

M4G Group (1)
Application Note
Full Universal Asynchronous Receiver
Transmitter Circuit
(FUART-B)

Outlines

This application note is a reference material for developing products using Full Universal Asynchronous Receiver Transmitter Circuit (FUART) function of M4G group (1).
This document helps the user check operation of the product and develop its program.

Target sample program: FUART_Echo

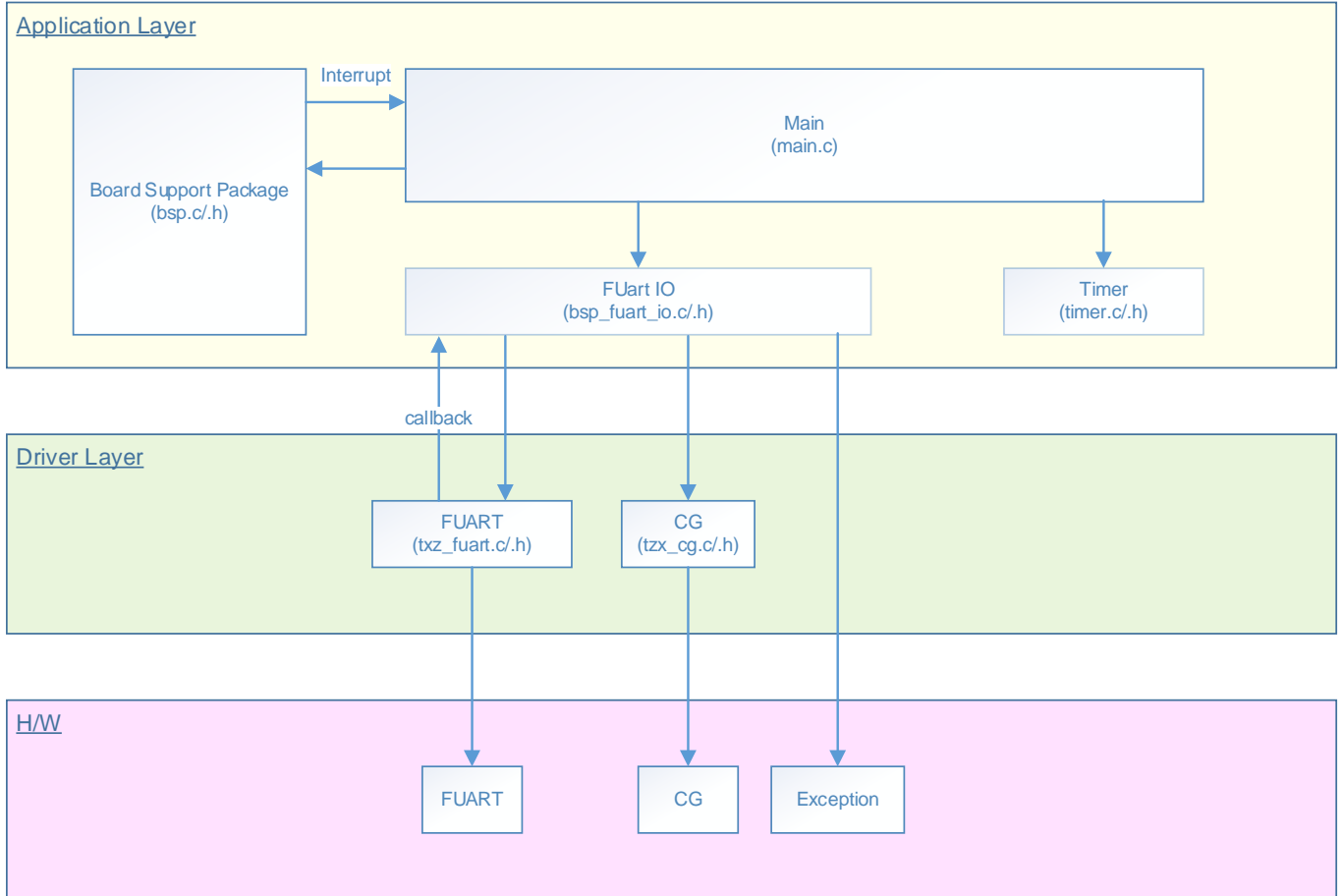
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1. Preface

This sample program should be used to check the operation of the FUART. The data input from the terminal software is echoed back using the FUART. The data is output to the terminal software.

Structure diagram of Sample program



2. Reference Document

- Datasheet
TMPM4G group (1) datasheet Rev1.0 (Japanese edition)
- Reference manual
Full Universal Asynchronous Receiver Transmitter Circuit (FUART-B) Rev1.0 (Japanese edition)
- Application note
M4G group (1) Application Note Startup (CMSIS System & Clock Configuration) Rev1.0
- Other reference document
TMPM4G (1) Group Peripheral Driver User Manual (Doxygen)

3. Function to Use

IP	Channel	Port	Function/Operation mode
Full Universal Asynchronous Receiver Transmitter Circuit	ch0	PG4 (FUT0TXD) PG5 (FUT0RXD)	FUART mode

4. Target Device

The target devices of this application note are as follows.

TMPM4G9F15FG	TMPM4G9F10FG	TMPM4G9FEFG	TMPM4G9FDFG
TMPM4G9F15XBG	TMPM4G9F10XBG	TMPM4G9FEXBG	TMPM4G9FDXBG
TMPM4G8F15FG	TMPM4G8F10FG	TMPM4G8FEFG	TMPM4G8FDFG
TMPM4G8F15XBG	TMPM4G8F10XBG	TMPM4G8FEXBG	TMPM4G8FDXBG
	TMPM4G7F10FG	TMPM4G7FEFG	TMPM4G7FDFG
	TMPM4G6F10FG	TMPM4G6FEFG	TMPM4G6FDFG

* This sample program operates on the evaluation board of TMPM4G9F15FG.

