M4G Group (1)
Application Note
Serial Memory Interface
(SMIF-A)

Outlines

This application note is a reference material for developing products using serial memory interface (SMIF) function of M4G Group (1). This document helps the user check operation of the product and develop its program.

Target sample program: SMIF_UART

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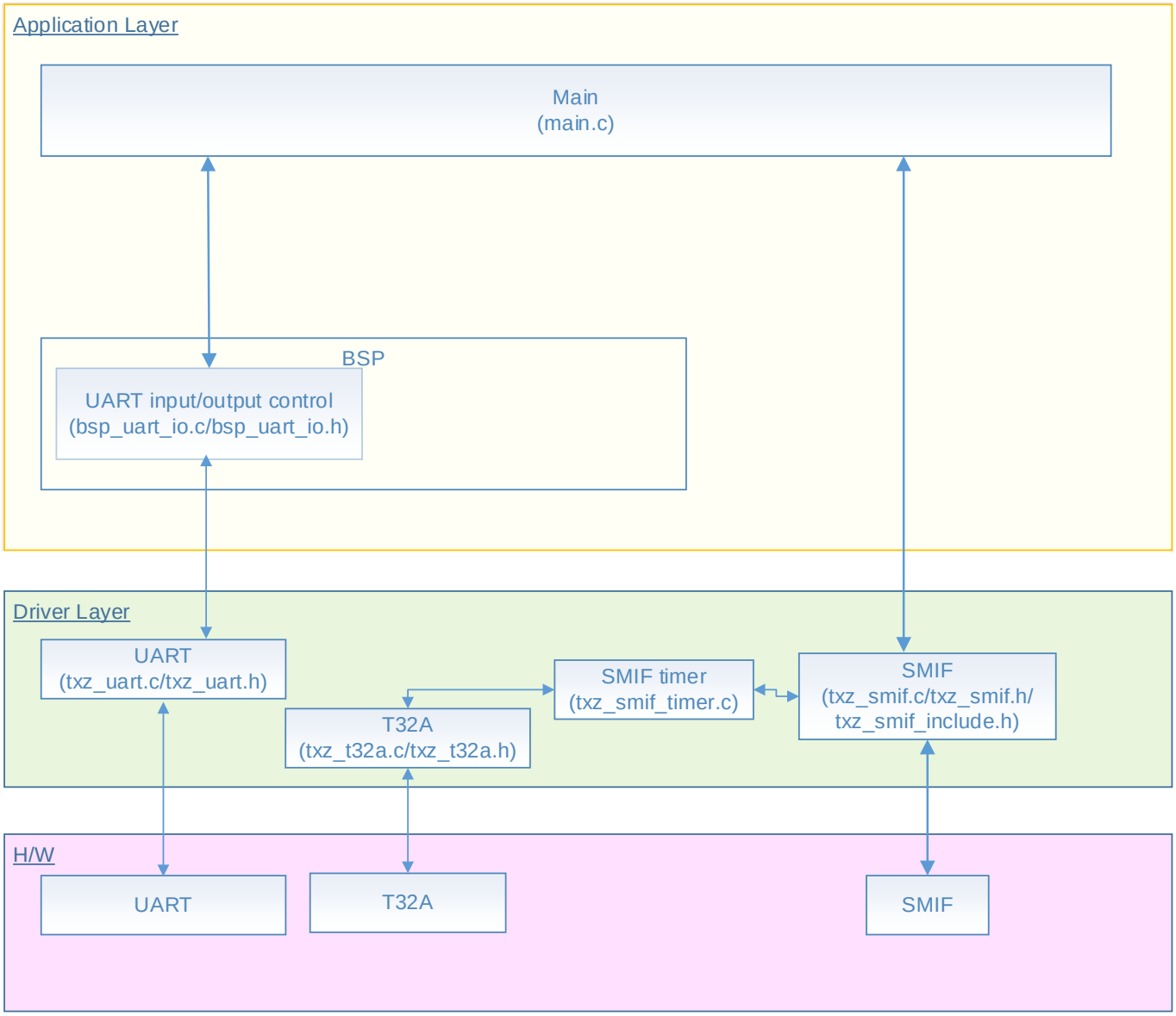
1. Preface

This sample program should be used to check the operation of the serial memory interface function.

Structure diagram of Sample program



2. Reference Document

- Datasheet
  TMPM4G Group (1) datasheet Rev1.0 (Japanese edition)
- Reference manual
  Serial Memory Interface (SMIF-A) Rev1.0 (Japanese edition)
  Asynchronous Serial Communication Circuit (UART-C) Rev3.0 (Japanese edition)
  32-bit Timer Event Counter (T32A-B) Rev2.1 (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
Serial Memory Interface	ch0	PK2 (SMI0D0)	Serial memory interface
		PK3 (SMI0D1)	
		PK4 (SMI0D2)	
		PK5 (SMI0D3)	
		PK6 (SMI0SLK)	
		PK7 (SMI0SC0_N)	
Asynchronous Serial Communication Circuit	ch0	PE2 (UT0RXD)	UART mode
		PE3 (UT0TXDA)	
32-bit Timer Event Counter	Timer A ch5	-	Interval timer

4. Target Device

The target devices of this application note are as follows;

