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RENESAS

User's Manual

CC78K4 Ver. 2.40 or Later

C Compiler

Operation

Target Devices

78K4 Series

Document No. U16707EJ1V0UM00 (1st edition)
Date Published September 2003 N CP(K)

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INTRODUCTION

The purpose of this manual is to give the user a complete understanding of the functions and operation of the CC78K4 (78K4 Series C Compiler).

This manual does not explain how to write CC78K4 source programs. Therefore, before reading this manual, please read **"CC78K4 C Compiler Language User's Manual (U15556E)"** (hereafter called the "Language manual").

[Target Devices]

Software for 78K4 Series microcontrollers can be developed by using the CC78K4. To use this software, the RA78K4 (78K4 Series Assembler Package (sold separately)) and the target model's device file are required.

[Target Readers]

This manual is written for users who have the knowledge gained from reading through the user's manual for the device once and have software programming experience. However, since knowledge about C compilers and the C language is not particularly needed, first-time users of C compilers can use this manual.

[Organization]

The organization of this manual is described below.

CHAPTER 1 OVERVIEW

This chapter describes the role and position of the CC78K4 in microcontroller development.

CHAPTER 2 PRODUCT OVERVIEW AND INSTALLATION

This chapter describes how to install the CC78K4, the file names of the supplied programs, and the operating environment for programs.

CHAPTER 3 PROCEDURE FROM COMPILING TO LINKING

This chapter uses sample programs to describe how to run the CC78K4 and presents examples showing the processes from compiling to linking.

CHAPTER 4 CC78K4 FUNCTIONS

This chapter describes optimization methods and ROMization functions in the CC78K4.

CHAPTER 5 COMPILER OPTIONS

This chapter describes the functions of the compiler options, specification methods, and prioritization.

CHAPTER 6 C COMPILER OUTPUT FILES

This chapter describes the output of various list files output by the CC78K4.

CHAPTER 7 USING C COMPILER

This chapter introduces techniques to aid in the skillful use of the CC78K4.

CHAPTER 8 STARTUP ROUTINES

The CC78K4 provides startup routines as samples. This chapter describes the uses of the startup routines and provides suggestions on how to improve them.

CHAPTER 9 ERROR MESSAGES

This chapter describes the error messages output by the CC78K4.

APPENDICES

The appendices provide and a sample program, a list of the cautions encountered during use, lists of the restrictions related to the CC78K4, and an index.

[How to Read This Manual]

First, those who want to see how to actually use CC78K4, read **CHAPTER 3 PROCEDURE FROM COMPILING TO LINKING**.

Users with a general knowledge of C compilers or users who have read the Language manual can skip **CHAPTER 1 OVERVIEW**.

[Related Documents]

The table below shows the documents (such as user's manuals) related to this manual. The related documents indicated in this publication may include preliminary versions. However, preliminary versions are not marked as such.

Document Name		Document No.
CC78K4 C Compiler	Operation	This manual
	Language	U15556E
RA78K4 Assembler Package	Operation	U16708E
	Language	U15255E
	Structured Assembler Language	U11743E
SM78K4 Series System Simulator Windows™ Based	Operation	To be prepared
SM78K Series System Simulator Ver. 1.40 or Later	External Part User Open Interface Specifications	U10092E
ID78K4-NS Integrated Debugger Ver. 2.52 or Later Windows Based	Operation	U16632E
ID78K4 Integrated Debugger Windows Based	Reference	U10440E
RX78K4 Real-Time OS	Fundamental	U10603E
	Installation	U10604E
PM plus Ver. 5.10		To be prepared

[Conventions]

The meanings of the symbols used in this manual are explained.

