PROFINET IRT: Getting Started with The Siemens CPU 315 PLC

This document shows how to demonstrate a working design using the PROFINET isochronous real-time (IRT) device firmware. Associated equipment includes the Altera® DE2-115 Evaluation Board and the Siemens CPU 315 Programmable Logic Controller (PLC). You can use this design as the starting point for any custom design that can make use of Altera FPGAs and the Softing PROFINET IRT.

The steps in this document assume that the Altera DE2-115 board has been updated with the IP provided by Softing. Consult the Softing documentation for the appropriate steps to build, download, and optionally debug the firmware. For more information, refer to the Design for Multiple Industrial Ethernet Protocols page.

Required Equipment and Components

Review the following list of equipment and components:

- Siemens SIMATIC Step7 version 5.5 SP2.

  This version installs and runs on Microsoft Windows 7 (64-bit) and as WinXP running under Virtual PC on 64-bit Windows 7.

  Siemens SIMATIC Step7 version 5.5 *without SP2* installs and runs on Windows XP, but does not install on a 64-bit operating system. Altera strongly recommends Step7 version 5.5 including SP2.

  If you see the following message (Figure 1) when attempting to install SIMATIC Step7, please update the version of Step7 to SP2 or install on Windows XP 32-bit. Windows XP on Virtual PC also works.

Figure 1. Setup Warning for Incompatible Version

- Siemens PLC, CPU 315-2 PN/DP.

  Other Siemens S7-300 PLC models could work with this design, but for assured results, Altera recommends the CPU 315-2 PN/DP.

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- Siemens SIMATIC S7-300 memory card.
- Siemens Power Supply PS307 24 V/2A.

  You can also use an industrial 24-V, 1-A power supply.
- Altera DE2-115 Evaluation Board, or equivalent (Real-Time Ethernet Module (RTEM) from Softing).

  The instructions in this application note use the Altera DE2-115.
- CAT5 Ethernet Cables.
- *Optional*: Ethernet switch (managed or unmanaged).

  However, a managed switch with port mirroring capabilities is useful for debugging.
- *Optional*: Siemens USB PC adapter.

  All configuration can be done through the SIMATIC Step7 software through an Ethernet connection.

A list of Siemens part descriptions and inventory part number are provided in Table 1.

Table 1. Siemens Part Numbers

Siemens Part Description	Siemens Part Number
Siemens Step7 v5.5 SP2	SC 6ES78104CC100YA5
Siemens S7-300 Micro Memory Card	SC 6ES79538LJ300AA0
Siemens CPU 315-2 PN/DP, 384	SC 6ES73152EH140AB0
Siemens Power Supply PS307 24 V/2A	SC 6ES73071BA010AA0
SIMATIC S7-300 Rail	SC 6ES73901AE800AA0

Connect Devices

To connect the devices, perform these steps:

1. Connect the CPU 315-2 PN/DP to the power supply.
2. Connect the CPU 315 to the personal computer running Step7 through an Ethernet connection to one of the two Ethernet connectors, either directly or through a common Ethernet switch.
3. Connect power to the Altera DE2-115 board.
4. Connect Ethernet from the remaining Ethernet port on the CPU 315 to the Altera DE2-115 board.

The PROFINET-IRT design has a built-in time limitation that allows for a two-hour evaluation period. Contact your local FAE for a security development kit to extend the evaluation time period.

Installation and Setup

The installation and setup requires that you install Siemens Step7 v5.5 SP2 and initially accept all the defaults.

If you need to install a license, follow the installation instructions for getting the license installed.

After installation, perform the steps in next section. These steps assume that the software is running for the first time, so not all steps may be necessary.

Using the SIMATIC Manager

To open the SIMITAC Manager, perform the following:

1. From the **Start** button, click **Siemens Automation > SIMATIC > SIMATIC Manager**.

   When running for the first time, a dialog box may appear titled *STEP 7 Wizard: "New Project."* Click **Cancel** and continue with the following step 2.

2. From the SIMATIC Manager, click **Help > About** and verify the version is v5.5 + SP2.

3. Ensure the *Active* network interface is selected and that the PLC and INK board are connected using the *Active* TCP/IP network interface.