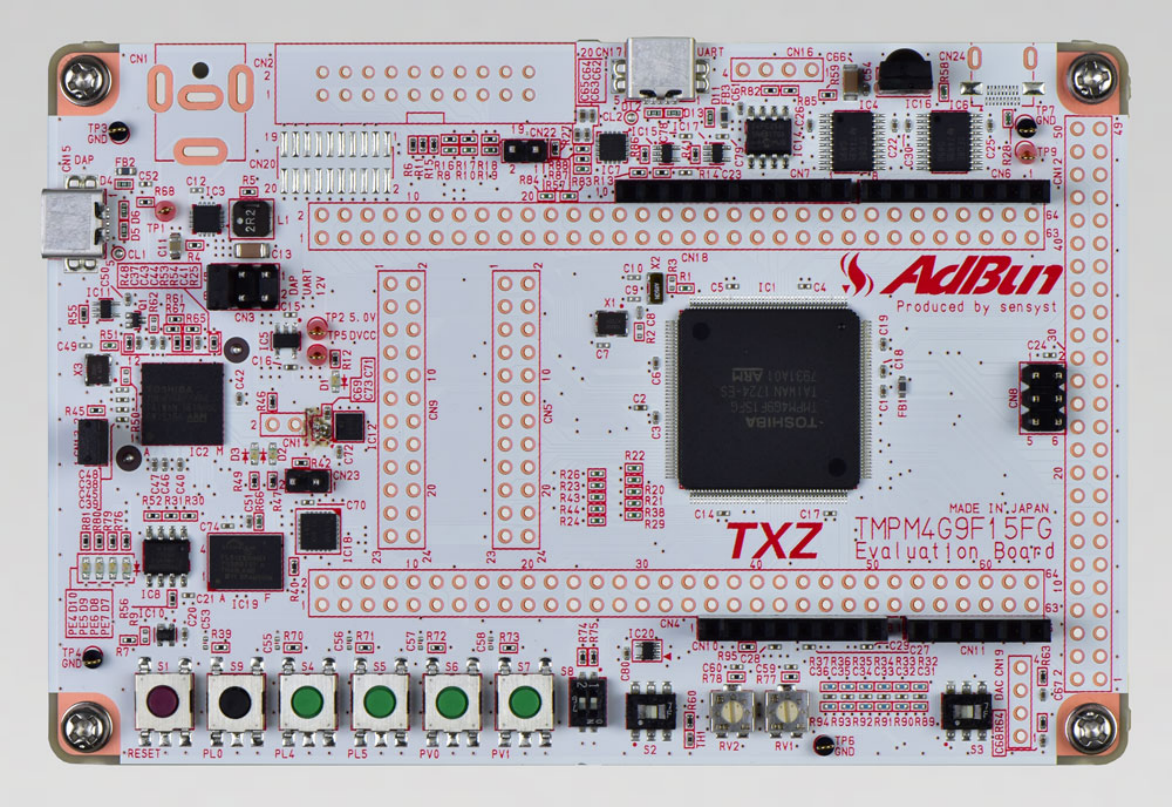
TMPM4G9F15FG	TMPM4G9F10FG	TMPM4G9FEFG	TMPM4G9FDFG
TMPM4G9F15XBG	TMPM4G9F10XBG	TMPM4G9FEXBG	TMPM4G9FDXBG
TMPM4G8F15FG	TMPM4G8F10FG	TMPM4G8FEFG	TMPM4G8FDFG
TMPM4G8F15XBG	TMPM4G8F10XBG	TMPM4G8FEXBG	TMPM4G8FDXBG
	TMPM4G7F10FG	TMPM4G7FEFG	TMPM4G7FDFG
	TMPM4G6F10FG	TMPM4G6FEFG	TMPM4G6FDFG

