ST_ROR_N1 : DINT :=1;
012   ST_CompareEqual : BOOL;
013   ST_CompareNotEqual : BOOL;
014 END_VAR
```

- Instruction part

```
015   // Standard Bit data
016   LDN  ST_Input02
017   ST   ST_Output02
018   STN  ST_Output01
019   LDN  ST_Input01
020   ST   ST_Output01
021   STN  ST_Output02
022
023   // Comparison, if the generated Output-Word on PSS4000 side
024   // is NOT EQUAL to the returned Input-Word from AB side.
025   // If TRUE, do nothing; else lead the code continues.
026   LD   ST_Input_WORD01
027   NE   ST_Output_WORD01
028   ST   ST_CompareNotEqual
029   LD   ST_CompareNotEqual
030   JMPC ENDE
031   // Comparison, if the generated Output-Word on PSS4000 side
032   // is EQUAL to the returned Input-Word from AB side.
033   // If TRUE, generate next Output-Word.
034   LD   ST_Input_WORD01
035   EQ   ST_Output_WORD01
036   ST   ST_CompareEqual
037   LD   ST_CompareEqual
038   // Rotate right the 16 Bit with start value
039   // and set it to Output-WORD.
040   JMPC ROR1
041   JMP  ENDE
042   ROR1:
043   ROR(
044   IN := ST_ROR_IN1,
045   N := ST_ROR_N1
046   )
047   ST   ST_ROR_IN1
048   LD   ST_ROR_IN1
049   ST   ST_Output_WORD01
050   ENDE:
051 END_PROGRAM
```

Notice: This program code is only an example.

The 4 failsafe outputs are directly wired to the 4 failsafe inputs in the same order.
The 4 standard outputs are directly wired to the 4 standard inputs in the same order.

- “Save all Editors”.

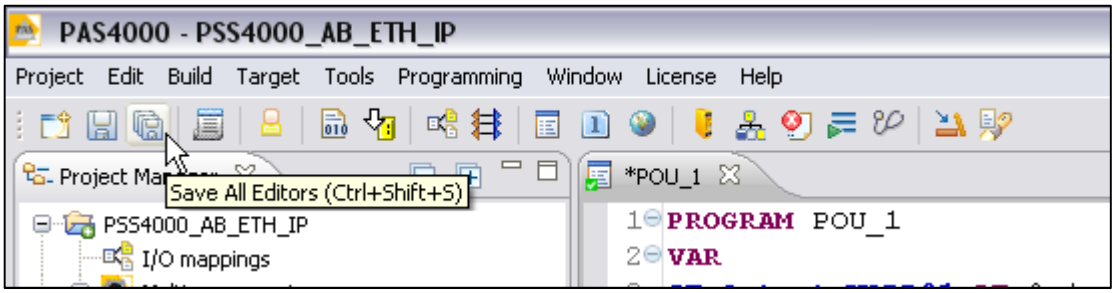


Fig. 51: PAS4000 – Save all Editors (2)

- Assign the program resource to the PLC head module
  Drag “POU_1 [PRG]” and drop it to the “PSS_PLC” hardware.

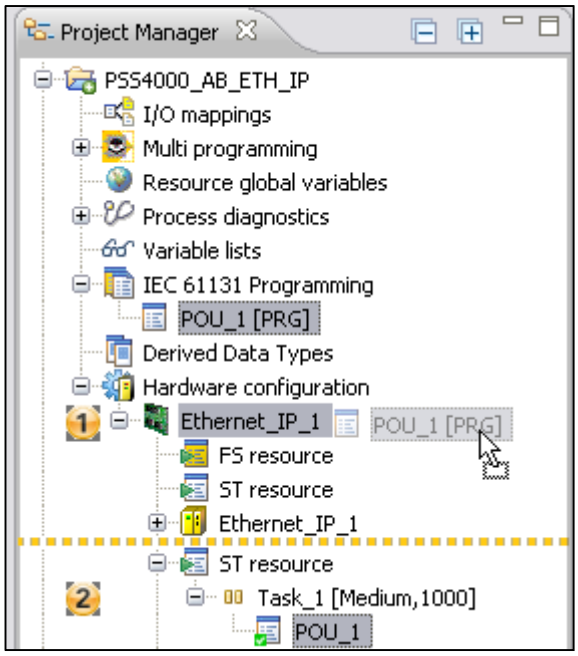


Fig. 52: PAS4000 – Assign POU to PSS 4000 PLC

- Now you have to set the I/O mappings.
  Double-Click at “I/O mappings”

Fig. 53: PAS4000 – Start I/O mapping

- Set filter to “PI variables < - > EtherNet/IP”.

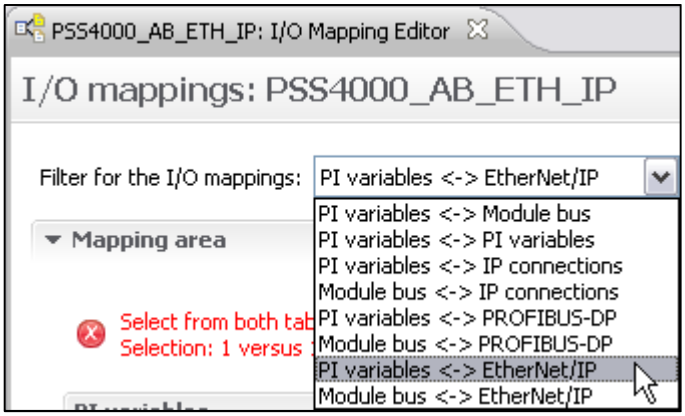


Fig. 54: PAS4000 – Set Filter of I/O mappings (PI variables < - > EtherNet/IP) [A]

- Assign I/Os of the PI variables to I/O data of EtherNet/IP connection.