4. Ensure that the CAT5 network cable is connected directly between the PC or laptop and the PLC or INK board.

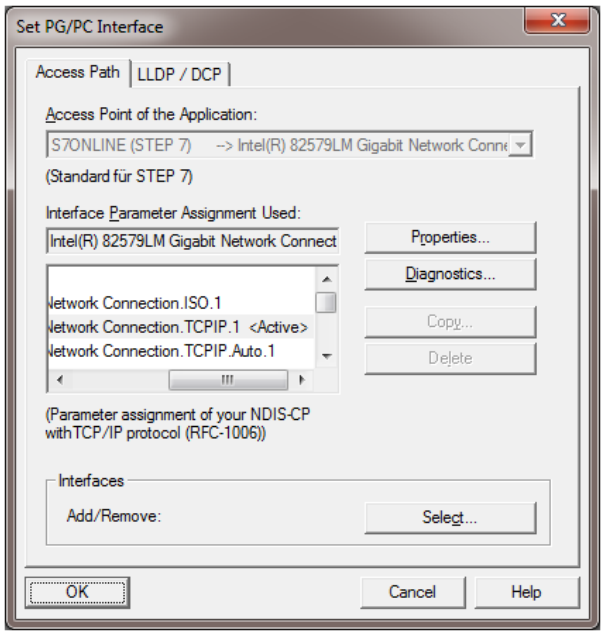
5. Ensure that the PLC and INK boards are connected through a CAT5 cable. It does not matter if the PC or laptop network interface TCP/IP address is set to the same TCP/IP subnet address or not.

6. Set the interface to the PLC and INK from the SIMATIC Manager: **Options > Set PG/PC Interface**. The **Set PG/PC Interface** dialog box (Figure 2 on page 4) appears.

7. Select the **Intel 82579LM Gigabit Network Connection.TCPIP.1 <Active>** interface parameter for the attached device under test (DUT) and click **OK**.

Figure 2 shows the **Intel 82579LM Gigabit Network Connection.TCPIP.1 <Active>** interface parameter assignment for configuring the PLC and INK.

Figure 2. Set PG/PC Interface

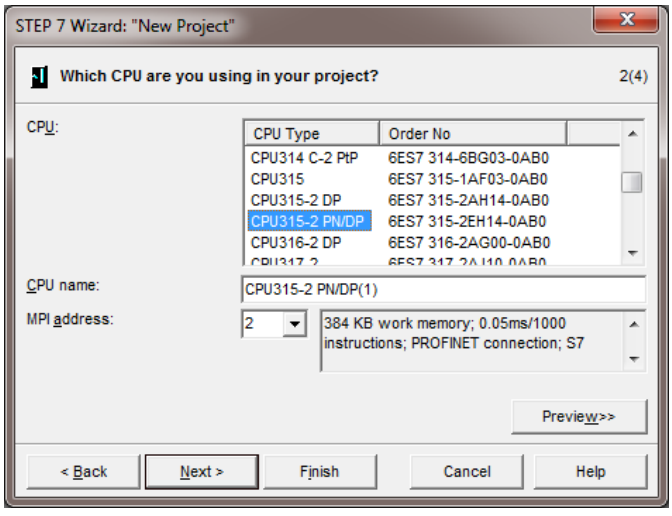


Creating a New Project

To create a new project, perform these steps:

1. From the SIMATIC Manager, click **File > New Project Wizard**. The **STEP 7 Wizard: "New Project"** dialog box appears, and click **Next**.
2. Select the PLC CPU type: **CPU315-2 PN/DP** as shown in Figure 3, and click **Next**.

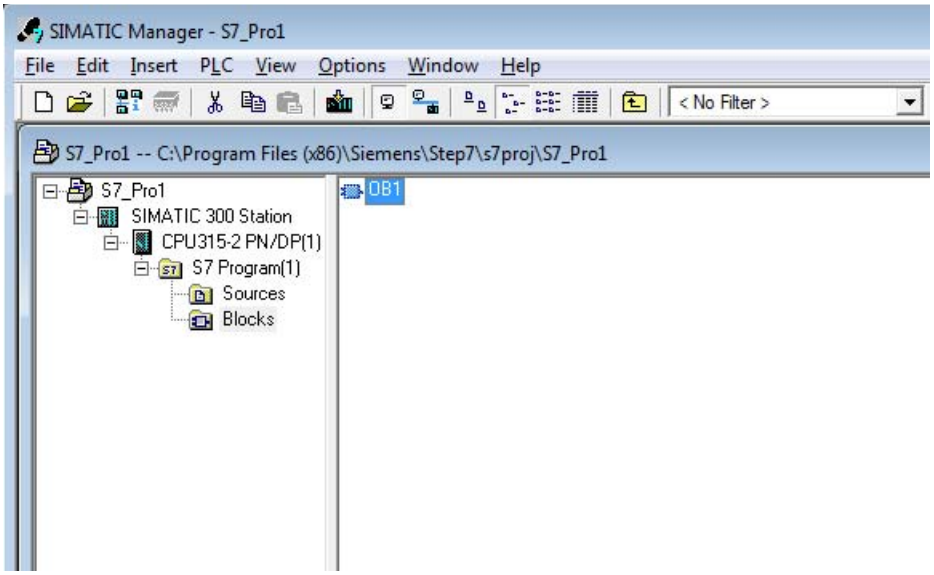
Figure 3. Choosing the CPU Type



3. Ensure that the **OB1 (Cycle Execution) Block** is checked and the **Language STL** option is selected, and click **Next**.
4. Edit the project name, or use the default name, and click **Finish**.