* 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

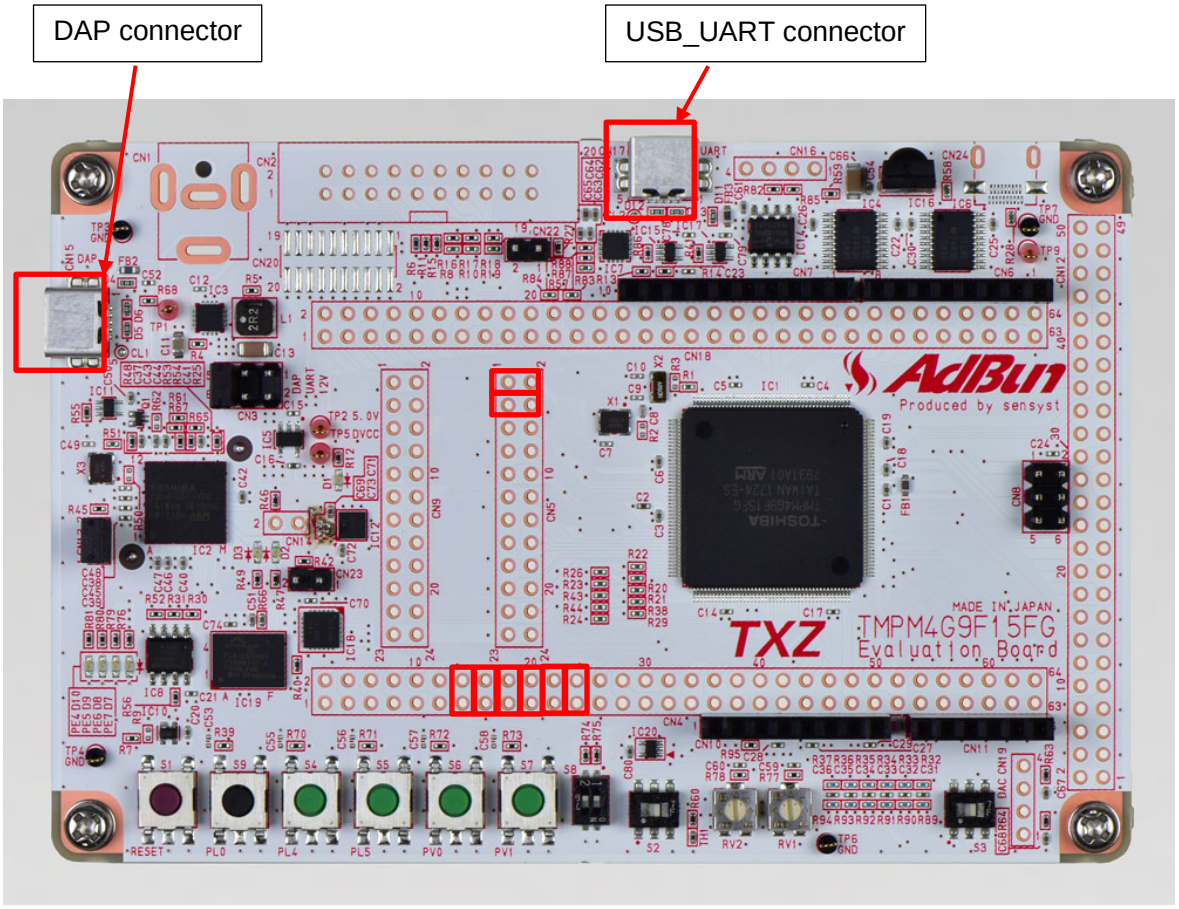


6. Evaluation Board Setting

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

CN4		
Board function	Through-hole No.	Through-hole No.
Serial interface	13: SMI_CS0	14: PK7
Serial interface	15: SMI_CLK	16: PK6
Serial interface	17: SMI_D3	18: PK5
Serial interface	19: SMI_D2	20: PK4
Serial interface	21: SMI_D1	22: PK3
Serial interface	23: SMI_D0	24: PK2

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.
Starts up the terminal software (Tera Term), then executes the communication setting on the PC.
The reset button should be pushed down on the evaluation board.
The communication starts according to an input command.
For the details of the operation of the command input, refer to the section “Sample Program Main Operation”.
(Note) CN23 is a jumper to switch the function between the SMIF and the SPI. It should be open when the SMIF function is evaluated.

8. Outline of Serial Memory Interface Function

The serial memory interface (SMIF) connects to the memory which has serial I/O's (SPI Flash memory and others).
The list of the functions of SMIF is shown in the following table.

Function category	Function	Description
Connection to a serial memory	Connection	- 2 serial memories at maximum can be connected.
	Memory capacity	- 64 KB to 16 MB
	Transfer clock	- 20 MHz at maximum
	Communication Mode	- SPI compatible: SPI Mode 0 support. Single I/O, Dual I/O read, and Quad I/O read are supported. - MSB first
	Memory mapping	- Mapping is possible to addresses: 0xA0000000 to 0xA0FFFFFF.
	Access mode	- Direct access - Program register access
	Command transfer count	- 264 bytes at maximum can be transferred through a register.
	Chip select	- Selection from Serial memory 0 and Serial memory 1. - Deassertion times of SMIxCS0_N and SMIxCS1_N can be set.
	Other functions	- Read after Write/Erase completion using the polling of the status of SPI Flash memory.

9. Sample Program

The sample program executes according to the command (“write” or “read”) which is input to the terminal software (Tera Term). The “write” command stores an input character to the SPI Flash ROM. And the “read” command reads data from the SPI Flash ROM and displays the data on the Tera Term.
The data input or output of the serial memory is controlled in the Quad mode.
The access mode is as follows;
write: Program register access
read: Direct access

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 procedure, the “main” function executes the following procedure;
1. Procedure mode (proc) is initialized.
2. The variables are initialized.
3. The BSP (Board support package) is initialized.
4. The driver is initialized.
5. The application initialization is done.

After the procedure above completes, the main operation is executed.
The data clear is done. The sample program waits for a command input.
On the terminal software, the “write” command and a character should be input.
A character string including the “write” command is checked. If one or more characters are input, the characters are stored to the SPI Flash ROM (address 0x00000000).
The characters stored in the SPI Flash ROM are displayed on the Tera Term as an echo back data.
When the “read” command is input, the data stored in the SPI Flash ROM (address 0x00000000) is read and is displayed on the Tera Term.
The “damp” command displays the write address and the write data.
The “bw” command writes are specified character to the address which is specified by the command.
The “br” command reads one byte data from a specified address and displays it.
The “erase” command erases the sector (256 KB) which is specified by the command.
The “bank” command specifies a bank in the memory.

This sample program uses S25FL512SDPBHI310 as the SPI Flash memory.

