Application Note

RZ/N1D Group
RZ/N1S Group
RZ/N1L Group

Application Note:
CANopen Quick Start Guide

RZ Family RZ/N1 Series

Preliminary

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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 an MPU or MCU 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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1 Introduction

This document describes how to run *port GmbH*'s CANopen Library on the RZ/N1 Series. It is possible either to run a standalone variant only using one core, the CM3-core, or to use two seperate cores in the case of the RZ/N1D communicating via Core To Core. Both cores feature the GOAL (Generic OS Abstraction Layer) which handles the communication of the cores and provides basic functionality e.g. timer handling.

The CANopen Library stack is located at the CM3-core in both the standalone and the Core To Core variant. Its task is the communication with other operators, therefore the alias name of the CM3-core is communication core (CC) in this document.

In the Core To Core variant the user application is executed on the Linux based CA7-core. This core is also named as application core (AC). In the standalone variant the user application is running on the communication core, either.

The Software is built for the RZ/N1D. It was tested with the CPU and extension board version 2.10.

2 Features

The *port GmbH*'s CANopen Library stack via Core To Core provides the standard CANopen functionality. It features:

- producing of Process Data Objects
- consuming of Process Data Objects
- Service Data Objects for client and server

3 Project Setup

The following chapter describes the setup and usage of *port GmbH*'s CANopen Library via Core to Core.

3.1 Requirements

Please extract the released archive to the workspace.

Please make sure the following components are installed on the computer:

IAR Embedded Workbench for ARM	8.32.3.20228 or newer
IAR C/C++ Compiler for ARM	8.32.3.193 or newer
GCC	8.2.0

Table 1: Development Tools required by CANopen Library

If you need logging, a terminal emulator like putty should be installed and configured to the correct USB serial interface of the RZ/N1 board. If no messages appear after the board is started then another serial port (from the 4 installed devices) must be tried.

3.2 Hardware

Please take care of following the setup guidelines for the RZ/N1 Demo Board from the Linux and U-boot documentation - *RZN1x-Quick-Start-Guide.pdf*

Please follow these initial steps to setup the UART and DFU connection.

1. Connect the board to a Linux PC via the UART and the DFU interface. After the driver for the device has been installed, four additional serial ports will exist. The board uses the 3rd port for serial output. On Linux PCs, if you have no other serial-over-USB devices attached, this is /dev/tttyUSB2.

2. Open a serial terminal on the Linux PC e.g. with
   cu -e -o -115200 -l /dev/XXX
   Replace the "XXX" with the serial device where the UART of the board is connected to.

3.3 Sample Application

The *port GmbH*'s CANopen Library stack for Core to Core contains two sample applications at *goal/appl/goal_co/*.

- 00_rpc_cc – communication core (Core To Core variant only)
- 01_io_data – simple IO application (Standalone variant or Core To Core variant for AC)

It provides the source and configuration files. It also contains the sources of the CANopen Library configuration and the object dictionary. Furthermore, the EDS and XDD device description and an CAN file for *port GmbH*'s CANopen design tool are placed here.

3.4 Configuring the sample application

3.4.1 Application behavior

The application behavior is controlled by the files *canopen_task.c*, *nmtslave.c* and *usr_301.c* located at the CANopen application folder goal/appl/goal_epl/01_io_data. It creates a simple CANopen device supporting SDO and PDO read and write access.

The simple example can be expanded on by adding general behavior to the *canopen_task.c* while loop or adding specific reactions to any of the indications in *nmtslave.c* or *usr_301.c*.

The goal specific CANopen API is a work in progress and does not yet support the full functionality of the *port GmbH* CANopen Library.

3.4.2 Changing the Node ID

The default node ID of the device is 100. Changing the node ID is possible by editing the source code. The variable lNodeId is set in the file goal/appl/goal_co/01_io_data/canopen_task.c

Changing the node ID at runtime is not supported by this example.

3.4.3 Changing the Bitrate

The default node bitrate of the device is 125kBit/s. Changing the bitrate is possible by editing the source code. The variable bitrate is set in the file goal/appl/goal_co/01_io_data/canopen_task.c

Changing the bitrate at runtime is not supported by this example.

3.5 Running the sample application

The RZ/N1D uses the U-Boot bootloader for initial setup of the hardware, loading of the CM3 firmware and booting the Linux Kernel. This chapter describes how to install the management software on the flash of the board. If no bootloader was yet installed on the board please refer to the Linux documentation - Quick Start Guide for U-Boot and Linux - *RZN1x-Quick-Start-Guide.pdf.*

The standalone project and the CC project of the Core To Core variant contain one workspaces for the RZ/N1D inclusive extension board (4 switch ports).

3.5.1 Standalone Variant – RZ/N1D

It is possible to load the code via debugger into RAM, which is a very fast approach to test the user application, or to flash the CM3 core. In both cases any application located in goal\projects\goal_eip_lib and must be built using IAR Embedded Workbench.

