

M4G Group (1)
Application Note
Asynchronous Serial Communication
Circuit
(UART-C)

Outlines

This application note is a reference material for developing products using the Asynchronous Serial Communication Circuit (UART) function of M4G Group (1).
This document helps the user check operation of the product and develop its program.

Target sample program: UART_Echo

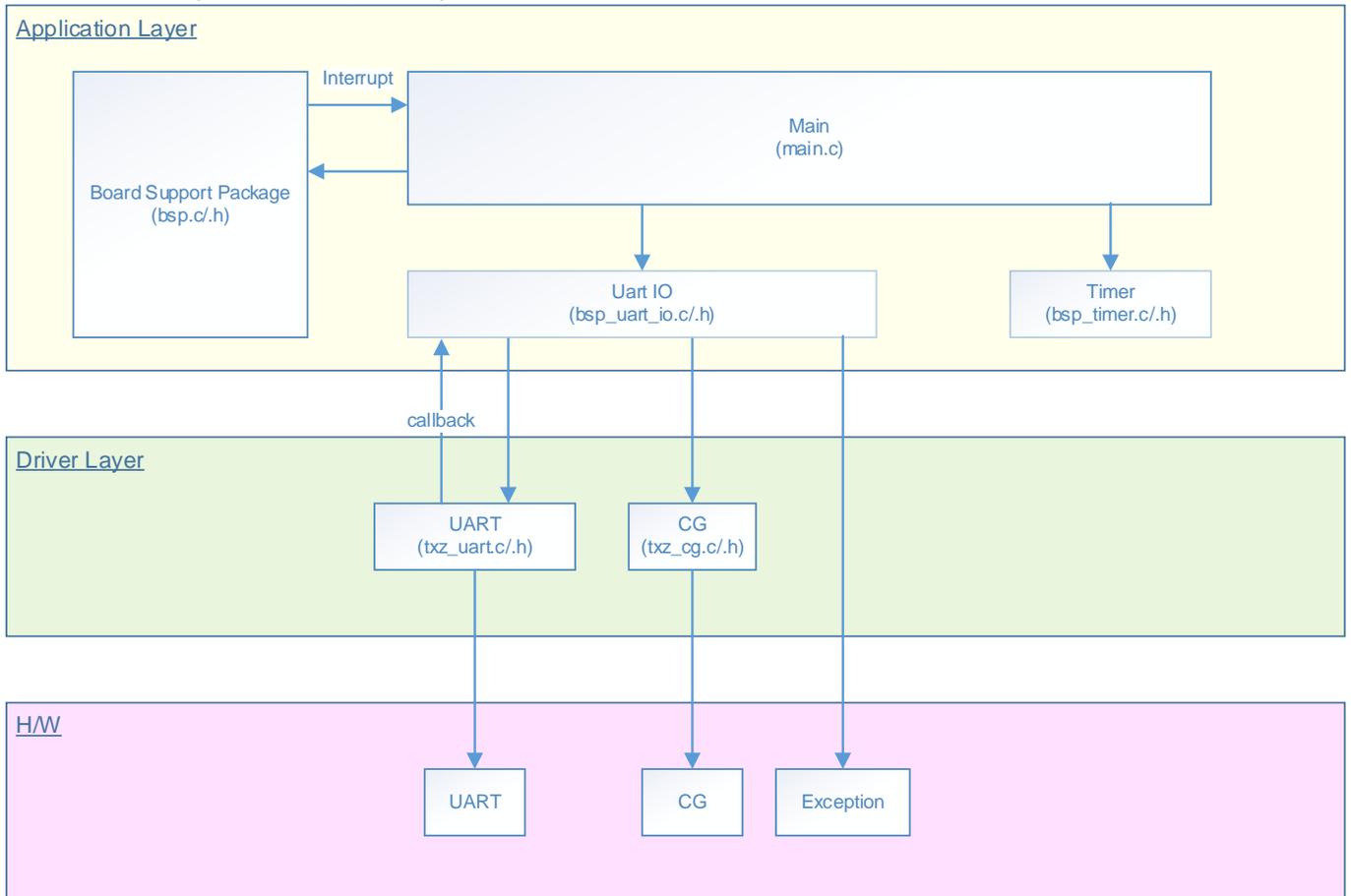
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1. Preface

This sample program should be used to check the operation of the UART. The data input from the terminal software is echoed back using the UART. 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
Asynchronous Serial Communication Circuit (UART-C) Rev3.0 (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
Asynchronous Serial Communication Circuit	ch0	PE2 (UT0RXD) PE3 (UT0TXDA)	UART 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.

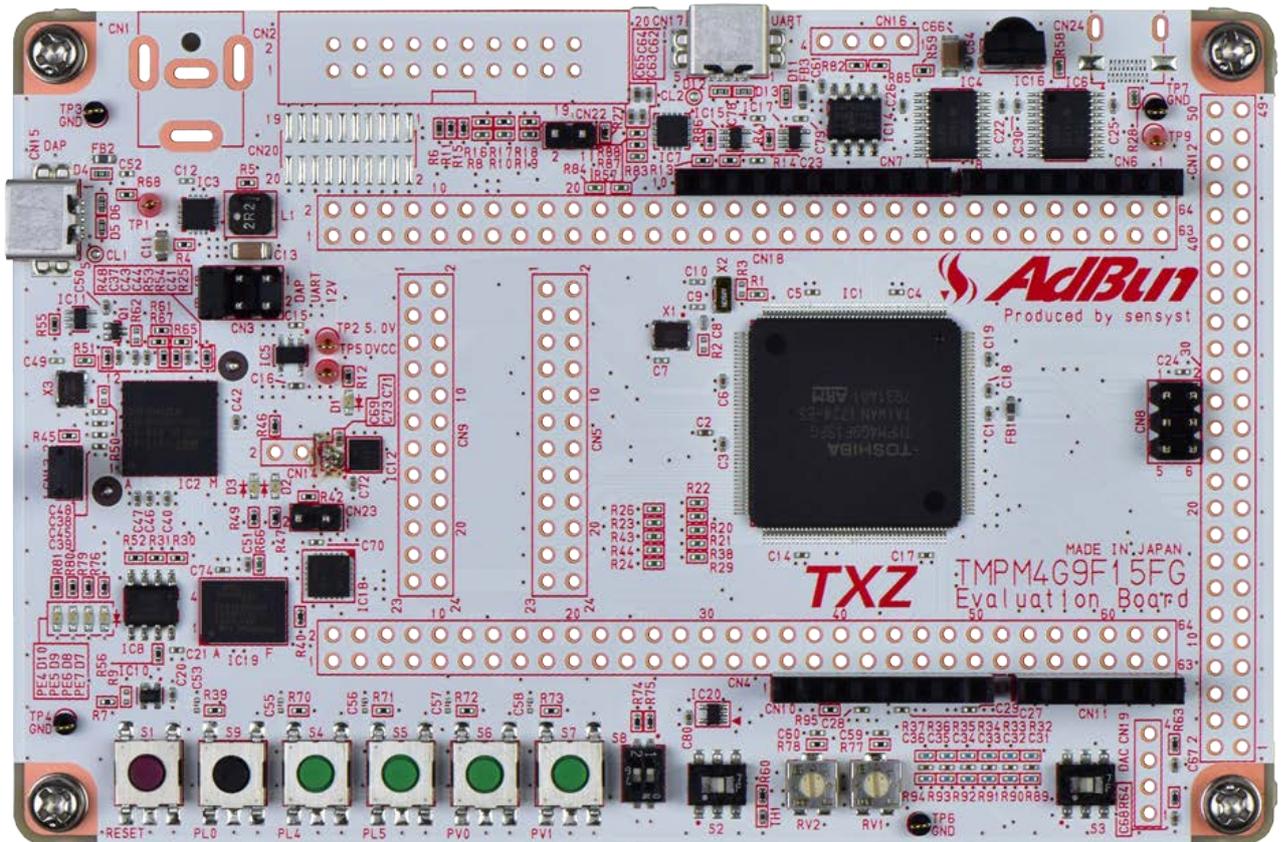
If other function than the TMPM4G9F15 one is checked, it is necessary that CMSIS Core related files (C startup file and I/O header file) should be changed properly.

