NEC

Application Note

78K0R/Kx3

16-bit Single-Chip Microcontrollers

Flash Memory Programming (Programmer)

μPD78F1142
μPD78F1143
μPD78F1144
μPD78F1145
μPD78F1146

μPD78F1152
μPD78F1153
μPD78F1154
μPD78F1155
μPD78F1156

μPD78F1162
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μPD78F1166
μPD78F1167
μPD78F1168

Document No. U18433EJ2V0AN00 (2nd edition)
Date Published April 2007 N

[MEMO]

NOTES FOR CMOS DEVICES

① VOLTAGE APPLICATION WAVEFORM AT INPUT PIN

Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (MAX) and V_{IH} (MIN) due to noise, etc., the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (MAX) and V_{IH} (MIN).

② HANDLING OF UNUSED INPUT PINS

Unconnected CMOS device inputs can be cause of malfunction. If an input pin is unconnected, it is possible that an internal input level may be generated due to noise, etc., causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using pull-up or pull-down circuitry. Each unused pin should be connected to V_{DD} or GND via a resistor if there is a possibility that it will be an output pin. All handling related to unused pins must be judged separately for each device and according to related specifications governing the device.

③ PRECAUTION AGAINST ESD

A strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it when it has occurred. Environmental control must be adequate. When it is dry, a humidifier should be used. It is recommended to avoid using insulators that easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors should be grounded. The operator should be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with mounted semiconductor devices.

④ STATUS BEFORE INITIALIZATION

Power-on does not necessarily define the initial status of a MOS device. Immediately after the power source is turned ON, devices with reset functions have not yet been initialized. Hence, power-on does not guarantee output pin levels, I/O settings or contents of registers. A device is not initialized until the reset signal is received. A reset operation must be executed immediately after power-on for devices with reset functions.

⑤ POWER ON/OFF SEQUENCE

In the case of a device that uses different power supplies for the internal operation and external interface, as a rule, switch on the external power supply after switching on the internal power supply. When switching the power supply off, as a rule, switch off the external power supply and then the internal power supply. Use of the reverse power on/off sequences may result in the application of an overvoltage to the internal elements of the device, causing malfunction and degradation of internal elements due to the passage of an abnormal current.

The correct power on/off sequence must be judged separately for each device and according to related specifications governing the device.

⑥ INPUT OF SIGNAL DURING POWER OFF STATE

Do not input signals or an I/O pull-up power supply while the device is not powered. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements.

Input of signals during the power off state must be judged separately for each device and according to related specifications governing the device.

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INTRODUCTION

Target Readers

This application note is intended for users who understand the functions of the 78K0R/Kx3 and who will use this product to design application systems.

Purpose

The purpose of this application note is to help users understand how to develop dedicated flash memory programmers for rewriting the internal flash memory of the 78K0R/Kx3.

The sample programs and circuit diagrams shown in this document are for reference only and are not intended for use in actual design-ins.

Therefore, these sample programs must be used at the user's own risk. Correct operation is not guaranteed if these sample programs are used.

Organization

This manual consists of the following main sections.

- Flash memory programming
- Programmer operating environment
- Basic programmer operation
- Command/data frame format
- Description of command processing
- UART communication mode
- Flash memory programming parameter characteristics

How to Read This Manual

It is assumed that the reader of this manual has general knowledge in the fields of electrical engineering, logic circuits, and microcontrollers.

- To gain a general understanding of functions:
  → Read this manual in the order of the **CONTENTS**.
- To learn more about the 78K0R/Kx3's hardware functions:
  → See the user's manual of each 78K0R/Kx3 product.

Conventions

Data significance:	Higher digits on the left and lower digits on the right
Active low representation:	$\overline{xxx}$ (overscore over pin or signal name)
Note:	Footnote for item marked with **Note** in the text
Caution:	Information requiring particular attention
Remark:	Supplementary information
Numeral representation:	Binary.....xxxx or xxxxB
	Decimal.....xxxx
	Hexadecimal .....xxxxH

CONTENTS

CHAPTER 1 FLASH MEMORY PROGRAMMING

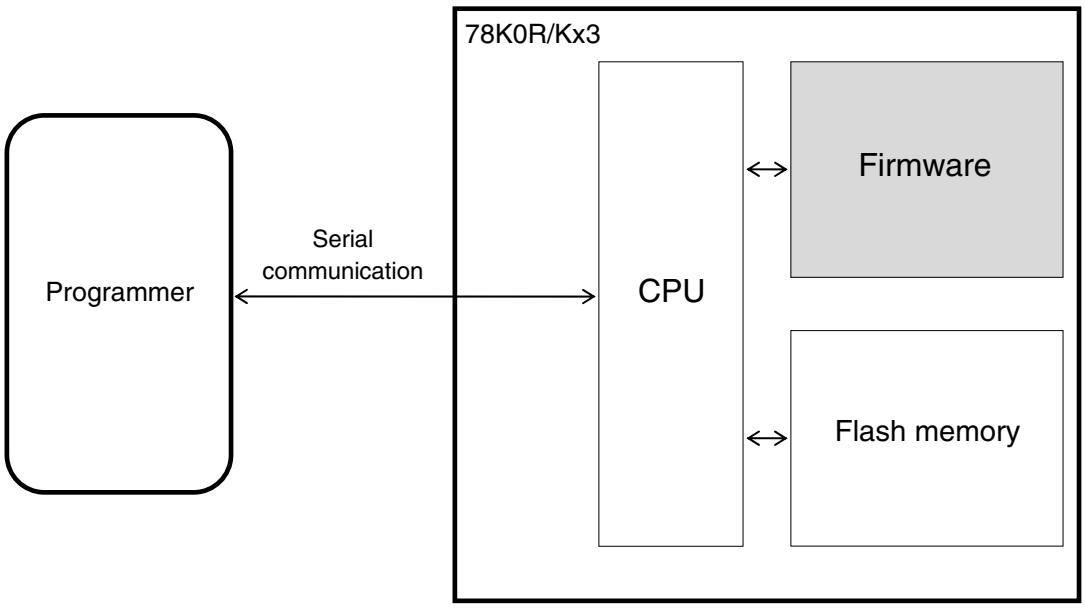
To rewrite the contents of the internal flash memory of the 78K0R/Kx3, a dedicated flash memory programmer (hereafter referred to as the “programmer”) is usually used.

This application note explains how to develop a dedicated programmer.

1.1 Overview

The 78K0R/Kx3 incorporates firmware that controls flash memory programming. The programming to the internal flash memory is performed by transmitting/receiving commands between the programmer and the 78K0R/Kx3 via serial communication.

Figure 1-1. System Outline of Flash Memory Programming in 78K0R/Kx3



1.2 System Configuration

Examples of the system configuration for programming the flash memory are illustrated in Figure 1-2.

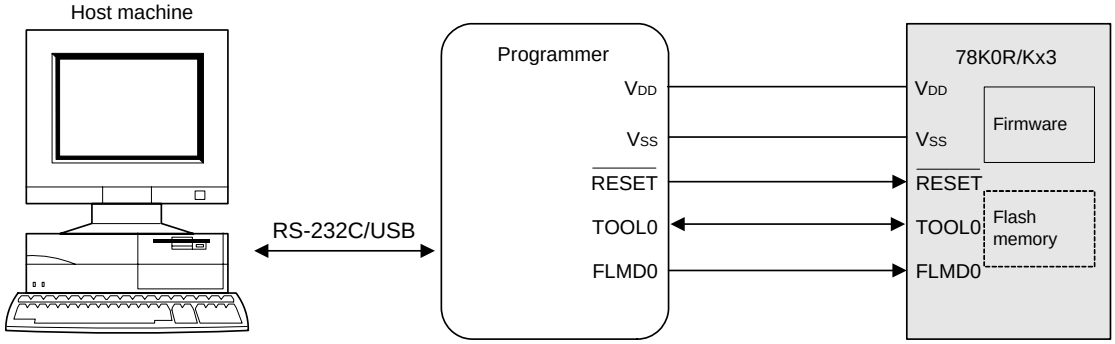
This figure illustrates how to program the flash memory with the programmer, under control of a host machine.

Depending on how the programmer is connected, the programmer can be used in a standalone mode without using the host machine, if a user program has been downloaded to the programmer in advance.

For example, NEC Electronics' flash memory programmer PG-FP4 can execute programming either by using the GUI software with a host machine connected or by itself (standalone).

Figure 1-2. System Configuration

Single-wire UART communication mode (LSB-first transfer)

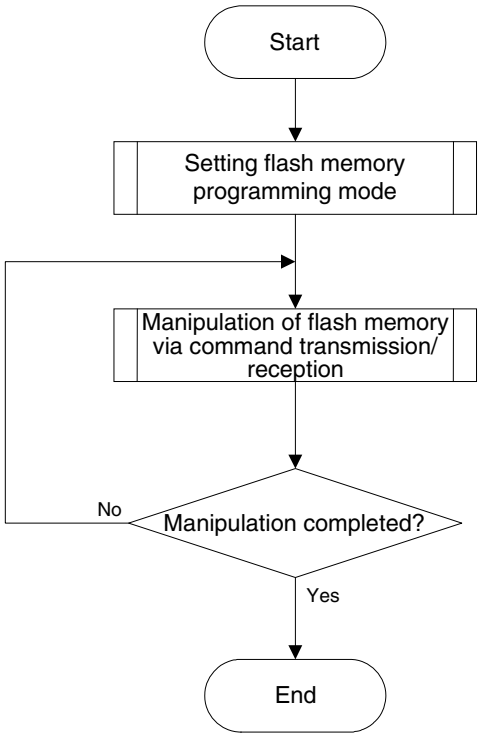


Remark The 78K0R/Kx3 can only communicate via the single-wire UART communication mode.

1.3 Programming Overview

To rewrite the contents of the flash memory with the programmer, the 78K0R/Kx3 must first be set to the flash memory programming mode. After that, transmit commands from the programmer via serial communication, and then rewrite the flash memory. The flowchart of programming is illustrated in Figure 1-3.

Figure 1-3. Programming Flowchart



1.3.1 Setting flash memory programming mode

Supply a specific voltage to the flash memory programming mode setting pin (FLMD0) in the 78K0R/Kx3 and release a reset; the flash memory programming mode is then set.

1.3.2 Manipulating flash memory via command transmission/reception

The flash memory incorporated in the 78K0R/Kx3 has functions to rewrite the flash memory contents. The flash memory manipulating functions shown in Table 1-1 are available.

Table 1-1. Outline of Flash Memory Functions

Function	Outline
Erase	Erases the flash memory contents.
Write	Writes data to the flash memory.
Verify	Compares the flash memory contents with data for verify.
Acquisition of information	Reads information related to the flash memory.

To control these functions, the programmer transmits commands to the 78K0R/Kx3 via serial communication. The 78K0R/Kx3 returns the response status for the commands. The programming to the flash memory is performed by repeating these series of serial communications.

1.4 Information Specific to 78K0R/Kx3

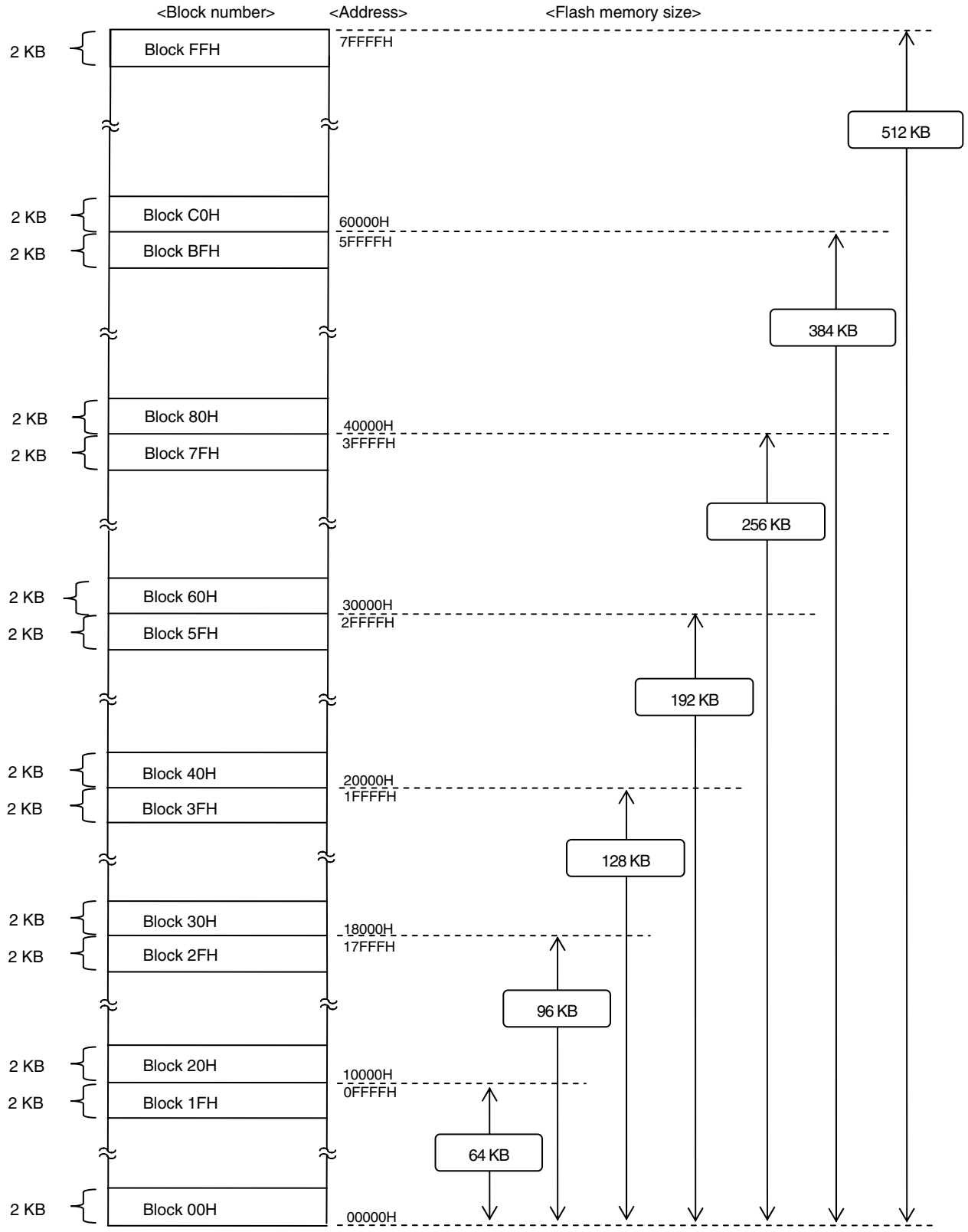
The programmer must manage product-specific information (such as a device name and memory information).

Table 1-2 shows the flash memory size of the 78K0R/Kx3 and Figure 1-4 shows the configuration of the flash memory.

Table 1-2. Flash Memory Size of 78K0R/Kx3

Device Name		Flash Memory Size
78K0R/KE3	μPD78F1142	64 KB
	μPD78F1143	96 KB
	μPD78F1144	128 KB
	μPD78F1145	192 KB
	μPD78F1146	256 KB
78K0R/KF3	μPD78F1152	64 KB
	μPD78F1153	96 KB
	μPD78F1154	128 KB
	μPD78F1155	192 KB
	μPD78F1156	256 KB
78K0R/KG3	μPD78F1162	64 KB
	μPD78F1163	96 KB
	μPD78F1164	128 KB
	μPD78F1165	192 KB
	μPD78F1166	256 KB
	μPD78F1167	384 KB
	μPD78F1168	512 KB

Figure 1-4. Flash Memory Configuration



Remark Each block consists of 2 KB (this figure only illustrates some parts of entire blocks in the flash memory).

CHAPTER 2 PROGRAMMER OPERATING ENVIRONMENT

2.1 Programmer Control Pins

Table 2-1 lists the pins that the programmer must control to implement the programmer function in the user system. See the following pages for details on each pin.

Table 2-1. Pin Description

Programmer			78K0R/Kx3	Procedure When Connecting
Signal Name	I/O	Pin Function	Pin Name	
FLMD0	Output	Mode signal	FLMD0	√
V_{DD}	I/O	V_{DD} voltage generation/monitoring	V_{DD} $EV_{DD\ (0/1)}$ $AV_{REF\ (0/1)}$ Note	√
GND	–	Ground	V_{SS} $EV_{SS\ (0/1)}$ AV_{SS}	√
CLK	Output	Clock output	–	×
/RESET	Output	Reset signal	$\overline{RESET}$	√
SI/RxD	Input	Receive signal	TOOL0	√
SO/TxD	Output	Transmit signal		
SCK	Output	Transfer clock	–	×

Note When performing off-board write operation, connect this pin to V_{DD}.
When performing on-board write operation, supply the same power as in normal operation mode. (At this time, make sure to set so that $V_{DD} \geq AV_{REF(0/1)}$.)

Remark √: Be sure to connect the pin.
×: The pin does not have to be connected.

For the voltage of the pins controlled by the programmer, refer to the user's manual of the device that is subject to flash memory programming.

2.2 Details of Control Pins

2.2.1 Flash memory programming mode setting pin (FLMD0)

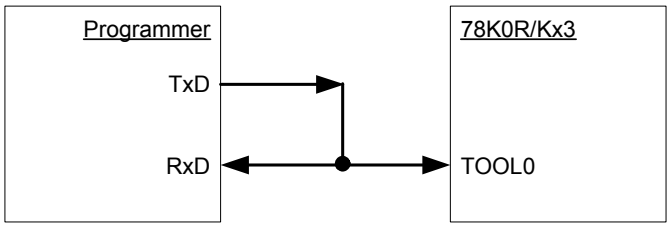
The FLMD0 pin is used to control the operating mode of the 78K0R/Kx3. The 78K0R/Kx3 operates in flash memory programming mode when a specific voltage is supplied to this pin and a reset is released.

2.2.2 Serial interface pin (TOOL0)

The serial interface pin is used to transfer the flash memory writing commands between the programmer and the 78K0R/Kx3.

The following figure illustrates the connection of pins used.

Figure 2-1. Serial Interface Pin

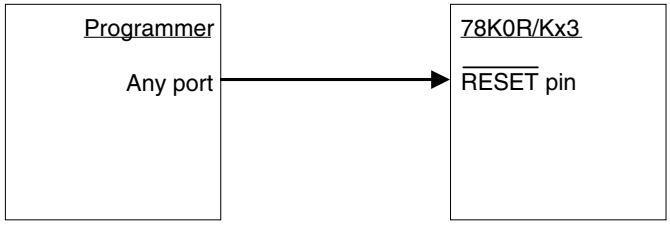


Single-wire UART communication

2.2.3 Reset control pin ($\overline{\text{RESET}}$)

The reset control pin ($\overline{\text{RESET}}$ pin) is used to control the system reset for the 78K0R/Kx3 from the programmer. The flash memory programming mode can be selected when a specific voltage is supplied to the FLMD0 pin and a reset is released.

Figure 2-2. $\overline{\text{RESET}}$ Pin

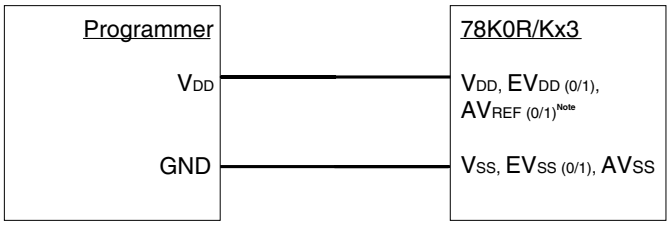


2.2.4 V_{DD}/GND control pins

The V_{DD} control pin is used to supply power to the 78K0R/Kx3 from the programmer. Connection of this pin is not necessary when it is not necessary to supply power to the 78K0R/Kx3 from the programmer. However, this pin must be connected regardless of whether the power is supplied from the programmer when the dedicated programmer is used, because the dedicated programmer monitors the power supply status of the 78K0R/Kx3.

The GND control pin must be connected to V_{SS} of the 78K0R/Kx3 regardless of whether the power is supplied from the programmer.

Figure 2-3. V_{DD}/GND Control Pin



Note When performing off-board write operation, connect this pin to V_{DD}.
When performing on-board write operation, supply the same power as in normal operation mode. (At this time, make sure to set so that $V_{DD} \geq AV_{REF(0/1)}$.)

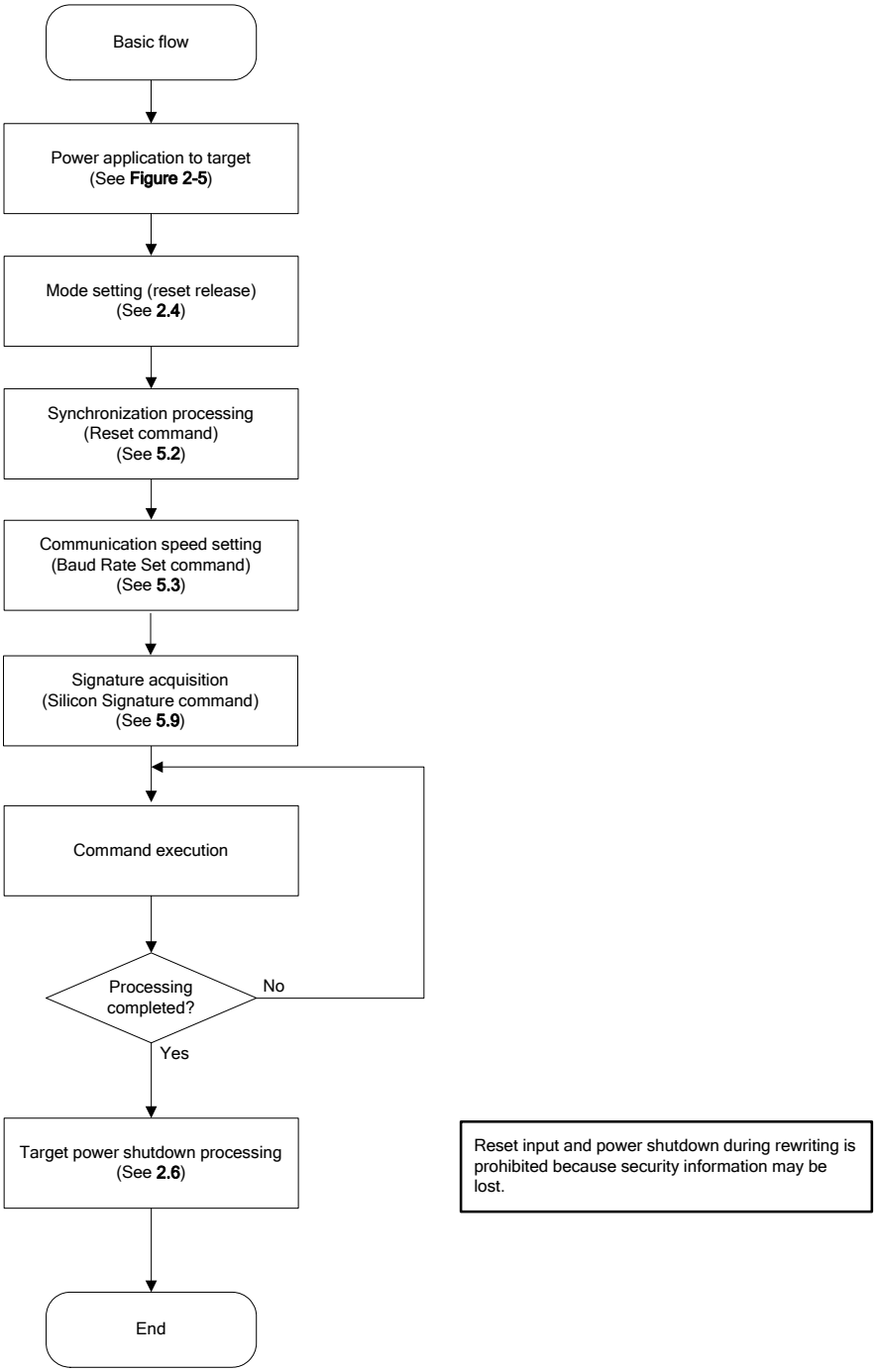
2.2.5 Other pins

For the connection of the pins that are not connected to the programmer, refer to the chapter describing the flash memory in the user's manual of each device.

2.3 Basic Flowchart

The following illustrates the basic flowchart for performing flash memory rewriting with the programmer.

Figure 2-4. Basic Flowchart for Flash Memory Rewrite Processing

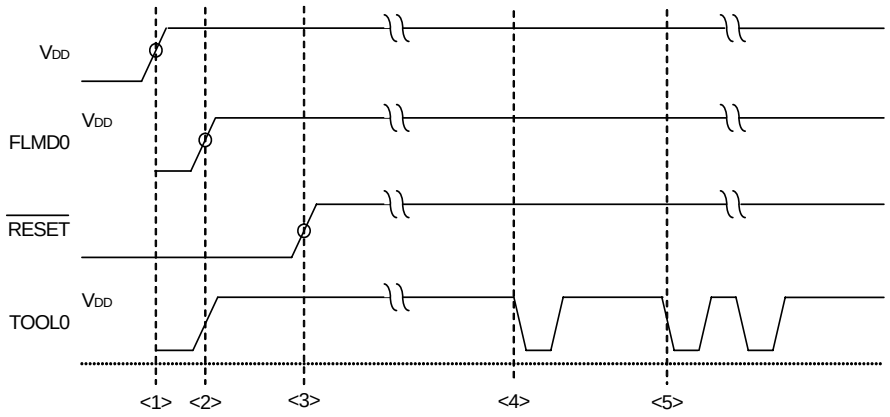


2.4 Setting Flash Memory Programming Mode

To rewrite the contents of the flash memory with the programmer, the 78K0R/Kx3 must first be set to the flash memory programming mode by supplying a specific voltage to the flash memory programming mode setting pin (FLMD0) in the 78K0R/Kx3, then releasing a reset.

The following illustrates a timing chart for setting the flash memory programming mode.

Figure 2-5. Setting Flash Memory Programming Mode



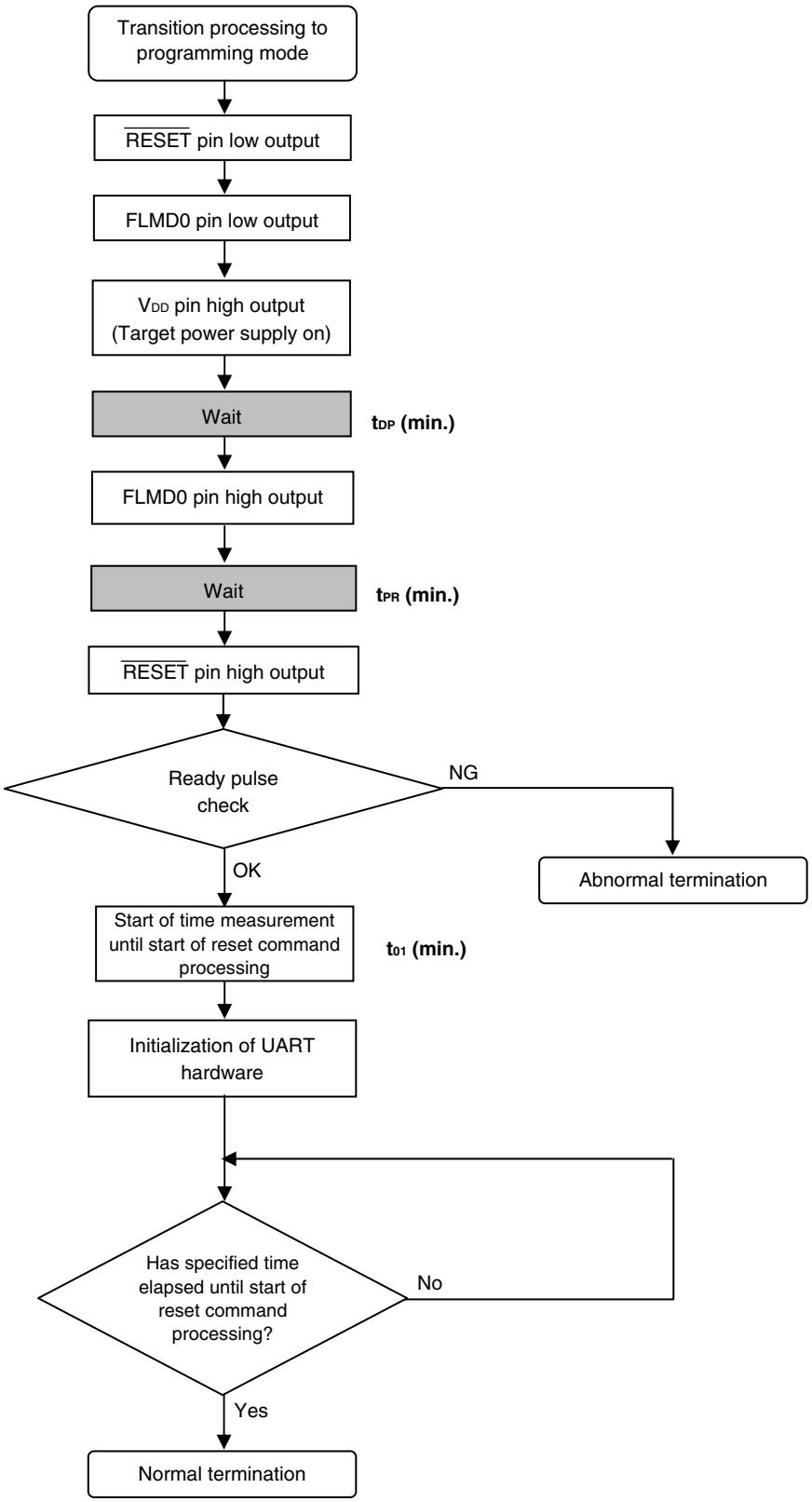
<1>: Power application (V_{DD})
<2>: FLMD0 = high level
<3>: Reset release (serial programming mode setting)
<4>: READY pulse (“00”@9600 bps) input start (78K0R/Kx3 → programmer)
<5>: LOW pulse (“00”@9600 bps) output start (programmer → 78K0R/Kx3)

The relationship between the setting of the FLMD0 pin after reset release and the operating mode is shown below.

