

M4G Group (1)
Application Note
I²C Interface
(I2C-B)
MASTER/SLAVE

Outlines

This application note is a reference material for developing products using I²C interface (I2C) Master/Slave functions of M4G group (1).
This document helps the user check operation of the product and develop its program.

Target sample program: I2C_MASTER_SLAVE

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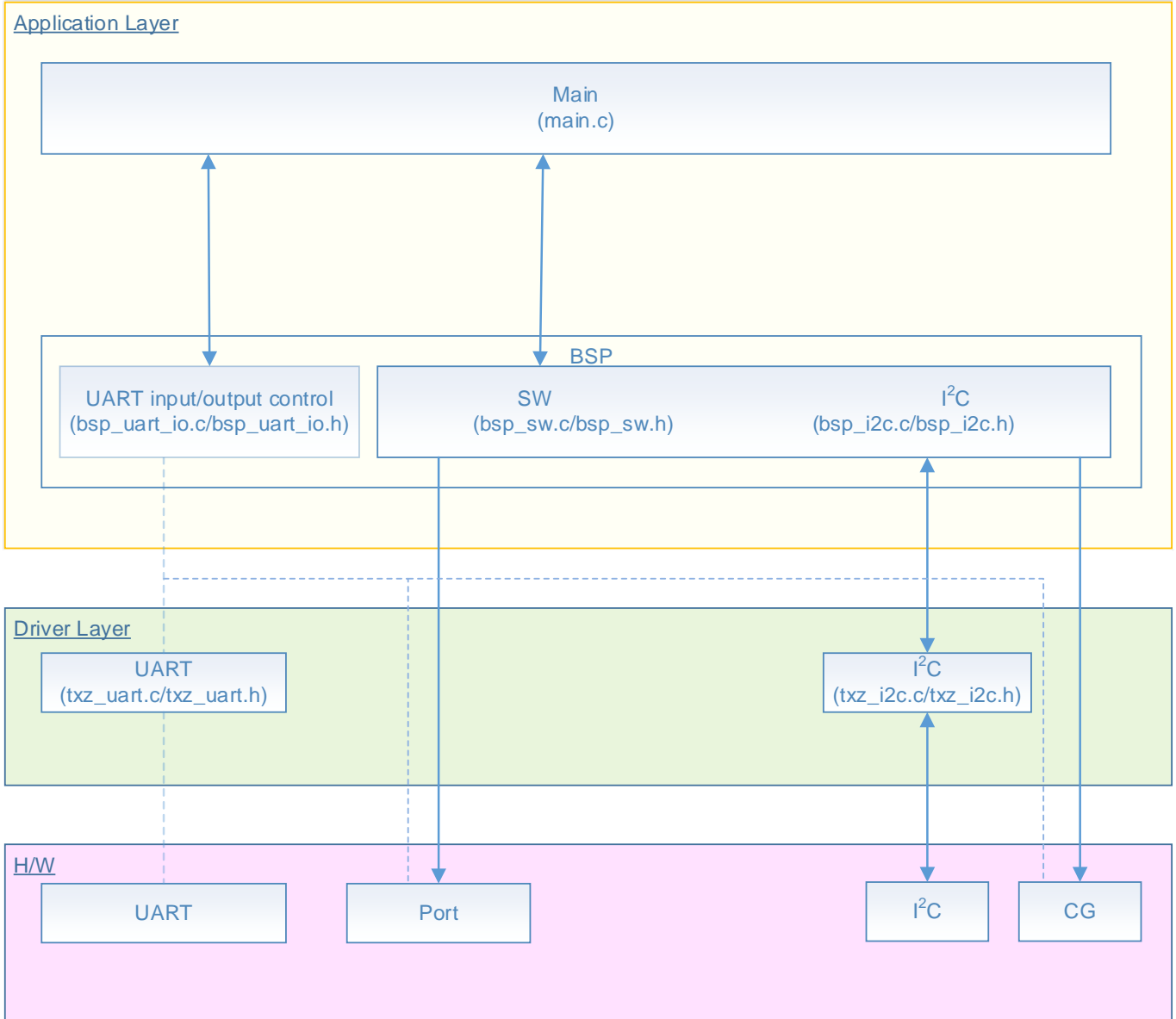
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1. Preface

This sample program should be used to check the operation of the Master/Slave function in the I²C interface.

Two evaluation boards are used. The slave board is controlled by the command which is input to the master board via terminal software on PC.

Structure diagram of Sample program



2. Reference Document

- Datasheet
TMPM4G group (1) datasheet Rev1.0 (Japanese edition)
- Reference manual
I²C Interface (I2C-B) Rev2.1 (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
Asynchronous Serial Communication Circuit	ch0	PE2 (UT0RXD) PE3 (UT0TXDA)	UART mode
I ² C Interface	ch3	PJ6 (I2C3SDA) PJ7 (I2C3SCL)	I ² C 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.