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

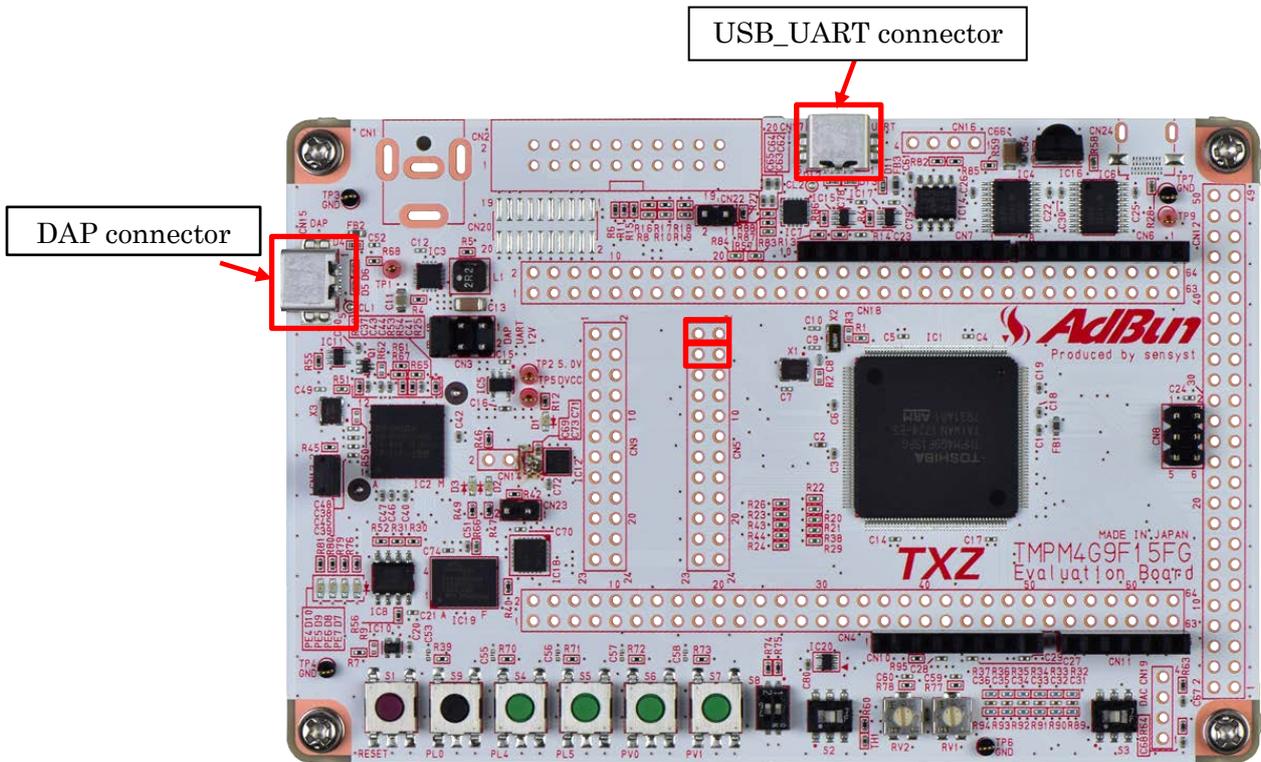
Evaluation board (TMPM4G9F15FG Evaluation Board) Top view



6. Evaluation Board Setting

The following pin connections should be done on the evaluation board.

CN5		
Board function	Through-hole No.	Through-hole No.
USB_UART conversion	1: USB_UT_RX	2: PE2
USB_UART conversion	3: USB_UT_TX	4: PE3



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 UART.

8. Outline of UART

The asynchronous serial communication circuit (UART) can operate as a transmission / reception circuit of 1 channel (UTxTXDA / UTxTXDB / UTxRXD) per unit. The following is a list of functions.

Function category	Function	Description
Baud rate control	Frequency dividing of prescaler	Selectable from 1/1 to 1/512 of the $\Phi T0$ frequency.
	Baud rate generator	N dividing or $N + (64 - K) / 64$ ($N = 1$ to 65535 and $K = 0$ to 63) dividing of the source clock frequency are possible.
Data format	Data length	Selectable 7, 8, or 9-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	Selectable LSB first or MSB first.
	Data signal inversion	Inversion control of the input and output data signal. Selectable disabled or enabled.
Transmission / reception control	FIFO storage stages	Reception: 8 stages Transmission: 8 stages
	Noise cancelling function	Reception: Noise cancelling function is enabled or disabled for UTxRXD.
	Error detection	Reception: Parity error, Framing error, Break error, and Overrun error Transmission: Trigger transmission error
	Handshake function	Transmission / reception control by handshake with UTxCTS_N / UTxRTS_N signal is possible.
	Wake-up function	Serial link operation using the wakeup function in the 9-bit mode is possible.
Interlocking control	Interrupt	Reception interrupt, Transmission interrupt, and Error interrupt
	DMA request	Reception DMA request: Burst transfer or Single transfer Transmission DMA request: Burst transfer or Single transfer
Special control	Half clock mode (Transmission /reception)	Transmission and reception with half width of "Low" width of the normal UART waveform is possible.
	Loopback function (Test function)	The transmission data is connected to the reception data and the loopback test is possible.
	Software reset	Initialization can be done by software.

UTxTXDA can be exchanged for UTxRXD and UTxCTS_N can be exchanged for UTxRTS_N, too. This is done by a port setting. Refer to "Input/Output Ports" of the reference manual.

9. Sample Program

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

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

The BSP (Board Support Package) is initialized.

The driver is initialized.

The initialization of the application is done.

As the application initialization, the initialization of the UART and enable of the interrupt are done.

After the procedure above has been done, "Input =" is displayed on the terminal software. It means a wait for an input character.

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

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

The input data length is 32 bytes at maximum.

If the length exceeds the value, "Input Error !!" is displayed.