  Set ...
  - POU_1 data “ST_Input01/02” to ...
    ... Assembly Object 100 – 0 : 16IX : ARRAY [0..15] of BOOL “InputData[0/1]”
  - POU_1 data “ST_Input_WORD01” to ...
    ... Assembly Object 100 – 1 : IW : WORD “InputData”
  - POU_1 data “ST_Output01/02” to ...
    ... Assembly Object 101 – 0 : 16OX : ARRAY [0..15] of BOOL “OutputData[0/1]”
  - POU_1 data “ST_Output_WORD01” to ...
    ... Assembly Object 101 – 1 : OW : WORD “OutputData”

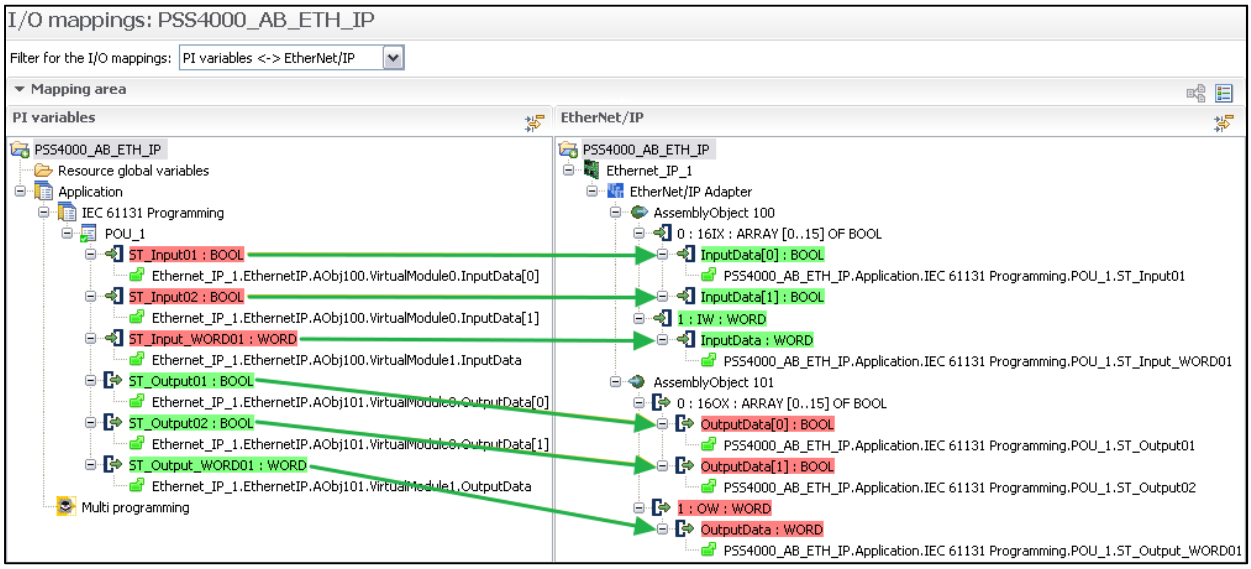


Fig. 55: PAS4000 – Assign I/Os of PI variables to I/O data of EtherNet/IP connection [A]

Notice: After I/O assignment the “PI variables” and “I/O data EtherNet/IP” have to change colour to green or red.

Overview of I/O mappings

Block	Data type	Direction	PI variable	...	Device	Assembly Object	Virtual Slot	Module	Data	Datatype
POU_1	BOOL	Input	POU_1.ST_Input01	<--	Ethernet_IP_1	100	0	16IX	InputData[0]	BOOL
POU_1	BOOL	Input	POU_1.ST_Input02	<--	Ethernet_IP_1	100	0	16IX	InputData[1]	BOOL
POU_1	WORD	Input	POU_1.ST_Input_WORD01	<--	Ethernet_IP_1	100	1	IW	InputData	WORD
POU_1	BOOL	Output	POU_1.ST_Output01	-->	Ethernet_IP_1	101	0	16OX	OutputData[0]	BOOL
POU_1	BOOL	Output	POU_1.ST_Output02	-->	Ethernet_IP_1	101	0	16OX	OutputData[1]	BOOL
POU_1	WORD	Output	POU_1.ST_Output_WORD01	-->	Ethernet_IP_1	101	1	OW	OutputData	WORD

Fig. 56: PAS4000 – Result of correct Assignment, Part [A]

4.3.3.2. [B] PSS 4000-I/O data of Module bus «– EtherNet/IP –» RSLogix 5000-Program

Here I/O data of the PSS 4000 system are read and write directly from Allen-Bradley side.
The outputs on PSS 4000 I/O modules are directly wired to its inputs of same type (FS and ST).