Table 2-2. Relationship Between FLMD0 Pin Setting After Reset Release and Operating Mode

FLMD0	Operating Mode
Low (GND)	Normal operating mode
High (V_{DD})	Flash memory programming mode

2.4.1 Mode setting flowchart



2.4.2 Sample program

The following shows a sample program for mode setting processing.

```
/*************************************************************/
/*                                                           */
/* connect to Flash device                                   */
/*                                                           */
/*************************************************************/
u16     fl_con_dev(void)
{
extern  void   init_fl_uart(void);
extern  void   init_fl_csi(void);
extern  void   stop_UART0(void);

  u16    rc = NO_ERROR;

  SRMK0 = true;              // disable UART Rx INT.
  UARTE0 = false;            // disable UART H.W.
  stop_UART0();              // TxD/RxD = Hi-Z

  pFL_RES       = low;       // RESET = low
  pmFL_FLMD0    = PM_OUT;    // FLMD0 = Low output
  pFL_FLMD0     = low;
  FL_VDD_HI();               // VDD = high

  fl_wait(tDP);              // wait

  pFL_FLMD0     = hi;        // FLMD0 = high
  fl_wait(tPR);              // wait

  pFL_RES       = hi;        // RESET = high

  rc = check_ready_pulse();  // check "READY PULSE" from target device
  if (rc){
        return rc;           // pulse width/timing error
  }
  start_flto(t01);           // start "t01" wait timer

  init_fl_uart();            // Initialize UART h.w.(for Flash device control)
  UARTE0 = true;             // enable UART h.w.
  SRIF0 = false;             // clear UART Rx IRQ flag
  SRMK0 = false;             // enable UART Rx INT.

  while(!check_flto())       // timeout "t01" ?
        ;                    // no

  return rc;
  // start RESET command proc.
}
```

2.5 Single-Wire UART Communication Mode

The TOOL0 pin of the 78K0R/Kx3 is used for single-wire UART communication. The communication conditions are as shown below.

Table 2-3. Single-Wire UART Communication Conditions

Item	Description
Baud rate	Communication is performed at 9,600 bps until the Baud Rate Set command for baud rate setting command processing is transmitted. The transmission rate is changed to the baud rate set by the Baud Rate Set command from the transmission of the Reset command for baud rate command processing. For details of the settable baud rate, refer to **5.3 Baud Rate Set Command**.
Parity bit	None
Data length	8 bits (LSB first)
Stop bit	2 bits (programmer → 78K0R/Kx3)/1 bit (78K0R/Kx3 → programmer)

Caution Set the same baud rate to the programmer and 78K0R/Kx3.

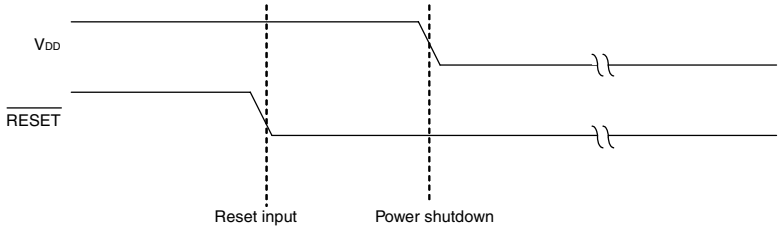
2.6 Shutting Down Target Power Supply

After each command execution is completed, shut down the power supply to the target after setting the $\overline{\text{RESET}}$ pin to low level, as shown below.

Set other pins to Hi-Z when shutting down the power supply to the target.

Caution Shutting down the power supply and inputting a reset during command processing are prohibited.

Figure 2-6. Timing for Terminating Flash Memory Programming Mode



2.7 Manipulation of Flash Memory

The flash memory incorporated in the 78K0R/Kx3 has functions to manipulate the flash memory, as listed in Table 2-4. The programmer transmits commands to control these functions to the 78K0R/Kx3, and checks the response status sent from the 78K0R/Kx3, to manipulate the flash memory.

Table 2-4. List of Flash Memory Manipulating Functions

Classification	Function Name	Description
Erase	Chip erase	Erases the entire flash memory area. Clears the security flag.
	Block erase	Erases a specified block in the flash memory.
Write	Write	Writes data to a specified area in the flash memory.
Verify	Verify	Compares data acquired from a specified address in the flash memory with data transmitted from the programmer, on the 78K0R/Kx3 side.
Blank check	Block blank check	Checks the erase status of a specified area in the flash memory.
Information acquisition	Silicon signature acquisition	Acquires writing protocol information.
	Version acquisition	Acquires version information of the 78K0R/Kx3 and firmware.
	Checksum acquisition	Acquires checksum data of a specified area.
Security	Security setting	Sets security information.
Other	Reset	Detects synchronization in communication.

2.8 Command List

The commands used by the programmer and their functions are listed below.

Table 2-5. List of Commands Transmitted from Programmer to 78K0R/Kx3

Command Number	Command Name	Function
00H	Reset	Detects synchronization in communication.
9AH	Baud Rate Set	Sets the baud rate for single-wire UART.
20H	Chip Erase	Erases the entire flash memory area.
22H	Block Erase	Erases a specified area in the flash memory.
40H	Programming	Writes data to a specified area in the flash memory.
13H	Verify	Compares the contents in a specified area in the flash memory with data transmitted from the programmer.
32H	Block Blank Check	Checks the erase status of a specified block in the flash memory.
C0H	Silicon Signature	Acquires 78K0R/Kx3 information (part number, flash memory configuration, etc.).
C5H	Version Get	Acquires version information of the 78K0R/Kx3 and firmware.
B0H	Checksum	Acquires checksum data of a specified area.
A0H	Security Set	Sets security information.

2.9 Status List

The following table lists the status codes the programmer receives from the 78K0R/Kx3.

Table 2-6. Status Code List

Status Code	Status	Description
04H	Command number error	Error returned if a command not supported is received
05H	Parameter error	Error returned if command information (parameter) is invalid
06H	Normal acknowledgment (ACK)	Normal acknowledgment
07H	Checksum error	Error returned if data in a frame transmitted from the programmer is abnormal
0FH	Verify error	Error returned if a verify error has occurred upon verifying data transmitted from the programmer
10H	Protect error	Error returned if an attempt is made to execute processing that is prohibited by the Security Set command
15H	Negative acknowledgment (NACK)	Negative acknowledgment
1AH	MRG10 error	Erase verify error
1BH	MRG11 error	Internal verify error or blank check error during data write
1CH	Write error	Write error
FFH	Processing in progress (BUSY)	Busy response[Note]

Note During CSI communication, 1-byte “FFH” may be transmitted, as well as “FFH” as the data frame format.

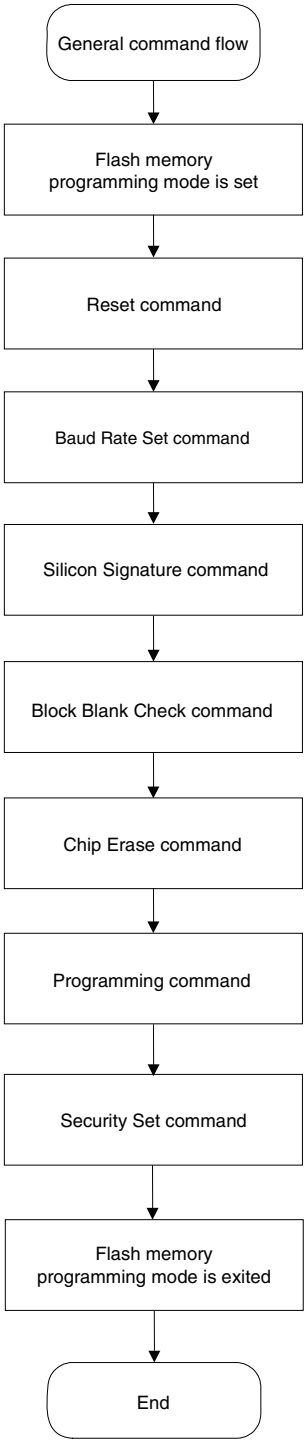
Reception of a checksum error or NACK is treated as an immediate abnormal end in this manual. When a dedicated programmer is developed, however, the processing may be retried without problem from the wait immediately before transmission of the command that results a checksum error or NACK. In this event, limiting the retry count is recommended for preventing infinite repetition of the retry operation.

Although not listed in the above table, if a time-out error (BUSY time-out or time-out in data frame reception during UART communication) occurs, it is recommended to shutdown the power supply to the 78K0R/Kx3 (refer to **2.6 Shutting Down Target Power Supply**) and then connect the power supply again.

CHAPTER 3 BASIC PROGRAMMER OPERATION

Figure 3-1 illustrates the general command execution flow when flash memory rewriting is performed with the programmer.

Figure 3-1. General Command Execution Flow at Flash Memory Rewriting



Remark The Verify command and Checksum command can also be supported.

CHAPTER 4 COMMAND/DATA FRAME FORMAT

The programmer uses the command frame to transmit commands to the 78K0R/Kx3. The 78K0R/Kx3 uses the data frame to transmit write data or verify data to the programmer. A header, footer, data length information, and checksum are appended to each frame to enhance the reliability of the transferred data.

The following shows the format of a command frame and data frame.

Figure 4-1. Command Frame Format

SOH (1 byte)	LEN (1 byte)	COM (1 byte)	Command information (variable length) (Max. 255 bytes)	SUM (1 byte)	ETX (1 byte)

Figure 4-2. Data Frame Format

STX (1 byte)	LEN (1 byte)	Data (variable length) (Max. 256 bytes)	SUM (1 byte)	ETX or ETB (1 byte)

Table 4-1. Description of Symbols in Each Frame

Symbol	Value	Description
SOH	01H	Command frame header
STX	02H	Data frame header
LEN	–	Data length information (00H indicates 256). Command frame: COM + command information length Data frame: Data field length
COM	–	Command number
SUM	–	Checksum data for a frame Obtained by sequentially subtracting all of calculation target data from the initial value (00H) in 1-byte units (borrow is ignored). The calculation targets are as follows. Command frame: LEN + COM + all of command information Data frame: LEN + all of data
ETB	17H	Footer of data frame other than the last frame
ETX	03H	Command frame footer, or footer of last data frame

The following shows examples of calculating the checksum (SUM) for a frame.

[Command frame]

No command information is included in the following example of a Status command frame, so LEN and COM are targets of checksum calculation.

SOH	LEN	COM	SUM	ETX
01H	01H	70H	Checksum	03H
	Checksum calculation targets			

For this command frame, checksum data is obtained as follows.

00H (initial value) – 01H (LEN) – 70H (COM) = 8FH (Borrow ignored. Lower 8 bits only.)

The command frame finally transmitted is as follows.

SOH	LEN	COM	SUM	ETX
01H	01H	70H	8FH	03H

[Data frame]

To transmit a data frame as shown below, LEN and D1 to D4 are targets of checksum calculation.

STX	LEN	D1	D2	D3	D4	SUM	ETX
02H	04H	FFH	80H	40H	22H	Checksum	03H
	checksum calculation targets						

For this data frame, checksum data is obtained as follows.

00H (initial value) – 04H (LEN) – FFH (D1) – 80H (D2) – 40H (D3) – 22H (D4)
= 1BH (Borrow ignored. Lower 8 bits only.)

The data frame finally transmitted is as follows.

STX	LEN	D1	D2	D3	D4	SUM	ETX
02H	04H	FFH	80H	40H	22H	1BH	03H

When a data frame is received, the checksum data is calculated in the same manner, and the obtained value is used to detect a checksum error by judging whether the value is the same as that stored in the SUM field of the receive data. When a data frame as shown below is received, for example, a checksum error is detected.

STX	LEN	D1	D2	D3	D4	SUM	ETX
02H	04H	FFH	80H	40H	22H	1AH	03H

↑ Should be 1BH, if normal

4.1 Command Frame Transmission Processing

For details of the flowchart of processing to transmit command frames, read **6.1 Command Frame Transmission Processing Flowchart**.

4.2 Data Frame Transmission Processing

The write data frame (user program), verify data frame (user program), and security data frame (security flag) are transmitted as a data frame.

For details of the flowchart of processing to transmit data frames, read **6.2 Data Frame Transmission Processing Flowchart**.

4.3 Data Frame Reception Processing

The status frame, silicon signature data frame, version data frame, and checksum data frame are received as a data frame.

For details of the flowchart of processing to receive data frames, read **6.3 Data Frame Reception Processing Flowchart**.

CHAPTER 5 DESCRIPTION OF COMMAND PROCESSING

5.1 Status Command

5.1.1 Description

The 78K0R/Kx3 automatically transmits a status frame within a given period of time to report its operation status after issuing various commands, such as write or erase.

After the programmer has issued each command, if the Status command frame cannot be received normally by the 78K0R/Kx3 due to problems based on communication or the like, the status setting will not be performed with the 78K0R/Kx3. As a result, a busy response (FFH), not the status frame, may be received. In such a case, retry each command.

5.1.2 Status frame

Figure 5-1 shows the status frame corresponding to each command.

Figure 5-1. Status Frame for Status Command (from 78K0R/Kx3 to Programmer)

STX	LEN	Data			SUM	ETX
02H	n	ST1	…	STn	Checksum	03H

Remarks 1. ST1 to STn: Status #1 to Status #n

2. The length of a status frame varies according to each command (such as write or erase) to be transmitted to the 78K0R/Kx3.

5.2 Reset Command

5.2.1 Description

This command is used to check the establishment of communication between the programmer and the 78K0R/Kx3 after the communication mode is set.

The same baud rate must be set for the programmer and 78K0R/Kx3, however, the 78K0R/Kx3 cannot detect its own baud rate generation clock frequency so the baud rate cannot be set. The 78K0R/Kx3 is enabled to detect the baud rate generation clock frequency by itself, when “00H” is transmitted twice at 9,600 bps from the programmer, and the 78K0R/Kx3 measures the low-level width of “00H” and calculates the average of the two sent signals. The baud rate can consequently be set, which enables synchronous detection in communication.

5.2.2 Command frame and status frame

Figure 5-2 shows the format of a command frame for the Reset command, and Figure 5-3 shows the status frame for the command.

Figure 5-2. Reset Command Frame (from Programmer to 78K0R/Kx3)

SOH	LEN	COM	SUM	ETX
01H	01H	00H (Reset)	Checksum	03H

Figure 5-3. Status Frame for Reset Command (from 78K0R/Kx3 to Programmer)

STX	LEN	Data	SUM	ETX
02H	1	ST1	Checksum	03H

Remark ST1: Synchronization detection result

Read **6.4 Reset Command** for details on the flowchart of the processing sequence between the programmer and the 78K0R/Kx3, the flowchart of command processing, and the sample program.

5.3 Baud Rate Set Command

5.3.1 Description

This command is used to change the baud rate for UART communication (9,600 bps by default).

After the Baud Rate Set command has been executed, the Reset command must be executed to check synchronization at the changed baud rate.

The baud rate setting data is represented in 1-byte values.

5.3.2 Command frame and status frame

Figure 5-4 shows the format of a command frame for the Baud Rate Set command, and Figure 5-5 shows the status frame for the command.

Figure 5-4. Baud Rate Set Command Frame (from Programmer to 78K0R/Kx3)

SOH	LEN	COM	Command Information[Note]				SUM	ETX
01H	05H	9AH	D01	D02H	D02L	D03	sum	03H

Note For details of the command information setting, refer to **Table 5-1**. If data other than in Table 5-1 is set, a time-out error will occur.
If a time-out error has occurred, execute a hardware reset and re-set the flash memory programming mode.

Remark D01: Synchronization correction mode
D02H, D02L: Baud rate setting
D03: Noise filter setting

Table 5-1. Command Information Setting

Synchronization Correction Mode	D01	D02H	D02L	D03
Microcontroller correction mode	00H	Fixed to 00H	Fixed to 0AH (115,200 bps)	Noise filter 00H: Off 01H: On
Programmer correction mode	01H	**Note**	**Note**	

Note Substitute the k value calculated by the expression below for D02H/D02L in hexadecimal. Make sure that the k value is greater than 0003H.
$k = (8 \times 10^6 \times E)/BAUD\ RATE$
E: READY pulse (9,600 bps) error of the 78K0R during flash lead-in

Example 1: 0% error for READY pulse (low-level 9 bits @ 9,600 bps) length
(READY pulse = 937.5 μs)
When set to 250,000 bps
E = 1.00
k = 0020H
D02H = 00H
D02L = 20H

Example 2: +5% error for READY pulse (low-level 9 bits @ 9,600 bps) length
(READY pulse = 984.375 μs)
When set to 250,000 bps
E = 1.05
k = 0021H
D02H = 00H
D02L = 21H

Example 3: –5% error for READY pulse (low-level 9 bits @ 9,600 bps) length
(READY pulse = 890.625 μs)
When set to 250,000 bps
E = 0.95
k = 001EH
D02H = 00H
D02L = 1EH

Figure 5-5. Status Frame for Baud Rate Set Command (from 78K0R/Kx3 to Programmer)

STX	LEN	Data	SUM	ETX
02H	01H	ST1	checksum	03H

Remark ST1: Synchronization detection result

Read **6.5 Baud Rate Set Command** for details on the flowchart of the processing sequence between the programmer and the 78K0R/Kx3, the flowchart of command processing, and the sample program.

5.4 Chip Erase Command

5.4.1 Description

This command is used to erase the entire contents of the flash memory. In addition, all of the information that is set by security setting processing can be initialized by chip erase processing, as long as erasure is not prohibited by the security setting (see **5.12 Security Set Command**).

5.4.2 Command frame and status frame

Figure 5-6 shows the format of a command frame for the Chip Erase command, and Figure 5-7 shows the status frame for the command.

Figure 5-6. Chip Erase Command Frame (from Programmer to 78K0R/Kx3)

SOH	LEN	COM	SUM	ETX
01H	01H	20H (Chip Erase)	Checksum	03H

Figure 5-7. Status Frame for Chip Erase Command (from 78K0R/Kx3 to Programmer)

STX	LEN	Data	SUM	ETX
02H	01H	ST1	Checksum	03H

Remark ST1: Chip erase result

Read **6.6 Chip Erase Command** for details on the flowchart of the processing sequence between the programmer and the 78K0R/Kx3, the flowchart of command processing, and the sample program.

5.5 Block Erase Command

5.5.1 Description

This command is used to erase the content of flash memory of the block with the specified number.

A block can be specified with the first address of the block where erasing starts and the last address where erasing ends. Successive multiple blocks can be specified.

Erasing cannot be performed, however, if erasing is prohibited due to the security setting (see **5.12 Security Set Command**).

5.5.2 Command frame and status frame

Figure 5-8 shows the format of a command frame for the Block Erase command, and Figure 5-9 shows the status frame for the command.

Figure 5-8. Block Erase Command Frame (from Programmer to 78K0R/Kx3)

SOH	LEN	COM	Command Information						SUM	ETX
01H	07H	22H (Block Erase)	SAH	SAM	SAL	EAH	EAM	EAL	Checksum	03H

Remark SAH, SAM, SAL: Block erase start address (start address of any block)
SAH: Start address, high (bits 23 to 16)
SAM: Start address, middle (bits 15 to 8)
SAL: Start address, low (bits 7 to 0)
EAH, EAM, EAL: Block erase end address (last address of any block)
EAH: End address, high (bits 23 to 16)
EAM: End address, middle (bits 15 to 8)
EAL: End address, low (bits 7 to 0)

Figure 5-9. Status Frame for Block Erase Command (from 78K0R/Kx3 to Programmer)

STX	LEN	Data	SUM	ETX
02H	01H	ST1	Checksum	03H

Remark ST1: Block erase result

Read **6.7 Block Erase Command** for details on the flowchart of the processing sequence between the programmer and the 78K0R/Kx3, the flowchart of command processing, and the sample program.

5.6 Programming Command

5.6.1 Description

This command is used to write the user program to the flash memory by transmitting write data after having transmitted the write start address and the write end address. Internal verification is then executed after the last data has been transmitted and writing has been completed.

The write start/end address can be set only in the block start/end address units.

If both of the status frames (ST1 and ST2) after the last data transmission indicate ACK, the 78K0R/Kx3 firmware automatically executes internal verify. Therefore, the Status command for this internal verify must be transmitted.

5.6.2 Command frame and status frame

Figure 5-10 shows the format of a command frame for the Programming command, and Figure 5-11 shows the status frame for the command.

Figure 5-10. Programming Command Frame (from Programmer to 78K0R/Kx3)

SOH	LEN	COM	Command Information						SUM	ETX
01H	07H	40H (Programming)	SAH	SAM	SAL	EAH	EAM	EAL	Checksum	03H

Remark SAH, SAM, SAL: Write start addresses
EAH, EAM, EAL: Write end addresses

Figure 5-11. Status Frame for Programming Command (from 78K0R/Kx3 to Programmer)

STX	LEN	Data	SUM	ETX
02H	01H	ST1 (a)	Checksum	03H

Remark ST1 (a): Command reception result

5.6.3 Data frame and status frame

Figure 5-12 shows the format of a frame that includes data to be written, and Figure 5-13 shows the status frame for the data.

Figure 5-12. Data Frame to Be Written (from Programmer to 78K0R/Kx3)

STX	LEN	Data	SUM	ETX/ETB
02H	00H to FFH (00H = 256)	Write Data	Checksum	03H/17H

Remark Write Data: User program to be written

Figure 5-13. Status Frame for Data Frame (from 78K0R/Kx3 to Programmer)

STX	LEN	Data		SUM	ETX
02H	02H	ST1 (b)	ST2 (b)	Checksum	03H

Remark ST1 (b): Data reception check result
ST2 (b): Write result

5.6.4 Completion of transferring all data and status frame

Figure 5-14 shows the status frame after transfer of all data is completed.

Figure 5-14. Status Frame After Completion of Transferring All Data (from 78K0R/Kx3 to Programmer)

STX	LEN	Data	SUM	ETX
02H	01H	ST1 (c)	Checksum	03H

Remark ST1 (c): Internal verify result

Read **6.8 Programming Command** for details on the flowchart of the processing sequence between the programmer and the 78K0R/Kx3, the flowchart of command processing, and the sample program.

5.7 Verify Command

5.7.1 Description

This command is used to compare the data transmitted from the programmer with the data read from the 78K0R/Kx3 (read level) in the specified address range, and check whether they match.

The verify start/end address can be set only in the block start/end address units.

5.7.2 Command frame and status frame

Figure 5-15 shows the format of a command frame for the Verify command, and Figure 5-16 shows the status frame for the command.

Figure 5-15. Verify Command Frame (from Programmer to 78K0R/Kx3)

SOH	LEN	COM	Command Information						SUM	ETX
01H	07H	13H (Verify)	SAH	SAM	SAL	EAH	EAM	EAL	Checksum	03H

Remark SAH, SAM, SAL: Verify start addresses
EAH, EAM, EAL: Verify end addresses

Figure 5-16. Status Frame for Verify Command (from 78K0R/Kx3 to Programmer)

STX	LEN	Data	SUM	ETX
02H	01H	ST1 (a)	Checksum	03H

Remark ST1 (a): Command reception result

5.7.3 Data frame and status frame

Figure 5-17 shows the format of a frame that includes data to be verified, and Figure 5-18 shows the status frame for the data.

Figure 5-17. Data Frame of Data to Be Verified (from Programmer to 78K0R/Kx3)

STX	LEN	Data	SUM	ETX/ETB
02H	00H to FFH (00H = 256)	Verify Data	Checksum	03H/17H

Remark Verify Data: User program to be verified

Figure 5-18. Status Frame for Data Frame (from 78K0R/Kx3 to Programmer)

STX	LEN	Data		SUM	ETX
02H	02H	ST1 (b)	ST2 (b)	Checksum	03H

Remark ST1 (b): Data reception check result
ST2 (b): Verify result[Note]

Note Even if a verify error occurs in the specified address range, ACK is always returned as the verify result. The status of all verify errors are reflected in the verify result for the last data. Therefore, the occurrence of verify errors can be checked only when all the verify processing for the specified address range is completed.

Read **6.9 Verify Command** for details on the flowchart of the processing sequence between the programmer and the 78K0R/Kx3, the flowchart of command processing, and the sample program.

5.8 Block Blank Check Command

5.8.1 Description

This command is used to check if a block in the flash memory, with a specified block number, is blank (erased state).

A block can be specified with the start address of the blank check start block and the last address of the blank check end block. Successive multiple blocks can be specified.

5.8.2 Command frame and status frame

Figure 5-19 shows the format of a command frame for the Block Blank Check command, and Figure 5-20 shows the status frame for the command.

Figure 5-19. Block Blank Check Command Frame (from Programmer to 78K0R/Kx3)

SOH	LEN	COM	Command Information							SUM	ETX
01H	08H	32H (Block Blank Check)	SAH	SAM	SAL	EAH	EAM	EAL	D01	Checksum	03H

Remark SAH, SAM, SAL: Block blank check start address (start address of any block)
- SAH: Start address, high (bits 23 to 16)
- SAM: Start address, middle (bits 15 to 8)
- SAL: Start address, low (bits 7 to 0)

EAH, EAM, EAL: Block blank check end address (last address of any block)
- EAH: End address, high (bits 23 to 16)
- EAM: End address, middle (bits 15 to 8)
- EAL: End address, low (bits 7 to 0)

D01:
- 00H: When performing a block blank check for a single block
- 01H: When performing a blank check for the complete area before erasing the chip

Figure 5-20. Status Frame for Block Blank Check Command (from 78K0R/Kx3 to Programmer)

STX	LEN	Data	SUM	ETX
02H	01H	ST1	Checksum	03H

Remark ST1: Block blank check result

Read **6.10 Block Blank Check Command** for details on the flowchart of the processing sequence between the programmer and the 78K0R/Kx3, the flowchart of command processing, and the sample program.

5.9 Silicon Signature Command

5.9.1 Description

This command is used to read information such as the write protocol information (silicon signature) of the device and security flag information.

If the programmer supports a programming protocol that is not supported in the 78K0R/Kx3, for example, execute this command to select an appropriate protocol in accordance with the values of the second and third bytes.

5.9.2 Command frame and status frame

Figure 5-21 shows the format of a command frame for the Silicon Signature command, and Figure 5-22 shows the status frame for the command.

Figure 5-21. Silicon Signature Command Frame (from Programmer to 78K0R/Kx3)

SOH	LEN	COM	SUM	ETX
01H	01H	C0H (Silicon Signature)	Checksum	03H

Figure 5-22. Status Frame for Silicon Signature Command (from 78K0R/Kx3 to Programmer)

STX	LEN	Data	SUM	ETX
02H	01H	ST1	Checksum	03H

Remark ST1: Command reception result

5.9.3 Silicon signature data frame

Figure 5-23 shows the format of a frame that includes silicon signature data.

Figure 5-23. Silicon Signature Data Frame (from 78K0R/Kx3 to Programmer)

STX	LEN	Data						
02H	n	VEN	MET	MSC	DEC1	DEC2	UAE(3)	DEV(10)

Data (continued)						SUM	ETX
SCF	BOT	FSWSH	FSWSL	FSWEH	FSWEL	checksum	03H

Remarks 1. n (LEN): Data length
VEN: Vendor code (NEC: 10H)
MET: Macro extension code
MSC: Macro function code
DEC1: Device extension code 1
DEC2: Device extension code 2
UAE: User flash ROM last address (3 bytes)
DEV: Device name (10 bytes)
SCF: Security flag information
BOT: Boot block number
FSWSH: Higher 8-bit side of flash shield window (FSW) start block
FSWSL: Lower 8-bit side of flash shield window (FSW) start block
FSWEH: Higher 8-bit side of flash shield window (FSW) end block
FSWEL: Lower 8-bit side of flash shield window (FSW) end block

2. For the vendor code (VEN), extension code (MET), function code (MSC), device extension code 1 (DEC1), and device extension code 2 (DEC2), the lower 7 bits are used as data entity, and the highest bit is used as an odd parity. The following shows an example.

Table 5-2. Example of Silicon Signature Data

Field	Content	Length (Byte)	Example of Silicon Signature Data	Actual Value	Parity
VEN	Vendor code (NEC)	1	10H (00010000B)	10H	Added
MET	Macro extension code	1	7FH (01111111B)	7FH	Added
MSC	Macro function code	1	04H (01000000B)	04H	Added
DEC1	Device extension code 1	1	DCH (11011100B)	DCH	Added
DEC2	Device extension code 2	1	FDH (11111101B)	FDH	Added
UAE	User flash ROM last address	3	FFH (11111111B)	00FFFFH	Not added
			FFH (11111111B)		
			00H (00000000B)		
DEV	Device name	10	44H (01000100B) = 'D'	'D'	Not added
			37H (00110111B) = '7'	'7'	
			38H (00111000B) = '8'	'8'	
			46H (01001111B) = 'F'	'F'	
			31H (00110001B) = '1'	'1'	
			31H (00110001B) = '1'	'1'	
			34H (00110100B) = '4'	'4'	
			32H (00110010B) = '2'	'2'	
			20H (00100000B) = ' '	' '	
			20H (00100000B) = ' '	' '	
SCF	Security flag information	1	Any	Same as left column	Not added
BOT	Boot block number (fixed)	1	01H (00000001B)	01H	Not added
FSWS(H)	Higher 8-bit side of flash shield window start block	1	Any	Same as left column	Not added
FSWS(L)	Lower 8-bit side of flash shield window start block	1	Any	Same as left column	Not added
FSWE(H)	Higher 8-bit side of flash shield window end block	1	Any	Same as left column	Not added
FSWE(L)	Lower 8-bit side of flash shield window end block	1	Any	Same as left column	Not added

Read **6.11 Silicon Signature Command** for details on the flowchart of the processing sequence between the programmer and the 78K0R/Kx3, the flowchart of command processing, and the sample program.

5.9.4 78K0R/Kx3 silicon signature list

Table 5-3. 78K0R/Kx3 Silicon Signature Data List

Item	Description	Length (Byte)	Data (Hex)
Vendor code	NEC	1	10
Extension code	Extension code	1	7F
Function code	Function information	1	04
Device information	Device information	2	DC
			FD
Internal flash ROM last address	Transmitted from lower bytes of address	3	**Note 1**
Device name (μPD)	78F1142/78F1152/78F1162 78F1143/78F1153/78F1163 78F1144/78F1154/78F1164 78F1145/78F1155/78F1165 78F1146/78F1156/78F1166 78F1167/78F1168	10	**Note 2**
Security information	Security information	1	Any
Boot block number	The last block number of the boot cluster that is currently selected	1	01
FSW block number	FSW information	4	Any

Note 1. List of internal flash ROM last addresses

Item	Description	Length (Byte)	Data (Hex)
Internal flash ROM last address	64 KB (00FFFFH)	3	FFFF00
	96 KB (017FFFH)		FF7F01
	128 KB (01FFFFH)		FFFF01
	192 KB (02FFFFH)		FFFF02
	256 KB (03FFFFH)		FFFF03
	384 KB (05FFFFH)		FFFF05
	512 KB (07FFFFH)		FFFF07

(Note 2 is on the next page.)

Note 2. The device names are listed below.