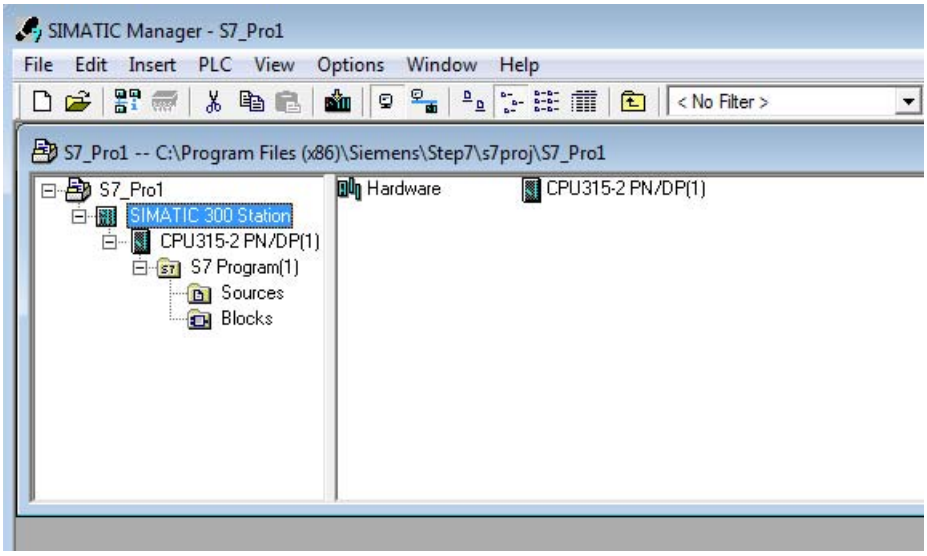
   After clicking **Finish**, the output should look like Figure 4. If the screen looks different, try clicking on **Blocks** in the left panel to display the **OB1** block in the right panel.

Figure 4. SIMATIC Manager with OB1 Block (Detail)



5. Click **SIMATIC 300 Station** in the left panel to reveal **Hardware** and **CPU315-2 PN/DP(1)** blocks in the right panel (Figure 5).

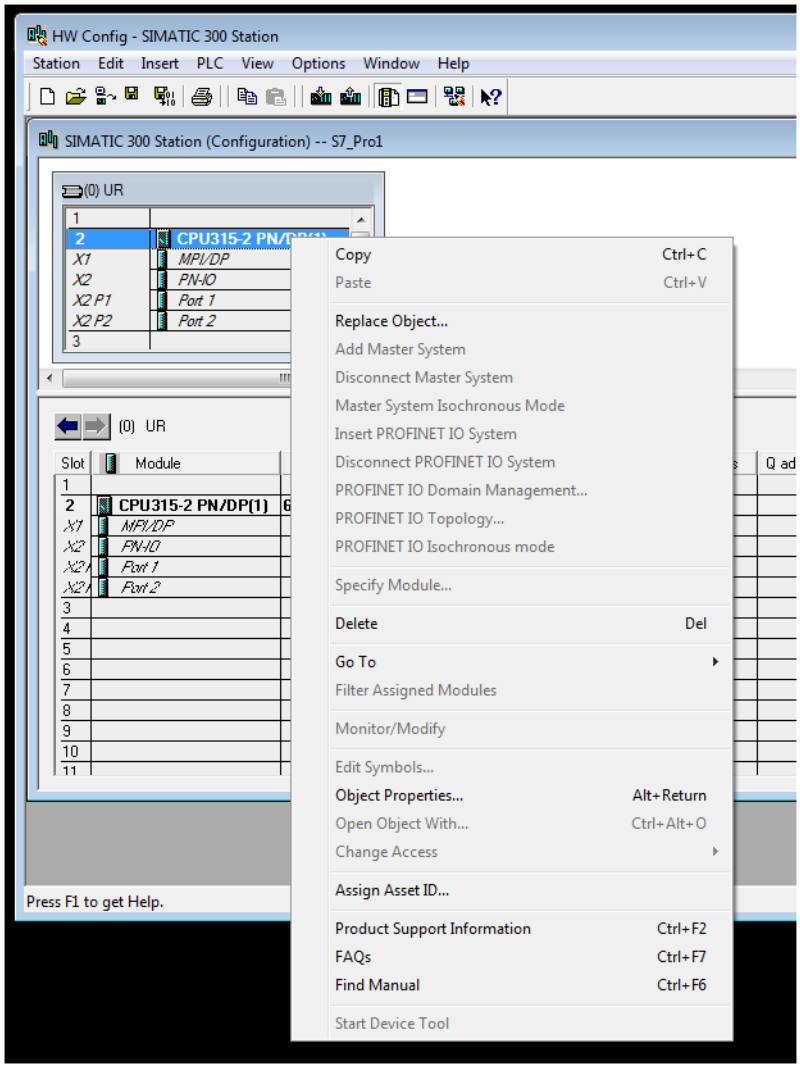
Figure 5. SIMATIC Manager with Hardware and CPU Blocks (Detail)



