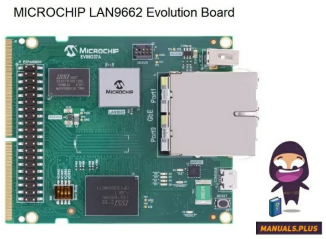
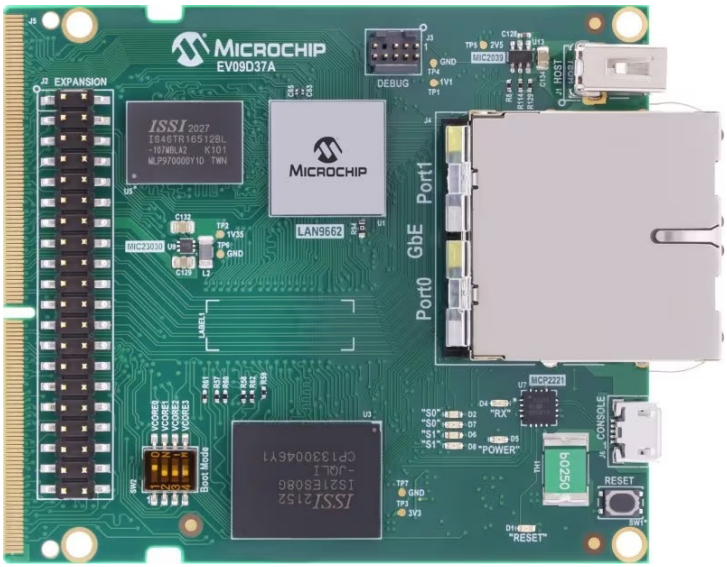


MICROCHIP LAN9662 Evolution Board User Guide

Contents

MICROCHIP LAN9662 Evolution Board



SPECIFICATIONS

- Product Name: LAN9662/LAN9668
- Manufacturer: Microchip Technology Inc.
- Function: TSN-capable Ethernet devices for PROFINET or PROFINET@TSN industrial network

Product Usage Instructions

Introduction

This application note provides instructions on how to use and operate the LAN966x family of TSN-capable Ethernet devices within a PROFINET or PROFINET@TSN industrial network. PROFINET is an Industrial Ethernet control protocol that enables real-time data transfer between a Controller and a Device. PROFINET@TSN additionally utilizes TSN functions. The application note covers the PROFINET profiles, which are commonly referred to as Conformance Class A to D (CC-A, CC-B, CC-C, and CC-D).

LAN9662 AND LAN9668

The LAN9662 and LAN9668 are TSN-capable Ethernet devices. The LAN9662 has a hardware offload for PPM (Producer/Provider Machine) and CPM (Consumer/Processor Machine), making it suitable for building an IOC (Input Output Controller) and an IOD (Input Output Device). The LAN9668, on the other hand, does not offload PPM or CPM and is intended for building a TSN switch.

Hardware Overview

The LAN9662 can be used to speed up the PROFINET protocol data transfers. It is recommended to refer to the documents in the References section for more information about the LAN9662 evaluation boards.

Software Overview

The LAN9662 RT Labs PROFINET Source and Build software provides the necessary tools and packages for building the image. The following software packages are required:

- build-essential
- cmake
- cpio
- dblatex
- file
- get text-base

- git
- Graphviz
- help2man
- iproute2
- utils-ping
- libacl1-dev
- libglade2-0
- libgtk2.0-0
- libncurses5
- libncurses5-dev
- python3
- python3-pip
- qt5-default
- rsync
- ruby-full
- sudo
- Texinfo
- tree
- w3m
- wget

1. To enable additional Ruby packages, run the following command: `$ sudo gem install nokogiri asciidoctor`
2. To enable the use of the `python` command instead of `python3`, run the following command: `$ sudo update-alternatives --install /usr/bin/python python /usr/bin/python3 100`
3. To enable additional Python packages, run the following command: `$ sudo python -m pip install matplotlib`

LAN9662 RT Labs PROFINET Source and Build
Follow the steps below to pull the latest source code from the main repository and build the image:

- From your Linux PC with authentication keys installed for Github, run the following command: `$ git clone git@github.com:microchip-ung/rtlabs-pnet-bsp-append.git`
- Navigate to the cloned repository: `$ cd rtlabs-pnet-bsp-append/`
- Run the prepared script as root: `$ sudo ./prepare.sh`

Note: Depending on the source version, the yaml config may point to a BSP (Board Support Package) that is not available for download. This can cause a build error. To correct this, update line 73 in cmake-presets. yaml as instructed in the documentation.

INTRODUCTION

This application note describes how the following LAN966x family of TSN-capable Ethernet devices can be used and operated within a PROFINET or PROFINET@TSN industrial network:

- LAN9662 4-port TSN endpoint
- LAN9668 8-port TSN switch

PROFINET is an Industrial Ethernet control protocol using real-time data transfer between the Controller and the Device. PROFINET@TSN additionally utilizes TSN functions. These are included in the following list:

- Shaping
  - Credit-based shaping IEEE802.1av
  - Time-aware shaping IEEE802.1bv—also referred to as TAS—this mechanism reserves time slots in the network for priority traffic
- Queue system—reduced latency on express traffic
  - Cut-through: This means that the transmission of a frame starts before the entire frame is received. This reduces latency. There is currently no standard for cut-through.
  - Preemption, IEEE802.Qbu + 802.3br: The transmission of a low-priority frame can be interrupted in favor of a high-priority frame. The transmission of the low-priority frame can continue where it left off when the high-priority frames have been transmitted.
  - Per-stream filtering and policing (PSFP), IEEE802.1Qci
- Time synchronization
  - The goal is that participating devices—IEEE 1588—have a common understanding of time.
  - IEEE802.1AS (PPTP), an IEEE 1588 profile
  - Supporting multiple time domains
- Protection and network redundancy
  - Frame Replication and Elimination for Reliability (FRER) IEEE802.1CB
  - IEC-62439-2 2016 Media Redundancy Protocol (MRP)
  - Linear and Ring Protection G.8031/G.8032
  - Device Level Ring (DLR) as per Open DeviceNet Vendors Association (ODVA)
  - IEC-61158-6-10 Profinet Fieldbus Application Layer (MRPD)
    - PROFINET and PROFIBUS are defined in IEC 61784. At the time of writing, the latest revision of this standard is IEC CD 61784© IEC 2022. In this standard, the Communication Profile Family 3 (CPF-3) is defined. This family is a set of Communication Profiles named CP 3/1 through CP 3/7. The first three profiles are for PROFIBUS and the rest (that is, CP 3/4 through CP 3/7) are for PROFINET.
    - This application note covers the PROFINET profiles. These four PROFINET profiles are commonly referred to as Conformance Class A to D (that is, CC-A, CC-B, CC-C, and CC-D).
- CC-A (CP 3/4) is also known as PROFINET-RT
  - Allows cycle time down to 1 ms. Most do not go lower than 10 ms.
  - Requires LLDP integration and several optional features like SNMP, MRP, and more
  - Supported by LAN9662 and P-NET stack
- CC-B (CP 3/5) is CC-A + SNMP
  - Supported by LAN9662. Hardware and API are the same as CC-A.
- CC-C (CP 3/6) is also known as PROFINET-IRT
  - Low cycle time for motion control applications
  - Originated from pre-TSN days, not compatible with standard Ethernet
  - Not supported by LAN9662
- CC-D (CP 3/7) is also known as PROFINET@TSN
  - Cycle time down to 31.25 µs
  - Targets the same market as CC-C, but with technology based on IEEE standards

- Uses Frame Preemption, gPTP, and TAS
- LAN9662 is designed to support CC-D.

In PROFINET, the terminologies, IO controller (IOC) and IO device (IOD), are used. An IOC is typically a Programmable Logic Controller (PLC) and an IOD, which is also called a field device, can read and/or write values. An IOC and an IOD run state machines to exchange values. One end of a connection runs a Provider Protocol Machine (PPM), and the other end runs a Consumer Protocol Machine (CPM). If an IOD reads a value that will be sent to an IOC, then the IO D must run a PPM for this value and the IOC must run a CPM. If the direction of the value is in the opposite direction, then the protocol machines are swapped:

FIGURE 1: COMMUNICATION EXAMPLE BETWEEN IOC AND IOD

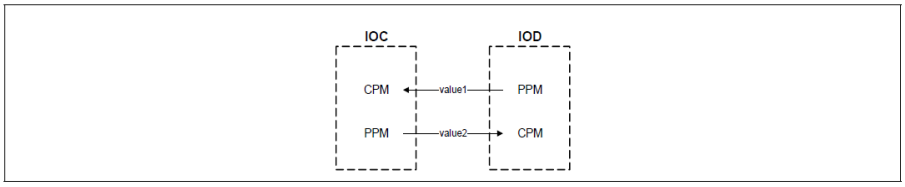


Figure 1 illustrates that value1 is sent from an IOD to an IOC, and value2 is sent in the opposite direction.

The LAN9662 has a hardware offload for PPM and CPM machines, and it can be used to build an IOC and an IOD. However, it must be noted that IOCs and IODs have different feature requirements. P-NET supports implementing an IOD on LAN9662.

Note: See https://rt-labs.com/profinet/microchip-lan9662-integration-with-p-net-profinet-stack/ and https://rt-labs.com/docs/p-net/reference-library/lan9662/ for more information on the use with P-NET.