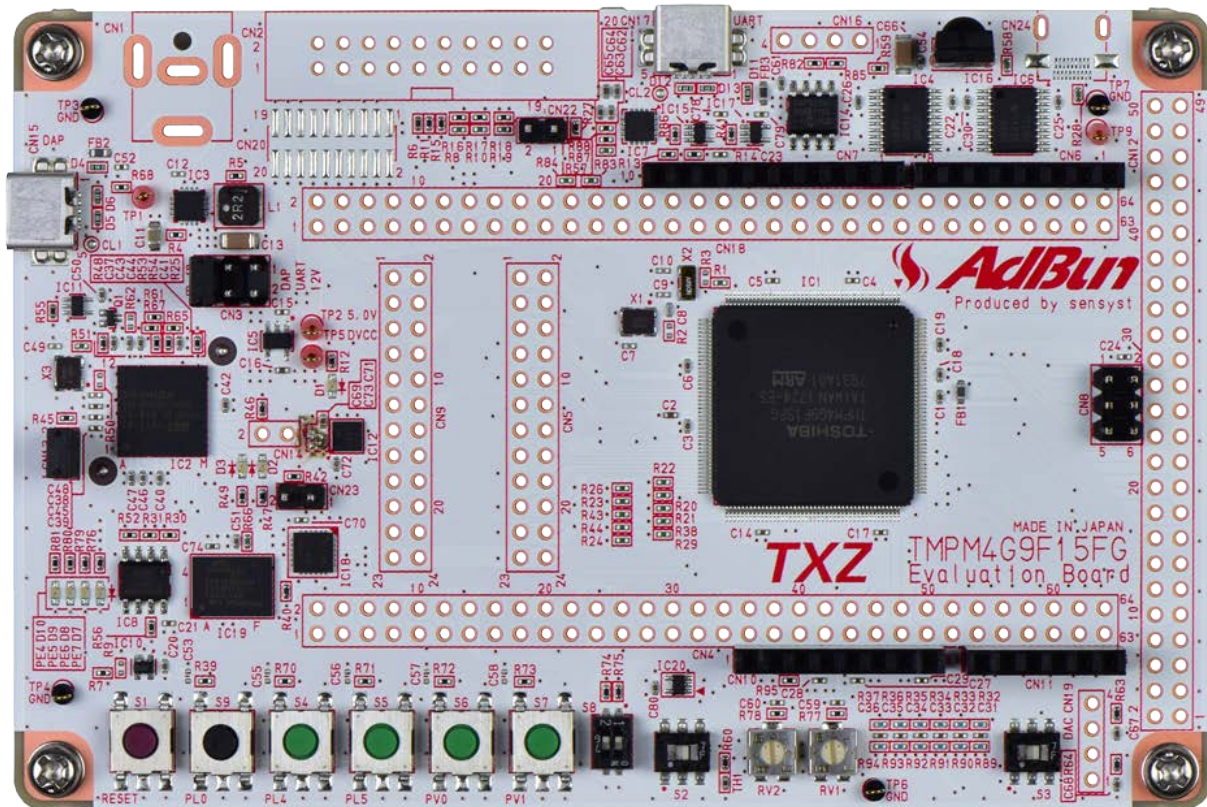
If other function than the TMPM4G9F15 one is checked, it is necessary that CMSIS Core related files (C startup file and I/O header file) should be changed properly.

The BSP related file is dedicated to the evaluation board (TMPM4G9F15). If other function than the TMPM4G9F15 one is checked, the BSP related file should be changed properly.

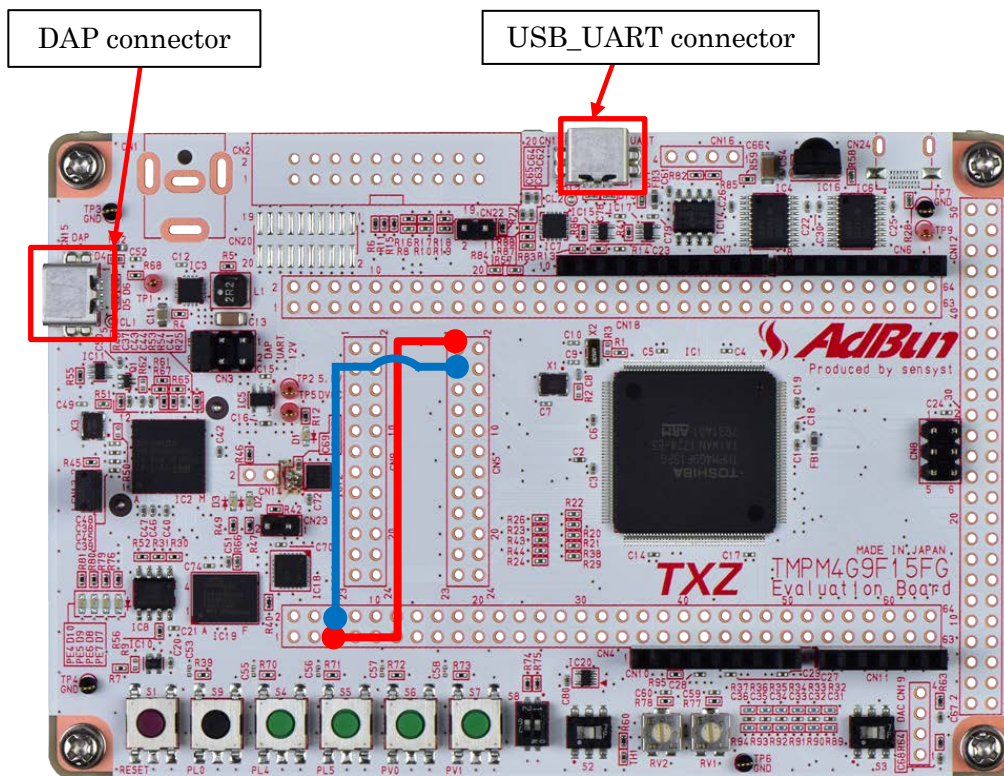
5. Operation Confirmation Condition

Used microcontroller	TMPM4G9F15FG
Used board	TMPM4G9F15FG Evaluation Board by Sensyst
Unified development environment	IAR Embedded Workbench for ARM 8.11.2.13606
Unified development environment	µVision MDK Version 5.24.2.0
Terminal software	Tera Term V4.96
Sample program	V1000

Evaluation board (TMPM4G9F15FG Evaluation Board) Top view



6. Evaluation Board Setting



* Connection between through-holes in the evaluation board
 [CN5] No.1 and [CN4] No.5 on the evaluation board should be connected.
 [CN5] No.3 and [CN4] No.6 on the evaluation board should be connected.

7. Operation of Evaluation Board

PC and the USB_UART are connected for communication with the terminal software.
 After the sample program starts up, the terminal software receives a user input.
 When a user inputs data, the data is echoed back, and is output to the terminal software through the FUART.

8. Outline of UART Function

The Full Universal Asynchronous Receiver Transmitter (UART) can operate as a transmission/reception circuit of 1 channel (FUTxTXD/FUTxRXD/FUTxCTS_N/FUTxRTS_N) per unit. And reception function using IrDA circuit. The following is a list of functions.

Function classification	Function	Operation explanation
Baud rate control	Frequency dividing of prescaler	Selectable from 1/1, 1/2, 1/4 to 1/512 of the $\Phi T0$ frequency.
	Baud rate generator	$N + (K / 64)$ ($N = 2$ to 65535 and $K = 0$ to 63) dividing of the source clock frequency are possible.
	Baud rate (Note1)	Maximum 921.6Kbps
Data format	Data length	Selectable 5, 6, 7 or 8 bit.
	Parity	Parity control: Enable or disable selection Parity type: Even or odd parity is selectable
	Stop bit length	Selectable 1-bit or 2-bit.
	Data transfer order	LSB first
Transmission/reception control	FIFO function	FIFO ON and OFF is selectable.
	FIFO storage stages	Reception: 32 stages (12-bit width) Transmission: 32 stages(8-bit width)
	Error detection	Reception: Parity error, Framing error, Break error, Overrun error
	Handshake function	Transmission/reception control by handshake with FUTxCTS_N/FUTxRTS_N signal is possible.
IrDA 1.0 circuit	Data rate	Maximum 115.2 kbps (Half duplex)
	Mode	Normal IrDA mode and Low power IrDA mode
Interlocking control	Interrupt	Interrupt of combination of a transmission/reception completion interrupt, error occurrence interrupt, and a receive timeout interrupt
	DMA request (Note2)	Reception DMA request: Burst transfer or Single transfer Transmission DMA request: Burst transfer or Single transfer

Note1: Regarding Maximum baud rate, please refer datasheet each production.

