RZ/N1D

CODESYS Quick Start Guide

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Introduction

This document is giving an insight in CODESYS runtime environment for RZ/N1D. This guide shall assist you to quickly start evaluation of CODESYS runtime on RZ/N1D. It provides step-by-step instructions to setup the run-time configuration of CODESYS and run it on the CPU Board in the configuration with RZ/N1-EB (Expansion Board).

Target Device

RZ/N1D

Contents

1. CODESYS Package Content

The CODESYS package for RZ/N1 consists of

1. Runtime binary „…\Software\CODESYS\Platforms\Linux\Bin**codesyscontrol**"
2. Sample configuration file for Linux "… \Software\CODESYS\Platforms\Linux\Bin**CODESYSControl.cfg**"
3. Device description file „…\Software\CODESYS\Configuration**Renesas-Cortex-Linux DEMO.devdesc.xml**"
4. Linux rootfile system (rootfs) tarball with all the required Qt libraries – "…\Software\CODESYS\Linux-rzn1d**qt-image-rzn1d400-db.tar.bz2**"
5. Linux DTB File - "…\Software\CODESYS\Linux-rzn1d**rzn1d400-db.dtb**"
6. Linux Kernel Image - "…\Software\CODESYS\Linux-rzn1d**uImage**"
7. U-Boot Image - "…\Software\CODESYS\Linux-rzn1d**u-boot-rzn1d400-db.bin.spkg**"
8. HTML-based Documentation base "…/Software/CODESYS/Documentation/**RTS-Documentation.html**"
9. This Document
10. CODESYSControl_V3_Manual.pdf

Please make sure that you use exactly the above-mentioned Linux DTB, Kernel Image and root file system when running CODESYS.

2. How does it work

CODESYS V3 programming tool for Windows is used to configure the target board as a desired PLC. In order for CODESYS V3 to communicate with the target, it is required to run the provided codesyscontrol runtime binary on the target platform and connect the target board with the host PC running CODESYS V3. CODESYS V3 is used then to create PLC applications and perform all the required settings of the runtime system, additionally making graphic user interfaces to remotely observer and control your PLC device.

The CODESYS V3 programming tool runs on the host PC and generates a symbol file that gets transferred to the target. This file is interpreted by the runtime binary running on the target. The system consists of a Codesys development environment V3 running on a host, and the runtime binary running in parallel on the target.

In RZ/N1D case, the evaluation example environment consists of a host PC on which CODESYS V3 is running, an RZ/N1D-DB CPU Board mounted on the Expansion Board which runs the CODESYS runtime binary (**codesyscontrol)** and an EtherCAT slave that is used for EtherCAT testing purposes. You can also use the same principle with any other industrial network protocol. You may see the setup diagram below. The host PC and the PLC acting RZ/N1D board are interconnected in a subnet network directly over an Ethernet cable.

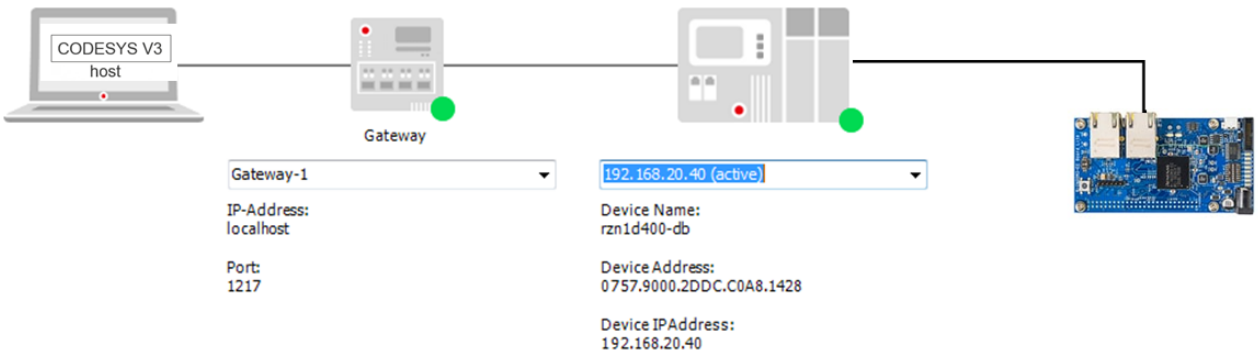


Figure 1: CODESYS setup diagram

For more information about CODESYS setup and other related information about CODESYS, please check the comprehensive documentation base "…/Software/CODESYS/Documentation/**RTS-Documentation.html**".

3. Hardware and Software Environment

Please go through the document "…\Documents\RZN.Software\U-Boot-and-Linux**RZN1D-Quick-Start-Guide.pdf**" on how to bring up Linux and U-Boot for RZ/N1D board for the first time. Installation/programming of U-Boot in QSPI is required, before continuing with CODESYS setup.