6. Double-click **Hardware** and a separate HW Config - SIMATIC 300 Station window should appear.

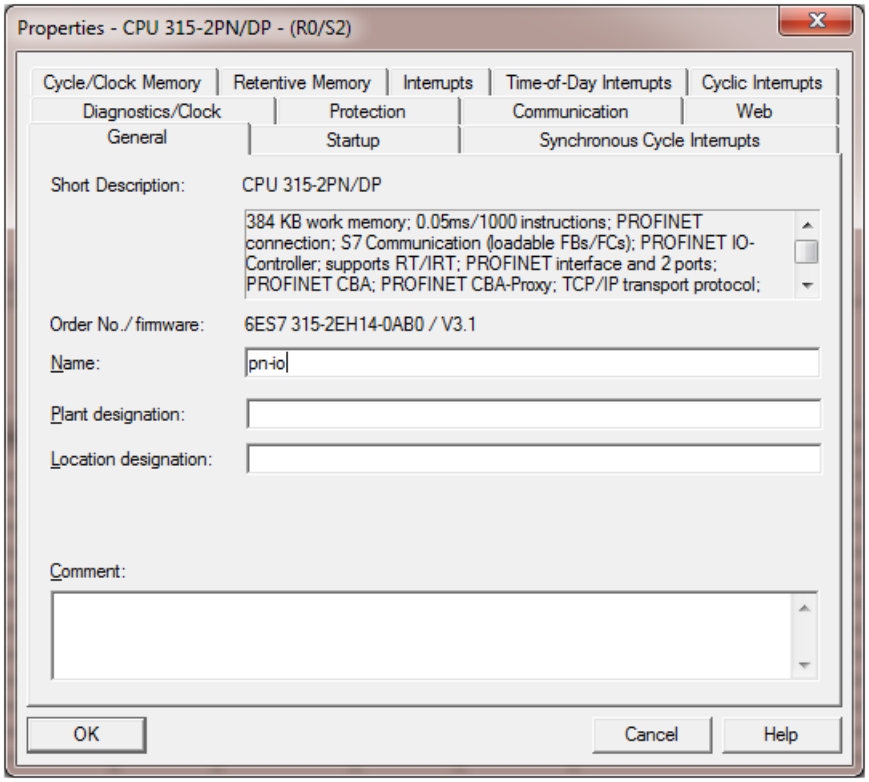
7. Right-click **CPU315-2 PN/DP(1)** and select **Object Properties** on the menu (Figure 6).

Figure 6. HW Config - SIMATIC 300 Station Window



8. In the **Properties** dialog box (Figure 7), change the **Name** property from `CPU315-2 PN/DP(1)` to `pn-io`, and click **OK**.

Figure 7. Properties Dialog Box



Inserting a New PROFINET I/O Network from the CPU Object

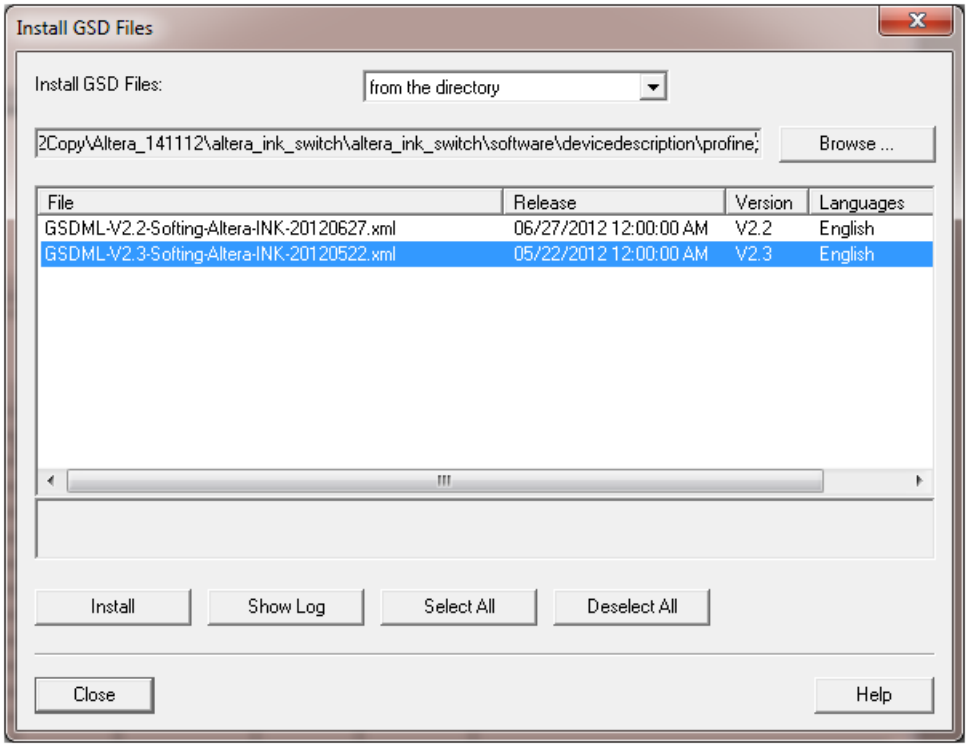
9. Left-click **PN-IO** in the top section of the Station Configuration window next to **X2**. This is not the same as the name you edited in the previous step.
10. Right-click **Insert PROFINET IO System** and the **Properties - Ethernet Interface** dialog appears.
11. Set the values for the **IP Address** and **Subnet mask** boxes to suitable addresses for your configuration. If you need a suggested address, try `172.20.40.1/255.255.0.0`.
12. Select the **Do not use router** radio button.
13. Click the **New** button next to the **Subnet** box and the **Properties - New Subnet** dialog box appears.
14. In the **Name** box, under the **General** tab, type `IRT`, and click **OK**.

