RL78/F24

CAN Driver and CAN Self-Test

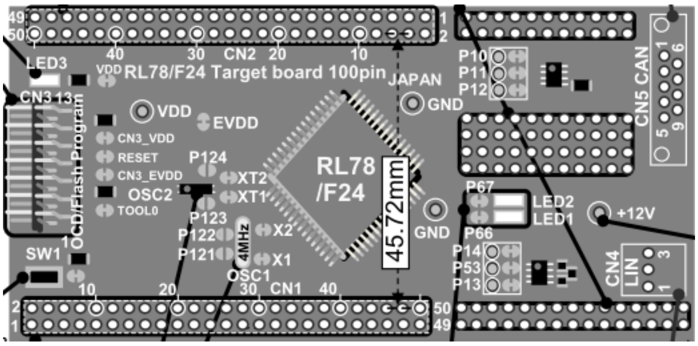
Introduction

This application note describes how to use the CAN driver of RL78 SmartConfigurator, and how to perform a CAN self-test with an extension of the driver.

The application is generated for the IAR™ development environment, and the sample code is separately available by downloading the ZIP archive.

The sample code runs on the RL78/F24 target board "RTK7F124FPC01000BJ", in combination with the Renesas E2 debugger. On the IAR™ workbench, the integrated I/O terminal provides a dialogue with the included monitor program, to call the self-test, receive and transmit functions provided in this application note.

Figure 1: RL78/F24 Target Board



Target Device

RL78/F24: RS-CANFDLite CAN Controller (single channel CAN-FD)

References

[1] R01UH0944[…]: RL78/F23, F24 User's Manual: Hardware
[2] R12UZ0100[…]: RL78/F24 Target Board RTK7F124FPC01000BJ User's Manual
[3] R01AN6334[…]: RS-CANFD lite Module Software Integration System
[4] Renesas Smart Configurator plug-in for RS-CANFD support
https://www.renesas.com/eu/en/search?keywords=R01AN6334
[5] Renesas Smart Configurator for RL78:
https://www.renesas.com/eu/en/software-tool/rl78-smart-configurator
[6] IAR Workbench for RL78:
https://www.renesas.com/eu/en/software-tool/iar-embedded-workbench-renesas-rl78

Contents

1. Hardware / System Requirements

The following conditions on hardware are valid to use CAN-FD on RL78/F24:

- CAN-FD is only implemented in RL78/F24 controller types.
  RL78/F23 types do not contain a CAN-FD controller.
- For downloading, debugging (and optionally supplying power) to the target board [2], the Renesas debugger E2 shall be used, because this configuration has been tested to work with the conditions of this application note.
- The sample software configuration for this application note is generated and set up for the IAR development system EW Version 5.10.1. Higher versions are compatible typically.
- The lower-level driver for the CAN-FD module in RL78/F24 has been generated and set up for Renesas Smart Configurator version 1.5.0 for RL78. As this version is probably intermediate, an update of the Smart Configurator to a higher version may require several actions of redesign of the sample software. Documentation for the lower-level driver is available in [3].
- Renesas Smart Configurator for RL78 requires a plug-in for CAN-FD support.
  The version of this plug-in used for this application note is 1.00.
  The integration of the plug-in into Smart Configurator is explained in the accompanying documentation, using XML data.
- Clock settings of RL78/F24:
  - An external quartz of 20 MHz is highly recommended.
  - It is required to have quartz accuracy for CAN-FD operation.
  - If the external quartz is at a different frequency than 20 MHz, then the internal PLL of RL78/F24 has to be used to reach an internal communication clock speed for CAN-FD of either 20 MHz or 40 MHz.
- Power Supply settings of the target board [2]:
  The board must be powered with a 5V power. Either this is set in the attached debugger, or an external power of this level must be attached.
- Jumpers of the target board [2]:
  Connections of P10, P11 and P12 must be set.
- CAN bus connector of the target board [2]:
  - It is recommended to mount the 9-pin D-Sub connector to attach the target board to standardized CAN bus analysis tools.
  - The target board does not support a CAN bus termination.
    Therefore, an external termination adapter has to be connected on the 9-pin D-Sub connector (between pins 7 and 2).
    The termination on CAN bus side in total shall be 60 Ohms between CAN_H and CAN_L.