3.1 Hardware

The following hardware was used in the above-mentioned example:

- Office Laptop (64-bit Windows 7, 8GB RAM) with an Ethernet network adapter
- RZ/N1D-DB + RZ/N1-EB Board
- 2 USB Cables for serial over USB (CN10) and for DFU Functionality (CN9)
- R-IN32-EC Board Lite as EtherCAT slave (optional)
- 2x RJ45 Cat5E Ethernet patch cables for connecting the RZ/N1D board to the PC and to the R-IN32-EC slave board
- Micro-SD-Card SanDisk Mobile Ultra 16GB

3.2 Software

The following software was used in the evaluation procedure:

1. CODESYS V3.5 SP9 Patch 5+ on the PC

   You can download the installation file from the official CODESYS website free of charge: https://store.codesys.com/codesys.html
2. U-Boot 2017.01 for RZ/N1D – stored as "…\Software\CODESYS\Linux-rzn1d\u-boot-rzn1d400-db.bin.spkg"
3. Linux version 4.9.0 for RZ/N1D - stored as "…\Software\CODESYS\Linux-rzn1d\uImage"
4. Codesys Control runtime binary– stored as "…\Software\CODESYS\Platforms\Linux\Bin\codesyscontrol"

4. Setup instructions

Please follow the instructions in the following chapters to setup a CODESYS project and start with evaluating it on RZ/N1D.

4.1 Install/run the CODESYS release in RZ/N1 Linux

Please make sure first that you set up the connectors and switches as described in Linux and U-Boot Quick Start Guide - …\Documents\RZN.Software\U-Boot-and-Linux**RZN1D-Quick-Start-Guide.pdf** except of the RZ/N1 Extension Board switches:

- CN15 PHY2/PHY3 MDC Connect pins 1 and 2 (MDIO1)
- CN16 PHY2/PHY3 MDIO Connect pins 1 and 2 (MDIO1)

This is also shown in the image below:

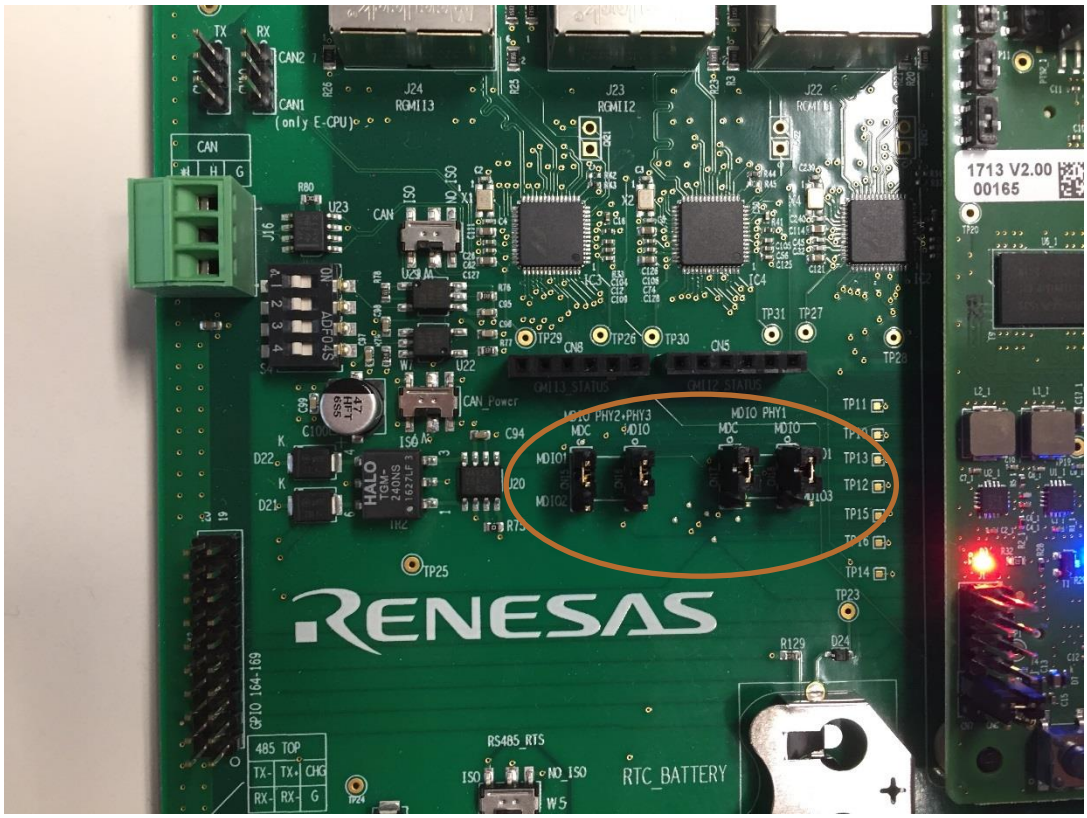


Figure 2: MDIO Jumper Settings

On the expansion board, there are 2 ports being used for CODESYS. J22 is used to connect directly the board to the network interface of the PC. J23 can be used for real-time communication - to connect a slave device to the board, in our example it was used to connect R-IN32-EC Board Lite as EtherCAT slave.