Command format:
“write” command
write␣X
X: Any character (16 characters or less)
“read” command
read
“damp” command
damp␣xxxxxx␣yyyy
xxxxxx: Start address (hexadecimal: 0 to FFFFFF)
yyyy: Display byte count (hexadecimal: 0 to FFFF)
When Start address and Display byte count are omitted, “damp 0 20” should be input.

The following commands are used to do extended operations.
“bw” command
bw␣xxxxxx␣Y xxxxxx: Address (0 to FFFFFF) and Y: Character (1 character)
The specified character is written to the address which is specified by the command.

“br” command
br␣xxxxxx xxxxxx: Address (0 to FFFFFF)
One byte data is read from the address which is specified by the command and is displayed.

“erase” command
erase␣xxxxxx xxxxxx: Address (0 to FFFFFF)
The sector (256 KB) which is specified by the command is erased.

“bank” command
bank␣x x: The bank is accessed.
If the “bank” command is input without the “x”, the current bank is displayed.

9.3. Output Example of Sample Program

When the sample program executes, the command results are displayed as shown in the following figures.

“write” command to write:

```
command > write toshiba
write data > toshiba
```

“read” command to read:

```
command > read
read data > toshiba
```

“damp” command to read:

```
command > damp
damp data >
0x00000000: 74 6F 73 68 69 62 61 00 FF FF FF FF FF FF FF FF
0x00000010: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
```

“bw” command:

```
command > bw 1000 a
0x1000 = a(0x61)
```

“br” command:

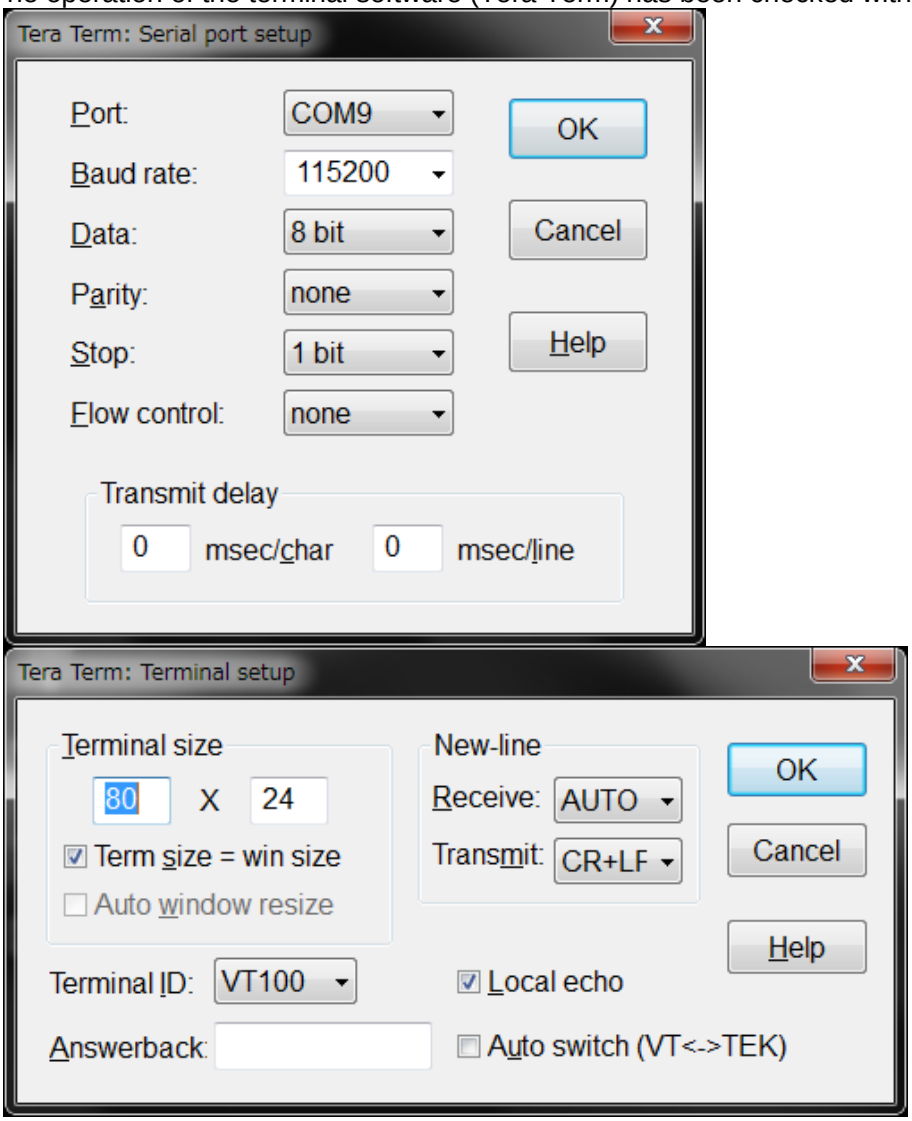
```
command > br 1000
byte read data >0x1000 = a(0x61)
```

“erase” command:

```
command > erase 0
erase data > erase:0x0
command > damp
damp data >
0x00000000: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0x00000010: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
```