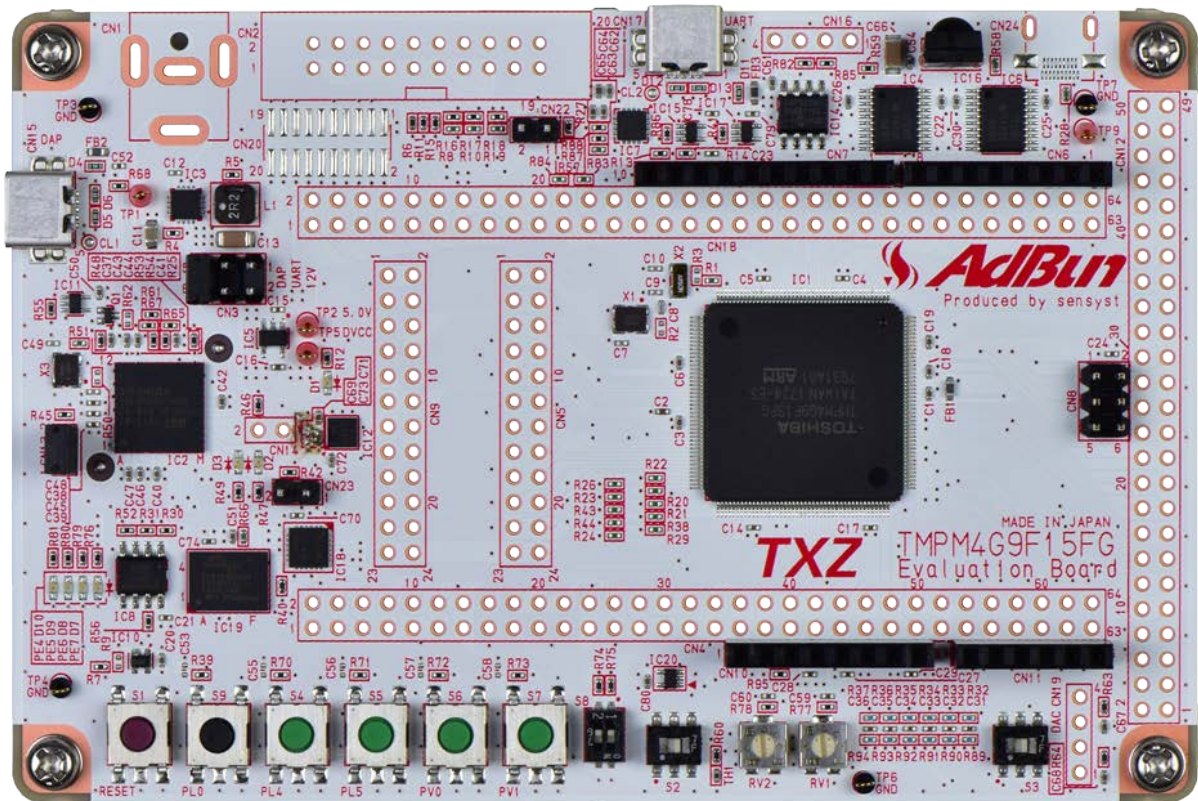
If other function than the TMPM4G9F15 one is checked, it is necessary that CMSIS Core related files (C startup file and I/O header file) should be changed properly.

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

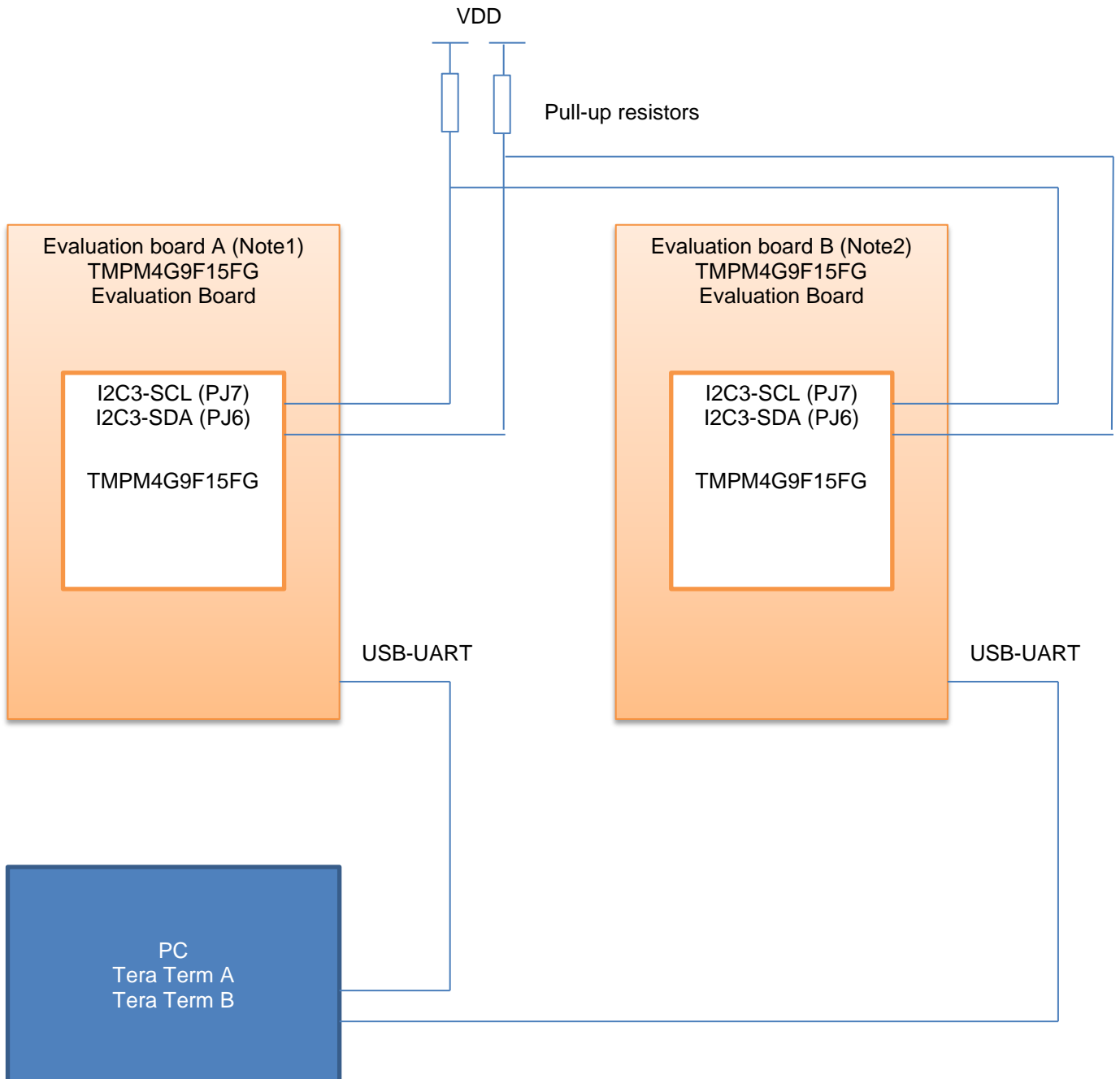
Two evaluation boards are necessary for this project.