Device name list (1/4)

Item	Description	Length (Byte)	Actual Value
Device name	D78F1142	10	44 = ‘D’ 37 = ‘7’ 38 = ‘8’ 46 = ‘F’ 31 = ‘1’ 31 = ‘1’ 34 = ‘4’ 32 = ‘2’ 20 = ‘ ‘ 20 = ‘ ‘
	D78F1143		44 = ‘D’ 37 = ‘7’ 38 = ‘8’ 46 = ‘F’ 31 = ‘1’ 31 = ‘1’ 34 = ‘4’ 33 = ‘3’ 20 = ‘ ‘ 20 = ‘ ‘
	D78F1144		44 = ‘D’ 37 = ‘7’ 38 = ‘8’ 46 = ‘F’ 31 = ‘1’ 31 = ‘1’ 34 = ‘4’ 34 = ‘4’ 20 = ‘ ‘ 20 = ‘ ‘
	D78F1145		44 = ‘D’ 37 = ‘7’ 38 = ‘8’ 46 = ‘F’ 31 = ‘1’ 31 = ‘1’ 34 = ‘4’ 35 = ‘5’ 20 = ‘ ‘ 20 = ‘ ‘
	D78F1146		44 = ‘D’ 37 = ‘7’ 38 = ‘8’ 46 = ‘F’ 31 = ‘1’ 31 = ‘1’ 34 = ‘4’ 36 = ‘6’ 20 = ‘ ‘ 20 = ‘ ‘

Device name list (2/4)

Item	Description	Length (Byte)	Actual Value
Device name	D78F1152	10	44 = ‘D’ 37 = ‘7’ 38 = ‘8’ 46 = ‘F’ 31 = ‘1’ 31 = ‘1’ 35 = ‘5’ 32 = ‘2’ 20 = ‘ ‘ 20 = ‘ ‘
	D78F1153		44 = ‘D’ 37 = ‘7’ 38 = ‘8’ 46 = ‘F’ 31 = ‘1’ 31 = ‘1’ 35 = ‘5’ 33 = ‘3’ 20 = ‘ ‘ 20 = ‘ ‘
	D78F1154		44 = ‘D’ 37 = ‘7’ 38 = ‘8’ 46 = ‘F’ 31 = ‘1’ 31 = ‘1’ 35 = ‘5’ 34 = ‘4’ 20 = ‘ ‘ 20 = ‘ ‘
	D78F1155		44 = ‘D’ 37 = ‘7’ 38 = ‘8’ 46 = ‘F’ 31 = ‘1’ 31 = ‘1’ 35 = ‘5’’ 35 = ‘5’ 20 = ‘ ‘ 20 = ‘ ‘
	D78F1156		44 = ‘D’ 37 = ‘7’ 38 = ‘8’ 46 = ‘F’ 31 = ‘1’ 31 = ‘1’ 35 = ‘5’ 36 = ‘6’ 20 = ‘ ‘ 20 = ‘ ‘

Device name list (3/4)

Item	Description	Length (Byte)	Actual Value
Device name	D78F1162	10	44 = ‘D’ 37 = ‘7’ 38 = ‘8’ 46 = ‘F’ 31 = ‘1’ 31 = ‘1’ 36 = ‘6’ 32 = ‘2’ 20 = ‘ ‘ 20 = ‘ ‘
	D78F1163		44 = ‘D’ 37 = ‘7’ 38 = ‘8’ 46 = ‘F’ 31 = ‘1’ 31 = ‘1’ 36 = ‘6’ 33 = ‘3’ 20 = ‘ ‘ 20 = ‘ ‘
	D78F1164		44 = ‘D’ 37 = ‘7’ 38 = ‘8’ 46 = ‘F’ 31 = ‘1’ 31 = ‘1’ 36 = ‘6’ 34 = ‘4’ 20 = ‘ ‘ 20 = ‘ ‘
	D78F1165		44 = ‘D’ 37 = ‘7’ 38 = ‘8’ 46 = ‘F’ 31 = ‘1’ 31 = ‘1’ 36 = ‘6’ 35 = ‘5’ 20 = ‘ ‘ 20 = ‘ ‘
	D78F1166		44 = ‘D’ 37 = ‘7’ 38 = ‘8’ 46 = ‘F’ 31 = ‘1’ 31 = ‘1’ 36 = ‘6’ 36 = ‘6’ 20 = ‘ ‘ 20 = ‘ ‘

Device name list (4/4)

Item	Description	Length (Byte)	Actual Value
Device name	D78F1167	10	44 = ‘D’ 37 = ‘7’ 38 = ‘8’ 46 = ‘F’ 31 = ‘1’ 31 = ‘1’ 36 = ‘6’ 37 = ‘7’ 20 = ‘ ‘ 20 = ‘ ‘
	D78F1168		44 = ‘D’ 37 = ‘7’ 38 = ‘8’ 46 = ‘F’ 31 = ‘1’ 31 = ‘1’ 36 = ‘6’ 38 = ‘8’ 20 = ‘ ‘ 20 = ‘ ‘

5.10 Version Get Command

5.10.1 Description

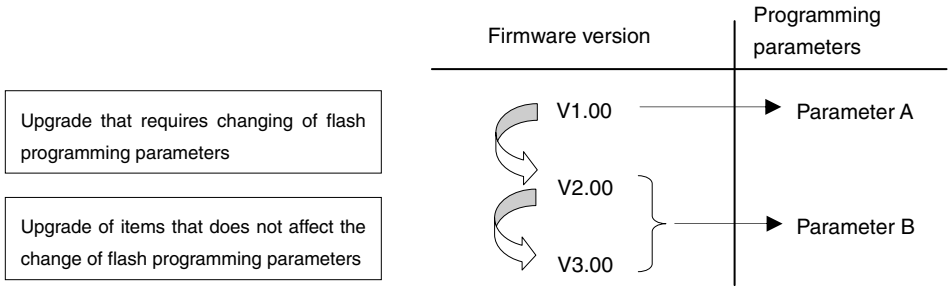
This command is used to acquire information on the 78K0R/Kx3 device version and firmware version.

The device version value is fixed to 00H.

Use this command when the programming parameters must be changed in accordance with the 78K0R/Kx3 firmware version.

Caution The firmware version may be updated during firmware update that does not affect the change of flash programming parameters (at this time, update of the firmware version is not reported).

Example Firmware version and reprogramming parameters



5.10.2 Command frame and status frame

Figure 5-24 shows the format of a command frame for the Version Get command, and Figure 5-25 shows the status frame for the command.

Figure 5-24. Version Get Command Frame (from Programmer to 78K0R/Kx3)

SOH	LEN	COM	SUM	ETX
01H	01H	C5H (Version Get)	Checksum	03H

Figure 5-25. Status Frame for Version Get Command (from 78K0R/Kx3 to Programmer)

STX	LEN	Data	SUM	ETX
02H	01H	ST1	Checksum	03H

Remark ST1: Command reception result

5.10.3 Version data frame

Figure 5-26 shows the data frame of version data.

Figure 5-26. Version Data Frame (from 78K0R/Kx3 to Programmer)

STX	LEN	Data						SUM	ETX
02H	06H	DV1	DV2	DV3	FV1	FV2	FV3	Checksum	03H

Remark DV1: Integer of device version (fixed to 00H)
DV2: First decimal place of device version (fixed to 00H)
DV3: Second decimal place of device version (fixed to 00H)
FV1: Integer of firmware version
FV2: First decimal place of firmware version
FV3: Second decimal place of firmware version

Read **6.12 Version Get Command** for details on the flowchart of the processing sequence between the programmer and the 78K0R/Kx3, the flowchart of command processing, and the sample program.

5.11 Checksum Command

5.11.1 Description

This command is used to acquire the checksum data in the specified area.

For the checksum calculation start/end address, specify a fixed address in block units (2 KB) starting from the top of the flash memory.

Checksum data is obtained by sequentially subtracting data in the specified address range from the initial value (0000H) in 1-byte units.

5.11.2 Command frame and status frame

Figure 5-27 shows the format of a command frame for the Checksum command, and Figure 5-28 shows the status frame for the command.

Figure 5-27. Checksum Command Frame (from Programmer to 78K0R/Kx3)

SOH	LEN	COM	Command Information						SUM	ETX
01H	07H	B0H (Checksum)	SAH	SAM	SAL	EAH	EAM	EAL	Checksum	03H

Remark SAH, SAM, SAL: Checksum calculation start addresses
EAH, EAM, EAL: Checksum calculation end addresses

Figure 5-28. Status Frame for Checksum Command (from 78K0R/Kx3 to Programmer)

STX	LEN	Data	SUM	ETX
02H	01H	ST1	Checksum	03H

Remark ST1: Command reception result

5.11.3 Checksum data frame

Figure 5-29 shows the format of a frame that includes checksum data.

Figure 5-29. Checksum Data Frame (from 78K0R/Kx3 to Programmer)

STX	LEN	Data		SUM	ETX
02H	02H	CK1	CK2	Checksum	03H

Remark CK1: Higher 8 bits of checksum data
CK2: Lower 8 bits of checksum data

Read **6.13 Checksum Command** for details on the flowchart of the processing sequence between the programmer and the 78K0R/Kx3, the flowchart of command processing, and the sample program.

5.12 Security Set Command

5.12.1 Description

This command is used to perform security settings (enabling/disabling of write, block erase, chip erase, and boot block rewriting, and setting of flash shield window start/end block number). By performing these settings with this command, rewriting of the flash memory by an unauthorized party can be restricted and the rewrite area for self programming can be specified.

Caution Even after the security setting, additional setting of changing from enable to disable can be performed; however, changing from disable to enable is not possible. If an attempt is made to perform such a setting, a protect error (10H) will occur. If such setting is required, all of the security flags must first be initialized by executing the Chip Erase command (the Block Erase command cannot be used to initialize the security flags).
If chip erase or boot block rewrite has been disabled, however, chip erase itself will be impossible, so the settings cannot be erased from the programmer. Re-confirmation of security setting execution is therefore recommended before disabling chip erase, due to this programmer specification.

5.12.2 Command frame and status frame

Figure 5-30 shows the format of a command frame for the Security Set command, and Figure 5-31 shows the status frame for the command.

Figure 5-30. Security Set Command Frame (from Programmer to 78K0R/Kx3)

SOH	LEN	COM	Command Information		SUM	ETX
01H	03H	A0H (Security Set)	00H (fixed)	00H (fixed)	Checksum	03H

Figure 5-31. Status Frame for Security Set Command (from 78K0R/Kx3 to Programmer)

STX	LEN	Data	SUM	ETX
02H	01H	ST1 (a)	Checksum	03H

Remark ST1 (a): Command reception result

5.12.3 Data frame and status frame

Figure 5-32 shows the format of a security data frame, and Figure 5-33 shows the status frame for the data.

Figure 5-32. Security Data Frame (from Programmer to 78K0R/Kx3)

STX	LEN	Data						SUM	ETX
02H	06H	FLG	BOT	FSWS(H)	FSWS(L)	FSWE(H)	FSWE(L)	Checksum	03H

Remarks 1. FLG: Security flag
BOT: Boot cluster last block number (fixed to 01H)
FSWS(H): Higher 8 bits of flash shield window start block number (fixed to 00H)
FSWS(L): Lower 8 bits of flash shield window start block number
FSWE(H): Higher 8 bits of flash shield window end block number (fixed to 00H)
FSWE(L): Lower 8 bits of flash shield window end block number

2. If the flash shield window is not to be set, set FSWS to 0000H and the end block to the target device end block number.

Figure 5-33. Status Frame for Security Data Writing (from 78K0R/Kx3 to Programmer)

STX	LEN	Data	SUM	ETX
02H	01H	ST1 (b)	Checksum	03H

Remark ST1 (b): Security data write result

5.12.4 Internal verify check and status frame

Figure 5-34 shows the status frame for internal verify check.

Figure 5-34. Status Frame for Internal Verify Check (from 78K0R/Kx3 to Programmer)

STX	LEN	Data	SUM	ETX
02H	01H	ST1 (c)	Checksum	03H

Remark ST1 (c): Internal verify result

The following table shows the contents in the security flag field.

Table 5-4. Contents of Security Flag Field

Item	Contents
Bit 7	Fixed to “1”
Bit 6	
Bit 5	
Bit 4	Boot block rewrite disable flag (1: Enables boot block rewrite, 0: Disable boot block rewrite)
Bit 3	Fixed to “1”
Bit 2	Programming disable flag (1: Enables programming, 0: Disable programming)
Bit 1	Block erase disable flag (1: Enables block erase, 0: Disable block erase)
Bit 0	Chip erase disable flag (1: Enables chip erase, 0: Disable chip erase)

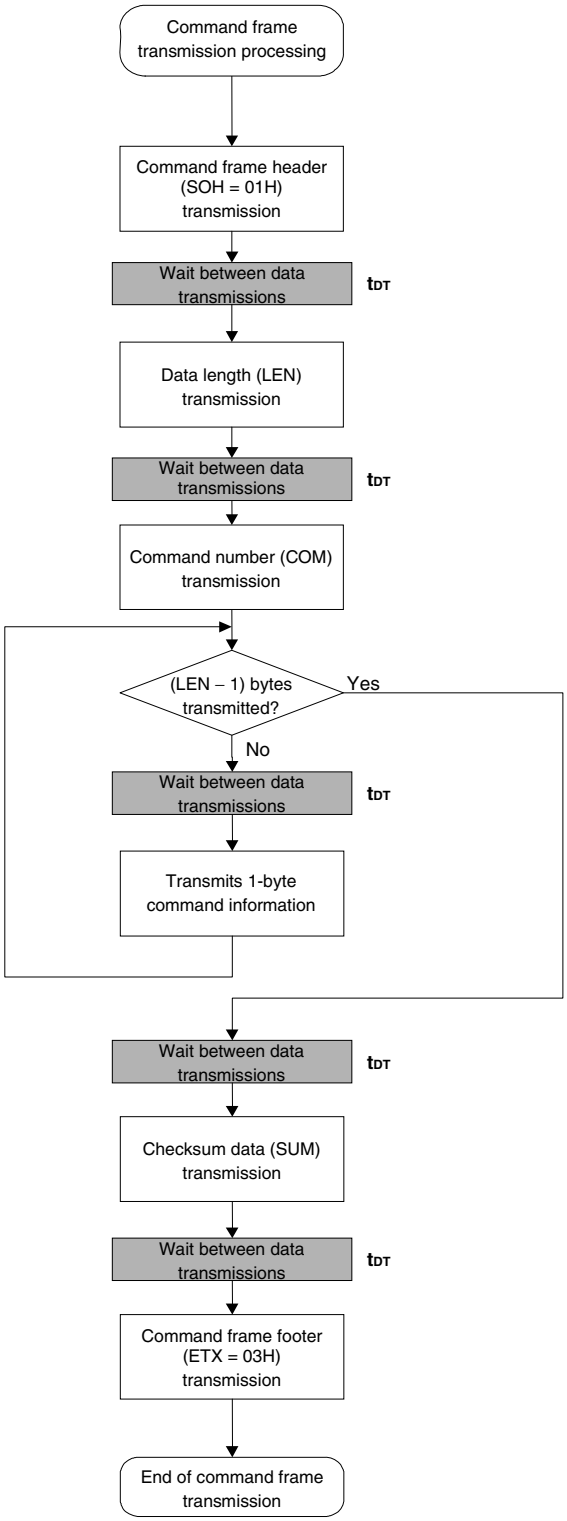
The following table shows the relationship between the security flag field settings and the enable/disable status of each operation.

Table 5-5. Security Flag Field and Enable/Disable Status of Each Operation

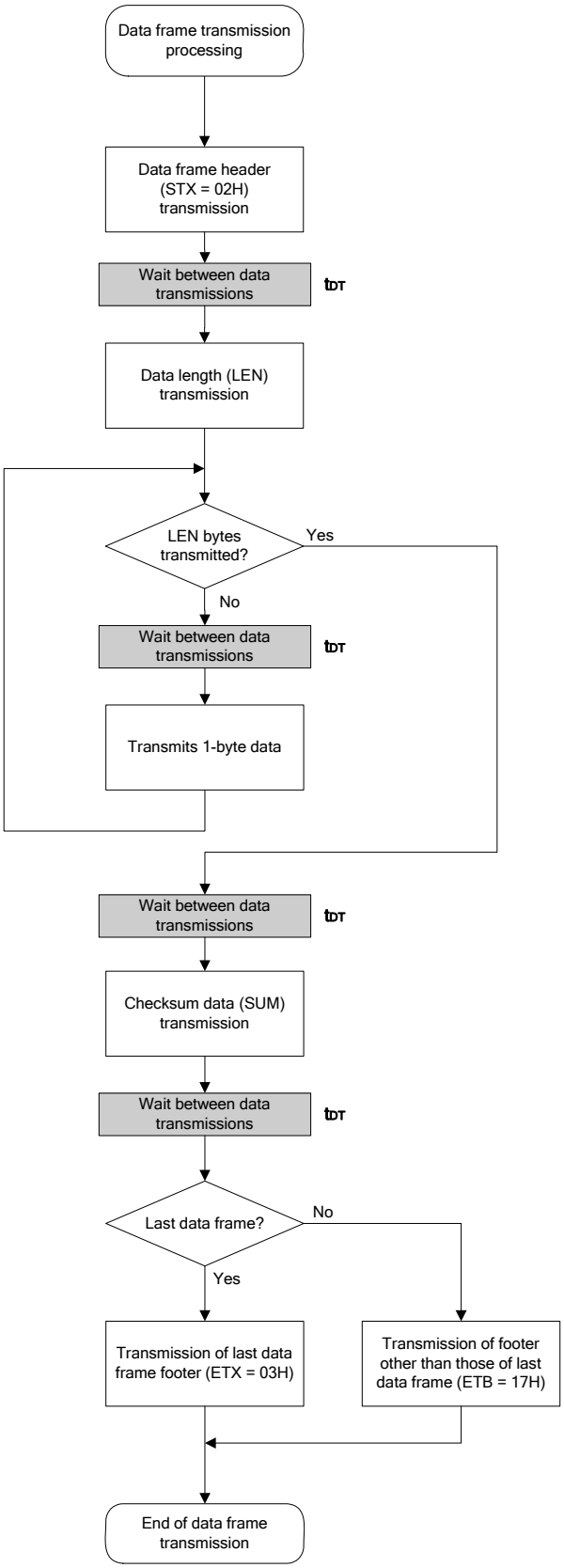
Operating Mode	Flash Memory Programming Mode			Self-Programming Mode
Command / Security Setting Item	Command Operation After Security Setting √: Execution possible, ×: Execution impossible △: Writing and block erase in boot area are impossible			• All commands can be executed regardless of the security setting values • Only retention of security setting values is possible
	Programming	Chip Erase	Block Erase	
Disable programming	×	√	×	
Disable chip erase	√	×	×	
Disable block erase	√	√	×	
Boot block rewrite disable flag	△	×	△	Same condition as that in flash memory programming mode (on-board/off-board programming)

Read **6.14 Security Set Command** for details on the flowchart of the processing sequence between the programmer and the 78K0R/Kx3, the flowchart of command processing, and the sample program.

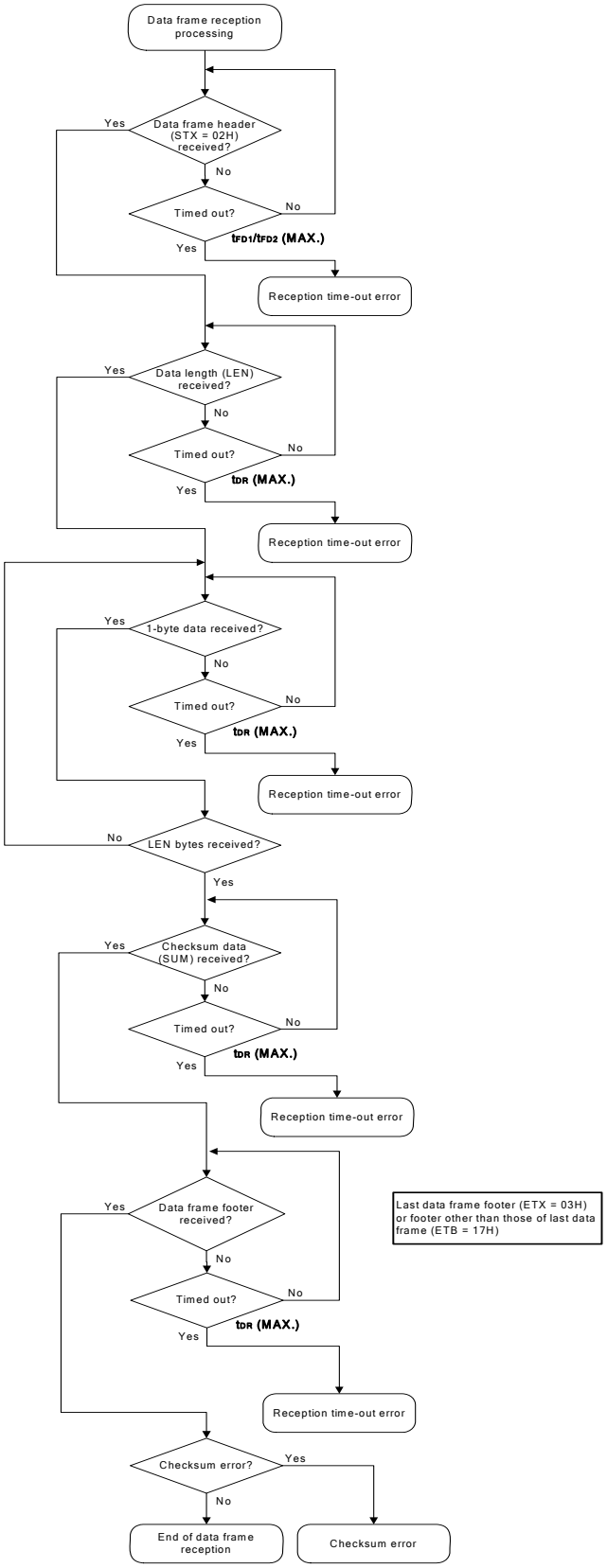
6.1 Command Frame Transmission Processing Flowchart



6.2 Data Frame Transmission Processing Flowchart



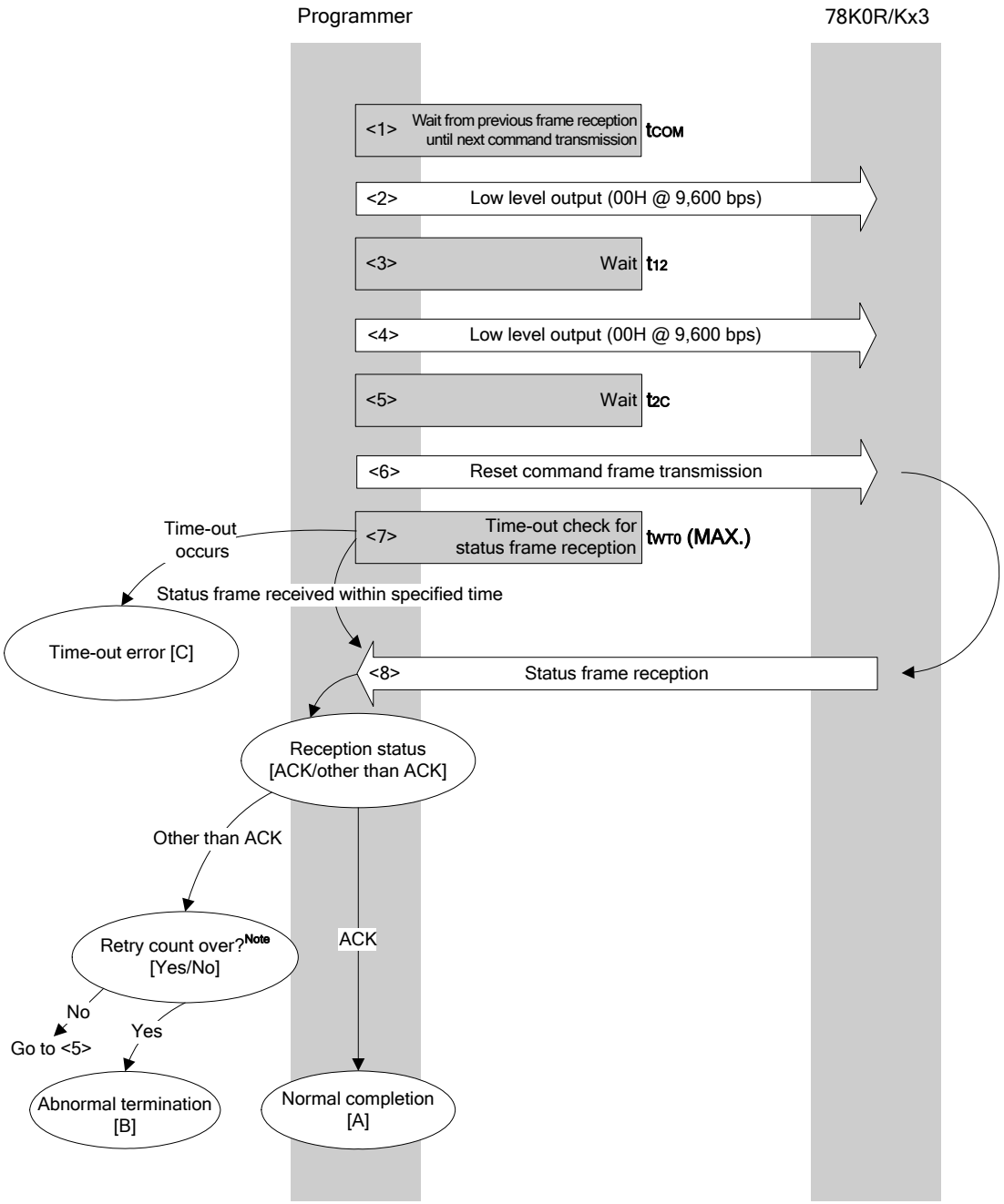
6.3 Data Frame Reception Processing Flowchart



6.4 Reset Command

6.4.1 Processing sequence chart

Reset command processing sequence



Note Do not exceed the retry count for the reset command transmission (up to 16 times).

6.4.2 Description of processing sequence

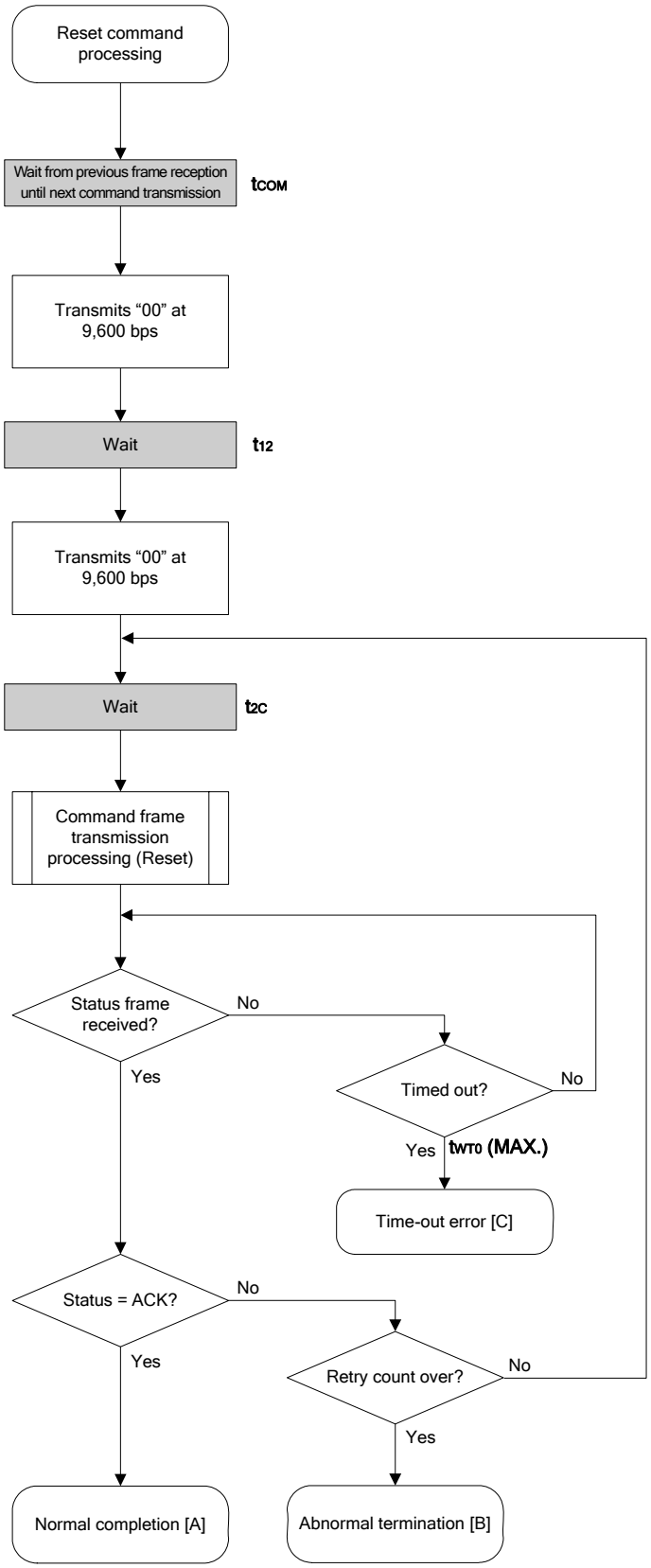
<1> Waits from the previous frame reception until the next command processing starts (wait time t_{COM}).
<2> The low level is output (data 00H is transmitted at 9,600 bps).
<3> Wait state (wait time t_{12}).
<4> The low level is output (data 00H is transmitted at 9,600 bps).
<5> Wait state (wait time t_{2C}).
<6> The Reset command is transmitted by command frame transmission processing.
<7> A time-out check is performed from command transmission until status frame reception.
If a time-out occurs, a time-out error [C] is returned (time-out time $t_{WT0(MAX.)}$).
<8> The status code is checked.

When ST1 = ACK: Normal completion [A]
When ST1 ≠ ACK: The retry count (t_{RS}) is checked.
The sequence is re-executed from <5> if the retry count is not over.
If the retry count is over, the processing ends abnormally [B].

6.4.3 Status at processing completion

Status at Processing Completion		Status Code	Description
Normal completion [A]	Normal acknowledgment (ACK)	06H	The command was executed normally and synchronization between the programmer and the 78K0R/Kx3 has been established.
Abnormal termination [B]	Checksum error	07H	The checksum of the transmitted command frame does not match.
	Negative acknowledgment (NACK)	15H	Command frame data is abnormal (such as invalid data length (LEN) or no ETX).
Time-out error [C]		–	The status frame was not received within the specified time.