The LAN9668 cannot offload PPM or CPM. The LAN9668 is intended for building a TSN switch.

Sections
This document includes the following topics:

- Section 2.0, “LAN9662 and LAN9668”
- Section 2.1, “Hardware Overview”
- Section 2.2, “Software Overview”
- Section 2.3, “LAN9662 RT Labs PROFINET Source and Build”
- Section 2.4, “LAN9662 RT Labs PROFINET Image Install and Bring-up”
- Section 2.5, “Siemens S7-1200 PLC and TIA V17 Software Bring-up”
- Section 2.6, “RT-LABS PROFINET Sample Application”
- Section 2.7, “Standalone Tools”

References
Consult the following references for details on the specific parts referred to in this document:

- LAN9662 Data Sheet
- LAN9668 Data Sheet
- EVB-LAN9662 Evaluation Board User’s Guide
- EVB-LAN9668 Evaluation Board User’s Guide
- LAN9668 U-Boot Upgrade for EVB-LAN9668 (https://www.microchip.com/myMicrochip/#/secure-document-down-load/440111/0)

LAN9662 AND LAN9668
For each of the LAN9662 and LAN9668 devices, there is a corresponding evaluation board:

- LAN9662: EVB-LAN9662 CPU board (also called UNG8291 B)
- LAN9668: EVB-LAN9668 board (also called UNG8290 B)

Note: There is also an EVB-LAN9662 carrier board (also called UNG8309 B), which is an extension board to the EVB-LAN9662 with additional port connectors and an FPGA.

For more information about these evaluation boards, refer to the documents in Section 1.2, “References”.

Hardware Overview

The EVB-LAN9662 evaluation board has an Edge connector that is SODIMM type. On this connector, GPIO1,…, GPIO77, QSPI, S0, S1, S2 and PCIe® are provided. This Edge connector is used when plugging the EVB-LAN9662 into the EVB-LAN9662 carrier board. On this carrier board, there is an FPGA (IGLOO2 FPGA M2GL050), where the signals GPIO1,…, GPIO77, and QSPI are connected.

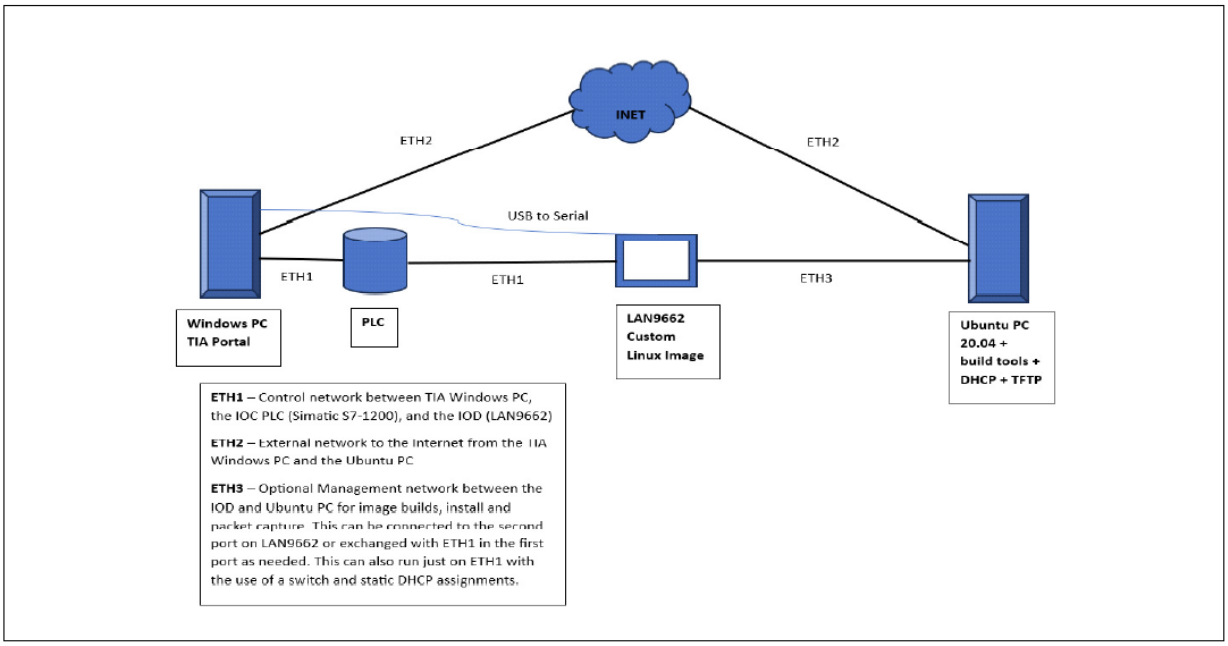
The LAN9662 is not considered a switch. To build a TSN switch, the LAN9668 can be used. The LAN9662 has the hardware to process PROFINET frames. This hardware is referred to as the Real-Time Engine (RTE). The RTE runs the PPM and CPM state machines. The PROFINET frames can be processed by the RTE without involving the CPU, except for the initial configuration. Depending on the requirements, PROFINET frames can be handled entirely in hardware. In this case, PROFINET values are exchanged over the QSPI interface. Another use case is that the RTE exchanges values via the RAM area in the chip instead. From there, the CPU can read and write values.

Although the CPU can handle PROFINET frames on its own, the use of the LAN9662 speeds up the PROFINET protocol data transfers.

The minimum required hardware for a simple IOC/IOD LAN9662 PROFINET demonstration includes:

- PC (Windows® 10) with 2 Ethernet ports and at least 2 USB Type® C ports
- PC (Ubuntu 20.04) with 2 Ethernet ports (only required if building from source code or if an ITB image is used)
- PLC – Siemens Simatic S7-1200 CPU 1215C AC/DC/RLY 6ES7 215-1BG40
- EVB-LAN9662
- EVB-LAN9662 Carrier
- Mini-USB to USB2 and Ethernet cables

FIGURE 2: COMMON TEST BENCH SETUP



Software Overview

In this section, references to EVB-LAN966x and LAN966x apply to both LAN9662 and LAN9668. The hardware in the LAN9662 is supported via Switchdev plus some proprietary tools. This software/tool package is referred to as standalone software. This standalone software can also run on the LAN9668. The EVB-LAN966x is equipped with a NOR and an e-MMC™ Flash device. The LAN966x can boot from either device, depending on the DIP-switch setting on the EVB-LAN966x. This DIP switch has four contacts marked VCORE0,

VCORE1, VCORE2, and VCORE3. See the LAN9662/LAN9668 Data Sheet for DIP switch setting descriptions. When an EVB-LAN966x is obtained, it is recommended that the bootloader be upgraded to the latest release. See the LAN9668 U-Boot Upgrade for EVB-LAN9668 for upgrade instructions.

The bootloader code can be found at **https://github.com/microchip-ung/arm-trusted-firmware**. On the GitHub page, the available releases are shown. As of this writing, the latest release is 1.0.5. Click on Latest to show the number of files, and use the lan966x_b0-release-bl2normal-auth.fip file.

Apart from the bootloader, the Linux® application is required with Switchdev support for the LAN966x hardware. For the EVB-LAN966x board, the Linux application can be found by downloading the board support package (BSP). See Appendix A: “Installing the BSP”. The standard standalone binary can be found by running the command: $ find /opt/mc/music-back-arm-2023.06/ -name “*.ext4.gz”

This finds the brsdk_standalone_arm.ext4.gz file that can be installed using the procedure in Appendix A: “Installing the BSP”. The LAN9668 is also supported by Microchip’s common switch applications like WebStaX, SMBStaX, and IStaX. Of these applications, IStaX is the most relevant because it supports TSN features that are significant to PROFINET. IStaX is the default software in the EVB-LAN9668 board. The switch application filename is istax_ lan966x.ext4.gz. Note, however, that although the name indicates lan966x, the file does not work with LAN9662 but only with LAN9668.

The minimum required software for a simple IOC/IOD LAN9662 PROFINET demonstration includes:

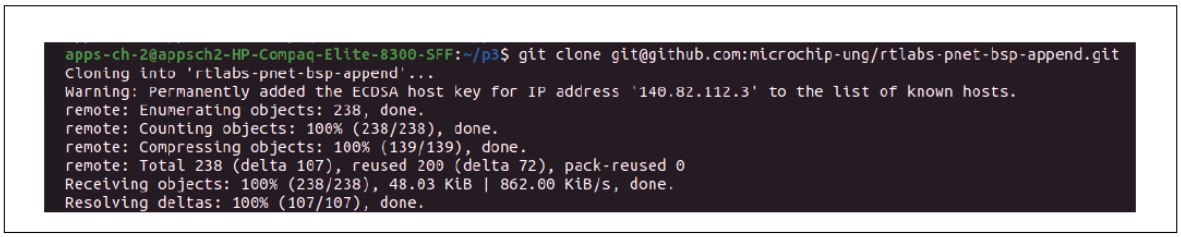
- Siemens TIA V17 PLC control software
- RT Lab Sample LAN9662 Image
- RT Lab Sample Siemens TIA GSDML File
- Ubuntu 20.04
- Windows® 10
- DHCP/TFTP server

- Serial console (Tera Term)
- Linux® required packages (see below)

LAN9662 RT Labs PROFINET Source and Build
The following source and build steps have only been verified using the B0 version on LAN9662. Please note that the repo(s) referenced below or accessed with a setup script are currently private. While the intent is to make this public, until such changes are made, your Microchip contact can provide the repo and source in static, tar-ball form. Additional source-and-build documentation can be found at **https://rt-labs.com/docs/p-net/reference-library/lan9662/**.