- Set filter to “Module bus < - > EtherNet/IP”.

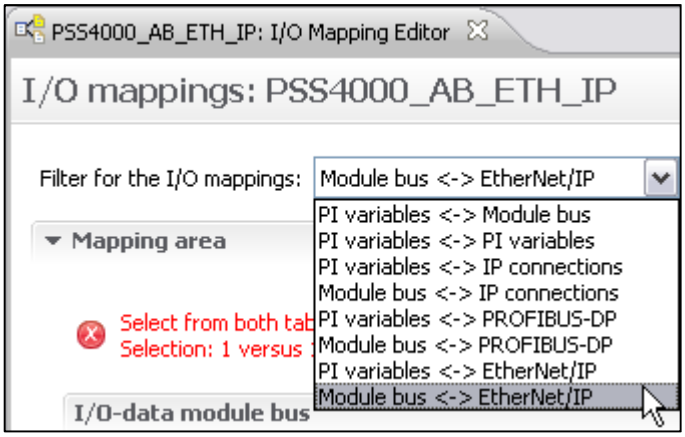
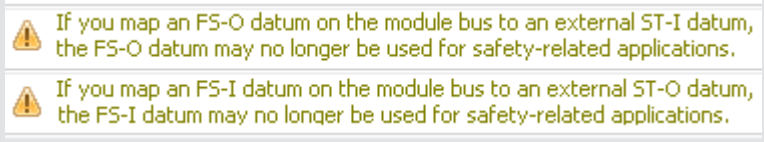


Fig. 57: PAS4000 – Set Filter of I/O mappings (Module bus < - > EtherNet/IP) [B]

- Assign I/O-data of module bus to I/O data of EtherNet/IP connection.
  Set ...
  - Ethernet_IP_1 FS Outputs “O0(11)..O3(24)”of “0 : PSSu E F 4DO 0.5” to ...
    ... Assembly Object 100 – 0 : 16IX : ARRAY [0..15] of BOOL “InputData[8..11]”
  - Ethernet_IP_1 FS Inputs “I0(11)..I3(24)”of “0 : PSSu E F 4DI” to ...
    ... Assembly Object 101 – 0 : 16OX : ARRAY [0..15] of BOOL “OutputData[8..11]”
  - Ethernet_IP_1 ST Outputs “O0(11)..O3(24)”of “2 : PSSu E S 4DO 0.5” to ...
    ... Assembly Object 100 – 0 : 16IX : ARRAY [0..15] of BOOL “InputData[12..15]”
  - Ethernet_IP_1 ST Inputs “I0(11)..I3(24)”of “3 : PSSu E S 4DI” to ...
    ... Assembly Object 101 – 0 : 16OX : ARRAY [0..15] of BOOL “OutputData[12..15]”

Notice: You cannot use Failsafe I/Os for safety-related applications, if you assign an FS datum to an (external) ST datum!



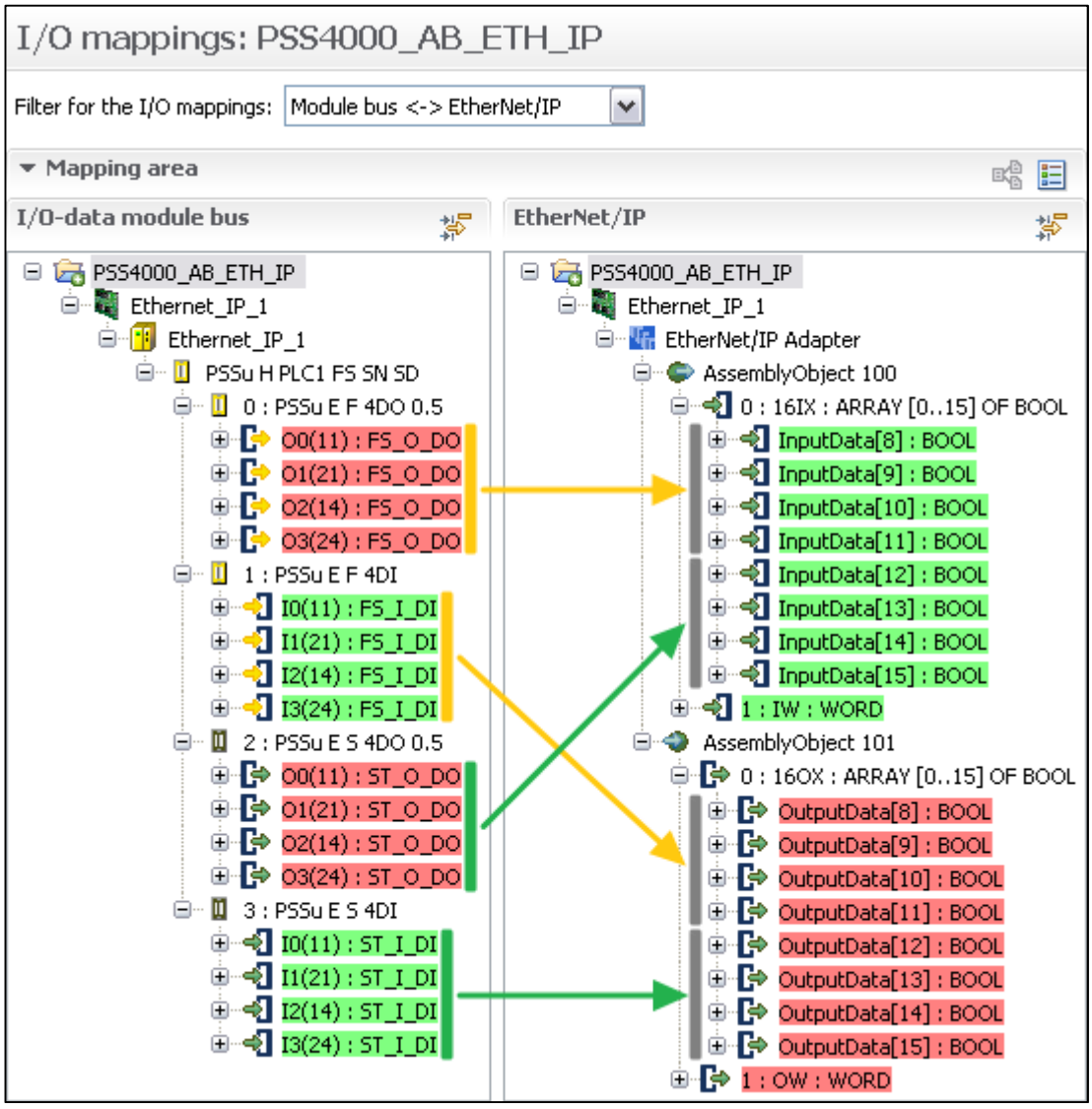


Fig. 58: PAS4000 – Assign I/O-data of module bus to I/O data of EtherNet/IP connect. [B]

Overview of I/O mappings

Device	Slot	Module	Terminal	Data type	N...	Direction	:::	Device	Assembly Object	Virtual Slot	Module	Data	Datatype
Ethernet_IP_1	0	PSSu E F 4DO 0.5	11	SAFEBOOL	Data	Output	<--	Ethernet_IP_1	100	0	16IX	InputData[8]	BOOL
Ethernet_IP_1	0	PSSu E F 4DO 0.5	21	SAFEBOOL	Data	Output	<--	Ethernet_IP_1	100	0	16IX	InputData[9]	BOOL