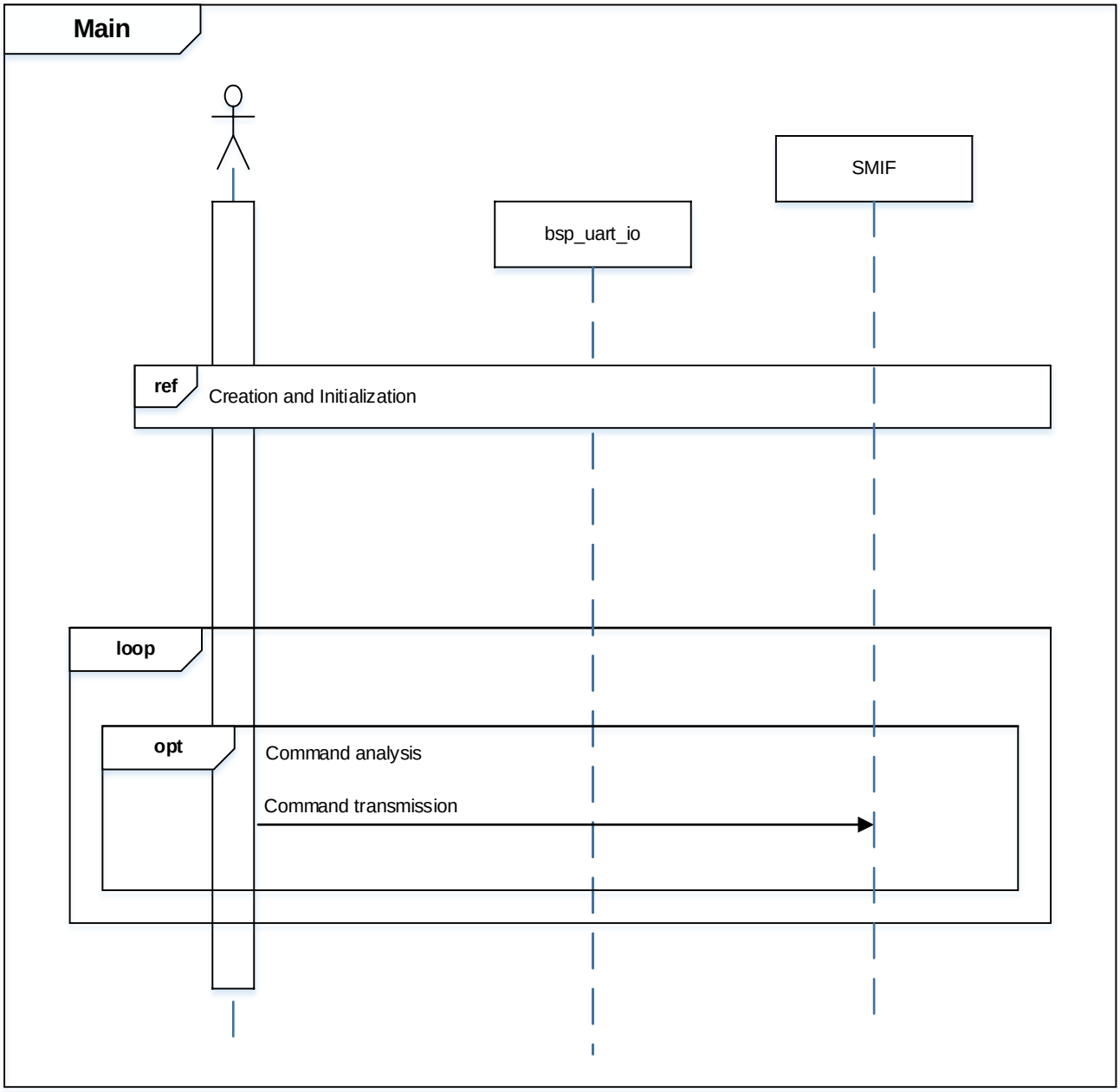
9.3.1. Setting Example of Terminal Software

