

Linux Interface Specification Device Driver CANFD

User's Manual: Software

RZ/G2L Group, RZ/V2L Group, RZ/V2N Group,
RZ/G3E and RZ/Five

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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.

4. 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 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.

8. Differences between products

Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of 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.

How to Use This Manual

1. Purpose and Target Readers

This manual is designed to provide the user with an understanding of the hardware functions and electrical characteristics of the MPU. It is intended for users designing application systems incorporating the MPU. It is intended for users developing software incorporating the processors. A basic knowledge of software development and Linux systems is necessary in order to use this document.

Particular attention should be paid to the precautionary notes when using the manual. These notes occur within the body of the text, at the end of each section, and in the Usage Notes section.

The revision history summarizes the locations of revisions and additions. It does not list all revisions. Refer to the text of the manual for details.

The following documents apply to the RZ/G2L Group, RZ/V2L Group, RZ/V2N Group, RZ/G3E Group and RZ/Five Group. Make sure to refer to the latest versions of these documents. The newest versions of the documents listed may be obtained from the Renesas Electronics Web site.

Document Type	Description	Document Title	Document No.
User's manual for Hardware	Hardware specifications (pin assignments, memory maps, peripheral function specifications, electrical characteristics, timing charts) and operation description Note: Refer to the application notes for details on using peripheral functions.	RZ/G2L Group User's Manual: Hardware	---
		RZ/V2L Group User's Manual: Hardware	---
		RZ/V2N Group User's Manual: Hardware	
		RZ/Five Group User's Manual: Hardware	---
		RZ/G3E Group User's Manual: Hardware	---
User's manual for Software	Software specifications (basic function of Linux kernel, memory maps, interrupt, clock, pins mux, device tree)	Linux Interface Specification CANFD Device Driver	This User's manual
Application Note	Information on using peripheral functions and application examples Sample programs Information on writing programs in assembly language and C	Available from Renesas Electronics Web site.	
Renesas Technical Update	Product specifications, updates on documents, etc.		

2. Notation of Numbers and Symbols

3. Register Notation

4. List of Abbreviations and Acronyms

Abbreviation	Full Form
ACIA	Asynchronous Communications Interface Adapter
bps	bits per second
CRC	Cyclic Redundancy Check
DMA	Direct Memory Access
DMAC	Direct Memory Access Controller
GSM	Global System for Mobile Communications
Hi-Z	High Impedance
IEBus	Inter Equipment Bus
I/O	Input/Output
IrDA	Infrared Data Association
LSB	Least Significant Bit
MSB	Most Significant Bit
NC	Non-Connect
PLL	Phase Locked Loop
PWM	Pulse Width Modulation
SFR	Special Function Register
SIM	Subscriber Identity Module
UART	Universal Asynchronous Receiver/Transmitter
VCO	Voltage Controlled Oscillator

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1. Overview

1.1 Overview

This manual explains the driver module that controls the CANFD Interface (RS-CANFD) controller in the CANFD on RZ/G2L Group, RZ/V2L, RZ/V2N, RZ/G3E and RZ/Five.

Note: Currently, the device can support both Linux kernel versions with the information below:

- v5.10: RZ/G2L Group, RZ/V2L group and RZ/Five.
- v6.1: RZ/G2L, RZ/G2LC, RZ/G3E and RZ/V2N.

1.2 Function

This module supports the following functions by controlling RS-CANFD on RZ/G2L, RZ/G2LC, RZ/G2UL, RZ/V2L, RZ/V2N, RZ/G3E and RZ/Five.

- CAN FD mode supports both Classical CAN & CAN FD frame formats. The controller supports ISO 11898-1:2015 CAN FD format only.
- Transmission and reception of CANFD frame.
- Communication speed is up to 1 Mbps maximum with Classical CAN mode, 4 Mbps with CANFD mode, 8Mbps Data bit rate with RZ/V2N and RZ/G3E.
- Interval transmission function: Transmit messages at configurable intervals.
- Transmit queue function: Transmits all stored messages according to the ID priority.
- Error status monitoring.

1.3 CANFD devices

Supported CAN Transceiver device of this module is as follows.

Table 1-1 Supported CANFD transceiver Devices

Vendor	Product	Interface	Note
-	TCAN1046V-Q1	CAN transceiver	Support CAN transceiver that meets the physical layer requirement of the ISO 11898 high-speed CAN specification

1.4 Connected Port

Table 1-2 Connector for RZ/G2L, RZ/V2L, and RZ/Five Evaluation Board Kit.

Channel	Connector
can0	CN2
can1	CN3

Table 1-3 Connector for RZ/G2L, RZ/V2L, and RZ/Five Promotion Board.

Channel	Connector
can0	CN15
can1	CN16

Table 1-4 Connector for RZ/V2N Evaluation Board Kit.

Channel	Connector
can0	CN1
can1	CN1
can2	CN1
can3	CN1

Table 1-5 Connector for RZ/G3E Evaluation Board Kit.

Channel	Connector
can0	CAN0
can1	CAN1

1.5 Reference

1.5.1 Standard

There are no reference documents on standards.

1.5.2 Related documents

The following table shows the document related to this module.

Table 1-6 Related document

Number	Issue	Title	Edition	Date
-	-	-	-	-

1.6 Restrictions

There is no restriction in this module.