Ethernet_IP_1	0	PSSu E F 4DO 0.5	14	SAFEBOOL	Data	Output	<--	Ethernet_IP_1	100	0	16IX	InputData[10]	BOOL
Ethernet_IP_1	0	PSSu E F 4DO 0.5	24	SAFEBOOL	Data	Output	<--	Ethernet_IP_1	100	0	16IX	InputData[11]	BOOL
Ethernet_IP_1	1	PSSu E F 4DI	11	SAFEBOOL	Data	Input	-->	Ethernet_IP_1	101	0	16OX	OutputData[8]	BOOL
Ethernet_IP_1	1	PSSu E F 4DI	21	SAFEBOOL	Data	Input	-->	Ethernet_IP_1	101	0	16OX	OutputData[9]	BOOL
Ethernet_IP_1	1	PSSu E F 4DI	14	SAFEBOOL	Data	Input	-->	Ethernet_IP_1	101	0	16OX	OutputData[10]	BOOL
Ethernet_IP_1	1	PSSu E F 4DI	24	SAFEBOOL	Data	Input	-->	Ethernet_IP_1	101	0	16OX	OutputData[11]	BOOL
Ethernet_IP_1	2	PSSu E S 4DO 0.5	11	BOOL	Data	Output	<--	Ethernet_IP_1	100	0	16IX	InputData[12]	BOOL
Ethernet_IP_1	2	PSSu E S 4DO 0.5	21	BOOL	Data	Output	<--	Ethernet_IP_1	100	0	16IX	InputData[13]	BOOL
Ethernet_IP_1	2	PSSu E S 4DO 0.5	14	BOOL	Data	Output	<--	Ethernet_IP_1	100	0	16IX	InputData[14]	BOOL
Ethernet_IP_1	2	PSSu E S 4DO 0.5	24	BOOL	Data	Output	<--	Ethernet_IP_1	100	0	16IX	InputData[15]	BOOL
Ethernet_IP_1	3	PSSu E S 4DI	11	BOOL	Data	Input	-->	Ethernet_IP_1	101	0	16OX	OutputData[12]	BOOL
Ethernet_IP_1	3	PSSu E S 4DI	21	BOOL	Data	Input	-->	Ethernet_IP_1	101	0	16OX	OutputData[13]	BOOL
Ethernet_IP_1	3	PSSu E S 4DI	14	BOOL	Data	Input	-->	Ethernet_IP_1	101	0	16OX	OutputData[14]	BOOL
Ethernet_IP_1	3	PSSu E S 4DI	24	BOOL	Data	Input	-->	Ethernet_IP_1	101	0	16OX	OutputData[15]	BOOL

Fig. 59: PAS4000 – Result of correct Assignment, Part [B]

Notice: The 4 failsafe outputs are directly wired to the 4 failsafe inputs in the same order.
The 4 standard outputs are directly wired to the 4 standard inputs in the same order.