Evaluation boards:

Evaluation board A: TPM4G9F15FG Evaluation Board

Evaluation board B: TPM4G9F15FG Evaluation Board

These evaluation boards should be connected as shown in the following figure.



Note1: Evaluation board A

- The program which is generated in the project for TMPM4G9 should be written.
- Details of the connection:

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

Through-hole connection on the board A:

[CN4] No. 39 on Evaluation board A and [CN5] No. 6 on Evaluation board A are connected.

[CN4] No. 41 on Evaluation board A and [CN5] No. 8 on Evaluation board A are connected.

Note) The connection to CN4 is done to use the pull-up resistor of the Port dip switch.

The Port dip switch should be set to OFF.

Note2: Evaluation board B

- The program which is generated in the project for TMPM4G9 should be written (the same program for Evaluation board A).
- Details of the connection:

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

The interconnection between the boards:

[CN5] No. 6 on Evaluation board A and [CN5] No. 6 on Evaluation board B are connected.

[CN5] No. 8 on Evaluation board A and [CN5] No. 8 on Evaluation board B are connected.

7. Operation of Evaluation Board

Prepare two evaluation boards and connect each DAP connector and USB_UART connector to the PC. When the sample program executes, both evaluation boards start up in the Master mode. "slave" command should be input to one of the boards. Then, the board enters the Slave mode. For the details of the operation of an input command, refer to the section "Sample Program Main Operation".

8. Outline of I²C Function

The I²C can operate as a transceiver circuit of 1ch (SCL, SDA) in 1 unit circuit. The list of the functions is shown below.

Function classification (Note1)	Function	A Functional Description or the range
Transmission speed Control	prescaler dividing selection	It is dividing about a prescaler clock to 1/1, 1/2, 1/3 to 1/30, 1/31 and 1/32.
	Clock source	A selection setup of the HIGH/LOW time of SCL is possible in master mode.
	The maximum transfer rate	1Mbps (it corresponds to Fm+) (fsys = 8 to 200 MHz)
Communication Format	I ² C bus format	Selection of Addressing/Data Free Format is possible. Selection of a master/slave is possible.
	Data length	1 to 8 bits
	acknowledge	The existence of acknowledging can be chosen.
	Start/stop condition	Generating of start/stop condition is possible.
	Slave address	Only a 7-bit addressing format. 2 sets of slave addresses can be set up. (1st/2nd Slave Address)
	General call	Detection of a general call is possible in slave mode.
Transmission and reception Control	Arbitration	Multi-master Clock synchronization Existence selection of Arbitration lost detection is possible.
	Repetitive start detection, generating	Detection of a repetitive start of a bus line (at the time of slave mode) and generating (at the time of master mode) are possible.
	Noise cancellation	Digital
Ganged control	Interruption	4 kinds (The completion interruption of transmission, Arbitration lost detection interruption, Bus free detection interruption, NACK reception detection interruption)
	DMA request	A setup according to transmission and reception is possible.
	Software reset	Reset by the software of an I ² C circuit is possible.
	Bus terminal state monitor function	The level monitor of SDA and a SCL pin
	Address match Wakeup function	Slave address match detection can use the release factor for the Low power consumption mode release.

Note1: It does not support HS (High Speed) mode, 10-bit addressing, and a START byte.

Note2: There is a function in which it cannot support depending on products, such as slope control, I/O correspondence at the time of the power supply OFF, an Input voltage (VIH/VIL), and an Output voltage (VOL=0.4V, VDD>2V). Please refer to the "Product Information" of the reference manual for details.

9. Sample Program

One of the evaluation boards can be set to the Slave mode by the command input on the terminal software. Then the Master board can control the Slave board.

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.

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

The configuration procedure of the I²C interface is done.

The transmission and reception data of master and slave are initialized.

The setting values of the I²C interface are initialized.

The sample program waits for the input of a command to the terminal software.

The I²C master function or the I²C slave function in the microcontroller can be executed by the input of a proper character according to the command format.

The master mode can be changed to the slave mode by a corresponding command. The command can be accepted only in the master mode.

Command format

"command[_parameter]"

The parameter depends on a command.

Command	Parameter	Input example	note
write	non	write	The initial data is transmitted to the address of the initial value.
	address	write B0	The initial data is transmitted to the address B0.
	address+data	write B011223344	The setting data is transmitted to address B0.
read	non	read	Send the initial value from the setting address and receive the initial value.
	address	read B0	Send the initial value from the setting address and receive the initial value.
	address+data	read B05566	Send the setting value from the setting address and receive the initial value.
slave	non	slave	Set to slave mode.
	address	slave B0	Set slave mode and slave address.

Note: Input data is a hexadecimal number. "12" should be input for "0x12", as an example.

