MF757-03

EPSON

CMOS 4-BIT SINGLE CHIP MICROCOMPUTER

E0C623E DEVELOPMENT TOOL MANUAL

ENERGY SAVING EPSON

SEIKO EPSON CORPORATION

E0C623E Development Tool Manual

PREFACE

This manual mainly explains the outline of the development support tool for the 4-bit Single Chip Microcomputer E0C623E.

Refer to the "E0C62 Family Development Tool Reference Manual" for the details (common to all models) of each development support tool. Manuals for hardware development tools are separate, so you should also refer to the below manuals.

Development tools	☞ E0C62 Family Development Tool Reference Manual EVA623E Manual ICE6200 Hardware Manual
Development procedure	☞ E0C62 Family Technical Guide
Device (E0C623E)	☞ E0C623E Technical Manual
Instructions	☞ E0C6200/6200A Core CPU Manual

CONTENTS

1 COMPOSITION OF DEVELOPMENT SUPPORT TOOL

Here we will explain the composition of the software for the development support tools, developmental envilonment and how to generate the execution disk.

1.1 Configuration of DEV623E

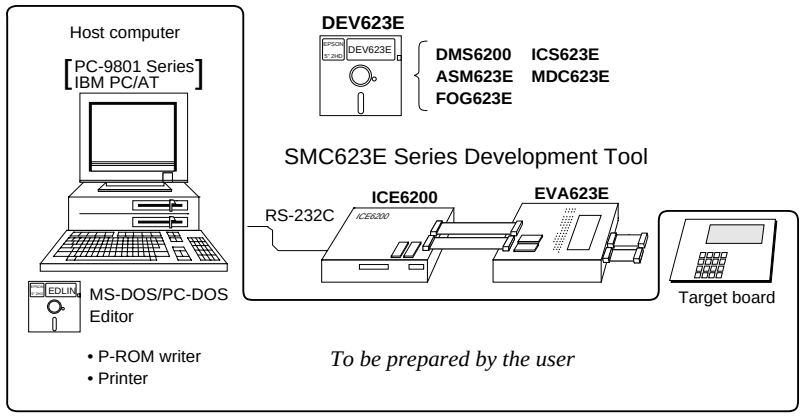
The below software are included in the product of the E0C623E development support tool DEV623E.

1. Development Tool Management System DMS6200 ..... Menu selection for each software / start-up software
2. Cross Assembler ASM623E ..... Cross assembler for program preparation
3. Function Option Generator FOG623E ..... Function option data preparation program
4. ICE Control Software ICS623E ..... ICE control program
5. Mask Data Checker MDC623E ..... Mask data preparation program

1.2 Developmental Environment

The software product of the development support tool DEV623E operates on the following host systems:

- IBM PC/AT (at least PC-DOS Ver. 2.0)
- NEC PC-9801 Series (at least MS-DOS Ver. 3.1)



When developing the E0C623E, the above-mentioned host computer, editor, P-ROM writer, printer, etc. must be prepared by the user in addition to the development tool which is normally supported by Seiko Epson. *Fig. 1.2.1*

System configuration

Note The DEV623E system requires a host computer with a RAM capacity of about 140K bytes. Since the ICE6200 is connected to the host computer with a RS-232C serial interface, adapter board for asynchronous communication will be required depending on the host computer used.

1.3 Development Flow

Figure 1.3.1 shows the development flow through the DEV623E.

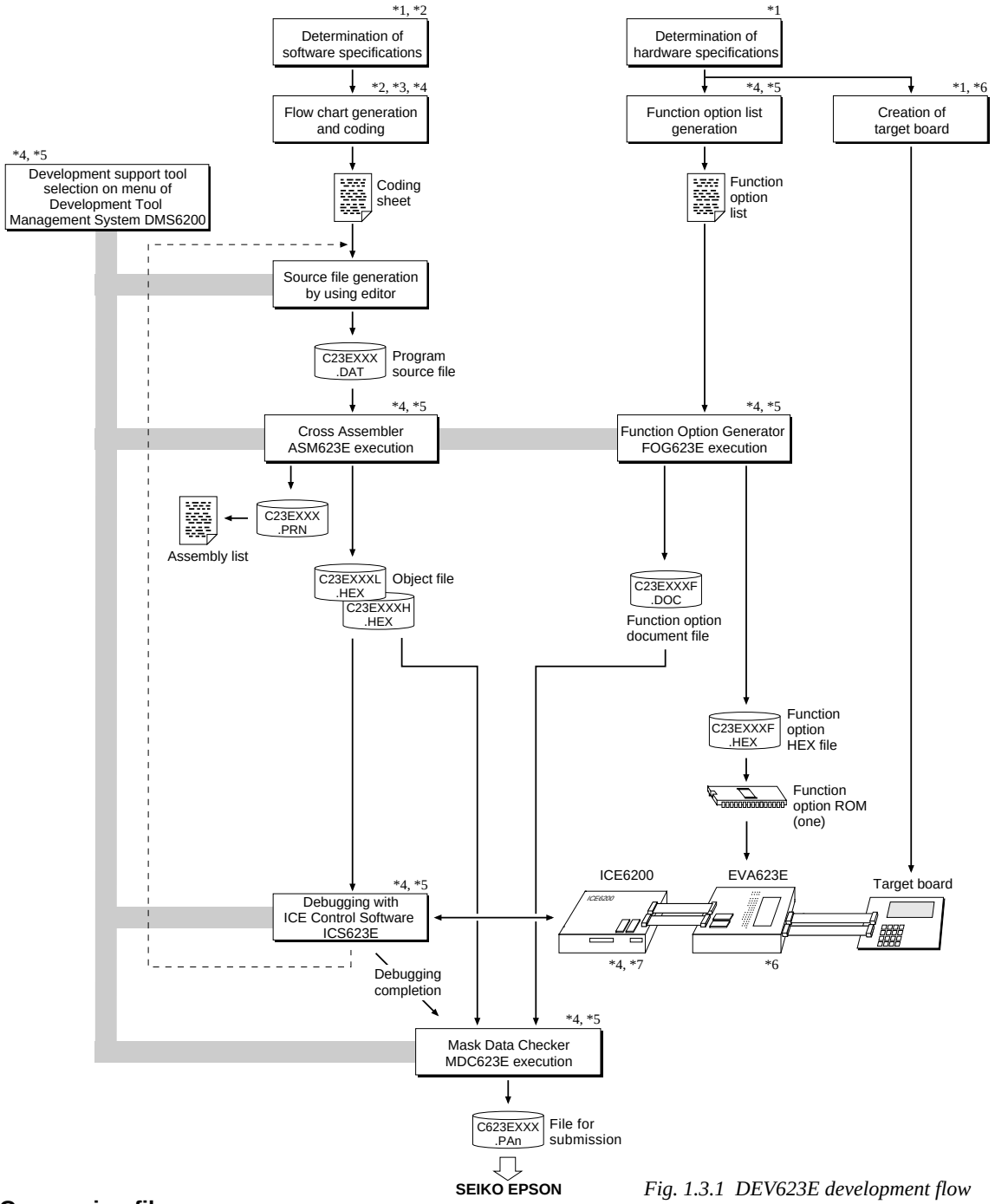


Fig. 1.3.1 DEV623E development flow

Concerning file names

All the input-output file name for the each development support tool commonly use "C23EXXX". In principle each file should be produced in this manner. Seiko Epson will designate the "XXX" for each customer.

☞ Reference Manual

*1 E0C623E Technical Hardware Manual
*2 E0C623E Technical Software Manual
*3 E0C6200/6200A Core CPU Manual
*4 E0C62 Family Development Tool Reference Manual
*5 E0C623E Development Tool Manual (this manual)
*6 EVA623E Manual
*7 ICE6200 Hardware Manual

1.4 Production of Execution Disk

Execution files for each software development support tool and batch and parameter files for the ICE6200 are recorded in the DEV623E floppy disk.
The content of the files contained in the DEV623E floppy disk are shown below.

PC-DOS version	MS-DOS version	Contents
ASM623E.EXE	ASM623E.EXE	Cross Assembler execution file
DMS6200.EXE	DMS6200.EXE	Development Tool Management System execution file
FOG623E.EXE	FOG623E.EXE	Function Option Generator execution file
ICS623EB.BAT	ICS623E.BAT	ICE Control Software batch file
ICS623EW.EXE	ICS623EJ.EXE	ICE Control Software execution file
ICS623EP.PAR	ICS623EP.PAR	ICE Control Software parameter file
MDC623E.EXE	MDC623E.EXE	Mask Data Checker execution file

■ First copy the entire content of this disk using commands such as DISKCOPY then make the execution disk. Carefully conserve the original floppy disk for storage purposes.
When copying into a hard disk, make a sub-directory with an appropriate name (DEV623E, etc.) then copy the content of the floppy disk into that subdirectory using the COPY command.

Example:

Copying into a floppy disk

Insert the original disk into the A drive and the formatted disk to be copied into B drive, then execute the DISKCOPY command.

```
A>DISKCOPY  A:  B:↵
```

Copying into a hard disk (C drive)

Make a subdirectory (DEV623E), then insert the original disk into the A drive and execute the COPY command.

```
C\>MD DEV623E↵
C\>CD DEV623E↵
C\DEV623E\>COPY A:*.*↵
```

■ Next make a CONFIG.SYS file using Editor or the like.
When a CONFIG.SYS has previously been made using a hard disk system, check the setting of the FILES within it. (If there is none add it.)
Set the number of files to be described in CONFIG.SYS at 10 or more, so that the Mask Data Checker MDC623E will handle many files.

Example:

Setting of FILES (CONFIG.SYS)

```
C\>TYPE  CONFIG.SYS↵
    :
FILES=20
    :
```

Note *The driver for the RS-232C must be included in CONFIG.SYS by the host computer.*

■ It is a good idea to copy the editor into the disk to be copied and the subdirectory so you can also select the editor from the DMS6200 menu.

■ In "ICS623E(B).BAT" the batch process is indicated such that the ICS623EJ(W).EXE is executed after the execution of the command for the setting of the RS-232C communication parameters. When first executing the ICE Control Software after resetting the host computer, select then activate this batch file from the DMS6200 menu.
The SPEED (MS-DOS) or MODE (PC-DOS) command is used for setting the RS-232C, so you should copy these commands into the disk to be executed or specify a disk or directory with the command using the PATH command.

RS-232C Setting (PC-DOS version)

```
MODE  COM1:  4800, n, 8, 1, p
```

RS-232C Setting (MS-DOS version)

```
SPEED  R0  9600  B8  PN  S1
```

Note *The DMS6200 prepares a menu from files that are in the current directory. Consequently, be sure to arrange the above mentioned files in the same disk or the same directory.*

2 DEVELOPMENT TOOL MANAGEMENT SYSTEM DMS6200

2.1 DMS6200 Outline

The DMS6200 (Development Tool Management System) is a software which selects the DEV623E software development support tool and the program such as an editor in menu form and starts it.
In this way the various software frequently executed during debugging can be effectively activated.

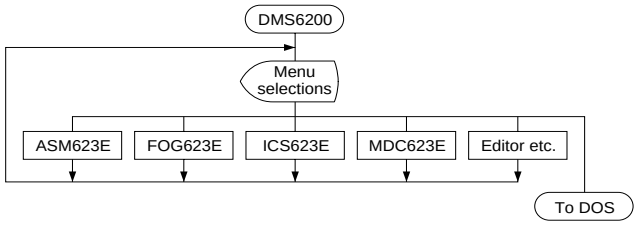


Fig. 2.1.1 DMS6200 execution flow

Refer to the "E0C62 Family Development Tool Reference Manual" for detailes of the operation.

2.2 DMS6200 Quick Reference

■ Starting command

Execution file: **DMS6200.EXE** ***Starting command:*** **DMS6200**↵ ↵ *indicates the Return key.*

■ Display examples

```
   *** E0C6200 Development tool Management System. --- Ver 1.0 ***

EEEEEEEEEE   PPPPPPPP        SSSSSSS       00000000     NNN     NNN
EEEEEEEEEE   PPPPPPPPPP     SSS    SSSS    000    000    NNNN    NNN
EEE          PPP     PPP   SSS      SSS   000      000   NNNNN   NNN
EEE          PPP     PPP    SSS           000      000   NNNNNN  NNN
EEEEEEEEEE   PPPPPPPPPP      SSSSSS       000      000   NNN NNN NNN
EEEEEEEEEE   PPPPPPPP           SSSS      000      000   NNN  NNNNNN
EEE          PPP                 SSS     000      000   NNN   NNNNN
EEE          PPP           SSS     SSS    000    000    NNN    NNNN
EEEEEEEEEE   PPP           SSSS    SSS     000    000    NNN     NNN
EEEEEEEEEE   PPP             SSSSSSS       00000000     NNN      NN

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                          STRIKE ANY KEY.
```

Start message
When DMS6200 is started, the following message is displayed. For "STRIKE ANY KEY.", press any key to advance the program execution.
To suspend execution, press the "CTRL" and "C" keys together: the sequence returnsto the DOS command level.

```
     DMS6200 Version 1.0     Copyright(C) SEIKO EPSON CORP. 1991.

1) ASM623E .EXE
2) FOG623E .EXE
3) ICS623EB.BAT
4) ICS623EW.EXE
5) MDC623E .EXE

Input Number ? [1  ]
```

Menu screen (PC-DOS Version)
A list of all executable files will appear on this menu screen.
Input the number of the development support tool you wish to start and then press the "RETURN" key. To return to DOS at this point, press the "ESC" key.

```
     DMS6200 Version 1.0     Copyright(C) SEIKO EPSON CORP. 1991.

 1) C23E0A0 .DAT
 2) C23E0A0 .PRN
 3) C23E0A0F.DOC
 4) C23E0A0F.HEX
 5) C23E0A0H.HEX
 6) C23E0A0L.HEX
 7) C623E0A0.PA0

 Input Number ? [1  ]

   Edit > [ASM623E C23E0A0                                    ]
```

Source file selection screen
To starting ASM623E, select the source file on this screen. When the source file is selected by number, the edit line enclosed in [ ] will appear; enter the option parameter if necessary. Press the "RETURN" key when input is completed. When starting, press the "RETURN" key twice particularly for the support tools which do not require source files. To return to DOS at this point, press the "ESC" key.