3.5.1.1 Loading application into RAM via IAR Embedded Workbench

To compile a project, follow these steps:

1. Start the IAR Workbench IDE
2. Open a project via Open/Workspace
3. Go to the workspace folder and open it:
4. In case the CPU board is used together with the extension board, please ensure to select the correct IAR-project.
   Compile the project via “Project/Compile” or “Project/Rebuild all”.
5. Power up the device
6. Open a serial terminal e.g. PuTTY and connect it to the serial interface where the UART is connected to (also see step 1 in section 3.2 for selecting the correct device). The following settings must be configured for the connection:

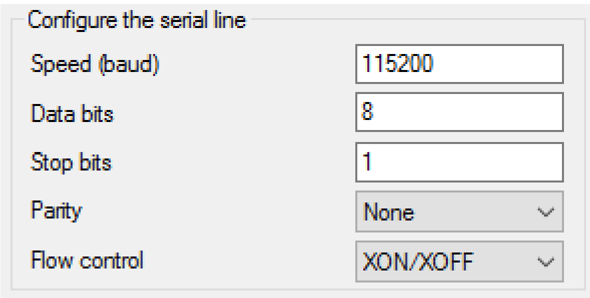

Figure 3-1: Serial Terminal settings RZ/N1D and RZ/N1S

7. Press any key on your keyboard to interrupt the bootloader.
8. Ensure to configure the U-boot boot command to release the CM3 core after reset. This is done by the command:
   setenv bootcmd "mw 0x04000004 1 && rzn1_start_cm3 && loop 0 1"
   followed by
   saveenv
   and reset the board.
9. Connect the debugger to the system via the “Download and Debug” button of the IAR Workbench.
10. After the Debug view opened, click on the “Go” button.

3.5.1.2 Loading application into flash via dfu-util

The board uses the u-boot bootloader for initial setup of the hardware and loading of the CM3 core firmware. This chapter describes how to install the compiled management software on the flash of the board. If no bootloader was yet installed on the board please refer to the Linux documentation - Quick Start Guide for U-Boot and Linux - *RZN1x-Quick-Start-Guide.pdf.*
The following steps describe the installation of the management software:

1. Connect a Linux PC to the board according to section 3.2.
2. Power up the board.
3. Hit any key to stop the autoboot of the u-boot
4. Type *"dfu"* in the serial terminal of the board and hit enter.
5. On a Linux terminal start the command

   sudo dfu-util -a'sf_cm3' -D FIRMWARE.bin

   Replace FIRMWARE.bin with the file name of the software to install. The binary is placed at the

   subfolder Debug-RAM\Exe of the IAR project folder.
6. When the download process is complete, press Ctrl+C on u-boot.
7. If the autoboot command was already configured, go to step 10.
8. Set the autoboot command in the u-boot:

   setenv bootcmd "sf probe && sf read 0x4000000 d0000 80000 && rzn1_start_cm3 && loop 0 1"
9. Save the command to the flash: *saveenv*
10. Reset the device

3.5.2 Core To Core variant – RZ/N1D (Communication Core)

The binary file for the CM3 core is located in the board type related IAR Embedded Workbench folder goal\projects\goal_co_rpc\00_goal_rpc_demo\.

Load the binary file to the flash according to the following steps.

1. Connect a Linux PC to the board according to section 3.2
2. Power up the board.
3. Hit any key to stop the autoboot of the U-Boot
4. Type *"dfu"* in the serial terminal of the board and hit enter.
5. On a Linux terminal start the command
   sudo dfu-util -a"sf_cm3" -D FIRMWARE
   Replace FIRMWARE with the file name of the software to install.
6. When the download process is complete, press Ctrl+C on u-boot.
7. If the autoboot command was already configured, go to step 10.
8. Set the autoboot command in the u-boot:
   setenv bootcmd "sf probe && sf read 0x4000000 d0000 80000 && sf read 0x80fe0000 b0000 20000 && sf read 0x80008000 1d0000 f00000 && rzn1_start_cm3 && sleep 4 && bootm 0x80008000 - 0x80fe0000"
9. Save the command to the flash by: *saveenv*
10. Reset the device

3.5.3 Core To Core variant – RZ/N1D (Application Core)

The user application runs on the Linux system of the CA7. Its binary must be created by GCC and downloaded to the RZ/N board manually.

3.5.3.1 Building and downloading the user application

The following steps describe, how to build a binary and download it to the RZ/N1 board.