Other command example

“w” command

“w” is the same as the command of “write” without any arguments.

“r” command

“r” is the same as the command of “read” without any arguments.

9.3. Output Example of Sample Program

When the sample program executes, the command input and the result are displayed as shown in the following figure.

[Basic log information]

"I2C3" shows the used channel in the I²C interface.

"sa B0" shows the reception-wait Slave address.

"tx[]" and "rx[]" show a transmission data and a reception data, respectively.

Example of Master output log

```
I2C TEST - I2C3
-----
| I2C master mode |
-----
command >
```

```
command > write
master
sa    B0
tx[0] 00
tx[1] 01
tx[2] 02
tx[3] 03
command >
```

```
command > read
master
sa    B0
tx[0] 00
tx[1] 01
rx[0] 80
rx[1] 81
command >
```

Example of Slave output log

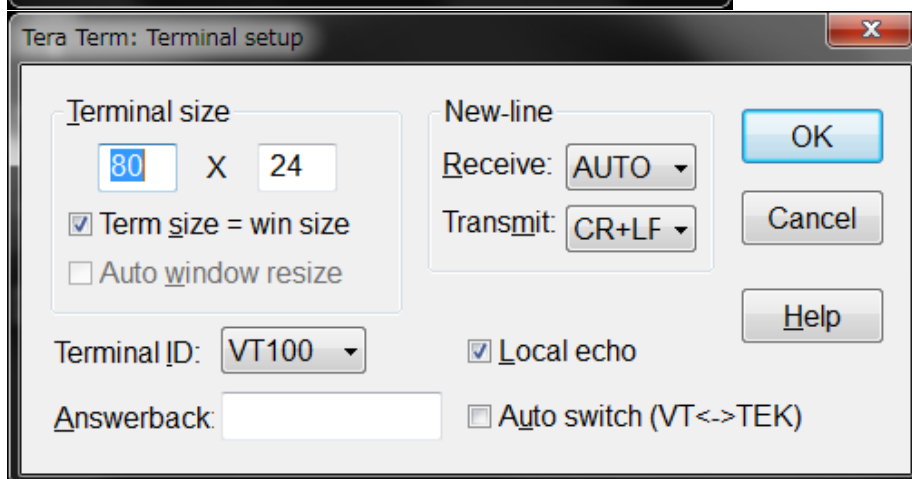
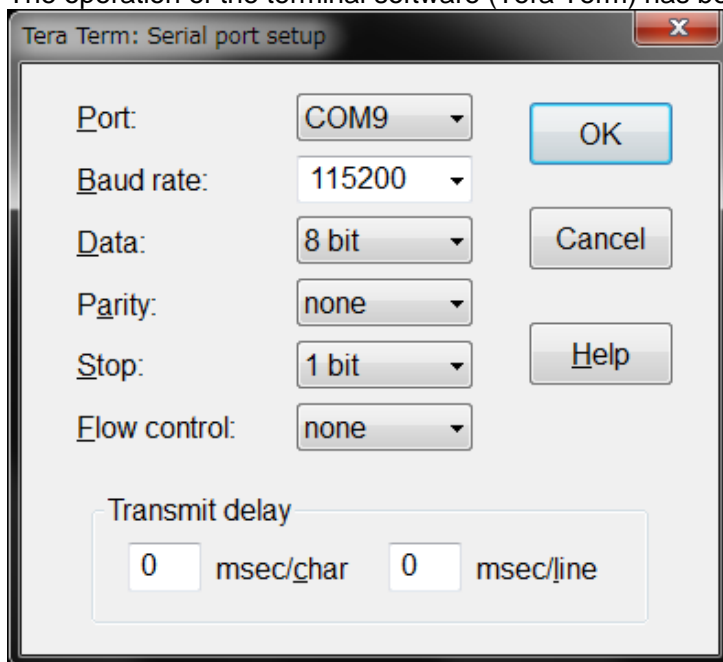
```
I2C TEST - I2C3
-----
| I2C master mode |
-----
command > slave
-----
| I2C slave mode |
-----
slave
sa    B0
```

```
slave
sa    B0
rx[0] 00
rx[1] 01
rx[2] 02
rx[3] 03
slave
sa    B0
```

```
slave
sa    B0
rx[0] 00
rx[1] 01
tx[0] 80
tx[1] 81
slave
sa    B0
```