3 CROSS ASSEMBLER ASM623E

3.1 ASM623E Outline

The ASM623E cross assembler is an assembler program for generating the machine code used by the E0C623E 4-bit, single-chip microcomputers. The Cross Assembler ASM623E will assemble the program source files which have been input by the user's editor and will generate an object file in Intel-Hex format and assembly list file.
In this assembler, program modularization has been made possible through macro definition functions and programming independent of the ROM page structure has been made possible through the auto page set function. In addition, consideration has also been given to precise error checks for program capacity (ROM capacity) overflows, undefined codes and the like, and for debugging of such things as label tables for assembly list files and cross reference table supplements.

☞ *The format of the source file and its operating method are same as for the E0C62 Family. Refer to the "E0C62 Family Development Tool Reference Manual" for details.*

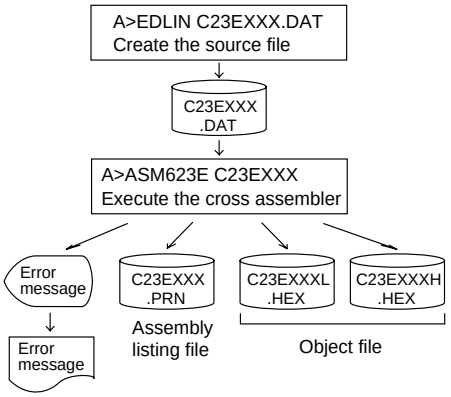

Fig. 3.1.1 ASM623E execution flow

3.2 E0C623E Restrictions

Note the following when generating a program by the E0C623E:

■ ROM area

The capacity of the E0C623E ROM is 2K steps (0000H to 07FFH).
Therefore, the specification range of the memory setting pseudo-instructions and PSET instruction is restricted.

Memory configuration:

Bank: Only bank 0, Page: 8 pages (0 to 7H), each 256 steps

Significant specification range:

ORG	pseudo-instruction:	0000H to 07FFH
PAGE	pseudo-instruction:	00H to 07H
BANK	pseudo-instruction:	Only 0H
PSET	instruction:	00H to 07H

■ RAM area

The capacity of the E0C623E RAM is 243 words (000H to 0FCH, 4 bits/word). However, the following addresses become unused area. Memory access is invalid when the unused area is specified.
0E1H, 0E6H, 0E7H, 0E9H, 0ECH, 0F1H, 0F2H, 0F5H, 0F7H, 0F8H

Example:

```
LD    X,0F5H    F5H is loaded into the IX register, but an
                unused area has been specified so that the
                memory accessible with the IX register
                (MX) is invalid.
LD    Y,0FDH    FDH is loaded into the IY register, but an
                unused area has been specified so that the
                memory accessible with the IY register
                (MY) is invalid.
```

■ Undefined codes

The following instructions have not been defined in the E0C623E instruction sets.

```
SLP
PUSH  XP      PUSH  YP
POP   XP      POP   YP
LD    XP,r    LD    YP,r
LD    r,XP    LD    r,YP
```

3.3 ASM623E Quick Reference

■ Starting command and input/output files

_ indicates a blank.
↵ indicates the Return key.
A parameter enclosed by [ ] can be omitted.

Execution file: ASM623E.EXE

Starting command: **ASM623E_ [drive-name:] source-file-name [.shp]_ [-N]↵**

Option:

.shp	Specifies the file I/O drives.
s	Specifies the drive from which the source file is to be input. (A–P, @)
h	Specifies the drive to which the object file is to be output. (A–P, @, Z)
p	Specifies the drive to which the assembly listing file is to be output. (A–P, @, Z) @: Current drive, Z: File is not generated
-N option	The code (FFH) in the undefined area of program memory is not created.
Default	ASM623E_<source file name>.@@@

Input file: C23EXXX.DAT (Source file)

Output file:
C23EXXXL.HEX (Object file, low-order)
C23EXXXH.HEX (Object file, high-order)
C23EXXX.PRN (Assembly listing file)

■ Display example

```
          *** E0C623E CROSS ASSEMBLER. --- Ver 2.00 ***

EEEEEEEEEE   PPPPPPPP         SSSSSSS       00000000     NNN     NNN
EEEEEEEEEE   PPPPPPPPPP      SSS    SSSS    000    000    NNNN    NNN
EEE          PPP     PPP   SSS     SSS    000      000   NNNNN   NNN
EEE          PPP     PPP    SSS           000      000   NNNNNN  NNN
EEEEEEEEEE   PPPPPPPPPP      SSSSSS       000      000   NNN NNN NNN
EEEEEEEEEE   PPPPPPPP           SSSS      000      000   NNN  NNNNNN
EEE          PPP                 SSS     000      000   NNN   NNNNN
EEE          PPP           SSS     SSS    000    000    NNN    NNNN
EEEEEEEEEE   PPP           SSSS    SSS     000    000    NNN     NNN
EEEEEEEEEE   PPP             SSSSSSS       00000000     NNN      NN

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         SOURCE FILE NAME IS " C23EXXX.DAT "

         THIS SOFTWARE MAKES NEXT FILES.

            C23EXXXH.HEX  ...  HIGH BYTE OBJECT FILE.
            C23EXXXL.HEX  ...  LOW BYTE OBJECT FILE.
            C23EXXX .PRN  ...  ASSEMBLY LIST FILE.

DO YOU NEED AUTO PAGE SET? (Y/N) Y                              ...(1)

DO YOU NEED CROSS REFERENCE TABLE? (Y/N) Y                      ...(2)
```

When ASM623E is started, the start-up message is displayed.
At (1), select whether or not the auto-page-set function will be used.

Use ..... Y
Not use ..... N

If the assembly listing file output is specified, message (2) is displayed. At this stage, cross-reference table generation may be selected.

Generating ..... Y
Not generating ..... N

When the above operation is completed, ASM623E assembles the source file.
To suspend execution, press the "CTRL" and "C" keys together at stage (1) or (2).

■ Operators

Arithmetic operators		Logical operators	
+a	Monadic positive	a_AND_b	Logical product
-a	Monadic negative	a_OR_b	Logical sum
a+b	Addition	a_XOR_b	Exclusive logical sum
a-b	Subtraction	NOT_a	Logical negation
a*b	Multiplication	**Relational operators**	
a/b	Division	a_EQ_b	True when a is equal to b
a_MOD_b	Remainder of a/b	a_NE_b	True when a is not equal to b
a_SHL_b	Shifts a b bits to the left	a_LT_b	True when a is less than b
a_SHR_b	Shifts a b bits to the right	a_LE_b	True when a is less than or equal to b
HIGH_a	Separates the high-order eight bits from a	a_GT_b	True when a is greater than b
LOW_a	Separates the low-order eight bits from a	a_GE_b	True when a is greater than or equal to b

■ Pseudo-instructions

Pseudo-instruction	Meaning	Example of Use
EQU (Equation)	To allocate data to label	`ABC EQU 9` `BCD EQU ABC+1`
SET (Set)	To allocate data to label (data can be changed)	`ABC SET 0001H` `ABC SET 0002H`
DW (Define Word)	To define ROM data	`ABC DW 'AB'` `BCD DW 0FFBH`
ORG (Origin)	To define location counter	`ORG 100H` `ORG 256`
PAGE (Page)	To define boundary of page	`PAGE 1H` `PAGE 7`
SECTION (Section)	To define boundary of section	`SECTION`
END (End)	To terminate assembly	`END`

MACRO (Macro)	To define macro	`CHECK MACRO DATA`
		`LOCAL LOOP`
		`LOOP CP MX,DATA`
		`JP NZ,LOOP`
		`ENDM`
		
		`CHECK 1`

LOCAL (Local)	To make local specification of label during macro definition	
ENDM (End Macro)	To end macro definition	

■ Error messages

Error message	Explanation
S (Syntax Error)	An unrecoverable syntax error was encountered.
U (Undefined Error)	The label or symbol of the operand has not been defined.
M (Missing Label)	The label field has been omitted.
O (Operand Error)	A syntax error was encountered in the operand, or the operand could not be evaluated.
P (Phase Error)	The same label or symbol was defined more than once.
R (Range Error)	• A statement exceeded a page boundary although its location was not specified. • The location counter value exceeded the upper limit of the program memory, or a location exceeding the upper limit was specified. • A value greater than that which the number of significant digits of the operand will accommodate was specified.
! (Warning)	Memory areas overlapped because of a "PAGE" or "ORG" pseudo-instruction or both.
FILE NAME ERROR	The source file name was longer than or equal to 8 characters.
FILE NOT PRESENT	The specified source file was not found.
DIRECTORY FULL	No space was left in the directory of the specified disk.
FATAL DISK WRITE ERROR	The file could not be written to the disk.
LABEL TABLE OVERFLOW	The number of defined labels and symbols exceeded the label table capacity (4000).
CROSS REFERENCE TABLE OVERFLOW	The label/symbol reference count exceeded the cross-reference table capacity (only when the cross-reference table is generated).

4 FUNCTION OPTION GENERATOR FOG623E

4.1 FOG623E Outline

With the 4-bit single-chip E0C623E microcomputers, the customer may select 13 hardware options. By modifying the mask patterns of the E0C623E according to the selected options, the system can be customized to meet the specifications of the target system.
The Function Option Generator FOG623E is a software tool for generating data files used to generate mask patterns. It enables the customer to interactively select and specify pertinent items for each hardware option. From the data file created with FOG623E, the E0C623E mask pattern is automatically generated by a general purpose computer. The HEX file for the evaluation board (EVA623E) hardware option ROM is simultaneously generated with the data file.

☞ *The operating method is same as for the E0C62 Family. Refer to the "E0C62 Family Development Tool Reference Manual" for details.*

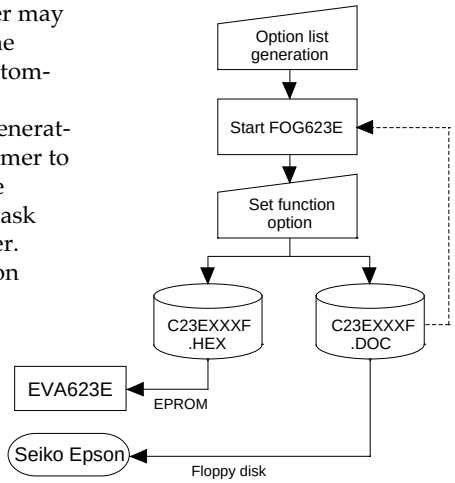

Fig. 4.1.1 FOG623E execution flow

4.2 E0C623E Option List

Multiple specifications are available in each option item as indicated in the Option List. Using "4.3 Option Specifications and Selection Message" as reference, select the specifications that meet the target system. Be sure to record the specifications for unused ports too, according to the instructions provided.

1. DEVICE TYPE

☐ 1. E0C623E(3.0V)
☐ 2. E0C62L3E(1.5V)
☐ 3. E0C62A3E(3.0V/TWIN CLOCK)

2. HEAVY LOAD PROTECTION FUNCTION FOR E0C623E/62A3E

☐ 1. Not Use
☐ 2. Use

(Selection item of the heavy load protection circuit for E0C623E/62A3E. Select "Not Use" when E0C62L3E is selected.)