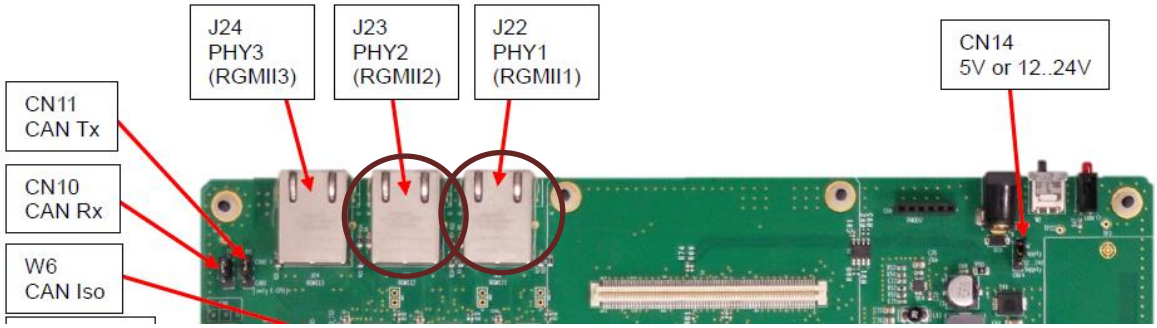


Figure 3: Ports used by CODESYS on RZ/N1-EB

1. Format an SD card as ext4 (eg. a useful tool in Windows for that is MiniTool Partition Wizard)
2. Extract the provided Yocto Qt root file system (**qt-image-rzn1d400-db.tar.bz2**) to this SD card:
   - Copy the rootfs tarball qt-image-rzn1d400-db.tar.bz2 to a Linux Host PC
   - Mount the SD card, e.g. `sudo mount /dev/sdb1 /media/sdcard`
   - Extract the tarball, e.g. `sudo tar xvjf qt-image-rzn1d400-db.tar.bz2 -C /media/sdcard/`
3. Unmount the SD card and plug it in the SD Card slot on the expansion board
4. Program the U-Boot …\Software\CODESYS\Linux-rzn1d**u-boot-rzn1d400-db.bin.spkg** in QSPI as explained in chapter 2.2 of the "…\Software\U-Boot-and-Linux\Documentation\RZN1D-DB-Quick-Start-Guide.pdf".

If you are programing the board for the first time, you first need to load the U-Boot in SRAM, as explained in the following points, otherwise jump to 5.

- On the board, hold down switch SW5 (to select DFU boot mode instead of QSPI) and press switch SW4 (soft reset). The RZ/N1 serial port should output
  - `sudo dfu-util -D u-boot-rzn1d400-db.bin.spkg`
- If your board has been programmed with an older version of U-Boot, the dfu_ext_info environment variable may be incompatible. If so, please run
  - `env default -f dfu_ext_info`
  - `saveenv`
- Ensure the U-Boot/SPL region of QSPI Flash is erased, run:
  - `sf probe`
  - `sf erase 0 10000`

5. Flash the provided u-boot image ("…\Software\CODESYS\Linux-rzn1d**u-boot-rzn1d400-db.bin.spkg**"), the DTB ("…\Software\CODESYS\Linux-rzn1d**rzn1d400-db.dtb**") and Linux Kernel Image ("…\Software\CODESYS\Linux-rzn1d**uImage**") in QSPI on the board as instructed in "…\Software\U-Boot-and-Linux\Documentation\RZN1D-DB-Quick-Start-Guide.pdf, chapter 2.4.
   - `sudo dfu-util –a "sf_uboot" –D u-boot-rzn1d400-db.bin.spkg`
   - `sudo dfu-util –a "sf_dtb" –D rzn1d400-db.dtb`
   - `sudo dfu-util –a "sf_kernel" –D uImage`
6. On the board, use U-Boot to set the Linux boot arguments to instruct kernel to use the rootfile system from the SD card:
   - `setenv bootargs "console=ttyS0,115200 root=/dev/mmcblk0p1 rootfstype=ext4 rw rootwait ip=192.168.20.40:::::eth0 earlyprintk clk_ignore_unused"`
   - `setenv bootcmd "sf probe && sf read 0x8ffe0000 b0000 20000 && sf read 0x80008000 1d0000 600000 && bootm 0x80008000 - 0x8ffe0000"`
   - `saveenv`
7. Attach the Ethernet cable from your PC Network Interface to J22 plug on the expansion board
8. Reset the board, and log into Linux
9. Bring the interface eth1 up on the board in the Linux console – this interface is to be used for real-time Ethernet
   - `ifconfig eth1 up`
10. Run the CODESYS runtime binary
    - `cd /home/root`
    - `./codesyscontrol`

Now you have a running CODESYS runtime environment on your board. Please note that it is a demo version that runs for 2 hours, after which it gets stopped. You should see an output in Linux console as shown below. Ignore “ts_open() failed (No such file or directory)” message" from Linux. It appears when there is no LCD Display attached to the board.