RTOS:	Real-time OS for 78K4 Series RX78K4
…:	Repeat in the same format.
[ ]:	Characters enclosed in these brackets can be omitted.
⌈ ⌋:	Characters enclosed in these brackets are as shown (character string).
“ ”:	Characters enclosed in these brackets are as shown (character string).
‘ ’:	Characters enclosed in these brackets are as shown (character string).
Boldface:	Characters in bold face are as shown (character string).
_ :	Underlining at important locations or in examples is the input character sequence.
Δ :	At least one space
⋮ :	Indicates an omission in a program description
( ) :	Characters between parentheses are as shown (character string).
/ :	Delimiter
\:	Backslash

[File Name Conventions]

The conventions for specifying the input files that are designated in the command line are shown below.

(1) Specifying disk file names

```
[drive-name]   [\]   [[path-name]...]   primary-name   [.[file-type]]
    <1>        <2>   <3>                 <4>               <5>
```

<1> Specifies the name of the drive (A: to Z:) storing the file.

<2> Specifies the name of the root directory.

<3> Specify the subdirectory name.

Specify a character string of a length allowed by the OS.

Characters that can be used:

All the characters allowed by the OS, except parentheses (()), semicolons (:), and commas (,).

Note that a hyphen (-) cannot be used as the first character of a path name.

<4> Primary name

Specify a character string of a length allowed by the OS.

Characters that can be used:

All the characters allowed by the OS, except parentheses (( )), semicolons (:), and commas (,).

Note that a hyphen (-) cannot be used as the first character of a path name.

<5> File type

Specify a character string of a length allowed by the OS.

Characters that can be used:

All the characters allowed by the OS, except parentheses (( )), semicolons (:), and commas (,).

```
Example:  C:\nectools32\smp78k4\CC78k4\prime.C
```

Remarks **1.** A space cannot be specified before and after ‘:’, ‘.’, or ‘\’.

2. Uppercase and lowercase letters are not distinguished (not case-sensitive).

(2) Specifying device file names

The following logical devices are available.

Logical Device	Description
CON	Output to the console.
PRN	Output to the printer.
AUX	Output to an auxiliary output device.
NUL	Dummy output (nothing is output.)

CONTENTS

CHAPTER 1 OVERVIEW

The CC78K4 C compiler program translates C source programs written in ANSI-C[Note] or the C language for the 78K4 Series into the machine language for the 78K4 Series.