3. MULTIPLE KEY ENTRY RESET

• COMBINATION ..... ☐ 1. Not Use
☐ 2. Use K00, K01
☐ 3. Use K00, K01, K02
☐ 4. Use K00, K01, K02, K03

4. INTERRUPT NOISE REJECTOR

• K00–K03 ..... ☐ 1. Not Use ☐ 2. Use

5. INPUT PORT PULL DOWN RESISTOR

• K00 ..... ☐ 1. With Resistor ☐ 2. Gate Direct
• K01 ..... ☐ 1. With Resistor ☐ 2. Gate Direct
• K02 ..... ☐ 1. With Resistor ☐ 2. Gate Direct
• K03 ..... ☐ 1. With Resistor ☐ 2. Gate Direct

6. OUTPUT PORT OUTPUT SPECIFICATION (R00–R03)

- R00 ..... ☐ 1. Complementary ☐ 2. Pch-OpenDrain
- R01 ..... ☐ 1. Complementary ☐ 2. Pch-OpenDrain
- R02 ..... ☐ 1. Complementary ☐ 2. Pch-OpenDrain
- R03 ..... ☐ 1. Complementary ☐ 2. Pch-OpenDrain

7. R10 SPECIFICATION

- OUTPUT TYPE ..... ☐ 1. D.C.
  ☐ 2. FOUT 32768 [Hz]
  ☐ 3. FOUT 16384 [Hz]
  ☐ 4. FOUT 8192 [Hz]
  ☐ 5. FOUT 4096 [Hz]
  ☐ 6. FOUT 2048 [Hz]
  ☐ 7. FOUT 1024 [Hz]
  ☐ 8. FOUT 512 [Hz]
  ☐ 9 FOUT 256 [Hz]
  ☐ 10. FOUT OSC3 (Only E0C62A3E)
- OUTPUT SPECIFICATION ..... ☐ 1. Complementary ☐ 2. Pch-OpenDrain

8. R11, SOUT SPECIFICATION

- R11 ..... ☐ 1. Complementary ☐ 2. Pch-OpenDrain
- SOUT ..... ☐ 1. Complementary ☐ 2. Pch-OpenDrain

9. R12 SPECIFICATION

- OUTPUT TYPE ..... ☐ 1. D.C. output ☐ 2. SOUT inverted output
- OUTPUT SPECIFICATION (When D.C. is selected for R12)
  ..... ☐ 1. Complementary ☐ 2. Pch-OpenDrain

10. I/O PORT SPECIFICATION

- P00 ..... ☐ 1. Complementary ☐ 2. Pch-OpenDrain
- P01 ..... ☐ 1. Complementary ☐ 2. Pch-OpenDrain
- P02 ..... ☐ 1. Complementary ☐ 2. Pch-OpenDrain
- P03 ..... ☐ 1. Complementary ☐ 2. Pch-OpenDrain

11. LCD COMMON DUTY

☐ 1. 1/4 Duty
☐ 2. 1/8 Duty

12. OSC3 SYSTEM CLOCK

☐ 1. Not Use
☐ 2. Ceramic
☐ 3. CR

(Only E0C62A3E. Select "Not Use" when E0C623E/62L3E is selected.)

13. OSC1 SYSTEM CLOCK

☐ 1. Crystal
☐ 2. CR

4.3 Option Specifications and Selection Message

Screen that can be selected as function options set on the E0C623E are shown below, and their specifications are also described.

1 Device type

```
*** OPTION  NO.1 ***

--- DEVICE TYPE ---

       1. E0C623E   ( 3.0V )
       2. E0C62L3E  ( 1.5V )
       3. E0C62A3E  ( 3.0V/TWIN CLOCK )

PLEASE SELECT NO.(1) ? 1  ↵

       1. E0C623E   ( 3.0V )   SELECTED
```

Select the chip specification.
E0C623E, E0C62L3E and E0C62A3E denote 3 V power source voltage specification, LOW POWER specification for 1.5 V power source voltage and TWIN CLOCK specification respectively.
When E0C623E or E0C62L3E is selected, oscillation circuit OSC3 can not be selected.

2 Heavy load protection function for E0C623E/62A3E

```
*** OPTION  NO.2 ***

--- HEAVY LOAD PROTECTION FOR E0C623E/62A3E ---

       1. NOT USE
       2. USE

PLEASE SELECT NO.(2) ? 2  ↵

       2. USE   SELECTED
```

When E0C623E or E0C62A3E is selected for "Device type", select whether the heavy load protection function will be used or not.
Select "NOT USE" when E0C62L3E is selected for "Device type".
In case of the E0C62L3E, the heavy load protection function can be used regardless of this option selection.

3 Multiple key entry reset

```
*** OPTION  NO.3 ***

--- MULTIPLE KEY ENTRY RESET ---

       COMBINATION

       1. NOT USE
       2. USE  K00,K01
       3. USE  K00,K01,K02
       4. USE  K00,K01,K02,K03

PLEASE SELECT  NO.(4) ? 4  ↵

       4. USE  K00,K01,K02,K03   SELECTED
```

The reset function is set when K00 through K03 are entered.
When "NOT USE" is selected, the reset function is not activated even if K00 through K03 are entered.
When "USE K00, K01" is selected, the system is reset immediately the K00 and K01 inputs go high at the same time. Similarly, the system is reset as soon as the K00 through K02 inputs or the K00 through K03 inputs go high.
However, the system is reset when a high signal is input for more than a rule time (1–3 sec).
The system reset circuit is shown in Figure 4.3.1.

However, this function does not operate in the status where the oscillation circuit is reset by software and continues.

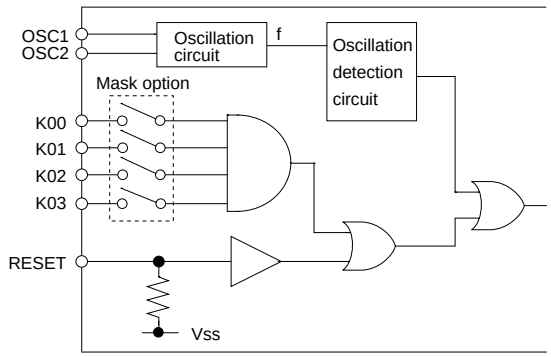

Fig. 4.3.1
System reset circuit

4 Interrupt noise rejector

```
*** OPTION  NO.4 ***

--- INTERRUPT NOISE REJECTOR ---

        K00-K03          1. NOT USE
                         2. USE

PLEASE SELECT NO.(2) ? 2  ↵

        K00-K03          2. USE   SELECTED
```

Select whether noise rejector will be supplemented to the input interrupter of K00–K03. When "USE" is selected, the entry signal will pass the noise rejector, and occurrence of interrupt errors due to noise or chattering can be avoided. Note, however, that because the noise rejector performs entry signal sampling at 4 kHz, "NOT USE" should be selected when high speed response is required.

5 Input ports pull down resistor

```
*** OPTION  NO.5 ***

--- INPUT PORT PULL DOWN RESISTOR ---

        K00              1. WITH RESISTOR
                         2. GATE DIRECT

PLEASE SELECT NO.(1) ? 1  ↵

        K01              1. WITH RESISTOR
                         2. GATE DIRECT

PLEASE SELECT NO.(1) ? 1  ↵

        K02              1. WITH RESISTOR
                         2. GATE DIRECT

PLEASE SELECT NO.(1) ? 1  ↵

        K03              1. WITH RESISTOR
                         2. GATE DIRECT

PLEASE SELECT NO.(1) ? 1  ↵

        K00              1. WITH RESISTOR   SELECTED
        K01              1. WITH RESISTOR   SELECTED
        K02              1. WITH RESISTOR   SELECTED
        K03              1. WITH RESISTOR   SELECTED
```

Select whether input ports (K00–K03) will each be supplemented with pull down resistors or not. When "GATE DIRECT" is selected, see to it that entry floating state does not occur. Select "WITH RESISTOR" pull down resistor for unused ports. Moreover, the input port status is changed from "H" level (V_{DD}) to "L" (V_{SS}) with pull down resistors, a delay of approximately 1 msec in waveform rise time will occur depending on the pull down resistor and entry load time constant. Because of this, when input reading is to be conducted, ensure the appropriate wait time with the program.
The configuration of the pull down resistor circuit is shown in Figure 4.3.2.

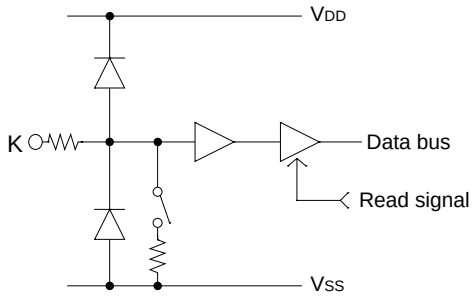

Fig. 4.3.2 Configuration of pull down resistor

6 Output port (R00–R03) output specification

```
*** OPTION  NO.6 ***

--- OUTPUT PORT OUTPUT SPECIFICATION R00-R03 ---

        R00             1. COMPLEMENTARY
                        2. PCH-OPENDRAIN

PLEASE SELECT NO.(1)? 1  ↵

        R01             1. COMPLEMENTARY
                        2. PCH-OPENDRAIN

PLEASE SELECT NO.(1)? 1  ↵

        R02             1. COMPLEMENTARY
                        2. PCH-OPENDRAIN

PLEASE SELECT NO.(1)? 1  ↵

        R03             1. COMPLEMENTARY
                        2. PCH-OPENDRAIN

PLEASE SELECT NO.(1)? 1  ↵

        R00             1. COMPLEMENTARY   SELECTED
        R01             1. COMPLEMENTARY   SELECTED
        R02             1. COMPLEMENTARY   SELECTED
        R03             1. COMPLEMENTARY   SELECTED
```

Select the output specification for the output ports (R00–R03).
Either complementary output or Pch open drain output may be selected.
When output port is to be used on key matrix configuration, select Pch open drain output.
For unused output ports, select complementary output.
The output circuit configuration is shown in Figure 4.3.3.

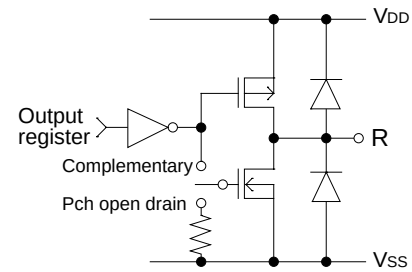

Fig. 4.3.3 Configuration of output circuit

7 R10 specification

```
*** OPTION  NO.7 ***

--- R10 SPECIFICATION ---

        OUTPUT TYPE             1. D.C.
                                2. FOUT  32768 [HZ]
                                3. FOUT  16384 [HZ]
                                4. FOUT   8192 [HZ]
                                5. FOUT   4096 [HZ]
                                6. FOUT   2048 [HZ]
                                7. FOUT   1024 [HZ]
                                8. FOUT    512 [HZ]
                                9. FOUT    256 [HZ]
                               10. FOUT   OSC3

PLEASE SELECT NO.(1) ? 1  ↵

        OUTPUT SPECIFICATION    1. COMPLEMENTARY
                                2. PCH-OPENDRAIN

PLEASE SELECT NO.(1) ? 1  ↵

        OUTPUT TYPE             1. D.C.   SELECTED
        OUTPUT SPECIFICATION    1. COMPLEMENTARY
SELECTED
```

Select the output specification for R10 terminal. Either complementary output or Pch open drain output may be selected.
When DC output is selected, R10 becomes a regular output port. When FOUT is selected, clock with frequency selected from R10 terminal is generated by writing "1" to the R10 register.

- When DC output is selected
  When R10 register (F4 address, D0 bit) is set to "1", the R10 terminal output goes high (VDD), and goes low (VSS) when set to "0".
  Output waveform is shown in Figure 4.3.4.

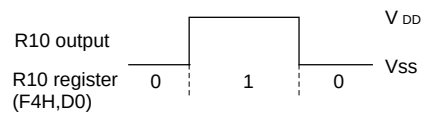

Fig. 4.3.4 Output waveform at DC output selection

- When FOUT output is selected
  When FOUT bit (R10 register) is set to "1", 50% duty and VDD–VSS amplitude square wave is generated at the specified frequency. When set to "0", the FOUT terminal goes low (VSS).
  A FOUT frequency may be selected from among 9 types, ranging from 256 Hz to 32,768 Hz and OSC3. (OSC3 may be selected only when the E0C62A3E is selected for "Device type".
  FOUT output is normally utilized to provide clock to other devices but since hazard occurs at the square wave breaks, great caution must be observed when using it.
  Output waveform is shown in Figure 4.3.5.

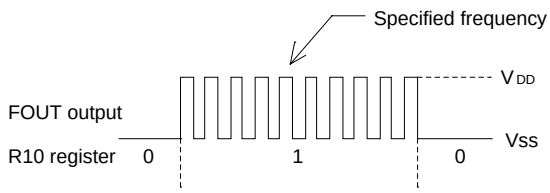

Fig. 4.3.5 Output waveform at R10 FOUT output selection

8 R11, SOUT specification

```
"10. FOUT OSC3" is displayed only when the E0C62A3E is selected.
*** OPTION  NO.8 ***

--- R11, SOUT SPECIFICATION ---

        R11             1. COMPLEMENTARY
                        2. PCH-OPENDRAIN

PLEASE SELECT NO.(1)? 1  ↵

        SOUT            1. COMPLEMENTARY
                        2. PCH-OPENDRAIN

PLEASE SELECT NO.(1)? 1  ↵

        R11             1. COMPLEMENTARY   SELECTED
```

Select the output specification for R11 and SOUT terminals.
Either complementary output or Pch open drain output can be selected.
The circuit configuration is the same as that of output ports (R00–R03 shown in Figure 4.3.3).
The SOUT terminal can be used only for sound signal output, and cannot be set to the DC output.

9 R12 specification

```
        SOUT            1. COMPLEMENTARY   SELECTED
*** OPTION  NO.9 ***

--- R12 SPECIFICATION ---

 OUTPUT TYPE            1. D.C.
                        2. SOUND INVERTED OUTPUT

PLEASE SELECT NO.(2) ? 2  ↵

 OUTPUT SPECIFICATION   1. COMPLEMENTARY
                        2. PCH-OPENDRAIN

PLEASE SELECT NO.(1) ? 1  ↵

 OUTPUT TYPE            2. SOUND INVERTED OUTPUT    SELECTED
 OUTPUT SPECIFICATION   1. COMPLEMENTARY   SELECTED
```

Select the specification for R12 terminal.
When DC output is selected for the R12 output type, either complementary output or Pch open drain output may be selected for the output specification.
When sound inverted output is selected, SOUT inverted signal is output from the R12 terminal and output specification is fixed to complementary output.