6.4.4 Flowchart



6.4.5 Sample program

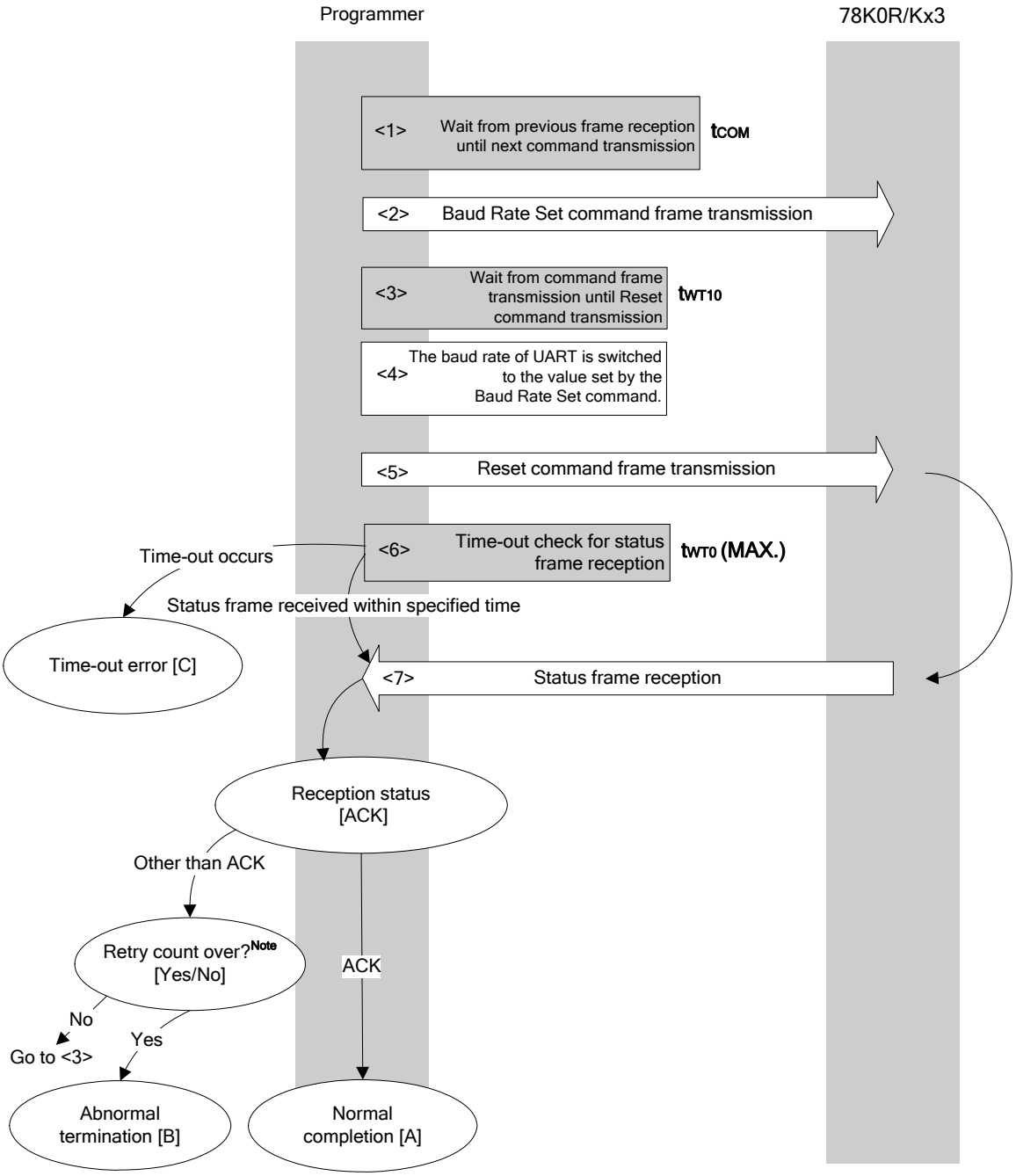
The following shows a sample program for Reset command processing.

```
/*****************************************************************/
/*                                                               */
/*   Reset command                                               */
/*                                                               */
/*****************************************************************/
/*   [r] u16             ... error code                          */
/*****************************************************************/
u16  fl_ua_reset(void)
{
     u16    rc;
     u32    retry;

     set_uart0_br(BR_9600);     // change to 9600bps

     fl_wait(tCOM);             // wait

     set_ua_dir_tx();           // Change Mono-wire UART transmit mode
     putc_ua(0x00);             // send 0x00 @ 9600bps

     fl_wait(t12);              // wait

     putc_ua(0x00);             // send 0x00 @ 9600bps
     set_ua_dir_rx();           // Change Mono-wire UART receive mode

     for (retry = 0; retry < tRS; retry++){

            fl_wait(t2C);       // wait

            put_cmd_ua(FL_COM_RESET, 1, fl_cmd_prm); // send RESET command

            rc = get_sfrm_ua(fl_ua_sfrm, tWT0_MAX);
            if (rc == FLC_DFTO_ERR)         // t.o. ?
                   break;                   // yes  // case [C]
            if (rc == FLC_ACK){             // ACK ?
                   break;                   // yes  // case [A]
            }
            else{
                   NOP();
            }
            //continue;                     // case [B] (if exit from loop)
     }
//   switch(rc) {
//
//          case   FLC_NO_ERR:     return rc;       break;  // case [A]
//          case   FLC_DFTO_ERR:   return rc;       break;  // case [C]
//          default:               return rc;       break;  // case [B]
//   }
     return rc;
}
```

6.5 Baud Rate Set Command

6.5.1 Processing sequence chart

Baud Rate Set command processing sequence



Note Do not exceed the retry count for the reset command transmission (up to 16 times).

6.5.2 Description of processing sequence

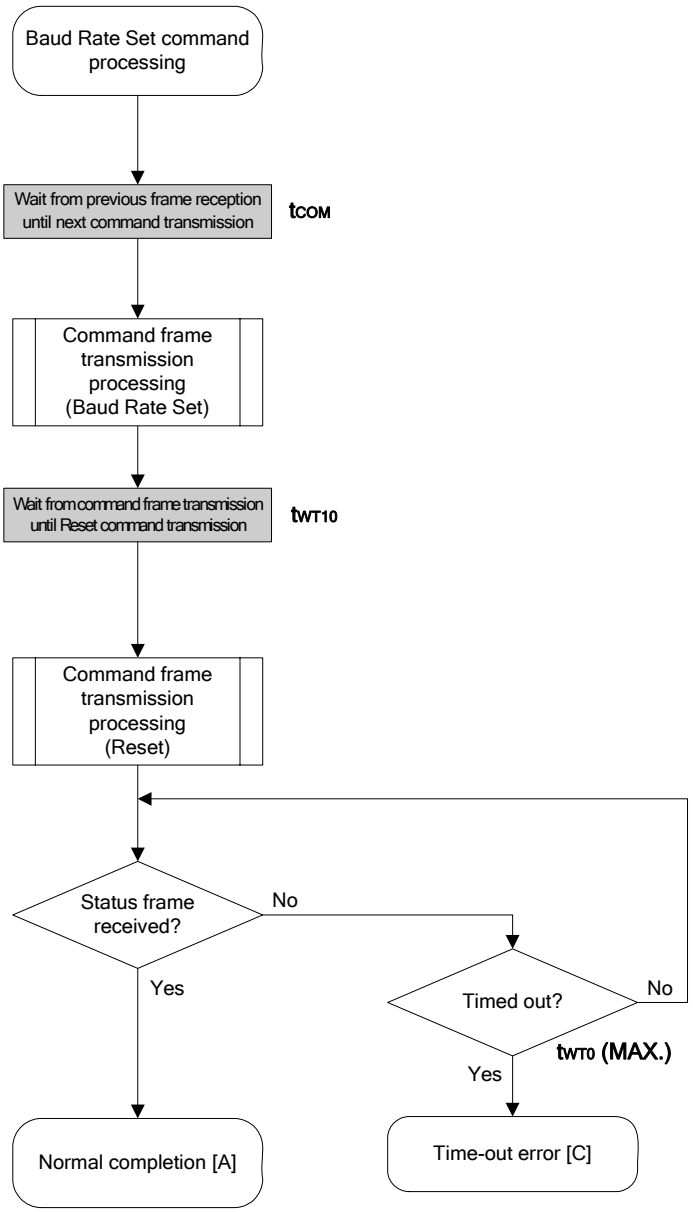
<1> Waits from the previous frame reception until the next command transmission (wait time t_{COM}).
<2> The Baud Rate Set command is transmitted by command frame transmission processing.
<3> Waits from command transmission until Reset command transmission (wait time t_{WT10}).
<4> The baud rate of UART communication is switched to the value set by the Baud Rate Set command.
<5> The Reset command is transmitted by command frame transmission processing.
<6> A time-out check is performed from command transmission until status frame reception.
If a time-out occurs, a time-out error [C] is returned (time-out time t_{WT0}(MAX.)).
<7> Since the status code should be ACK, the processing ends normally [A].

6.5.3 Status at processing completion

Status at Processing Completion		Status Code	Description
Normal completion [A]	Normal acknowledgment (ACK)	06H	The command was executed normally and the synchronization of the UART communication speed has been established between the programmer and the 78K0R/Kx3.
Abnormal termination [B]	Checksum error	07H	The checksum of the transmitted command frame does not match.
	Negative acknowledgment (NACK)	15H	Command frame data is abnormal (such as invalid data length (LEN) or no ETX).
Time-out error [C]Note		–	Data frame reception was timed out. With the 78K0R/Kx3, this command also results in errors in the following cases. • Command information (D01, D02H, D02L, D03) is invalid • The command frame includes the checksum error • The data length of the command frame (LEN) is invalid • The footer of the command frame (ETX) is missing • The Reset command was not detected after setting the baud rate and receiving command frame data for 16 times.

Note If a time-out error has occurred, execute a hardware reset and re-set to the flash memory programming mode.

6.5.4 Flowchart



6.5.5 Sample program

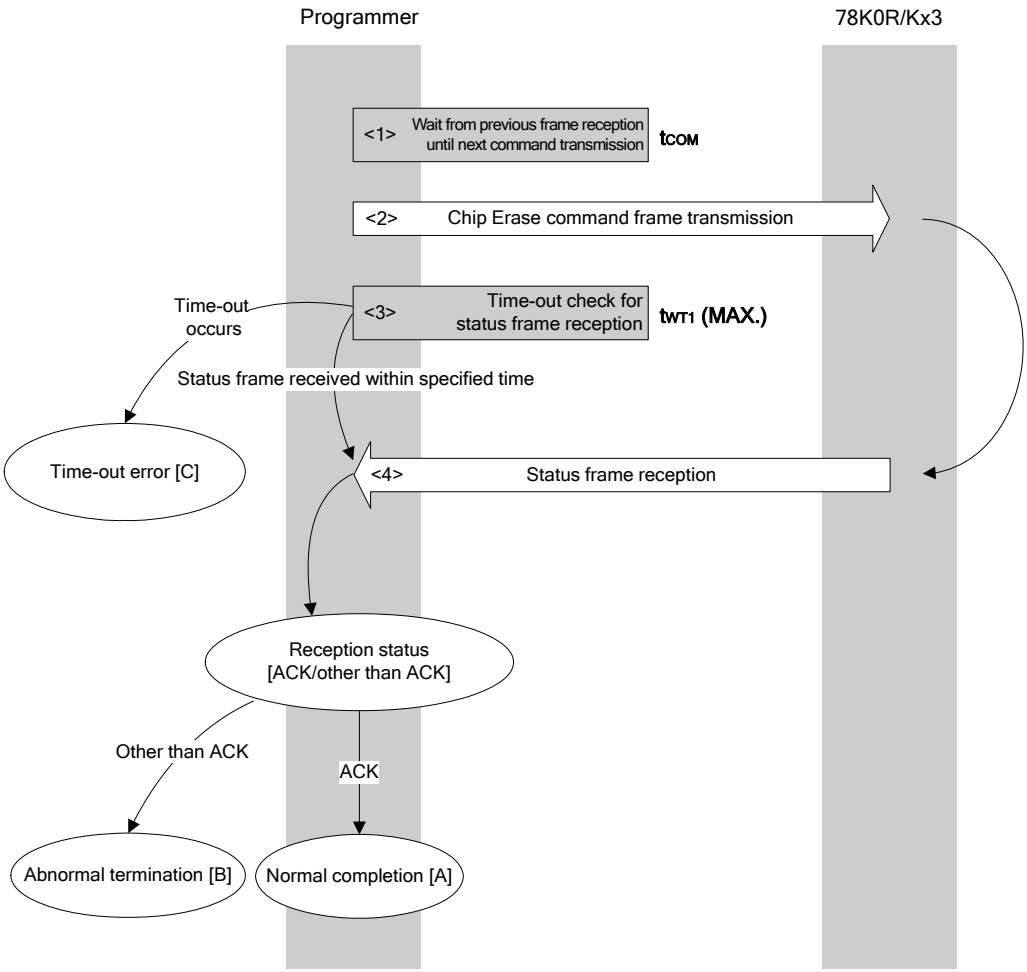
The following shows a sample program for Baud Rate Set command processing.

```
/*************************************************************/
/*                                                           */
/*   Set baudrate command                                    */
/*                                                           */
/*************************************************************/
/*   [i]  u8 brid  ... baudrate ID                           */
/*   [r] u16       ... error code                            */
/*************************************************************/
u16  fl_ua_setbaud(u8 brid)
{
     u16    rc;
     u8     br;
     u32    retry;

     fl_cmd_prm[0] = 0x00;      // "D01" : adjust by target device (115200bps)
     fl_cmd_prm[1] = 0x00;      // "D02" : adjust by target device (115200bps)
     fl_cmd_prm[2] = 0x0a;      // "D03" : (fixed value)
     fl_cmd_prm[3] = 0x01;      // "D04" : noise filter on

     fl_wait(tCOM);             // wait before sending command
     put_cmd_ua(FL_COM_SET_BAUDRATE, 1+4, fl_cmd_prm);// send "Baudrate Set" command
     set_flbaud(brid);          // change baud-rate
     set_uart0_br(brid);        // change baud-rate (h.w.)

     retry = tRS;
     while(1){
            fl_wait(tWT10);

            put_cmd_ua(FL_COM_RESET, 1, fl_cmd_prm);// send RESET command
            rc = get_sfrm_ua(fl_ua_sfrm, tWT0_MAX); // get status frame
            if (rc){
                   if (retry--)
                          continue;
                   else
                          return  rc;
            }
            break;          // got ACK !!

     }
//   switch(rc) {
//          case   FLC_NO_ERR:  return  rc;   break;  // case [A]
//          case   FLC_DFTO_ERR:return  rc;   break;  // case [C]
//          default:            return  rc;   break;  // case [B]
//   }

     return rc;
}
```

6.6 Chip Erase Command

6.6.1 Processing sequence chart

Chip Erase command processing sequence



6.6.2 Description of processing sequence

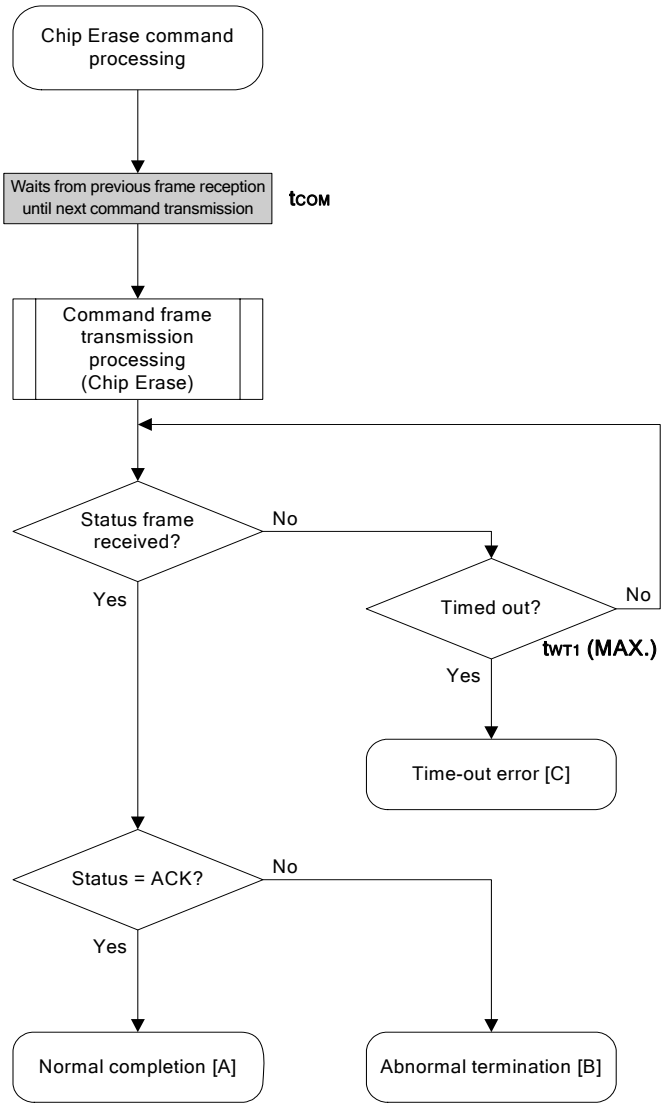
<1> Waits from the previous frame reception until the next command transmission (wait time t_{COM}).
<2> The Chip Erase command is transmitted by command frame transmission processing.
<3> A time-out check is performed from command transmission until status frame reception.
If a time-out occurs, a time-out error [C] is returned (time-out time t_{WT1}(MAX.)).
<4> The status code is checked.

When ST1 = ACK: Normal completion [A]
When ST1 ≠ ACK: Abnormal termination [B]

6.6.3 Status at processing completion

Status at Processing Completion		Status Code	Description
Normal completion [A]	Normal acknowledgment (ACK)	06H	The command was executed normally and chip erase was performed normally.
Abnormal termination [B]	Checksum error	07H	The checksum of the transmitted command frame does not match.
	Protect error	10H	Chip erase or boot block rewrite is prohibited in the security setting.
	Negative acknowledgment (NACK)	15H	Command frame data is abnormal (such as invalid data length (LEN) or no ETX).
	MRG10 error	1AH	An erase error has occurred.
	MRG11 error	1BH	
	Write error	1CH	
Time-out error [C]		–	The status frame was not received within the specified time.

6.6.4 Flowchart



6.6.5 Sample program

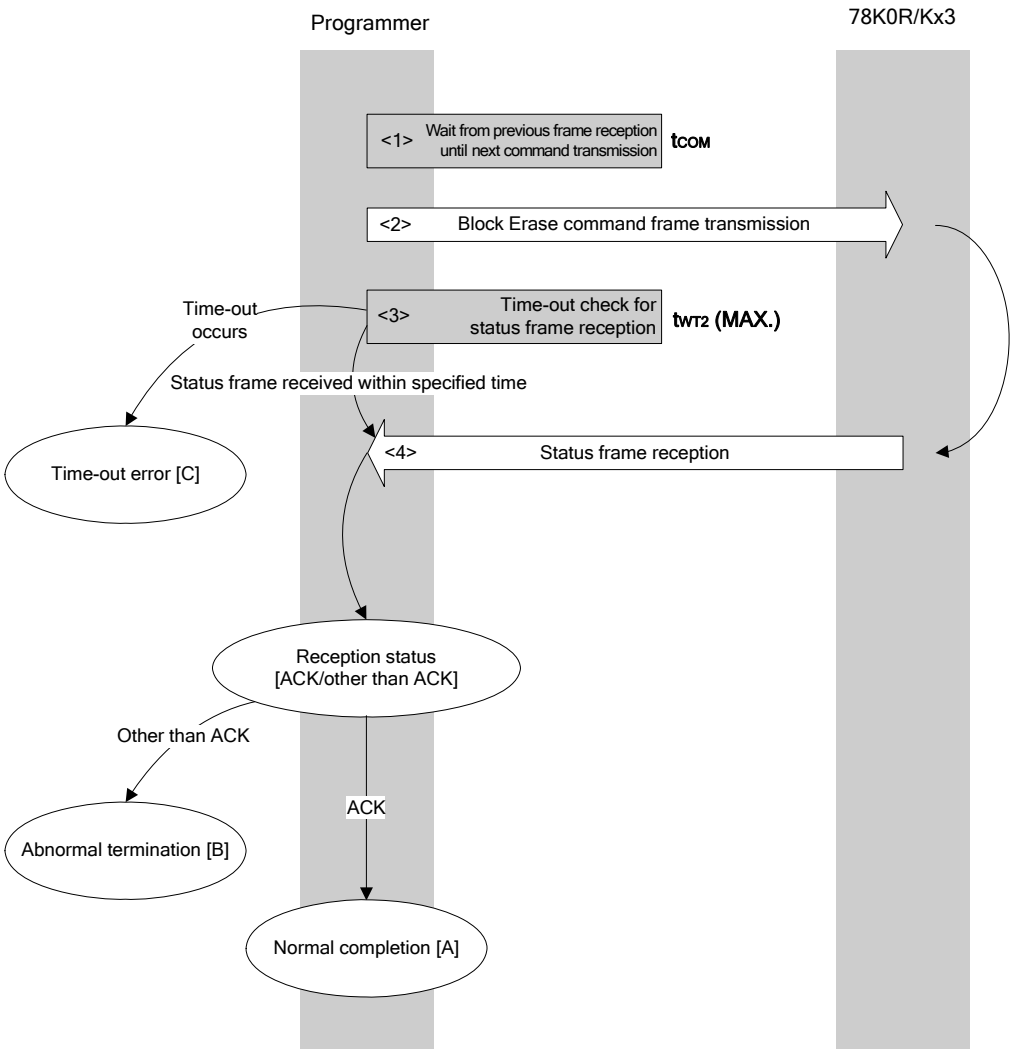
The following shows a sample program for Chip Erase command processing.

```
/*****************************************************************/
/*                                                               */
/*   Erase all(chip) command                                     */
/*                                                               */
/*****************************************************************/
/*   [r] u16             ... error code                          */
/*****************************************************************/
u16         fl_ua_erase_all(void)
{
     u16    rc;


     fl_wait(tCOM);             // wait before sending command

     put_cmd_ua(FL_COM_ERASE_CHIP, 1, fl_cmd_prm); // send ERASE CHIP command

     rc = get_sfrm_ua(fl_ua_sfrm, tWT1_MAX); // get status frame
//   switch(rc) {
//
//         case   FLC_NO_ERR:    return rc;         break; // case [A]
//         case   FLC_DFTO_ERR:  return rc;         break; // case [C]
//         default:              return rc;         break; // case [B]
//   }
     return rc;

}
```

6.7 Block Erase Command

6.7.1 Processing sequence chart

Block Erase command processing sequence



6.7.2 Description of processing sequence

<1> Waits from the previous frame reception until the next command transmission (wait time t_{COM}).

<2> The Block Erase command is transmitted by command frame transmission processing.

<3> A time-out check is performed from command transmission until status frame reception.
If a time-out occurs, a time-out error [C] is returned (time-out time t_{WT2}(MAX.)).

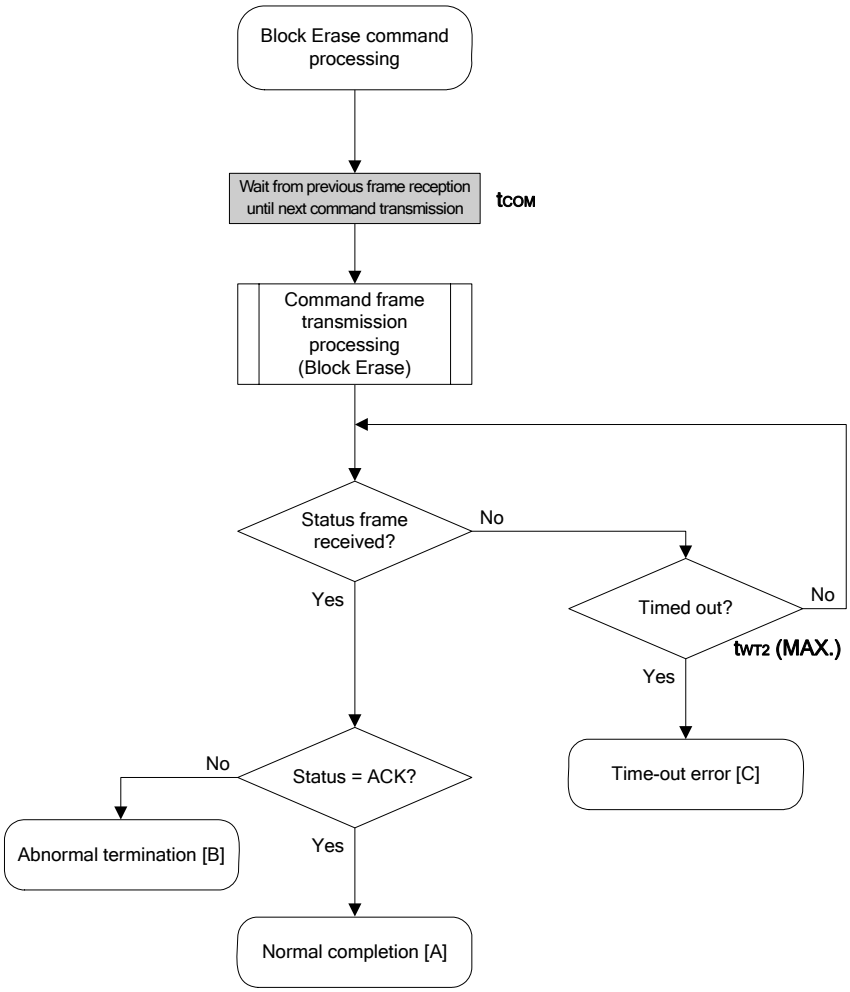
<4> The status code is checked.

When ST1 = ACK: Normal completion [A]
When ST1 ≠ ACK: Abnormal termination [B]

6.7.3 Status at processing completion

Status at Processing Completion		Status Code	Description
Normal completion [A]	Normal acknowledgment (ACK)	06H	The command was executed normally and block erase was performed normally.
Abnormal termination [B]	Parameter error	05H	The specified end address is out of the flash memory range, or the specified start/end address is not the first/end address of the block.
	Checksum error	07H	The checksum of the transmitted command frame does not match.
	Protect error	10H	Write, block erase, or chip erase is prohibited in the security setting. A boot block is included in the specified range and boot block rewrite is prohibited.
	Negative acknowledgment (NACK)	15H	Command frame data is abnormal (such as invalid data length (LEN) or no ETX).
	MRG10 error	1AH	An erase error has occurred.
Time-out error [C]		–	The status frame was not received within the specified time.

6.7.4 Flowchart



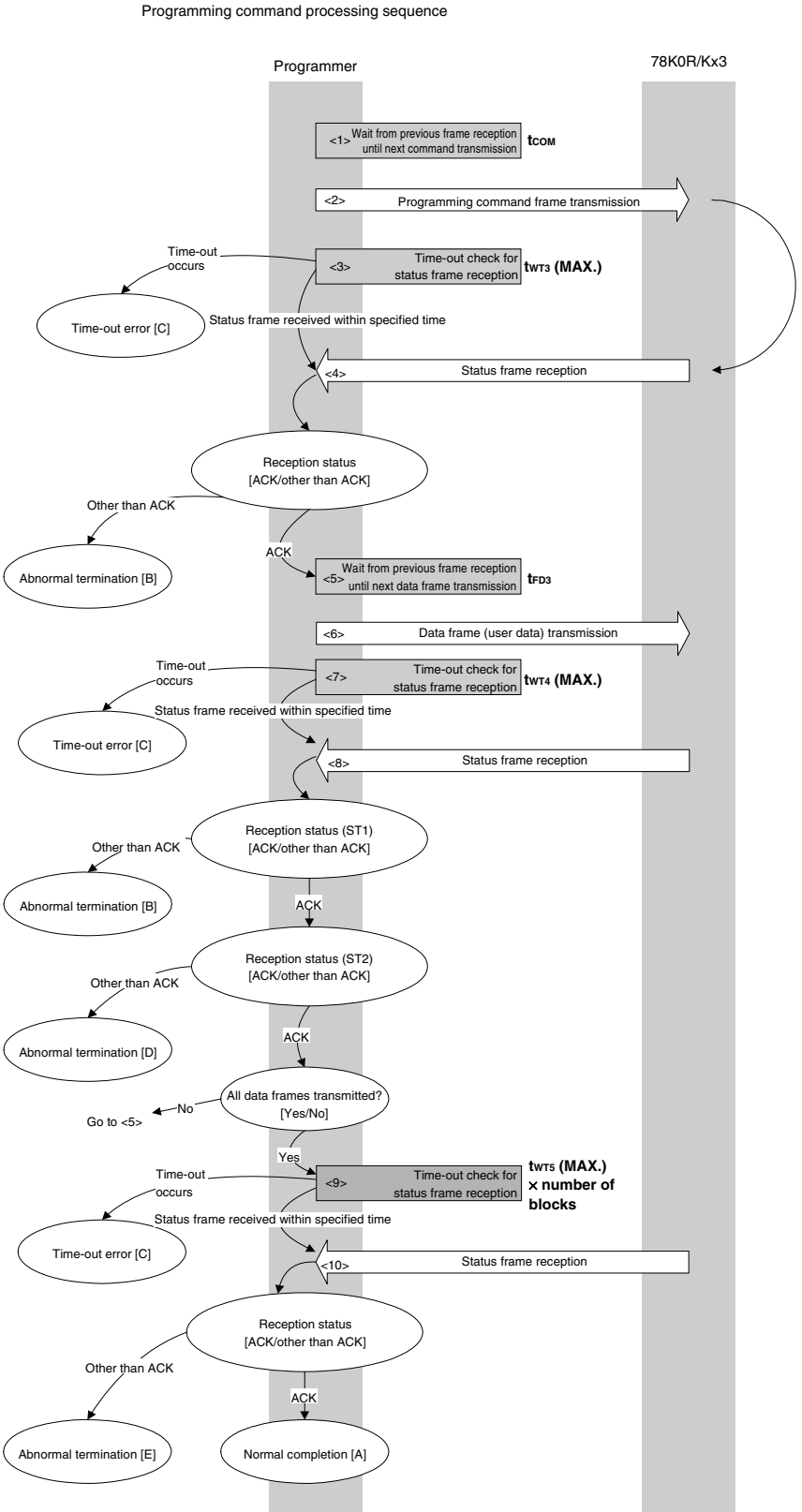
6.7.5 Sample program

The following shows a sample program for Block Erase command processing.

```
/*************************************************************/
/*                                                           */
/*   Erase block command                                     */
/*                                                           */
/*************************************************************/
/*   [i] u8 block        ... block number                    */
/*   [r] u16             ... error code                      */
/*************************************************************/
u16        fl_ua_erase_blk(u16 sblk, u16 eblk)
{

     u16    rc;
     u32    wt2_max;
     u32    top, bottom;

     top = get_top_addr(sblk);               // get start address of start block
     bottom = get_bottom_addr(eblk);         // get end address of end block

     set_range_prm(fl_cmd_prm, top, bottom); // set SAH/SAM/SAL, EAH/EAM/EAL

     wt2_max = make_wt2_max(sblk, eblk);

     fl_wait(tCOM);                          // wait before sending command

     put_cmd_ua(FL_COM_ERASE_BLOCK, 1+6, fl_cmd_prm); // send ERASE CHIP command

     rc = get_sfrm_ua(fl_ua_sfrm, wt2_max);  // get status frame
//   switch(rc) {
//
//         case   FLC_NO_ERR:   return rc;         break; // case [A]
//         case   FLC_DFTO_ERR: return rc;         break; // case [C]
//         default:             return rc;         break; // case [B]
//   }

     return rc;
}
```

6.8 Programming Command

6.8.1 Processing sequence chart



6.8.2 Description of processing sequence

<1> Waits from the previous frame reception until the next command transmission (wait time t_{COM}).
<2> The Programming command is transmitted by command frame transmission processing.
<3> A time-out check is performed from command transmission until status frame reception.
If a time-out occurs, a time-out error [C] is returned (time-out time t_{WT3}(MAX.)).
<4> The status code is checked.