Note2: Supported DMA requests depend on the product. Please refer to reference manual of "Product Information" for details.

9. Sample Program

The data received from the terminal software is echoed back, and the data is output to the terminal software through the FUART.

9.1. Initialization

The following initialization is done after power is supplied.

The initialization of each clock setting and the setting of the watchdog timer are done.

9.2. Sample Program Main Operation

After the initialization operation, shift to the main function and perform the following initialization.

The initialization of BSP is done.

A variable setting and the data clear are done.

The initialization of driver is done.

The initialization of the application is done.

As the application initialization, the timer and the FUART are initialized.

After the procedure above has been done, "Input =" on the terminal software will be displayed and it will wait for input.

After a character is input, the character is displayed after "Echo =" as the echo-back output.

Then, a character is received again. This procedure can be repeated.

9.3. Method of Input Character String Transmission

When "proc = PROC_STRING" is enabled in "main.c", the data transmission is not done until the characters of the specified count including a line-break code are input completely (STRING transmission). Usually, the data transmission starts when a line-break code is input.

```
#if 0
                                proc = PROC_STRING;
#else
                                proc = PROC_OUTPUT_MSG;
#endif
```

When "proc = PROC_STRING;" is enabled, the data transmission is done after the characters of the specified count are input.

The specified count is 24 as the initial setting value in this sample program.

In this sample program, data are transmitted 3 times by the line-break code, and the STRING transmission is done at the fourth time.

This can be used as a reference when the mixture of both transmissions is done.

9.4. Output Example of Sample Program

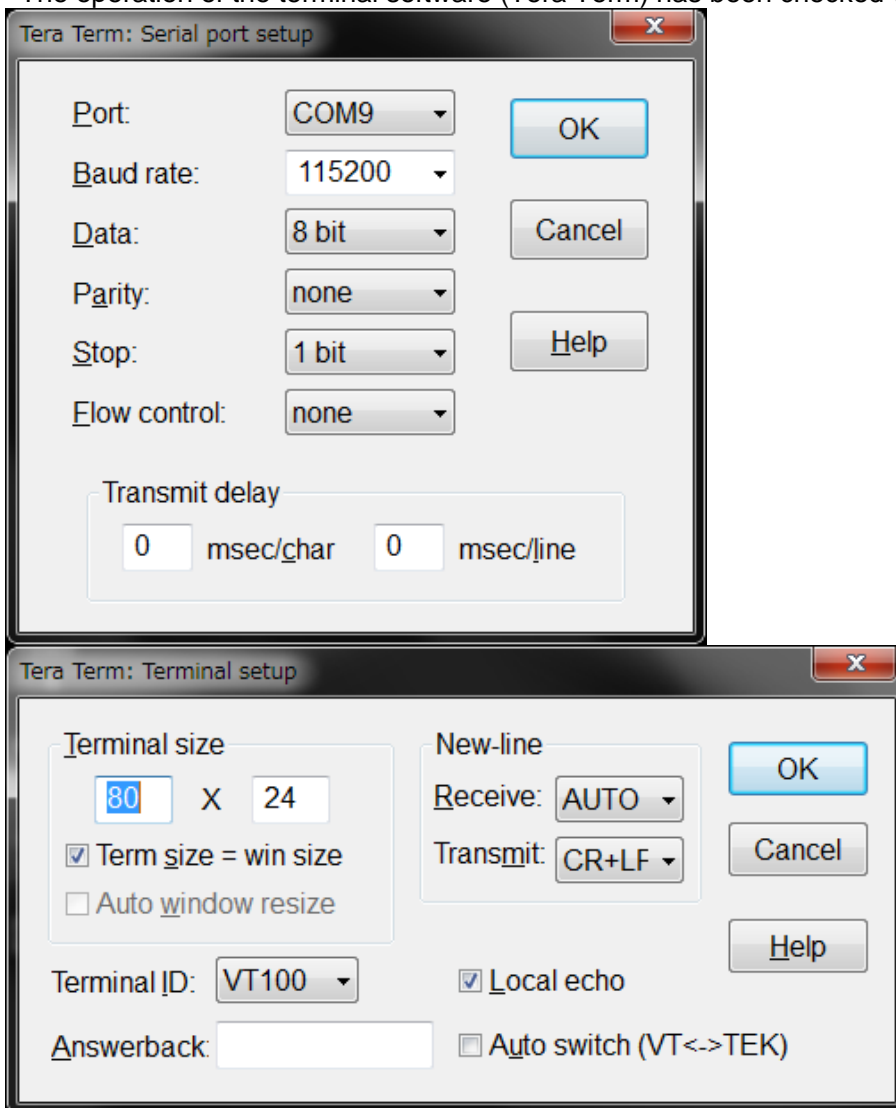
When the sample program executes, the input data is echoed back and is output to the terminal software as shown in the following figure.

```
Input = 12345
Echo = 12345
Input = 012345678901234567890123456789
Echo = 012345678901234567890123456789
Input = 0123456789012345678901234567890

Input Error !!
Input =
```