1. On Ubuntu 20.04 LTS, install the required packages as $ sudo apt-get install -y asciidoc bc build-essential cmake cpio dblatex file gettext-base git graphviz help2man iproute2 iputils-ping libacl1-dev libglade2-0 libgtk2.0-0 libncurses5 libncurses5-dev python3 python3-pip qt5-default rsync ruby-full sudo texinfo tree w3m wget
    - # Additional Ruby packages
    - $ sudo gem install nokogiri asciidoctor
    - # Enable the use of the `python` command instead of `python3`
    - $ sudo update-alternatives –install /usr/bin/python python /usr/bin/python3 100
    - # Enable Additional Python packages
    - $ sudo python -m pip install matplotlib
2. 2. Pull the latest source code from the main and build the image. From your Linux PC with authentication keys installed for Github:
    - $ git clone **git@github.com**:microchip-ung/rtlabs-pnet-bsp-append.git (See Figure 3.)

      FIGURE 3: GIT CLONE

    - $ cd rtlabs-pnet-bsp-append/
    - $ sudo ./prepare.sh

      Depending on the source version, the yaml config may point to a BSP that is not available for download. This will cause a build error. To correct this, update line 73 in cmake-presets.yaml to: :brsdk: “2021.09”. or to whatever newer version your Microchip contact advises.
3. Place the. itb built in the file directory used by the TFTP server.
    - $ cp build-arm/lan9662_mera_pnet.itb ~/<YOUR_TFTP_DIR>/img

LAN9662 RT Labs PROFINET Image Install and Bring-up
The following install and bring-up steps have only been verified using the B0 version on LAN9662. Additional RT Labs reference guides can be found at **https://rt-labs.com/docs/p-net/reference-library/**.

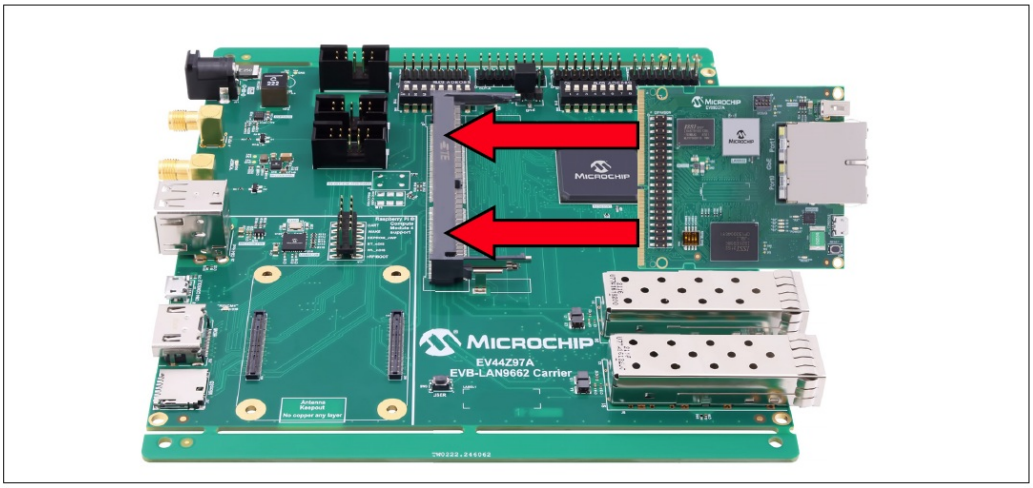
1. Establish the LAN9662 Connection.

   Connect the LAN9662 mini-USB port to the Linux® or Windows® system that will host the serial connection.

   Next, connect the Ethernet port 1 to the system that will host the DHCP and TFTP server.

   Lastly, connect the 12V power supply to the power source.

FIGURE 4: LAN9662 CARRIER WITH DAUGHTERBOARD



2. 2. With the serial console opened, power up the EVB-LAN9662 and immediately start pressing any key to break into u-boot.

FIGURE 5: U-BOOT

```
U-Boot 2019.04-linux4sam_6.2-icp (Sep 27 2022 - 16:19:43 +0200)

CPU: SAMA7
board type: 1
DRAM:  1022 MiB
MMC:   sdhci-host@e0830000: 0, emmc@e0830000: 1
Loading Environment from MMC... OK
In:    serial
Out:   serial
Err:   serial
Net:   eth0: port0
Warning: port1 (eth1) using random MAC address - 72:1e:b4:3a:99:64
, eth1: port1
Hit any key to stop autoboot:  0
m =>
```

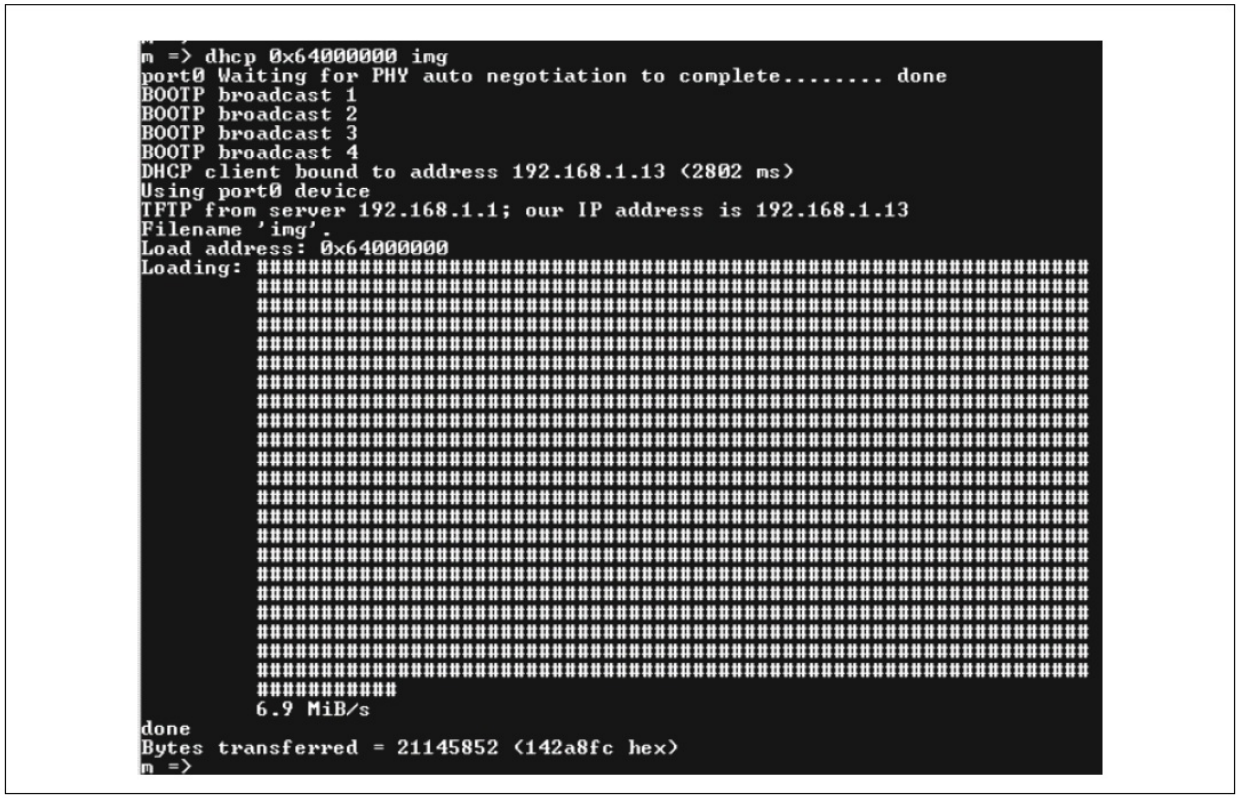
3. Make sure the environment variables include:
   - pcb=lan9662_ung8309_0_at_lan966x
   - ramboot=bootm start ${loadaddr}#${pcb}; bootm loados ${loadaddr}#${pcb}; bootm ram-disk ${loadaddr}#${pcb}; run set_rootargs; run setup; bootm fdt ${loadaddr}#${pcb}; bootm prep ${loadaddr}#${pcb}; bootm go ${loadaddr}#${pcb}
   - loadaddr=0x64000000
     - Variables can be checked with the “print” command. They can be changed with the “setenv” and “saveenv” commands.

FIGURE 6: SAVE VARIABLES

```
m => setenv loadaddr 0x64000000
m => saveenv
Saving Environment to MMC... Writing to MMC(0)... OK
m =>
```

4. Load and run the image from u-boot.
   - Run dhcp 0x64000000 img. (See Figure 7.)

FIGURE 7: DHCP IMG



- Then, run a reboot. (See Figure 8.)