2. Software Architecture

When unpacking the sample code archive, the following architecture is created:

Figure 2: Software Architecture

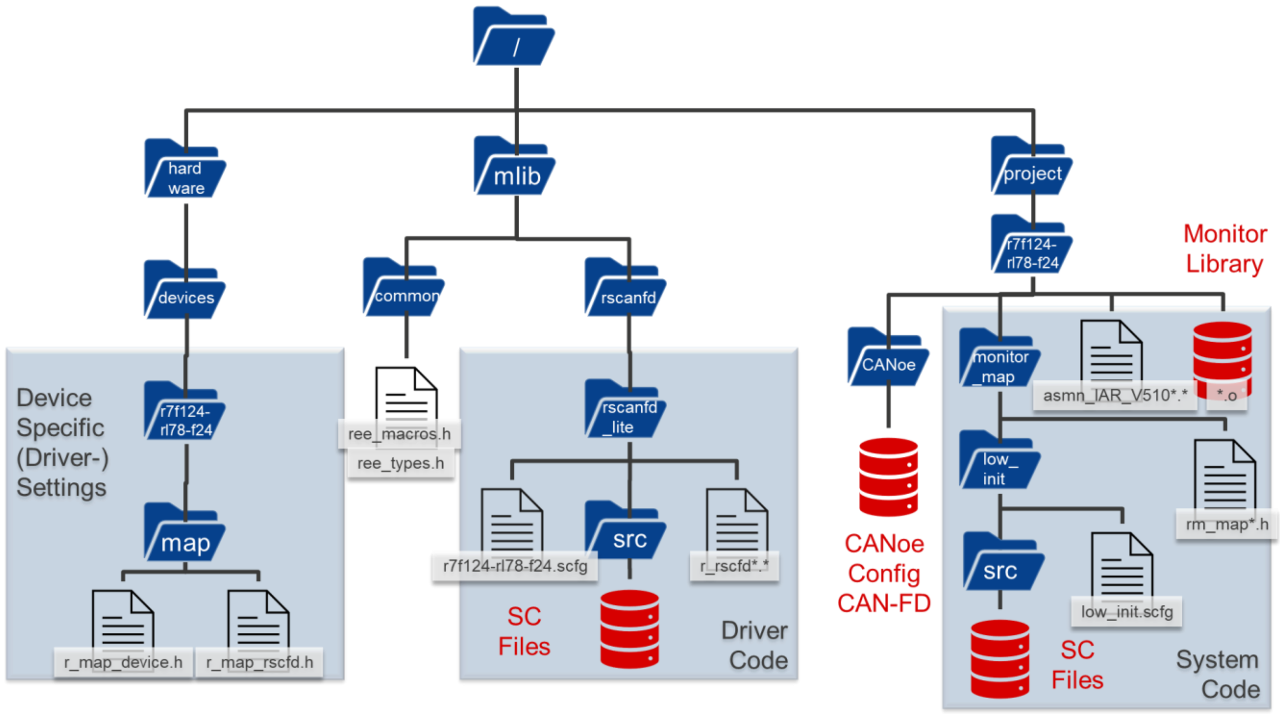


Table 1: Software Components Details

Path	SubDirs / File(s)	Function	
/hardware/devices/r7f124-rl78-f24/map	r_map_device.h	Definition of peripherals and peripheral types	Confi-guration
	r_map_rscfd.h	Definition of additional properties for upper driver code	
/mlib/common	ree_macros.h	Definition of peripheral type codes	Common Definitions
	ree_types.h	Definition of additional types for upper driver code	
/mlib/rscanfd/rscanfd_lite	r_rscfd.h	Definitions and structures of the upper driver code	Upper CAN Driver
	r_rscfd_p.h	API functions declarations of the upper driver code	
	r_rscfd_p.c	Upper driver code	
	r_rscfd_a.h	API functions of the CAN driver applications (Self-Test)	
	r_rscfd_a.c	CAN driver applications (Self-Test)	