2. Terminology

The following table shows the terminology related to this module.

Table 2-1 Terminology

Terms	Explanation
Classical CAN mode	Only classical CAN frames are handled
CAN FD mode	Both the classical CAN frames and CANFD frames are handled

3. Operating Environment

3.1 Hardware Environment

The following table lists the hardware needed to use this module.

Table 3-1 Hardware environment (RZ/G2L, RZ/V2L, RZ/Five)

Name	Version	Manufacture
RZ/G2L Evaluation Board Kit	SMARC module: v01 Carrier board: v03	Renesas Electronics Europe GmbH
RZ/G2LC Evaluation Board Kit	SMARC module: v01 Carrier board: v03	Renesas Electronics Europe GmbH
RZ/G2UL Evaluation Board Kit	SMARC module: v01 Carrier board: v03	Renesas Electronics Europe GmbH
RZ/V2L Evaluation Board Kit	SMARC module: v01 Carrier board: v03	Renesas Electronics Europe GmbH
RZ/Five Evaluation Board Kit	SMARC module: v01 Carrier board: v03	Renesas Electronics Europe GmbH

Table 3-2 Hardware environment (RZ/V2N)

Name	Product number
RZ/V2N Evaluation Kit	RTK0EF0186C03000BJ
RZ/G3E SMARC Evaluation Board Kit.	RTK9947E57S01000BE

3.2 Module Configuration

The following figure shows the configuration of this module.

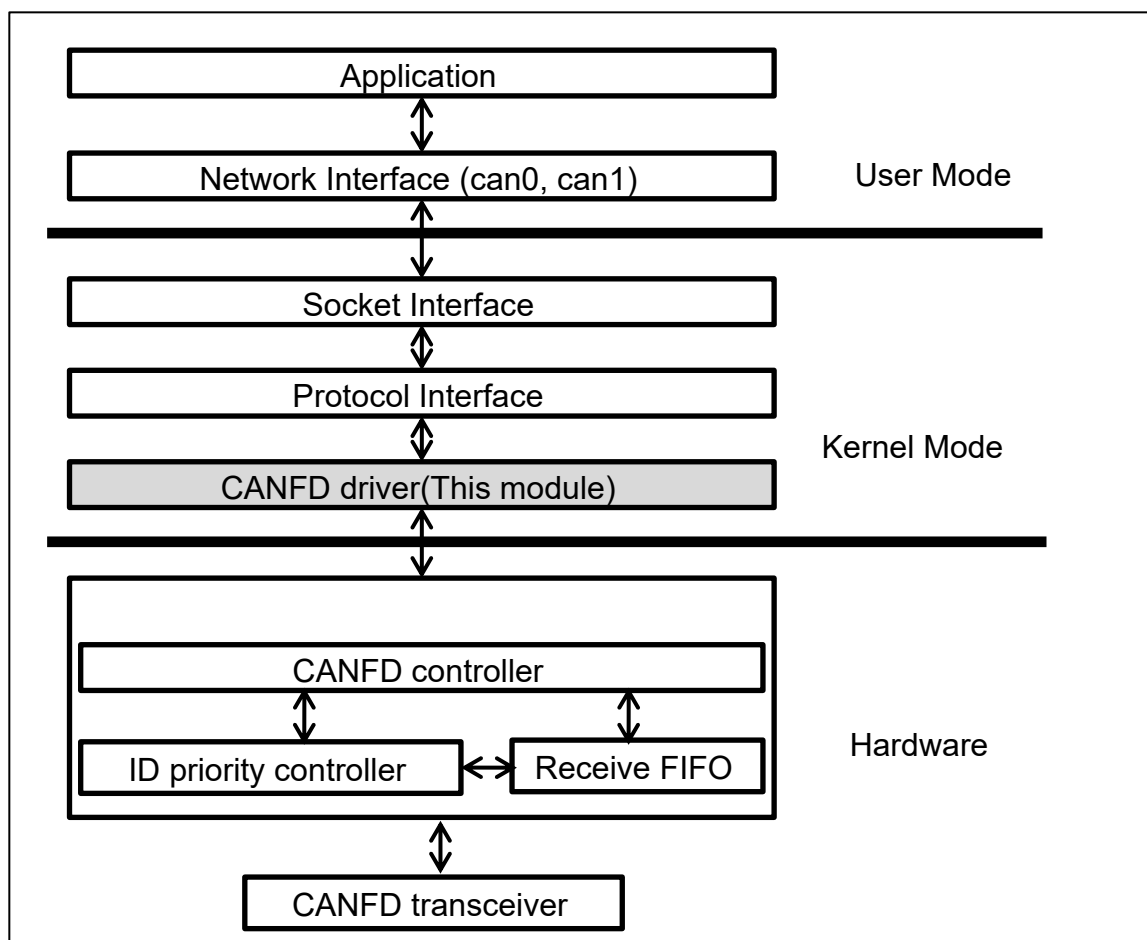


Figure 3-1 RS-CANFD Module Configuration

3.3 State Transition Diagram

There is no state transition diagram for this module.