4.3.4. Acyclical data exchange on PSS 4000 side (Explicit messages)

- Acyclical data exchange as "Explicit Message Server" is supported as:
  - Explicit Message Server functionality for explicit data
  - data exchange with the following CIP objects:
    - Identity Object (Class ID 0x01),
    - Port Object (Class ID 0xF4),
    - TCP/IP Object (Class ID 0xF5) and
    - Link Object (Class ID 0xF6)
  - Common Services:
    - Get Services
      - » “Get_Attribute_All” (Service Code 0x01) and
      - » “Get_Attribute_Single” (Service Code 0x0E)
    - Set Services
    - Reset Services (Service Code 0x00 or 0x01)

- For more details please see:
  - PAS4000 help,
    Chapter: Hardware configuration
    > Configuration of the EtherNet/IP Adapter
    > Basics on the EtherNet/IP Adapter
    > Supported EtherNet/IP objects and Common Services
  - Chapter 4.2.3 Acyclic data exchange on ControlLogix side, pages 18ff

4.3.5. Build and download project to PSS 4000 system

- First enter FS password:

Fig. 60: PAS4000 – Enter FS password

- "Build Changes", check the result of Build process and start "Download Project":

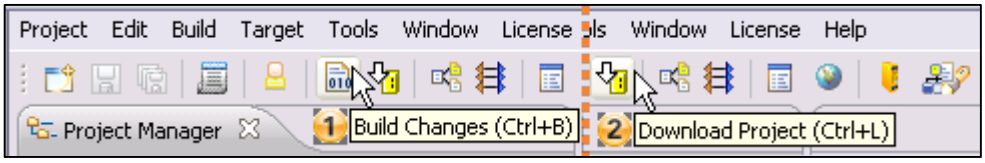


Fig. 61: PAS4000 – Build Changes and Start Download Project to Pilz PLC

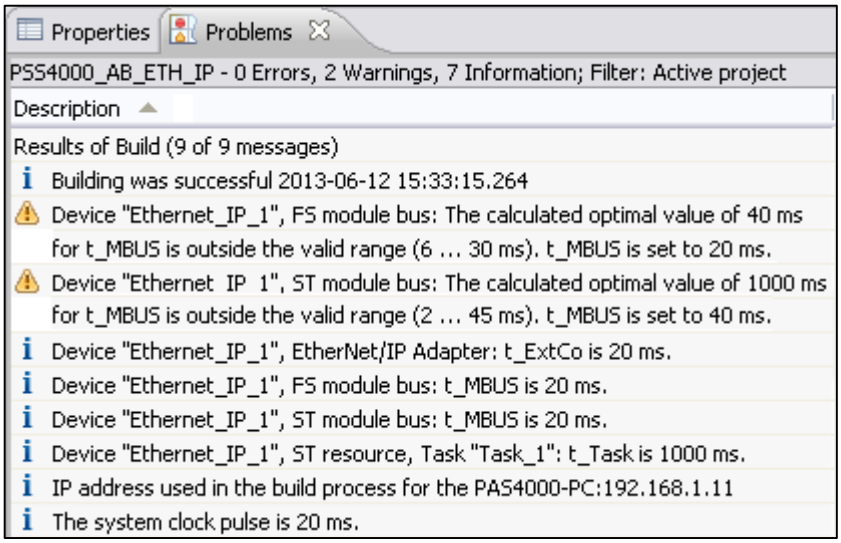


Fig. 62: PAS4000 – Result of Build process for example project

- Check the “Device” and continue with “Start Download”.