	r_rscfd_sc_gen_extension.h	API Extension functions declarations for the CAN driver by SmartConfigurator	
	r_rscfd_sc_gen_extension.c	Extension functions for the CAN driver by SmartConfigurator (Test Mode Setting)	
	r7f124-rl78-f24.scfg	SmartConfigurator configuration file of CAN driver	CAN Driver (SmartConfigurator)
/mlib/mlib/rscanfd/rscanfd_lite/src ([1])	smc_gen_r7f124-rl78-f24/r_config	SmartConfigurator generated settings configuration of CAN driver	
	smc_gen_r7f124-rl78-f24/ r_rscanfd_rl78	SmartConfigurator generated CAN driver	
/project/r7f124-rl78-f24	asmn_IAR_V510.eww asmn_IAR_V510.ewp	IAR® project top level	Project Top Level
	main_asmn.o rm_asmn_rscfd_a_asmnif.o	Monitor program (binary libraries) for interactive control using IAR® console	
/project/r7f124-rl78-f24/monitor_map	rm_map_asmn.h rm_map_asmn_basic.h	Global settings of the monitor program	
/project/r7f124-rl78-f24/monitor_map/low_init	low_init.scfg	SmartConfigurator configuration file of the RL78/F24 system settings	System Startup (SmartConfigurator)
/project/r7f124-rl78-f24/monitor_map/low_init/src ([2])	general r_bsp r_config	SmartConfigurator generated system configuration and startup code	
	Config_PORT	Global port settings within system startup. In this part, the CAN transceiver standby mode is released by a global port setting.	
	Config_WDT	Watchdog initialization and default handling. As the watchdog isn't disabled by default, the "Config_WDT_user.c" part contains a standard watchdog feeding routine by interrupt.	
/project/r7f124-rl78-f24/CANoe	Setting.cfg	Configuration setting of Vector CANoe®, a CAN frame analyzing and generation tool by Vector Informatik.	Tool Support

[1] The generated CAN driver by SmartConfigurator is described in accompanying documentation of SmartConfigurator [5].

[2] The generated system startup code by SmartConfigurator is described in accompanying documentation of SmartConfigurator [5].

3. Project Organization

3.1 Top Level

The project top level for IAR Embedded Workbench® is in the sub-path /project/r7f124-rl78-f24 (highlighted yellow in Table 1). To begin, open this project.

The project is not in the top area of the directory structure, because it has been configured for the dedicated RL78/F24 product, while it is making use of common resources like CAN (RS-CANFD), which are located in a separate tree.

3.2 Contents

The project contains all the required code for system startup, elementary configuration, and adaptation to the target hardware. Boot and interrupt vectors, clock settings, handling of the watchdog and activation of interrupts during system startup is included, too. All this is configured by the system configuration part of SmartConfigurator.

Besides that, the project includes the dedicated RS-CANFD driver by SmartConfigurator. To include this in SmartConfigurator, a plugin must be installed. Instructions on how to install the plugin are given in its documentation [3]. When this is done, SmartConfigurator can be used to open each one of the included ".scfg" files (highlighted yellow in Table 1), doing adjustments and generate/update the code.

As add-ons of this application note, the project contains an "upper driver", which is using the RS-CANFD driver of SmartConfigurator, in order to enhance it and to show its elementary use. Also, an extension of the RS-CANFD driver is provided, which allows the RS-CANFD module to be put into a self-testing mode.

By using the Self-Test, most of the functionality of the RS-CANFD module and its driver can be shown.

For using and testing additional functions for elementary reception and transmission with support of an external CAN-FD tool, associated functions are available in the project, and a configuration set is available for the CANoe® tool of Vector Informatik.

Revision History

Rev.	Date	Description	
		Page	Summary
00.90	20-JUL-2023	all	Initial creation.

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

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1. Precaution against Electrostatic Discharge (ESD)

   A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.
2. Processing at power-on

   The state of the product is undefined at the time 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 time 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 time 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 time when power is supplied until the power reaches the level at which resetting is specified.
3. Input of signal during power-off state

   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.
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   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 the 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.
5. Clock signals

   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is 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. Additionally, 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.
6. Voltage application waveform at input pin

   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).
7. Prohibition of access to reserved addresses

   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.
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Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

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