4. External Interface

4.1 Device node

The following table shows the device node of this module

If hardware setting enable both channel 0 and channel 1 (G2L, V2L, G2UL, RZ/Five)

Table 4-1 CANFD device node (RZ/G2L, RZ/V2L, RZ/G2UL, RZ/Five)

Channel	Device node	Device name
channel 0	can0	can0
channel 1	can1	can1

If hardware setting only enable channel 1 (G2LC)

Table 4-2 CANFD device node RZ/G2LC

Channel	Device node	Device name
channel 1	can1	can0

Table 4-3 CANFD device node RZ/V2N and RZ/G3E

channel	device node	device name
channel 0	can0	can0
channel 1	can1	can1
channel 2	can2	can2
channel 3	can3	can3
channel 4	can4	can4
channel 5	can5	can5

4.2 Sysfs interface specification

Please refer <https://www.kernel.org/doc/Documentation/networking/can.txt> to know how to control CANFD driver correctly in user-space.

4.3 Definitions

4.3.1 Device information in Device Tree

The RS-CANFD device properties are showed below.

```
canfd: can@10050000 {
    compatible = "renesas,r9a07g044-canfd", "renesas,rzg2l-canfd";
    reg = <0 0x10050000 0 0x8000>;
    interrupts = <GIC_SPI 426 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 427 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 422 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 424 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 428 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 423 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 425 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 429 IRQ_TYPE_LEVEL_HIGH>;
    interrupt-names = "g_err", "g_recc",
                    "ch0_err", "ch0_rec", "ch0_trx",
                    "ch1_err", "ch1_rec", "ch1_trx";
    clocks = <&cpg CPG_MOD R9A07G044_CANFD_PCLK>,
            <&cpg CPG_CORE R9A07G044_CLK_P0_DIV2>,
            <&can_clk>;
    clock-names = "fck", "canfd", "can_clk";
    assigned-clocks = <&cpg CPG_CORE R9A07G044_CLK_P0_DIV2>;
    assigned-clock-rates = <500000000>;
    resets = <&cpg R9A07G044_CANFD_RSTP_N>,
            <&cpg R9A07G044_CANFD_RSTC_N>;
    reset-names = "rstp_n", "rstc_n";
    power-domains = <&cpg>;
    status = "disabled";

    channel0 {
        status = "disabled";
    };
    channel1 {
        status = "disabled";
    };
};
```

Note) All of the information in above device tree is used for both RZ/G2L, RZ/V2L, RZ/G2LC, RZ/G2UL, RZ/Five except compatible, clocks and resets:

The RS-CANFD device required properties:

compatible:

Must be set

"renesas,r9a07g044-canfd" for R9A07G044L (RZ/G2L), R9A07G054L (RZ/V2L), R9A07G044C (RZ/G2LC) and

"renesas,r9a07g043-canfd" for R9A07G043U (RZ/G2UL),

"renesas,r9a07g043f-canfd" for R9A07G043F (RZ/Five) as a fallback.

reg:

Base address and length of the memory resource used by the CANFD driver.

interrupt:

<GIC_SPI 426 IRQ_TYPE_LEVEL_HIGH>	CAN global error interrupt
<GIC_SPI 422 IRQ_TYPE_LEVEL_HIGH>	CAN0 error interrupt
<GIC_SPI 428 IRQ_TYPE_LEVEL_HIGH>	CAN0 transmit interrupt
<GIC_SPI 423 IRQ_TYPE_LEVEL_HIGH>	CAN1 error interrupt
<GIC_SPI 429 IRQ_TYPE_LEVEL_HIGH>	CAN1 transmit interrupt
<GIC_SPI 424 IRQ_TYPE_LEVEL_HIGH>	CAN0 transmit/receive FIFO receive completion interrupt
<GIC_SPI 425 IRQ_TYPE_LEVEL_HIGH>	CAN1 transmit/receive FIFO receive completion interrupt
<GIC_SPI 427 IRQ_TYPE_LEVEL_HIGH>	CAN receive FIFO interrupt

Note) +32 into each Interrupt ID of RZ/Five.

clocks:

slot 1:

The 1st cell is a node or label of CPG clock to be used.

The 2nd cell must be set to CPG_MOD.

The 3rd cell must be set to R9A07G044_CANFD_PCLK for (RZ/G2L, RZ/V2L, RZ/G2LC), R9A07G043_CANFD_PCLK for RZ/G2UL, R9A07G043F_CANFD_PCLK for RZ/Five.

slot 2:

The 1st cell is a node or label of CPG clock to be used.

The 2nd cell must be set to CPG_MOD.

The 3rd cell must be set to R9A07G044_CLK_P0_DIV2 for (RZ/G2L, RZ/V2L, RZ/G2LC), R9A07G043_CLK_P0_DIV2 for RZ/G2UL, R9A07G043F_CLK_P0_DIV2 for RZ/Five

reset:

slot 1:

The 1st cell is a node or label of CPG clock to be used.

The 2nd cell must be set to R9A07G044_CANFD_RSTP_N for (RZ/G2L, RZ/V2L, RZ/G2LC), R9A07G043_CANFD_RSTP_N for RZ/G2UL, R9A07G043F_CANFD_RSTP_N for RZ/Five

slot 2:

The 1st cell is a node or label of CPG clock to be used.