9.3. Output Example of Sample Program

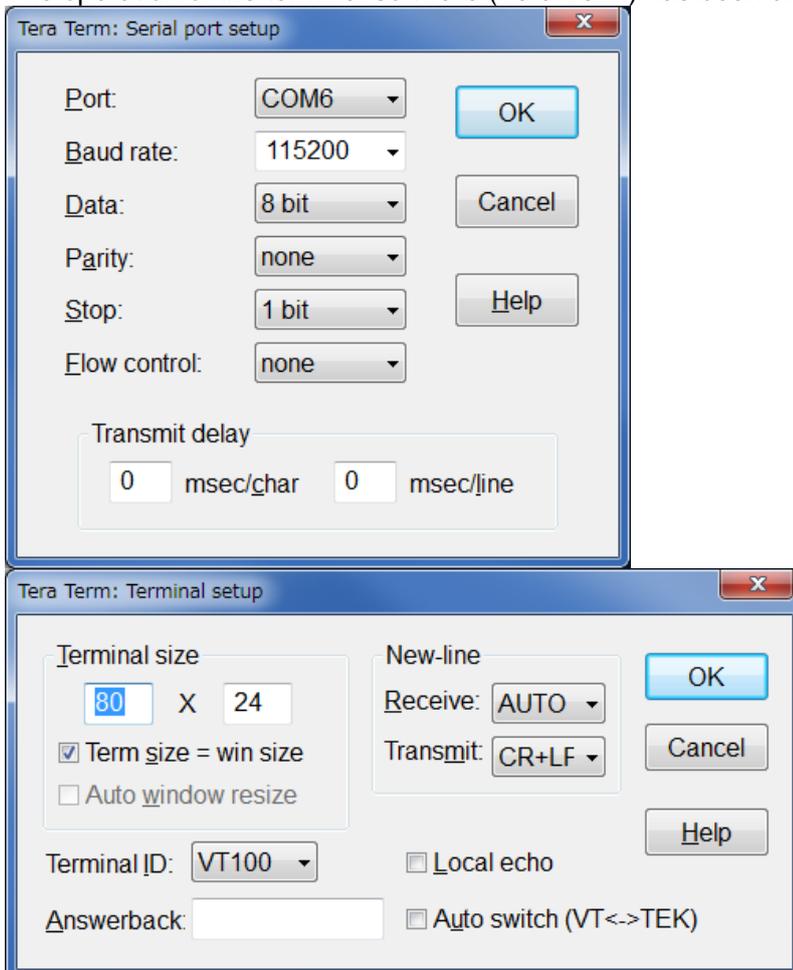
When the sample program executes, the input data is echoed back and is output to the terminal software as shown in the following figure.