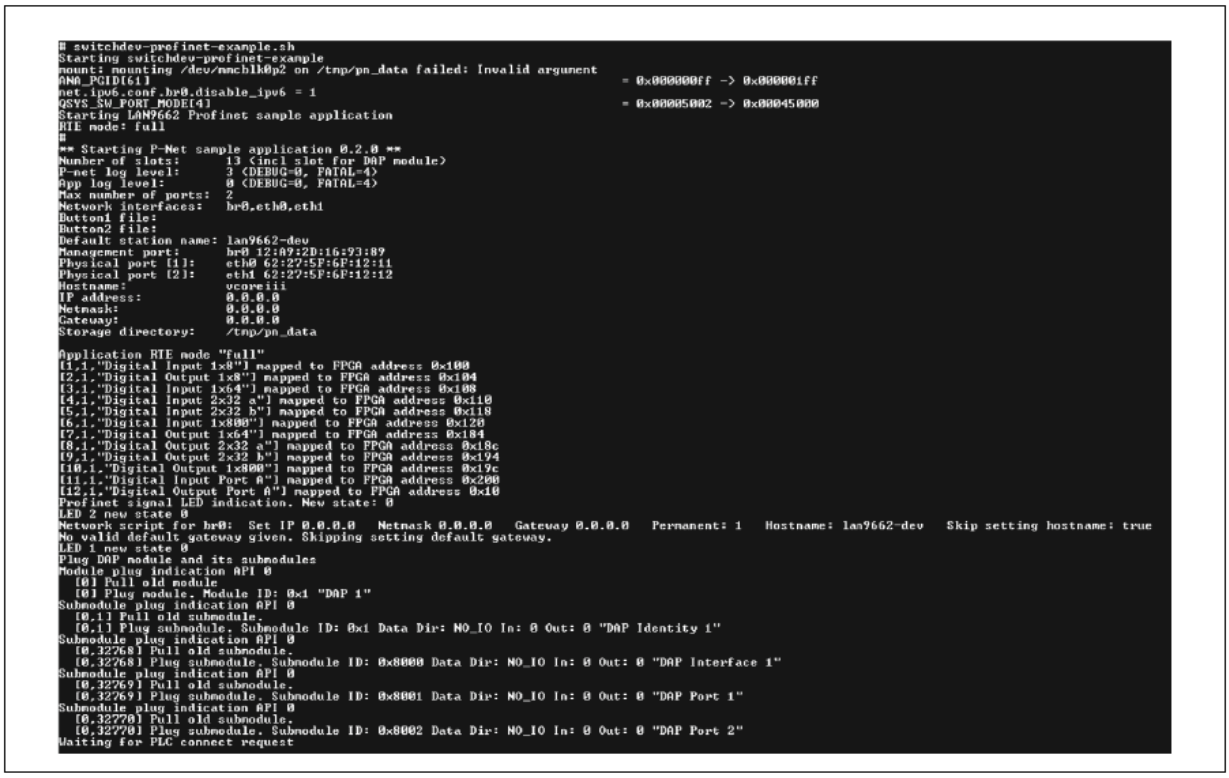
FIGURE 8: RAMBOOT

5. Start the RT Labs LAN9662 sample application. (See Figure 9.) switchdev-profinet-example.sh <MODE>
   - <MODE> = 'none' RTE disabled. Application process data mapped to shared memory.
   - <MODE> = 'cpu' RTE enabled. RTE maps process data to SRAM. Application process data mapped to

shared memory.

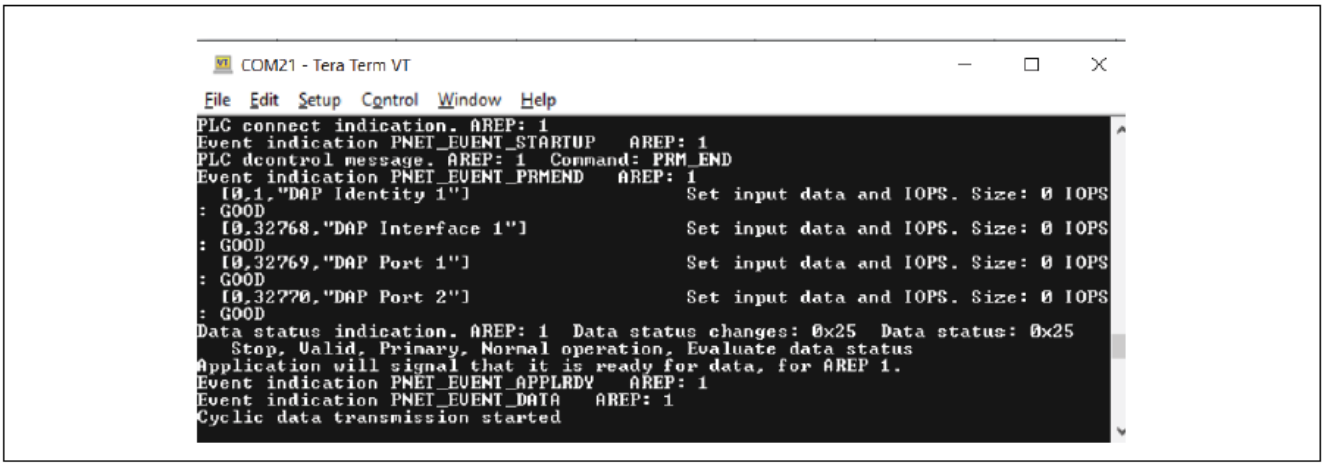
- <MODE> = ‘full’ <DEFAULT> RTE enabled. RTE maps process data to QSPI. Application process data mapped to io-fpga.

FIGURE 9: RT-LABS PROFINET EXAMPLE



The EVB-LAN9662 becomes online, waiting for a PLC connection. After the successful completion of the proceeding sections regarding TIA V17 and the sample application bring-up, a series of connection messages appear. See Figure 10.

FIGURE 10: CONNECTION MESSAGES



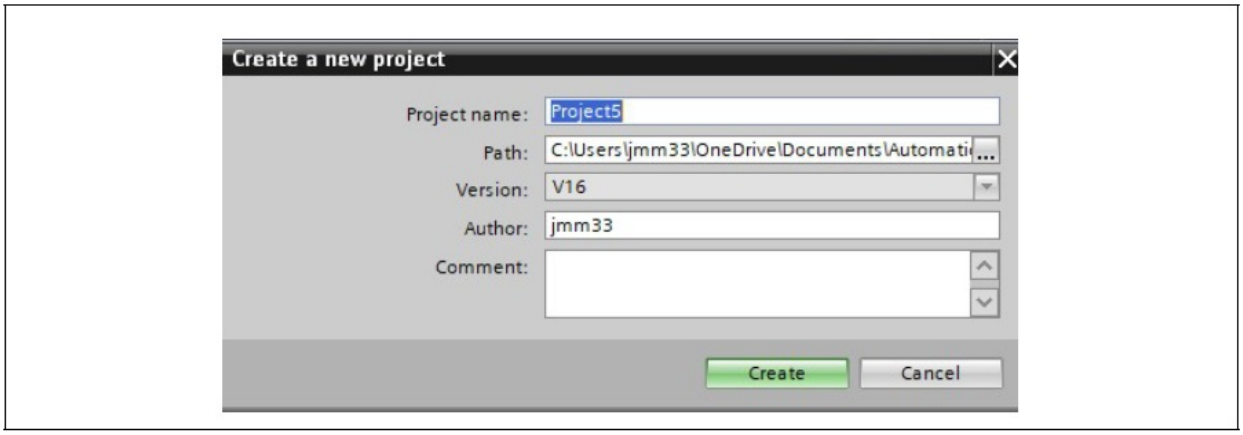
Siemens S7-1200 PLC and TIA V17 Software Bring-up

Perform the following set of steps for the Siemens S7-1200 PLC and TIA V17 software bring-up.

1. Install the TIA V17 on the user’s Windows system. See full directions from Siemens at https://github.com/rtlabs-com/p-net/blob/master/doc/use_with_siematic.rst
2. Add a Project and Devices.
    - Start the application by searching for “TIA portal” in the Windows start menu.

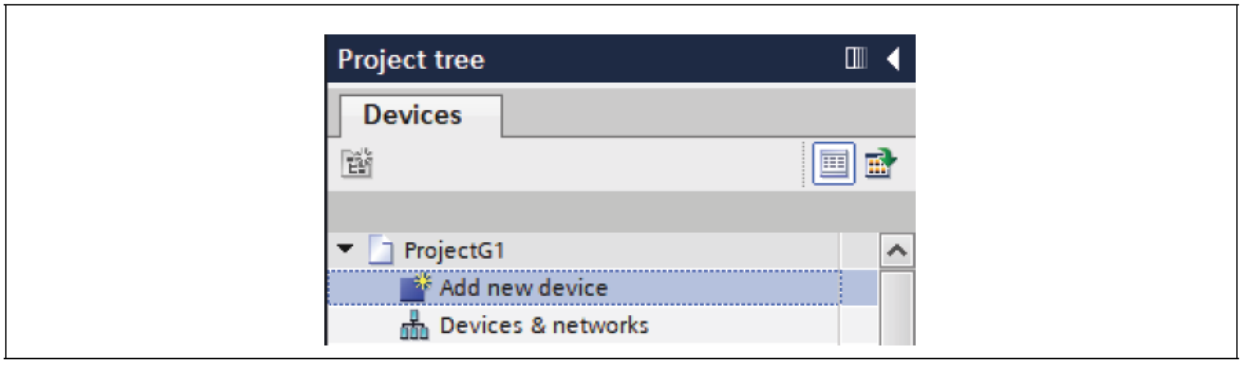
- In the start screen, select Create a new project and enter the Project name. The Path, Version, and Author can be left default. Click on Create. See Figure 11.