The 2rd cell must be set to R9A07G044_CANFD_RSTC_N for (RZ/G2L , RZ/V2L, RZ/G2LC), R9A07G043_CANFD_RSTC_N for RZ/G2UL, R9A07G043F_CANFD_RSTC_N for RZ/Five

power domain:

Must be set to always on.

Interrupt-names:

Name of each interrupt source, driver get interrupt by interrupt-name

clock-names:

Name of each clock source, driver get clock by clock-name

reset-names:

Name of each reset source, driver get reset by reset-name

Please set “output-high” to pull up pin standby input for mode control of device tree file (rzg2l-smarc-pinfunction.dtsi) in arch/arm64/boot/dts/renesas for RZ/G2L, RZ/V2L.

```
can0_stb {
    gpio-hog;
    gpios = <RZG2L_GPIO(42, 2) GPIO_ACTIVE_LOW>;
    output-low;
    line-name = "can0_stb";
};

can1_stb {
    gpio-hog;
    gpios = <RZG2L_GPIO(42, 3) GPIO_ACTIVE_LOW>;
    output-low;
    line-name = "can1_stb";
};
```

Please set “output-high” to pull up pin standby input for mode control of device tree file (rzg2l-smarc-pinfunction.dtsi) in arch/arm64/boot/dts/renesas for RZ/G2LC

```
#if SW_RSPI_CAN
    /* SW8 should be at position 2->3 so that GPIO9_CAN1_STB line is activated */
    can1-stb {
        gpio-hog;
        gpios = <RZG2L_GPIO(44, 3) GPIO_ACTIVE_HIGH>;
        output-low;
        line-name = "can1_stb";
    };
};
```


Please set “output-high” to pull up pin standby input for mode control of device tree file :
(rzg2ul-smarc.dtsi) in arch/arm64/boot/dts/renesas for RZ/G2UL
(rzfive-smarc.dtsi) in arch/risv/boot/dts/renesas for RZ/Five

```
#if (SW_ET0_EN_N)
    canfd0_en {
        gpio-hog;
        gpios = <RZG2L_GPIO(2, 2) GPIO_ACTIVE_LOW>;
        output-high;
        line-name = "canfd0_en";
    };
    canfd1_en {
        gpio-hog;
        gpios = <RZG2L_GPIO(2, 3) GPIO_ACTIVE_LOW>;
        output-high;
        line-name = "canfd1_en";
    };
};
#endif
```

The CAN-FD of RZ/V2N device properties are shown below.

```

canfd: can@12440000 {
    compatible = "renesas,r9a09g056-canfd";
    reg = <0 0x12440000 0 0x40000>;
    interrupts = <GIC_SPI 709 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 710 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 697 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 703 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 711 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 698 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 704 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 712 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 699 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 705 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 713 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 700 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 706 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 714 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 701 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 707 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 715 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 702 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 708 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 716 IRQ_TYPE_LEVEL_HIGH>;
    interrupt-names = "g_err", "g_recc",
                    "ch0_err", "ch0_rec", "ch0_trx",
                    "ch1_err", "ch1_rec", "ch1_trx",
                    "ch2_err", "ch2_rec", "ch2_trx",
                    "ch3_err", "ch3_rec", "ch3_trx",
                    "ch4_err", "ch4_rec", "ch4_trx",
                    "ch5_err", "ch5_rec", "ch5_trx";
    clocks = <&cpg CPG_MOD 0x9c>,
            <&cpg CPG_MOD 0x9d>,
            <&cpg CPG_MOD 0x9e>;
    clock-names = "fck", "clk_ram", "can_clk";
    resets = <&cpg 0xa1>,
            <&cpg 0xa2>;
    reset-names = "rstp_n", "rstc_n";
    power-domains = <&cpg>;
    status = "disabled";

    channel0 {
        status = "disabled";
    };
    channel1 {
        status = "disabled";
    };
    channel2 {
        status = "disabled";
    };
    channel3 {
        status = "disabled";
    };
    channel4 {
        status = "disabled";
    };
    channel5 {
        status = "disabled";
    };
};

```

Note: Example of CAN-FD device tree setting for RZ/V2N.

The CAN-FD device required properties:

compatible:

Must be set

"renesas,r9a09g056-canfd" for R9A09G056 (RZ/V2N).

reg:

Base address and length of the memory resource used by the CANFD driver.

interrupt:

<GIC_SPI 709 IRQ_TYPE_LEVEL_HIGH>	CAN global error interrupt
<GIC_SPI 710 IRQ_TYPE_LEVEL_HIGH>	CAN RX FIFO interrupt
<GIC_SPI 697 IRQ_TYPE_LEVEL_HIGH>	CAN0 error interrupt
<GIC_SPI 703 IRQ_TYPE_LEVEL_HIGH>	CAN0 common RX FIFO or TXQ interrupt
<GIC_SPI 711 IRQ_TYPE_LEVEL_HIGH>	CAN0 TX interrupt
<GIC_SPI 698 IRQ_TYPE_LEVEL_HIGH>	CAN1 error interrupt
<GIC_SPI 704 IRQ_TYPE_LEVEL_HIGH>	CAN1 common RX FIFO or TXQ interrupt
<GIC_SPI 712 IRQ_TYPE_LEVEL_HIGH>	CAN1 TX interrupt
<GIC_SPI 699 IRQ_TYPE_LEVEL_HIGH>	CAN2 error interrupt
<GIC_SPI 705 IRQ_TYPE_LEVEL_HIGH>	CAN2 common RX FIFO or TXQ interrupt
<GIC_SPI 713 IRQ_TYPE_LEVEL_HIGH>	CAN2 TX interrupt
<GIC_SPI 700 IRQ_TYPE_LEVEL_HIGH>	CAN3 error interrupt
<GIC_SPI 706 IRQ_TYPE_LEVEL_HIGH>	CAN3 common RX FIFO or TXQ interrupt
<GIC_SPI 714 IRQ_TYPE_LEVEL_HIGH>	CAN3 TX interrupt
<GIC_SPI 701 IRQ_TYPE_LEVEL_HIGH>	CAN4 error interrupt
<GIC_SPI 707 IRQ_TYPE_LEVEL_HIGH>	CAN4 common RX FIFO or TXQ interrupt
<GIC_SPI 715 IRQ_TYPE_LEVEL_HIGH>	CAN4 TX interrupt
<GIC_SPI 702 IRQ_TYPE_LEVEL_HIGH>	CAN5 error interrupt
<GIC_SPI 708 IRQ_TYPE_LEVEL_HIGH>	CAN5 common RX FIFO or TXQ interrupt
<GIC_SPI 716 IRQ_TYPE_LEVEL_HIGH>	CAN5 TX interrupt

clocks:

slot 1:

The 1st cell is a node or label of CPG clock to be used.

The 2nd cell must be set to CPG_MOD.

The 3rd cell must be set to CANFD PCLK CLK index 0x9c for RZ/V2N .

slot 2:

The 1st cell is a node or label of CPG clock to be used.

The 2nd cell must be set to CPG_MOD.

The 3rd cell must be set to CANFD RAM CLK index 0x9d for RZ/V2N.

slot 3:

The 1st cell is a node or label of CPG clock to be used.

The 2nd cell must be set to CPG_MOD.

The 3rd cell must be set to CANFD CLKC CLK 0x9e for RZ/V2N.

reset:

slot 1:

The 1st cell is a node or label of CPG clock to be used.

The 2rd cell must be set to CANFD RSTP_N reset index 0xa1 for RZ/V2N.

slot 2:

The 1st cell is a node or label of CPG clock to be used.

The 2rd cell must be set to CANFD RSTC_N reset index 0xa2 for RZ/V2N.

power domain:

Must be set to always on.

Interrupt-names:

Name of each interrupt source, driver get interrupt by interrupt-name

clock-names:

Name of each clock source, driver get clock by clock-name

reset-names:

Name of each reset source, driver get reset by reset-name

The CAN-FD of RZ/G3E device properties are shown below.

```
canfd: can@12440000 {
    compatible = "renesas,r9a09g047-canfd";
    reg = <0 0x12440000 0 0x40000>;
    interrupts = <GIC_SPI 709 IRQ_TYPE_LEVEL_HIGH>,
        <GIC_SPI 710 IRQ_TYPE_LEVEL_HIGH>,
        <GIC_SPI 697 IRQ_TYPE_LEVEL_HIGH>,
        <GIC_SPI 703 IRQ_TYPE_LEVEL_HIGH>,
        <GIC_SPI 711 IRQ_TYPE_LEVEL_HIGH>,
        <GIC_SPI 698 IRQ_TYPE_LEVEL_HIGH>,
        <GIC_SPI 704 IRQ_TYPE_LEVEL_HIGH>,
        <GIC_SPI 712 IRQ_TYPE_LEVEL_HIGH>,
        <GIC_SPI 699 IRQ_TYPE_LEVEL_HIGH>,
        <GIC_SPI 705 IRQ_TYPE_LEVEL_HIGH>,
        <GIC_SPI 713 IRQ_TYPE_LEVEL_HIGH>,
        <GIC_SPI 700 IRQ_TYPE_LEVEL_HIGH>,
        <GIC_SPI 706 IRQ_TYPE_LEVEL_HIGH>,
        <GIC_SPI 714 IRQ_TYPE_LEVEL_HIGH>,
        <GIC_SPI 701 IRQ_TYPE_LEVEL_HIGH>,
        <GIC_SPI 707 IRQ_TYPE_LEVEL_HIGH>,
        <GIC_SPI 715 IRQ_TYPE_LEVEL_HIGH>,
        <GIC_SPI 702 IRQ_TYPE_LEVEL_HIGH>,
        <GIC_SPI 708 IRQ_TYPE_LEVEL_HIGH>,
        <GIC_SPI 716 IRQ_TYPE_LEVEL_HIGH>;
    interrupt-names = "g_err", "g_recc",
        "ch0_err", "ch0_rec", "ch0_trx",
        "ch1_err", "ch1_rec", "ch1_trx",
        "ch2_err", "ch2_rec", "ch2_trx",
        "ch3_err", "ch3_rec", "ch3_trx",
        "ch4_err", "ch4_rec", "ch4_trx",
        "ch5_err", "ch5_rec", "ch5_trx";
    clocks = <&cpg CPG_MOD 156>,
        <&cpg CPG_MOD 157>,
        <&cpg CPG_MOD 158>;
    clock-names = "fck", "clk_ram", "can_clk";
    resets = <&cpg 161>,
        <&cpg 162>;
    reset-names = "rstp_n", "rstc_n";
    power-domains = <&cpg>;
    status = "disabled";

    channel0 {
        status = "disabled";
    };
    channel1 {
        status = "disabled";
    };
    channel2 {
        status = "disabled";
    };
    channel3 {
        status = "disabled";
    };
    channel4 {
        status = "disabled";
    };
    channel5 {
        status = "disabled";
    };
};
```

Note: Example of CAN-FD device tree setting for RZ/G3E.