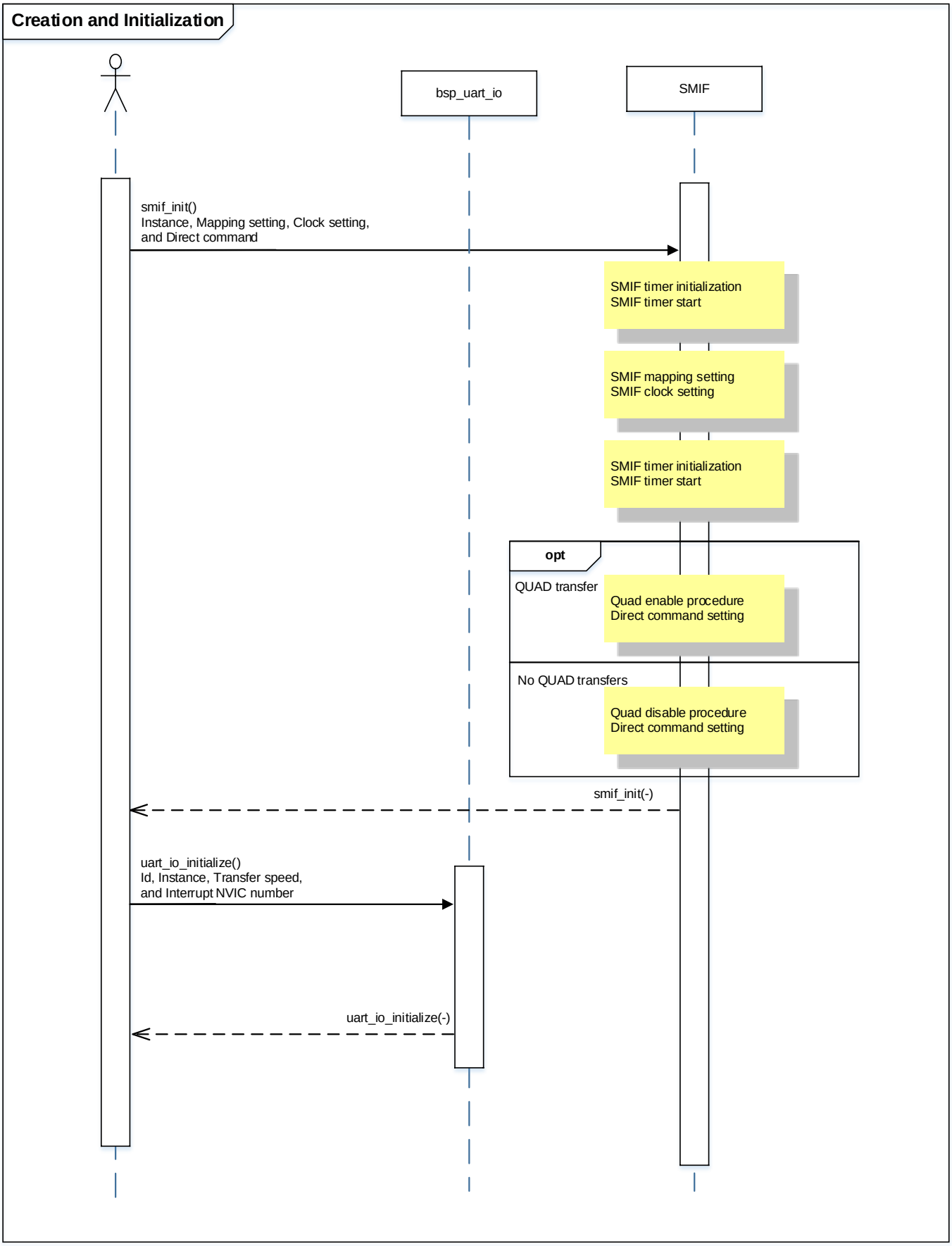
The operation of the terminal software (Tera Term) has been checked with the following settings.