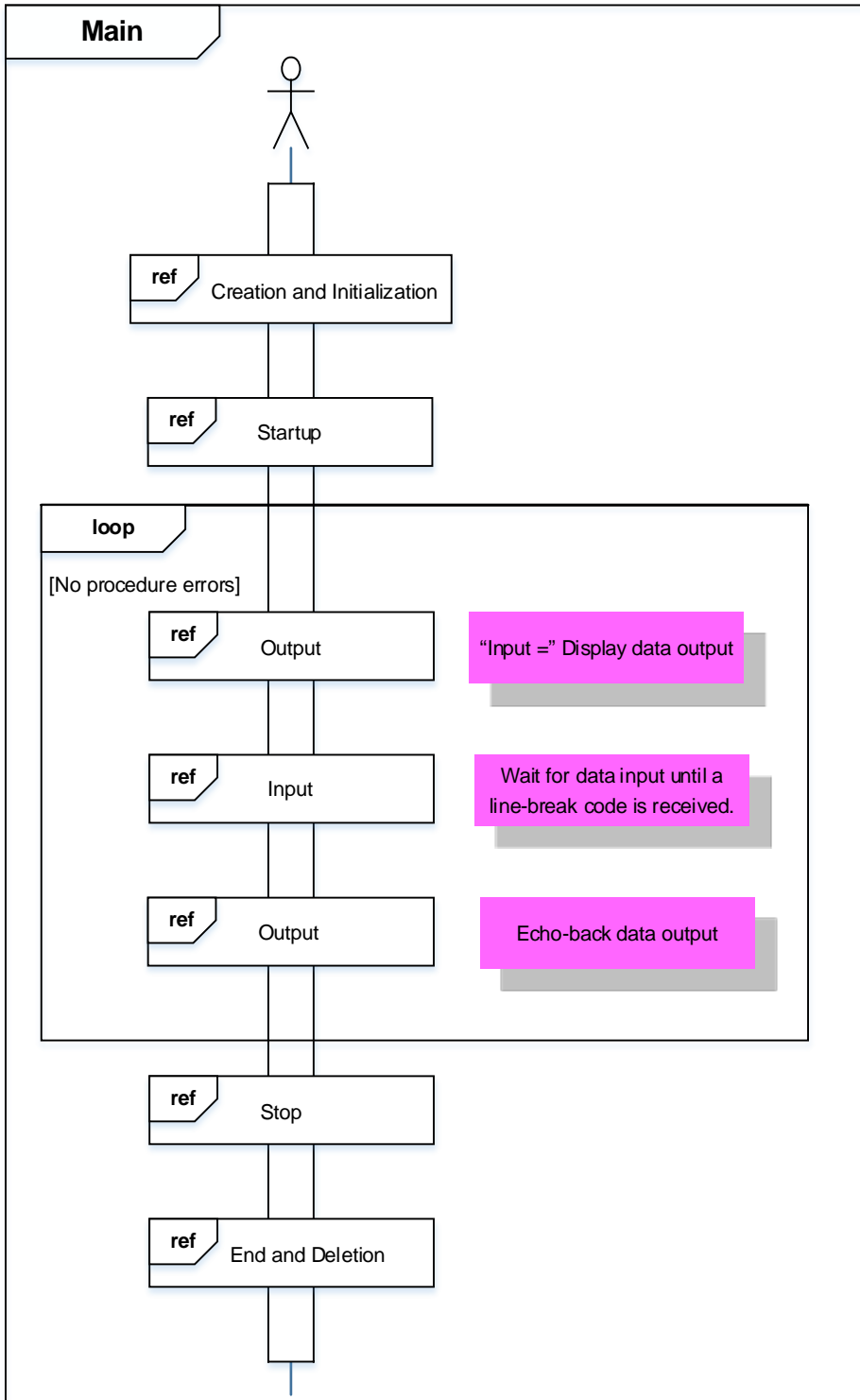
9.4.1. Setting Example of Terminal Software

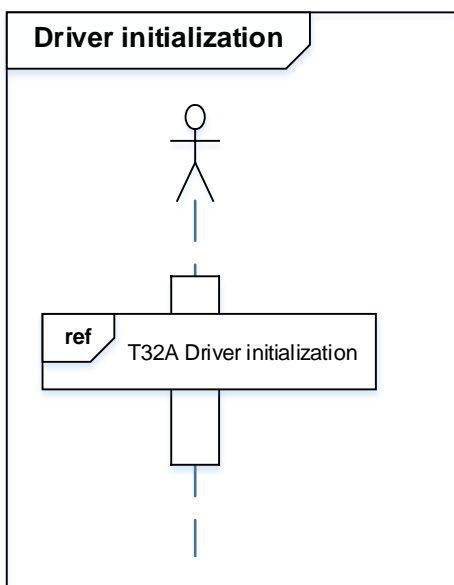
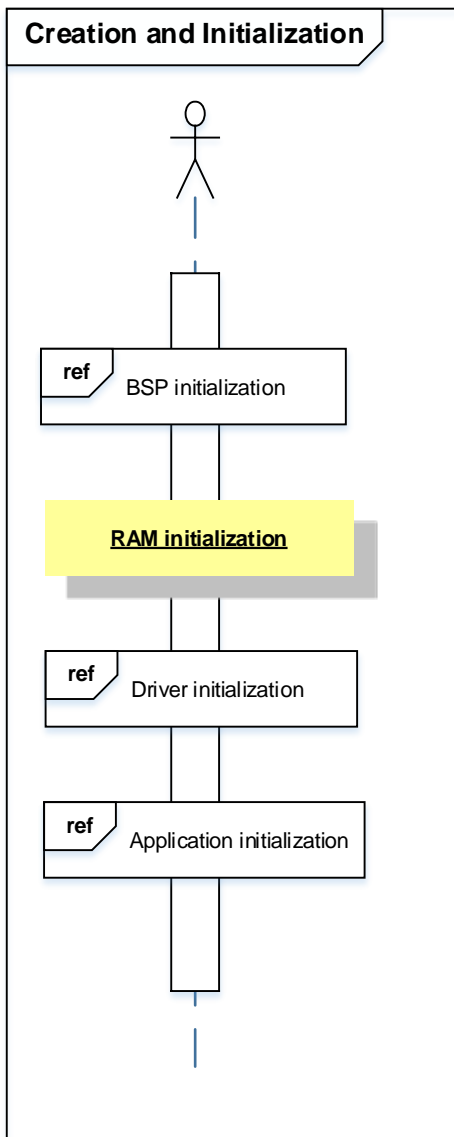
The operation of the terminal software (Tera Term) has been checked with the following settings.



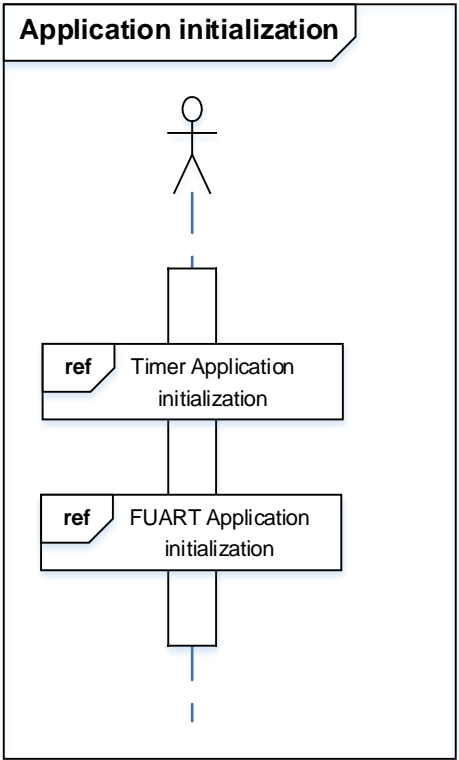
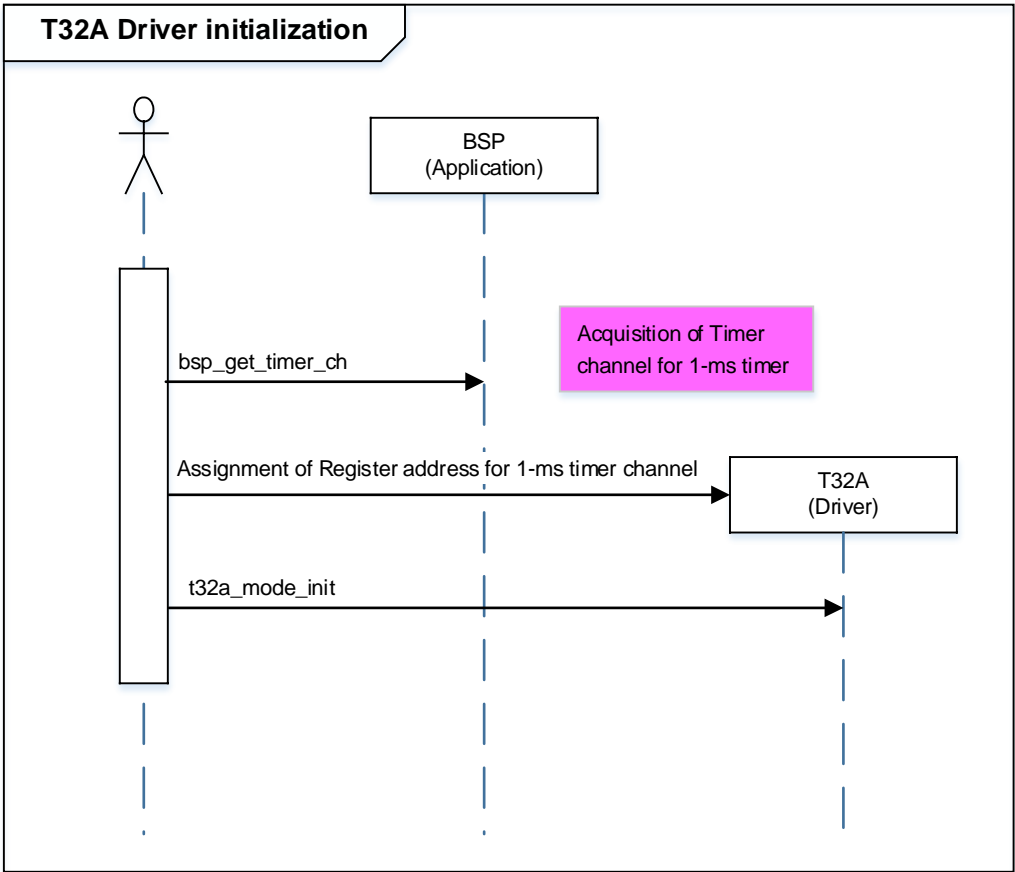
9.5. Operating Flow of Sample Program