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

Input Error !!
Input =
```

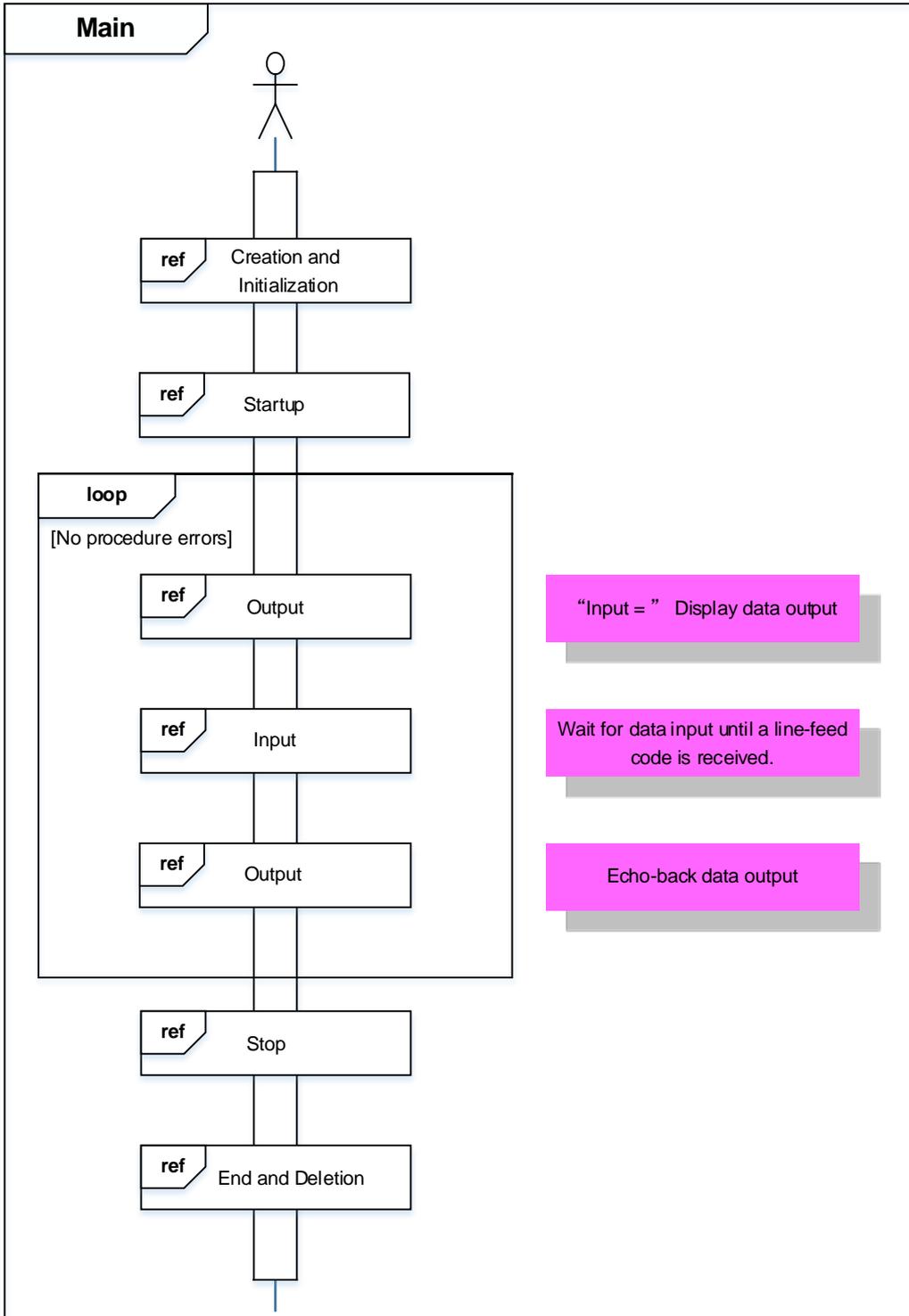
9.3.1. Setting Example of Terminal Software

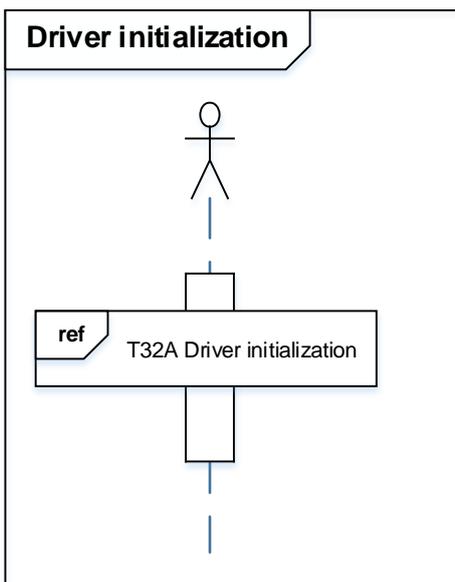
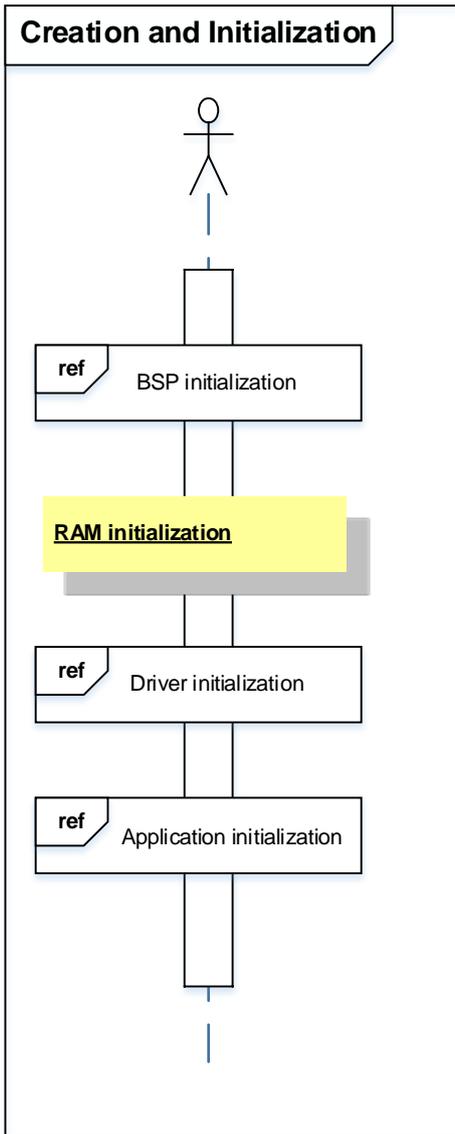