Installing the GSD File for the Example Device

15. In the HW Config - SIMATIC 300 Station window, on the **Options** menu, click **Install GSD File** and the **Install GSD Files** dialog box appears.
16. In the **Install GSD Files** dialog box, click **Browse** and point to the directory where the **GSDML-V2.*.xml** is located. The directory is under **altera_ink_switch\software\devicedescription\profinet**.

17. Select **GSDML-V2.3-Softing-Altera-INK-20120522.xml** and click **Install** (Figure 8).

Figure 8. Install GSD Files Dialog Box



Adding the Softing I/O Device to the PROFINET IO Network

18. In the right panel of the HW Config - SIMATIC 300 Station window, under **PROFINET IO**, select **PROFINET IO Reference Device for Altera INK** (Figure 9) and drag it to connect to the **IRT: PROFINET-IO-System** network in the left panel as shown in Figure 10.

Figure 9. Right Panel on the SIMATIC 300 Station

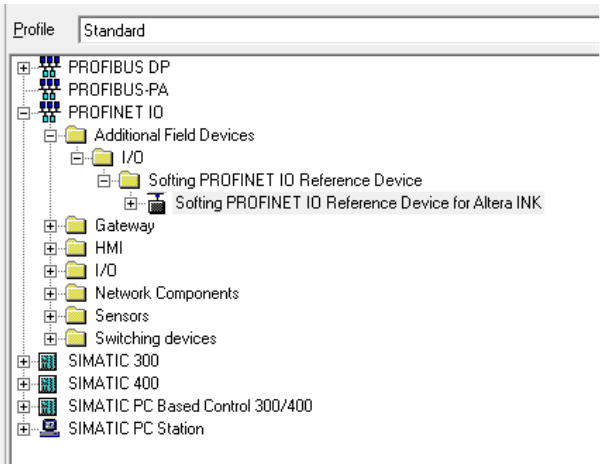
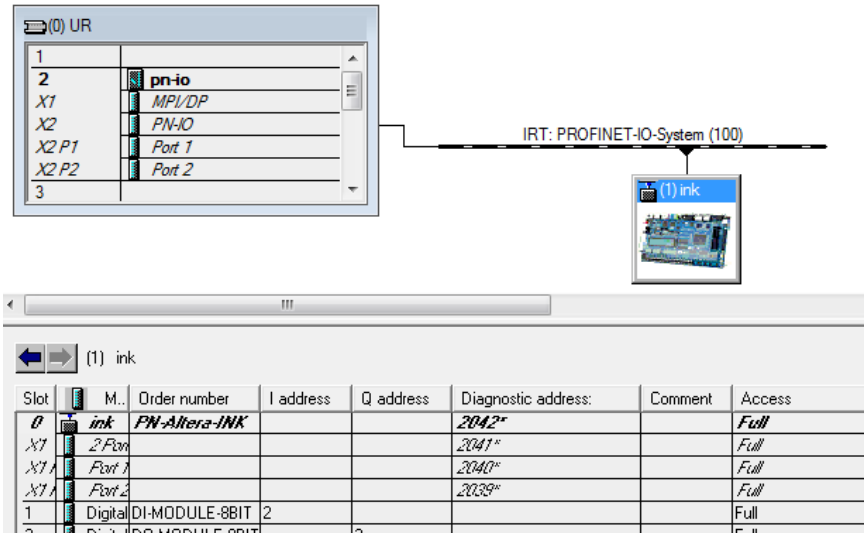


Figure 10. Left Panel on the SIMATIC 300 Station



When connected properly, you can see a picture of the INK as shown in Figure 10.