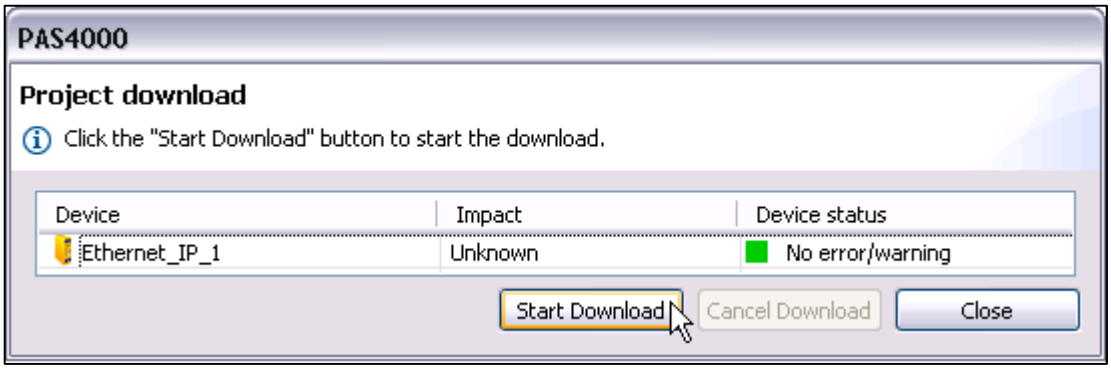


Fig. 63: PAS4000 – Check device and Start Download

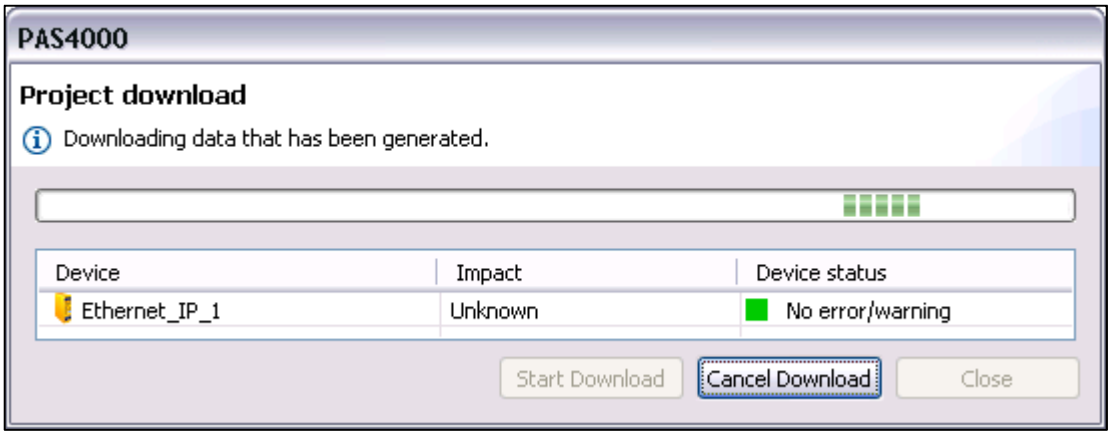


Fig. 64: PAS4000 – Project download and Restart of Pilz PLC

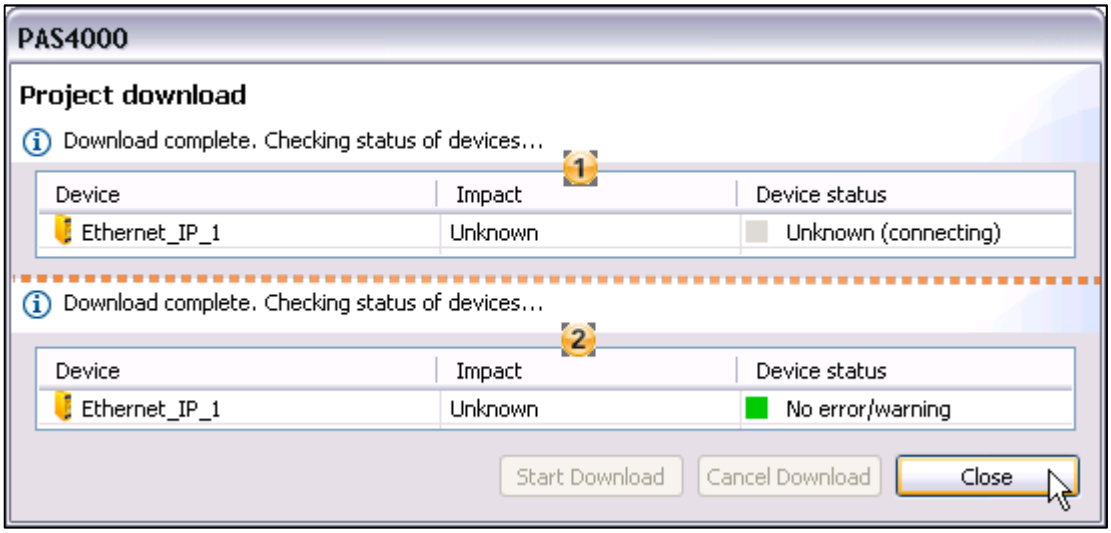


Fig. 65: PAS4000 – Close Project download

If the project download was successful, the EtherNet/IP communication of Pilz PLC is ready.

- Now you can exchange data between Allen-Bradley ControlLogix PLC and PSS 4000 PLC over EtherNet/IP.

Properties | Problems | Variable lists

Variable	Data type	Current value	Current value
VL01_PSS4000_AB_ETH_IP			
POU_1	**PROGRAM**		
ST_Output01	**BOOL**	TRUE	FALSE
ST_Output02	**BOOL**	FALSE	TRUE
ST_Input01	**BOOL**	FALSE	TRUE
ST_Input02	**BOOL**	TRUE	FALSE
ST_Output_WORD01	**WORD**	2#0010_0000_0000_0000	2#0000_0001_0000_0000
ST_Input_WORD01	**WORD**	2#0100_0000_0000_0000	2#0000_0010_0000_0000
ST_ROR_IN1	**WORD**	2#0010_0000_0000_0000	2#0000_0001_0000_0000
ST_ROR_N1	**DINT**	1	1
ST_CompareEqual	**BOOL**	TRUE	TRUE
ST_CompareNotEqual	**BOOL**	FALSE	FALSE

Fig. 66: PAS4000 – Cyclic change of process data

5. Appendix

5.1. Reaction times of cyclic data transfer

5.1.1. [A] Data transfer of PI-Variables of PAS4000-Program

Reaction times for mapping type “PI variables < - > EtherNet/IP”
Please see also Chapter 4.3.3.1 [A] PI-Variables of PAS4000-Program «– EtherNet/IP –» RSLogix 5000-Program, page 36ff.