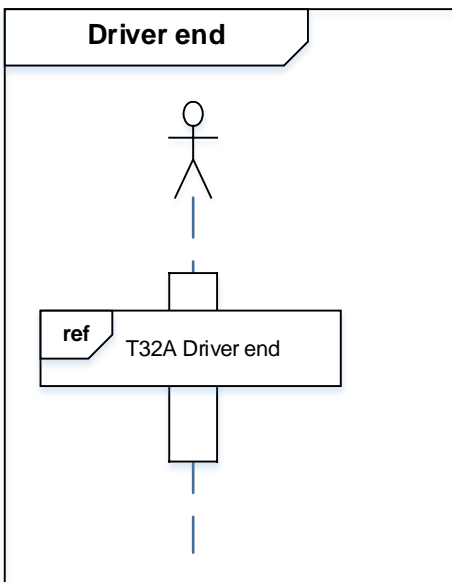
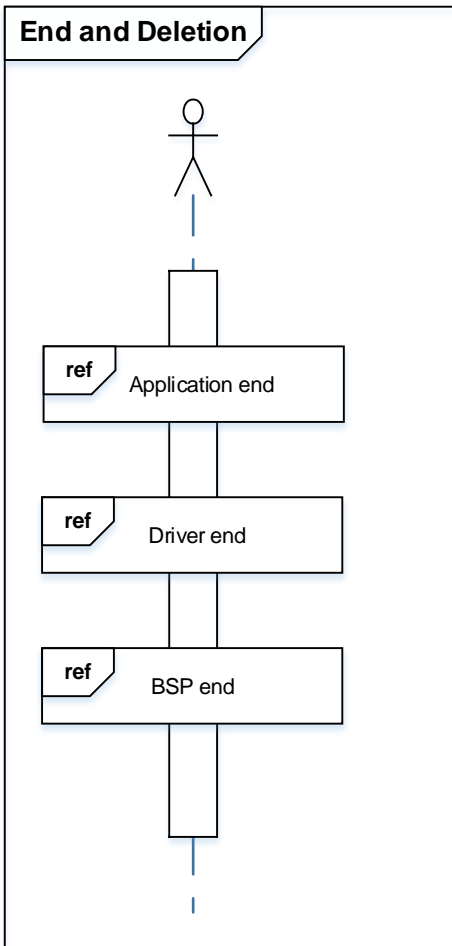
The basic operating flows of the sample program are shown in the following;

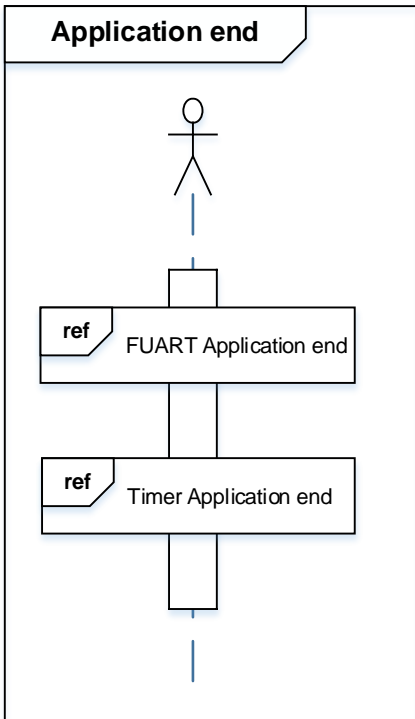
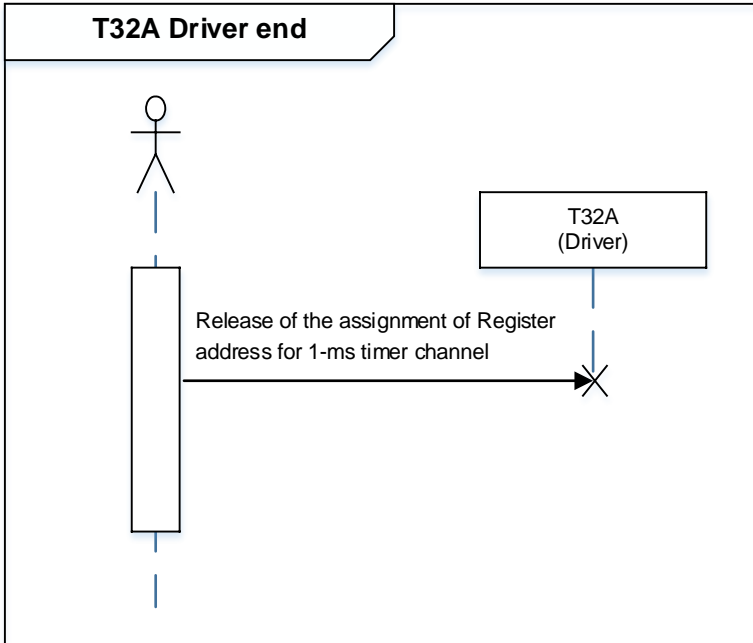


