

**M4G Group (1)**  
**Application Note**  
**Remote Control Signal Processor**  
**(RMC-B)**

**Outlines**

This application note is a reference material for developing products using Remote control signal preprocessor (RMC) function of M4G group (1).  
This document helps the user check operation of the product and develop its program.

Target sample program: RMC\_VersionB\_UART

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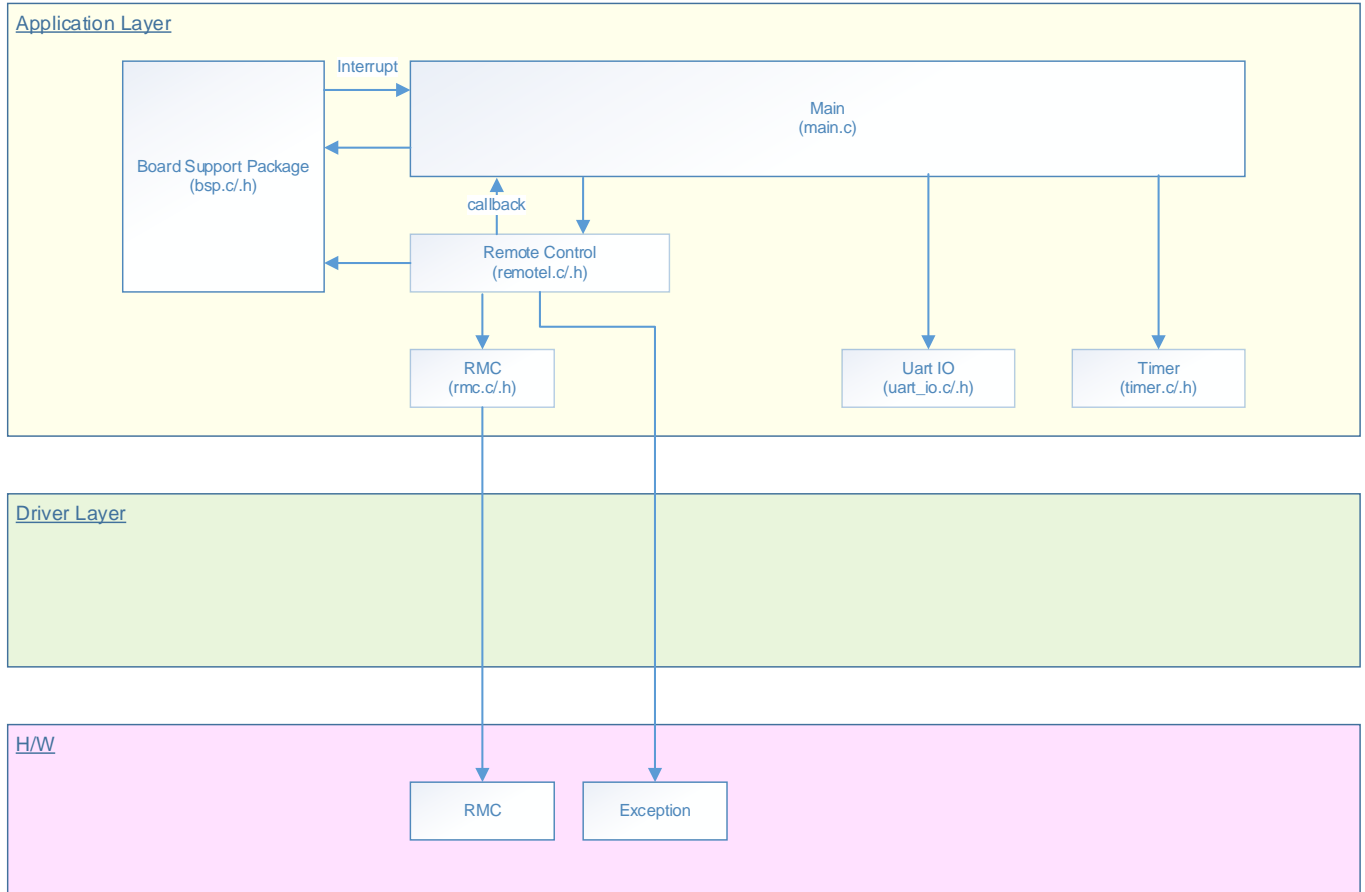
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## 1. Preface

This sample program receives the remote control signal whose carrier wave is removed, using the Remote control signal preprocessor (RMC).  
 The received signal is transferred to the terminal software to be displayed.

### Structure diagram of Sample program



## 2. Reference Document

- Datasheet  
     TMPM4G Group (1) datasheet Rev1.0 (Japanese edition)
- Reference manual  
     Remote Control Signal Processor (RMC-B) Rev1.0 (Japanese edition)  
     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
Remote Control Signal Processor	ch0	PT3 (RXIN0)	Remote control signal reception circuit
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.

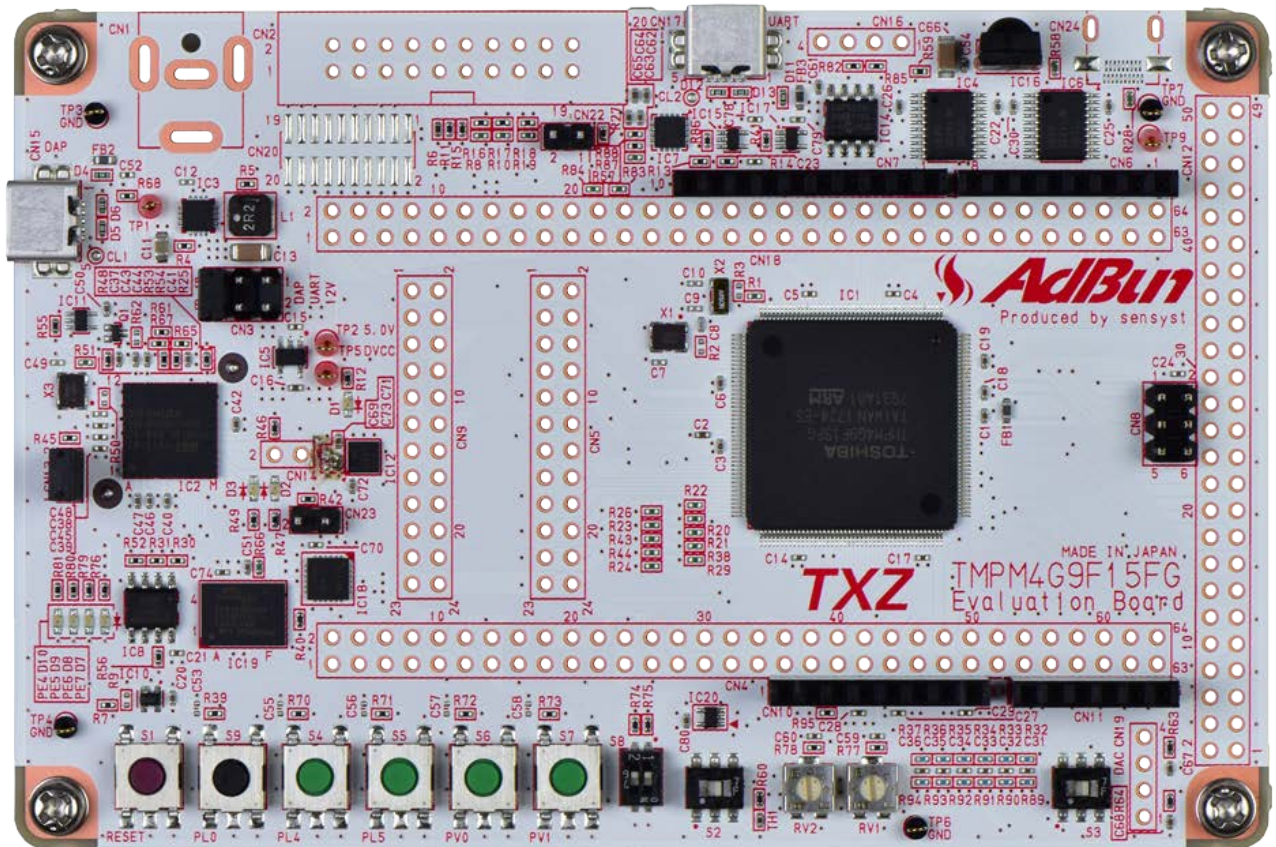
If other function than the TMPM4G9F15 one is checked, it is necessary that CMSIS Core related files (C startup file and I/O header file) should be changed properly.