The output specification may be selected only when the D.C. output is selected

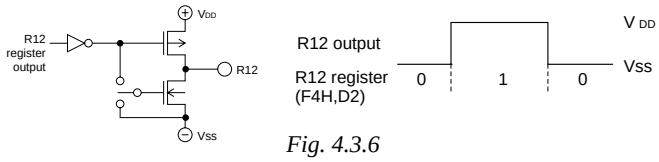

Fig. 4.3.6
Output circuit and output waveform (when DC output is selected)

- When DC output is selected
  From the R12 terminal, data written on the "R12" register is output. Complementary output or Pch open drain output may be selected for the R12 terminal.

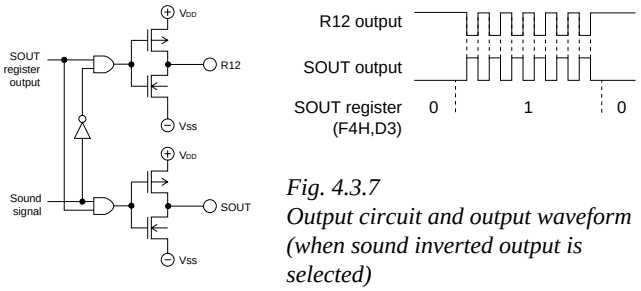

Fig. 4.3.7
Output circuit and output waveform (when sound inverted output is selected)

- When sound inverted output is selected
  Using SOUT and R12 terminals, the piezo buzzer may be directly driven. During output, inverted signal of the SOUT terminal is output from the R12 terminal. Both terminals go high when sound signal is not being output. The output configuration of both terminals becomes complementary.

10 I/O port specification

```
for R12 output type.
*** OPTION  NO.10 ***

--- I/O PORT OUTPUT SPECIFICATION ---

        P00             1. COMPLEMENTARY
                        2. PCH-OPENDRAIN

PLEASE SELECT NO.(1) ? 1  ↵

        P01             1. COMPLEMENTARY
                        2. PCH-OPENDRAIN

PLEASE SELECT NO.(1) ? 1  ↵

        P02             1. COMPLEMENTARY
                        2. PCH-OPENDRAIN

PLEASE SELECT NO.(1) ? 1  ↵

        P03             1. COMPLEMENTARY
                        2. PCH-OPENDRAIN

PLEASE SELECT NO.(1) ? 1  ↵

        P00             1. COMPLEMENTARY   SELECTED
        P01             1. COMPLEMENTARY   SELECTED
        P02             1. COMPLEMENTARY   SELECTED
```

Select the output specification to be used during I/O ports (P00–P03) output mode selection.
Either complementary output or Pch open drain output may be selected.
The circuit configuration of the output driver is the same as that of output ports (R00–R03 shown in Figure 4.3.3).
Select complementary output for unused ports.

The I/O ports can control the input/output direction according to the IOC bit (FC address, D0 bit); at "1" and "0" settings, it is set to output port and input port, respectively.

The pull down resistor of this port is turned on by the read signal and is normally turned off to minimize leak current.

11 LCD common duty

```
        P03             1. COMPLEMENTARY
SELECTED
*** OPTION  NO.11 ***

--- LCD COMMON DUTY ---

        1. 1/4 DUTY
        2. 1/8 DUTY

PLEASE SELECT NO.(2) ? 2  ↵
```

Select the common (drive) duty for the LCD segment.
When 1/4 duty is selected, with 4 COM terminals and 42 SEG terminals, i.e., up to168 segments may be driven; when 1/8 duty is selected, with 8 COM terminals and 38 SEG terminals, up to 304 segment drives will be possible.

12 OSC3 system clock (E0C62A3E)

```
       2. 1/8 DUTY   SELECTED
*** OPTION  NO.12 ***

--- OSC3 SYSTEM CLOCK ---

       1. NOT USE
       2. CERAMIC
       3. CR

PLEASE SELECT NO.(1) ? 1  ↵
       1. NOT USE   SELECTED
```

Select oscillation circuit that uses OSC3 and OSC4 for the E0C62A3E.
Select the "NOT USE" when the E0C623E/62L3E is selected for "Device type".
To minimize external components, CR oscillation circuit would be suitable; to obtain a stable oscillation frequency, ceramic oscillation circuit would be suitable.
When CR oscillation circuit is selected, only resistors are needed as external components since capacities are built-in. On the other hand, when ceramic oscillation circuit is selected, ceramic oscillator, gate capacity and drain capacity are needed as external components. Although when ceramic oscillation circuit is selected, it is fixed at 1 MHz, when CR oscillation circuit is selected, frequency may be modified to a certain extent depending on the resistance of external components.

13 OSC1 system clock

Select oscillation circuit that uses OSC1 and OSC2.

```
This option can be selected only when the E0C62A3E
is selected.
*** OPTION  NO.13 ***

--- OSC1 SYSTEM CLOCK ---

       1. CRYSTAL
       2. CR

PLEASE SELECT NO.(1) ? 1  ↵
       1. CRYSTAL   SELECTED
```

To minimize external components, CR oscillation circuit would be suitable; to obtain a stable oscillation frequency, crystal oscillation circuit would be suitable.
When crystal oscillation circuit is selected, it is fixed at 32.768 kHz, when CR oscillation circuit is selected, frequency may be modified to a certain extent depending on the resistance of external components.

4.4 FOG623E Quick Reference

■ Starting command and input/output files

Execution file: FOG623E.EXE

Starting command: **FOG623E**↵ ↵ *indicates the Return key.*

Input file: C23EXXXF.DOC (Function option document file, when modifying)

Output file: C23EXXXF.DOC (Function option document file)
C23EXXXF.HEX (Function option HEX file)

■ Display example

```
     ***  E0C623E FUNCTION OPTION GENERATOR. --- Ver 3.13  ***

EEEEEEEEEE   PPPPPPPP         SSSSSSS       OOOOOOOO     NNN      NNN
EEEEEEEEEE   PPPPPPPPPP     SSS    SSSS    OOO    OOO    NNNN     NNN
EEE          PPP     PPP   SSS     SSS    OOO      OOO   NNNNN    NNN
EEE          PPP     PPP    SSS           OOO      OOO   NNNNNN   NNN
EEEEEEEEEE   PPPPPPPPPP      SSSSSS       OOO      OOO   NNN NNN  NNN
EEEEEEEEEE   PPPPPPPP           SSSS      OOO      OOO   NNN  NNNNNN
EEE          PPP                 SSS     OOO      OOO   NNN   NNNNN
EEE          PPP            SSS     SSS   OOO      OOO   NNN    NNNN
EEEEEEEEEE   PPP            SSSS    SSS    OOO    OOO    NNN     NNN
EEEEEEEEEE   PPP              SSSSSSS       OOOOOOOO     NNN      NN

              (C) COPYRIGHT 1993  SEIKO EPSON CORP.

         THIS SOFTWARE MAKES NEXT FILES.

            C23EXXXF.HEX  ...  FUNCTION OPTION HEX FILE.
            C23EXXXF.DOC  ...  FUNCTION OPTION DOCUMENT FILE.

                         STRIKE ANY KEY.
```

Start-up message
When FOG623E is started, the start-up message is displayed.
For "STRIKE ANY KEY.", press any key to advance the program execution.

To suspend execution, press the "CTRL" and "C" keys together: the sequence returns to the DOS command level.

```
*** E0C623E USER'S OPTION SETTING. --- Ver 3.13 ***

CURRENT DATE IS  93/07/19
PLEASE INPUT NEW DATE  :   93/07/22 ↵
```

Date input
Enter the 2-digit year, month, and day of the month by delimiting them with a slash ("/"). When not modifying the date, press the RETURN key "↵" to continue.

```
*** OPERATION SELECT MENU ***

       1. INPUT NEW FILE
       2. EDIT FILE
       3. RETURN TO DOS

PLEASE SELECT NO.?
```

Operation selection menu
Enter a number from 1 to 3 to select a subsequent operation.
1. To set new function options.
2. To modify the document file.
3. To terminate FOG623E.

```
*** OPERATION SELECT MENU ***

       1. INPUT NEW FILE
       2. EDIT FILE
       3. RETURN TO DOS

PLEASE SELECT NO.? 1 ↵
PLEASE INPUT FILE NAME? C23E0A0 ↵                              ..(1)
PLEASE INPUT USER'S NAME? SEIKO EPSON CORP. ↵                  ..(2)
PLEASE INPUT ANY COMMENT
(ONE LINE IS 50 CHR)? TOKYO DESIGN CENTER ↵                    ..(3)
                    ? 421-8 HINO HINO-SHI TOKYO 191 JAPAN  ↵
                    ? TEL 0425-84-2551 ↵
                    ? FAX 0425-84-8512 ↵
                    ? ↵
```

Setting new function options
Select "1" on the operation selection menu.
(1) Enter the file name.
(2) Enter the customer's company name.
(3) Enter any comment.
(Within 50 characters x 10 lines)
Next, start function option setting from option No. 1.

```
PLEASE INPUT FILE NAME? C23E0A0 ↵
EXISTS OVERWRITE(Y/N)? N ↵
PLEASE INPUT FILE NAME? C23E0B0 ↵
PLEASE INPUT USER'S NAME?
```

In case a function option document file with the same name as the file name specified in the current drive exists, the user is asked whether overwrition is desired. Enter "Y" or "N" accordingly.

```
*** OPERATION SELECT MENU ***

        1. INPUT NEW FILE
        2. EDIT FILE
        3. RETURN TO DOS

PLEASE SELECT NO.? 2 ↵

*** SOURCE FILE(S) ***

C23E0A0         C23E0B0         C23E0C0                 ..(1)

PLEASE INPUT FILE NAME? C23E0A0 ↵                       ..(2)
PLEASE INPUT USER'S NAME? ↵                             ..(3)
PLEASE INPUT ANY COMMENT
(ONE LINE IS 50 CHR)? ↵                                 ..(4)
PLEASE INPUT EDIT NO.? 4 ↵                              ..(5)
            :
(Modifying function option settings)
            :
PLEASE INPUT EDIT NO.? E ↵
```

In step (1), if no modifiable source exists, the following message is displayed and the sequence returns to the operation selection menu.

```
*** SOURCE FILE(S) ***

FUNCTION OPTION DOCUMENT FILE IS NOT FOUND.
```

In step (2), if the function option document file is not in the current drive, the following message is displayed, prompting entry of other file name.

```
PLEASE INPUT FILE NAME? C23E0N0 ↵
FUNCTION OPTION DOCUMENT FILE IS NOT FOUND.
PLEASE INPUT FILE NAME?
```

```
*** OPTION  NO.3 ***

— MULTIPLE KEY ENTRY RESET —

        COMBINATION

        1. Not Use
        2. Use  K00,K01
        3. Use  K00,K01,K02
        4. Use  K00,K01,K02,K03

PLEASE SELECT  NO.(1) ? 2 ↵

        2. Use  K00,K01  SELECTED
```

```
END OF OPTION SETTING.
DO YOU MAKE HEX FILE (Y/N) ? Y ↵                        ..(1)

*** OPTION EPROM SELECT MENU ***

        1. 27C64
        2. 27C128
        3. 27C256
        4. 27C512

PLEASE SELECT NO.? 2 ↵                                  ..(2)

        2. 27C128   SELECTED

MAKING FILE(S) IS COMPLETED.

*** OPERATION SELECT MENU ***

        1. INPUT NEW FILE
        2. EDIT FILE
        3. RETURN TO DOS

PLEASE SELECT NO.?
```

Modifying function option settings

Select "2" on the operation selection menu.

(1) Will display the files on the current drive.
(2) Enter the file name.
(3) Enter the customer's company name.
(4) Enter any comment.
    Previously entered data can be used by pressing the RETURN key "↵" at (3) and (4).
(5) Enter the number of the function option to be modified. When selection of one option is complete, the system prompts entry of another function option number. Repeat selection until all options to be modified are selected.
    Enter "E↵" to end option setting. Then, move to the confirmation procedure for HEX file generation.

Option selection

The selections for each option correspond one to one to the option list. Enter the selection number. The value in parentheses ( ) indicates the default value, and is set when only the RETURN key "↵" is pressed.
In return, the confirmation is displayed.
When you wish to modify previously set function options in the new setting process, enter "B↵" to return 1 step back to the previous function option setting operation.

EPROM selection

When setting function options setting is completed, the following message is output to ask the operator whether to generate the HEX file.

(1) When debugging the program with EVA623E, HEX file is needed, so enter "Y↵". If "N↵" is entered, no HEX file is generated and only document file is generated.
(2) For the option ROM selection menu displayed when "Y↵" is entered in Step (1), select the EPROM to be used for setting EVA623E options.

When a series of operations are complete, the sequence returns to the operation selection menu.