The CAN-FD device required properties:

compatible:

Must be set

"renesas, r9a09g047-canfd" for R9A09G047 (RZ/G3E).

reg:

Base address and length of the memory resource used by the CANFD driver.

interrupt:

<GIC_SPI 709 IRQ_TYPE_LEVEL_HIGH>	CAN global error interrupt
<GIC_SPI 710 IRQ_TYPE_LEVEL_HIGH>	CAN RX FIFO interrupt
<GIC_SPI 697 IRQ_TYPE_LEVEL_HIGH>	CAN0 error interrupt
<GIC_SPI 703 IRQ_TYPE_LEVEL_HIGH>	CAN0 common RX FIFO or TXQ interrupt
<GIC_SPI 711 IRQ_TYPE_LEVEL_HIGH>	CAN0 TX interrupt
<GIC_SPI 698 IRQ_TYPE_LEVEL_HIGH>	CAN1 error interrupt
<GIC_SPI 704 IRQ_TYPE_LEVEL_HIGH>	CAN1 common RX FIFO or TXQ interrupt
<GIC_SPI 712 IRQ_TYPE_LEVEL_HIGH>	CAN1 TX interrupt
<GIC_SPI 699 IRQ_TYPE_LEVEL_HIGH>	CAN2 error interrupt
<GIC_SPI 705 IRQ_TYPE_LEVEL_HIGH>	CAN2 common RX FIFO or TXQ interrupt
<GIC_SPI 713 IRQ_TYPE_LEVEL_HIGH>	CAN2 TX interrupt
<GIC_SPI 700 IRQ_TYPE_LEVEL_HIGH>	CAN3 error interrupt
<GIC_SPI 706 IRQ_TYPE_LEVEL_HIGH>	CAN3 common RX FIFO or TXQ interrupt
<GIC_SPI 714 IRQ_TYPE_LEVEL_HIGH>	CAN3 TX interrupt
<GIC_SPI 701 IRQ_TYPE_LEVEL_HIGH>	CAN4 error interrupt
<GIC_SPI 707 IRQ_TYPE_LEVEL_HIGH>	CAN4 common RX FIFO or TXQ interrupt
<GIC_SPI 715 IRQ_TYPE_LEVEL_HIGH>	CAN4 TX interrupt
<GIC_SPI 702 IRQ_TYPE_LEVEL_HIGH>	CAN5 error interrupt
<GIC_SPI 708 IRQ_TYPE_LEVEL_HIGH>	CAN5 common RX FIFO or TXQ interrupt
<GIC_SPI 716 IRQ_TYPE_LEVEL_HIGH>	CAN5 TX interrupt

clocks:

slot 1:

The 1st cell is a node or label of CPG clock to be used.

The 2nd cell must be set to CPG_MOD.

The 3rd cell must be set to CANFD PCLK CLK index 156 for RZ/G3E.

slot 2:

The 1st cell is a node or label of CPG clock to be used.

The 2nd cell must be set to CPG_MOD.

The 3rd cell must be set to CANFD RAM CLK index 157 for RZ/G3E.

slot 3:

The 1st cell is a node or label of CPG clock to be used.

The 2nd cell must be set to CPG_MOD.

The 3rd cell must be set to CANFD CLKC CLK index 158 for RZ/G3E.

reset:

slot 1:

The 1st cell is a node or label of CPG clock to be used.

The 2nd cell must be set to CANFD RSTP_N reset index 161 for RZ/G3E.

slot 2:

The 1st cell is a node or label of CPG clock to be used.

The 2nd cell must be set to CANFD RSTC_N reset index 162 for RZ/G3E.

power domain:

Must be set to always on.

Interrupt-names:

Name of each interrupt source, driver get interrupt by interrupt-name

clock-names:

Name of each clock source, driver get clock by clock-name

reset-names:

Name of each reset source, driver get reset by reset-name

5. Integration

5.1 Directory Configuration

The directory configuration is shown below.

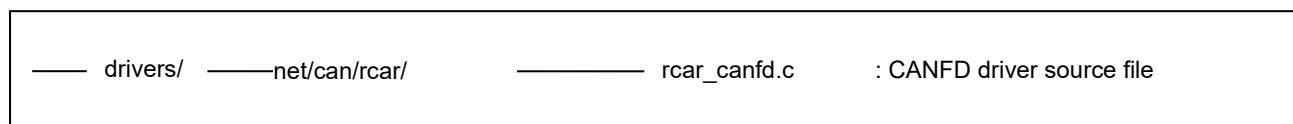


Figure 5-1 Directory Configuration

5.2 Integration Procedure

5.2.1 Kernel Configuration

To enable the function of this module, make the following setting with Kernel Configuration.