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	TeraTerm V4.96
Sample program	V1000

Evaluation board (TMPM4G9F15FG Evaluation Board) Top view

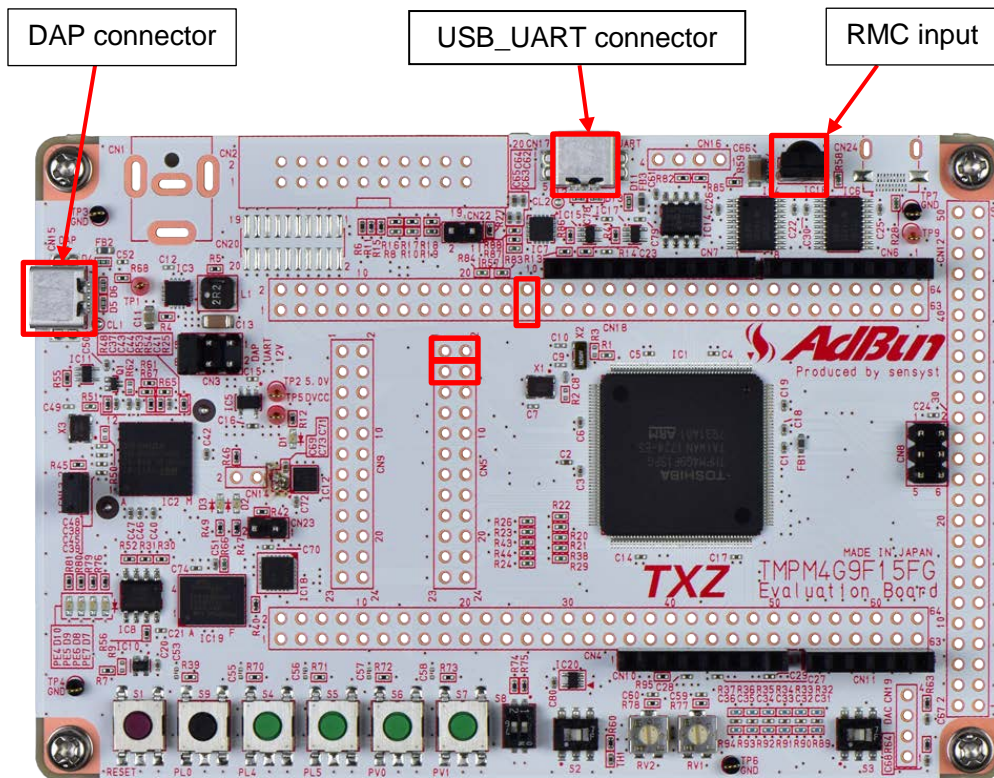


## 6. Evaluation Board Setting

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

CN18		
Board function	Through-hole No.	Through-hole No.
RMC input (IC16)	25: PT3	26: RMC



## 7. Operation of Evaluation Board

PC and the USB\_UART are connected for communication with the terminal software.  
 The remote control signal should be input to the PT3 pin (RXIN0).  
 The input signal is transmitted to the terminal software (Tera Term).



## 8. Outline of RMC Function

Remote control signal preprocessor (RMC) receives a remote control signal of which carrier is removed. The following table shows the list of the functions.

Function Classification	Function	Operation
Reception of a remote control signal	Sampling clock	The sampling clock can be selected from either Low speed clock (32.768 kHz) or Timer trigger for Clock source (TBxOUT).
	Noise filter	Noise canceling time can be adjusted (15 stages).
	Leader detection	Leader can be detected by the settings of a leader cycle and a Low width. <ul style="list-style-type: none"> <li>- Leader-less remote control signal can be received in the leader wait state.</li> <li>- Remote control signal which begins with only a Low width leader can be received.</li> <li>- Phase-type remote control signal with a fixed cycle can be received.</li> </ul>
	Repeat code detection	A leader and a repeat code can be distinguished and detected. <ul style="list-style-type: none"> <li>- The cycles of the leader and the repeat code are set, respectively, then they are distinguished from each other.</li> </ul>
	Data reception	Maximum of 72 bits can be received. <ul style="list-style-type: none"> <li>- Two kinds of data bit 0/1 judgment are possible. Judgment by setting a threshold value Judgment by Falling edge interrupt</li> </ul>
	Interrupt	Remote control interrupt (INTRMCx) can be generated by the following factors. They can be set to enable or disable. <ul style="list-style-type: none"> <li>- Leader detection</li> <li>- Repeat code detection</li> <li>- Low width detection</li> <li>- Maximum data bit cycle detection</li> <li>- Falling edge detection</li> </ul>
	Trigger output	The trigger signal is generated when a leader or a repeat code is detected. <ul style="list-style-type: none"> <li>- The reception interval of the leader or the repeat code can be measured by the combination of the trigger output and a timer capture function.</li> </ul>

## 9. Sample Program

The 16-bit customer code, the 8-bit data code, and the reversed 8-bit data code which are received by the RMC are transferred to the terminal software through the USB-UART interface.  
This sample program will receive in NEC format, AEHA format and Toshiba format.