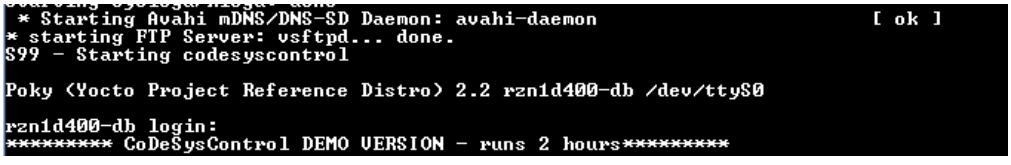


Figure 4: CoDeSysControl Linux console output

4.2 Instructions for installing RZ/N1D configuration file

- Click on Tools->Device Repository

- Click on the “Install…” button and select the device description xml file provided in “…Software\CODESYS\Configuration\Renesas-Cortex-Linux DEMO.devdesc.xml”
- You should be able to see now the Renesas-Cortex-Linux DEMO device under the PLCs structure as depicted below

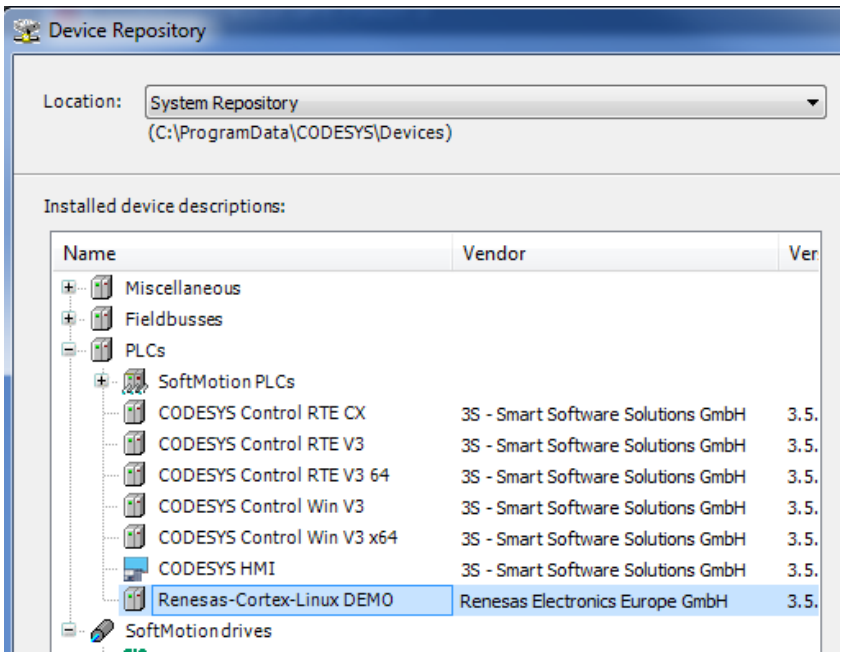


Figure 5: Add RZ/N1 to device repository

4.3 Create a project

Assuming you installed CODESYS V3 tool, to test your new device, you should create a new, simple standard project. Click on this symbol “new project”, select the type „Standard Project“, select your freshly installed Renesas Device Description from the drop down list and press OK. The result should be an empty project, with one task and a POU called „PLC_PRG“, which will be your “main” task.

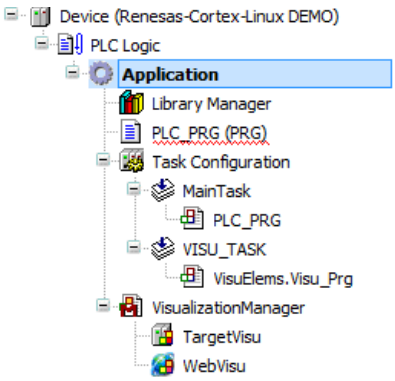


Figure 6: Project Tree example in CODESYS V3

4.4 Scan network for RZ/N1D

Make sure that the runtime environment is running on the board. Connect the board via port J22 to the PC Ethernet Interface.

Double click on „Device“ within your device tree. This should open a dialog, called „Communication Settings“. This dialog can be used to connect the device in your project with your physical device. If your device is connected to the network and you press „Scan network“ in this dialog, you should see your device after a short time. If not, check if your device is connected to the network and if it is in the same subnet as the PC running CODESYS V3. You can also check the network settings in the output of the runtime at startup

In the communication settings window, enter the IP address that you assigned to RZ/N1D board in Linux or via Linux boot arguments and press enter. For example, if your setenv bootargs are

```
console=ttyS0,115200 root=/dev/mmcblk0p1 rootfstype=ext4 rw rootwait
ip=192.168.20.40:::::eth0 …
```

then you should enter **192.168.20.40** for your target device, before scanning the network. Make sure that you assigned an IP address to your PC’s network interface controller in the same subnet as your target device.