The operation of the terminal software (Tera Term) has been checked with the following settings.



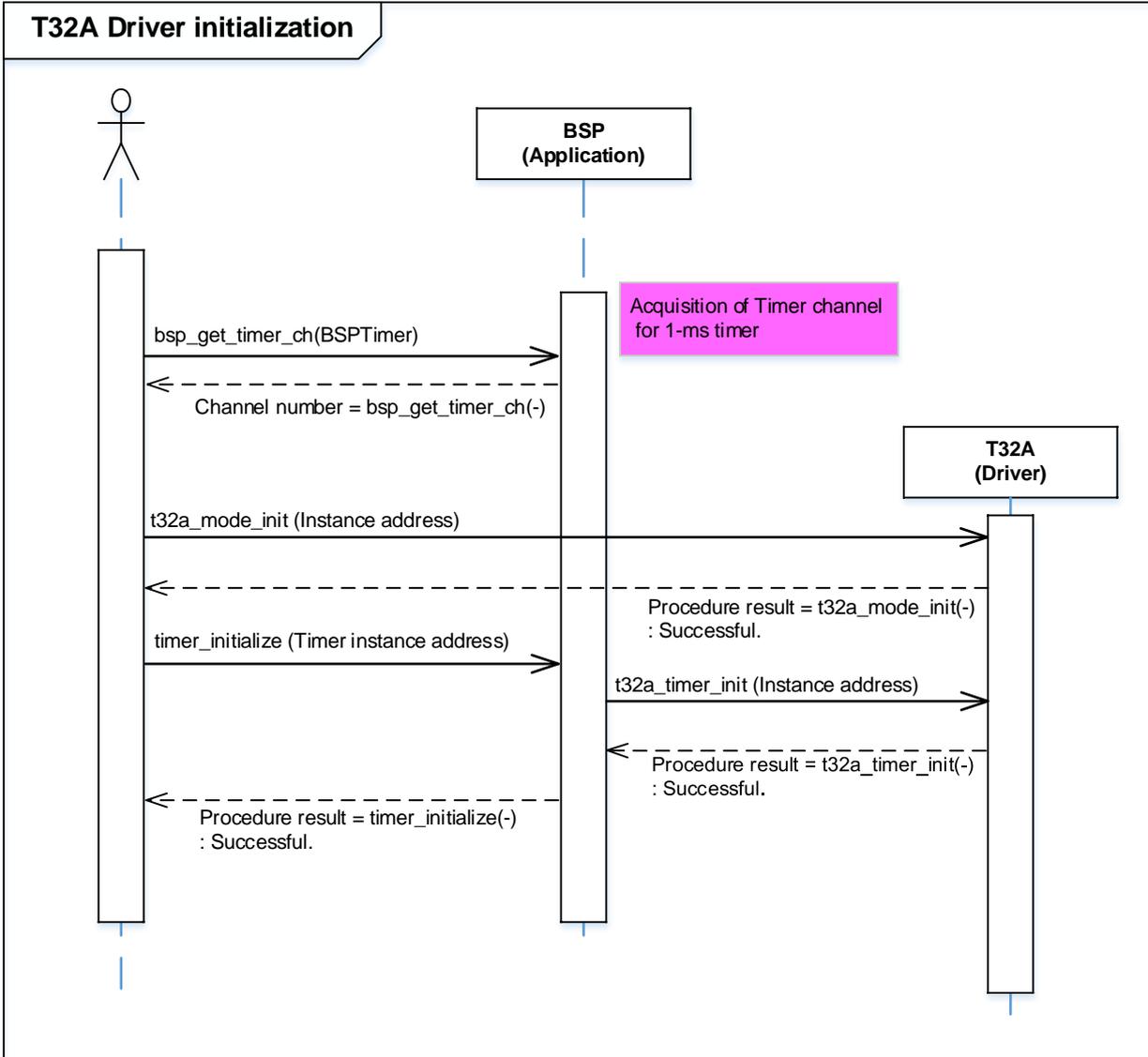
9.4. Operating Flow of Sample Program

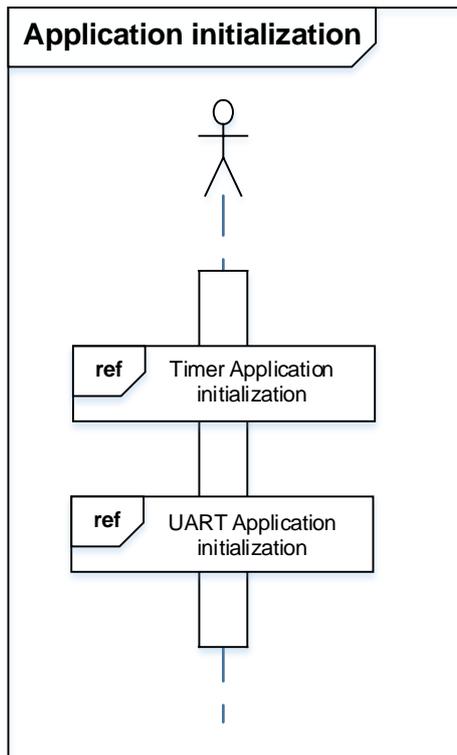
The basic operating flows of the sample program are shown in the following;