### 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 initialization of BSP is executed.  
The initialization of driver is executed.  
The initialization of application is executed.

The timer and the RMC start after each initialization setting completes.  
A remote control signal is received and the reception result is transmitted to the terminal software.  
The format of the reception result is "Customer code (16 bits) + Data code (16 bits)" in this sample program.

### 9.3. How to change remote control format

The NEC format is used in this sample program by default.  
The following setting should be done to change the format to the AEHA format.

The following should be changed in "main.c".

```
#define RMC_UART_CFG_FORMAT      (RMC_UART_CFG_NEC_FORMAT))
```

If you change "RMC\_UART\_CFG\_NEC\_FORMAT" to "RMC\_UART\_CFG\_AEHA\_FORMAT", you can change the corresponding format to AEHA format.



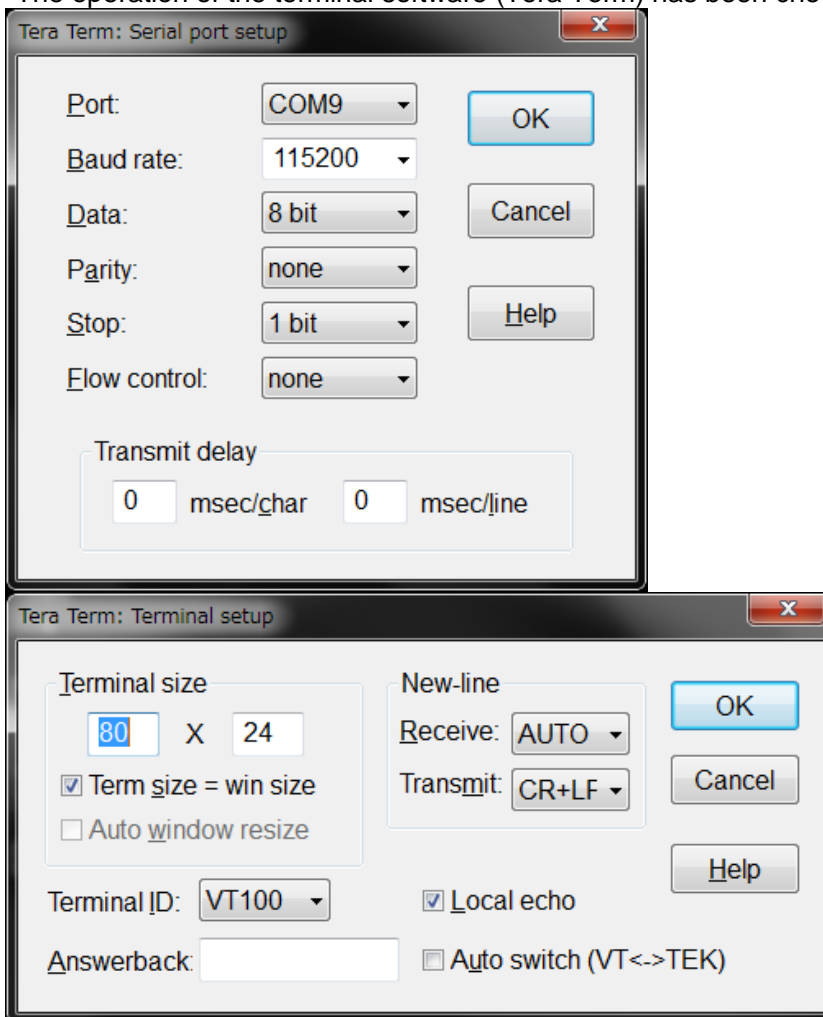
**9.4. Output Example of Sample Program**

The following is an example of outputting the result received from the remote control to the terminal software. The following is an example of the NEC format. Customer code and Data code are displayed.

```
Customer Code
=>00000010:0x02
=>11111101:0xFD
Data Code
=>00100000:0x20
=>11011111:0xDF
```

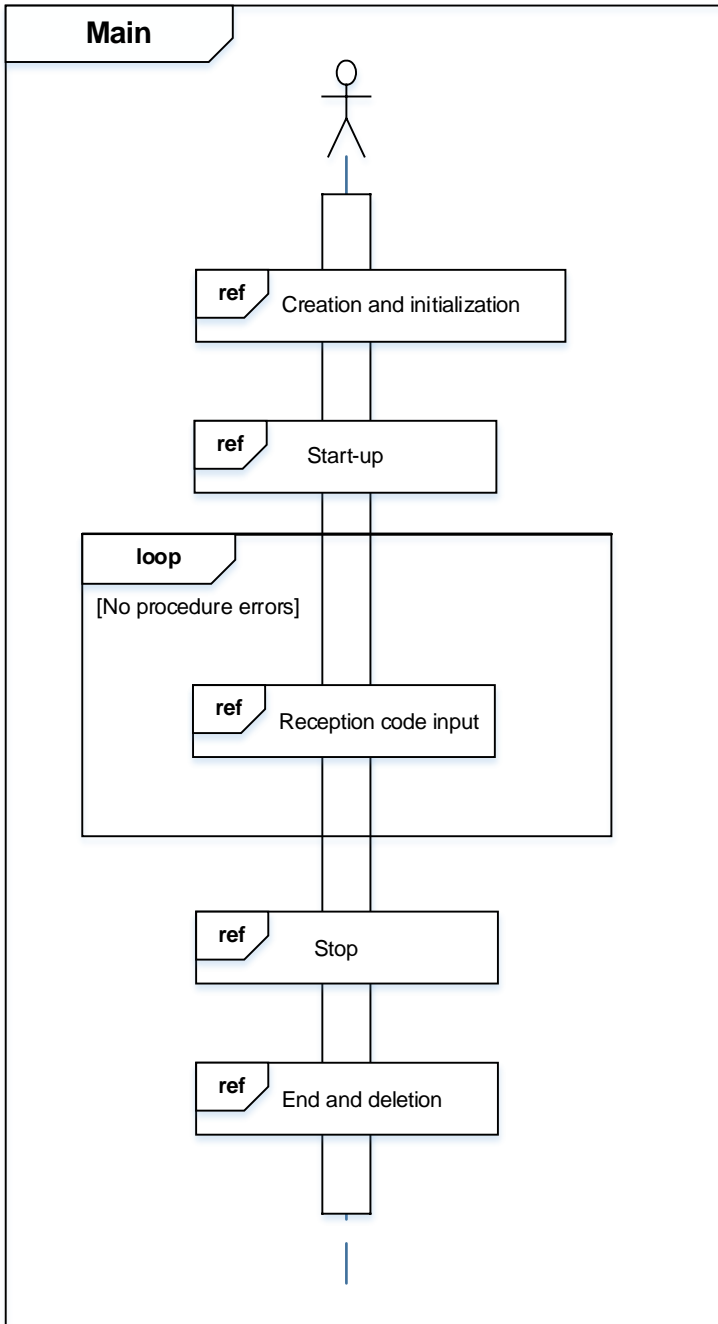
**9.4.1. Setting Example of Terminal Software**