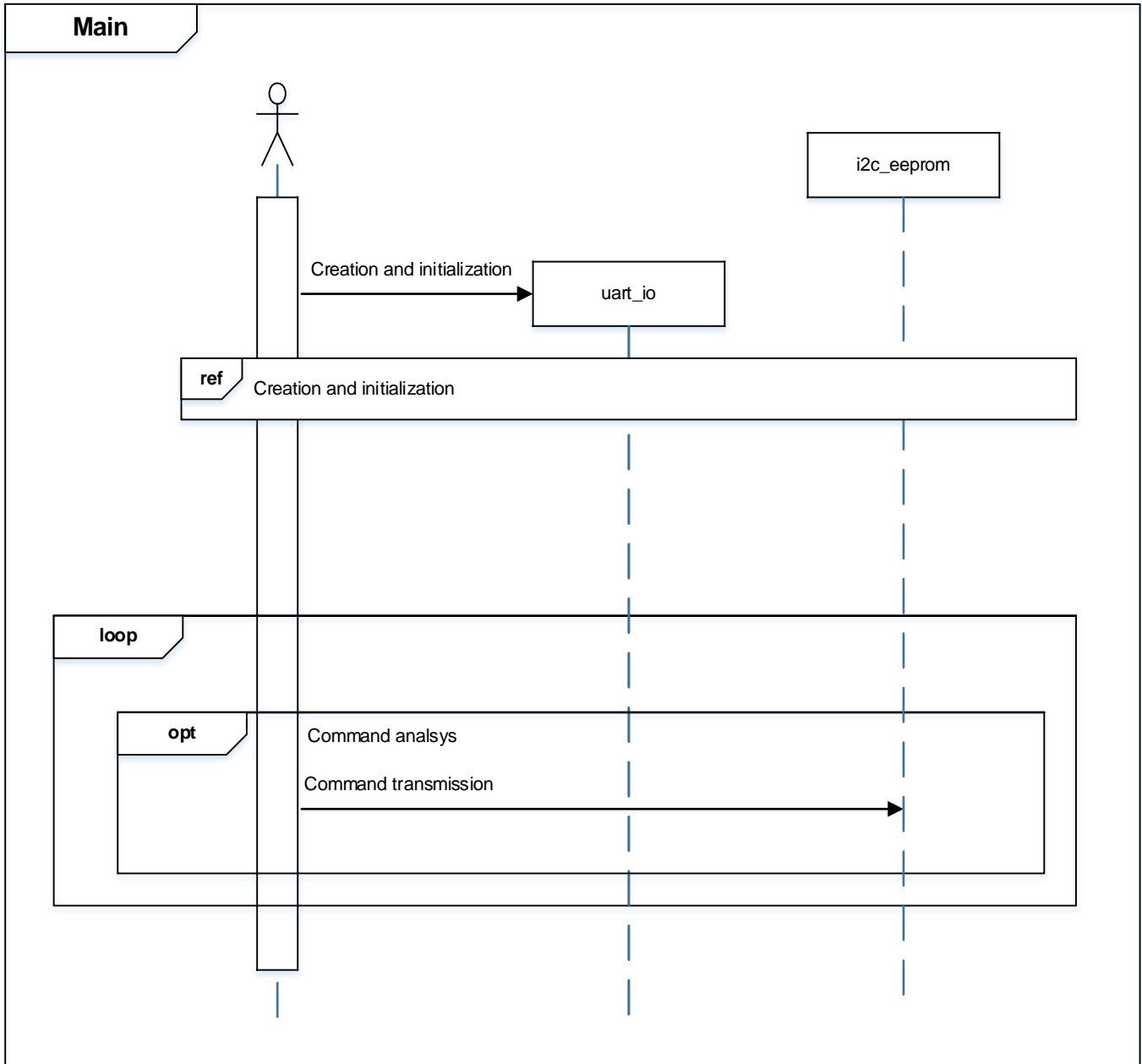
9.3.1. Setting Example of Terminal Software

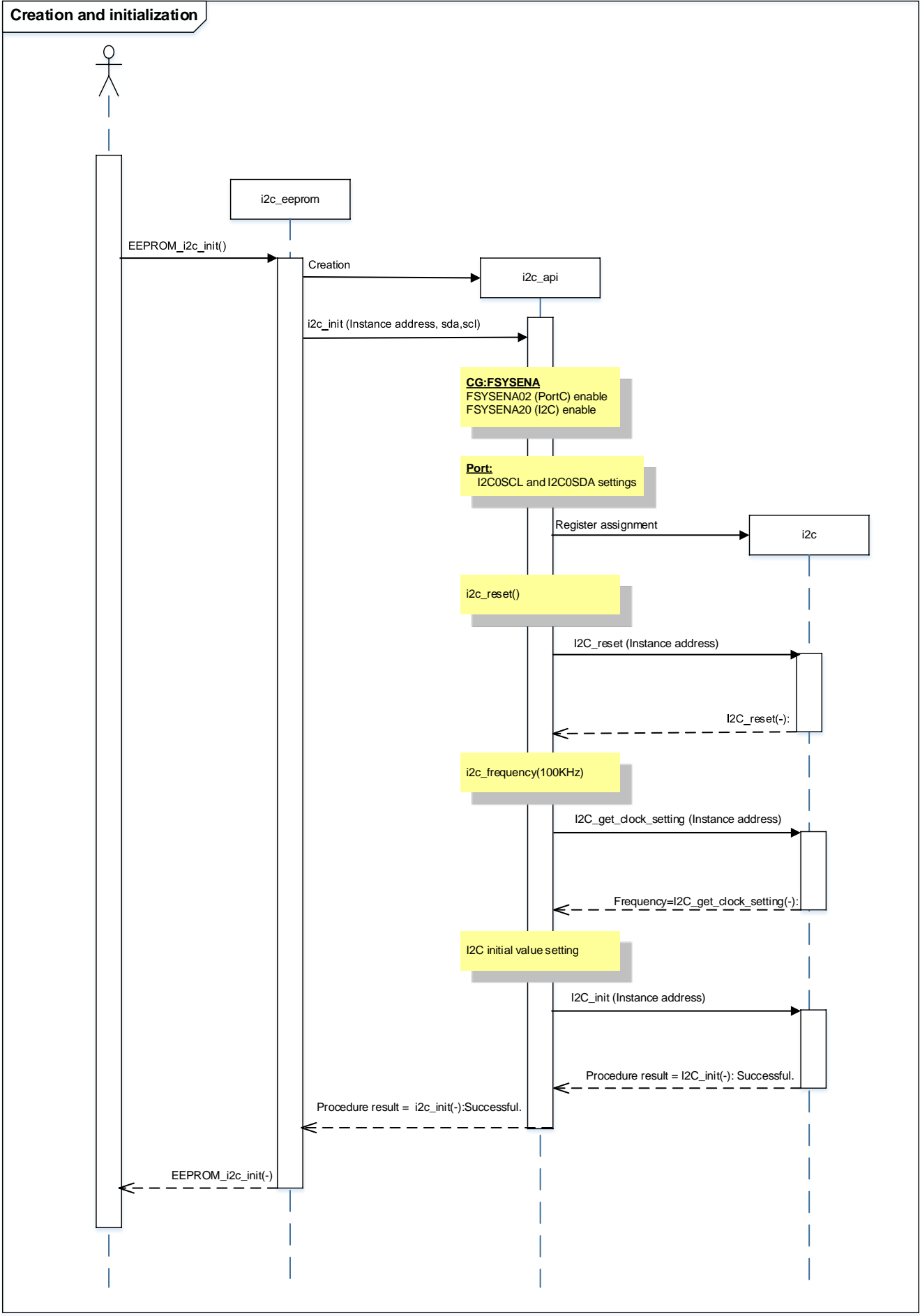
The operation of the terminal software (Tera Term) has been checked with the following settings.