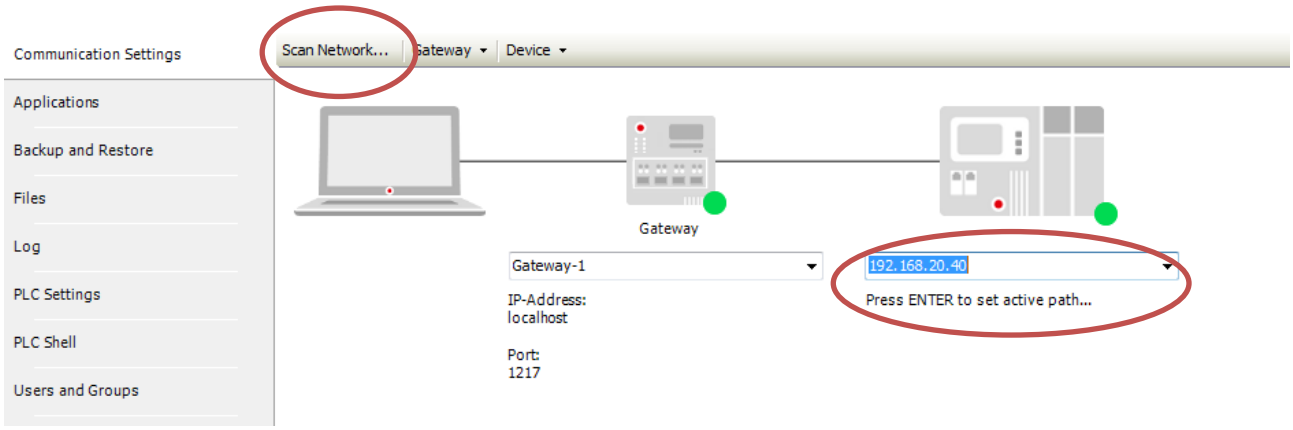


Figure 7: Scan network for RZ/N1D

After scanning the network and provided you connected the RZ/N1D Board on Port J22 with an Ethernet cable to one of your PC’s network interfaces you should be able to see RZ/N1D as active device in the network.

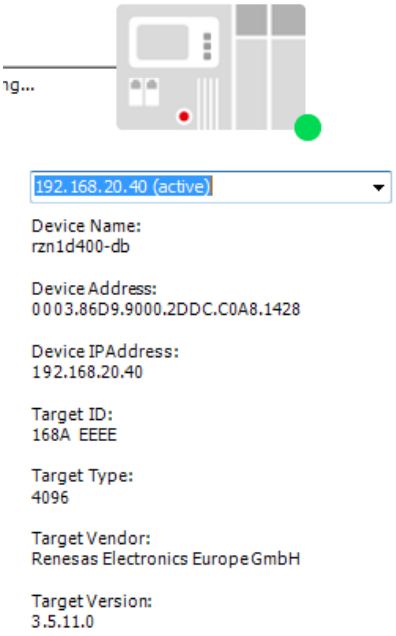


Figure 8: Device found in the network

4.5 Add Visualization Manager Object

CODESYS is well known for making it possible to configure different HMI interfaces to the remote target. This is achieved with the visualization manager. One can design various graphical user interfaces including gauges, alarms, LEDs etc. and present them either on the target's display – TargetVisu or in the web browser as an HTML based presentation - WebVisu. The manager object is used to administrate the representation of the visualization object.

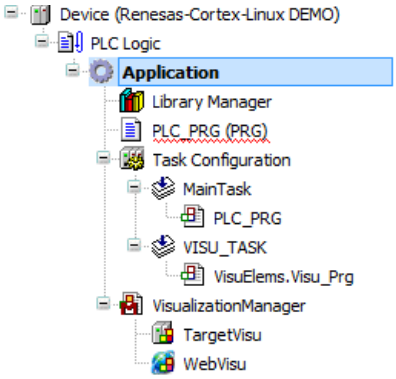


Figure 9: Visualization Manager Object

4.6 Add Visualization

Right click on the "Application" item in the project tree, select "Add object" and then select "Visualization" for adding a graphical user interface.

You can create a custom-made user interface by adding the visualization object to your application. In the visualization panel, you can choose different set of toolboxes with various controls, switches, gauges etc. to fit your interface. You can then link the custom-made interface to the target or web visualization by adding the respective objects in visualization manager.

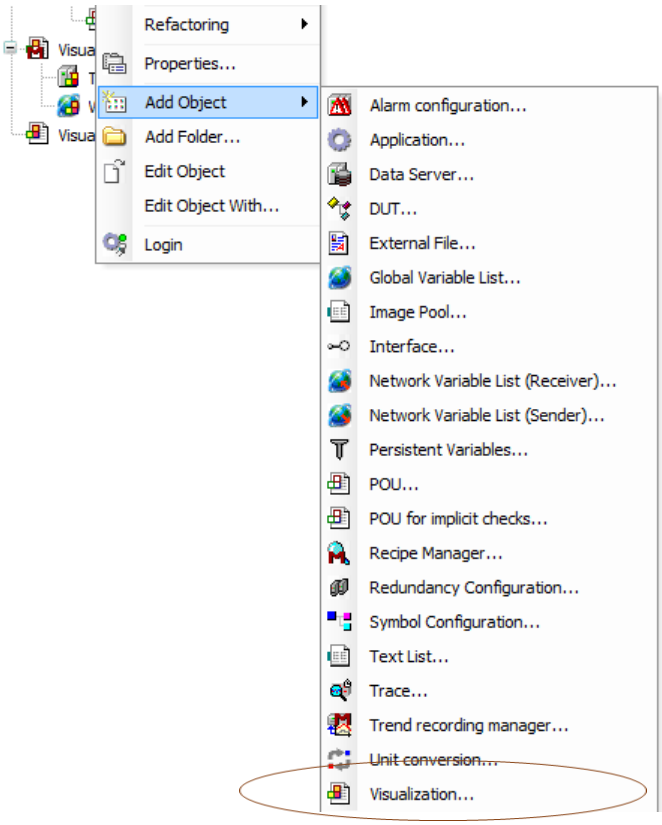
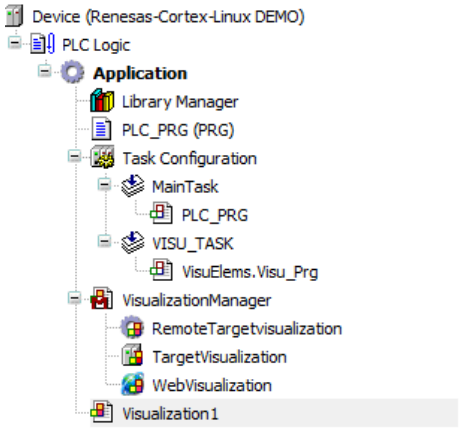