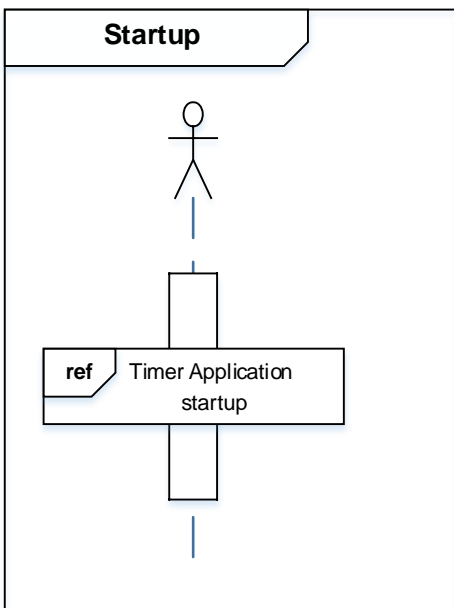
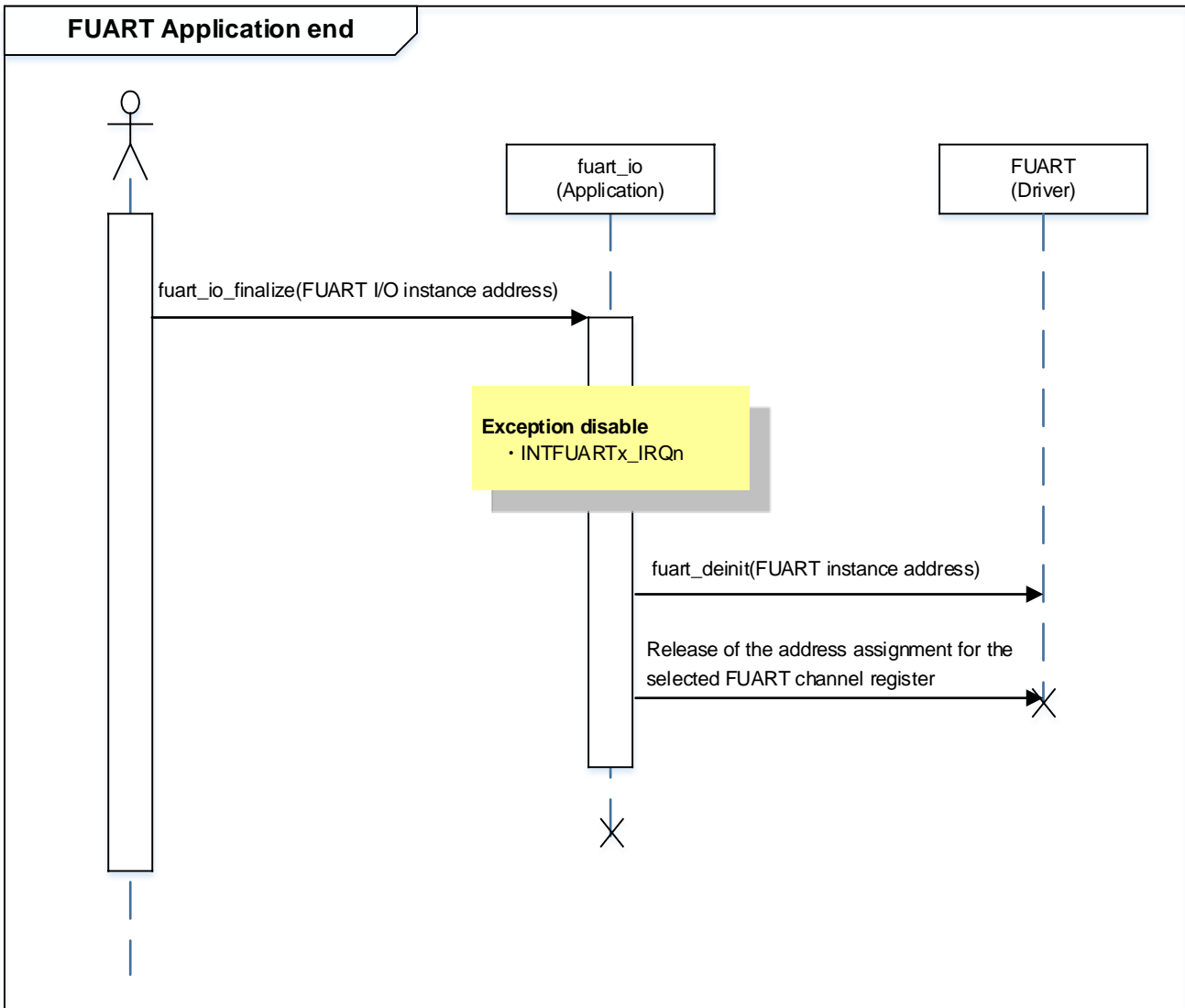


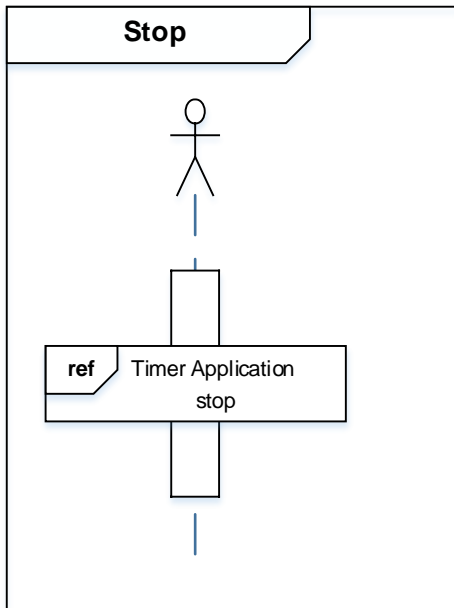
The 32-bit timer event counter of TPM4G9 is running, but processing using timer count is not performed.