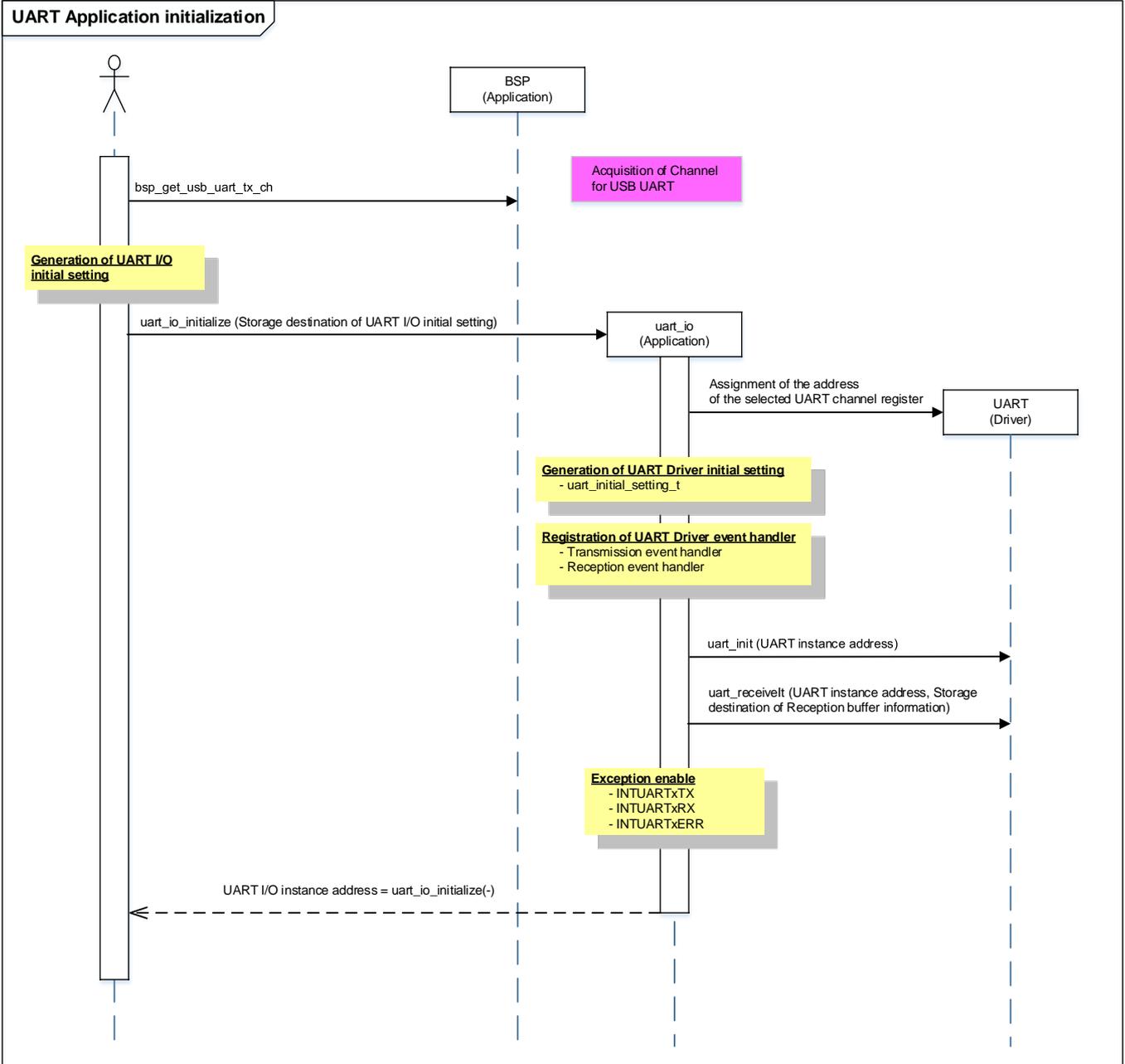


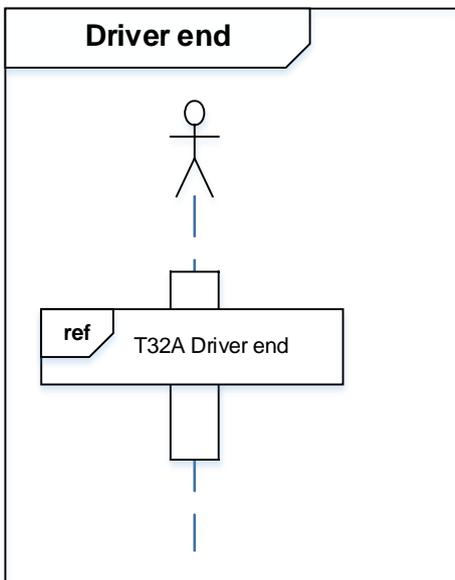
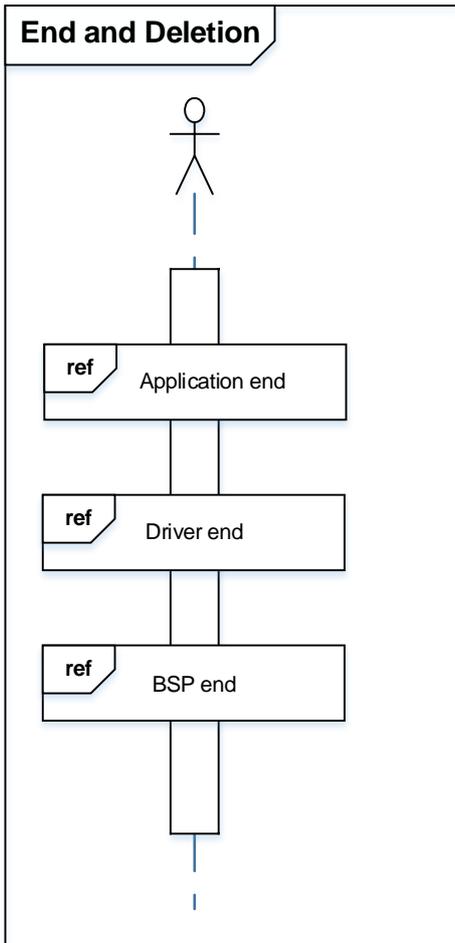


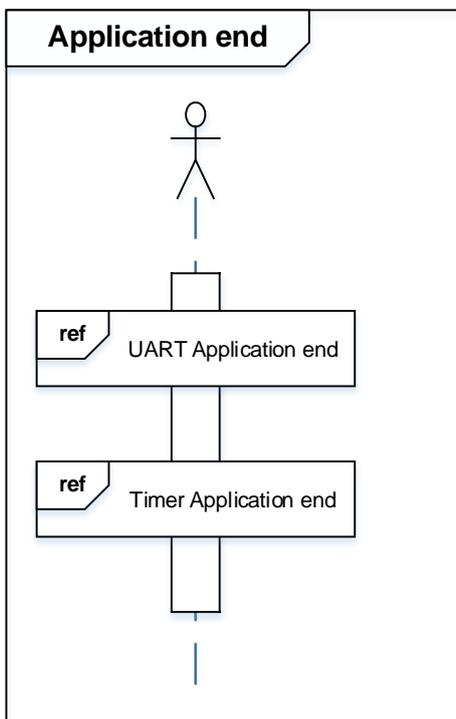
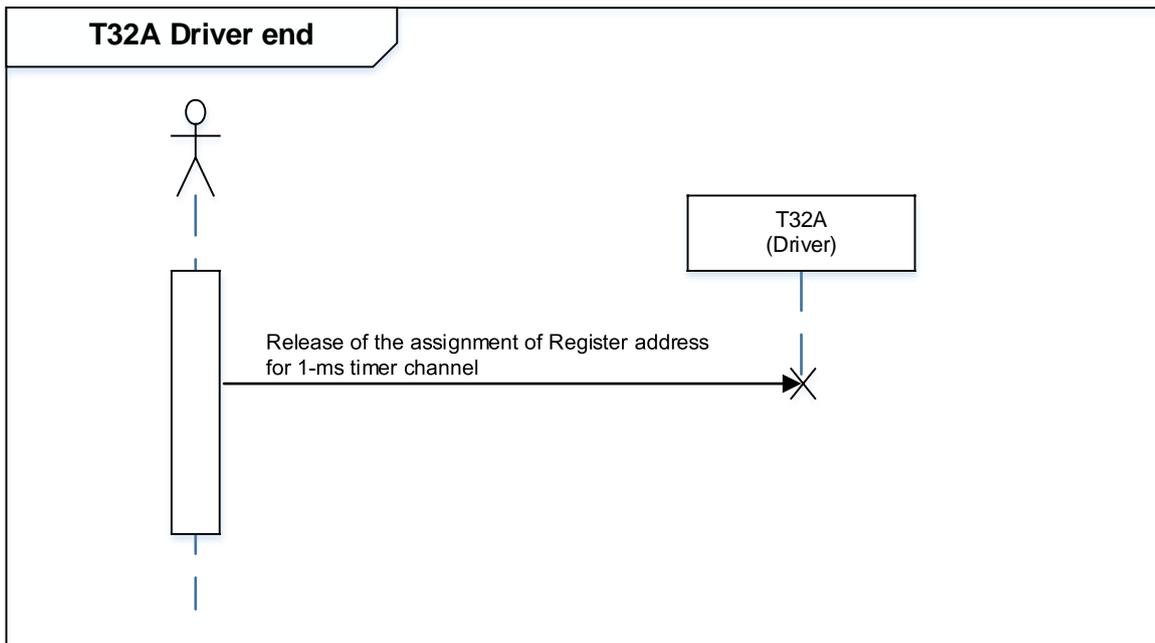
The 32-bit timer event counter of TPM4G9 is running, but processing using timer count is not performed.