Figure 10: Add visualization

Figure 11: Visualization object



In the interface editor you can add various visual objects to your surface as depicted below.

Figure 12: Example of a graphical interface

4.7 Web Visualization

If you added the WebVisualization object to the project tree, CODESYS can display the created user interface in the web browser. Enter the address in the following format in the web browser:

http://<IP address of webserver>:<port of webserver>/<name of HTM-file>

<name of HTM-file> is the HTML start page of the visualization defined in the object WebVisu.

The page is displayed and you can see the data of the application and operate the application

If the target has the IP address 192.168.20.40, you can call the following web page in your browser:
http://192.168.20.40:8080/webvisu.htm

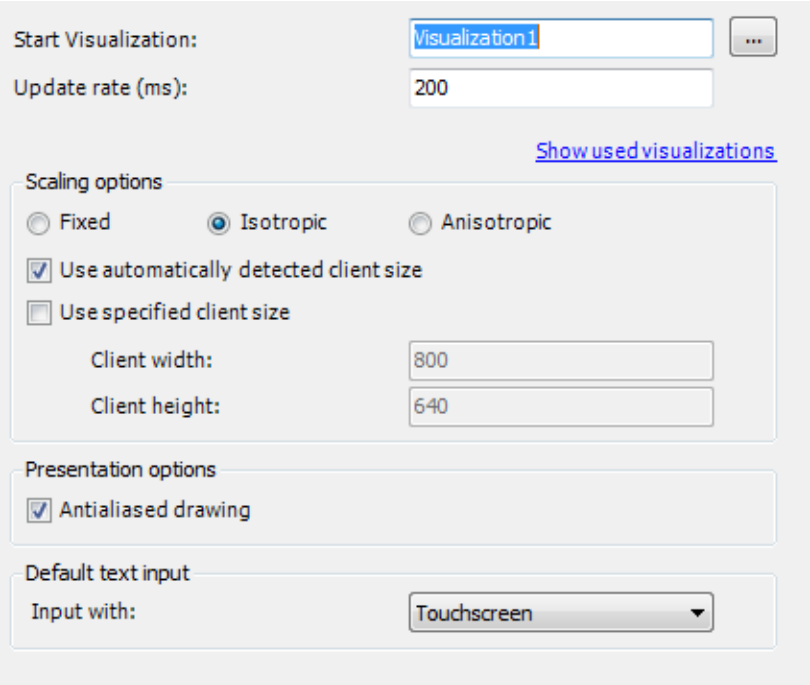


Figure 13: WebVisu settings

4.8 Target Visualization

The object is for the configuration of the CODESYS TargetVisu, in order to display the visualization directly on the controller on an integrated or connected display.

If the demo runtime of 2 hours expired, the execution of runtime binary on the target will stop with a log in Linux console that the demo mode expired. The LCD screen will freeze or turn off and the web browser will show the "License Expired" image.

4.9 Add EtherCAT Master Object

To add an EtherCAT Master object to the project tree, left click on the Device (Renesas-Cortex-Linux Demo) and click on "Add device". In the newly opened window select EtherCAT master as depicted below.

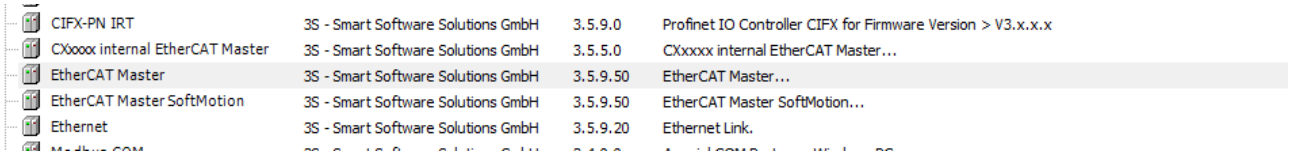


Figure 14: EtherCAT Master Object

Now your project tree should contain an EtherCAT_Master type of device as depicted below. Before connecting it to other EtherCAT slaves, you need to take care of configuring the EtherCAT network interface controller settings.