FIGURE 11: CREATE A NEW PROJECT



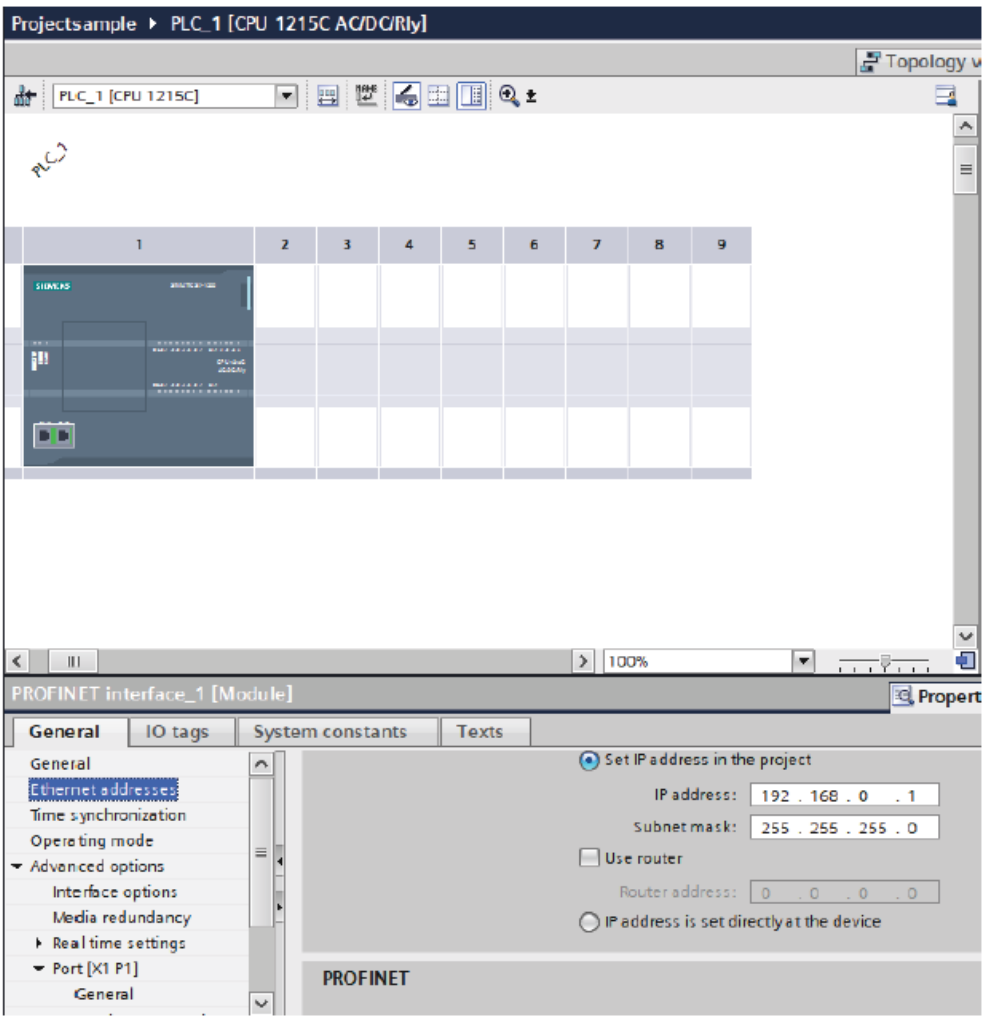
- Also on the start screen, in the project tree, select Add new device and select your PLC model (a CPU that will act as an IO-controller). Select your PLC model (a CPU that will act as an IO controller) and click on Add. See Figure 12.

FIGURE 12: PROJECT TREE



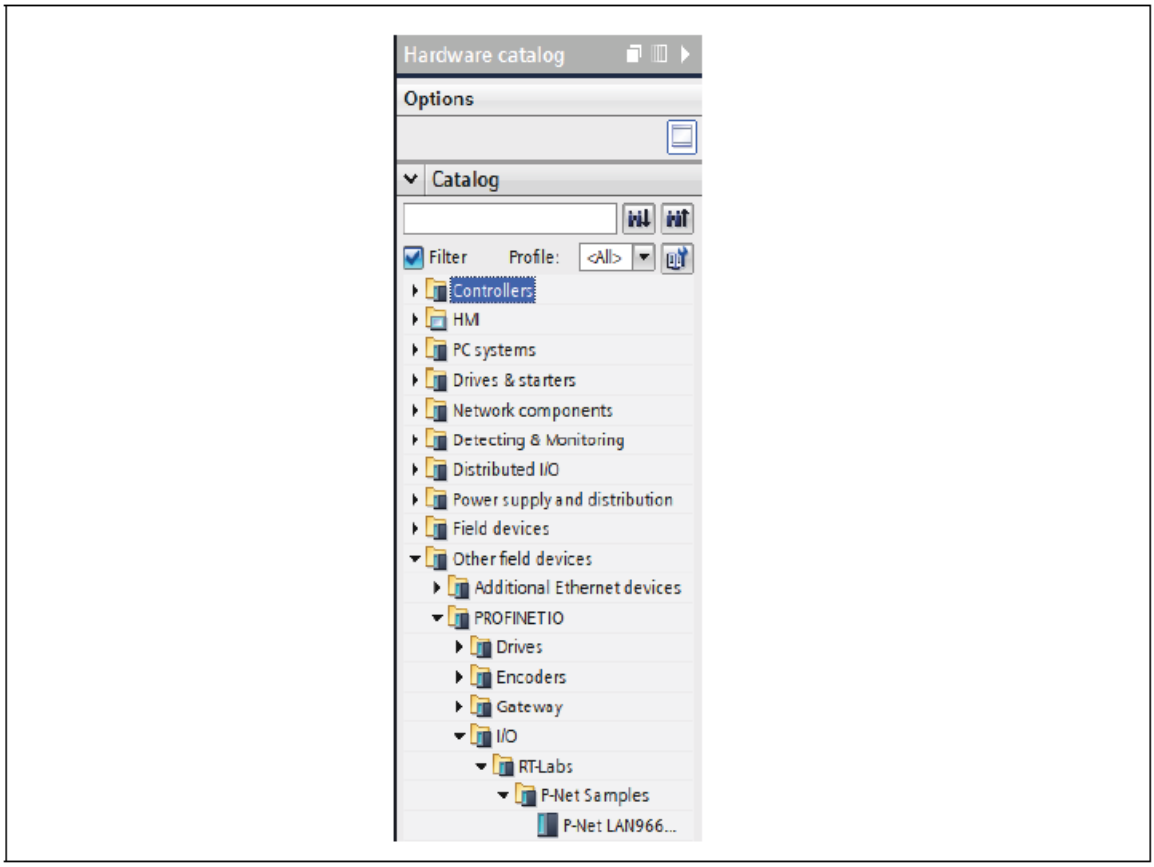
- From the Device View, double-click on the PROFINET Interface_1, the double RJ45 icon. In the Ethernet addresses section under the General tab, in the IP protocol fields, choose Set IP address in the project and enter “192.168.0.1” with a Subnet mask of “255.255.255.0.” (See Figure 13.) The Ethernet address of the PC running TIA V17 must be on the same network to connect to the PLC.

FIGURE 13: PLC WITH RJ45 ICONS



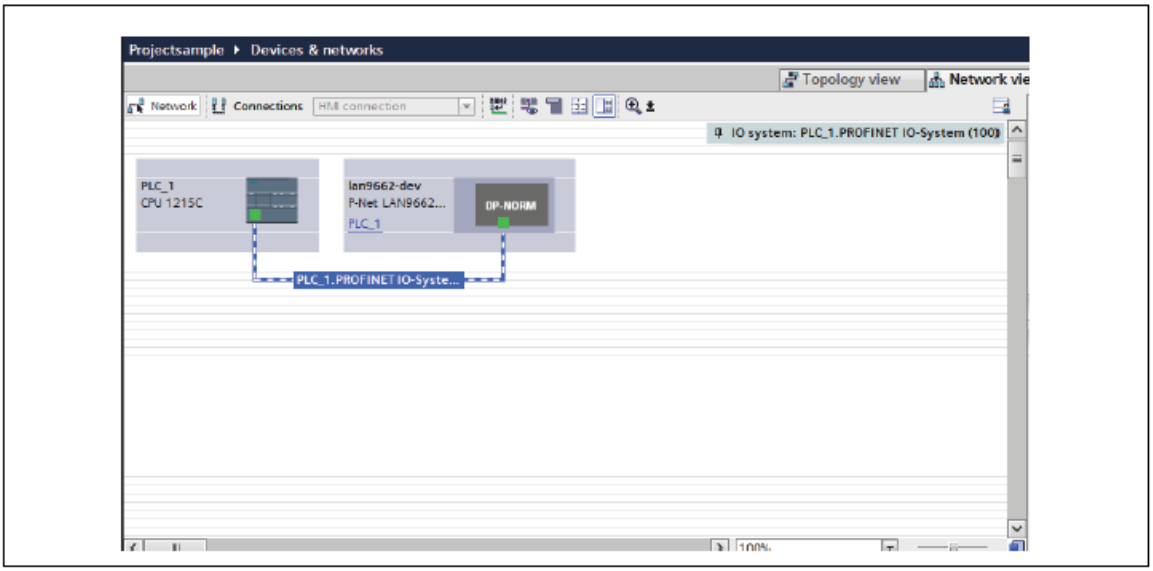
- Import a GSD file by using the menu Options>Manage general station description files (GSD). Browse to the directory with your GSD file. Mark the checkbox on the line with the file and click on Install.
- In the project view, go to the left menu and select the PLC and the sub-item Device configuration. Click the Network view tab. At the right edge, open the Hardware catalog. Select Other field devices>Profinet IO> I/ O> RT-Labs>P-Net Samples>-P-Net LAN9662 Sample App. (See Figure 14.) Double-click P-Net LAN966 2 Sample App, and it will appear in the main window.