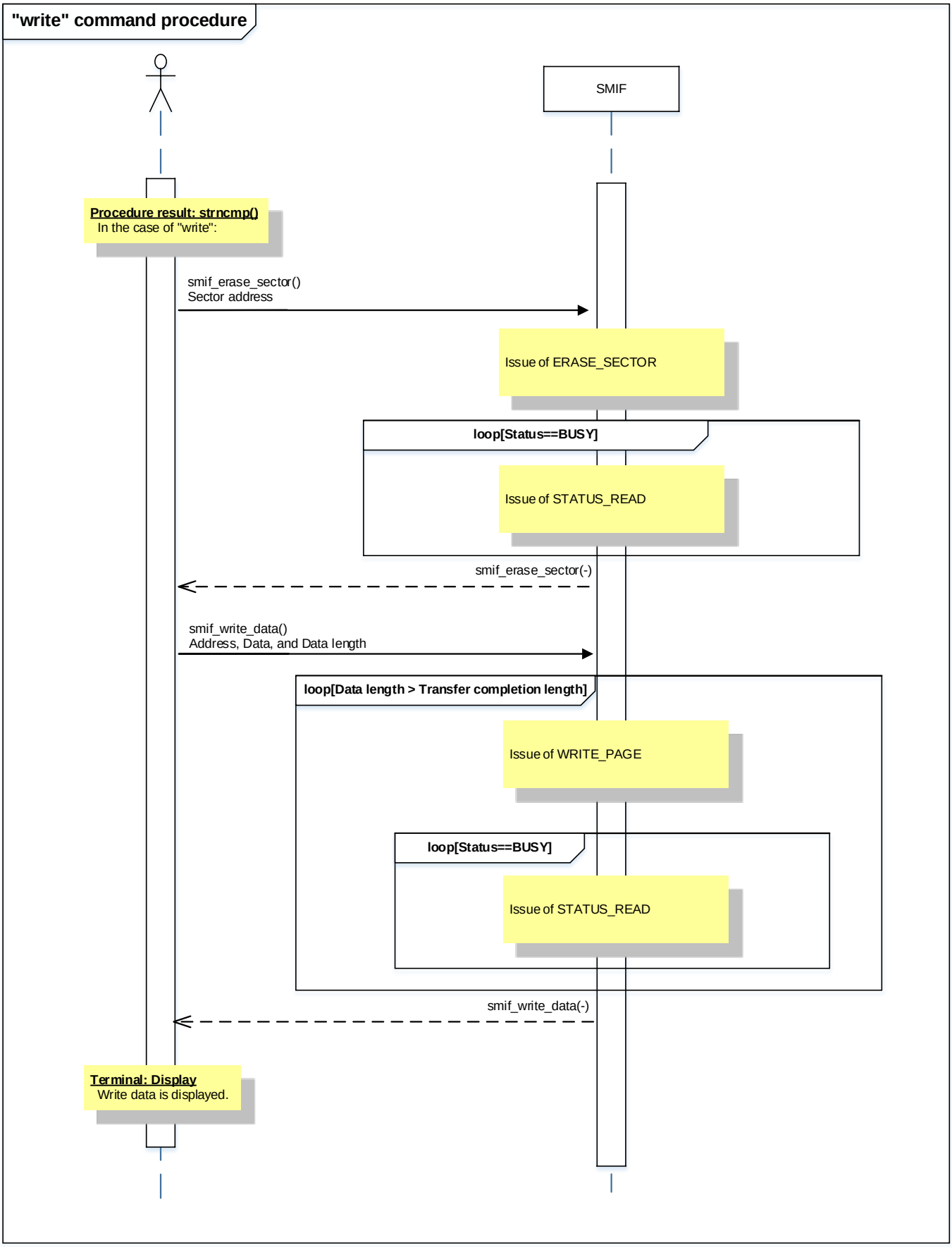


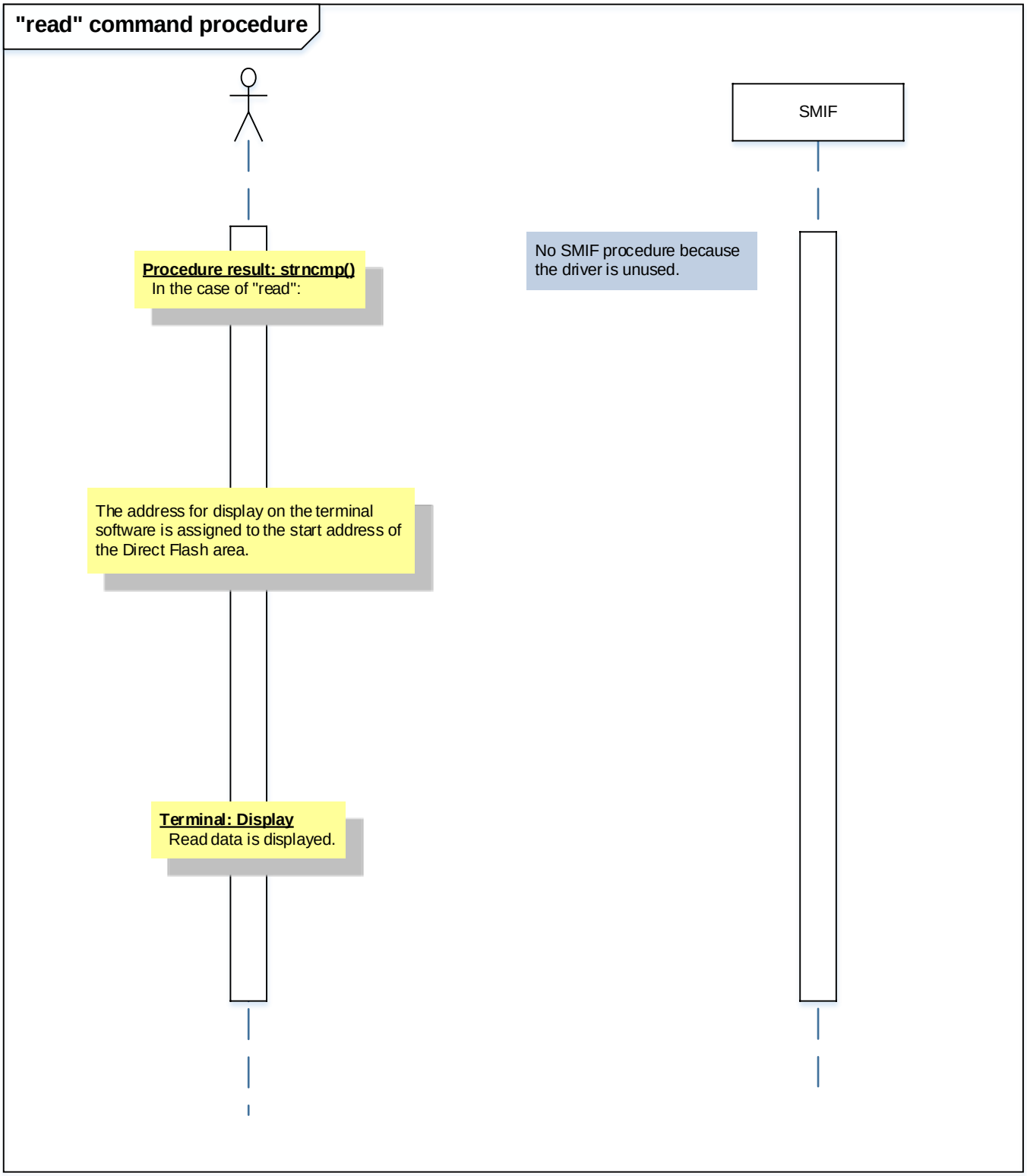
9.4. Operating Flow of Sample Program

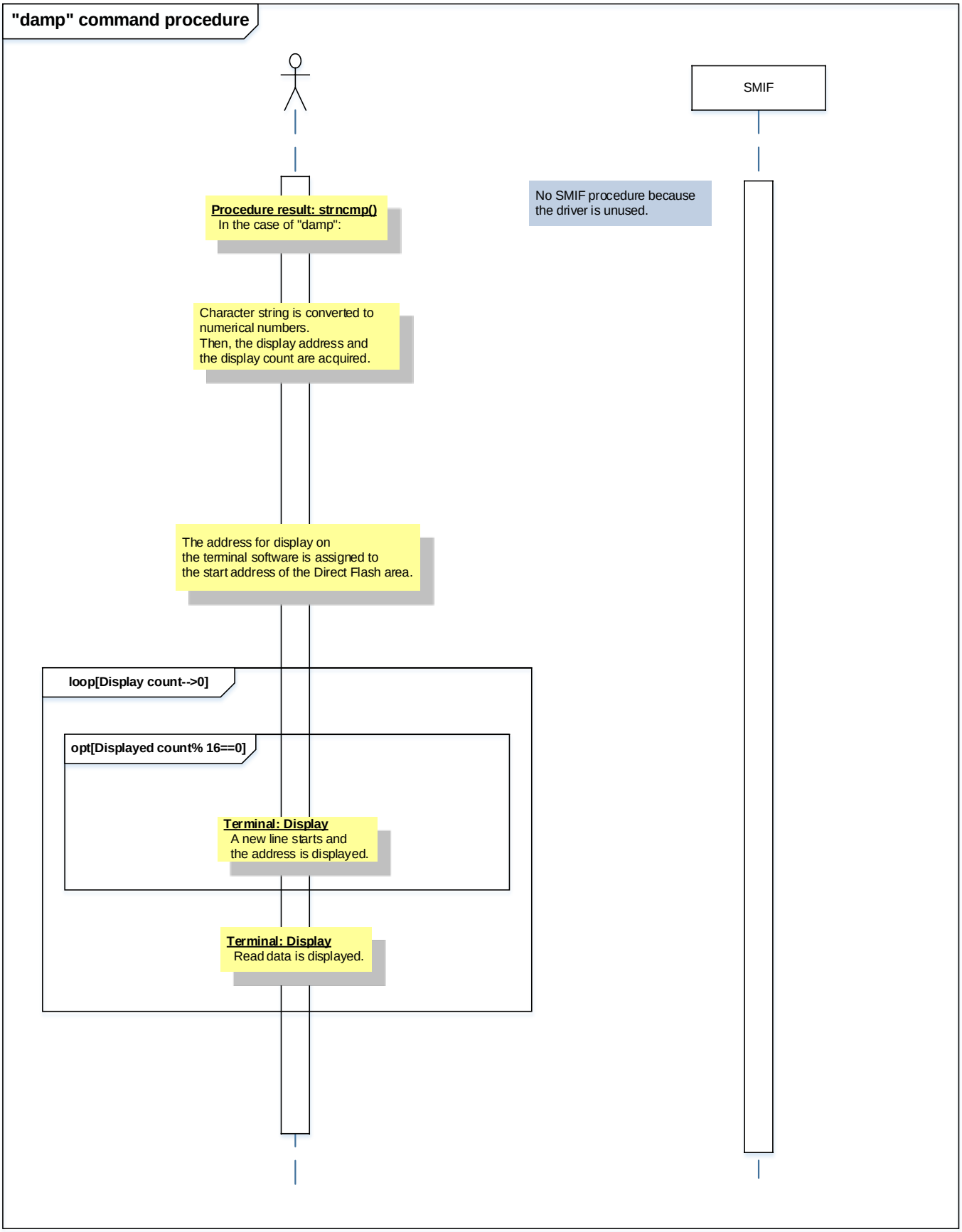
The basic operating flows of the sample program are shown in the following;




Creation and Initialization
bsp_uart_io
SMIF
smif_init()
Instance, Mapping setting, Clock setting,
and Direct command
SMIF timer initialization
SMIF timer start
SMIF mapping setting
SMIF clock setting
SMIF timer initialization
SMIF timer start
opt
QUAD transfer
Quad enable procedure
Direct command setting
No QUAD transfers
Quad disable procedure
Direct command setting
smif_init(-)
uart_io_initialize()
Id, Instance, Transfer speed,
and Interrupt NVIC number
uart_io_initialize(-)


"write" command procedure
SMIF
Procedure result: strncmp()
In the case of "write":
smif_erase_sector()
Sector address
Issue of ERASE_SECTOR
loop[Status==BUSY]
Issue of STATUS_READ
smif_erase_sector(-)
smif_write_data()
Address, Data, and Data length
loop[Data length > Transfer completion length]
Issue of WRITE_PAGE
loop[Status==BUSY]
Issue of STATUS_READ
smif_write_data(-)
Terminal: Display
Write data is displayed.


"read" command procedure
SMIF
No SMIF procedure because the driver is unused.
Procedure result: strncmp()
In the case of "read":
The address for display on the terminal software is assigned to the start address of the Direct Flash area.
Terminal: Display
Read data is displayed.


"damp" command procedure
SMIF
No SMIF procedure because the driver is unused.
Procedure result: strncmp()
In the case of "damp":
Character string is converted to numerical numbers.
Then, the display address and the display count are acquired.
The address for display on the terminal software is assigned to the start address of the Direct Flash area.
loop[Display count-->0]
opt[Displayed count% 16==0]
Terminal: Display
A new line starts and the address is displayed.
Terminal: Display
Read data is displayed.

10. Precaution

When using the sample program with CPU other than TMPM4G9F15, please check operation sufficiently.

11. Revision History

Rev	Date	page	Description
1.0	2018-12-20	-	First release

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