- **I-data area with external communication -> Task**

$$t_{ExtCo\_Task\_max} = 2t_{ExtCo} + 2t_{Task}$$

$t_{ExtCo\_Task\_max}$:	Max. reaction time for this data subpath
t_{ExtCo} :	Cycle time for cyclical reading of the external I-data from the I-data area
t_{Task}:	Task cycle time of the task on the PSSu system

- **Task -> O-data area with external communication**

$$t_{Task\_ExtCo\_max} = 2t_{ExtCo}$$

$t_{Task\_ExtCo\_max}$:	Max. reaction time for this data subpath
t_{ExtCo} :	Cycle time for the cyclical start of data transfer from the O-data area with external communication

5.1.2. [B] Data transfer of PSS 4000-I/O data of Module bus

- Reaction times for mapping type “Module bus < - > EtherNet/IP”
  Please see also Chapter 4.3.3.2 [B] PSS 4000-I/O data of Module bus «– EtherNet/IP –» RSLogix 5000-Program, page 41ff.

- **I-data area with external communication -> Module bus**

$$t_{ExtCo\_MBUS\_max} = t_{ExtCo} + \min(t_{ExtCo}, t_{MBUS}) + t_{MBUS} + t_{ProcOM}$$

$t_{ExtCo\_MBUS\_max}$:	Max. reaction time for this data subpath
t_{ExtCo} :	Cycle time for cyclical reading of the external I-data from the I-data area with external communication
t_{MBUS}:	PSSu system's module bus cycle time
t_{ProcOM}:	Processing time for O-data on a module

- **Module bus -> O-data area with external communication**

$$t_{MBUS\_ExtCo\_max} = t_{ProcIM} + 2t_{ExtCo}$$

$t_{MBUS\_ExtCo\_max}$:	Max. reaction time for this data subpath
t_{ProcIM}:	Processing time for a module's I-data
t_{MBUS}:	PSSu system's module bus cycle time
t_{ExtCo} :	Cycle time for the cyclical start of data transfer from the O-data area with external communication

Notice: You find current information about reaction times of Automation System PSS 4000 in System Description - No. 1001467, Chapter 9.14.

5.2. Parameter “Byte sequence”

You can choose in PAS 4000 EtherNet/IP configuration on parameter “Byte sequence” the Byte order:

- **Big Endian**
  The most significant byte is transmitted first.
  It’s also called “Motorola format”, because it is compatible with Motorola 68k-processor series.
- **Little Endian**
  The least significant byte is transmitted first.
  It’s also called “Intel format”, because it is compatible with Intel x86-processor series.

For more information please see: Internet-Link to: Wikipedia about "Endianness".

Notice: The recommended Byte-order is **Little Endian**, it is also the default setting of hardware configuration on PAS4000.

Example:

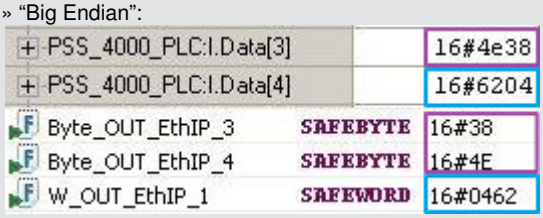
- The Byte-order on PSS 4000 side is always the same: 16#00CF_1974
- The Byte-order on Allen-Bradley side is for “Big Endian”: 16#CF00_7419

Fig. 67: Byte sequence – Big Endian, data type DWORD

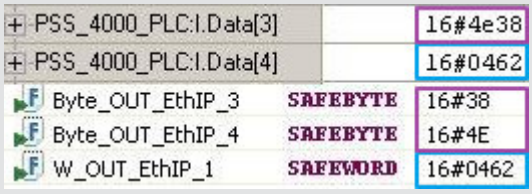
- The Byte-order on Allen-Bradley side is for “Little Endian”: 16#1974_00CF

Fig. 68: Byte sequence – Little Endian, data type DWORD

Notice:
- The Byte sequence is changed only for data types DWORD and WORD.
- For data type BYTE the Byte sequence cannot changed!
- Examples for data types (SAFE)BYTE and (SAFE)WORD
  » “Big Endian”:



  » “Little Endian”:



5.3. Status word: diagnostic data inside process data

As an option, the transmission of a status word can be configured in PAS4000 for the Scanner Input Assembly Object instance.
The status word contains device-based status information and is transmitted to the scanner for diagnostic purposes.

Notice: For actual information about status word:
» open in software “PAS4000” in menu “Help” the function "Contents and Index"
and
» choose chapter "Hardware configuration"
> “Configuration of the EtherNet/IP Adapter”
> “Basics on the EtherNet/IP Adapter”
> “EtherNet/IP diagnostics”: section “Structure and content of the status word”

5.3.1. Octet 1 of diagnostic data

Octet 1 contains error messages from the PSS 4000 device:

Bit	Value	Meaning	
0	0/1	Error message for the PSS 4000 device	
		0	▸ No message
		1	▸ A message of “Error” severity is present for at least one system section of the PSS 4000 device. or ▸ A major FS error is present for at least one FS system section of the PSS 4000 device. On PSSu systems, this corresponds to the status of the “DIAG” LED on the head module: Status: “lights up red” or “flashes red”.
1	0/1	Error in the FS/ST module bus system sections of the PSS 4000 device	
		0	▸ No message
		1	▸ Operating state: “Safe condition of all FS outputs on the PSSu system”. or ▸ At least one module cannot be accessed (e.g. a module has been removed during operation, actual/registered hardware does not match). or ▸ Operating state: “FS module bus in a STOP condition with error: Major FS error”. On PSSu systems, this corresponds to the status of the “MBUS” LED on the head module: Status: “lights up red” or “flashes red”.