FIGURE 14: HARDWARE CATALOG



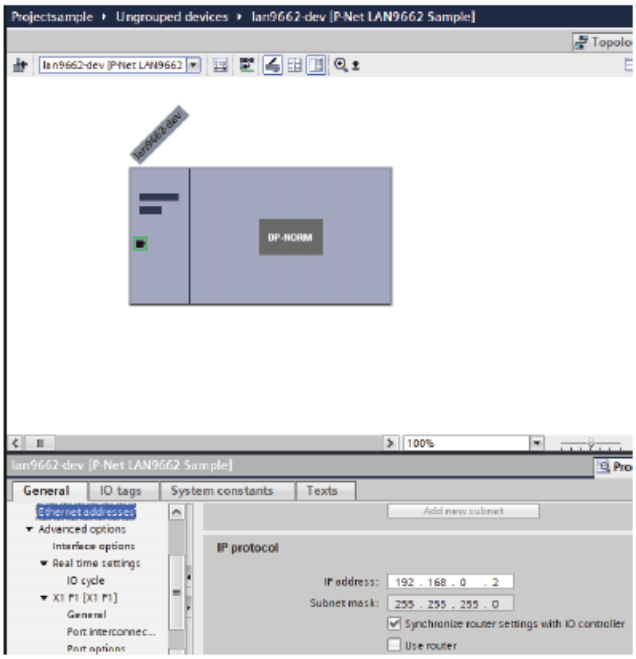
- Use the Network View tab and right-click Not assigned on the rt-labs-dev icon. Select Assign to new IO-controller and PLC_1.PROFINET interface_1 and a link will form on the Network view between the LAN966 2 and the PLC. (See Figure 15.)

FIGURE 15: DEVICES AND NETWORKS



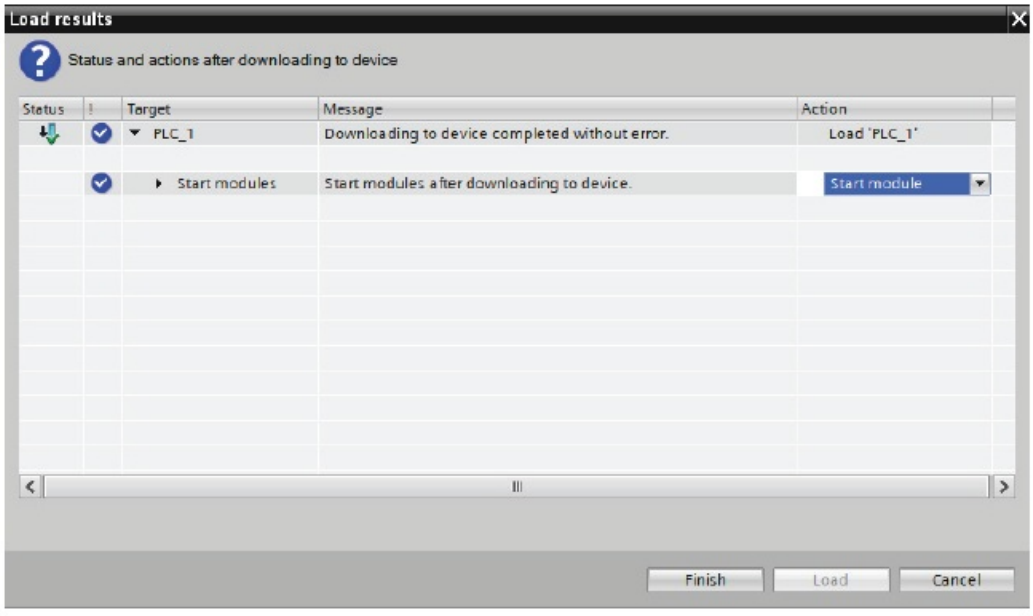
- Under the Project tree, PLC_1 on the right side, from Device configuration, select the lan9662-dev device from the center-left dropdown menu. (See Figure 16.) Double-click on the RJ45 icon. In the bottom General tab, under Ethernet Addresses in the IP protocol section, add “192.168.0.2” for the IP address with a subnet mask of “255.255.255.0.”

FIGURE 16: DEVICE CONFIGURATION



3. Run the application.
   - In the network view, right-click on the PLC icon and select Compile>Hardware (rebuild all).
   - In the network view, right-click on the PLC icon and select Compile>Software (rebuild all).
   - Right-click on the PLC icon. Download to device>Hardware configuration. In the resulting Extended download to device window that pops up, with the PLC_1 device selected, click on Load. (If the device is not yet visible, click the Start search button on the lower left of the window.) Select the Start module and then click on Finish. Click on Load. Select the Start module (if it is not selected already) and then click on Finish. (See Figure 17.)

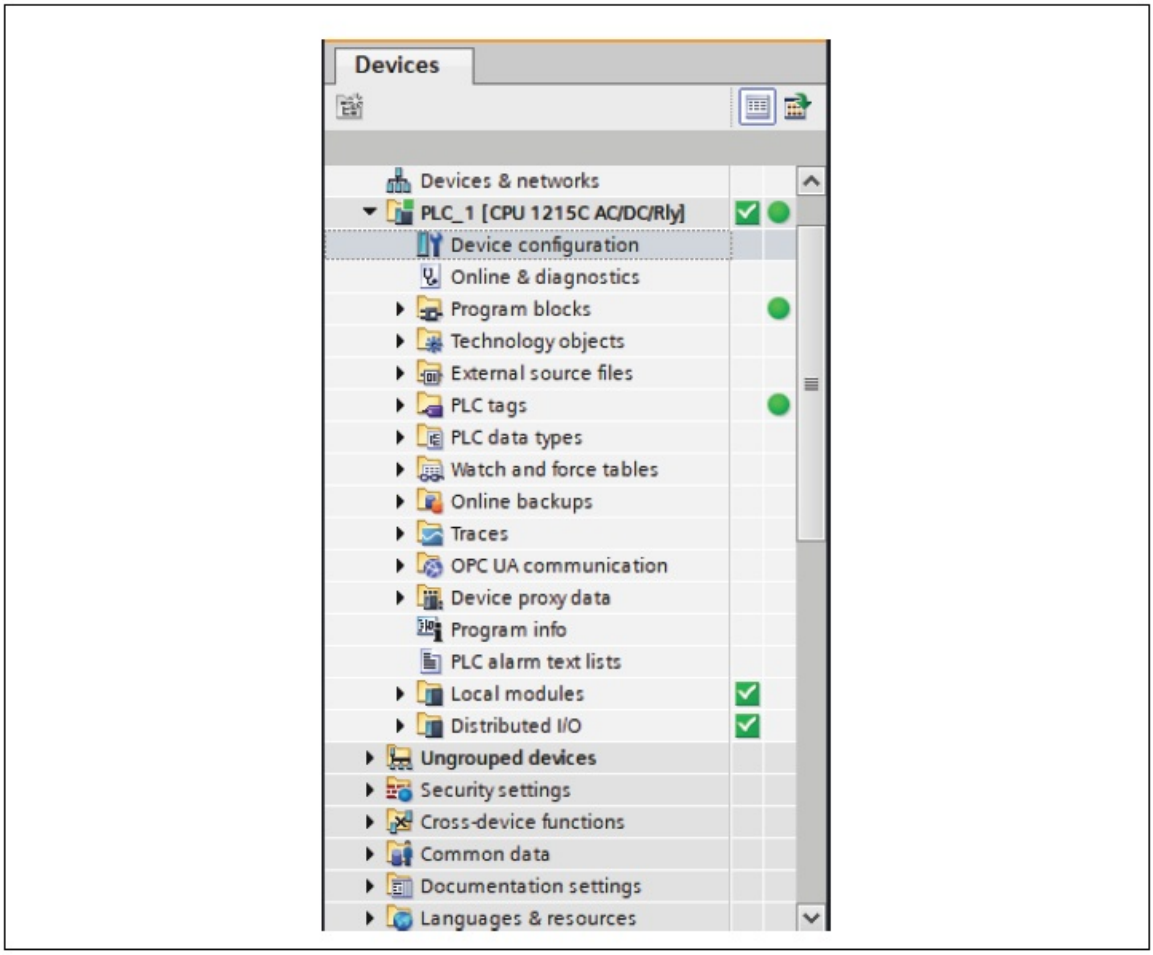
FIGURE 17: LOAD RESULTS



   - Repeat for Download to device>Software (all). Make sure the modules are stopped (i.e. stop all under actions if not already selected) before Load is clicked on, and that the Start module option shows before clicking on Finish.
   - In the main menu, use Online>Go online. There should be no errors in the Device project tree. See Figure

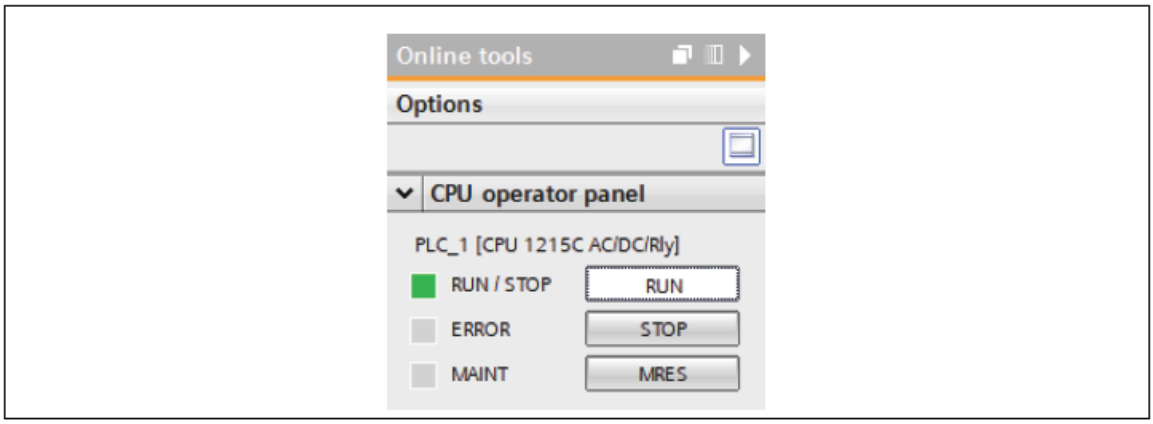
18.