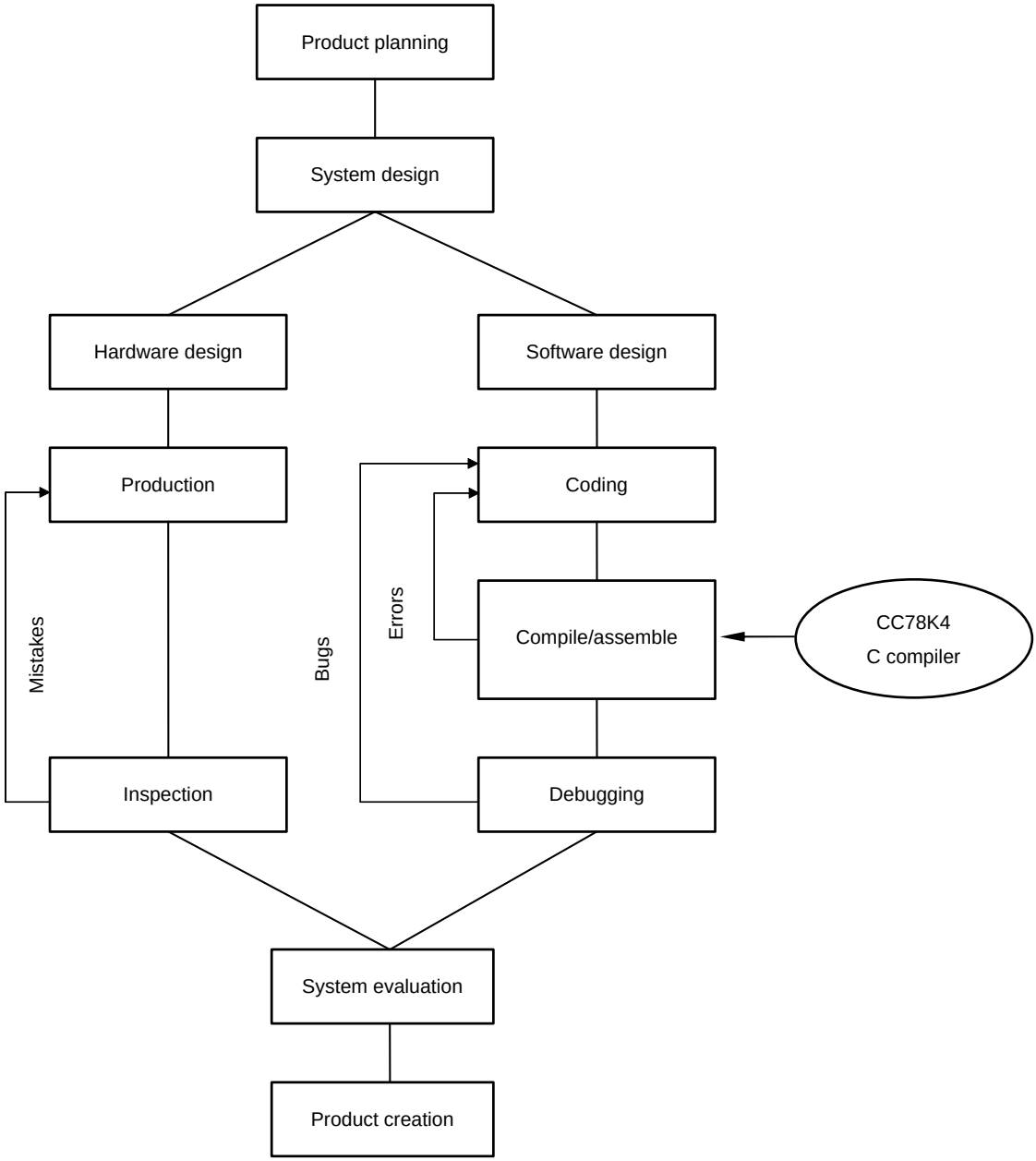
The CC78K4 can be run on Windows 98/Me/2000/XP or Windows NT™ 4.0 when using PM plus included in the assembler package for the 78K4 Series. If PM plus is not used, the compiler can be run from the DOS prompt (Windows 98/Me) or command prompt (Windows NT 4.0/2000/XP) (for Windows versions).

Note ANSI-C is the C language that conforms to the standard set by the American National Standards Institute.

1.1 Microcontroller Application Product Development and Role of CC78K4

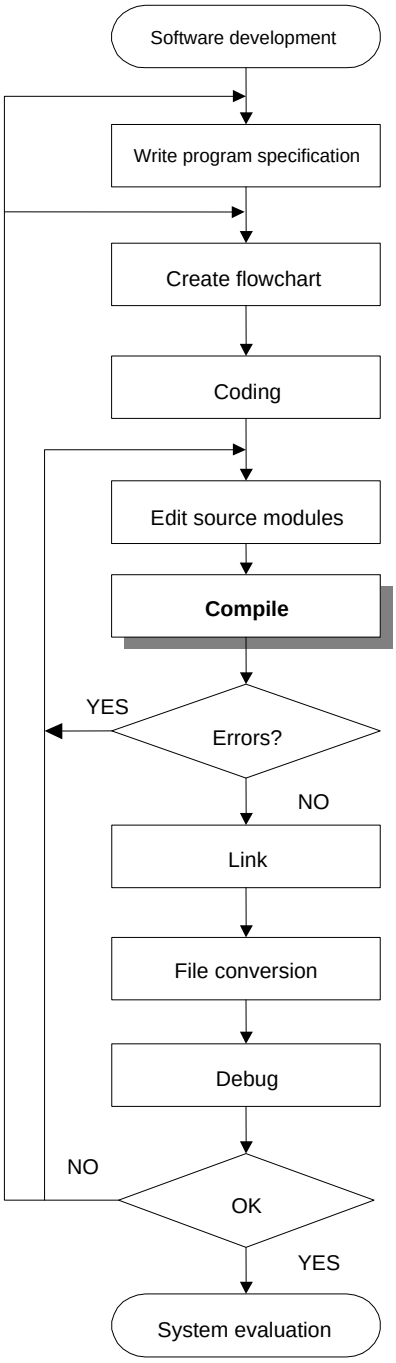
The position of CC78K4 in product development is shown below.