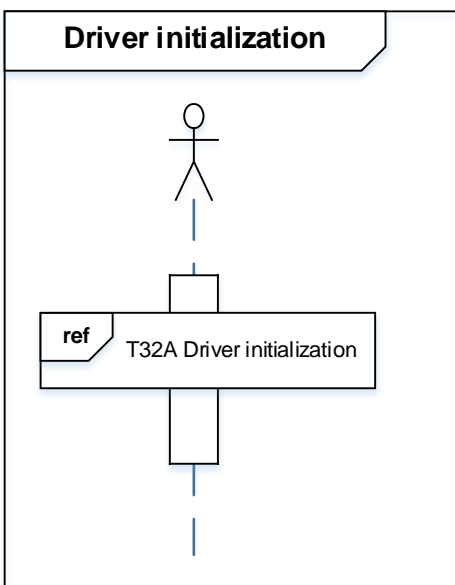
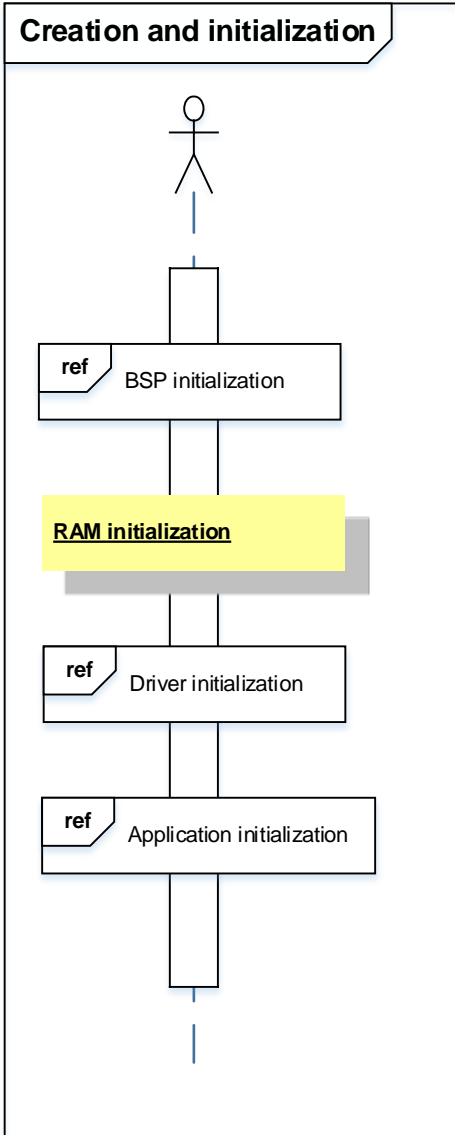
The operation of the terminal software (Tera Term) has been checked with the following settings.



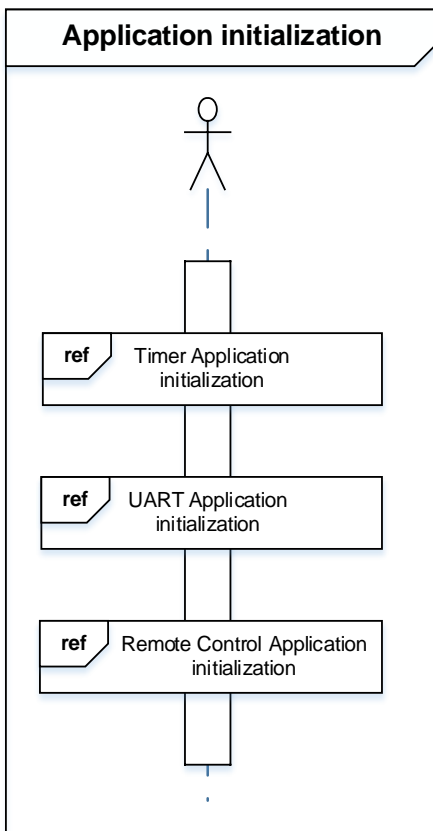
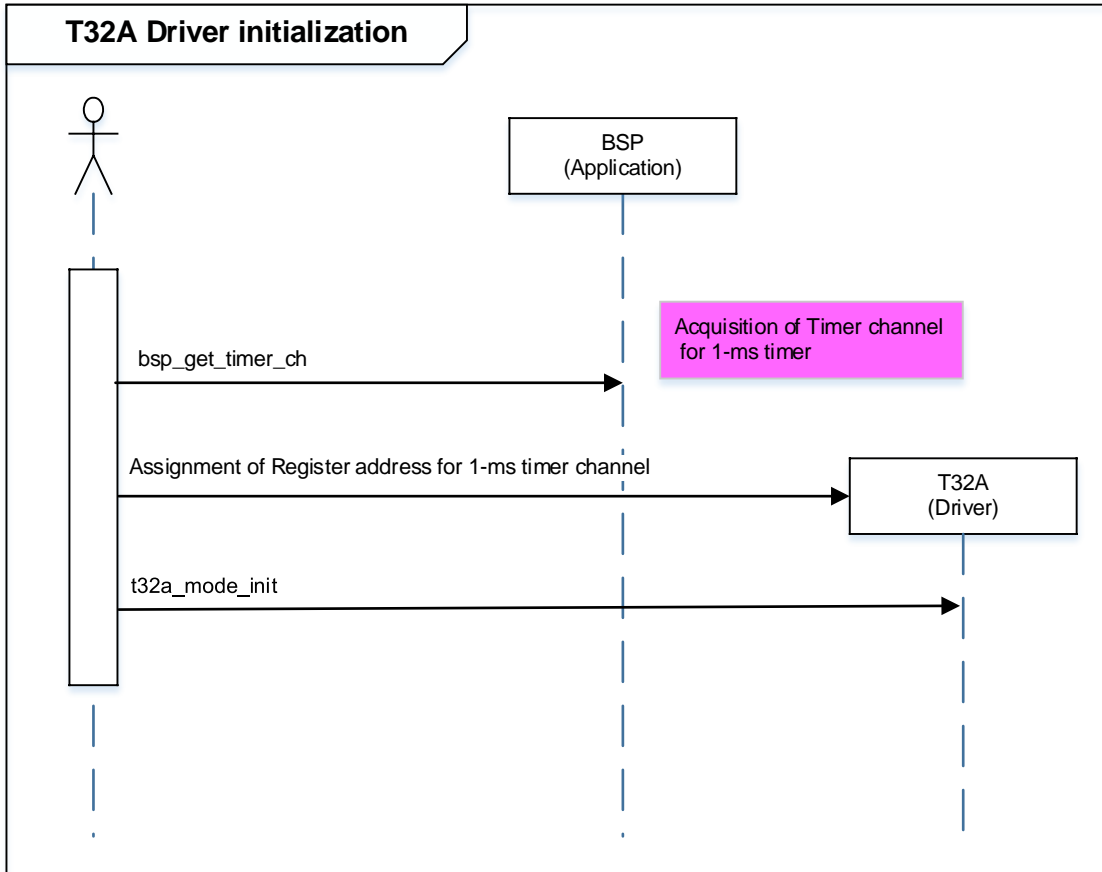
### 9.5. Operating Flow of Sample Program