Set kernel config for CANFD driver following as below of kernel config file (defconfig) in arch/arm64/configs/defconfig directory.

```

+CONFIG_CAN=y
+CONFIG_CAN_RCAR=y
+CONFIG_CAN_RCAR_CANFD=y
  
```

Figure 5-2 Kernel configuration

5.2.2 Enable Pin-function control for CANFD driver.

Enable pin function control for G2L, V2L.

```

can0_pins: can0 {
    pinmux = <RZG2L_PORT_PINMUX(10, 1, 2)>, /* TX */
             <RZG2L_PORT_PINMUX(11, 0, 2)>; /* RX */
};

can1_pins: can1 {
    pinmux = <RZG2L_PORT_PINMUX(12, 1, 2)>, /* TX */
             <RZG2L_PORT_PINMUX(13, 0, 2)>; /* RX */
};
  
```

Figure 5-3 Enable PFC for G2L, V2L

Enable pin function control for G2LC.

Set “SW_RSPI_CAN = 1” in device-tree

Setting on Smarc Module board RZ/G2LC SW1-3 = “ON” , SW1,4 = “OFF”

```
#if SW_RSPI_CAN
    can1_pins: can1 {
        pinmux = <RZG2L_PORT_PINMUX(44, 0, 3)>, /* TxD */
                <RZG2L_PORT_PINMUX(44, 1, 3)>; /* RxD */
    };
#endif
```

Figure 5-4 Enable PFC for G2LC

Enable pin function control for RZ/G2UL and RZ/Five.

Set “SW_ET0_EN_N = 1” in device-tree

Setting on Smarc Module board RZ/G2UL and RZ/Five SW1-3 = “OFF”

```
#if (SW_ET0_EN_N)
    canfd0_pins: can0 {
        pinmux = <RZG2L_PORT_PINMUX(1, 1, 3)>, /* TX */
                <RZG2L_PORT_PINMUX(1, 2, 3)>; /* RX */
    };

    canfd1_pins: can1 {
        pinmux = <RZG2L_PORT_PINMUX(2, 0, 3)>, /* TX */
                <RZG2L_PORT_PINMUX(2, 1, 3)>; /* RX */
    };
#endif
```

Figure 5-5 Enable PFC for RZ/G2UL and RZ/Five

Enable pin function control for RZ/V2N.

Enable pin function control for RZ/V2N in directory (arch/arm64/boot/dts/renesas/r9a09g056n44-evk.dts)

```
&pinctrl {
    ...
    #if (COMMON_PIN_SEL == CAN_SEL)

        can0_pins: can0 {
            pinmux = <RZG2L_PORT_PINMUX(8, 0, 5)>, /* TX */
                    <RZG2L_PORT_PINMUX(8, 1, 5)>; /* RX */
        };

        can1_pins: can1 {
            pinmux = <RZG2L_PORT_PINMUX(8, 2, 5)>, /* TX */
                    <RZG2L_PORT_PINMUX(8, 3, 5)>; /* RX */
        };

        can2_pins: can2 {
            pinmux = <RZG2L_PORT_PINMUX(8, 4, 5)>, /* TX */
                    <RZG2L_PORT_PINMUX(8, 5, 5)>; /* RX */
        };

        can3_pins: can3 {
            pinmux = <RZG2L_PORT_PINMUX(8, 6, 5)>, /* TX */
                    <RZG2L_PORT_PINMUX(8, 7, 5)>; /* RX */
        };
    #endif
    ...
}
```

Figure 5-6 Enable PFC for RZ/V2N

Enable pin function control for RZ/G3E.

Enable pin function control for RZ/G3E in directory (arch/arm64/boot/dts/renesas/rzg3e-smarc.dtsi)

```
&pinctrl {
    #if (!SW_LCD_EN) && (SW_GPIO8_CAN0_STB)
        can0-stb-hog {
            gpio-hog;

            gpios = <RZV2H_GPIO(5, 4) GPIO_ACTIVE_HIGH>;

            output-low;

            line-name = "can0_stb";
        };
    #endif

    #if (!SW_LCD_EN) && (SW_GPIO9_CAN1_STB)
        can1-stb-hog {
            gpio-hog;

            gpios = <RZV2H_GPIO(5, 5) GPIO_ACTIVE_HIGH>;

            output-low;

            line-name = "can1_stb";
        };
    #endif

    canfd_pins: canfd {
        #if (!SW_PDM_EN)
            can1_pins: can1 {
                pinmux = <RZV2H_PORT_PINMUX(L, 2, 3)>, /* RX */
                        <RZV2H_PORT_PINMUX(L, 3, 3)>; /* TX */
            };
        #endif

        #if (!SW_LCD_EN)
            can4_pins: can4 {
                pinmux = <RZV2H_PORT_PINMUX(5, 2, 3)>, /* RX */
                        <RZV2H_PORT_PINMUX(5, 3, 3)>; /* TX */
            };
        #endif
    };
};
```

5.2.3 Enable CANFD driver for each channel.

Enable both channel 0 and channel 1 for RZG2L, RZV2L, RZG2LC, RZG2UL, RZ/Five.

```
&can {
    pinctrl-0 = <&canfd0_pins &canfd1_pins>;
    pinctrl-names = "default";
    status = "okay";

    channel0 {
        status = "okay";
    };

    channel1 {
        status = "okay";
    };
};
```