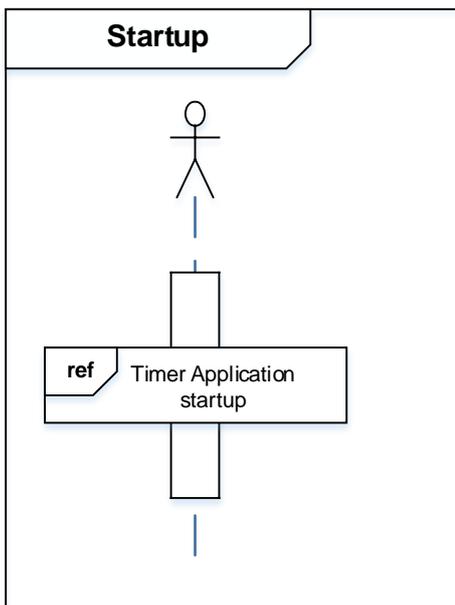
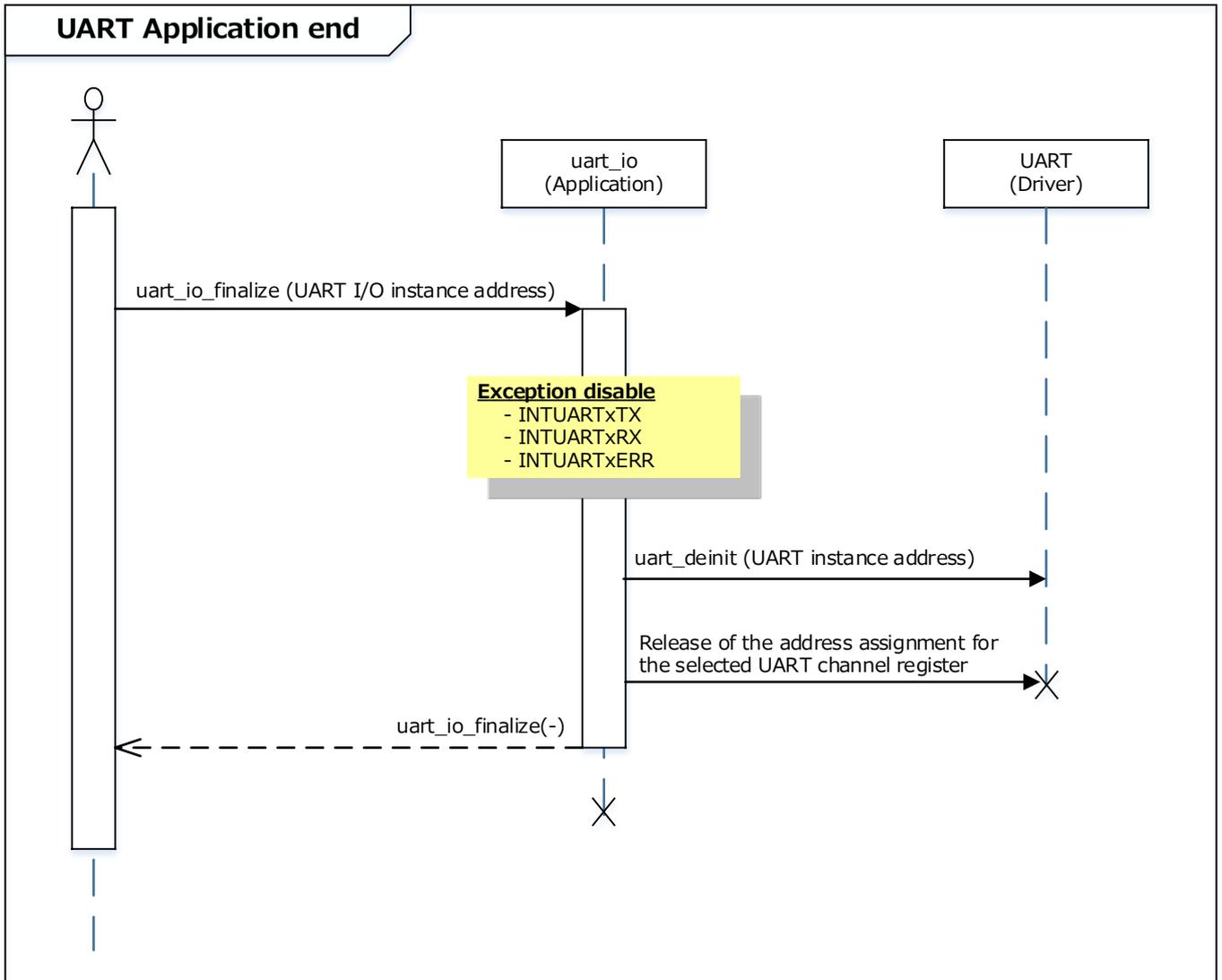


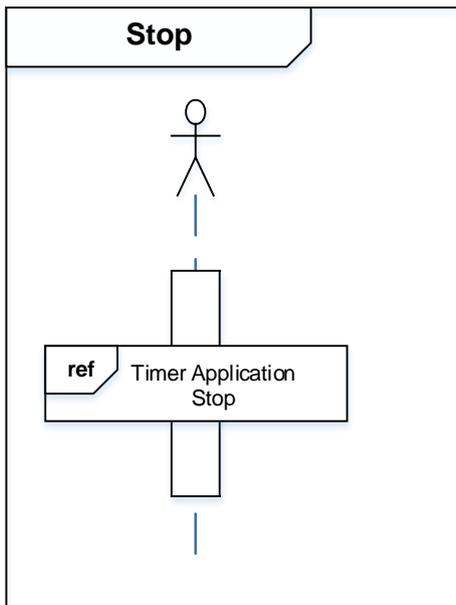


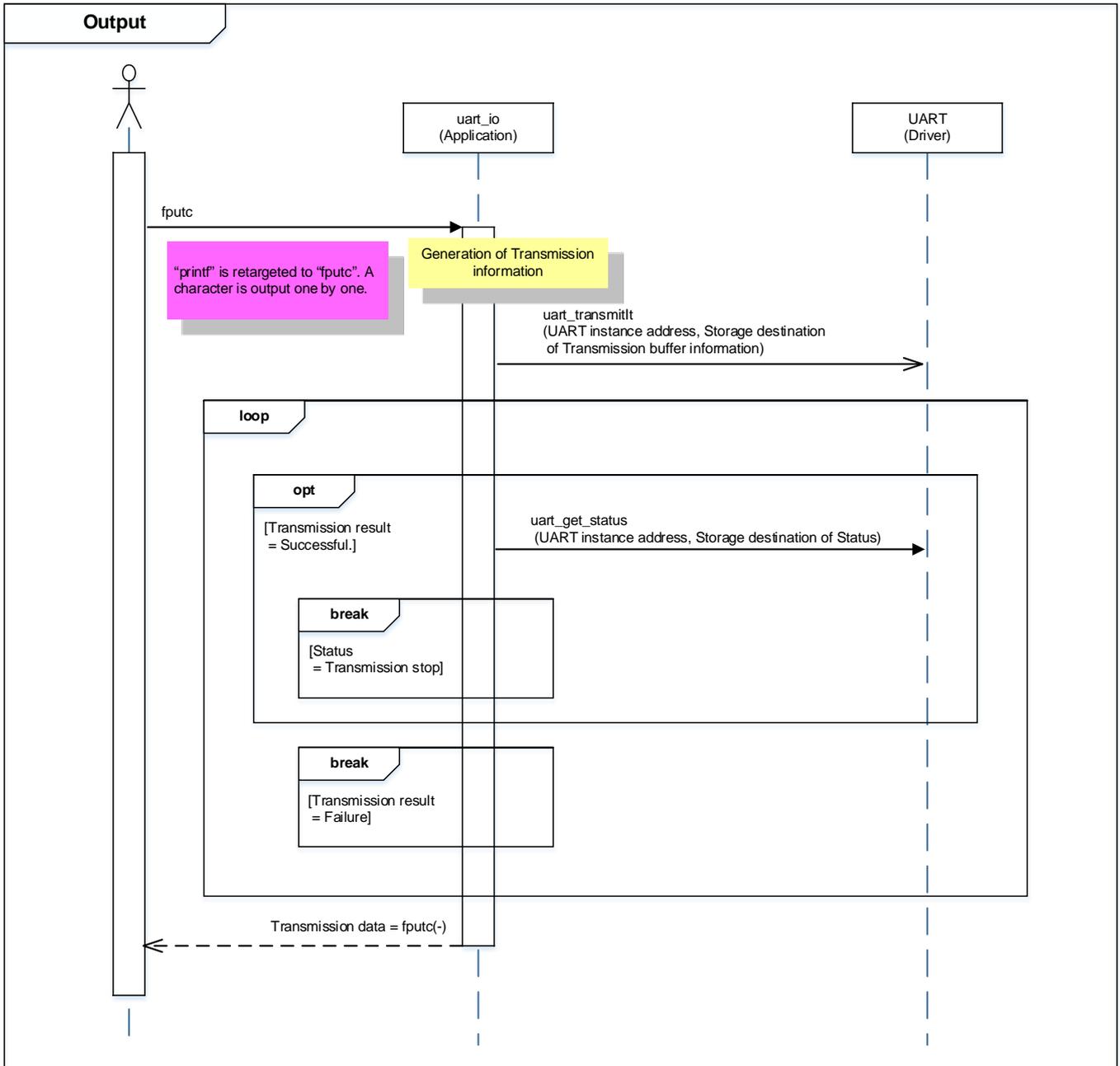


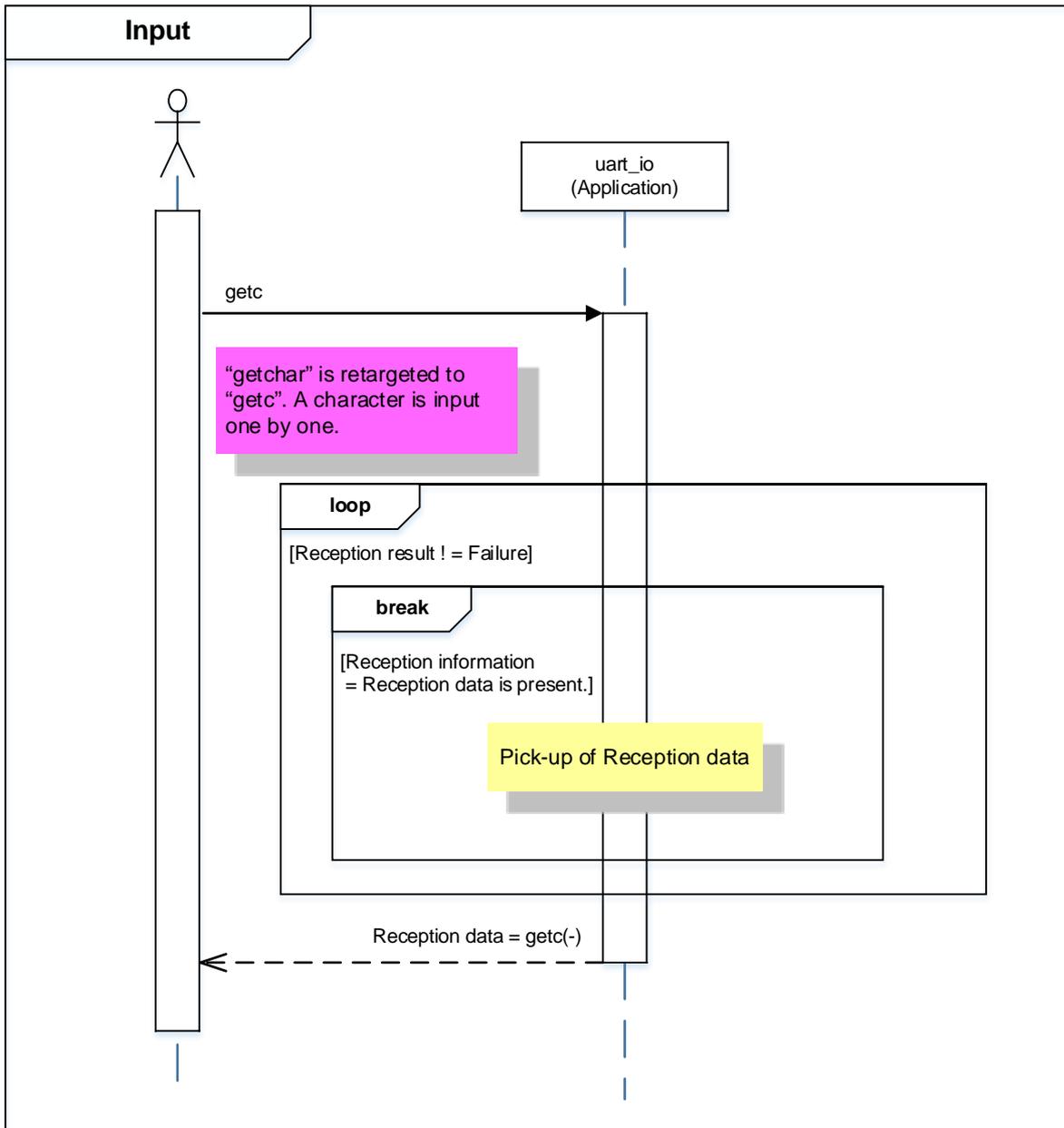


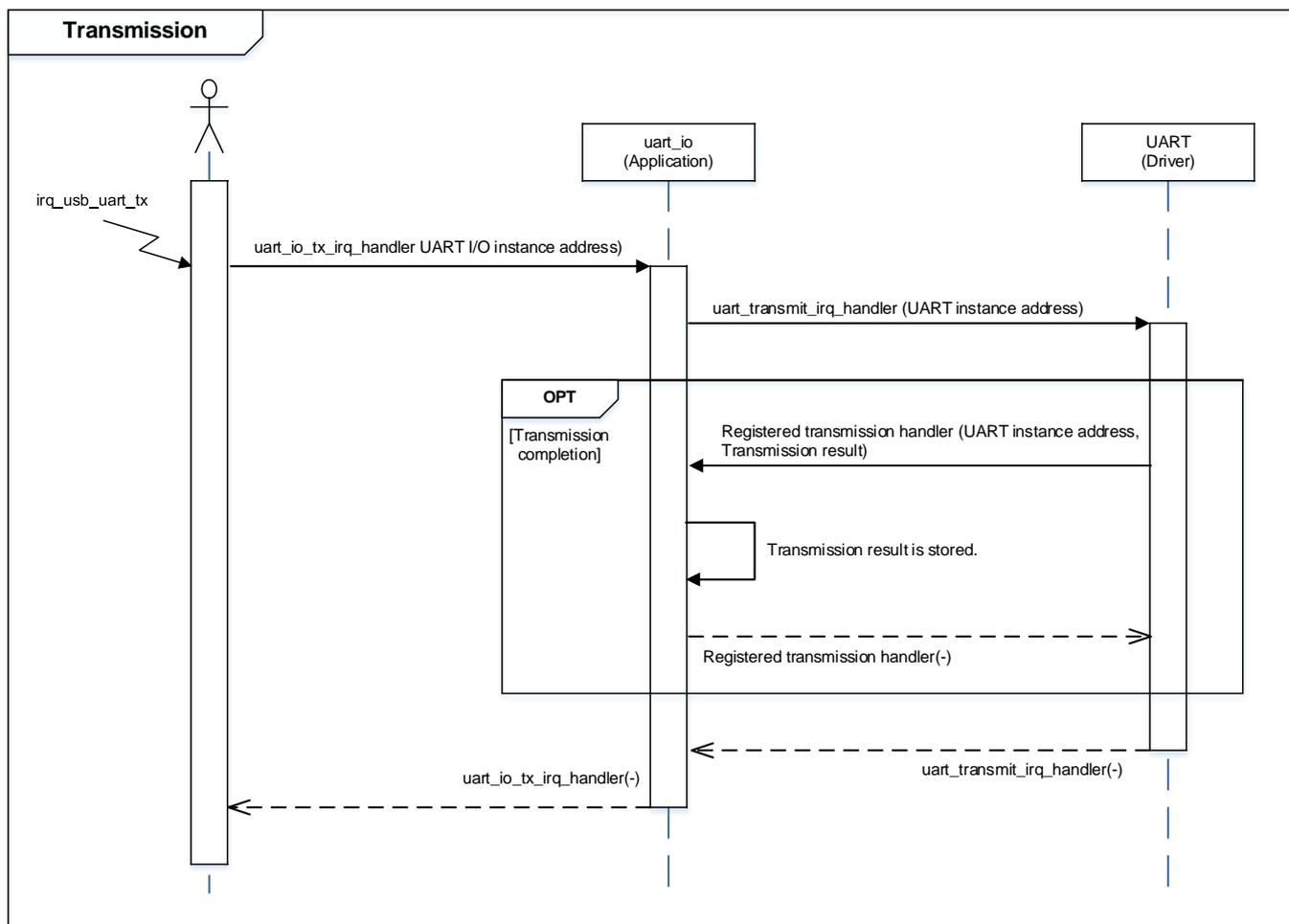