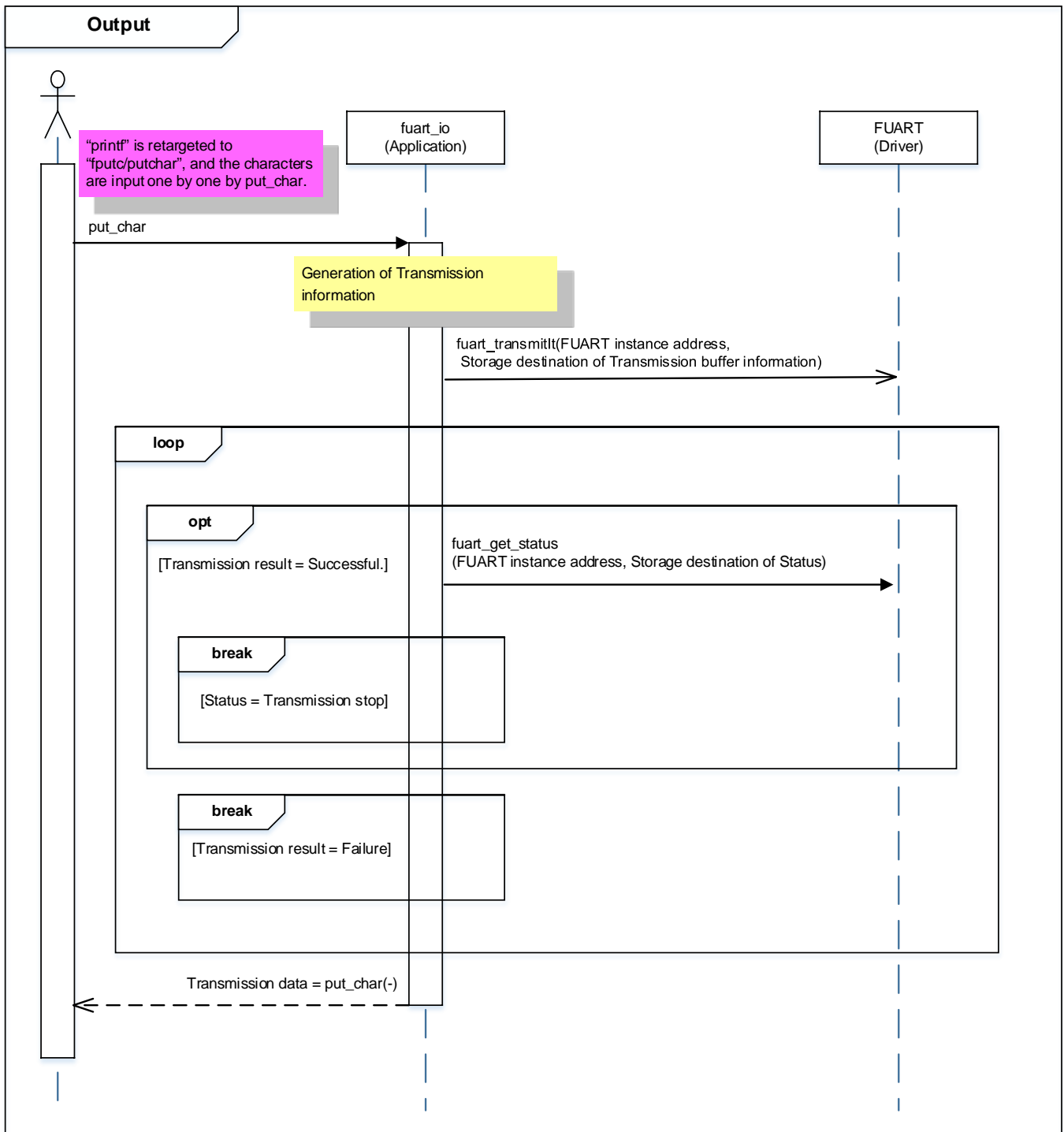


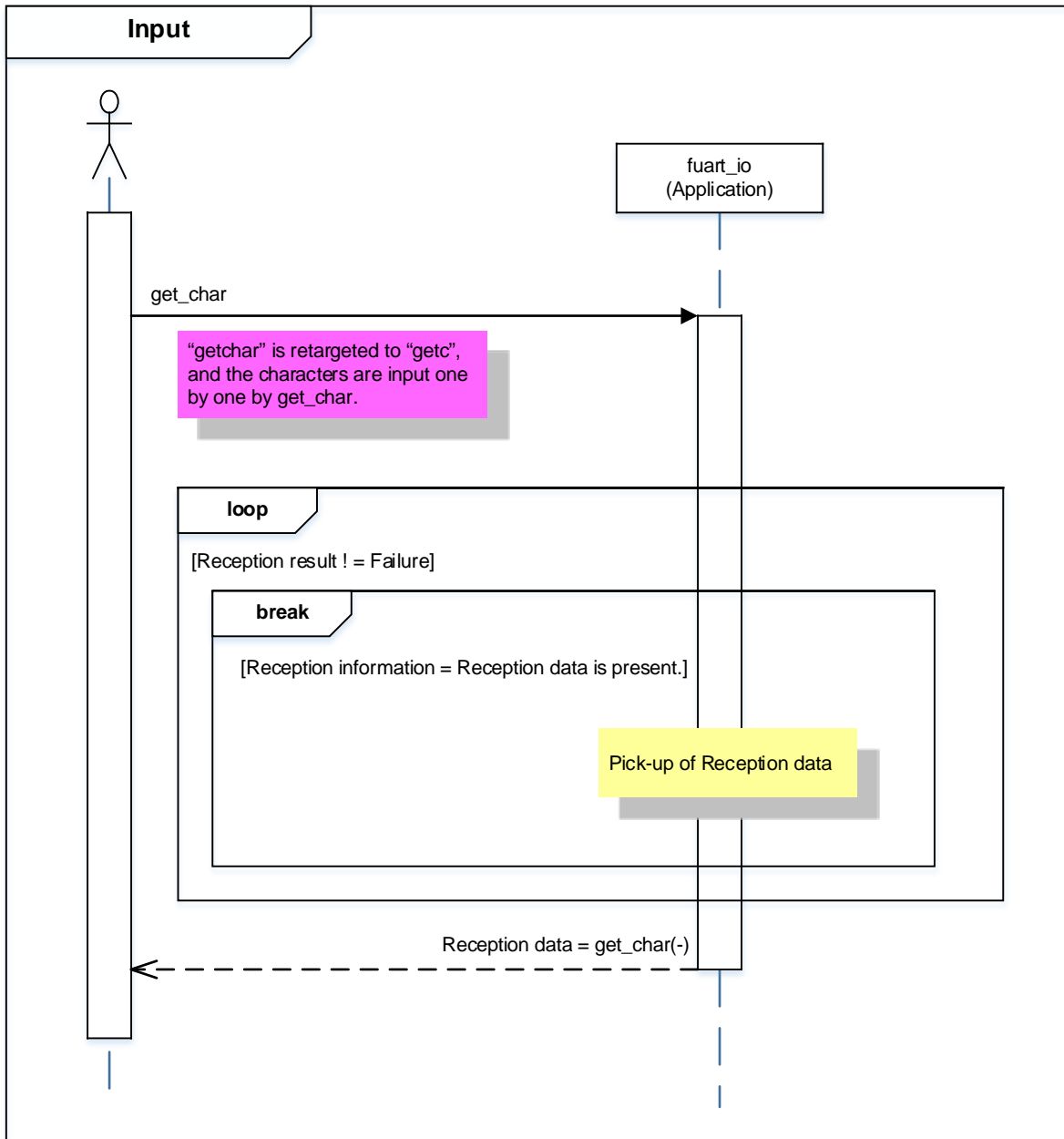


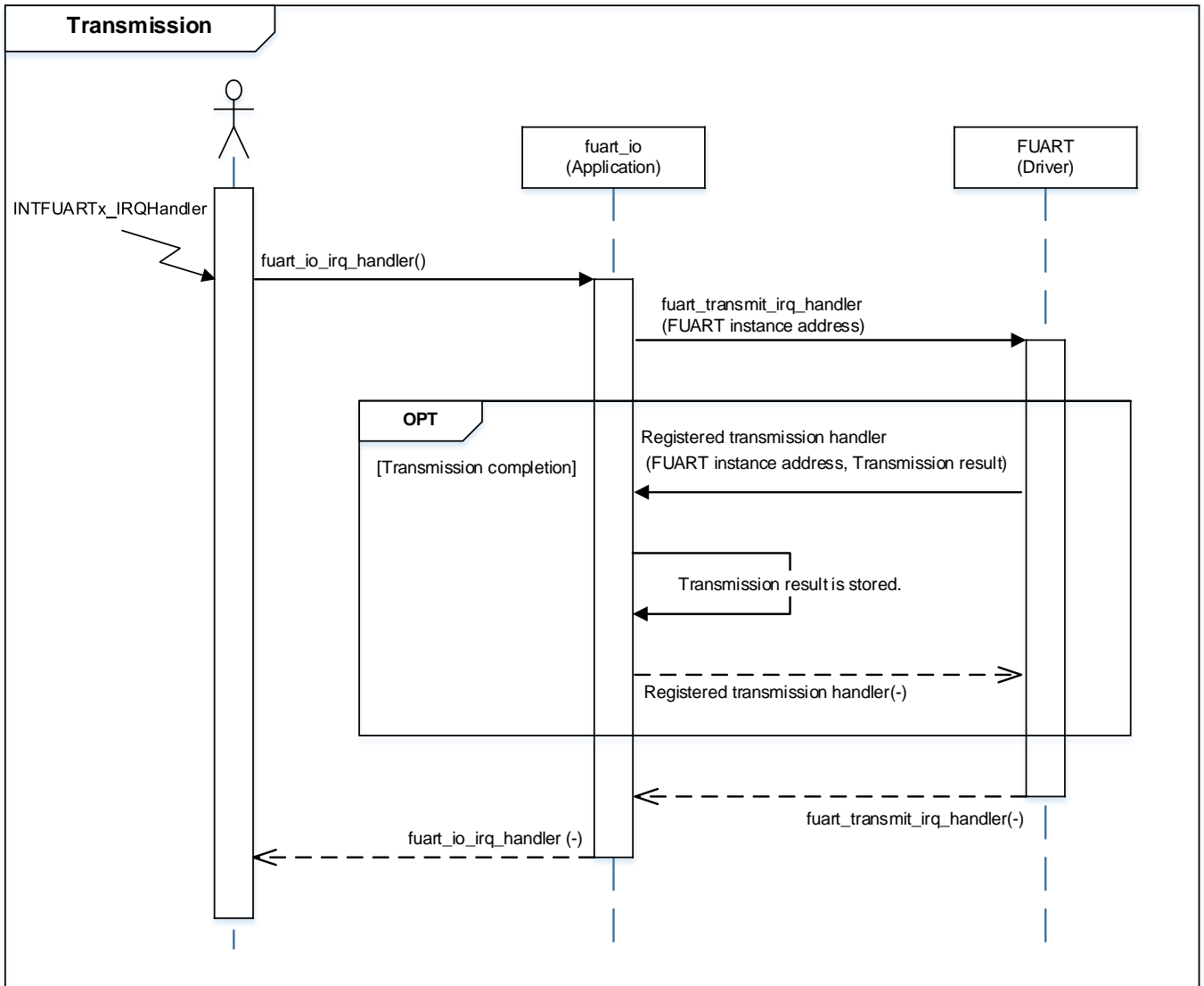


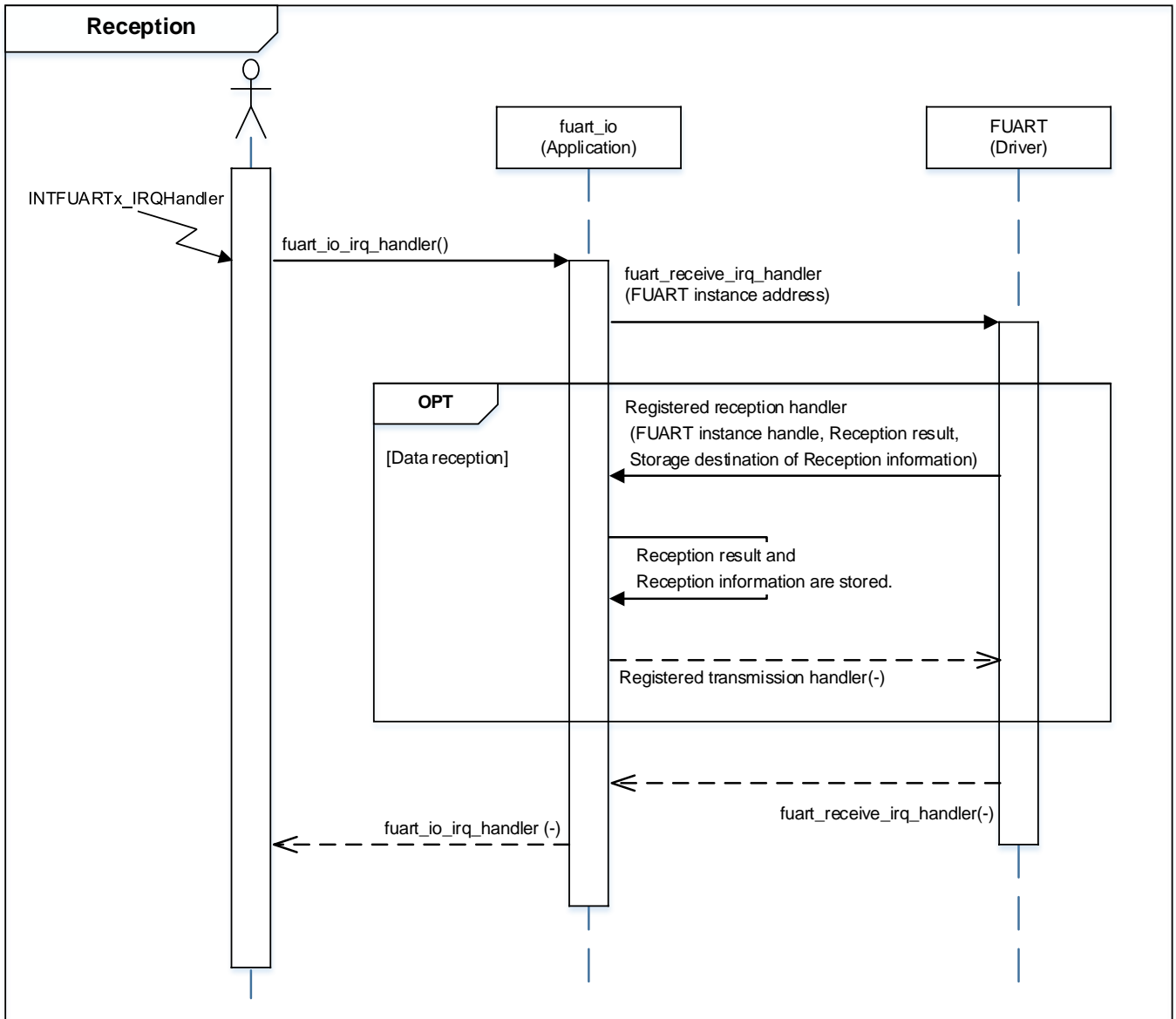












10. Precaution

When using the sample program with CPU other than TPM4G9F15, please check operation sufficiently.

11. Revision History

Rev	Date	Description
1.0	2018-11-30	First release

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