Figure 5-7 Enable channel CANFD

Enable channel 1 only for G2LC by delete node to disable channel-0

```
#if (SW_SCIF_CAN || SW_RSPI_CAN)
&canfd {
    pinctrl-0 = <&can1_pins>;
    /delete-node/ channel0;
};
#else
&canfd {
    /delete-property/ pinctrl-0;
    /delete-property/ pinctrl-names;
    status = "disabled";
};
#endif
```

Figure 5-8 Enable channel CANFD

Enable 4 channels 0, 1, 2, 3 for RZ/V2N in directory (arch/arm64/boot/dts/renesas/r9a09g056n44-evk.dts)

```
#if (COMMON_PIN_SEL == CAN_SEL)
&canfd {
    pinctrl-0 = <&can0_pins &can1_pins &can2_pins &can3_pins>;
    pinctrl-names = "default";
    status = "okay";

    channel0 {
        status = "okay";
    };

    channel1 {
        status = "okay";
    };

    channel2 {
        status = "okay";
    };

    channel3 {
        status = "okay";
    };
};
#endif
```

Figure 5-9 Enable 4 channels CAN-FD (RZ/V2N)

Hardware design of CANFD for RZ/V2N interface have some pins function control conflict with others function. Define switch macro to choose CANFD function for pins (arch/arm64/boot/dts/renesas/r9a09g056n44-evk.dts)

```
/* Select between CAN, SCI and SPDIF pins
 * COMMON_PIN_SEL value:
 * 0: CAN is selected (default)
 * 1: SCI is selected
 * 2: SPDIF is selected
 */
```

Figure 5-10 Define macro switch for CAN-FD (RZ/V2N)

If support both 4 channels enable, setting macro as below in device-tree (arch/arm64/boot/dts/renesas/r9a09g056n44-evk.dts) and delete-node that is not used.

```
#define COMMON_PIN_SEL 0
#define CAN_SEL 0
#define SCI_SEL 1
#define SPDIF_SEL 2
```

Figure 5-11 Macro switch support 4 channels CAN-FD (RZ/V2N)

Enable 2 channels 1, 4 for RZ/G3E in directory (arch/arm64/boot/dts/renesas/rzg3e-smarc.dtsi)

```
&canfd {
    #if ((!SW_PDM_EN) || (!SW_LCD_EN))
        pinctrl-0 = <&canfd_pins>;
        pinctrl-names = "default";
        status = "okay";
    #endif
    #if (!SW_PDM_EN)
        channel1 {
            status = "okay";
        };
    #endif
    #if (!SW_LCD_EN)
        channel4 {
            status = "okay";
        };
    #endif
};
```

Figure 5-12 Enable 2 channels CAN-FD (RZ/G3E)

Hardware design of CANFD for RZ/G3E interface have some pins function control conflict with others function. Define switch macro to choose CANFD function for pins (arch/arm64/boot/dts/renesas/rzg3e-smarc.dtsi)

```
* SW_GPIO_CAN_PMOD states:
* Please change the corresponding selection to below Macros:
* SW_GPIO8_CAN0_STB:
*   0 - Connect to GPIO8 PMOD (default)
*   1 - Connect to CAN0 transceiver STB pin
* SW_GPIO9_CAN1_STB:
*   0 - Connect to GPIO9 PMOD (default)
*   1 - Connect to CAN1 transceiver STB pin
```

Figure 5-13 Define macro switch for CAN-FD (RZ/G3E)

```
#define SW_LCD_EN 0
#define SW_PDM_EN 0
```

Figure 5-14 Macro switch support 2 channels CAN-FD (RZ/G3E)

5.3 Option Setting

5.3.1 Module Parameters

There are no module parameters.

5.3.2 Kernel Parameters

There are no kernel parameters.

5.3.3 Device tree bindings

Demonstrates an example of device tree setting which can be found in
Documentation/devicetree/bindings/net/can/rcar-canfd.txt

REVISION HISTORY	Linux Interface Specification Device Driver CANFD User's Manual: Software
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Rev.	Date	Description	
		Page	Summary
0.50	Apr. 31, 2021	-	First Edition issued
1.0	Jul. 15, 2021	-	No modification, keep version to keep consistent with other documents
1.1	Sep. 15, 2021	-	Merge RZ/G2L driver manual with RZ/V2L
1.2	Feb. 15, 2022	-	Add RZ/G2UL, RZ/G2LC device
1.3	Mar. 31, 2022	7,8,9	Update device-tree information
1.4	May. 31, 2022	-	No modification, change version to keep consistent with other documents
1.5	Jun. 24, 2022	-	Add support RZ/Five and update device-tree information
1.6	Sep. 15, 2022	-	No modification, change version to keep consistent with other documents
1.7	Dec. 15, 2022	-	No modification, change version to keep consistent with other documents
1.8	Mar. 15, 2023	-	No modification, change version to keep consistent with other documents
1.9	May. 30, 2025	1	- Add MPU information support for both kernel versions v5.10 and v6.1.
		3	- Correct remove redundant blank line at the top page.
		6	- Correct format of this page.
		10	- Correct remove redundant blank line at the top page.
		11	- Correct figure 5.3 enable PFC for G2L, V2L.
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