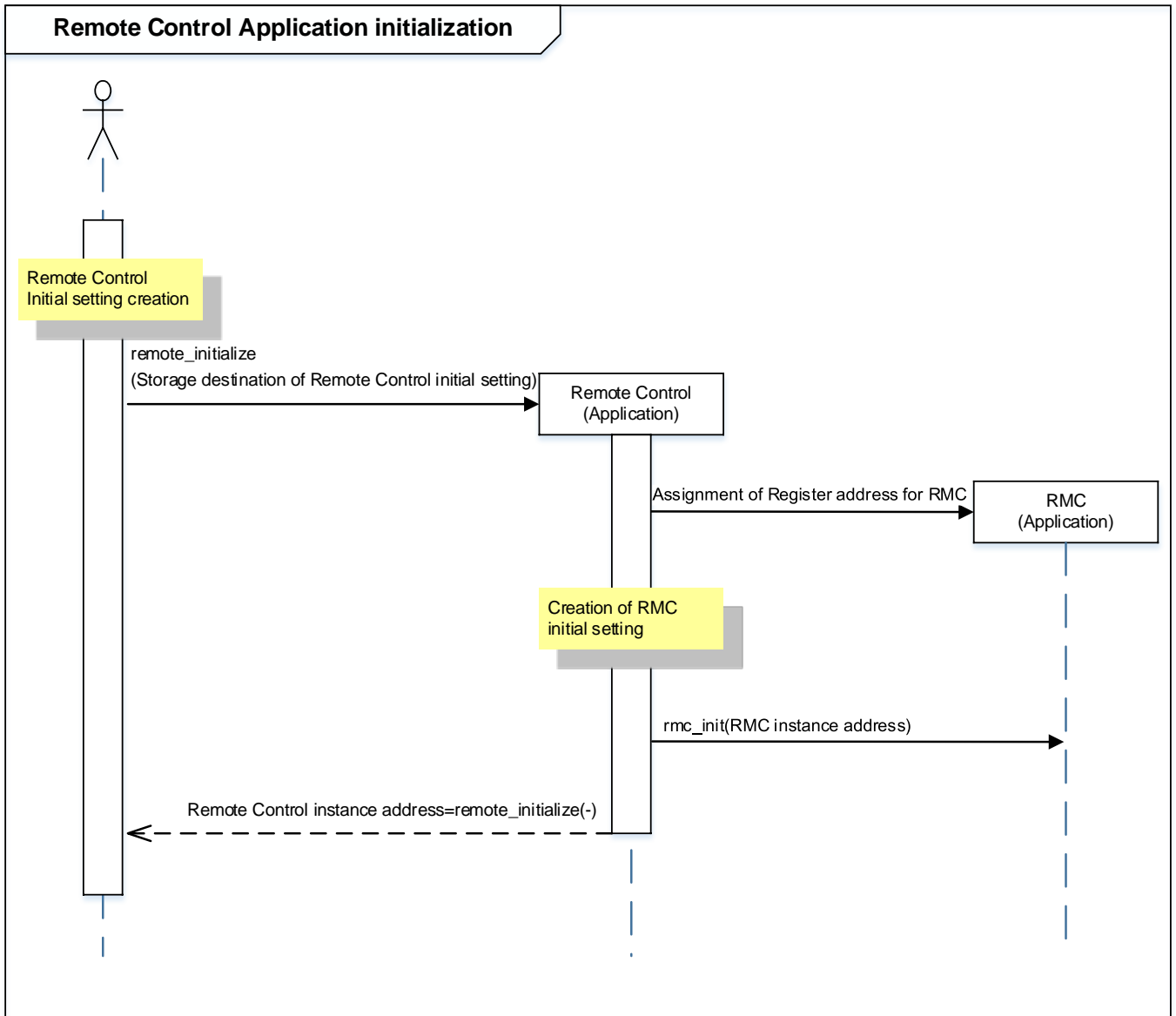
The basic operating flows of the sample program are shown in the following;