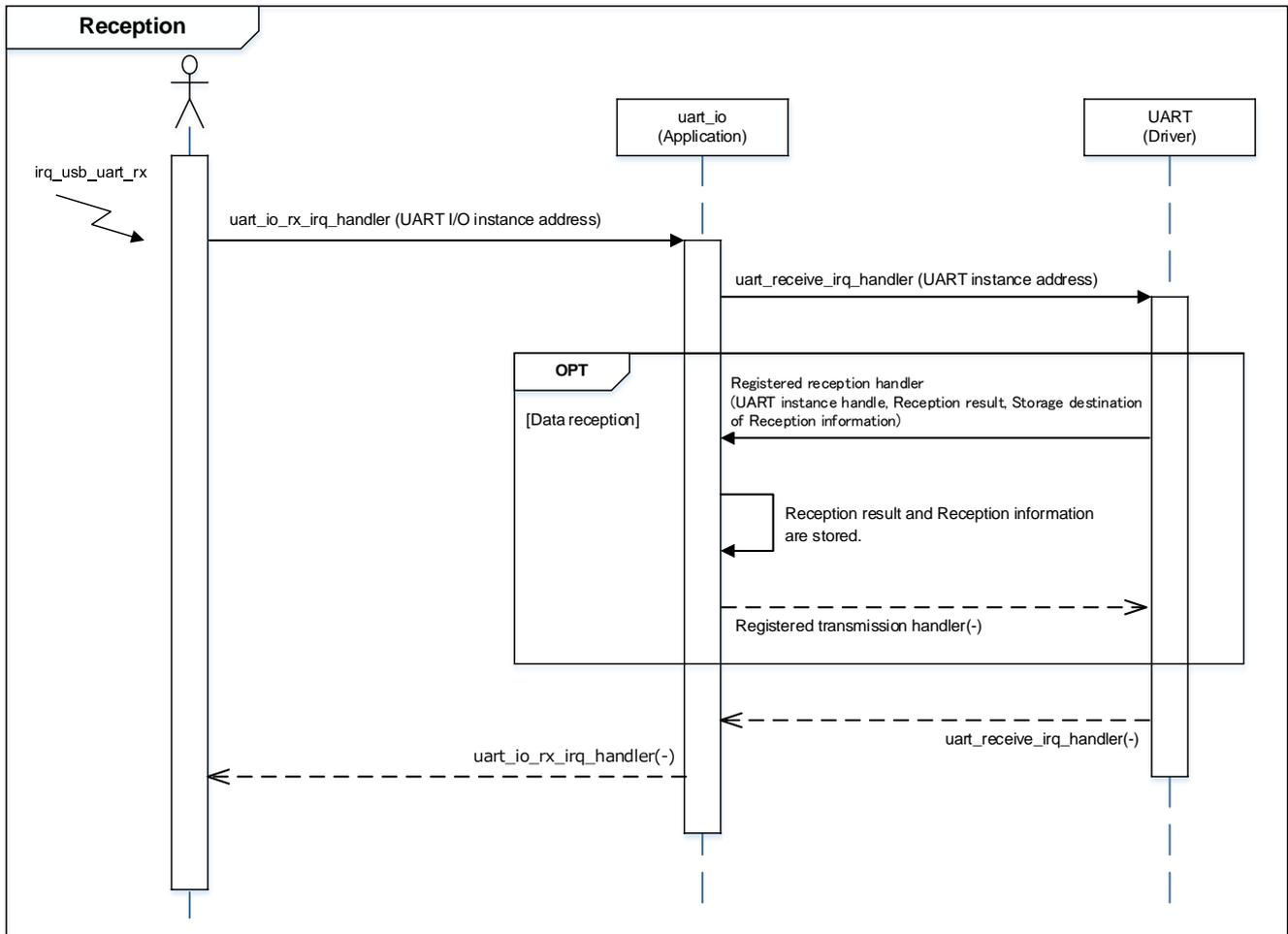












10. Precaution

When this sample program is used in other than TPM4G9F15, please check operation sufficiently.

11. Revision History

Rev	Date	Page	Description
1.0	2018-12-12	-	First release

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