When ST1 = ACK: Proceeds to <5>.
When ST1 ≠ ACK: Abnormal termination [B]

<5> Waits from the previous frame reception until the next data frame transmission (wait time t_{FD3}).
<6> User data is transmitted by data frame transmission processing.
<7> A time-out check is performed from user data transmission until data frame reception.
If a time-out occurs, a time-out error [C] is returned (time-out time t_{WT4}(MAX.)).
<8> The status code (ST1/ST2) is checked (also refer to the processing sequence chart and flowchart).

When ST1 ≠ ACK: Abnormal termination [B]
When ST1 = ACK: The following processing is performed according to the ST2 value.
- When ST2 = ACK: Proceeds to <9> when transmission of all data frames is completed.
If there still remain data frames to be transmitted, the processing re-executes the sequence from <5>.
- When ST2 ≠ ACK: Abnormal termination [D]

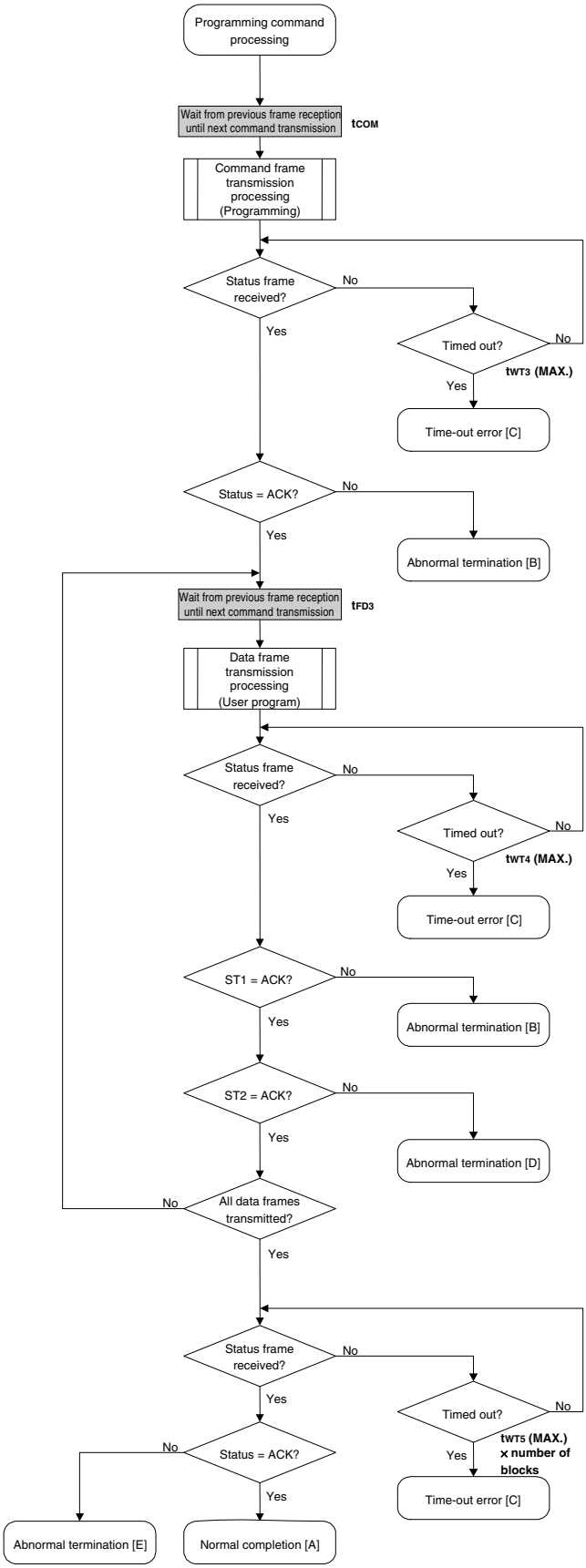
<9> A time-out check is performed until status frame reception.
If a time-out occurs, a time-out error [C] is returned (time-out time t_{WT5}(MAX.) × number of blocks).
<10> The status code is checked.

When ST1 = ACK: Normal completion [A]
When ST1 ≠ ACK: Abnormal termination [E]

6.8.3 Status at processing completion

Status at Processing Completion		Status Code	Description
Normal completion [A]	Normal acknowledgment (ACK)	06H	The command was executed normally and the user data was written normally.
Abnormal termination [B]	Parameter error	05H	The start/end address is out of the flash memory range, the specified start/end address is not the first/end address of the block, or the write start address is larger than the end address.
	Checksum error	07H	The checksum of the transmitted command frame or data frame does not match.
	Protect error	10H	Write is prohibited in the security setting. A boot block is included in the specified range and boot block rewrite is prohibited.
	Negative acknowledgment (NACK)	15H	Command frame data or data frame data is abnormal (such as invalid data length (LEN) or no ETX).
Time-out error [C]		–	The status frame was not received within the specified time.
Abnormal termination [D], [E]	MRG10 error	1AH	A write error has occurred.
	MRG11 error	1BH	
	Write error	1CH	

6.8.4 Flowchart



6.8.5 Sample program

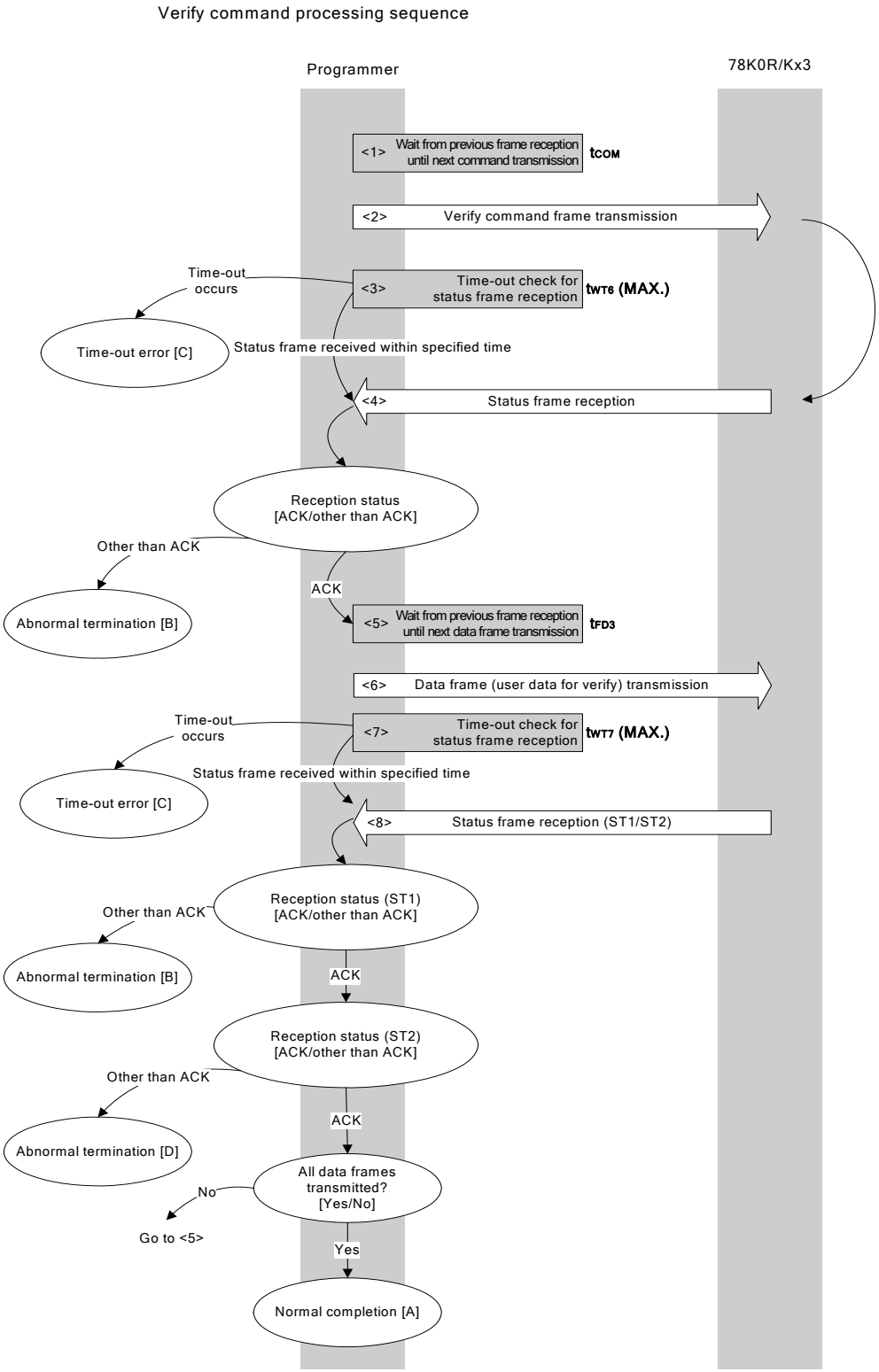
The following shows a sample program for Programming command processing.

```
/************************************************************/
/*                                                          */
/*   Write command                                          */
/*                                                          */
/************************************************************/
/*   [i] u32 top         ... start address                  */
/*   [i] u32 bottom      ... end address                    */
/*   [r] u16             ... error code                     */
/************************************************************/

#define           fl_st2_ua     (fl_ua_sfrm[OFS_STA_PLD+1])

u16        fl_ua_write(u32 top, u32 bottom)
{
     u16    rc;
     u32    send_head, send_size;
     bool   is_end;
     u16    block_num;


     block_num = get_block_num(top, bottom); // get block num

     /*********************************************/
     /*     set params                            */
     /*********************************************/
     set_range_prm(fl_cmd_prm, top, bottom); // set SAH/SAM/SAL, EAH/EAM/EAL


     /*********************************************/
     /*     send command & check status           */
     /*********************************************/
     fl_wait(tCOM);                          // wait before sending command

     put_cmd_ua(FL_COM_WRITE, 7, fl_cmd_prm);// send "Programming" command

     rc = get_sfrm_ua(fl_ua_sfrm, tWT3_MAX); // get status frame
     switch(rc) {
           case   FLC_NO_ERR:                      break; // continue
     //    case   FLC_DFTO_ERR: return rc;         break; // case [C]
           default:             return rc;         break; // case [B]
     }

     /*********************************************/
     /*     send user data                        */
     /*********************************************/
     send_head = top;

     while(1){

           // make send data frame
           if ((bottom - send_head) > 256){        // rest size > 256 ?
                 is_end = false;                   // yes, not is_end frame
                 send_size  = 256;                 // transmit size = 256 byte
```

```
            }
            else{
                  is_end = true;
                  send_size = bottom - send_head + 1;     // transmit size = (bottom
- send_head)+1 byte

            }
            memcpy(fl_txdata_frm, rom_buf+send_head, send_size); //  set  data  frame
payload
            send_head += send_size;

            fl_wait(tFD3);                          // wait before sending data frame

            put_dfrm_ua(send_size, fl_txdata_frm, is_end); // send user data

            rc = get_sfrm_ua(fl_ua_sfrm, tWT4_MAX);        // get status frame
            switch(rc) {
                  case   FLC_NO_ERR:                       break; // continue
                  case   FLC_DFTO_ERR: return rc;          break; // case [C]
                  default:             return rc;          break; // case [B]
            }
            if (fl_st2_ua != FLST_ACK){             // ST2 = ACK ?
                  rc = decode_status(fl_st2_ua);    // No
                  return rc;                        // case [D]
            }
            if (is_end)
                  break;

      }
      /*********************************************/
      /*     Check internally verify                */
      /*********************************************/
      rc = get_sfrm_ua(fl_ua_sfrm, tWT5_MAX*block_num);     // get status frame again

      switch(rc) {
//          case   FLC_NO_ERR:   return rc;          break; // case [A]
            case   FLC_DFTO_ERR: return rc;          break; // case [C]
            default:             return rc;          break; // case [E]
      }

      return rc;
}
```

6.9 Verify Command

6.9.1 Processing sequence chart



6.9.2 Description of processing sequence

<1> Waits from the previous frame reception until the next command transmission (wait time t_{COM}).
<2> The Verify command is transmitted by command frame transmission processing.
<3> A time-out check is performed from command transmission until status frame reception.
If a time-out occurs, a time-out error [C] is returned (time-out time t_{WT6}(MAX.)).
<4> The status code is checked.

When ST1 = ACK: Proceeds to <5>.
When ST1 ≠ ACK: Abnormal termination [B]

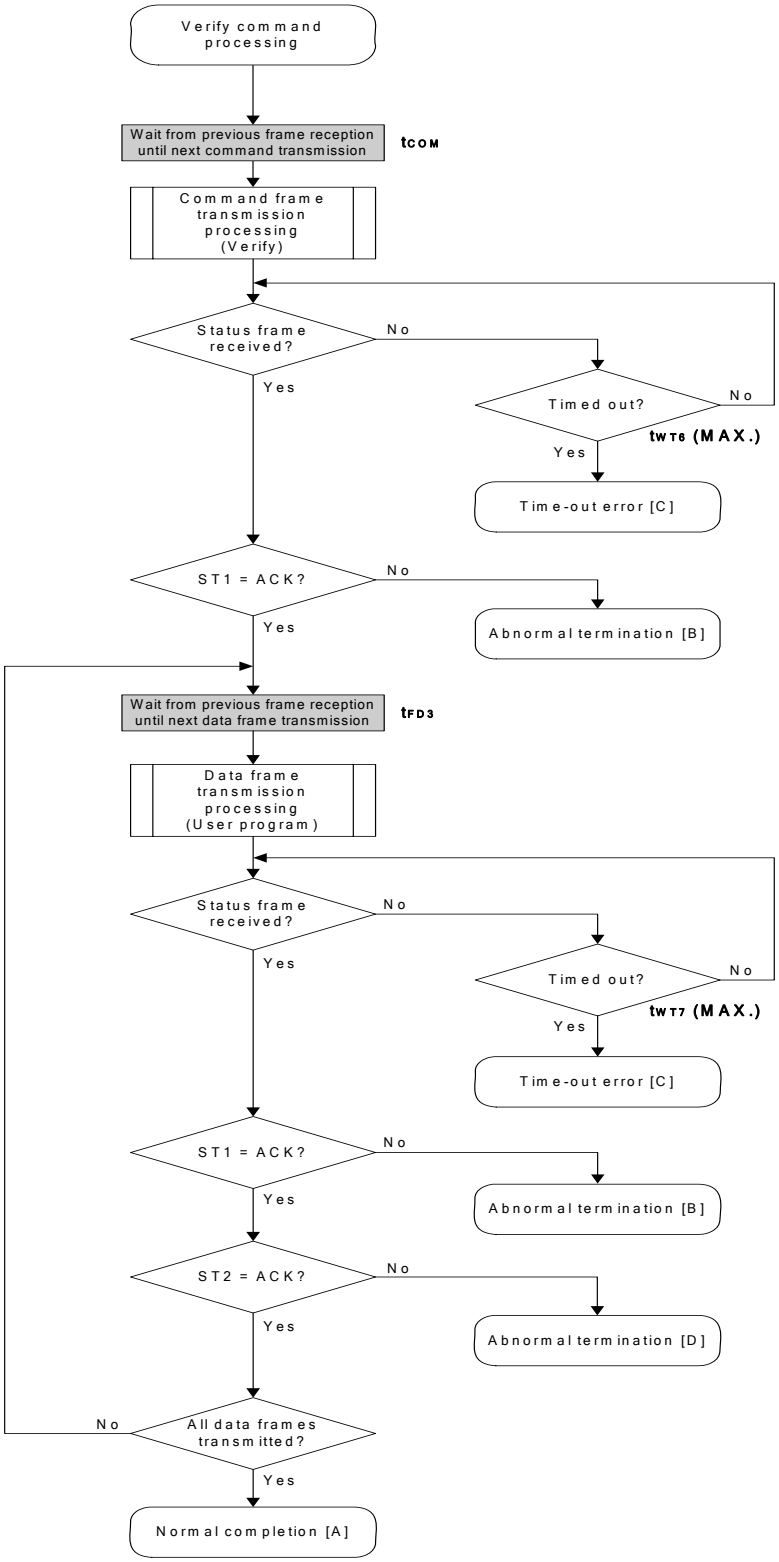
<5> Waits from the previous frame reception until the next data frame transmission (wait time t_{FD3}).
<6> User data for verifying is transmitted by data frame transmission processing.
<7> A time-out check is performed from user data transmission until status frame reception.
If a time-out occurs, a time-out error [C] is returned (time-out time t_{WT7}(MAX.)).
<8> The status code (ST1/ST2) is checked (also refer to the processing sequence chart and flowchart).

When ST1 ≠ ACK: Abnormal termination [B]
When ST1 = ACK: The following processing is performed according to the ST2 value.
- When ST2 = ACK: If transmission of all data frames is completed, the processing ends normally [A]. If there still remain data frames to be transmitted, the processing re-executes the sequence from <5>.
- When ST2 ≠ ACK: Abnormal termination [D]

6.9.3 Status at processing completion

Status at Processing Completion		Status Code	Description
Normal completion [A]	Normal acknowledgment (ACK)	06H	The command was executed normally and the verify was completed normally.
Abnormal termination [B]	Parameter error	05H	The start/end address is out of the flash memory range, the start/end address is not the start/end address of the block, or the write start address is larger than the end address.
	Checksum error	07H	The checksum of the transmitted command frame or data frame does not match.
	Negative acknowledgment (NACK)	15H	Command frame data is abnormal (such as invalid data length (LEN) or no ETX).
Time-out error [C]		–	The status frame was not received within the specified time.
Abnormal termination [D]	Verify error	0FH (ST2)	A verify error has occurred.

6.9.4 Flowchart



6.9.5 Sample program

The following shows a sample program for Verify command processing.

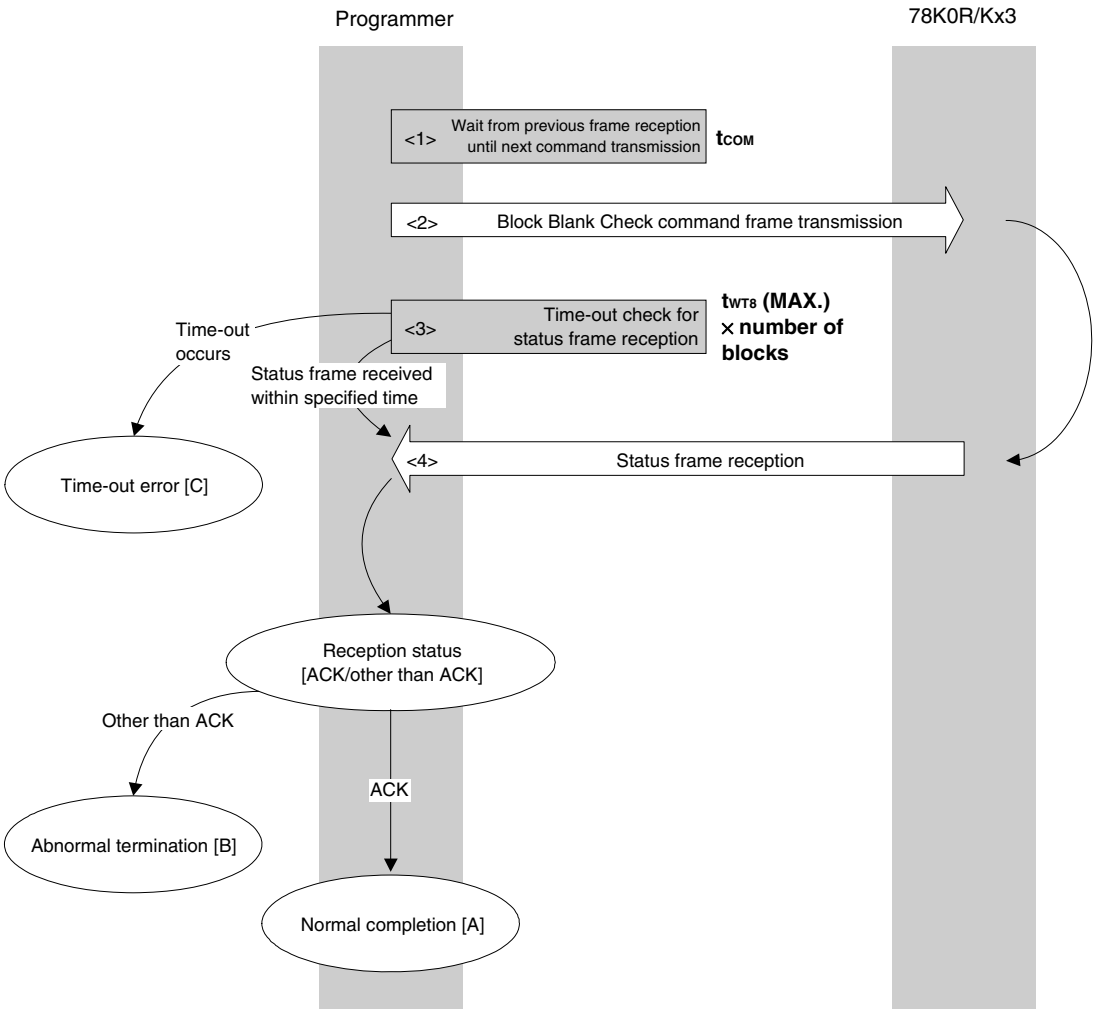
```
/************************************************************/
/*                                                          */
/*   Verify command                                         */
/*                                                          */
/************************************************************/
/*   [i] u32 top         ... start address                  */
/*   [i] u32 bottom      ... end address                    */
/*   [r] u16             ... error code                     */
/************************************************************/
u16        fl_ua_verify(u32 top, u32 bottom, u8 *buf)
{
     u16    rc;
     u32    send_head, send_size;
     bool   is_end;

     /*********************************************/
     /*     set params                            */
     /*********************************************/
     set_range_prm(fl_cmd_prm, top, bottom); // set SAH/SAM/SAL, EAH/EAM/EAL


     /*********************************************/
     /*     send command & check status           */
     /*********************************************/

     fl_wait(tCOM);                                  // wait before sending command

     put_cmd_ua(FL_COM_VERIFY, 7, fl_cmd_prm);       // send VERIFY command

     rc = get_sfrm_ua(fl_ua_sfrm, tWT6_MAX);         // get status frame
     switch(rc) {
            case   FLC_NO_ERR:                       break; // continue
     //     case   FLC_DFTO_ERR: return rc;          break; // case [C]
            default:             return rc;          break; // case [B]
     }

     /*********************************************/
     /*     send user data                        */
     /*********************************************/
     send_head = top;

     while(1){

            // make send data frame
            if ((bottom - send_head) > 256){         // rest size > 256 ?
                   is_end = false;                   // yes, not is_end frame
                   send_size  = 256;                 // transmit size = 256 byte
            }
            else{
                   is_end = true;
                   send_size = bottom - send_head + 1;// transmit size = (bottom -
send_head)+1 byte
```

```
            }
            memcpy(fl_txdata_frm, buf+send_head, send_size);// set data frame payload
            send_head += send_size;

            fl_wait(tFD3);
            put_dfrm_ua(send_size, fl_txdata_frm, is_end); // send user data

            rc = get_sfrm_ua(fl_ua_sfrm, tWT7_MAX);        // get status frame
            switch(rc) {
                  case   FLC_NO_ERR:                break; // continue
            //    case   FLC_DFTO_ERR: return rc;   break; // case [C]
                  default:             return rc;   break; // case [B]
            }
            if (fl_st2_ua != FLST_ACK){               // ST2 = ACK ?
                  rc = decode_status(fl_st2_ua);      // No
                  return rc;                          // case [D]
            }
            if (is_end)                     // send all user data ?
                  break;                    // yes
            //continue;
      }
      return FLC_NO_ERR;   // case [A]
}
```

6.10 Block Blank Check Command

6.10.1 Processing sequence chart

Block Blank Check command processing sequence



6.10.2 Description of processing sequence

<1> Waits from the previous frame reception until the next command transmission (wait time t_{COM}).

<2> The Block Blank Check command is transmitted by command frame transmission processing.

<3> A time-out check is performed from command transmission until status frame reception.
If a time-out occurs, a time-out error [C] is returned (time-out time t_{WT8}(MAX.) × number of blocks).

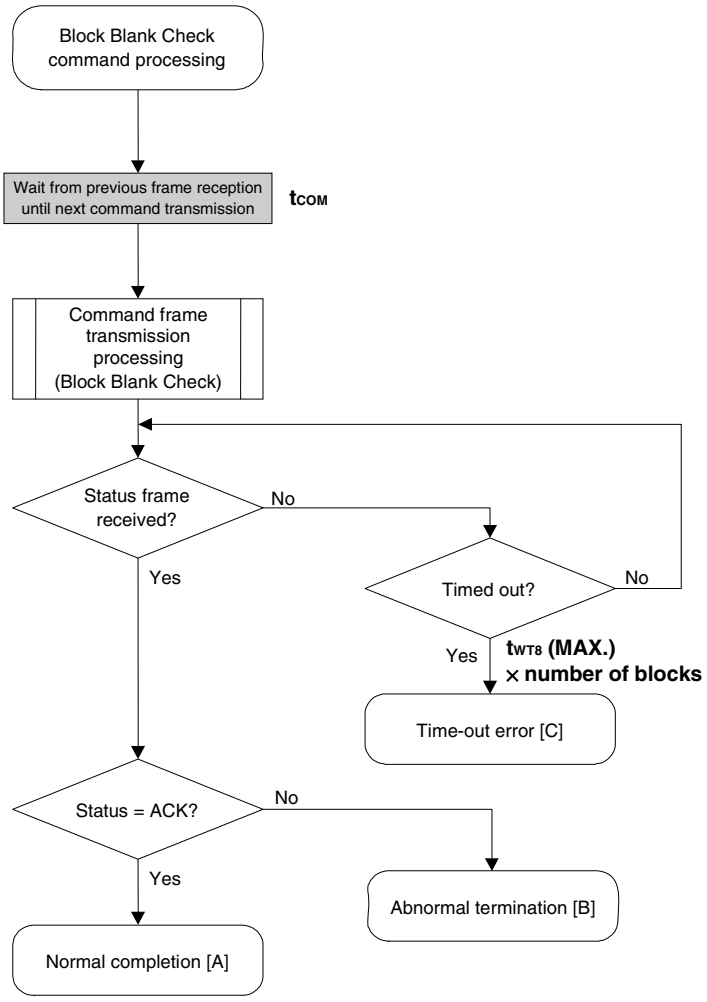
<4> The status code is checked.

When ST1 = ACK: Normal completion [A]
When ST1 ≠ ACK: Abnormal termination [B]

6.10.3 Status at processing completion

Status at Processing Completion		Status Code	Description
Normal completion [A]	Normal acknowledgment (ACK)	06H	The command was executed normally and block blank check was executed normally.
Abnormal termination [B]	Parameter error	05H	The end address is out of the flash memory range, the start/end address is not the first/end address of the block, or the value of parameter D01 is other than 00H or 01H.
	Checksum error	07H	The checksum of the transmitted command frame does not match.
	Negative acknowledgment (NACK)	15H	Command frame data is abnormal (such as invalid data length (LEN) or no ETX).
	MRG11 error	1BH	The flash memory of the specified block is not blank.
Time-out error [C]		–	The status frame was not received within the specified time.