Figure 1-1. Development Process for Microcontroller Application Products



The software development process is shown below.

Figure 1-2. Software Development Process



… Depends on 78K Series C language or ANSI-C

… Use the editor to create the C source module files.

… Link to the reference library and function library.

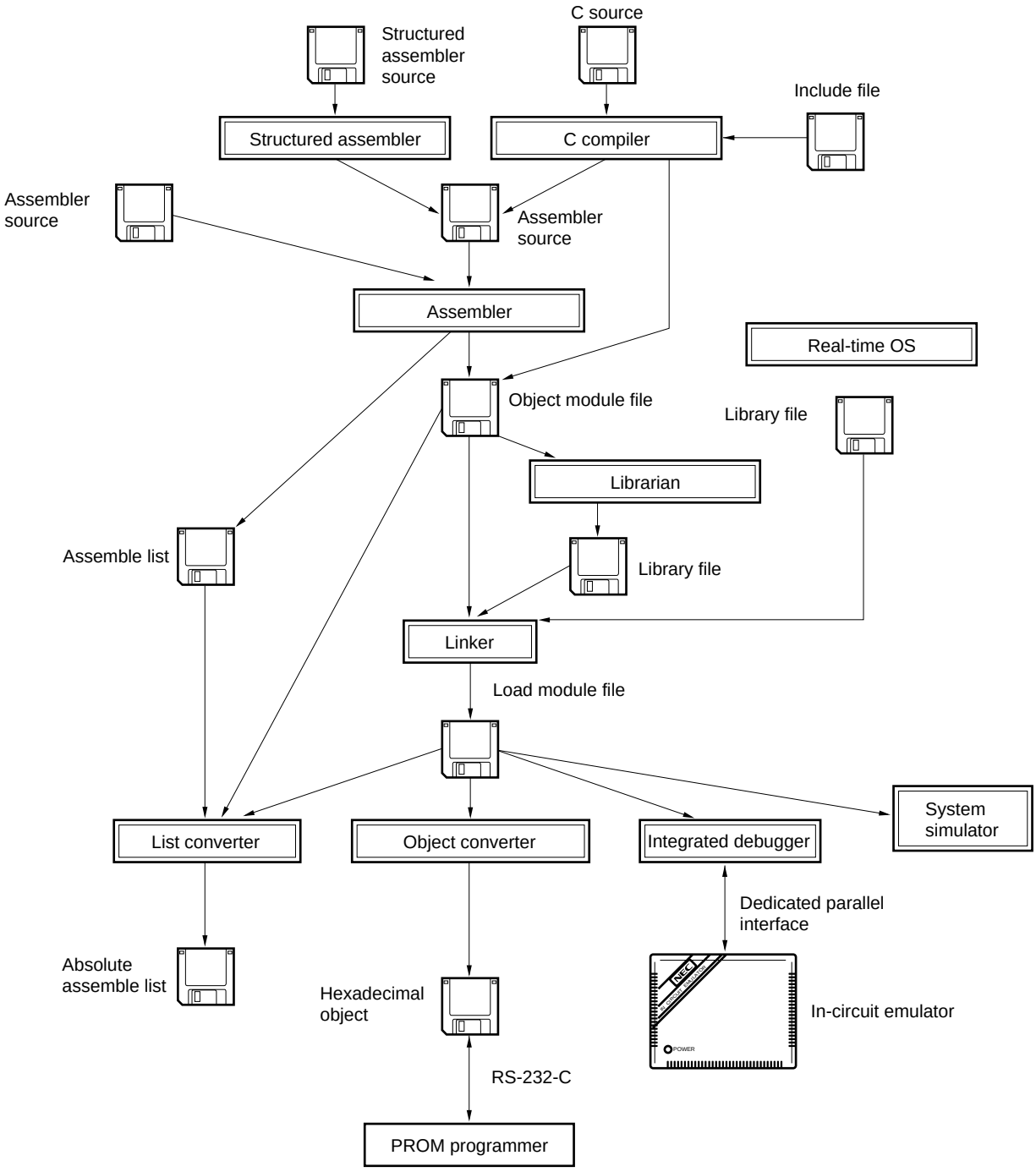
… Convert the file to the hexadecimal format.