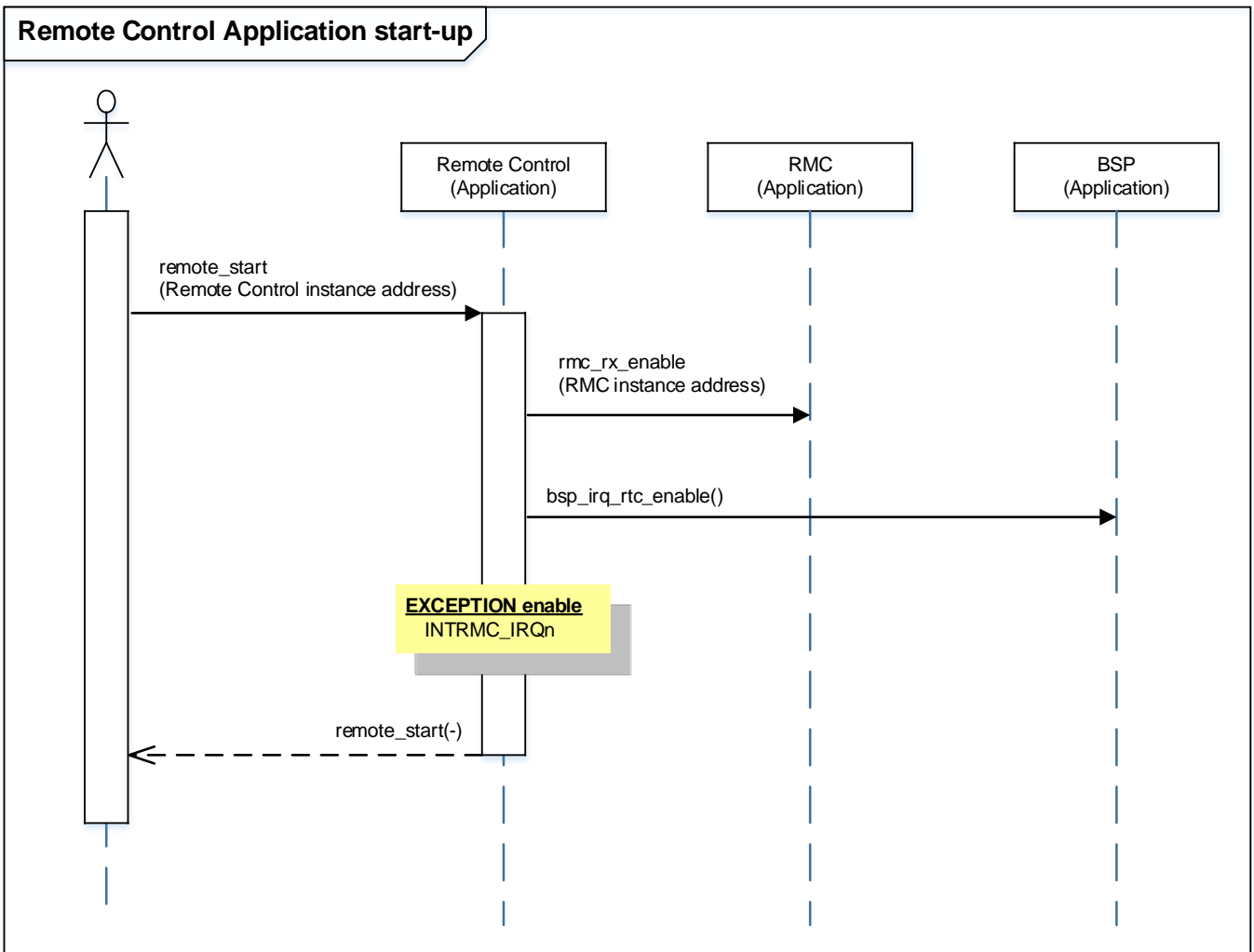
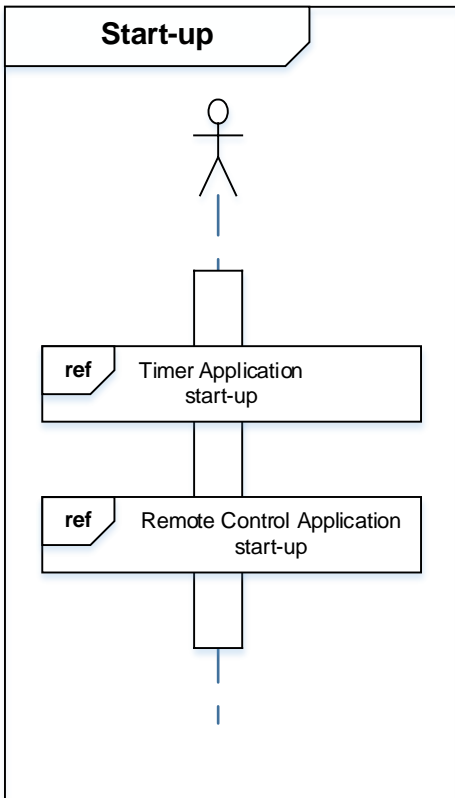




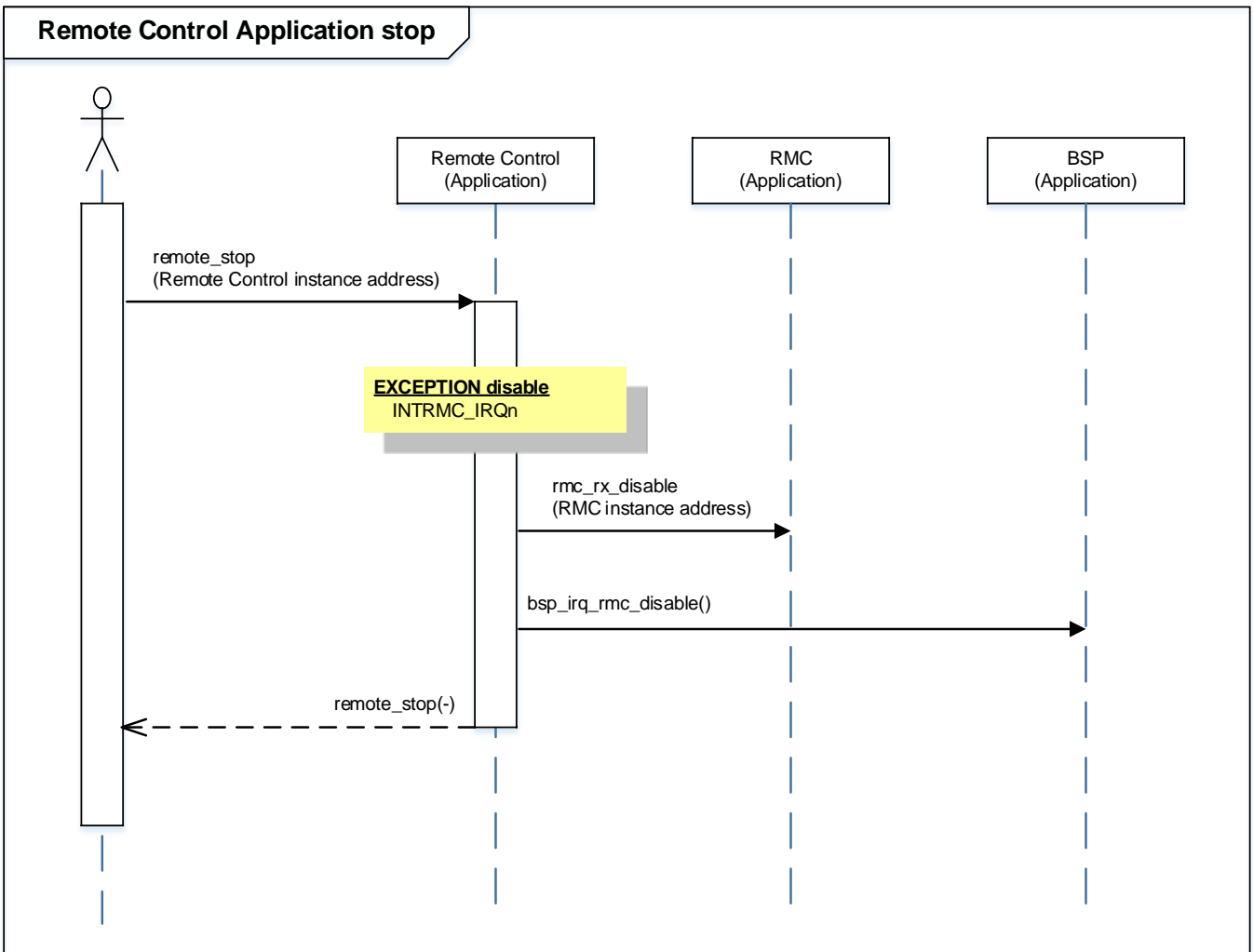
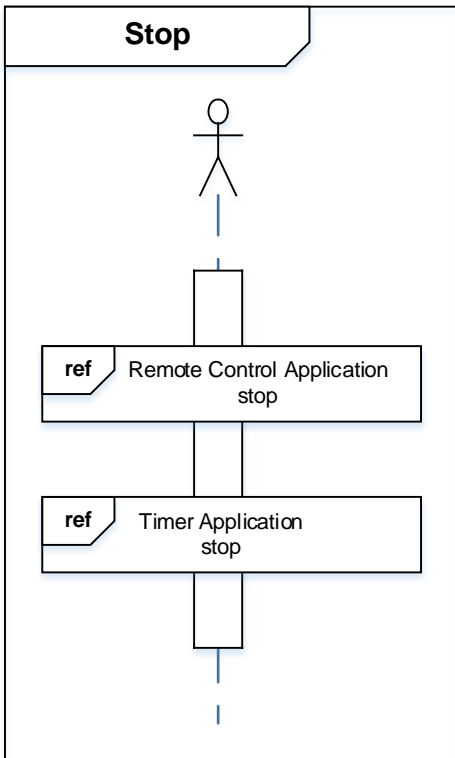
The 32-bit timer event counter of TPM4G9 is running, but processing using timer count is not performed.