6.10.4 Flowchart



6.10.5 Sample program

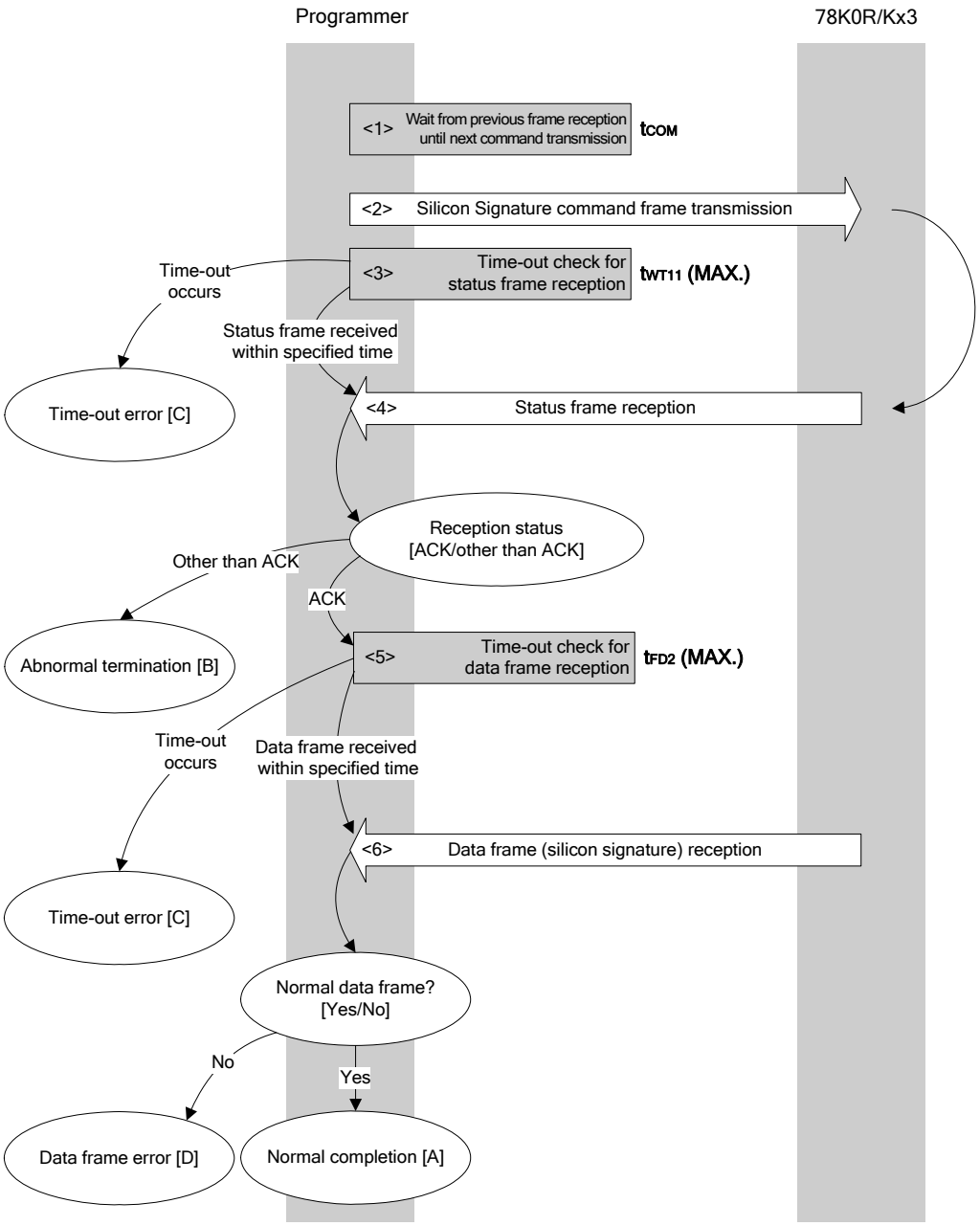
The following shows a sample program for Block Blank Check command processing.

```
/************************************************************/
/*                                                          */
/* Block blank check command                                */
/*                                                          */
/************************************************************/
/* [i] u32 top     ... top address of blank check           */
/* [i] u32 bottom  ... bottom address of blank check        */
/* [i]  u8 whole   ... <1>check w/NON user flash            */
/*                     <0>chek only user flash              */
/* [r] u16         ... error code                           */
/************************************************************/
u16         fl_ua_blk_blank_chk(u32 top, u32 bottom, u8 whole)
{
     u16    rc;
     u16    block_num;

     set_range_prm(fl_cmd_prm, top, bottom); // set SAH/SAM/SAL, EAH/EAM/EAL
     block_num = get_block_num(top, bottom); // get block num
     fl_cmd_prm[6] = whole;                  // check only user area or not

     fl_wait(tCOM);                          // wait before sending command

     put_cmd_ua(FL_COM_BLOCK_BLANK_CHK, 7+1, fl_cmd_prm);


     rc = get_sfrm_ua(fl_ua_sfrm, tWT8_MAX * block_num);  // get status frame
//   switch(rc) {
//
//         case    FLC_NO_ERR:    return rc;       break; // case [A]
//         case    FLC_DFTO_ERR:  return rc;       break; // case [C]
//         default:               return rc;       break; // case [B]
//   }
     return rc;
}
```

6.11 Silicon Signature Command

6.11.1 Processing sequence chart

Silicon Signature command processing sequence



6.11.2 Description of processing sequence

<1> Waits from the previous frame reception until the next command transmission (wait time t_{COM}).
<2> The Silicon Signature command is transmitted by command frame transmission processing.
<3> A time-out check is performed from command transmission until status frame reception.
If a time-out occurs, a time-out error [C] is returned (time-out time t_{WT11}(MAX.)).
<4> The status code is checked.

When ST1 = ACK: Proceeds to <5>.
When ST1 ≠ ACK: Abnormal termination [B]

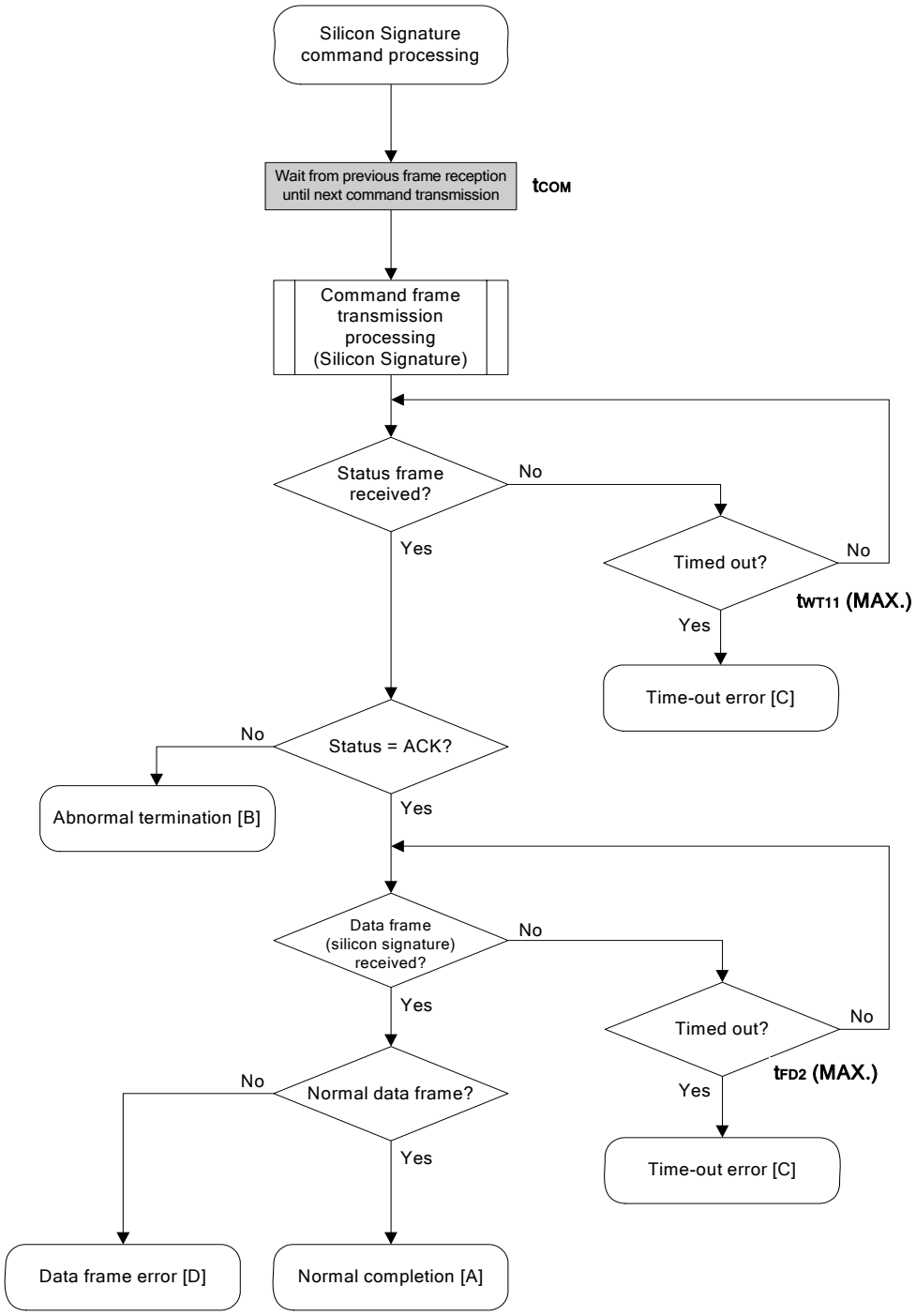
<5> A time-out check is performed until data frame (silicon signature data) reception.
If a time-out occurs, a time-out error [C] is returned (time-out time t_{FD2}(MAX.)).
<6> The received data frame (silicon signature data) is checked.

If data frame is normal: Normal completion [A]
If data frame is abnormal: Data frame error [D]

6.11.3 Status at processing completion

Status at Processing Completion		Status Code	Description
Normal completion [A]	Normal acknowledgment (ACK)	06H	The command was executed normally and silicon signature data was acquired normally.
Abnormal termination [B]	Checksum error	07H	The checksum of the transmitted command frame does not match.
	Negative acknowledgment (NACK)	15H	Command frame data is abnormal (such as invalid data length (LEN) or no ETX).
Time-out error [C]		–	The status frame or data frame was not received within the specified time.
Data frame error [D]		–	The checksum of the data frame received as silicon signature data does not match.

6.11.4 Flowchart



6.11.5 Sample program

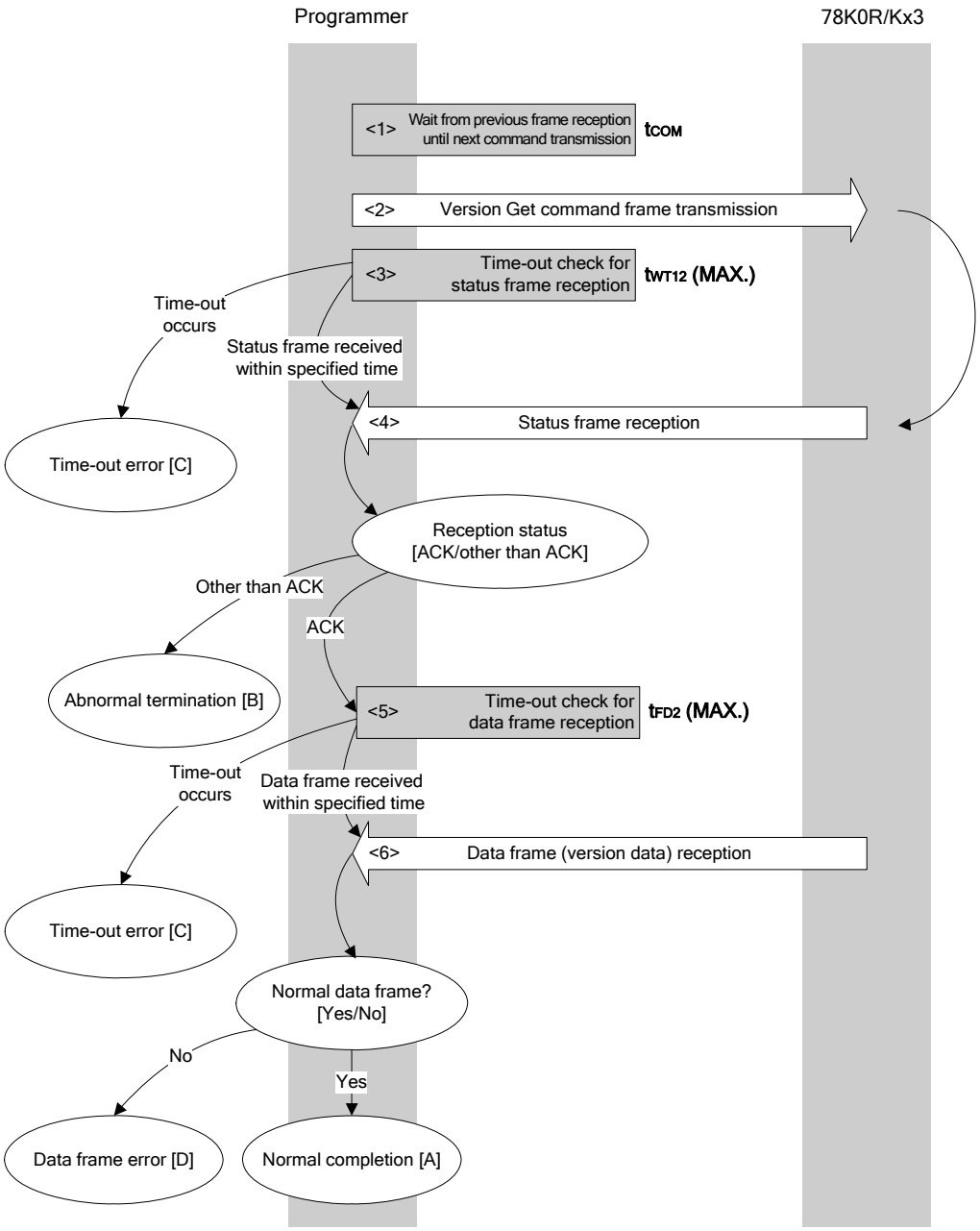
The following shows a sample program for Silicon Signature command processing.

```
/************************************************************/
/*                                                          */
/* Get silicon signature command                            */
/*                                                          */
/************************************************************/
/* [i] u8 *sig  ... pointer to signature save area          */
/* [r] u16      ... error code                              */
/************************************************************/
u16         fl_ua_getsig(u8 *sig)
{
     u16    rc;


     fl_wait(tCOM);                                  // wait before sending command

     put_cmd_ua(FL_COM_GET_SIGNATURE, 1, fl_cmd_prm); // send GET SIGNATURE command

     rc = get_sfrm_ua(fl_ua_sfrm, tWT11_MAX);        // get status frame
     switch(rc) {
            case   FLC_NO_ERR:               break; // continue
     //     case   FLC_DFTO_ERR: return rc;  break; // case [C]
            default:             return rc;  break; // case [B]
     }


     rc = get_dfrm_ua(fl_rxdata_frm, tFD2_MAX);      // get status frame
     if (rc){                                        // if error
            return rc;                               // case [D]
     }
     memcpy(sig, fl_rxdata_frm+OFS_STA_PLD, fl_rxdata_frm[OFS_LEN]);// copy Signature
data
     return rc;                                      // case [A]
}
```

6.12 Version Get Command

6.12.1 Processing sequence chart

Version Get command processing sequence



6.12.2 Description of processing sequence

<1> Waits from the previous frame reception until the next command transmission (wait time t_{COM}).

<2> The Version Get command is transmitted by command frame transmission processing.

<3> A time-out check is performed from command transmission until status frame reception.
If a time-out occurs, a time-out error [C] is returned (time-out time t_{WT12}(MAX.)).

<4> The status code is checked.

When ST1 = ACK: Proceeds to <5>.
When ST1 ≠ ACK: Abnormal termination [B]

<5> A time-out check is performed until data frame (version data) reception.
If a time-out occurs, a time-out error [C] is returned (time-out time t_{FD2}(MAX.)).

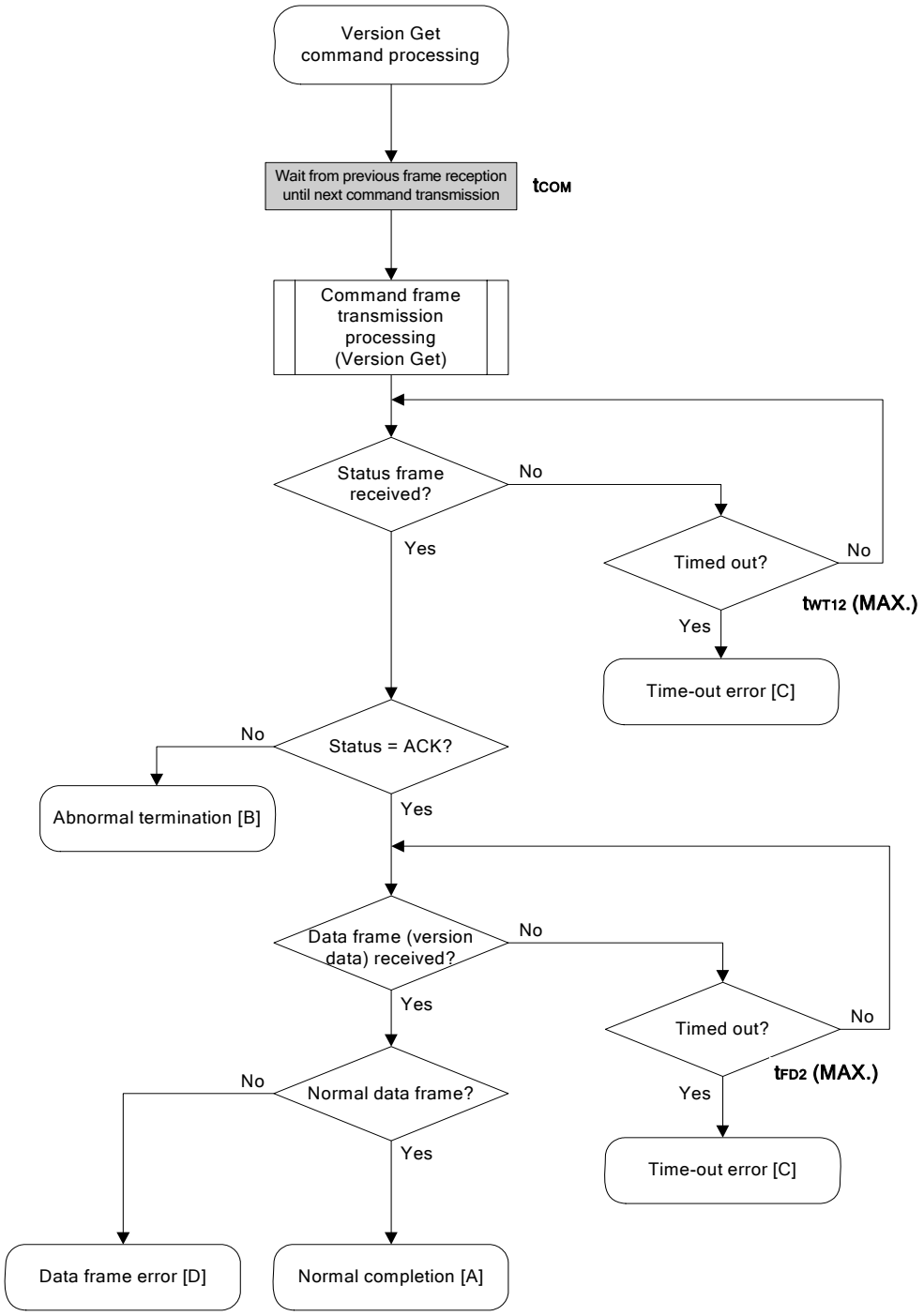
<6> The received data frame (version data) is checked.

If data frame is normal: Normal completion [A]
If data frame is abnormal: Data frame error [D]

6.12.3 Status at processing completion

Status at Processing Completion		Status Code	Description
Normal completion [A]	Normal acknowledgment (ACK)	06H	The command was executed normally and version data was acquired normally.
Abnormal termination [B]	Checksum error	07H	The checksum of the transmitted command frame does not match.
	Negative acknowledgment (NACK)	15H	Command frame data is abnormal (such as invalid data length (LEN) or no ETX).
Time-out error [C]		–	The status frame or data frame was not received within the specified time.
Data frame error [D]		–	The checksum of the data frame received as version data does not match.

6.12.4 Flowchart



6.12.5 Sample program

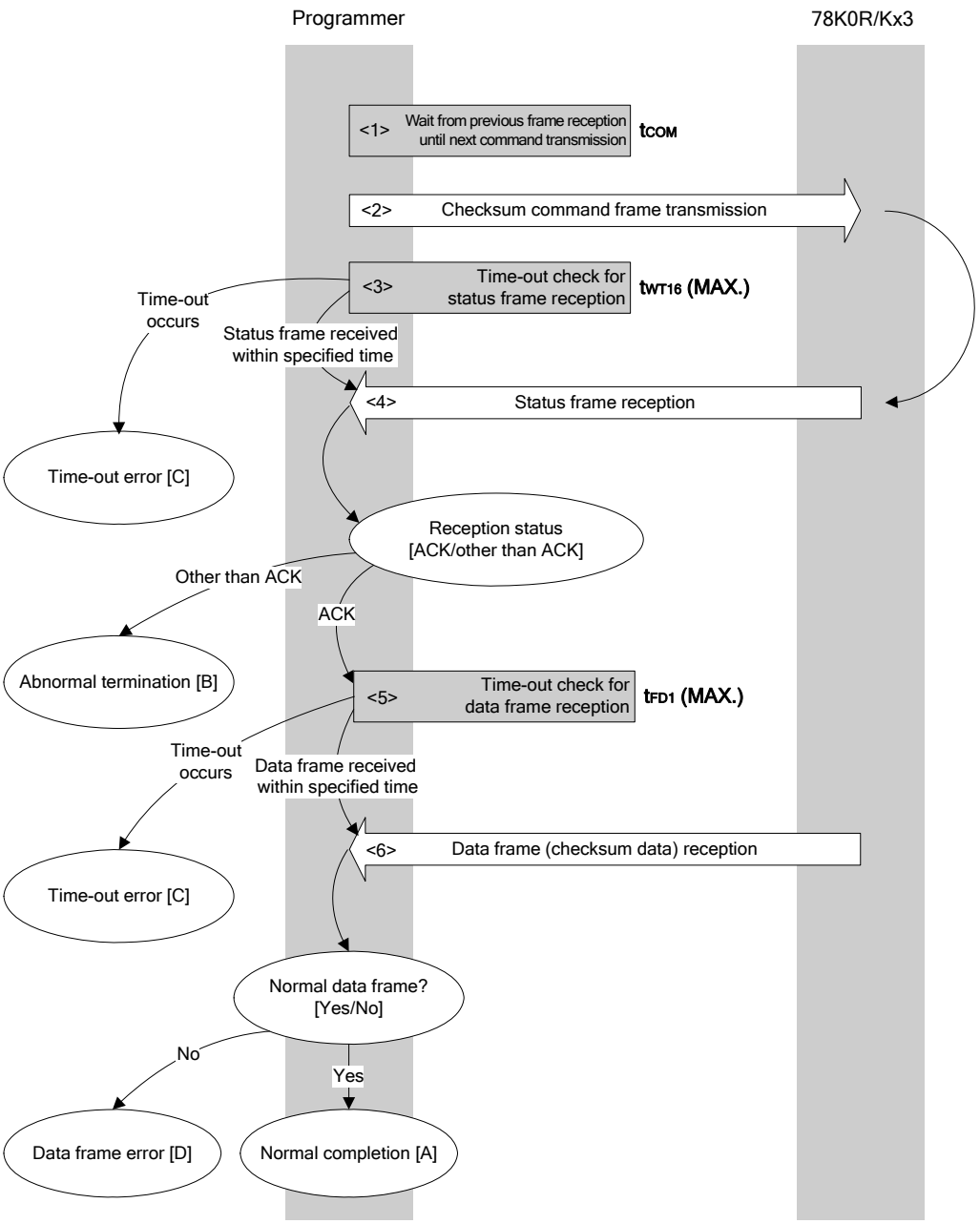
The following shows a sample program for Version Get command processing.

```
/************************************************************/
/*                                                          */
/* Get device/firmware version command                      */
/*                                                          */
/************************************************************/
/* [i] u8 *buf    ... pointer to version date save area     */
/* [r] u16        ... error code                            */
/************************************************************/
u16        fl_ua_getver(u8 *buf)
{
     u16    rc;


     fl_wait(tCOM);                                  // wait before sending command


     put_cmd_ua(FL_COM_GET_VERSION, 1, fl_cmd_prm); // send GET VERSION command

     rc = get_sfrm_ua(fl_ua_sfrm, tWT12_MAX);       // get status frame
     switch(rc) {
            case   FLC_NO_ERR:                      break; // continue
     //     case   FLC_DFTO_ERR: return rc;         break; // case [C]
            default:             return rc;         break; // case [B]
     }

     rc = get_dfrm_ua(fl_rxdata_frm, tFD2_MAX);     // get data frame
     if (rc){
            return rc;                              // case [D]
     }

     memcpy(buf, fl_rxdata_frm+OFS_STA_PLD, DFV_LEN);// copy version data
     return rc;                                     // case [A]
}
```

6.13 Checksum Command

6.13.1 Processing sequence chart

Checksum command processing sequence



6.13.2 Description of processing sequence

<1> Waits from the previous frame reception until the next command transmission (wait time t_{COM}).

<2> The Checksum command is transmitted by command frame transmission processing.

<3> A time-out check is performed from command transmission until status frame reception.
If a time-out occurs, a time-out error [C] is returned (time-out time t_{WT16}(MAX.)).

<4> The status code is checked.

When ST1 = ACK: Proceeds to <5>.
When ST1 ≠ ACK: Abnormal termination [B]

<5> A time-out check is performed until data frame (checksum data) reception.
If a time-out occurs, a time-out error [C] is returned (time-out time t_{FD1}(MAX.)).

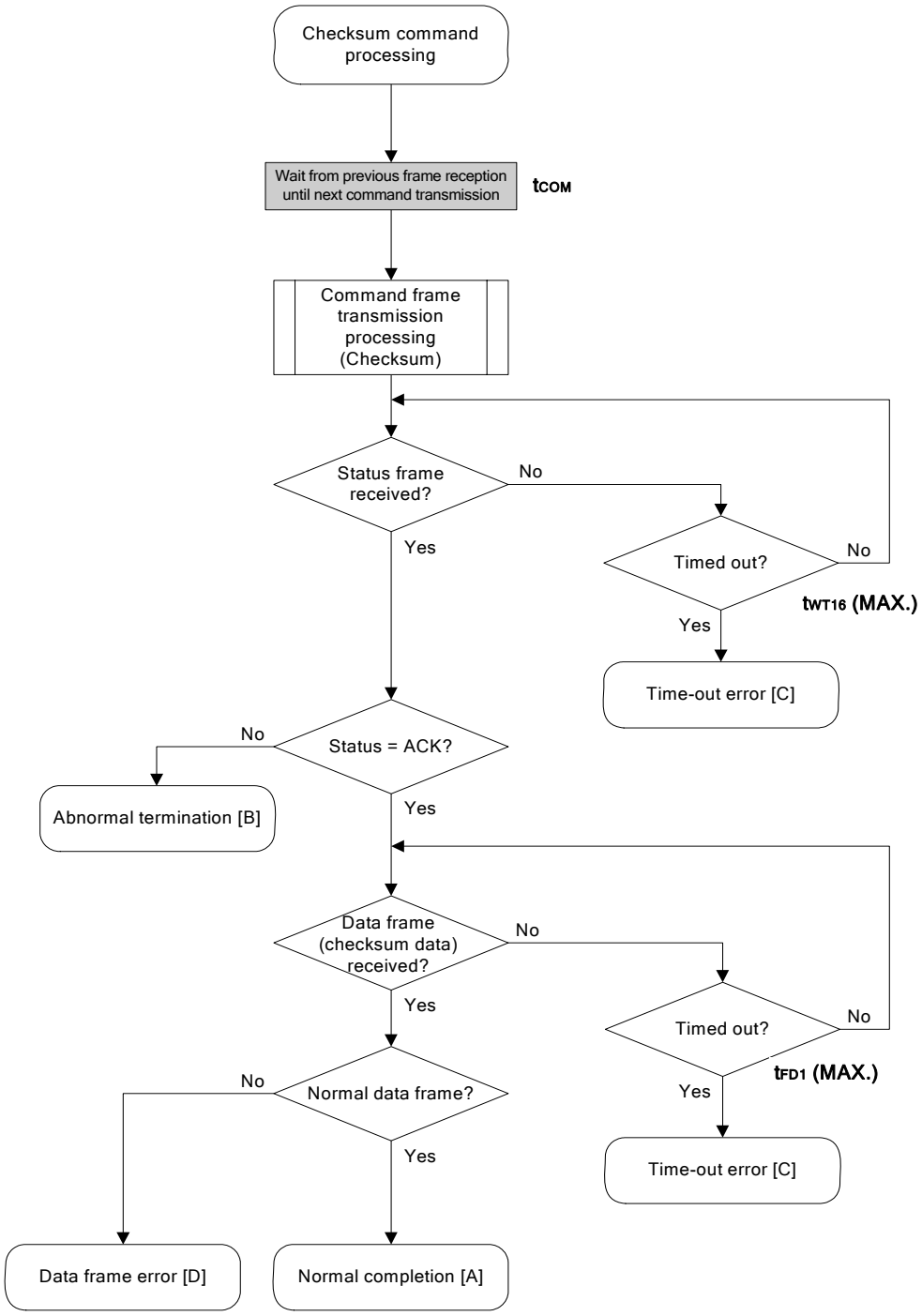
<6> The received data frame (checksum data) is checked.

If data frame is normal: Normal completion [A]
If data frame is abnormal: Data frame error [D]

6.13.3 Status at processing completion

Status at Processing Completion		Status Code	Description
Normal completion [A]	Normal acknowledgment (ACK)	06H	The command was executed normally and checksum data was acquired normally.
Abnormal termination [B]	Parameter error	05H	The specified start/end address is out of the flash memory range, or the start/end address is not the start/end address of the block.
	Checksum error	07H	The checksum of the transmitted command frame does not match.
	Negative acknowledgment (NACK)	15H	Command frame data is abnormal (such as invalid data length (LEN) or no ETX).
Time-out error [C]		–	The status frame or data frame was not received within the specified time.
Data frame error [D]		–	The checksum of the data frame received as checksum data does not match.