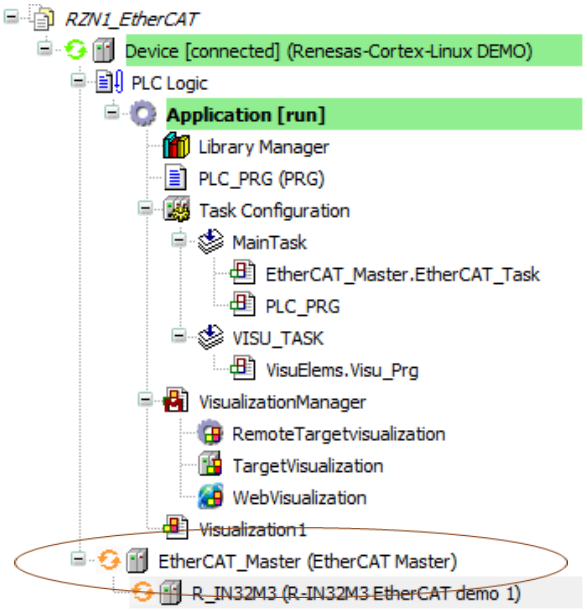


Figure 15: Project Tree with the EtherCAT Master Object

Double clicking on the EtherCAT Master object opens a configuration window. "General" tab of this window lets you to configure the interface setting on RZ/N1D board. You can choose which network adapter you want to choose for the EtherCAT port on the board. If you click on the browse button, you should see a list of options. Since eth0 is connected via J22 port on the extension board directly to the host PC and CODESYS V3 application, you can user **eth1** and respectively port **J23** for attaching a slave device to RZ/N1 board. Please make sure that eth1 interface is up and running in the Linux console as instructed in 4.1 by typing

```
ifconfig eth1 up
```

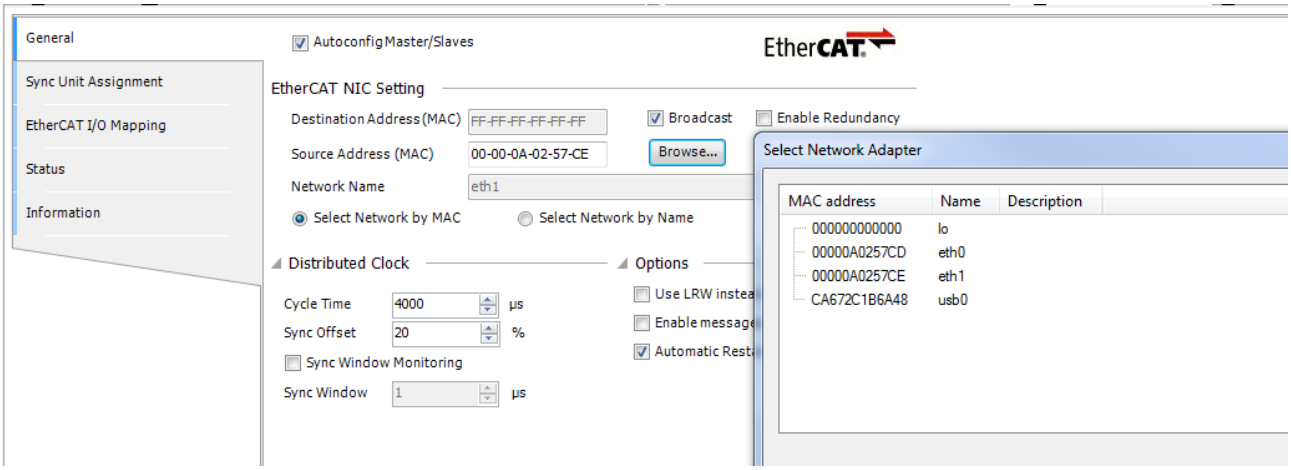


Figure 16: EtherCAT NIC Settings

In order to add a slave device object to you project, make sure that you installed the slave device in the device repository with the corresponding slave XML file. If you did this correctly, you should be able to see your slave device after right-clicking on EtherCAT Master Object in the project tree and then on "Add Device". In our example, we used Renesas R-IN32M3-EC evaluation board as slave.

4.10 Build your program

You can write your program in the PLC_PRG, link your variable with the visualization objects and build it by clicking F11 or build icon.

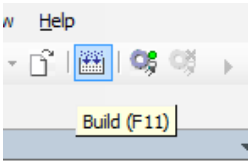


Figure 17: Build the PLC application

You should see 0 errors:

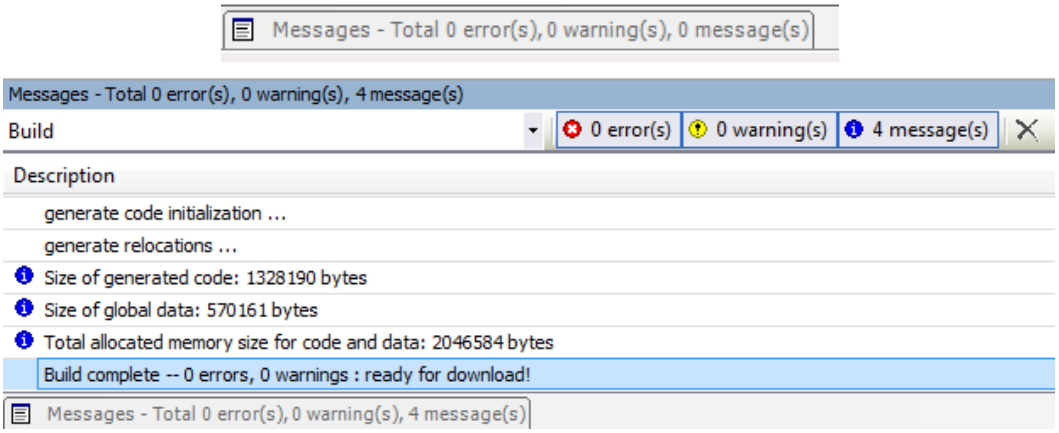


Figure 18: Build complete

It can happen when compiling for the first time that you are missing some libraries, which causes compilation errors. In that case make sure that you download the missing libraries. This information will appear in the message log below of the screen with an option to directly download and install the required libraries as depicted below.

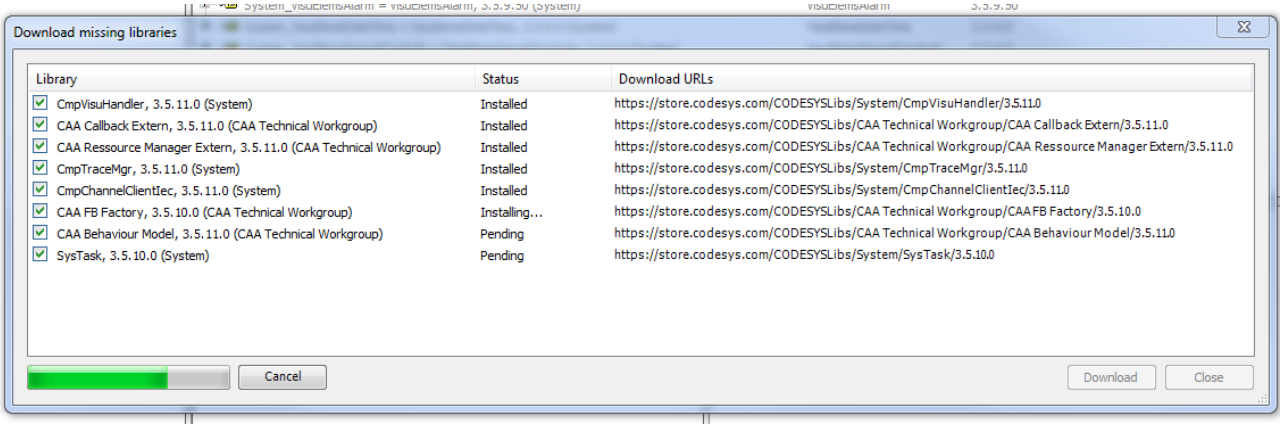


Figure 19: Download missing libraries

4.11 Login

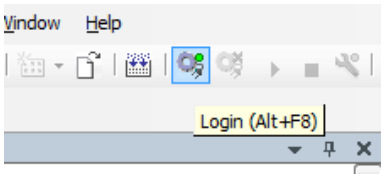


Figure 20: Login

Please note that if you restart the board, you will need to perform the network scanning again in CODESYS V3 to connect to the target again. Afterwards you can login as depicted above. And please assure that the codesyscontrol runtime binary is running on the target. CODESYS tries to authenticate itself on that target and tries to get a „communication channel“. After a few seconds, you should get a response to acknowledge the download of the application.

4.12 Play

After you built the program and logged in, you should run your program to start the execution including the web based live time visualization.

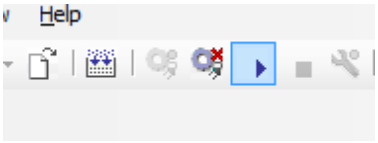


Figure 21: Play the program

At this moment you should be able to see the configured web visualization in your web browser as described in 4.7 and the project tree is displaying that the RZ/N1D is connected, with a green background.

Website and Support

Renesas Electronics Website
http://www.renesas.com/

Inquiries
http://www.renesas.com/contact/

Revision History

		Description	
Rev.	**Date**	**Page**	**Summary**
0.1	28.08.2017	all	First version
-	13.09.2017		Updated device installation instructions + typo fixes
	21.11.2017		Corrected document and binary references
	19.01.2018	4	MiniTool Partition Wizard typo updated
	28.02.2018	all	Typos fixes and tarball extraction instructions updates

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Handling of Unused Pins

   Handle unused pins in accordance with the directions given under Handling of Unused Pins in the manual.

   — The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

   The state of the product is undefined at the moment when power is supplied.

   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.
   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.
   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

   Access to reserved addresses is prohibited.

   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.

   — When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

5. Differences between Products

   Before changing from one product to another, i.e. to a product with a different part number, confirm that the change will not lead to problems.

   — The characteristics of Microprocessing unit or Microcontroller unit products in the same group but having a different part number may differ in terms of the internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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