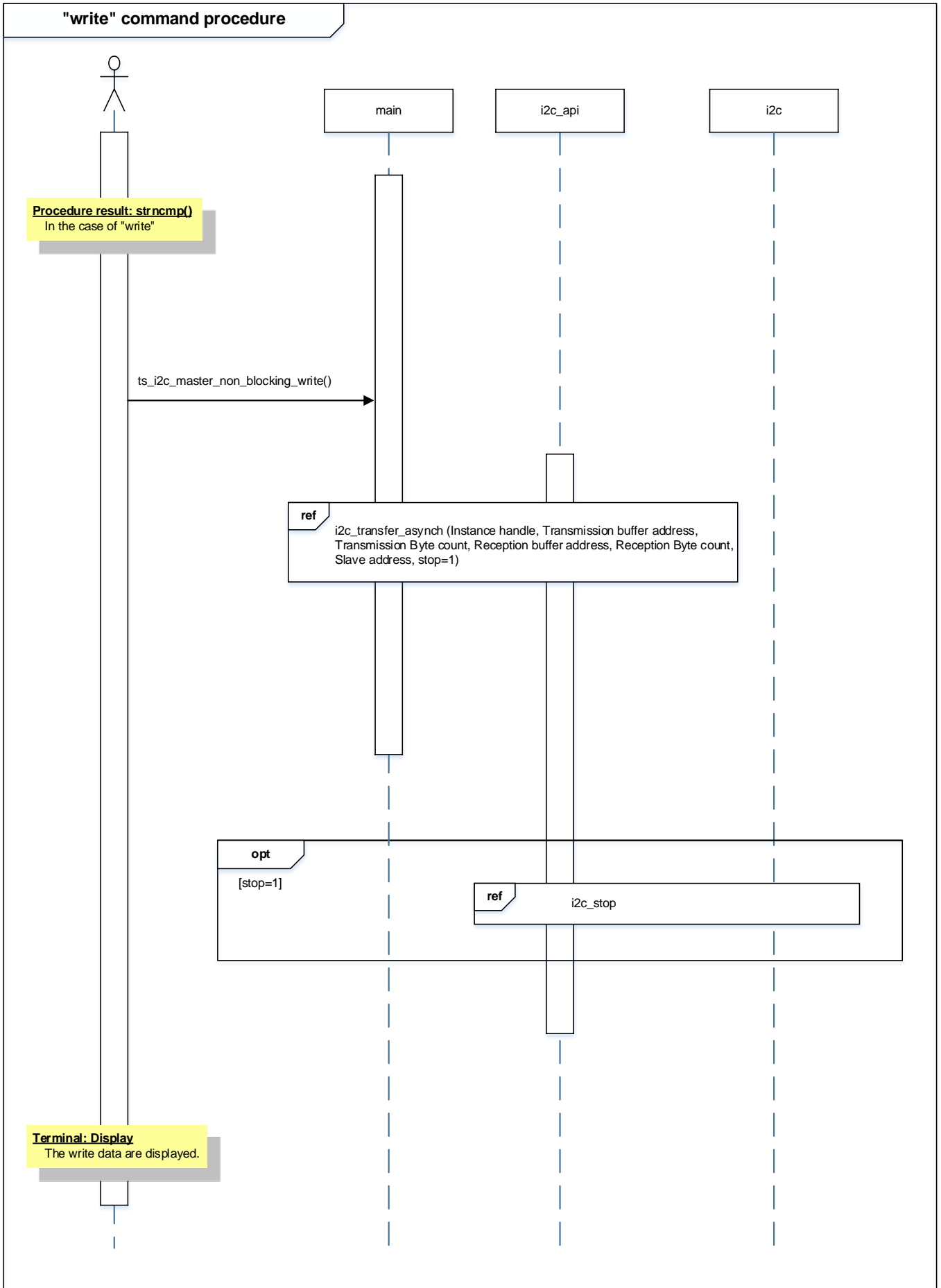


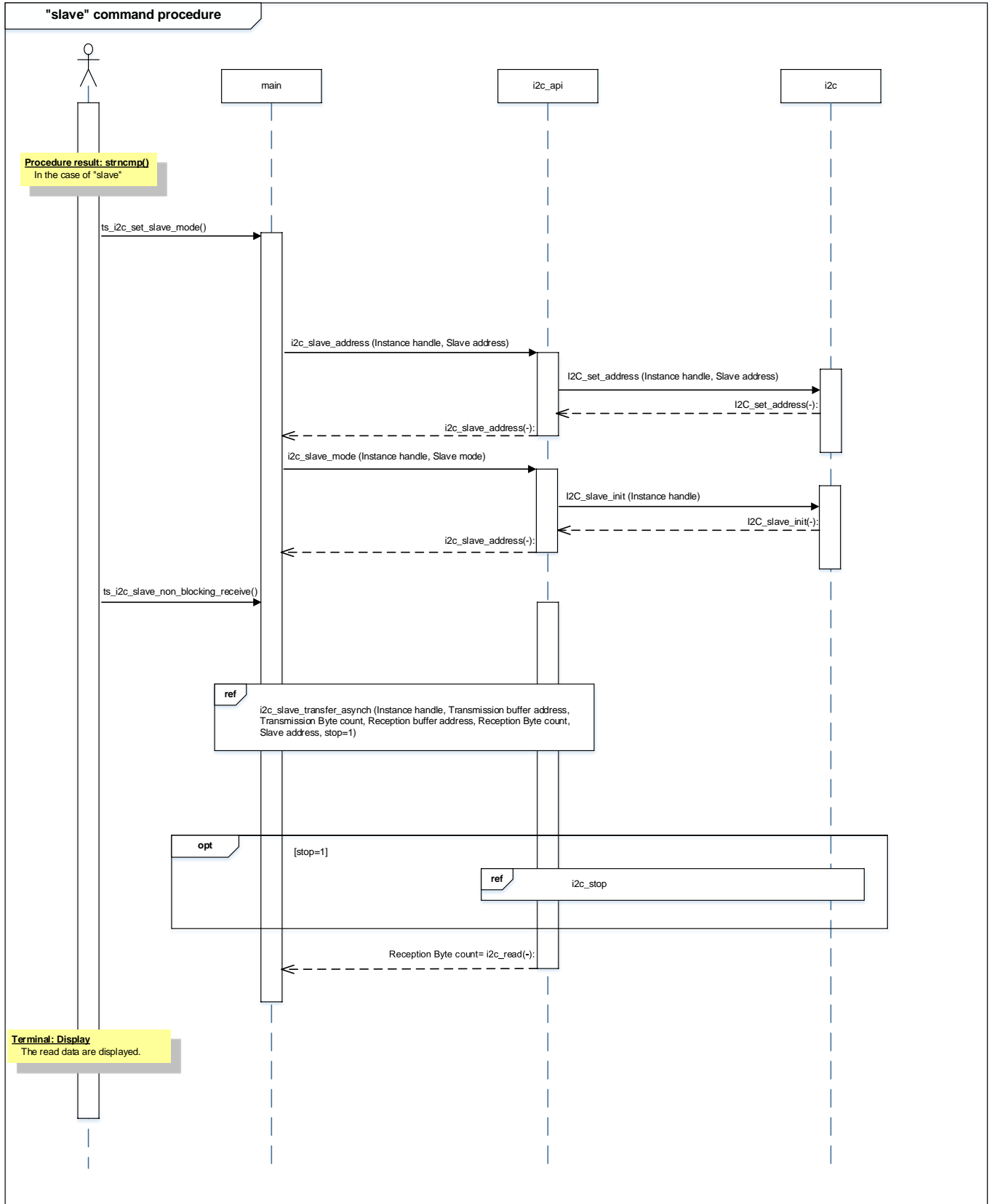
9.4. Operating Flow of Sample Program