1. Navigate with the terminal of a Linux PC to the project of the application core at *goal/projects/goal_co_rpc_lib/01_io_data/gcc.*
2. Start the build process by executing the Makefile by typing: *make*
3. Select as target platform “rzn_a7_demo_board”.
4. Power up the board and wait till Linux booted successfully.
5. Copy the created binary file *build/rzn_a7_demo_board/goal_rzn_a7_demo_board.bin* to the RZ/N1 board by e.g. secure copy (scp).
6. Copy the application corresponding library
7. *goal/projects/goal_co_rpc_lib/00_lib/gcc/build/rzn_a7_demo_board/libgoal_rzn_a7_demo_board.so* to the RZ/N1 board by e.g. secure copy (scp).
8. Start the binary file on the target by typing the commands

   export LD_LIBRARY_PATH=.

   ./goal_rzn_a7_demo_board.bin –i usb0

The GOAL setups the connection to the communication core via core to core and starts the user application. The initialization is done when the log message “*GOAL initialized”* is printed at the terminal, if logging is activated.

3.5.3.2 Auto start the user application

The Linux Kernel can start the user application on the CA7 automatically with the help of the start script

S99goal_app.sh

This script is placed at *linux_ctc/* of the release. Download the file to the CA7, like the user application binary, and place it at */etc/rc5.d/ if this file is not present*. Please ensure, that *goal_rzn_a7_demo_board.bin* and its library is placed at */home/root/*.

Disabling the start script is possible by adding the boot argument *GOAL_APPL_LINUX_PREV*.

1. Power up the board.
2. Hit any key to stop the autoboot of the U-Boot
3. Add the boot argument for preventing the application autoboot by
   setenv bootargs "${bootargs} GOAL_APPL_LINUX_PREV"
4. Save the command to the flash by:
   saveenv
5. Reset the device

Reenabling the start script is possible by deleting the boot argument *GOAL_APPL_LINUX_PREV.*

1. Power up the board.
2. Hit any key to stop the autoboot of the U-Boot
3. Display the environment by
   env print
4. The latest boot arguments are listed at the line *bootargs=*
5. Copy these arguments, except *GOAL_APPL_LINUX_PREV* and paste them at <paste> on the following command
   Setenv bootargs " <paste> "
6. Save the command to the flash by: *saveenv*
7. Reset the device

4 Using the application example

Out of the box, the example application 01_io_data provides an **SDO server** that can be accessed via SDO messages from the CANopen bus. The device supports writing values to predefined generic data objects in its object dictionary, those values can also be read back.

Both **PDO producers** and **PDO consumers** are included in the application, but they start unconfigured. To use them they can be configured via SDO messages from the CANbus, writing configuration and mapping values to the respective objects in the object dictionary. All generic data objects can be mapped into PDOs.

The application also contains several **SDO clients** but has no usage of them. For simple projects, the code of the application can be expanded with SDO client configuration (RX and TX cobIds) and some usage code, without the need to reconfigure the whole application.

5 Notes for hardware setup

All CANopen Library examples require the RZ/N1 extension board for CANbus access. The switch S4 needs pin 1 and pin 4 set to ON. Switch S4 is right next to the CANbus connector.
Both the CAN and the CAN power switch should be set to the respective ISO setting. The CAN Tx and Rx Jumpers should be set to CAN1.

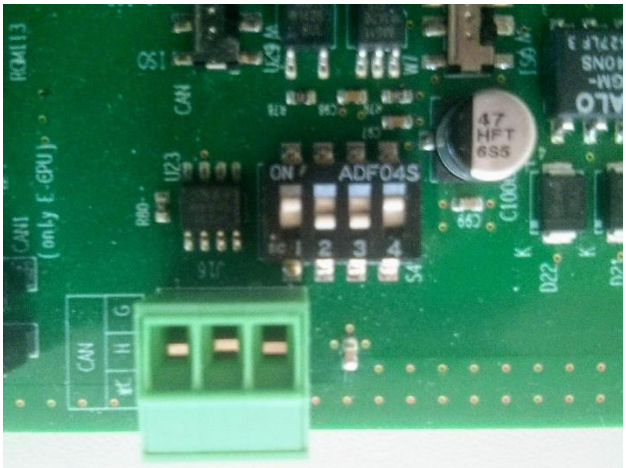

Figure 2 Switch S4 on the RZ/N1 extension board

The board needs to be powered by an 5V external power supply.

6 Revision History

Version	Process		Check		Release	
	Date	**Name**	**Date**	**Name**	**Date**	**Name**
1.0	2017-08-02	Ralf Lindau	2017-08-03	stm		
Initial document						
1.1	2017-08-11	Ralf Lindau				
Review by Renesas						
1.2	2017-12-15	Marcus Züche				
Add description for autostart the CA7 application. Minor updates						
1.3	2018-05-28	Martin Herberg				
Add description for standalone project variant. Minor updates						
1.4	2018-07-04	Martin Ehlert				
Added interface usb0 as parameter to start command in chapter 3.5.3.1						
1.4.3 (1.5)	2019-07-09	Martin Ehlert	2019-07-12	Marcus Züche		
Updated IAR reference version and added GCC version						

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