4.5 Sample File

■ Example of function option document file

```
* E0C623E FUNCTION OPTION DOCUMENT  V 3.13
*
* FILE NAME    C23E0A0F.DOC
* USER'S NAME  SEIKO EPSON CORP.
* INPUT DATE   93/06/03
* COMMENT      TOKYO DESIGN CENTER
*              421-8 HINO HINO-SHI TOKYO 191 JAPAN
*              TEL 0425-84-2551
*              FAX 0425-84-8512
*
*
* OPTION NO.1
* < DEVICE TYPE >
*                            E0C623E   ( 3.0V )  ------------  SELECTED
 OPT0101 01
 OPT0102 01
*
* OPTION NO.2
* < HEAVY LOAD PROTECTION FUNCTION FOR E0C623E/62A3E >
*                            USE  --------------------------  SELECTED
 OPT0201 01
*
* OPTION NO.3
* < MULTIPLE KEY ENTRY RESET >
*     COMBINATION            USE  K00,K01,K02,K03 -----------  SELECTED
 OPT0301 04
*
* OPTION NO.4
* < INTERRUPT NOISE REJECTOR >
*     K00-K03                USE  --------------------------  SELECTED
 OPT0401 01
*
* OPTION NO.5
* < INPUT PORT PULL DOWN RESISTOR >
*     K00                    WITH RESISTOR  -----------------  SELECTED
*     K01                    WITH RESISTOR  -----------------  SELECTED
*     K02                    WITH RESISTOR  -----------------  SELECTED
*     K03                    WITH RESISTOR  -----------------  SELECTED
 OPT0501 01
 OPT0502 01
 OPT0503 01
 OPT0504 01
*
* OPTION NO.6
* < OUTPUT PORT SPECIFICATION R00-R03 >
*     R00                    COMPLEMENTARY  -----------------  SELECTED
*     R01                    COMPLEMENTARY  -----------------  SELECTED
*     R02                    COMPLEMENTARY  -----------------  SELECTED
*     R03                    COMPLEMENTARY  -----------------  SELECTED
 OPT0601 01
 OPT0602 01
 OPT0603 01
 OPT0604 01
*
* OPTION NO.7
* < R10 SPECIFICATION >
*     OUTPUT TYPE            D.C.  --------------------------  SELECTED
*     OUTPUT SPECIFICATION   COMPLEMENTARY  -----------------  SELECTED
 OPT0701 01
 OPT0702 08
 OPT0703 01
*
```

```
* OPTION NO.8
* < R11, SOUT SPECIFICATION >
*     R11                    COMPLEMENTARY  -----------------  SELECTED
*     SOUT                   COMPLEMENTARY  -----------------  SELECTED
 OPT0801 01
 OPT0802 01
*
* OPTION NO.9
* < R12 SPECIFICATION >
*     OUTPUT TYPE            SOUND INVERTED OUTPUT ----------  SELECTED
*     OUTPUT SPECIFICATION   COMPLEMENTARY  -----------------  SELECTED
 OPT0901 02
 OPT0902 01
*
* OPTION NO.10
* < I/O PORT OUTPUT SPECIFICATION >
*     P00                    COMPLEMENTARY  -----------------  SELECTED
*     P01                    COMPLEMENTARY  -----------------  SELECTED
*     P02                    COMPLEMENTARY  -----------------  SELECTED
*     P03                    COMPLEMENTARY  -----------------  SELECTED
 OPT1001 01
 OPT1002 01
 OPT1003 01
 OPT1004 01
*
* OPTION NO.11
* < LCD COMMON DUTY >
*                            1/8 DUTY  ----------------------  SELECTED
 OPT1101 02
*
* OPTION NO.12
* < OSC3 SYSTEM CLOCK >
*                            NOT USE  -----------------------  SELECTED
 OPT1201 01
*
* OPTION NO.13
* < OSC1 SYSTEM CLOCK >
*                            CRYSTAL  -----------------------  SELECTED
 OPT1301 01
*
*
*
* SEIKO EPSON'S AREA
*
*
*
* OPTION NO.14
 OPT1401 01
 OPT1402 01
 OPT1403 01
 OPT1404 01
*
* OPTION NO.15
 OPT1501 01
 OPT1502 01
 OPT1503 01
 OPT1504 01
*
* OPTION NO.16
 OPT1601 01
*
* OPTION NO.17
 OPT1701 01
 OPT1702 01
*
* OPTION NO.18
 OPT1801 01
 OPT1802 01
\\END
```

Note End mark "\\END" may be used instead of "¥¥END" depending on the PC used. (The code of \ and ¥ is 5CH.)

5 ICE CONTROL SOFTWARE ICS623E

5.1 ICS623E Outline

The In-circuit Emulator ICE6200 connects the target board produced by the user via the EVA623E and performs real time target system evaluation and debugging by passing through the RS-232C from the host computer and controlling it. The operation on the host computer side and ICE6200 control is done through the ICE Control Software ICS623E.
The ICS623E has a set of numerous and highly functional emulation commands which provide sophisticated break function, on-the-fly data display, history display, etc., and so perform a higher level of debugging.

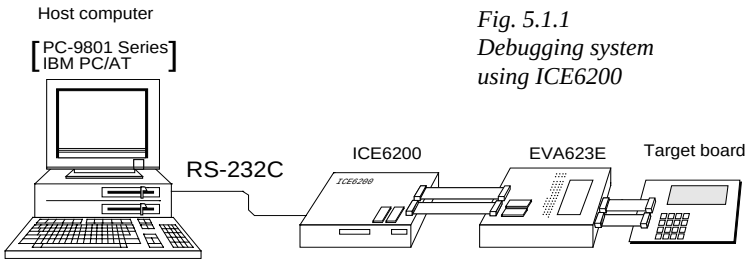

Fig. 5.1.1 Debugging system using ICE6200

☞ *The functions of the ICE6200 and commands are same as for the E0C62 Family. Refer to the "E0C62 Family Development Tool Reference Manual" for details.*

5.2 ICS623E Restrictions

Take the following precautions when using the ICS623E.

■ ROM Area

The ROM area is limited to a maximum address of 7FFH. Assigning data above the 7FFH address causes an error.

■ RAM Area

The RAM area is limited to a maximum address of 0FCH. However, as the following addresses are in the unused area, designation of this area with the ICE commands produces an error.
0E1H, 0E6H, 0E7H, 0E9H, 0ECH, 0F1H, 0F2H, 0F5H, 0F7H, 0F8H

■ Undefined Code

The instructions below are not specified for the E0C623E and so cannot be used.

```
SLP
PUSH    XP      POP   XP      LD    XP,r      LD    r,XP
PUSH    YP      POP   YP      LD    YP,r      LD    r,YP
```

■ OPTLD command

In the ICS623E, OPTLD command can be used.
This command is used to load HEX file (function option data) in the EVA623E memory with the ICE6200.

Load of function option data: `#OPTLD,1,C23EXXX` ↵

OPTLD *READ HEXA DATA FILE*

Format

#OPTLD,1,<*file name*>↵

Function

Load function option HEX file in the EVA623E function option data memory.
It is HEX file output by the function option generator and has intel HEX format.

* Since function option HEX file cannot be loaded in OSC3 clock operation, you should not change the operation clock.

Example

#OPTLD,1,C23EXXX ↵ ... C23EXXXF.HEX file is loaded in the function option data memory.

5.3 ICS623E Quick Reference

■ Starting command and input/output files

↲ *indicates the Return key.*

Execution file: ICS623E.BAT (ICS623EJ.EXE) . . . for MS-DOS
ICS623EB.BAT (ICS623EW.EXE) . . . for PC-DOS

Starting command: **ICS623E (ICS623EJ)↲** . . . for MS-DOS
ICS623EB (ICS623EW)↲ . . . for PC-DOS

Input file: C23EXXXL.HEX (Object file, low-order)
C23EXXXH.HEX (Object file, high-order)
C23EXXXD.HEX (Data RAM file)
C23EXXXC.HEX (Control file)
C23EXXXF.HEX (Function option HEX file)

Output file: C23EXXXL.HEX (Object file, low-order)
C23EXXXH.HEX (Object file, high-order)
C23EXXXD.HEX (Data RAM file)
C23EXXXC.HEX (Control file)

■ Display example

```
          *** E0C623E ICE CONTROL SOFTWARE. --- Ver 3.01 ***

EEEEEEEEEE   PPPPPPPP         SSSSSSS        00000000      NNN      NNN
EEEEEEEEEE   PPPPPPPPPP      SSS    SSSS     000     000    NNNN     NNN
EEE          PPP     PPP    SSS      SSS    000      000   NNNNN    NNN
EEE          PPP     PPP     SSS           000      000   NNNNNN   NNN
EEEEEEEEEE   PPPPPPPPPP       SSSSSS       000      000   NNN NNN NNN
EEEEEEEEEE   PPPPPPPP            SSSS      000      000   NNN  NNNNNN
EEE          PPP                  SSS     000      000   NNN   NNNNN
EEE          PPP            SSS     SSS    000      000   NNN    NNNN
EEEEEEEEEE   PPP            SSSS    SSS     000    000    NNN     NNN
EEEEEEEEEE   PPP              SSSSSSS        00000000      NNN      NN

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* ICE POWER ON RESET *
* DIAGNOSTIC TEST OK *
#
```

Start-up message
When ICS623E is started, the start-up message is displayed, and a self-test is automatically performed. ICS623E commands are awaited when the program is properly loaded and the # mark is displayed.
Debugging can be done by entering command after the # mark.
The ICS623E program is terminated by entering the Q (Quit) command.

Note *Confirm that the cables connected properly, then operate the ICS623E.*

■ Error messages

Error message	Meaning	Recover procedure
* COMMUNICATION ERROR OR ICE NOT READY *	ICE6200 is disconnected or power is OFF.	Switch OFF the host power supply, connect cable, and reapply power. Or switch ON power to ICE6200.
* TARGET DOWN (1) *	Evaluation board is disconnected. (Check at power ON)	Switch OFF power to ICE, and connect the evaluation board. Then, apply power to ICE6200.
* TARGET DOWN (2) *	Evaluation board is disconnected. (Check at command execution)	Switch OFF power to ICE, and connect the evaluation board. Then, apply power to ICE6200.
* UNDEFINED PROGRAM CODE EXIST *	Undefined code is detected in the program loaded from ROM or FD.	Convert ROM and FD data with the cross assembler, then restart the ICE6200.
* COMMAND ERROR *	A miss occurs by command input.	Reenter the proper command.
(No response after power on)	The ICE-to-HOST cable is disconnected on the host side.	Switch OFF the host power supply, connect cable, and reapply power.

■ ICE6200 commands

Item No.	Function	Command Format	Outline of Operation
1	Assemble	#A,a ↵	Assemble command mnemonic code and store at address "a"
2	Disassemble	#L,a1,a2 ↵	Contents of addresses a1 to a2 are disassembled and displayed
3	Dump	#DP,a1,a2 ↵	Contents of program area a1 to a2 are displayed
		#DD,a1,a2 ↵	Content of data area a1 to a2 are displayed
4	Fill	#FP,a1,a2,d ↵	Data d is set in addresses a1 to a2 (program area)
		#FD,a1,a2,d ↵	Data d is set in addresses a1 to a2 (data area)
5	Set Run Mode	#G,a ↵	Program is executed from the "a" address
		#TIM ↵	Execution time and step counter selection
		#OTF ↵	On-the-fly display selection
6	Trace	#T,a,n ↵	Executes program while displaying results of step instruction from "a" address
		#U,a,n ↵	Displays only the final step of #T,a,n
7	Break	#BA,a ↵	Sets Break at program address "a"
		#BAR,a ↵	Breakpoint is canceled
		#BD ↵	Break condition is set for data RAM
		#BDR ↵	Breakpoint is canceled
		#BR ↵	Break condition is set for EVA623ECPU internal registers
		#BRR ↵	Breakpoint is canceled
		#BM ↵	Combined break conditions set for program data RAM address and registers
		#BMR ↵	Cancel combined break conditions for program data ROM address and registers
		#BRES ↵	All break conditions canceled
		#BC ↵	Break condition displayed
		#BE ↵	Enter break enable mode
		#BSYN ↵	Enter break disable mode
		#BT ↵	Set break stop/trace modes
		#BRKSEL,REM ↵	Set BA condition clear/remain modes
8	Move	#MP,a1,a2,a3 ↵	Contents of program area addresses a1 to a2 are moved to addresses a3 and after
		#MD,a1,a2,a3 ↵	Contents of data area addresses a1 to a2 are moved to addresses a3 and after
9	Data Set	#SP,a ↵	Data from program area address "a" are written to memory
		#SD,a ↵	Data from data area address "a" are written to memory
10	Change CPU Internal Registers	#DR ↵	Display EVA623ECPU internal registers
		#SR ↵	Set EVA623ECPU internal registers
		#I ↵	Reset EVA623ECPU
		#DXY ↵	Display X, Y, MX and MY
		#SXY ↵	Set data for X and Y display and MX, MY

Item No.	Function	Command Format	Outline of Operation
11	History	#H,p1,p2 ↵	Display history data for pointer 1 and pointer 2
		#HB ↵	Display upstream history data
		#HG ↵	Display 21 line history data
		#HP ↵	Display history pointer
		#HPS,a ↵	Set history pointer
		#HC,S/C/E↵	Sets up the history information acquisition before (S), before/after (C) and after (E)
		#HA,a1,a2 ↵	Sets up the history information acquisition from program area a1 to a2
		#HAR,a1,a2 ↵	Sets up the prohibition of the history information acquisition from program area a1 to a2
		#HAD ↵	Indicates history acquisition program area
		#HS,a ↵	Retrieves and indicates the history information which executed a program address "a"
		#HSW,a ↵ #HSR,a ↵	Retrieves and indicates the history information which wrote or read the data area address "a"
12	File	#RF,file ↵	Move program file to memory
		#RFD,file ↵	Move data file to memory
		#VF,file ↵	Compare program file and contents of memory
		#VFD,file ↵	Compare data file and contents of memory
		#WF,file ↵	Save contents of memory to program file
		#WFD,file ↵	Save contents of memory to data file
		#CL,file ↵	Load ICE6200 set condition from file
		#CS,file ↵	Save ICE6200 set condition to file
		#OPTLD,1,file↵	Load function option data from file
13	Coverage	#CVD ↵	Indicates coverage information
		#CVR ↵	Clears coverage information
14	ROM Access	#RP ↵	Move contents of ROM to program memory
		#VP ↵	Compare contents of ROM with contents of program memory
		#ROM ↵	Set ROM type
15	Terminate ICE	#Q ↵	Terminate ICE and return to operating system control
16	Command Display	#HELP ↵	Display ICE6200 instruction
17	Self Diagnosis	#CHK ↵	Report results of ICE6200 self diagnostic test

↵ means press the RETURN key.