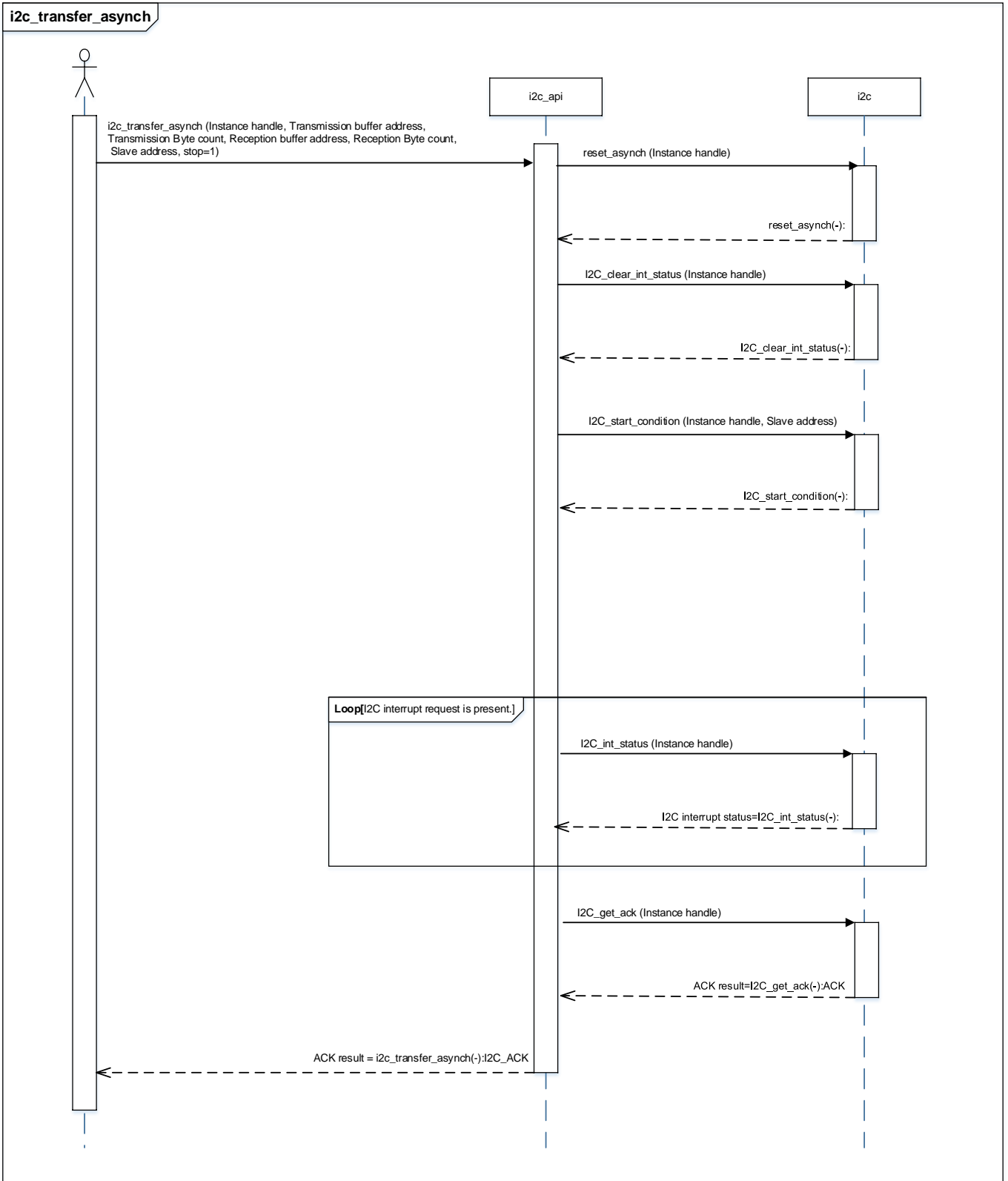
The basic operating flows of the sample program are shown in the following;