6.13.4 Flowchart



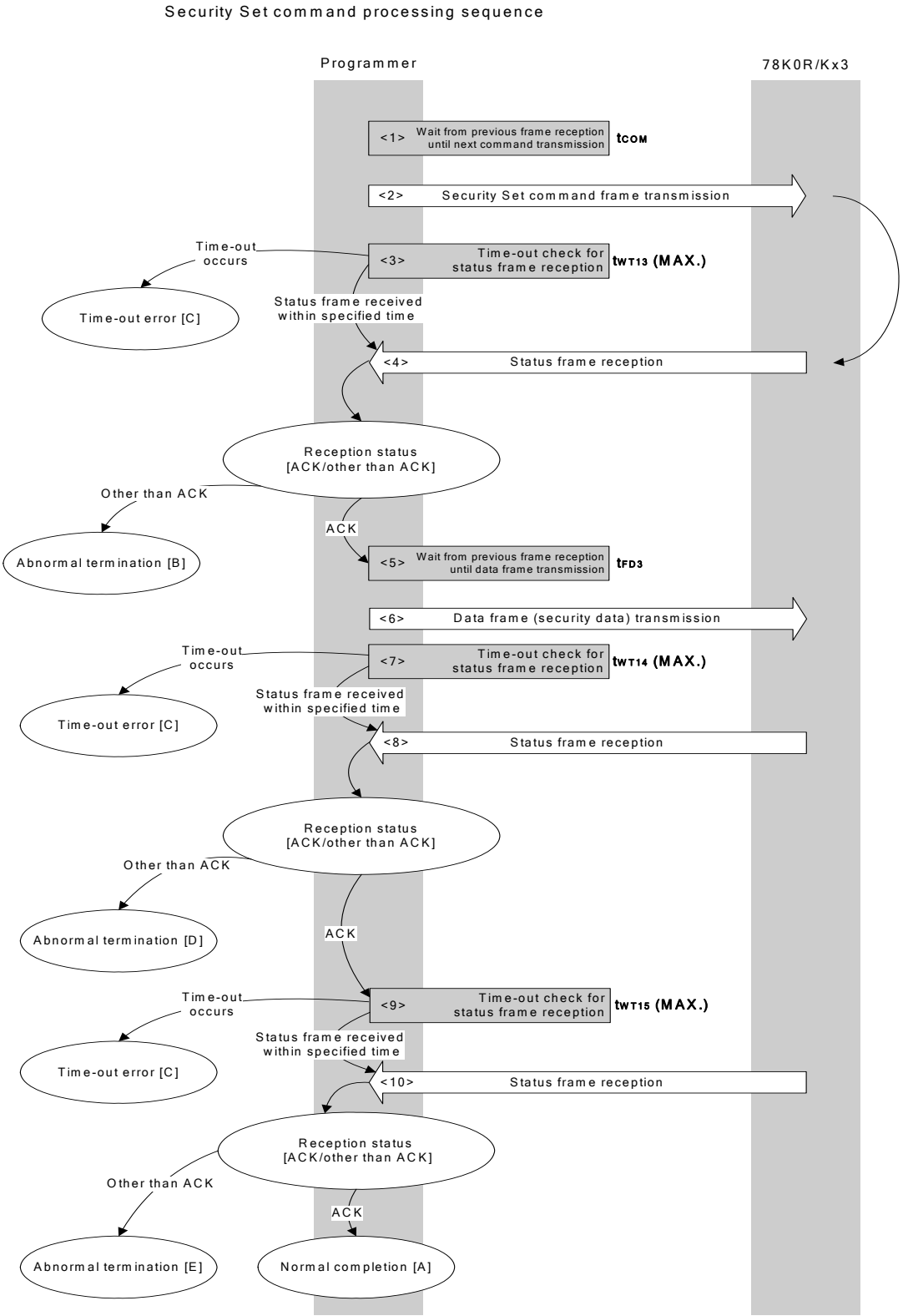
6.13.5 Sample program

The following shows a sample program for Checksum command processing.

```
/************************************************************/
/*                                                          */
/*   Get checksum command                                   */
/*                                                          */
/************************************************************/
/*   [i] u16 *sum    ... pointer to checksum save area      */
/*   [i] u32 top     ... start address                      */
/*   [i] u32 bottom  ... end address                        */
/*   [r] u16         ... error code                         */
/************************************************************/
u16        fl_ua_getsum(u16 *sum, u32 top, u32 bottom)
{
     u16    rc;

     /*********************************************/
     /*     set params                             */
     /*********************************************/
     // set params
     set_range_prm(fl_cmd_prm, top, bottom); // set SAH/SAM/SAL, EAH/EAM/EAL


     /*********************************************/
     /*     send command                           */
     /*********************************************/

     fl_wait(tCOM);                                  // wait before sending command

     put_cmd_ua(FL_COM_GET_CHECK_SUM, 7, fl_cmd_prm); // send GET VERSION command

     rc = get_sfrm_ua(fl_ua_sfrm, tWT16_MAX);        // get status frame
     switch(rc) {
           case   FLC_NO_ERR:                        break; // continue
     //    case   FLC_DFTO_ERR: return rc;           break; // case [C]
           default:             return rc;           break; // case [B]
     }

     /*********************************************/
     /*     get data frame (Checksum data)         */
     /*********************************************/
     rc = get_dfrm_ua(fl_rxdata_frm, tFD1_MAX);      // get status frame
     if (rc){                                        // if no error,
           return rc;                                // case [D]
     }

     *sum = (fl_rxdata_frm[OFS_STA_PLD] << 8) + fl_rxdata_frm[OFS_STA_PLD+1]; // set
SUM data
     return rc;                                      // case [A]

}
```

6.14 Security Set Command

6.14.1 Processing sequence chart



6.14.2 Description of processing sequence

<1> Waits from the previous frame reception until the next command transmission (wait time t_{COM}).
<2> The Security Set command is transmitted by command frame transmission processing.
<3> A time-out check is performed from command transmission until status frame reception.
If a time-out occurs, a time-out error [C] is returned (time-out time t_{WT13} (MAX.)).
<4> The status code is checked.

When ST1 = ACK: Proceeds to <5>.
When ST1 ≠ ACK: Abnormal termination [B]

<5> Waits from the previous frame reception until the next data frame transmission (wait time t_{FD3}).
<6> The data frame (security setting data) is transmitted by data frame transmission processing.
<7> A time-out check is performed until status frame reception.
If a time-out occurs, a time-out error [C] is returned (time-out time t_{WT14} (MAX.)).
<8> The status code is checked.

When ST1 = ACK: Proceeds to <9>.
When ST1 ≠ ACK: Abnormal termination [D]

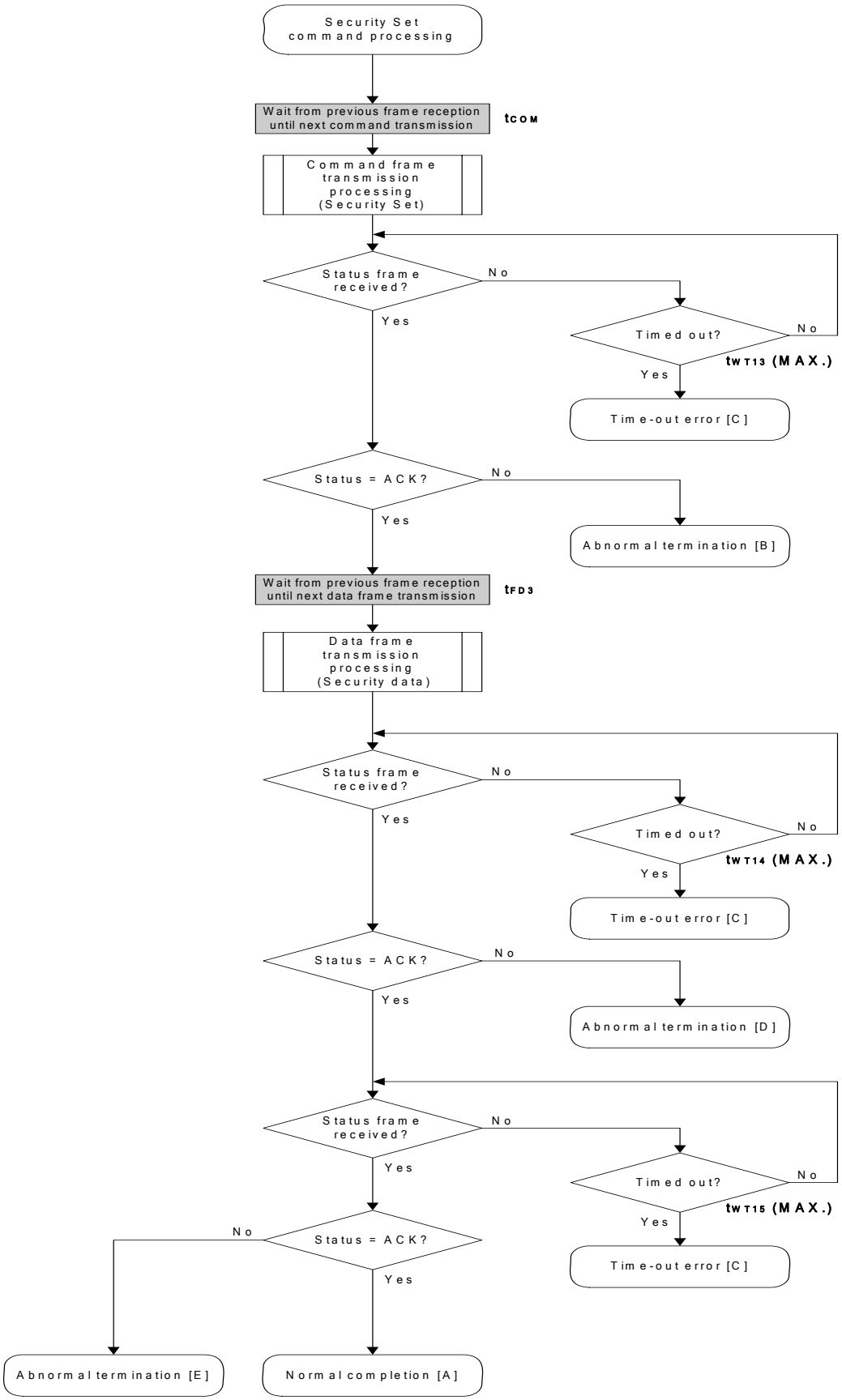
<9> A time-out check is performed until status frame reception.
If a time-out occurs, a time-out error [C] is returned (time-out time t_{WT15} (MAX.)).
<10> The status code is checked.

When ST1 = ACK: Normal completion [A]
When ST1 ≠ ACK: Abnormal termination [E]

6.14.3 Status at processing completion

Status at Processing Completion		Status Code	Description
Normal completion [A]	Normal acknowledgment (ACK)	06H	The command was executed normally and security setting data was set normally.
Abnormal termination [B]	Parameter error	05H	Parameter BOT is not 01H, the FSW setting block is not set so that the start block number is larger than the end block number, or the FSW end block number is larger than the last block number.
	Checksum error	07H	The checksum of the transmitted command frame or data frame does not match.
	Protect error	10H	An already prohibited flag is to be enabled.
	Negative acknowledgment (NACK)	15H	Command frame data is abnormal (such as invalid data length (LEN) or no ETX).
Time-out error [C]		–	The status frame or data frame was not received within the specified time.
Abnormal termination [D], [E]	MRG10 error	1AH	Writing security data has failed.
	MRG11 error	1BH	
	Write error	1CH	

6.14.4 Flowchart



6.14.5 Sample program

The following shows a sample program for Security Set command processing.

```
/************************************************************/
/*                                                          */
/*   Set security flag command                              */
/*                                                          */
/************************************************************/
/*   [i] u8 scf  ... Security flag data                     */
/*   [r] u16     ... error code                             */
/************************************************************/
u16        fl_ua_setscf(u8 scf, u8 bot, u8 fsws, u8 fswe)
{
     u16    rc;

     /*********************************************/
     /*     set params                             */
     /*********************************************/
     fl_cmd_prm[0] = 0x00;                  // "BLK" (must be 0x00)
     fl_cmd_prm[1] = 0x00;                  // "PAG" (must be 0x00)

     fl_txdata_frm[0] = scf|= 0b11101000;   // "FLG" (bit 7,6,5,3 must be '1')
     fl_txdata_frm[1] = bot;                // "BOT"
     fl_txdata_frm[2] = 0x00;               // "FSWS High"
     fl_txdata_frm[3] = fsws;               // "FSWS Low"
     fl_txdata_frm[4] = 0x00;               // "FSWE High"
     fl_txdata_frm[5] = fswe;               // "FSWE Low"

     /*********************************************/
     /*     send command                           */
     /*********************************************/
     fl_wait(tCOM);                                 // wait before sending command

     put_cmd_ua(FL_COM_SET_SECURITY, 3, fl_cmd_prm);

     rc = get_sfrm_ua(fl_ua_sfrm, tWT13_MAX);       // get status frame
     switch(rc) {
            case   FLC_NO_ERR:                      break; // continue
     //     case   FLC_DFTO_ERR: return rc;         break; // case [C]
            default:             return rc;         break; // case [B]
     }


     /*********************************************/
     /*    send data frame (security setting data)   */
     /*********************************************/

     fl_wait(tFD4);
     put_dfrm_ua(6, fl_txdata_frm, true);           // send securithi setting data

//   rc = get_sfrm_ua(fl_ua_sfrm, tWT14_MAX);       // get status frame
     rc = get_sfrm_ua(fl_ua_sfrm, tWT14_MAX+100);   //  get  status  frame  (+100us  is
overhead)
     switch(rc) {
            case   FLC_NO_ERR:                break; // continue
     //     case   FLC_DFTO_ERR: return rc;   break; // case [C]
```

```
            default:            return rc;    break; // case [B]
        }

        /*********************************************/
        /*     Check internally verify                */
        /*********************************************/
        rc = get_sfrm_ua(fl_ua_sfrm, tWT15_MAX);       // get status frame
//      switch(rc) {
//
//          case   FLC_NO_ERR:  return rc;    break; // case [A]
//          case   FLC_DFTO_ERR:return rc;    break; // case [C]
//          default:            return rc;    break; // case [B]
//      }
        return rc;
}
```

CHAPTER 7 FLASH MEMORY PROGRAMMING PARAMETER CHARACTERISTICS

This chapter describes the parameter characteristics between the programmer and the 78K0R/Kx3 in the flash memory programming mode.

Be sure to refer to the user's manual of the 78K0R/Kx3 for electrical specifications when designing a programmer.

(1) Flash memory parameter characteristics

(a) Flash memory programming mode setting time

Parameter	Symbol	MIN.	TYP.	MAX.
V_{DD}↑ to FLMD0↑	t_{DP}	0		
FLMD0↑ to $\overline{\text{RESET}}$↑	t_{PR}	2 ms		
Ready start time from $\overline{\text{RESET}}$↑	t_{R0}	3 ms		100 ms
Low level data0 (Ready) width[Note]	t_{L0}	892 μs	937.5 μs	987 μs
Wait for low level data1	t_{01}	120 μs		
Wait for low level data2	t_{02}	10 μs		
Wait for Read command	t_{2C}	300 μs		
Low level data1/data2 width[Note]	t_{L1}, t_{L2}		937.5 μs	

Note The low-level width is the same as the 00H data width at 9,600 bps. (It includes the start bit and is therefore "0" data of 9 bits.)

t_{L0} is the low-level width of the data transmitted from the 78K0R/Kx3 firmware. t_{L1} and t_{L2} are the low-level widths of the data transmitted from the flash programmer.

(b) Programming characteristics

Wait	Condition	Symbol	MIN.	MAX.
Between data frame transmissions	Data frame reception	t_{DR}	8.0 μs	
	Data frame transmission	t_{DT}	**Note**	
From status frame transmission until data frame transmission	–	t_{FD1}	**Note**	
From status frame transmission until data frame reception (1)	Program command	t_{FD2}	8.7 μs	
From status frame transmission until data frame reception (2)	Verify command	t_{FD3}	145 μs	
From status frame transmission until data frame reception (3)	Security setting command	t_{FD4}	120 μs	
From status frame transmission until command frame reception	–	t_{COM}	595 μs	

Note Enable successive reception for the programmer. Also, set the time-out time for the programmer to 3 seconds or more.

Remark The waits are defined as follows.

<t_{DR}, t_{FD2}, t_{FD3}, t_{FD4}, t_{COM}>

The 78K0R/Kx3 is readied for the next communication after the MIN. time has elapsed after completion of the previous communication.

<t_{DT}, t_{FD1}>

The 78K0R/Kx3 is readied for the next communication after the MIN. time has elapsed after completion of the previous communication.

(c) Command characteristics

Command	Symbol	Condition	MIN.	MAX.
Reset	t_{WT0}	–	**Note 1**	
Chip Erase	t_{WT1}	Product group A[Note 2]	(60.6 + 5.7 × total number of blocks) ms	(1112 + 140.9 × total number of blocks) ms
		Product group B[Note 3]	(812.9 + 5.7 × (total number of blocks – 128)) ms	(19403.5 + 140.9 × (total number of blocks – 128)) ms
Block Erase	t_{WT2}[Note 4]	–	17.5 ms	(1.1 + 275.5 × execution count of simultaneous selection and erasure + 137.9 × number of blocks to be erased) ms
Programming	t_{WT3}	–	**Note 1**	
	t_{WT4}[Note 5]	–	2.8 ms	47.2 ms
	t_{WT5}[Note 6]	Block 0	13.3 ms	860.0 ms
		Other than block 0	13.3 ms	16.3 ms
Verify	t_{WT6}	–	**Note 1**	
	t_{WT7}[Note 5]	–	**Note 7**	
Block Blank Check	t_{WT8}[Note 6]	–	5.7 ms	7.7 ms
Baud Rate Set	t_{WT10}	–	66.0 μs	
Silicon Signature	t_{WT11}	–	**Note 1**	
Version Get	t_{WT12}	–	**Note 1**	
Security Set	t_{WT13}	–	**Note 1**	
	t_{WT14}	–	**Note 1**	20.0 μs
	t_{WT15}	–	**Note 8**	843.7 ms
Checksum	t_{WT16}	–	**Note 1**	

Notes 1. Reception must be enabled for the programmer before command frame transmission. Also, set the time-out time for the programmer to 3 seconds or more.

2. Product group A: Flash size ≤ 256 KB (number of blocks ≤ 128)

3. Product group B: Flash size > 256 KB (number of blocks > 128)

4. See (2) Simultaneous selection and erasure performed by Block Erase command for the calculation method of the execution count of simultaneous selection and erasure.

5. Time for 256-byte data transmission

6. Time for one block transmission

7. Reception must be enabled for the programmer before data frame transmission. Also, set the time-out time for the programmer to 3 seconds or more.

8. Enable successive reception for the programmer. Also, set the time-out time for the programmer to 3 seconds or more.

(A Remark is on the next page.)

Remark The waits are defined as follows.

<t_{WT0} to t_{WT8}, t_{WT11} to t_{WT16}>

The 78K0R/Kx3 completes command processing between the MIN. and MAX. times and transmits a status frame.

For commands with a specified MAX. time, the programmer must wait for the start bit of the reception frame until the MAX. time has elapsed and then perform time-out processing.

See the corresponding note for commands without a specified MAX. time.

<t_{WT10}>

The 78K0R/Kx3 can perform the next communication after MIN., after the communication immediately before has been completed.

The programmer must transmit the next data after the MIN. time elapses, after the communication immediately before has been completed.

(2) Simultaneous selection and erasure performed by Block Erase command

The Block Erase command of the 78K0R/Kx3 is executed by repeating “simultaneous selection and erasure”, which erases multiple blocks simultaneously.
The wait time inserted during Block Erase command execution is therefore equal to the total execution time of “simultaneous selection and erasure”.
To calculate the “total execution time of simultaneous selection and erasure”, the execution count (M) of the simultaneous selection and erasure must first be calculated.
“M” is calculated by obtaining the number of blocks to be erased simultaneously (number of blocks to be selected and erased simultaneously).

The following describes the method for calculating the number of blocks to be selected and erased simultaneously and the execution count (M).

(a) Calculation of number of blocks to be selected and erased simultaneously

The number of blocks to be selected and erased simultaneously should be 1, 2, 4, 8, 16, 32, 64, or 128, depending on which satisfies all of the following conditions.

[Condition 1]

(Number of blocks to be erased) ≥ (Number of blocks to be selected and erased simultaneously)

[Condition 2]

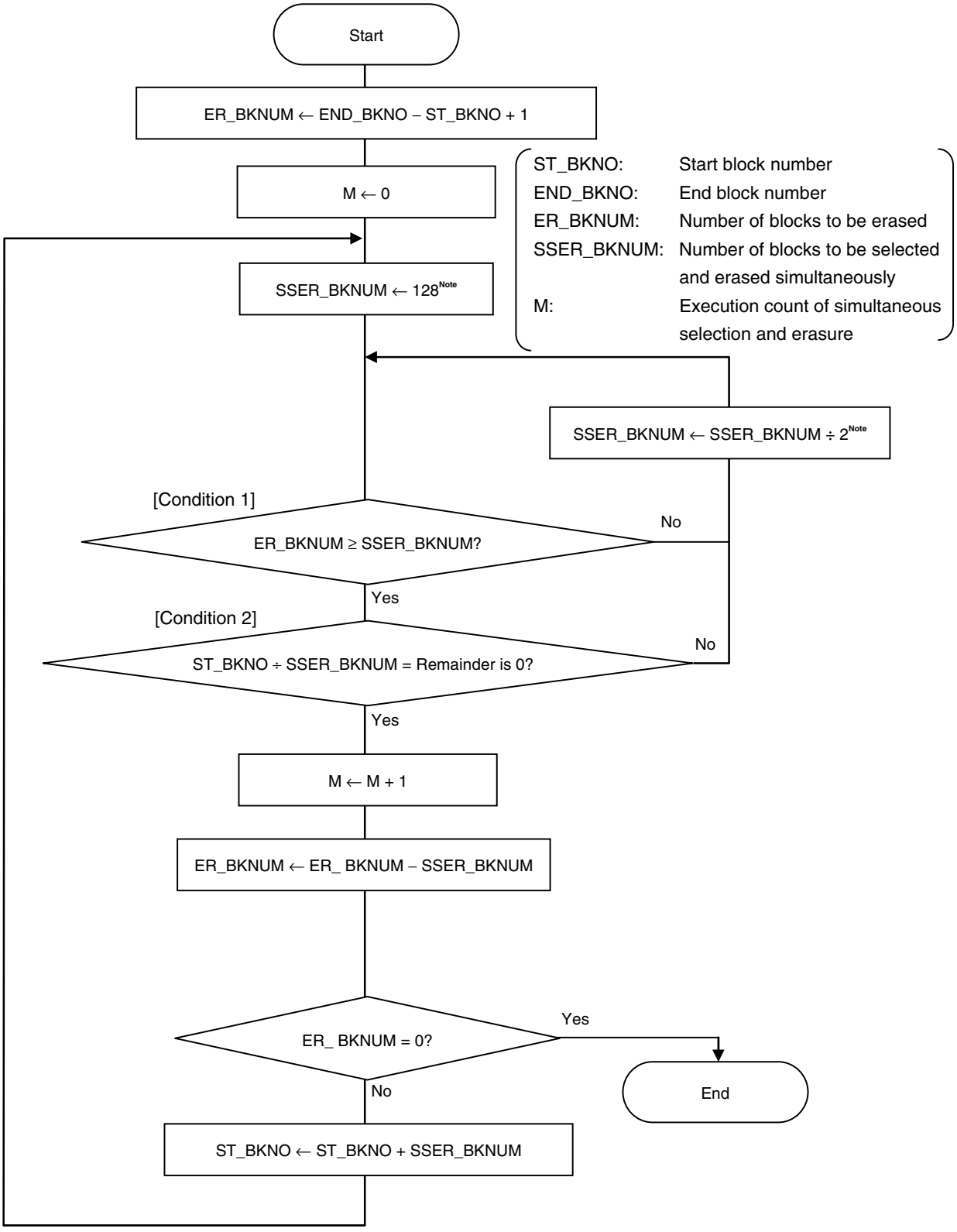
(Start block number) ÷ (Number of blocks to be selected and erased simultaneously) = Remainder is 0

[Condition 3]

The maximum value among the values that satisfy both Conditions 1 and 2

(b) Calculation of the execution count (M) of simultaneous selection and erasure

Calculation of the execution count (M) is illustrated in the following flowchart.



Note Based on the maximum value of SSER_BKNUM (128), obtain the value that satisfies Conditions 1 and 2 by executing SSER_BKNUM ÷ 2; Condition 3 is then satisfied.

Example 1 Erasing blocks 1 to 127 (N (number of blocks to be erased) = 127)

<1> The first start block number is 1 and the number of blocks to be erased is 127; the values that satisfy Condition 1 are therefore 1, 2, 4, 8, 16, 32, 64, and 128.
Moreover, the value that satisfies Condition 2 is 1 and the value that satisfies Condition 3 is 1, so the number of blocks to be selected and erased simultaneously is 1; only block 1 is then erased.

<2> After block 1 is erased, the next start block number is 2 and the number of blocks to be erased is 126; the values that satisfy Condition 1 are therefore 1, 2, 4, 8, 16, 32, and 64.
Moreover, the values that satisfy Condition 2 are 1 and 2, the value that satisfies Condition 3 is 2, so the number of blocks to be selected and erased simultaneously is 2; blocks 2 and 3 are then erased.

<3> After blocks 2 and 3 are erased, the next start block number is 4 and the number of blocks to be erased is 124; the values that satisfy Condition 1 are therefore 1, 2, 4, 8, 16, 32, and 64.
Moreover, the values that satisfy Condition 2 are 1, 2, and 4, the value that satisfies Condition 3 is 4, so the number of blocks to be selected and erased simultaneously is 4; blocks 4 to 7 are then erased.

<4> After blocks 4 to 7 are erased, the next start block number is 8 and the number of blocks to be erased is 120; the values that satisfy Condition 1 are therefore 1, 2, 4, 8, 16, 32, and 64.
Moreover, the values that satisfy Condition 2 are 1, 2, 4, and 8, the value that satisfies Condition 3 is 8, so the number of blocks to be selected and erased simultaneously is 8; blocks 8 to 15 are then erased.

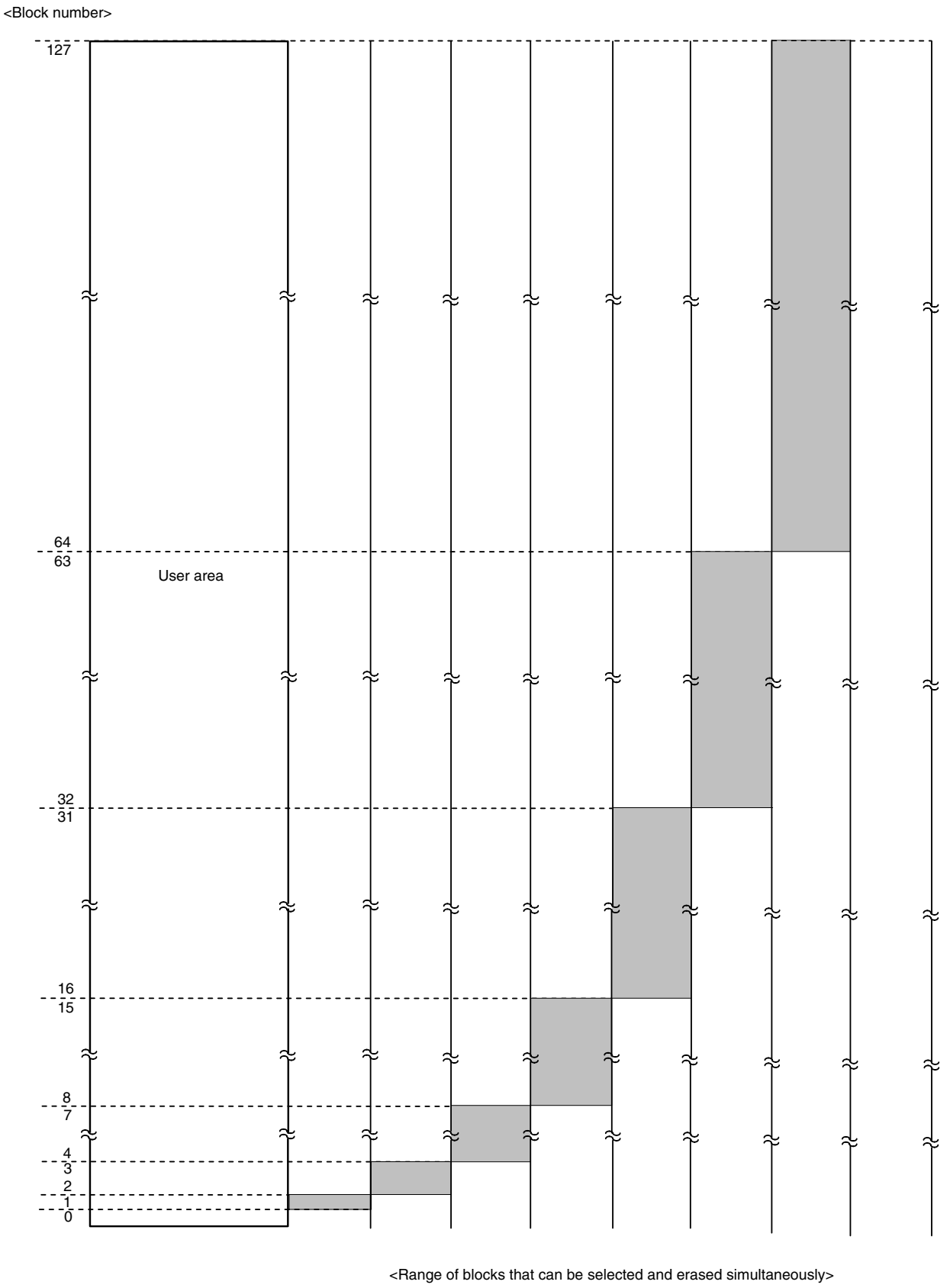
<5> After blocks 8 to 15 are erased, the next start block number is 16 and the number of blocks to be erased is 112; the values that satisfy Condition 1 are therefore 1, 2, 4, 8, 16, 32, and 64.
Moreover, the values that satisfy Condition 2 are 1, 2, 4, 8, and 16, the value that satisfies Condition 3 is 16, so the number of blocks to be selected and erased simultaneously is 16; blocks 16 to 31 are then erased.

<6> After blocks 16 to 31 are erased, the next start block number is 32 and the number of blocks to be erased is 96; the values that satisfy Condition 1 are therefore 1, 2, 4, 8, 16, 32, and 64.
Moreover, the values that satisfy Condition 2 are 1, 2, 4, 8, 16, and 32, the value that satisfies Condition 3 is 32, so the number of blocks to be selected and erased simultaneously is 32; blocks 32 to 63 are then erased.

<7> After blocks 32 to 63 are erased, the next start block number is 64 and the number of blocks to be erased is 64; the values that satisfy Condition 1 are therefore 1, 2, 4, 8, 16, 32, and 64.
Moreover, the values that satisfy Condition 2 are 1, 2, 4, 8, 16, 32, and 64, the value that satisfies Condition 3 is 64, so the number of blocks to be selected and erased simultaneously is 64; blocks 64 to 127 are then erased.

Therefore, simultaneous selection and erasure is executed seven times (1, 2 and 3, 4 to 7, 8 to 15, 16 to 31, 32 to 63, and 64 to 127) to erase blocks 1 to 127, so M = 7 is obtained.

Block configuration when executing simultaneous selection and erasure (when erasing blocks 1 to 127)



Example 2 Erasing blocks 5 to 10 (N (number of blocks to be erased) = 6)

<1> The first start block number is 5 and the number of blocks to be erased is 6; the values that satisfy Condition 1 are therefore 1, 2, and 4.
Moreover, the value that satisfies Condition 2 is 1 and the value that satisfies Condition 3 is 1, so the number of blocks to be selected and erased simultaneously is 1; only block 5 is the erased.