6 MASK DATA CHECKER MDC623E

6.1 MDC623E Outline

The Mask Data Checker MDC623E is a software tool which checks the program data (C23EXXXH.HEX and C23EXXXL.HEX) and option data (C23EXXXF.DOC) created by the user and creates the data file (C623EXXX.PAn) for generating mask patterns. The user must send the file generated through this software tool to Seiko Epson.

Moreover, MDC623E has the capability to restore the generated data file (C623EXXX.PA0) to the original file format.

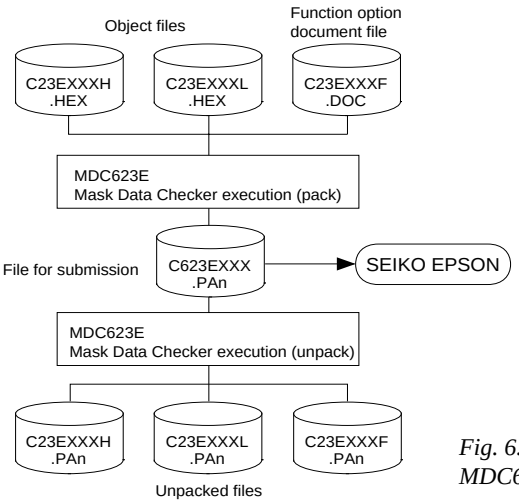

Fig. 6.1.1
MDC623E execution flow

☞ *The operating method is same as for the E0C62 Family. Refer to the "E0C62 Family Development Tool Reference Manual" for details.*

6.2 MDC623E Quick Reference

■ Starting command and input/output files

Execution file: MDC623E.EXE

Starting command: **MDC623E**↵ ↵ *indicates the Return key.*

Input file:

C23EXXXL.HEX	(Object file, low-order)	When packing
C23EXXXH.HEX	(Object file, high-order)	
C23EXXXF.DOC	(Function option document file)	
C623EXXX.PAn	(Packed file)	When unpacking

Output file:

C623EXXX.PAn	(Packed file)	When packing
C23EXXXL.PAn	(Object file, low-order)	When unpacking
C23EXXXH.PAn	(Object file, high-order)	
C23EXXXF.PAn	(Function option document file)	

■ Display examples

```
          *** E0C623E PACK / UNPACK PROGRAM Ver 2.001 ***

EEEEEEEEEE   PPPPPPPP        SSSSSSS       OOOOOOOO     NNN     NNN
EEEEEEEEEE   PPPPPPPPPP     SSS   SSSS    OOO    OOO    NNNN    NNN
EEE          PPP     PPP   SSS     SSS   OOO      OOO   NNNNN   NNN
EEE          PPP     PPP    SSS          OOO      OOO   NNNNNN  NNN
EEEEEEEEEE   PPPPPPPPPP      SSSSSS      OOO      OOO   NNN NNN NNN
EEEEEEEEEE   PPPPPPPP           SSSS     OOO      OOO   NNN  NNNNNN
EEE          PPP                 SSS    OOO      OOO   NNN   NNNNN
EEE          PPP            SSS     SSS  OOO      OOO   NNN    NNNN
EEEEEEEEEE   PPP            SSSS   SSS    OOO    OOO    NNN     NNN
EEEEEEEEEE   PPP              SSSSSSS       OOOOOOOO     NNN      NN

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                   --- OPERATION MENU ---

                          1. PACK
                          2. UNPACK

                   PLEASE SELECT NO.?
```

Start-up message

When MDC623E is started, the start-up message and operation menu are displayed. Here, the user is prompted to select operation options.

```
                   --- OPERATION MENU ---

                          1. PACK
                          2. UNPACK

                   PLEASE SELECT NO.? 1 ↵                          ...(1)

       C23EXXXH.HEX --------+
                            |
       C23EXXXL.HEX --------+-------- C23EXXX.PAn (PACK FILE)
                            |
       C23EXXXF.DOC --------+

 PLEASE INPUT PACK FILE NAME (C623EXXX.PAn) ?  C623E0A0.PA0 ↵    ...(2)

       C23E0A0H.HEX --------+
                            |
       C23E0A0L.HEX --------+-------- C23E0A0.PA0
                            |
       C23E0A0F.DOC --------+
```

Packing of data

(1) Select "1" in the operation menu.
(2) Enter the file name.
After submitting the data to Seiko Epson and there is a need to re-submit the data, increase the numeric value of "n" by one when the input is made.
(Example: When re-submitting data after "C623EXXX.PA0" has been submitted, the pack file name should be entered as "C623EXXX.PA1".)

With this, the mask file (C623EXXX.PAn) is generated, and the MDC623E program will be terminated.
Submit this file to Seiko Epson.

Note *Don't use the data generated with the -N option of the Cross Assembler (ASM623E) as program data. If the program data generated with the -N option of the Cross Assembler is packed, following message is displayed.*

```
HEX DATA ERROR : DATA (NO FFh)
```

```
                   --- OPERATION MENU ---

                          1. PACK
                          2. UNPACK

                   PLEASE SELECT NO.? 2 ↵                          ...(1)

 PLEASE INPUT PACKED FILE NAME (C623EXXX.PAn) ?  C623E0A0.PA0 ↵  ...(2)

                            +-------- C23E0A0H.PA0
                            |
       C623E0A0.PA0 --------+-------- C23E0A0L.PA0
                            |
                            +-------- C23E0A0F.PA0
```

Unpacking of data

(1) Select "1" in the operation menu.
(2) Enter the packed file name.

With this, the mask data file (C623EXXX.PAn) is restored to the original file format, and the MDC623E program will be terminated.

Since the extension of the file name remains as "PAn", it must be renamed back to its original form ("HEX" and "DOC") in order to re-debug or modify the restored file.

■ Error messages

Program data error

Error Message	Explanation
1. HEX DATA ERROR : NOT COLON.	There is no colon.
2. HEX DATA ERROR : DATA LENGTH. (NOT 00-20h)	The data length of 1 line is not in the 00–20H range.
3. HEX DATA ERROR : ADDRESS.	The address is beyond the valid range of the program, melody and scale ROM.
4. HEX DATA ERROR : RECORD TYPE. (NOT 00)	The record type of 1 line is not 00.
5. HEX DATA ERROR : DATA. (NOT 00-FFh)	The data is not in the range between 00H and 0FFH.
6. HEX DATA ERROR : TOO MANY DATA IN ONE LINE.	There are too many data in 1 line.
7. HEX DATA ERROR : CHECK SUM.	The checksum is not correct.
8. HEX DATA ERROR : END MARK.	The end mark is not : 00000001FF.
9. HEX DATA ERROR : DUPLICATE.	There is duplicate definition of data in the same address.
10. HEX DATA ERROR : DATA (NO FFh)	There is an undefined field in the HEX data.

Function option data error

Error Message	Explanation
1. OPTION DATA ERROR : START MARK.	The start mark is not "\OPTION". (during unpacking) *
2. OPTION DATA ERROR : OPTION NUMBER.	The option number is not correct.
3. OPTION DATA ERROR : SELECT NUMBER.	The option selection number is not correct.
4. OPTION DATA ERROR : END MARK.	The end mark is not "\\END" (packing) or "\END" (unpacking).*

File error

Error Message	Explanation
1. <File_name> FILE IS NOT FOUND.	The file is not found or the file number set in CONFIG.SYS is less than 10.
2. PACK FILE NAME (File_name) ERROR.	The packed input format for the file name is wrong.
3. PACKED FILE NAME (File_name) ERROR.	The unpacked input format for the file name is wrong.
4. VERSION NUMBER ERROR : X.DOC	FOG623E different from the version No. has been used.

System error

Error Message	Explanation
1. DIRECTORY FULL.	The directory is full.
2. DISK WRITE ERROR.	Writing on the disk is failed.

* \ *sometimes appears as ¥, depending on the personal computer being used.*

APPENDIX A. E0C623E INSTRUCTION SET

Classification	Mnemonic	Operand	Operation Code												Flag				Clock	Operation
			B	A	9	8	7	6	5	4	3	2	1	0	I	D	Z	C		
Branch instructions	PSET	p	1	1	1	0	0	1	0	p4	p3	p2	p1	p0					5	NBP ← p4, NPP ← p3~p0
	JP	s	0	0	0	0	s7	s6	s5	s4	s3	s2	s1	s0					5	PCB ← NBP, PCP ← NPP, PCS ← s7~s0
		C, s	0	0	1	0	s7	s6	s5	s4	s3	s2	s1	s0					5	PCB ← NBP, PCP ← NPP, PCS ← s7~s0 if C=1
		NC, s	0	0	1	1	s7	s6	s5	s4	s3	s2	s1	s0					5	PCB ← NBP, PCP ← NPP, PCS ← s7~s0 if C=0
		Z, s	0	1	1	0	s7	s6	s5	s4	s3	s2	s1	s0					5	PCB ← NBP, PCP ← NPP, PCS ← s7~s0 if Z=1
		NZ, s	0	1	1	1	s7	s6	s5	s4	s3	s2	s1	s0					5	PCB ← NBP, PCP ← NPP, PCS ← s7~s0 if Z=0
	JPBA		1	1	1	1	1	1	1	0	1	0	0	0					5	PCB ← NBP, PCP ← NPP, PCSH ← B, PCSL ← A
	CALL	s	0	1	0	0	s7	s6	s5	s4	s3	s2	s1	s0					7	M(SP-1) ← PCP, M(SP-2) ← PCSH, M(SP-3) ← PCSL+1 SP ← SP-3, PCP ← NPP, PCS ← s7~s0
	CALZ	s	0	1	0	1	s7	s6	s5	s4	s3	s2	s1	s0					7	M(SP-1) ← PCP, M(SP-2) ← PCSH, M(SP-3) ← PCSL+1 SP ← SP-3, PCP ← 0, PCS ← s7~s0
	RET		1	1	1	1	1	1	0	1	1	1	1	1					7	PCSL ← M(SP), PCSH ← M(SP+1), PCP ← M(SP+2) SP ← SP+3
	RETS		1	1	1	1	1	1	0	1	1	1	1	0					12	PCSL ← M(SP), PCSH ← M(SP+1), PCP ← M(SP+2) SP ← SP+3, PC ← PC+1
	RETD	*l*	0	0	0	1	*l*7	*l*6	*l*5	*l*4	*l*3	*l*2	*l*1	*l*0					12	PCSL ← M(SP), PCSH ← M(SP+1), PCP ← M(SP+2) SP ← SP+3, M(X) ← *l*3~*l*0, M(X+1) ← *l*7~*l*4, X ← X+2
System control instructions	NOP5		1	1	1	1	1	1	1	1	1	0	1	1					5	No operation (5 clock cycles)
	NOP7		1	1	1	1	1	1	1	1	1	1	1	1					7	No operation (7 clock cycles)
	HALT		1	1	1	1	1	1	1	1	1	0	0	0					5	Halt (stop clock)
Index operation instructions	INC	X	1	1	1	0	1	1	1	0	0	0	0	0					5	X ← X+1
		Y	1	1	1	0	1	1	1	1	0	0	0	0					5	Y ← Y+1
	LD	X, x	1	0	1	1	x7	x6	x5	x4	x3	x2	x1	x0					5	XH ← x7~x4, XL ← x3~x0
		Y, y	1	0	0	0	y7	y6	y5	y4	y3	y2	y1	y0					5	YH ← y7~y4, YL ← y3~y0
		XP, r*	1	1	1	0	1	0	0	0	0	0	r1	r0					5	XP ← r
		XH, r	1	1	1	0	1	0	0	0	0	1	r1	r0					5	XH ← r
		XL, r	1	1	1	0	1	0	0	0	1	0	r1	r0					5	XL ← r
		YP, r*	1	1	1	0	1	0	0	1	0	0	r1	r0					5	YP ← r
		YH, r	1	1	1	0	1	0	0	1	0	1	r1	r0					5	YH ← r
		YL, r	1	1	1	0	1	0	0	1	1	0	r1	r0					5	YL ← r
		r, XP*	1	1	1	0	1	0	1	0	0	0	r1	r0					5	r ← XP
		r, XH	1	1	1	0	1	0	1	0	0	1	r1	r0					5	r ← XH
		r, XL	1	1	1	0	1	0	1	0	1	0	r1	r0					5	r ← XL
		r, YP*	1	1	1	0	1	0	1	1	0	0	r1	r0					5	r ← YP
		r, YH	1	1	1	0	1	0	1	1	0	1	r1	r0					5	r ← YH
		r, YL	1	1	1	0	1	0	1	1	1	0	r1	r0					5	r ← YL
	ADC	XH, i	1	0	1	0	0	0	0	0	i3	i2	i1	i0			↕	↕	7	XH ← XH+i3~i0+C
		XL, i	1	0	1	0	0	0	0	1	i3	i2	i1	i0			↕	↕	7	XL ← XL+i3~i0+C
		YH, i	1	0	1	0	0	0	1	0	i3	i2	i1	i0			↕	↕	7	YH ← YH+i3~i0+C
		YL, i	1	0	1	0	0	0	1	1	i3	i2	i1	i0			↕	↕	7	YL ← YL+i3~i0+C