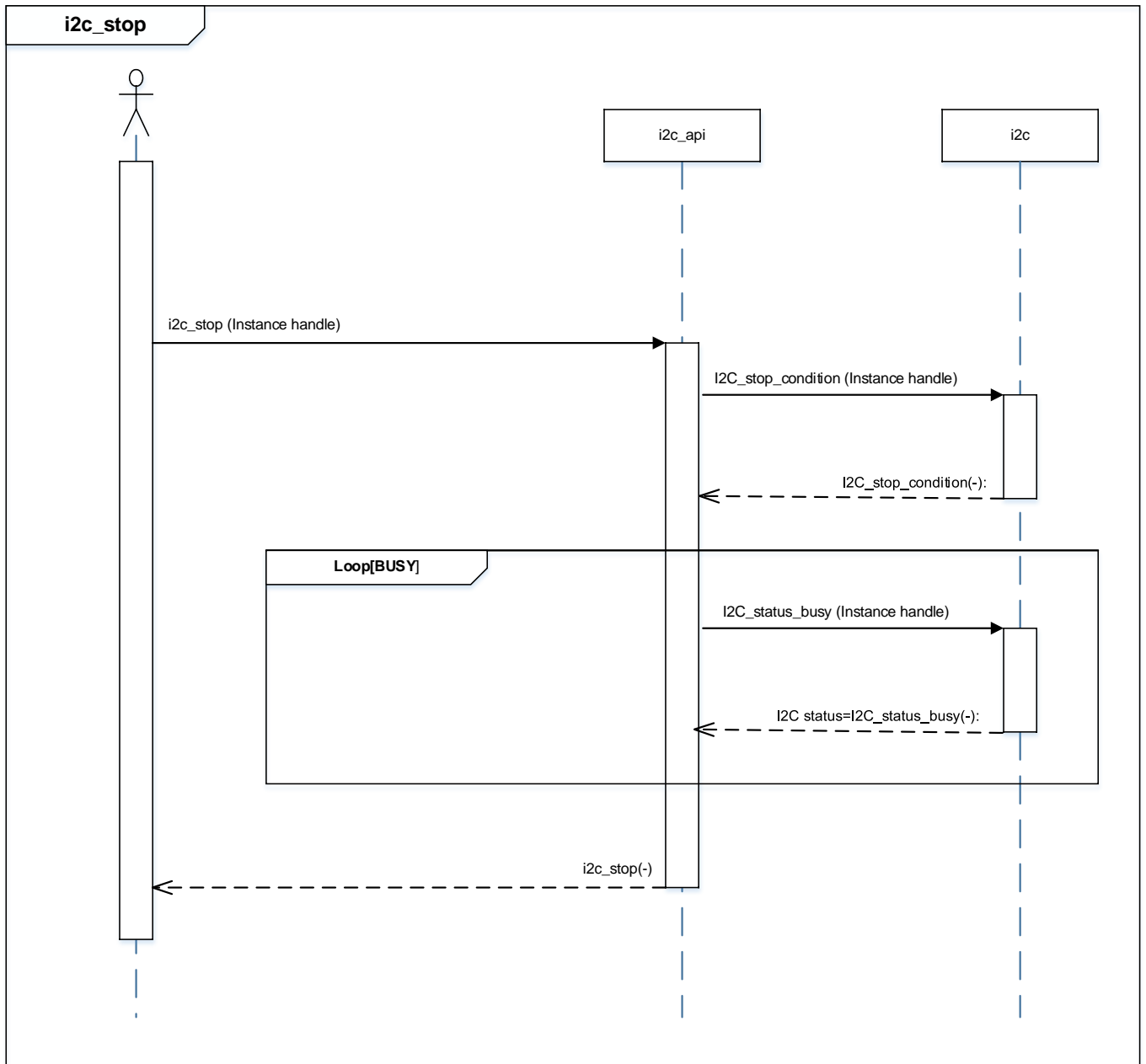












10. Precaution

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

11. Revision History

Rev	Date	Page	Description
1.0	2018-12-10	—	First release

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