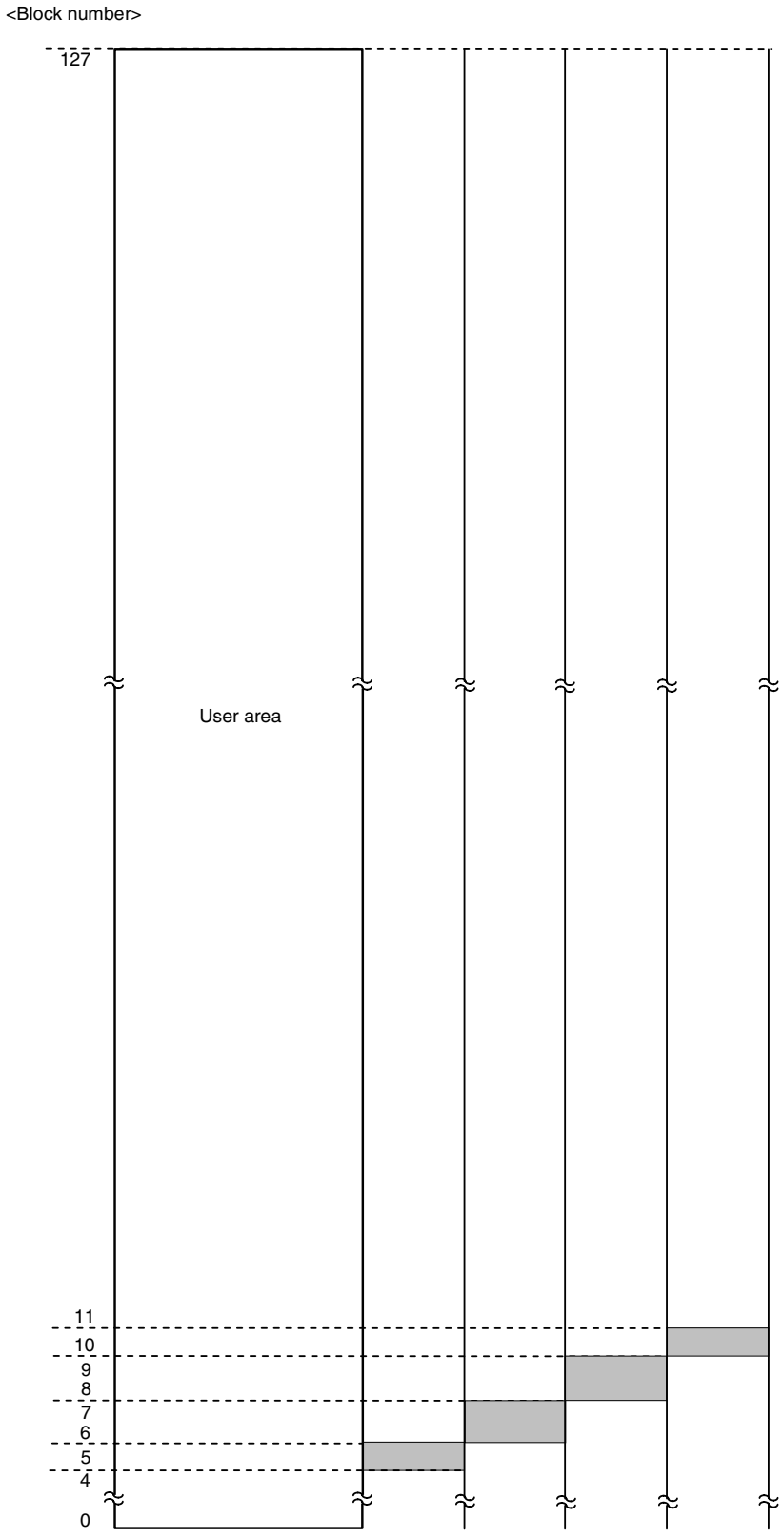
<2> After block 5 is erased, the next start block number is 6 and the number of blocks to be erased is 5; the values that satisfy Condition 1 are therefore 1, 2, and 4.
Moreover, the values that satisfy Condition 2 are 1 and 2, the value that satisfies Condition 3 is 2, so the number of blocks to be selected and erased simultaneously is 2; blocks 6 and 7 are then erased.

<3> After blocks 6 and 7 are erased, the next start block number is 8 and the number of blocks to be erased is 3; the values that satisfy Condition 1 are therefore 1 and 2.
Moreover, the values that satisfy Condition 2 are 1 and 2, the value that satisfies Condition 3 is 2, so the number of blocks to be selected and erased simultaneously is 2; blocks 8 and 9 are then erased.

<4> After blocks 8 and 9 are erased, the next start block number is 10 and the number of blocks to be erased is 1; the value that satisfies Condition 1 is therefore 1. This also satisfies Conditions 2 and 3, so the number of blocks to be selected and erased simultaneously is 1; block 10 is then erased.

Therefore, simultaneous selection and erasure is executed four times (5, 6 and 7, 8 and 9, and 10) to erase blocks 5 to 10, so M = 4 is obtained.

Block configuration when executing simultaneous selection and erasure (when erasing blocks 5 to 10)



<Range of blocks that can be selected and erased simultaneously>

Example 3 Erasing blocks 25 to 73 (N (number of blocks to be erased) = 49)

<1> The first start block number is 25 and the number of blocks to be erased is 49; the values that satisfy Condition 1 are therefore 1, 2, 4, 8, 16, and 32.
Moreover, the value that satisfies Condition 2 is 1 and the value that satisfies Condition 3 is 1, so the number of blocks to be selected and erased simultaneously is 1; only block 25 is then erased.

<2> After block 25 is erased, the next start block number is 26 and the number of blocks to be erased is 48; the values that satisfy Condition 1 are therefore 1, 2, 4, 8, 16, and 32.
Moreover, the values that satisfy Condition 2 are 1 and 2, the value that satisfies Condition 3 is 2, so the number of blocks to be selected and erased simultaneously is 2; blocks 26 and 27 are then erased.

<3> After blocks 26 and 27 are erased, the next start block number is 28 and the number of blocks to be erased is 46; the values that satisfy Condition 1 are therefore 1, 2, 4, 8, 16, and 32.
Moreover, the values that satisfy Condition 2 are 1, 2, and 4, the value that satisfies Condition 3 is 4, so the number of blocks to be selected and erased simultaneously is 4; blocks 28 to 31 are then erased.

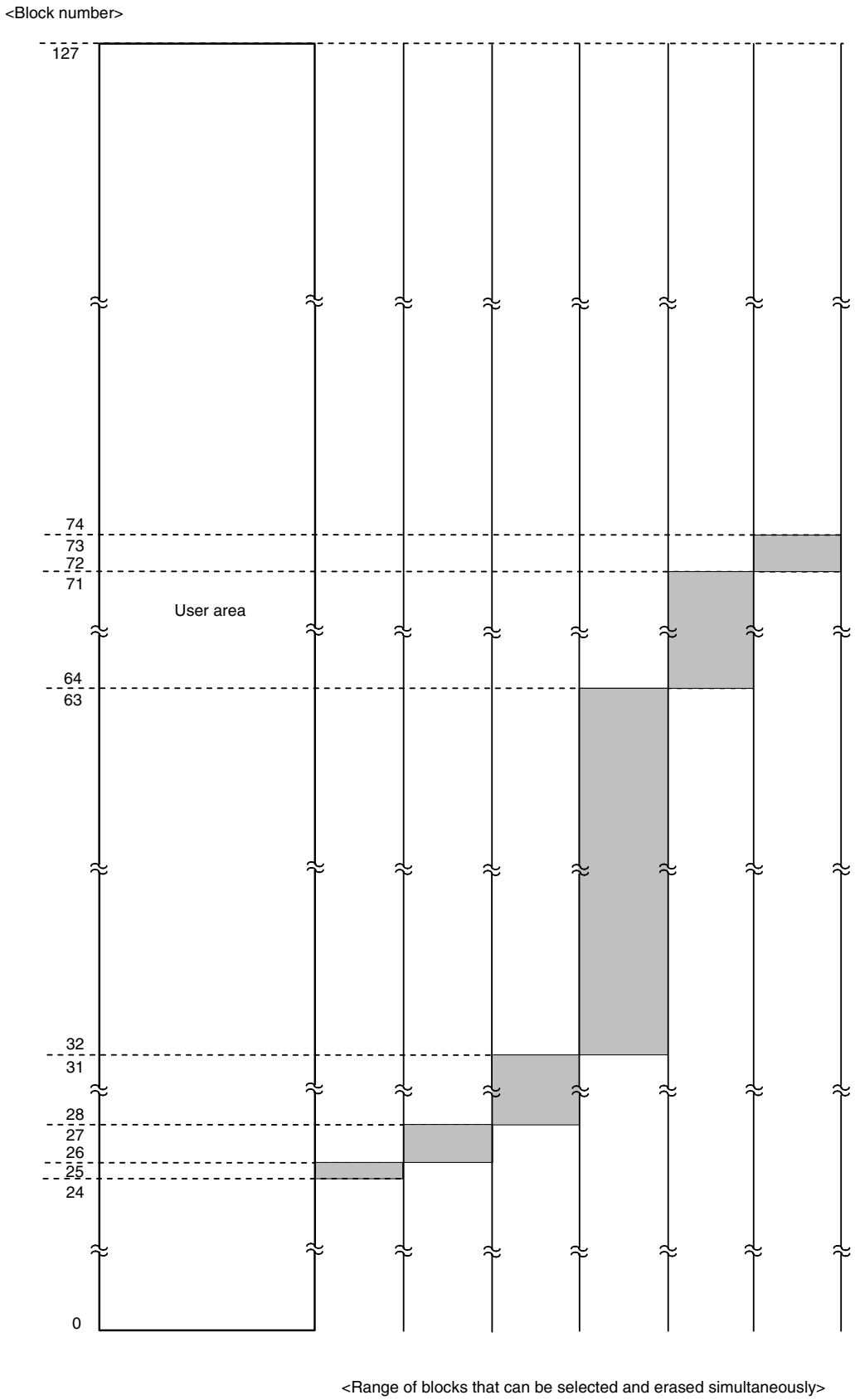
<4> After blocks 28 to 31 are erased, the next start block number is 32 and the number of blocks to be erased is 42; the values that satisfy Condition 1 are therefore 1, 2, 4, 8, 16, and 32.
Moreover, the values that satisfy Condition 2 are 1, 2, 4, 8, and 32, the value that satisfies Condition 3 is 32, so the number of blocks to be selected and erased simultaneously is 32; blocks 32 to 63 are then erased.

<5> After blocks 32 to 63 are erased, the next start block number is 64, and the number of blocks to be erased is 10; the values that satisfy Condition 1 are therefore 1, 2, 4, and 8.
Moreover, the values that satisfy Condition 2 are 1, 2, 4, and 8, the value that satisfies Condition 3 is 8, so the number of blocks to be selected and erased simultaneously is 8; blocks 64 to 71 are then erased.

<6> After blocks 64 to 71 are erased, the next start block number is 72, and the number of blocks to be erased is 2; the values that satisfy Condition 1 are therefore 1 and 2.
Moreover, the values that satisfy Condition 2 are 1 and 2, the value that satisfies Condition 3 is 2, so the number of blocks to be selected and erased simultaneously is 2; blocks 72 and 73 are then erased.

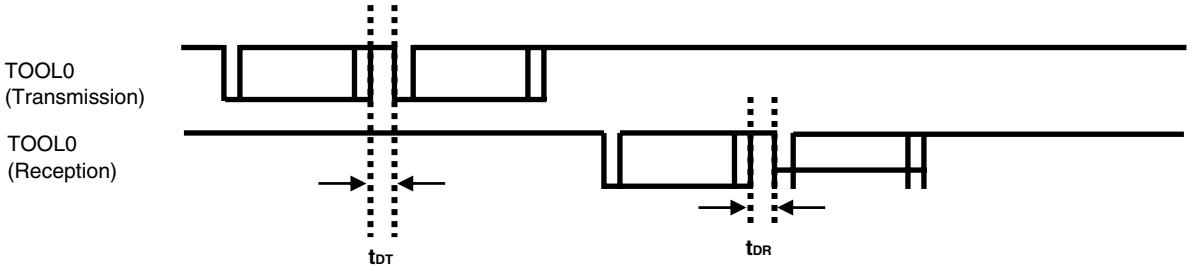
Therefore, simultaneous selection and erasure is executed six times (25, 26 and 27, 28 to 31, 32 to 63, 64 to 71, and 72 and 73) to erase blocks 25 to 73, so M = 6 is obtained.

Block configuration when executing simultaneous selection and erasure (when erasing blocks 25 to 73)



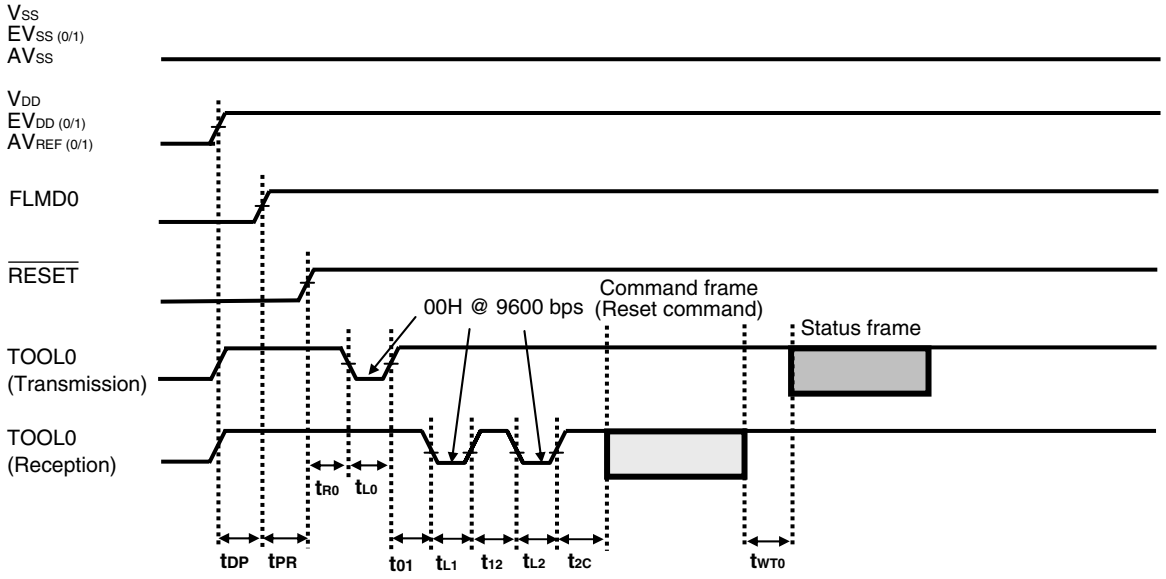
(3) UART communication mode

(a) Data frame



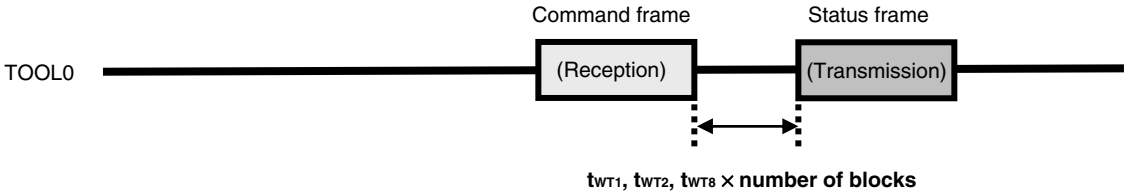
Remark In the above figure, TOOL0 is illustrated as two separate lines for the sake of description, but it is actually a single line. The V_{DD} level of TOOL0 can be achieved by using a pull-up resistor (the pin is Hi-Z).

(b) Programming mode setting/Reset command



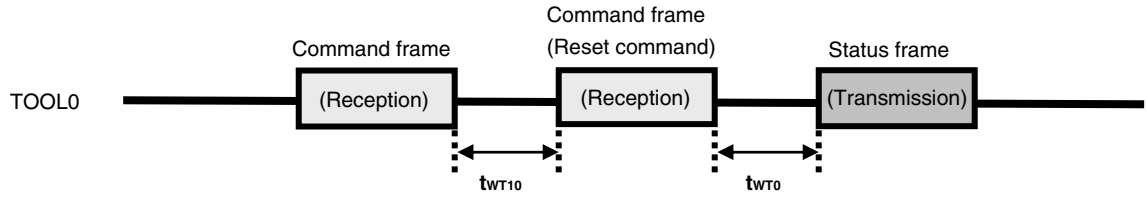
Remark In the above figure, TOOL0 is illustrated as two separate lines for the sake of description, but it is actually a single line. The V_{DD} level of TOOL0 can be achieved by using a pull-up resistor (the pin is Hi-Z).

(c) Chip Erase command/Block Erase command/Block Blank Check command/Oscillating Frequency Set command



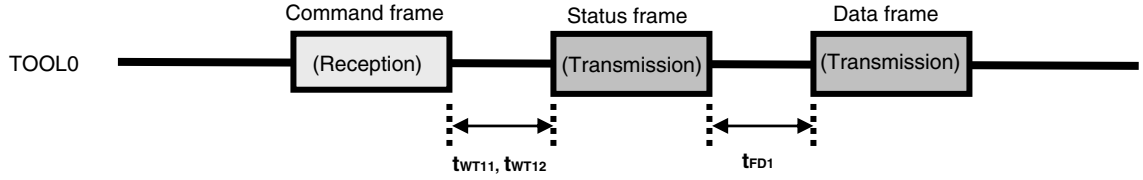
Remark The descriptions in parentheses indicate operations of the 78K0R/Kx3.

(d) Baud Rate Set command



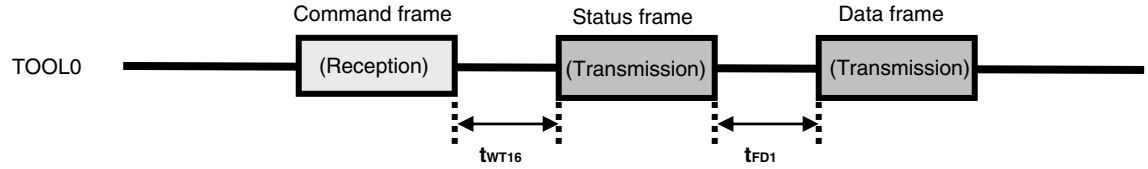
Remark The descriptions in parentheses indicate operations of the 78K0R/Kx3.

(e) Silicon Signature command/Version Get command



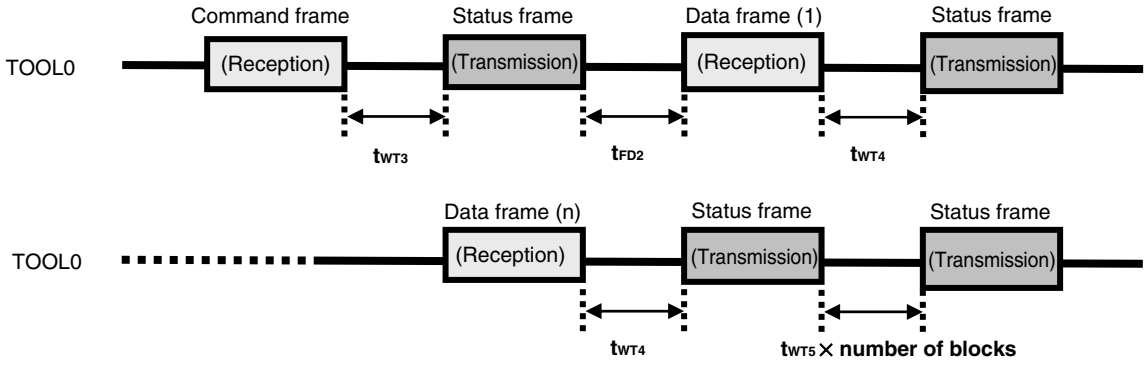
Remark The descriptions in parentheses indicate operations of the 78K0R/Kx3.

(f) Checksum command



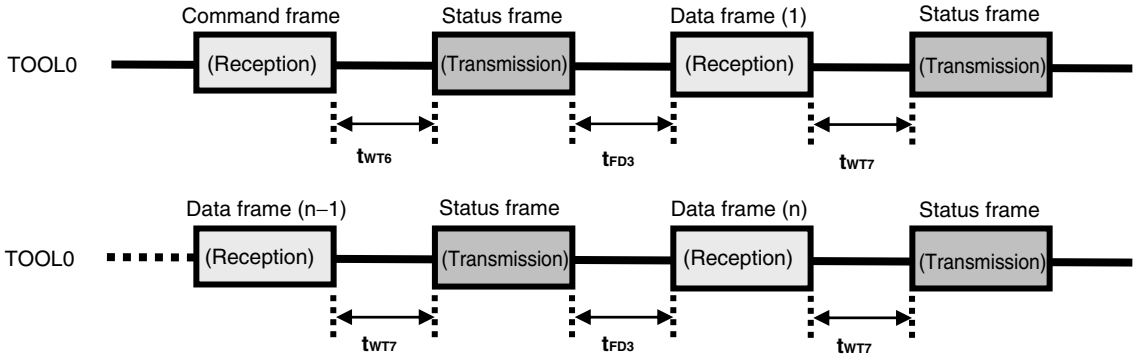
Remark The descriptions in parentheses indicate operations of the 78K0R/Kx3.

(g) Programming command



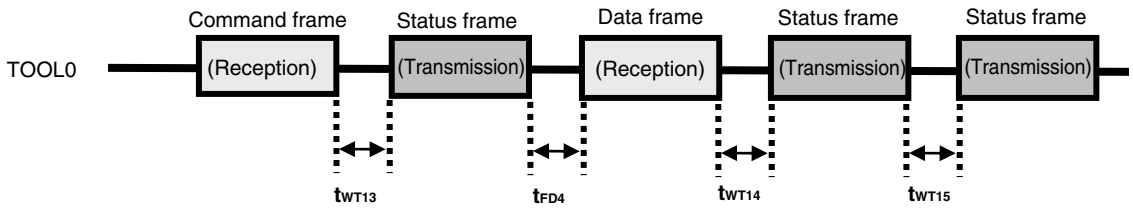
Remark The descriptions in parentheses indicate operations of the 78K0R/Kx3.

(h) Verify command



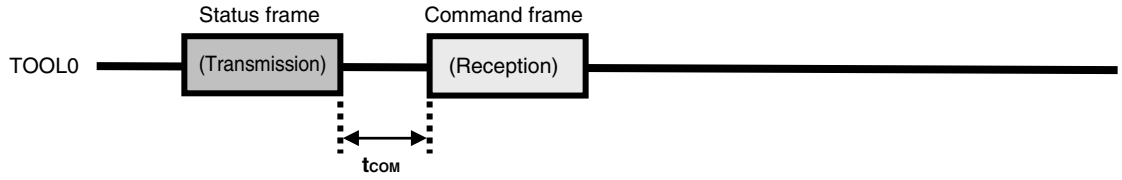
Remark The descriptions in parentheses indicate operations of the 78K0R/Kx3.

(i) Security Set command



Remark The descriptions in parentheses indicate operations of the 78K0R/Kx3.

(j) Wait before command frame transmission



Remark The descriptions in parentheses indicate operations of the 78K0R/Kx3.

[MEMO]

APPENDIX A CIRCUIT DIAGRAMS (REFERENCE)

Figures A-1 and A-2 show circuit diagrams of the programmer and the 78K0R/Kx3, for reference.

Figure A-1. Reference Circuit Diagram of Programmer and 78K0R/Kx3 (Main Board)

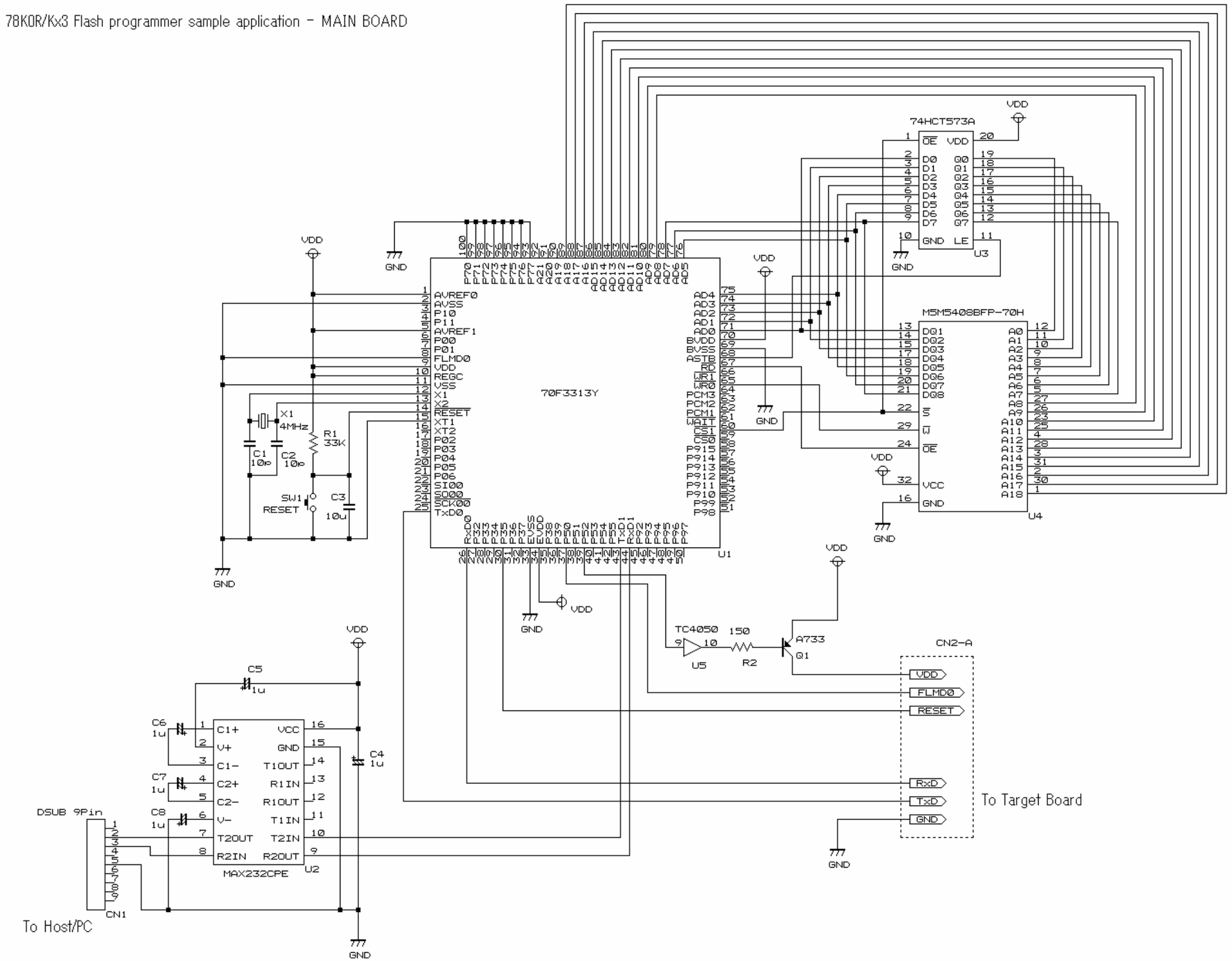
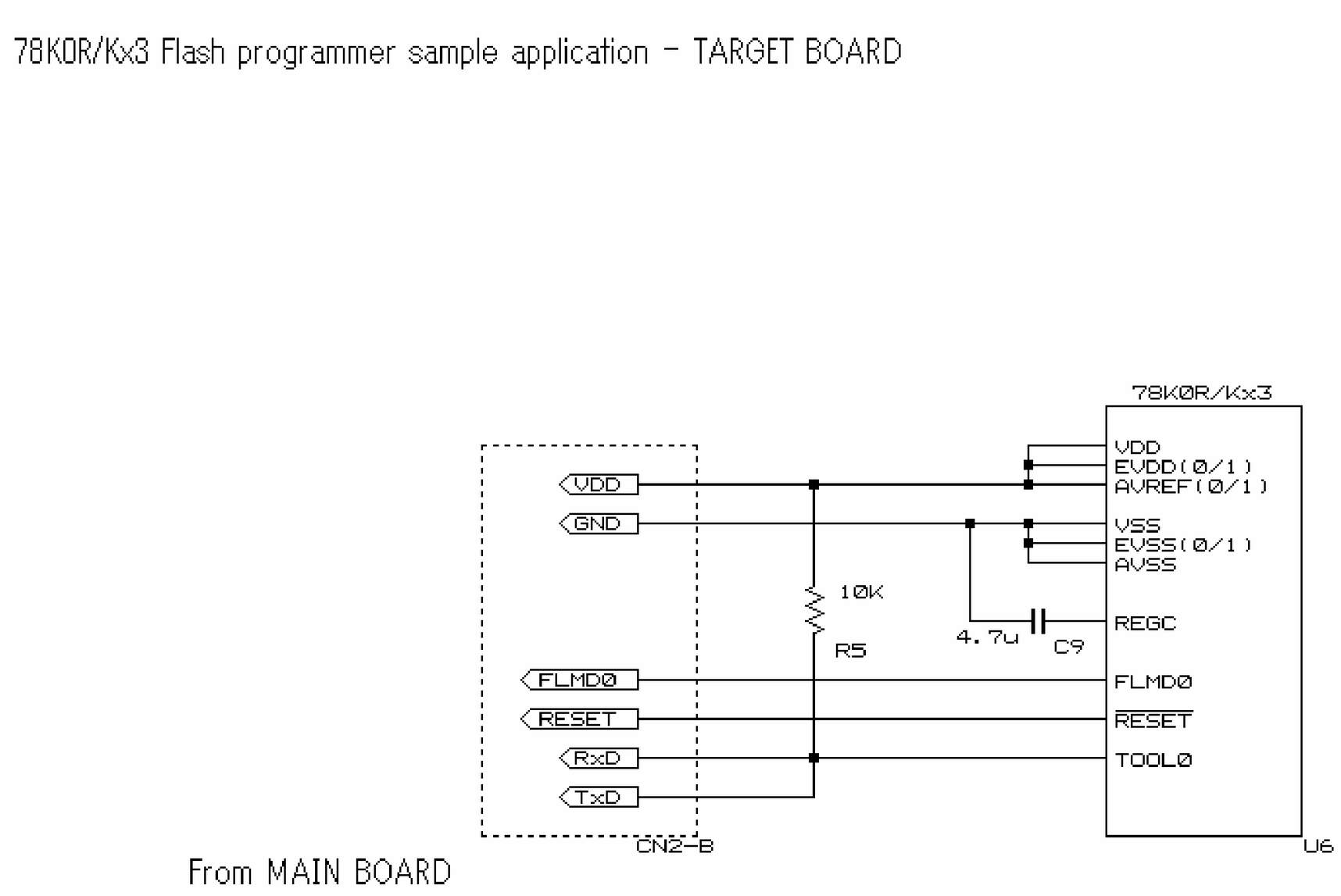


Figure A-2. Reference Circuit Diagram of Programmer and 78K0R/Kx3 (Target Board)



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