"" mean "not in E0C623E Series".*

Classification	Mne-monic	Operand	Operation Code												Flag				Clock	Operation
			B	A	9	8	7	6	5	4	3	2	1	0	I	D	Z	C		
Index operation instructions	CP	XH, i	1	0	1	0	0	1	0	0	i3	i2	i1	i0			↕	↕	7	XH-i3~i0
		XL, i	1	0	1	0	0	1	0	1	i3	i2	i1	i0			↕	↕	7	XL-i3~i0
		YH, i	1	0	1	0	0	1	1	0	i3	i2	i1	i0			↕	↕	7	YH-i3~i0
		YL, i	1	0	1	0	0	1	1	1	i3	i2	i1	i0			↕	↕	7	YL-i3~i0
Data transfer instructions	LD	r, i	1	1	1	0	0	0	r1	r0	i3	i2	i1	i0					5	r←i3~i0
		r, q	1	1	1	0	1	1	0	0	r1	r0	q1	q0					5	r←q
		A, Mn	1	1	1	1	1	0	1	0	n3	n2	n1	n0					5	A←M(n3~n0)
		B, Mn	1	1	1	1	1	0	1	1	n3	n2	n1	n0					5	B←M(n3~n0)
		Mn, A	1	1	1	1	1	0	0	0	n3	n2	n1	n0					5	M(n3~n0)←A
		Mn, B	1	1	1	1	1	0	0	1	n3	n2	n1	n0					5	M(n3~n0)←B
	LDPX	MX, i	1	1	1	0	0	1	1	0	i3	i2	i1	i0					5	M(X)←i3~i0, X←X+1
		r, q	1	1	1	0	1	1	1	0	r1	r0	q1	q0					5	r←q, X←X+1
	LDPY	MY, i	1	1	1	0	0	1	1	1	i3	i2	i1	i0					5	M(Y)←i3~i0, Y←Y+1
		r, q	1	1	1	0	1	1	1	1	r1	r0	q1	q0					5	r←q, Y←Y+1
	LBPX	MX, *l*	1	0	0	1	*l*7	*l*6	*l*5	*l*4	*l*3	*l*2	*l*1	*l*0					5	M(X)←*l*3~*l*0, M(X+1)←*l*7~*l*4, X←X+2
Flag operation instructions	SET	F, i	1	1	1	1	0	1	0	0	i3	i2	i1	i0	↑	↑	↑	↑	7	F←F∨i3~i0
	RST	F, i	1	1	1	1	0	1	0	1	i3	i2	i1	i0	↓	↓	↓	↓	7	F←F∧i3~i0
	SCF		1	1	1	1	0	1	0	0	0	0	0	1				↑	7	C←1
	RCF		1	1	1	1	0	1	0	1	1	1	1	0				↓	7	C←0
	SZF		1	1	1	1	0	1	0	0	0	0	1	0			↑		7	Z←1
	RZF		1	1	1	1	0	1	0	1	1	1	0	1			↓		7	Z←0
	SDF		1	1	1	1	0	1	0	0	0	1	0	0		↑			7	D←1 (Decimal Adjuster ON)
	RDF		1	1	1	1	0	1	0	1	1	0	1	1		↓			7	D←0 (Decimal Adjuster OFF)
	EI		1	1	1	1	0	1	0	0	1	0	0	0	↑				7	I ←1 (Enables Interrupt)
	DI		1	1	1	1	0	1	0	1	0	1	1	1	↓				7	I ←0 (Disables Interrupt)
Stack operation instructions	INC	SP	1	1	1	1	1	1	0	1	1	0	1	1					5	SP←SP+1
	DEC	SP	1	1	1	1	1	1	0	0	1	0	1	1					5	SP←SP-1
	PUSH	r	1	1	1	1	1	1	0	0	0	0	r1	r0					5	SP←SP-1, M(SP)←r
		XP *	1	1	1	1	1	1	0	0	0	1	0	0					5	SP←SP-1, M(SP)←XP
		XH	1	1	1	1	1	1	0	0	0	1	0	1					5	SP←SP-1, M(SP)←XH
		XL	1	1	1	1	1	1	0	0	0	1	1	0					5	SP←SP-1, M(SP)←XL
		YP *	1	1	1	1	1	1	0	0	0	1	1	1					5	SP←SP-1, M(SP)←YP
		YH	1	1	1	1	1	1	0	0	1	0	0	0					5	SP←SP-1, M(SP)←YH
		YL	1	1	1	1	1	1	0	0	1	0	0	1					5	SP←SP-1, M(SP)←YL
		F	1	1	1	1	1	1	0	0	1	0	1	0					5	SP←SP-1, M(SP)←F
	POP	r	1	1	1	1	1	1	0	1	0	0	r1	r0					5	r←M(SP), SP←SP+1
		XP *	1	1	1	1	1	1	0	1	0	1	0	0					5	XP←M(SP), SP←SP+1
		XH	1	1	1	1	1	1	0	1	0	1	0	1					5	XH←M(SP), SP←SP+1
		XL	1	1	1	1	1	1	0	1	0	1	1	0					5	XL←M(SP), SP←SP+1
		YP *	1	1	1	1	1	1	0	1	0	1	1	1					5	YP←M(SP), SP←SP+1

"" mean "not in E0C623E Series".*

Classification	Mnemonic	Operand	Operation Code												Flag				Clock	Operation
			B	A	9	8	7	6	5	4	3	2	1	0	I	D	Z	C		
Stack operation instructions	POP	YH	1	1	1	1	1	1	0	1	1	0	0	0					5	YH← M(SP), SP ← SP+1
		YL	1	1	1	1	1	1	0	1	1	0	0	1					5	YL ← M(SP), SP ← SP+1
		F	1	1	1	1	1	1	0	1	1	0	1	0	↕	↕	↕	↕	5	F ← M(SP), SP ← SP+1
	LD	SPH, r	1	1	1	1	1	1	1	0	0	0	r1	r0					5	SPH ← r
		SPL, r	1	1	1	1	1	1	1	1	0	0	r1	r0					5	SPL ← r
		r, SPH	1	1	1	1	1	1	1	0	0	1	r1	r0					5	r ← SPH
		r, SPL	1	1	1	1	1	1	1	1	0	1	r1	r0					5	r ← SPL
Arithmetic instructions	ADD	r, i	1	1	0	0	0	0	r1	r0	i3	i2	i1	i0	★		↕	↕	7	r ← r+i3~i0
		r, q	1	0	1	0	1	0	0	0	r1	r0	q1	q0	★		↕	↕	7	r ← r+q
	ADC	r, i	1	1	0	0	0	1	r1	r0	i3	i2	i1	i0	★		↕	↕	7	r ← r+i3~i0+C
		r, q	1	0	1	0	1	0	0	1	r1	r0	q1	q0	★		↕	↕	7	r ← r+q+C
	SUB	r, q	1	0	1	0	1	0	1	0	r1	r0	q1	q0	★		↕	↕	7	r ← r-q
	SBC	r, i	1	1	0	1	0	1	r1	r0	i3	i2	i1	i0	★		↕	↕	7	r ← r-i3~i0-C
		r, q	1	0	1	0	1	0	1	1	r1	r0	q1	q0	★		↕	↕	7	r ← r-q-C
	AND	r, i	1	1	0	0	1	0	r1	r0	i3	i2	i1	i0			↕		7	r ← r∧i3~i0
		r, q	1	0	1	0	1	1	0	0	r1	r0	q1	q0			↕		7	r ← r∧q
	OR	r, i	1	1	0	0	1	1	r1	r0	i3	i2	i1	i0			↕		7	r ← r∨i3~i0
		r, q	1	0	1	0	1	1	0	1	r1	r0	q1	q0			↕		7	r ← r∨q
	XOR	r, i	1	1	0	1	0	0	r1	r0	i3	i2	i1	i0			↕		7	r ← r∀i3~i0
		r, q	1	0	1	0	1	1	1	0	r1	r0	q1	q0			↕		7	r ← r∀q
	CP	r, i	1	1	0	1	1	1	r1	r0	i3	i2	i1	i0			↕	↕	7	r-i3~i0
		r, q	1	1	1	1	0	0	0	0	r1	r0	q1	q0			↕	↕	7	r-q
	FAN	r, i	1	1	0	1	1	0	r1	r0	i3	i2	i1	i0			↕		7	r∧i3~i0
		r, q	1	1	1	1	0	0	0	1	r1	r0	q1	q0			↕		7	r∧q
	RLC	r	1	0	1	0	1	1	1	1	r1	r0	r1	r0			↕	↕	7	d3 ← d2, d2 ← d1, d1 ← d0, d0 ← C, C ← d3
	RRC	r	1	1	1	0	1	0	0	0	1	1	r1	r0			↕	↕	5	d3 ← C, d2 ← d3, d1 ← d2, d0 ← d1, C ← d0
	INC	Mn	1	1	1	1	0	1	1	0	n3	n2	n1	n0			↕	↕	7	M(n3~n0) ← M(n3~n0)+1
	DEC	Mn	1	1	1	1	0	1	1	1	n3	n2	n1	n0			↕	↕	7	M(n3~n0) ← M(n3~n0)-1
	ACPX	MX, r	1	1	1	1	0	0	1	0	1	0	r1	r0	★		↕	↕	7	M(X) ← M(X)+r+C, X ← X+1
	ACPY	MY, r	1	1	1	1	0	0	1	0	1	1	r1	r0	★		↕	↕	7	M(Y) ← M(Y)+r+C, Y ← Y+1
	SCPX	MX, r	1	1	1	1	0	0	1	1	1	0	r1	r0	★		↕	↕	7	M(X) ← M(X)-r-C, X ← X+1
	SCPY	MY, r	1	1	1	1	0	0	1	1	1	1	r1	r0	★		↕	↕	7	M(Y) ← M(Y)-r-C, Y ← Y+1
	NOT	r	1	1	0	1	0	0	r1	r0	1	1	1	1			↕		7	r ← $\overline{r}$

Abbreviations used in the explanations have the following meanings.

Symbols associated with registers and memory

A A register
B B register
X XHL register
(low order eight bits of index register IX)
Y YHL register
(low order eight bits of index register IY)
XH XH register
(high order four bits of XHL register)
XL XL register
(low order four bits of XHL register)
YH YH register
(high order four bits of YHL register)
YL YL register
(low order four bits of YHL register)
XP XP register
(high order four bits of index register IX)
YP YP register
(high order four bits of index register IY)
SP Stack pointer SP
SPH High-order four bits of stack pointer SP
SPL Low-order four bits of stack pointer SP
MX, M(X) Data memory whose address is specified with index register IX
MY, M(Y) Data memory whose address is specified with index register IY
Mn, M(n) Data memory address 000H–00FH (address specified with immediate data n of 00H–0FH)
M(SP) Data memory whose address is specified with stack pointer SP
r, q Two-bit register code
r, q is two-bit immediate data; according to the contents of these bits, they indicate registers A, B, and MX and MY (data memory whose addresses are specified with index registers IX and IY)

r		q		Register specified
r1	r0	q1	q0	
0	0	0	0	A
0	1	0	1	B
1	0	1	0	MX
1	1	1	1	MY

Symbols associated with program counter

NBP New bank pointer
NPP New page pointer
PCB Program counter bank
PCP Program counter page
PCS Program counter step
PCSH Four high order bits of PCS
PCSL Four low order bits of PCS

Symbols associated with flags

F Flag register (I, D, Z, C)
C Carry flag
Z Zero flag
D Decimal flag
I Interrupt flag
↓ Flag reset
↑ Flag set
◊ Flag set or reset