19. Right-click the INK picture, and select **Object Properties**. The **Properties** dialog box appears.
    a. In the **Device name** box, type the name `irt-ink`.
    b. Change the **Device number** to 3.
    c. Click the **Ethernet** button and set the **IP address** to `172.20.40.4`, and verify the **Subnet mask** is `255.255.0.0`.

20. In the bottom panel of the HW Config - SIMATIC 300 Station window, right-click the **X1** slot, select **Object Properties**, and the **Properties** dialog box appears.
    a. On the **General** tab, and change the **Name** to `irt-ink`.
    b. On the **IO Cycle** tab, change **Mode** to `Fixed update time` and **Update Time [ms]** to 16.000. Click **OK**.

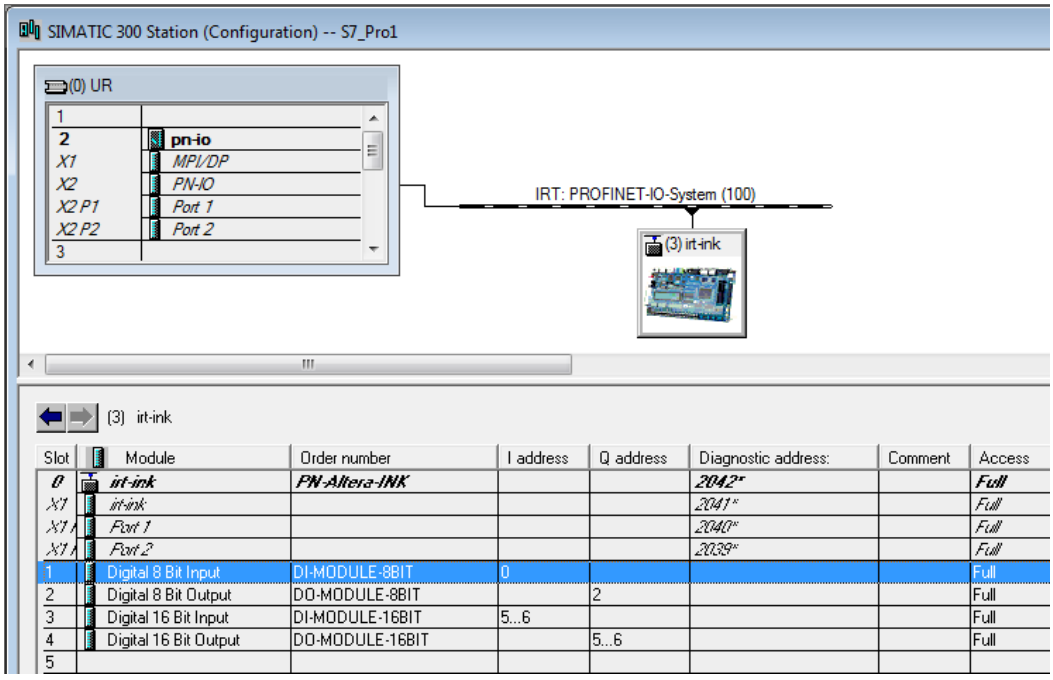
Setting the I/O Addresses on the INK

21. In the bottom panel of the SIMATIC 300 Station window, change the I/O addresses as shown in Table 2 and Figure 11.

Table 2. I/O Addresses on the INK

Slot	Module	Order number	I address	Q address
1	Digital 8 Bit Input	DI-MODULE-8BIT	0	—
2	Digital 8 Bit Output	DO-MODULE-8BIT	—	2
3	Digital 16 Bit Input	DI-MODULE-16BIT	5...6	—
4	Digital 16 Bit Output	DO-MODULE-16BIT	—	5...6

Figure 11. I/O Addresses on the INK (Detail)