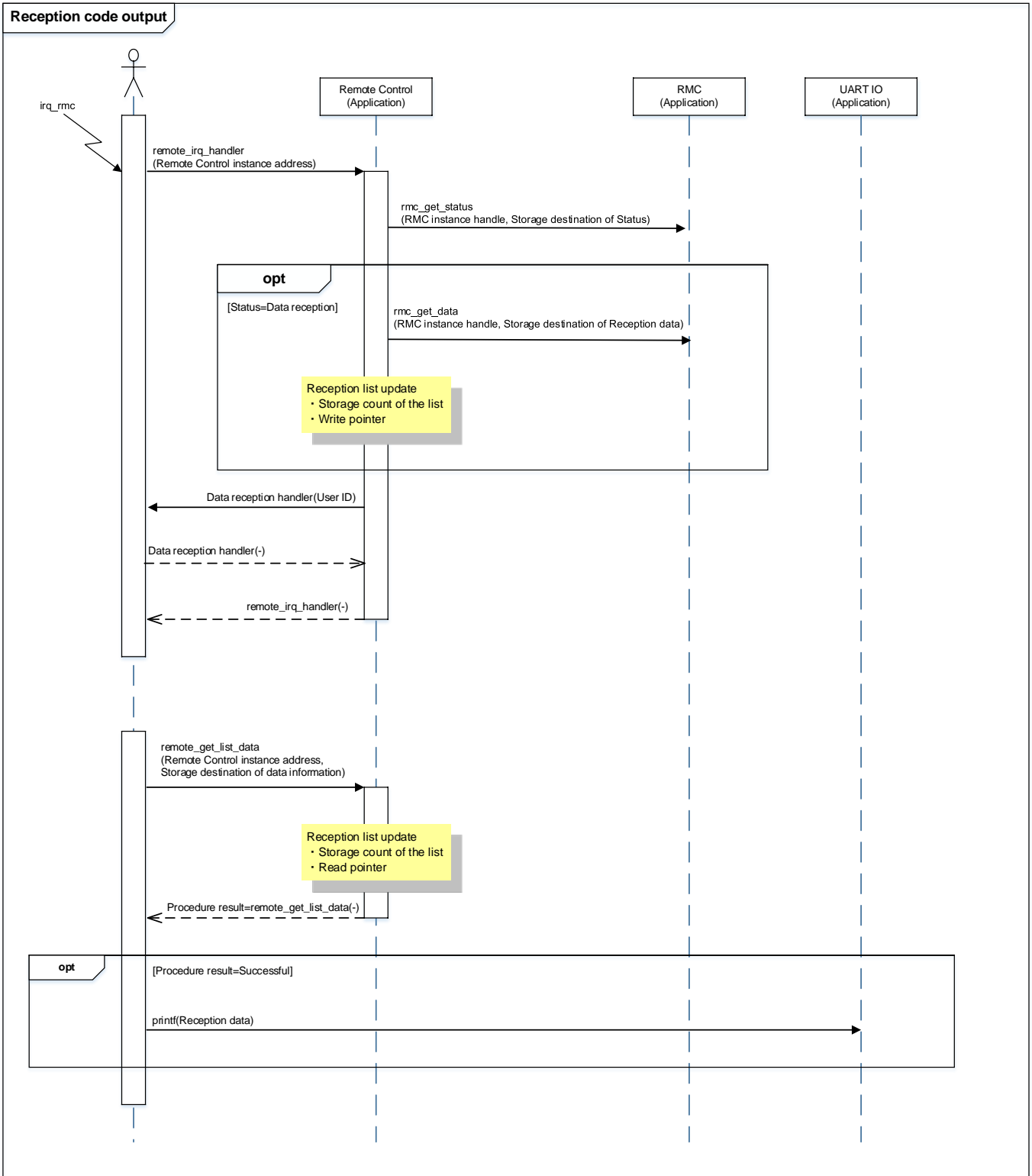


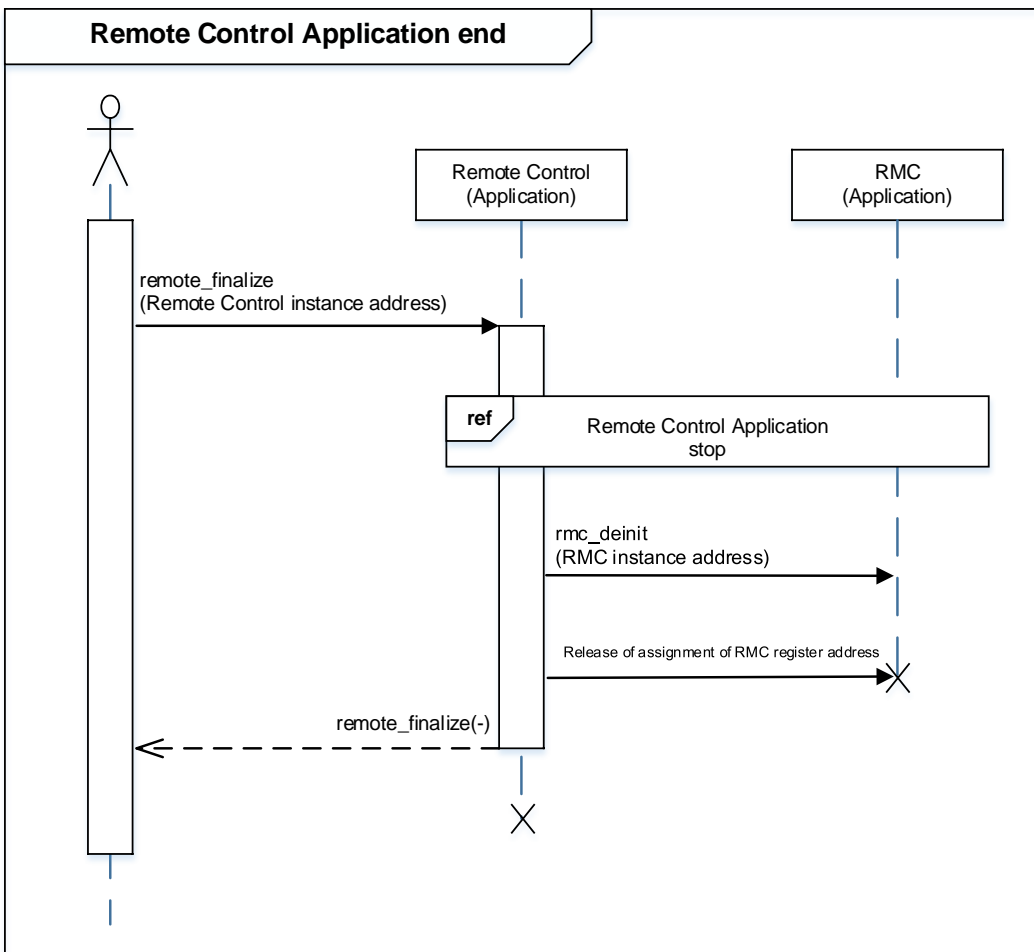
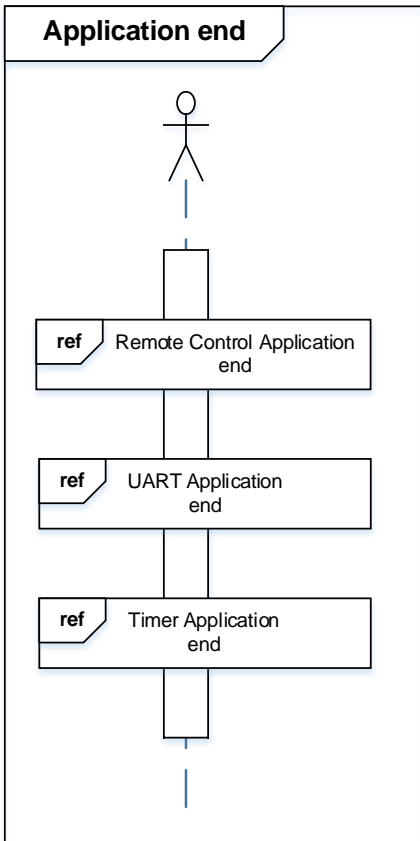


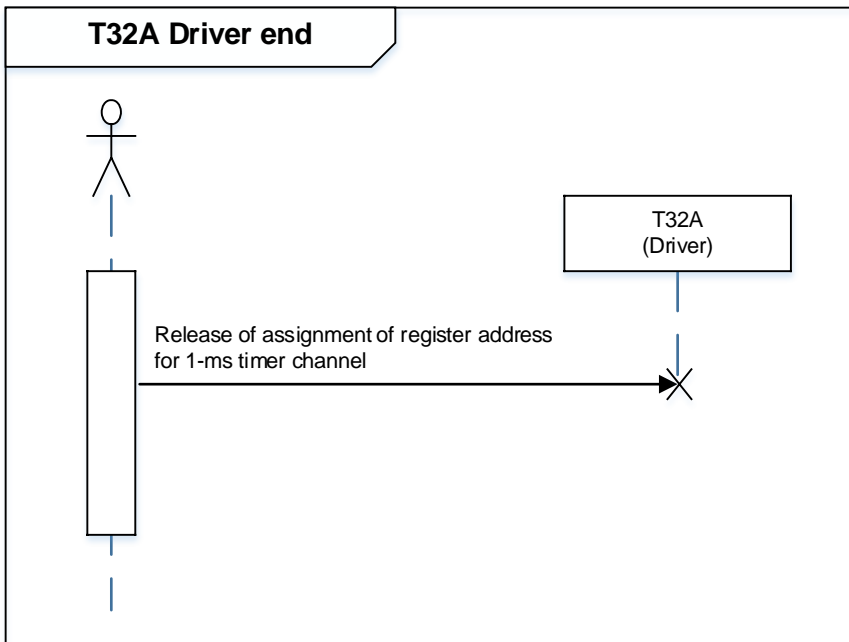
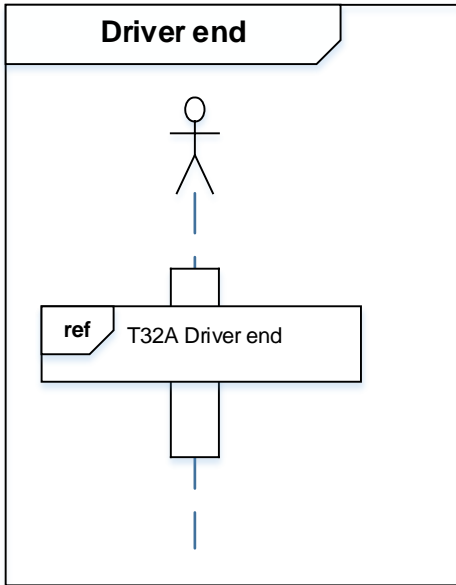