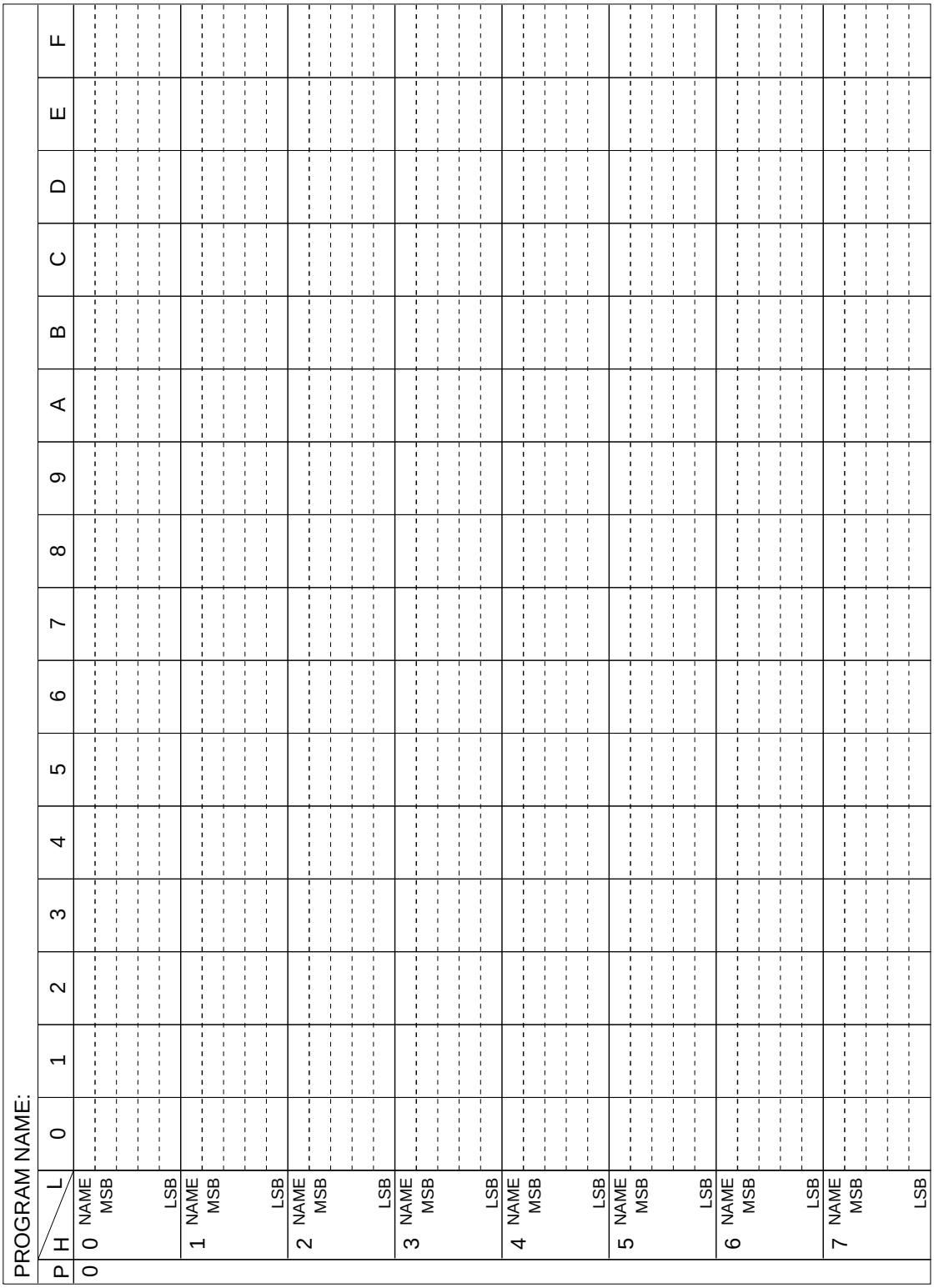
Associated withimmediate data

p Five-bit immediate data or label 00H–1FH
s Eight-bit immediate data or label 00H–0FFH
l Eight-bit immediate data 00H–0FFH
i Four-bit immediate data 00H–0FH

Associated with arithmetic and other operations

+ Add
- Subtract
∧ Logical AND
∨ Logical OR
∀ Exclusive-OR
★ Add-subtract instruction for decimal operation when the D flag is set

APPENDIX B. E0C623E RAM MAP



PROGRAM NAME:

P	H \ L	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	8 NAME																
	MSB																
	LSB																
	9 NAME																
	MSB																
	LSB																
	A NAME																
	MSB																
	LSB																
	B NAME																
	MSB																
	LSB																
	C NAME																
	MSB																
	LSB																
	D NAME																
	MSB																
	LSB																
	E NAME		–					–	–		–			–			
	MSB	K03	–	SWL3	SWH3	TM3	KCP03	–	–	EIK03	–	–	–	–	–	–	–
		K02	–	SWL2	SWH2	TM2	KCP02	–	–	EIK02	–	–	EIT2	–	–	–	IT2
		K01	–	SWL1	SWH1	TM1	KCP01	–	–	EIK01	–	EISW1	EIT8	–	–	ISW1	IT8
	LSB	K00	–	SWL0	SWH0	TM0	KCP00	–	–	EIK00	–	EISW0	EIT32	–	IK0	ISW0	IT32
	F NAME		–	–			–		–	–	–				–	–	–
	MSB	–	–	–	R03	SOUT	–	P03	–	–	–	HLMOD	CSDC	CLKCHG	–	–	–
		SAD2	–	–	R02	R12/$\overline{SO}$	–	P02	–	–	TMRST	–	–	OSCC	–	–	–
		SAD1	–	–	R01	R11	–	P01	–	–	SWRUN	SVDDT	–	–	–	–	–
	LSB	SAD0	–	–	R00	R10/FOUT	–	P00	–	–	SWRST	SVDON	–	IOC	–	–	–

APPENDIX C. E0C623E I/O MEMORY MAP

Address	Register D3	D2	D1	D0	Name	Init *1	1	0	Comment
0E0H	K03	K02	K01	K00	K03	– *2	High	Low	Input port (K00–K03)
					K02	– *2	High	Low	
	R				K01	– *2	High	Low	
					K00	– *2	High	Low	
0E2H	SWL3	SWL2	SWL1	SWL0	SWL3	0			MSB
					SWL2	0			Stopwatch timer 1/100 sec (BCD)
	R				SWL1	0			
					SWL0	0			LSB
0E3H	SWH3	SWH2	SWH1	SWH0	SWH3	0			MSB
					SWH2	0			Stopwatch timer 1/10 sec (BCD)
	R				SWH1	0			
					SWH0	0			LSB
0E4H	TM3	TM2	TM1	TM0	TM3	–	High	Low	Timer data (clock timer 2 Hz)
					TM2	–	High	Low	Timer data (clock timer 4 Hz)
	R				TM1	–	High	Low	Timer data (clock timer 8 Hz)
					TM0	–	High	Low	Timer data (clock timer 16 Hz)
0E5H	KCP03	KCP02	KCP01	KCP00	KCP03	0	↓	↑	Input comparison register (K00–K03)
					KCP02	0	↓	↑	
	R/W				KCP01	0	↓	↑	
					KCP00	0	↓	↑	
0E8H	EIK03	EIK02	EIK01	EIK00	EIK03	0	Enable	Mask	Interrupt mask register (K00–K03)
					EIK02	0	Enable	Mask	
	R/W				EIK01	0	Enable	Mask	
					EIK00	0	Enable	Mask	
0EAH	0	0	EISW1	EISW0	0 *5				
					0 *5				
	R		R/W		EISW1	0	Enable	Mask	Interrupt mask register (stopwatch 1 Hz)
					EISW0	0	Enable	Mask	Interrupt mask register (stopwatch 10 Hz)
0EBH	0	EIT2	EIT8	EIT32	0 *5				
					EIT2	0	Enable	Mask	Interrupt mask register (clock timer 2 Hz)
	R	R/W			EIT8	0	Enable	Mask	Interrupt mask register (clock timer 8 Hz)
					EIT32	0	Enable	Mask	Interrupt mask register (clock timer 32 Hz)
0EDH	0	0	0	IK0	0 *5				
					0 *5				
	R				0 *5				
					IK0*4	0	Yes	No	Interrupt factor flag (K00–K03)
0EEH	0	0	ISW1	ISW0	0 *5				
					0 *5				
	R				ISW1*4	0	Yes	No	Interrupt factor flag (stopwatch 1 Hz)
					ISW0*4	0	Yes	No	Interrupt factor flag (stopwatch 10 Hz)
0EFH	0	IT2	IT8	IT32	0 *5				
					IT2 *4	0	Yes	No	Interrupt factor flag (clock timer 2 Hz)
	R				IT8 *4	0	Yes	No	Interrupt factor flag (clock timer 8 Hz)
					IT32*4	0	Yes	No	Interrupt factor flag (clock timer 32 Hz)

Remarks

*1 Initial value at the time of initial reset
*2 Not set in the circuit
*3 Undefined
*4 Reset (0) immediately after being read
*5 Constantly "0" when being read
*6 Refer to main manual

Address	Register								Comment
	D3	D2	D1	D0	Name	Init *1	1	0	
0F0H	0	SAD2	SAD1	SAD0	0 *5				
					SAD2	0			Sound signal frequency selection
	R	R/W			SAD1	0			0: 4096.0, 1: 3276.8, 2: 2730.7, 3: 2340.6
					SAD0	0			4: 2048.0, 5: 1638.4, 6: 1365.3, 7: 1170.3 (Hz)
0F3H	R03	R02	R01	R00	R03	0	High	Low	Output port data (R00–R03)
					R02	0	High	Low	
	R/W				R01	0	High	Low	
					R00	0	High	Low	
0F4H	SOUT	R12 / $\overline{SO}$	R11	R10 / FOUT	SOUT	0	Enable	Mask	Sound output mask
					R12	0	High	Low	Output port data (R12)
					$\overline{SO}$	– *6	–	–	Inverting sound output
	R/W				R11	0	High	Low	Output port data (R11)
					R10	0	High	Low	Output port data (R10)
					FOUT		On	Off	Frequency output
0F6H	P03	P02	P01	P00	P03	– *2	High	Low	I/O port (P00–P03)
					P02	– *2	High	Low	
	R/W				P01	– *2	High	Low	
					P00	– *2	High	Low	
0F9H	0	TMRST	SWRUN	SWRST	0 *5				
					TMRST *5	Reset	Reset	–	Clock timer reset
	R	W	R/W	W	SWRUN	0	Run	Stop	Stopwatch timer Run/Stop
					SWRST *5	Reset	Reset	–	Stopwatch timer reset
0FAH	HLMOD	0	SVDDT	SVDON	HLMOD	0	Heavy	Normal	Heavy load protection mode register
					0 *5				
	R/W	R		R/W	SVDDT	0	Low	Normal	Supply voltage detection data
					SVDON	0	On	Off	Supply voltage detection On/Off
0FBH	CSDC	0	0	0	CSDC	0	1	0	Reserved register
					0 *5				
	R/W	R			0 *5				
					0 *5				
0FCH	CLKCHG	OSCC	0	IOC	CLKCHG	0	OSC3	OSC1	CPU clock switch
					OSCC	0	On	Off	OSC3 oscillation On/Off
	R/W		R	R/W	0 *5				
					IOC	0	Output	Input	I/O control register (P00–P03)

APPENDIX D. TROUBLESHOOTING

Tool	Problem	Remedy measures
ICE6200	Nothing appears on the screen, or nothing works, after activation.	Check the following and remedy if necessary: • Is the RS-232C cable connected correctly? • Is the RS-232C driver installed? • Is SPEED.COM or MODE.COM on the disk? • Is the execution file correct? MS-DOS ICS623EJ.EXE PC-DOS ICS623EW.EXE • Is the DOS version correct? MS-DOS Ver. 3.1 or later PC-DOS Ver. 2.1 or later • Is the DIP switches that set the baud rate of the main ICE6200 unit set correctly? • Is the breaker of the ICE6200 set to ON?
	The ICE6200 breaker tripped immediately after activation.	Check the following and remedy if necessary: • Are connectors F1 and F5 connected to the EVA623E correctly? • Is the target board power short-circuiting?
	<ILLEGAL VERSION ICE6200> appears on the screen immediately after activation.	The wrong version of ICE6200 is being used. Use the latest version.
	<ILLEGAL VERSION PARAMETER FILE> appears on the screen immediately after activation.	The wrong version of ICS623E.PAR is being used. Use the latest version.
	Immediate values A (10) and B (11) cannot be entered correctly with the A command.	The A and B registers are reserved for the entry of A and B. Write 0A and 0B when entering A (10) and B (11). *Example:* `LD A, B` Data in the B register is loaded into the A register. `LD B, 0A` Immediate value A is loaded into the B register.
	<UNUSED AREA> is displayed by the SD command.	This message is output when the address following one in which data is written is unused. It does not indicates problem. Data is correctly set in areas other than the read-only area.
	You can not do a real-time run in break-trace mode.	Since the CPU stops temporarily when breaking conditions are met, executing in a real-time is not performed.
	Output from the EVA is impossible when data is written to the I/O memory for Buzzer and Fout output with the ICE command.	Output is possible only in the real-time run mode.

Tool	Problem	Remedy measures
MDC623E	Activation is impossible.	Check the following and remedy if necessary: • Is the number of files set at ten or more in OS environment file CONFIG.SYS?
EVA623E	The EVA623E does not work when it is used independently.	Check the following and remedy if necessary: • Has the EPROM for F.HEX been replaced by the EPROM for the target? • Is the EPROM for F.HEX and S.HEX (attached) installed correctly? • Is the appropriate voltage being supplied? (5V DC, 3A, or more) • Are the program ROMs (H and L) installed correctly? • Is data written from address 4000H? (When the 27C256 is used as the program ROM) • Is the EN/DIS switch on the EVA623E set to EN?
	Target segment does not light.	Check the following and remedy if necessary: • Is the EPROM for S.HEX (attached) installed correctly? • Has the VADJ VR inside the EVA623E top cover been turned to a lower setting?

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■ Electronic devices information on the Epson WWW server

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