22. Before switching back to the SIMATIC Manager window, select **Save and Compile** from the **Station** menu.

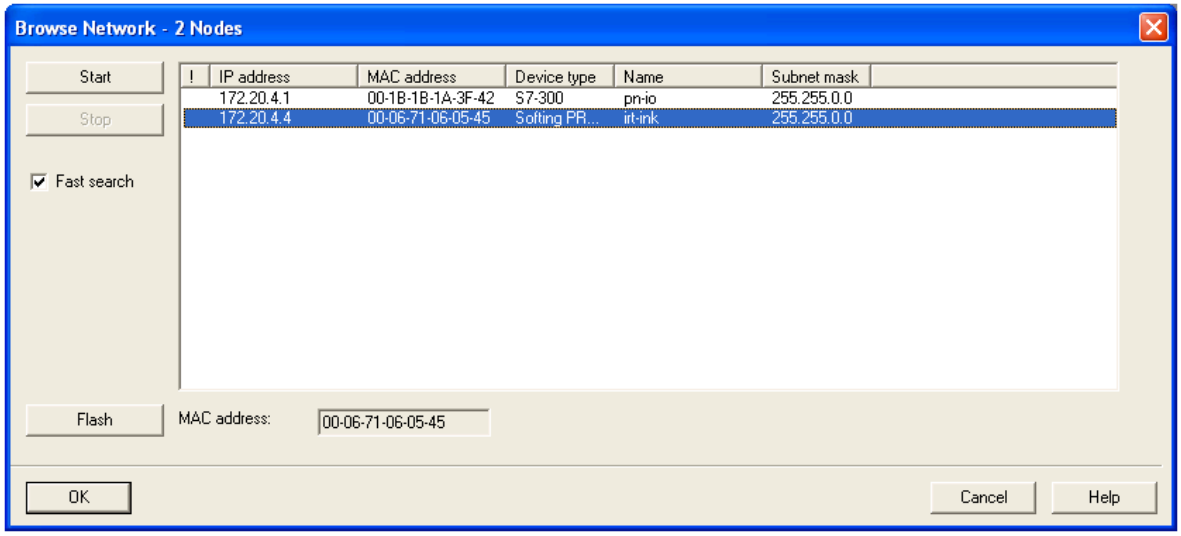
Check Connectivity

23. To check connectivity and configuration before adding the PLC program, switch to the SIMATIC Manager window.

24. On the PLC menu, click **Edit Ethernet Node**. In the **Edit Ethernet Node** dialog box, click **Browse**, and the **Browse Network** dialog box appears showing the devices (Figure 12).

☞ You should see at least the PLC and INK devices with the configured IP address, MAC address, and gateway. If these devices do not appear, check the previous steps and the network connectivity. There may be a connectivity problem between the PC and the devices.

Figure 12. Browse Network Nodes



☞ If the subnet mask addresses show up as dashes, simply clicking on the IP addresses row (Figure 12) should make the subnet addresses appear.

☞ If the devices do not appear in the **Browse Network** dialog box, there is a connectivity problem between the PC and the devices. Try configuring one device at a time instead of both devices simultaneously. Check all cables, make sure they are plugged in and power is applied.

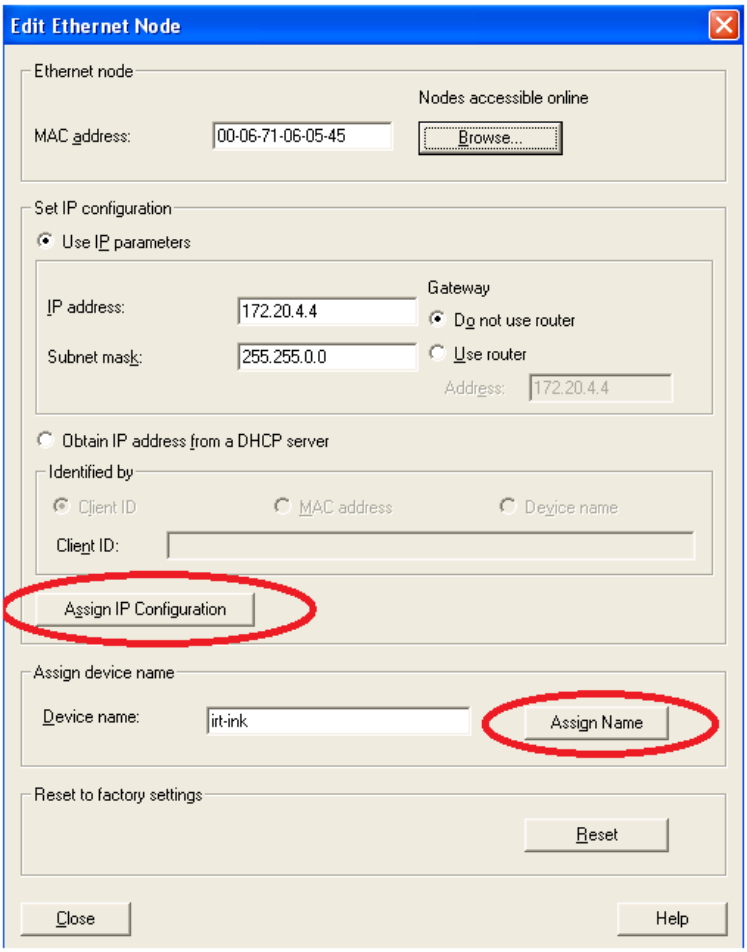
25. In the **Browser Network** dialog box, select a device in the **Edit Ethernet Node** dialog box and click **OK**. You will need to perform the following steps for both devices:

    a. Enter the values for **IP address** (`172.20.4.4`) and **Subnet mask** (`255.255.0.0`) as shown in Figure 13.

    b. Click **Assign IP Configuration**. The software then contacts the selected device and configures it based on the IP values you typed in the previous step.

    c. Type in a name for the **Device name** box, and click **Assign Name**.