… Use the hardware debugger (in-circuit emulator, etc.) to verify the operation.

1.2 Development Procedure Using CC78K4

The development procedure using CC78K4 is shown below.

Figure 1-3. Program Development Procedure Using CC78K4



1.2.1 Using editor to create source module files

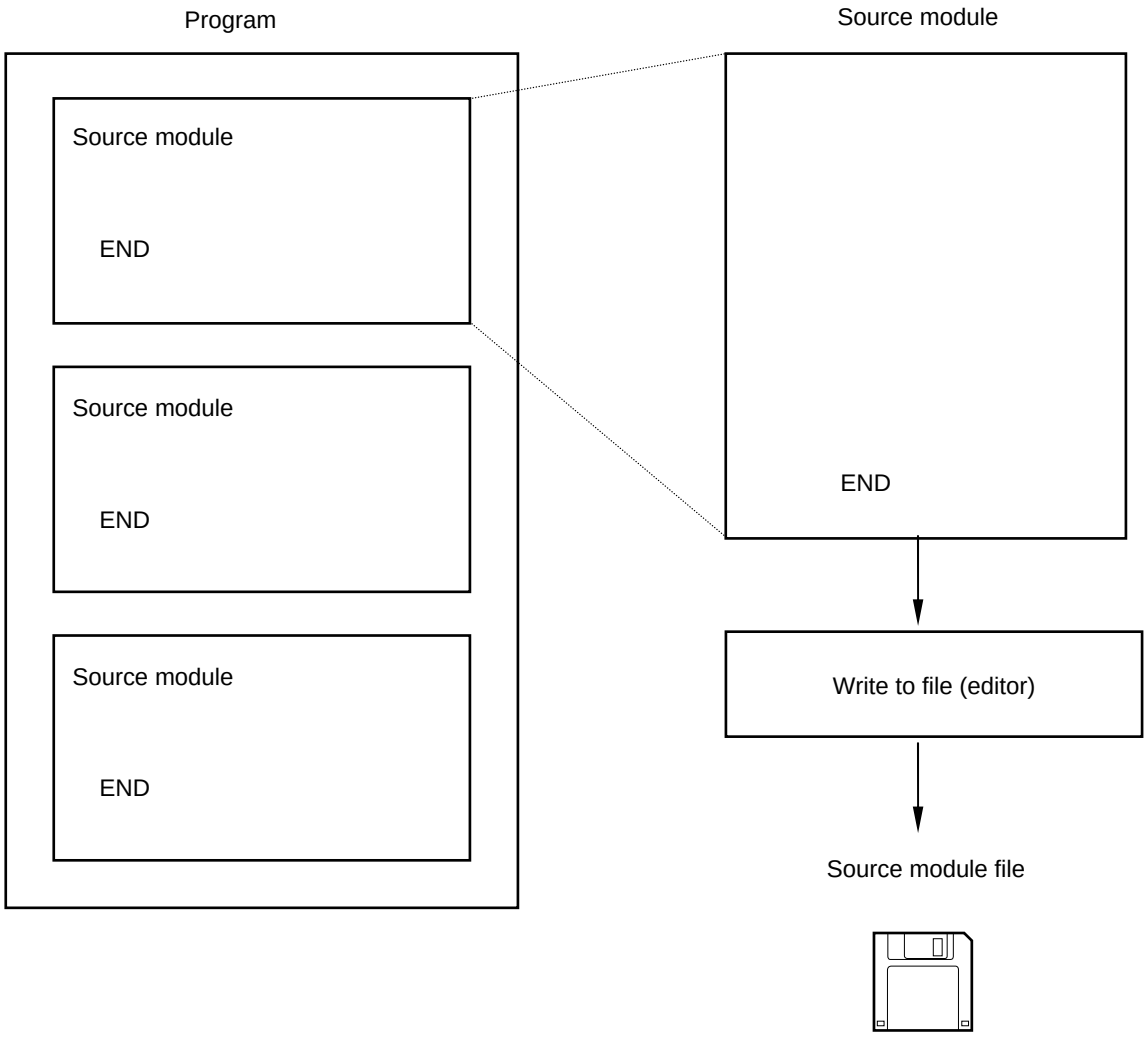
One program is divided into several functional modules.