2	0/1	Error in the "FS-SafetyNET p RTFN" system section of the PSS 4000 device	
		0	▸ No message
		1	▸ Operating state: “FS SafetyNET p RTFN in STOP condition with error: Major FS error”. or ▸ Operating state: “FS SafetyNET p RTFN in STOP condition with error: Major FS+ST error”. On PSSu systems, this corresponds to the status of the “FS SNp” LED on the head module: Status: “lights up red” or “flashes red”.
3	0/1	Error in the “FS-SafetyNET p RTFN” system section of the PSS 4000 device	
		0	▸ No message
		1	▸ Operating state: “ST SafetyNETp RTFN in STOP condition with error: Major FS+ST error". On PSSu systems, this corresponds to the status of the "ST SNp" LED on the head module: Status: “lights up red” or “flashes red”.
4	0	Reserved	
6	0	Reserved	
6	0	Reserved	
7	0	Reserved	

5.3.2. Octet 2 of diagnostic data

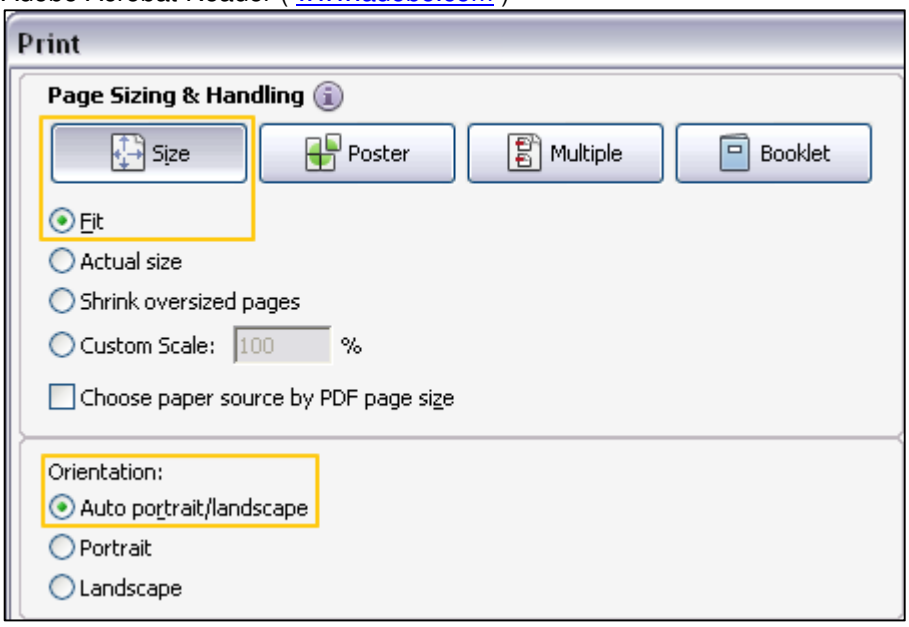
Octet 2 contains additional status information from the PSS 4000 device:

Bit	Value	Meaning	
0	0/1	Warning message for the PSS 4000 device	
		0	▸ No message
		1	▸ A message of “Warning” severity is present for the PSS 4000 device. On PSSu systems, this corresponds to the status of the “DIAG” LED on the head module: Status: “lights up orange”.
1	0/1	Forcing on the FS resource	
		0	▸ No message
		1	▸ Forcing on the FS resource is active. On PSSu systems, this corresponds to the status of the “FS FORCE” LED on the head module: Status: “lights up yellow”.
2	0/1	Forcing on the ST resource	
		0	▸ No message
		1	▸ Forcing on the ST resource is active. On PSSu systems, this corresponds to the status of the “ST FORCE” LED on the head module: Status: “lights up yellow”.
3	0	Reserved	
4	0	Reserved	
6	0	Reserved	
6	0	Reserved	
7	0	Reserved	

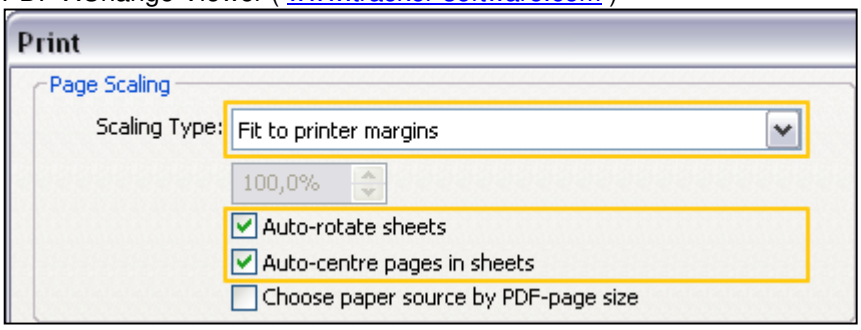
6. Table of figures

Recommended printer settings

Adobe Acrobat Reader (www.adobe.com)



PDF-XChange Viewer (www.tracker-software.com)



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In many countries we are represented by our subsidiaries and sales partners.

Please refer to our homepage for further details or contact our headquarters.

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