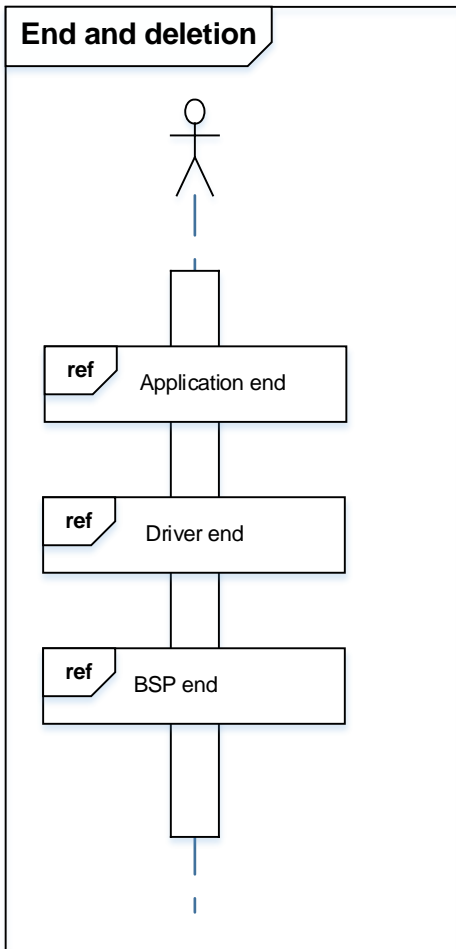












**10. Precaution**

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

**11. Revision History**

Rev	Date	Description
1.0	2018-12-14	First release



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