FIGURE 18: DEVICE CONFIGURATION



- On the right part of the screen, use Online tools to see the PLC LED states and to go to RUN and STOP modes. See Figure 19.

FIGURE 19: ONLINE TOOLS



RT-LABS PROFINET Sample Application

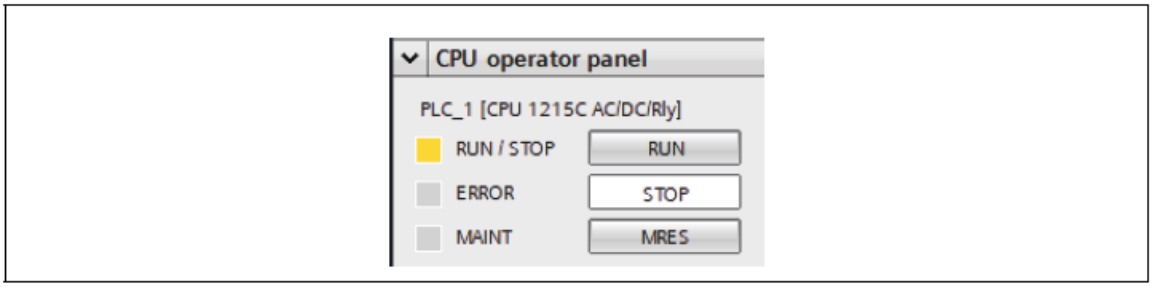
This application focuses on the process data and its mapping to the RTE. The source code is found at https://github.com/microchip-ung/rtlabs-pnet/tree/master/samples/pn_dev_lan9662. Perform the following steps for the demo:

1. Begin the demo with LAN9662 running the sample application and connected to the PLC as indicated in the previous steps.

   In the Online tools CPU operator panel window, press the STOP button. This will display a yellow square next to the RUN/STOP button. (See Figure 20.) Likewise, the RUN/STOP LED on the PLC will be orange, indicating

the device is in a Stop state.

FIGURE 20: STOP STATE



- Check if the LAN9662 serial console shows (if stopping from a running state):

```
PLC control message confirmation. AREP: 1 Status codes: 0 0 0 0
Data status indication. AREP: 1 Data status changes: 0x10  Data status: 0x35
Run, Valid, Primary, Normal operation, Evaluate data status
[1,1,"Digital Input 1x8"]    PLC reports Consumer Status (IOCS) GOOD
[2,1,"Digital Output 1x8"]         PLC reports Provider Status (IOPS) GOOD
```

2. Put the demo into RUN state.
   - Press the RUN button in the Online tools CPU operator panel window. This will display a green square next to the RUN/STOP button if no errors are seen during startup. (See Figure 21.) Likewise, the RUN/STOP LED on the PLC will be green, indicating the device is in Run state. (See Figure 22.)
   - Check if the LAN9662 serial console shows:

```
#Data status indication. AREP:      1  Data status changes: 0x10  Data status: 0x25
 Stop, Valid, Primary, Normal operation, Evaluate data status
 [1,1,"Digital Input 1x8"]              PLC reports Consumer Status (IOCS) 0x60 Is
 it in STOP mode?
 [2,1,"Digital Output 1x8"]             PLC reports Provider Status (IOPS) 0x60 Is
 it in STOP mode?
```

FIGURE 21: RUN STATE

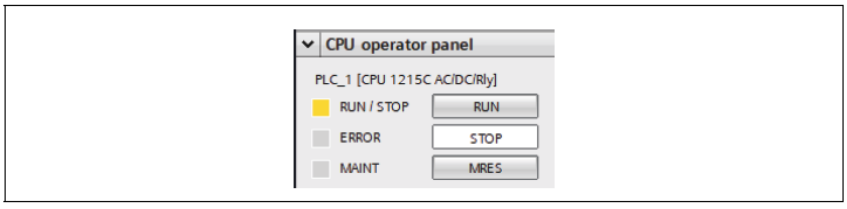
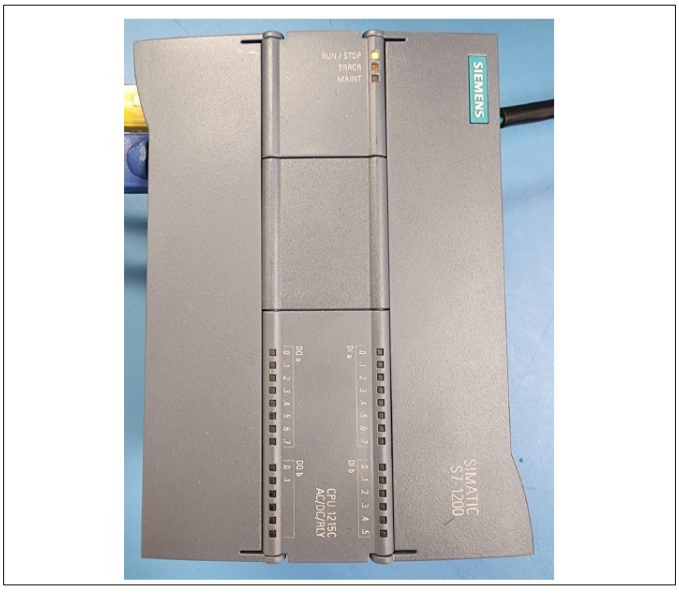


FIGURE 22: LED DISPLAY FOR RUN STATE



3. Put the demo into an ERROR state.

Disconnect the Ethernet cable running from LAN9662 to the PLC. A blinking red square shows next to the ERROR button in the Online tools CPU operator panel window. The center ERROR red LED on the PLC lights up.

Check if the LAN9662 serial console shows:

Event indication PNET_EVENT_ABORT AREP: 1

Error class: 0xfd Real-Time Acyclic Protocol

Error code: 0x05 Device missed cyclic data deadline, device terminated AR Connection closed

Waiting for PLC connect request

4. Recover the demo from the ERROR state.

   Reconnect the Ethernet cable running from LAN9662 to the PLC. The ERROR button in the Online tools CPU operator panel window will stop blinking. The center ERROR LED on the PLC will stop flashing, too.

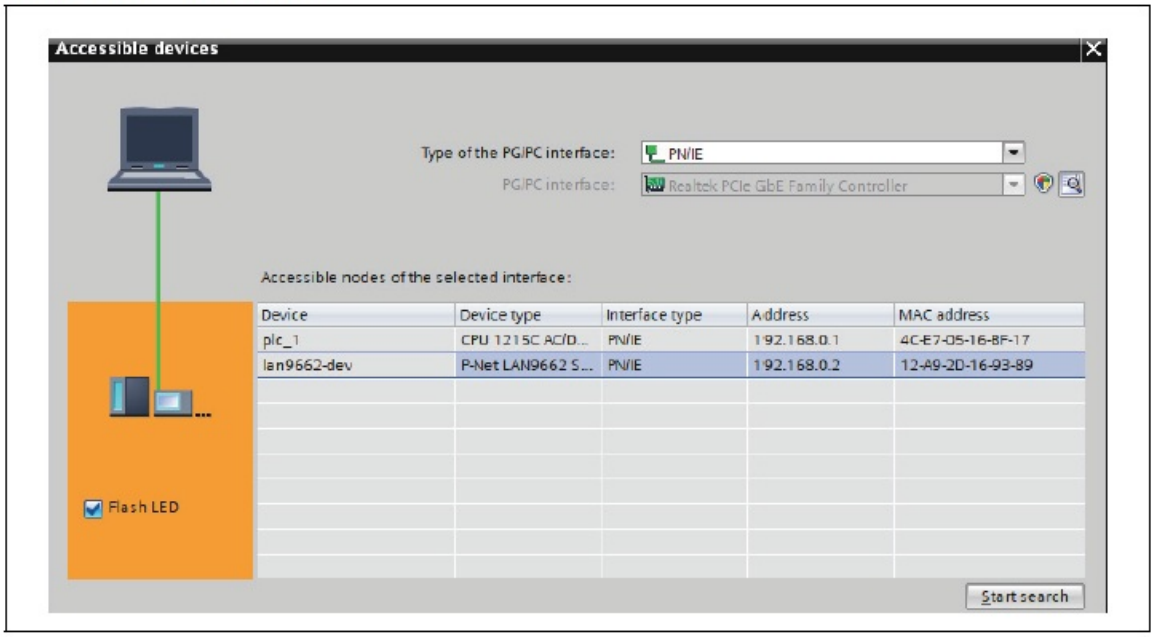
   Check if the LAN9662 serial console shows:

   - LC connect indication. AREP: 1
   - Event indication PNET_EVENT_STARTUP AREP: 1
   - Data status indication. AREP: 1 Data status changes: 0x25 Data status: 0x25
   - Stop, Valid, Primary, Normal operation, Evaluate data status
   - PLC control message. AREP: 1 Command: PRM_END
   - Event indication PNET_EVENT_PRMEND AREP: 1
     - [0,1, “DAP Identity 1”] Set input data and IOPS. Size: 0 IOPS: GOOD
     - [0,32768, “DAP Interface 1”] Set input data and IOPS. Size: 0 IOPS: GOOD
     - [0,32769, “DAP Port 1”] Set input data and IOPS. Size: 0 IOPS: GOOD
     - [0,32770, “DAP Port 2”] Set input data and IOPS. Size: 0 IOPS: GOOD
     - [1,1, “Digital Input 1×8”] Set input data and IOPS. Size: 1 IOPS: GOOD
     - [2,1, “Digital Output 1×8”] Set output IOCS: GOOD
   - Application will signal that it is ready for data, for AREP 1.
   - Event indication PNET_EVENT_APPLRDY AREP: 1
   - Event indication PNET_EVENT_DATA AREP: 1

     Cyclic data transmission started PLC control message confirmation. AREP: 1 Status codes: 0 0 0 0

5. Flash the LAN9662 LED using the SEARCH function.
   - From the Online menu, choose Accessible device. Click on the Start search button in the middle right of the Accessible Devices window. Select the LAN9662 device and tick the Flash LED box. (See Figure 23.)

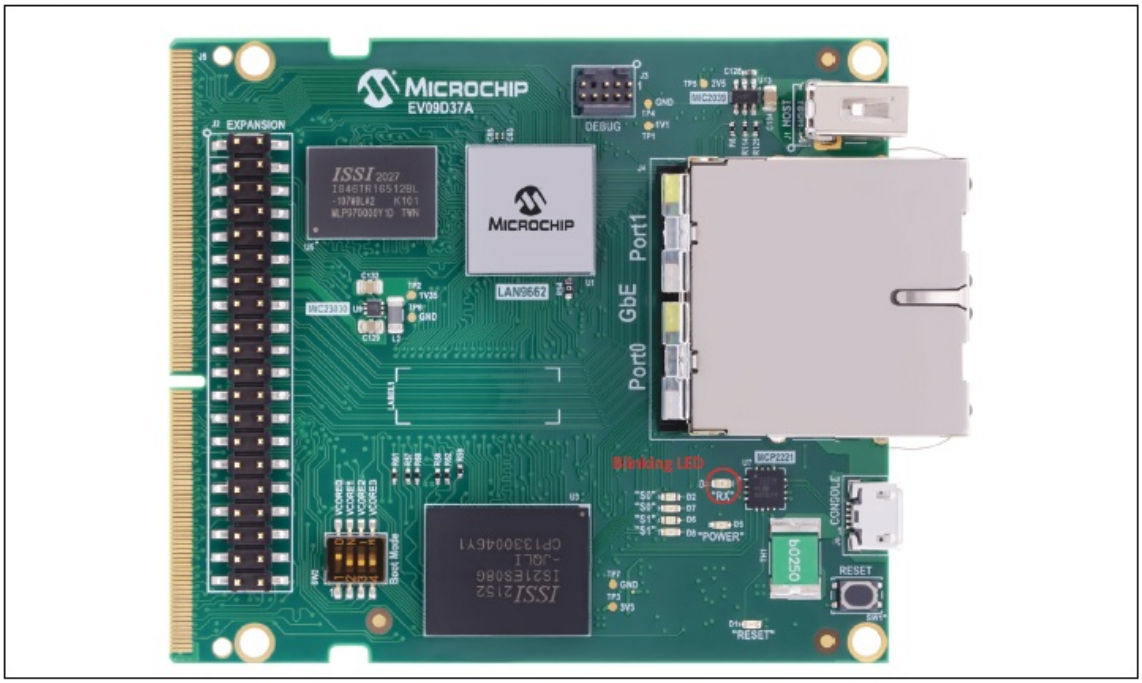
FIGURE 23: FLASH LED



- Check if the LAN9662 serial console shows the following:
  - Profinet signal LED indication. New state: 0
  - LED 2 new state 0
  - Profinet signal LED indication. New state: 1
  - LED 2 new state 1
  - Profinet signal LED indication. New state: 0
  - LED 2 new state 0
  - Profinet signal LED indication. New state: 1
  - LED 2 new state 1
  - Profinet signal LED indication. New state: 0
  - LED 2 new state 0
  - Profinet signal LED indication. New state: 1
  - LED 2 new state 1

    The LED that is controlled by this method is circled in Figure 24.

FIGURE 24: LED ACTIVATED BY SEARCH FUNCTION



All examples are performed without adding any additional PLC programming. Custom blocks can be added for more in-depth demonstrations.

Standalone Tools
Table 1 lists a set of tools in this version:

TABLE 1: STANDALONE TOOLS

Name	Origin	Example
Iproute2 suite	Linux community	ip, bridge, tc
ethtool	Linux community	ethtool
ptp4l	Linux community	ptp4l
tiny-did	Linux community	told
QoS tool	Microchip	QoS
VCAP	Microchip	cap
FP tool	Microchip	fp
PSFP tool	Microchip	pp
FREE	Microchip	free

Note 1: The Microchip provided tools show the syntax when run without parameters.

Table 2 lists a set of debugging tools:

TABLE 2: DEBUG TOOLS

Name	Origin	Example
Debug messages	Linux community	dmesg
Packet capture	Linux community	tcpdump
Packet injection and capture	Microchip	ef, ef-loop
ProcFS and DebugFS	Microchip	cat /proc/… cat /sys/kernel/info/…
Symbolic register access	Microchip	Cymraeg

INSTALLING THE BSP

To install the BSP:

1. Go to **http://mscc-ent-open-source.s3-website-eu-west-1.amazonaws.com**.
2. Click the BSP/ key link.
3. Locate **http://mscc-ent-open-source.s3-eu-west-1.amazonaws.com/public_root/bsp/mscc-brsdk-arm-2022.06.tar.gz** and download the file.
4. Unpack the file using:
    - mkdir -p /opt/mscc
    - tar xzf mscc-brsdk-arm-2023.06.tar.gz -C /opt/music
5. Download and install the toolchain:
    - Determine the version of the toolchain to download. In opt/mscc/mscc/mscc-brsdk-arm-2023.06/sdk-setup.mk, the version of the toolchain file is 2023.02-101; hence, mscc-toolchain-bin-2023.02 101.tar.gz should be installed.
    - On the page, **http://mscc-ent-open-source.s3-website-eu-west-1.amazonaws.com**, click toolchain/.
    - Download mscc-toolchain-bin-2023.02-101.tar.gz.
    - Install the downloaded file with:
        - tar xzf music-toolchain-bin-2023.02-101.tar.gz -C /opt/music

Note

1. The documentation for the BSP is located in the path bsp/mscc-brsdk-doc-2023.06.html. In the document, go to Supported HW>LAN966x to find the details related to LAN966x.
2. The related source code is located in the path bsp/mscc-brsdk-source-2023.06.tar.gz. From this, the BSP can be built and variations of it can be made. See the BSP documentation (bsp/mscc-brsdk-doc-2023.06.html) for descriptions.

APPLICATION NOTE REVISION HISTORY

TABLE B-1: REVISION HISTORY

Revision Level & Date	Section/Figure/Entry	Correction
DS00004826C (01-17-24)	Section 2.1, “Hardware Overview”	Added minimum hardware requirements.
	Section 2.2, “Software Overview”	Added minimum software requirements.
	Section 2.3, “LAN9662 RT Labs PROFINET Source and Build”, Section 2.4, “LAN9662 RT Labs PROFINET Image Install and Bring-up”, Section 2.5, “Siemens S7- 1200 PLC and TIA V17 Soft- ware Bring-up”, and Section 2.6, “RT-LABS PROF- INET Sample Application”	Added new sections.
DS00004826B (09-19-23)	All	Updated reference links.
		Updated links, file paths, and software versions for the board support package.
		Removed “Microchip Confidential” markings from the footer and made minor formatting changes.
DS00004826A (11-29-22)	Initial release	

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FAQ'S

What is PROFINET?

PROFINET is an Industrial Ethernet control protocol that enables real-time data transfer between a Controller and Device.

What is PROFINET@TSN?

PROFINET@TSN is an extension of PROFINET that utilizes Time-Sensitive Networking (TSN) functions.

What are IOCs and IODs?

IOCs (Input Output Controllers) and IODs (Input Output Devices) are different feature requirements for building industrial network systems.

Can the LAN9662 offload PPM and CPM?

Yes, the LAN9662 has a hardware offload for PPM and CPM machines.

What is the LAN9668 intended for?

The LAN9668 is intended for building a TSN switch and cannot offload PPM or CPM.

Documents / Resources

	**MICROCHIP LAN9662 Evolution Board** [pdf] User Guide LAN9662 Evolution Board, LAN9662, Evolution Board, Board

References

- **User Manual**