Figure 13. Edit Ethernet Node Dialog Box



Setting Up the Sample PLC Program

26. From the SIMATIC Manager program window, click **File > Open > Browse**.

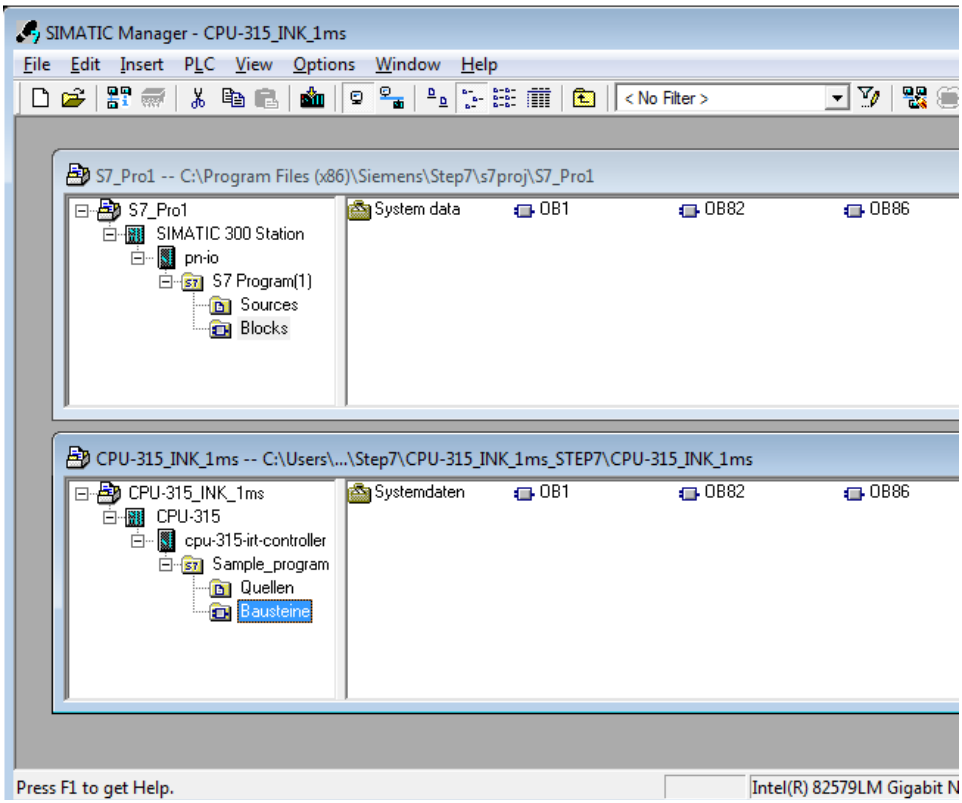
27. Navigate to the directory that contains the sample project: *<ProjectRoot>***Altera_141112\altera_ink_switch\altera_ink_switch\software\plc\profinet\Siemens\Step7\CPU-315_INK_1ms_STEP7\CPU-315_INK_1ms**, where *<ProjectRoot>* is a location such as *C:\INKProject*.

28. Open the sample PLC project file **CPU-315_INK_1ms**.

29. In the sample PLC project, click on *Bausteine* as shown in the bottom window of Figure 14.

Bausteine is German for *bricks, modules, or blocks*, same as *Blocks* in the English language project in the top window.

Figure 14. Sample PLC Project (Detail)



30. Copy only **OB1**, **OB82**, and **OB86** objects from the sample project to the newly created project.

Do not copy the **Systemdaten** object from the sample project to the new project. This object is a symbol file in German. If you copied it in your English project, it could corrupt your project and cause you to recreate the project from the beginning.

Download the PLC Configuration, Program, and Run

31. Switch back to the HW Config - SIMATIC 300 Station window.
32. Click **PLC > Download > pn-io > OK**. Allow the newly created configuration and program to download and run. At this point, the PLC and INK should be configured and ready to run.
33. Flip the switch on the PLC from stop mode to run mode and allow the program to run. It may take several minutes for the PLC to configure and start running the program on the INK as expected. If the PLC program is not running within five minutes, go back and check all the steps.

After this last step has been completed, you do not need to use the Siemens SIMATIC software since the PLC has been programmed. However, if any of the I/O addresses have changed, then the PLC may need to be reprogrammed.

Document Revision History

Table 3 lists the revision history for this document.

Table 3. Document Revision History

Date	Version	Changes
April 2013	1.0	Initial release.