One module is the coding unit and becomes the input unit to the compiler. A module that is the input unit to the C compiler is called a C source module.

After each C source module is coded, use the editor to save the source module to a file. A file created in this way is called a C source module file.

The C source module files become the CC78K4 input files.

Figure 1-4. Creating Source Module Files

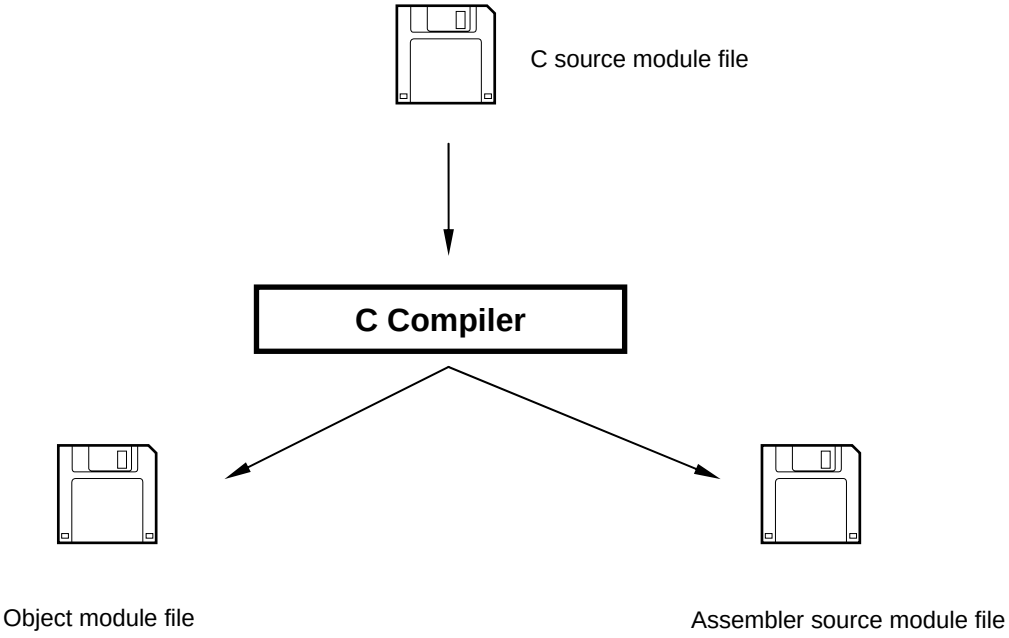


1.2.2 C compiler

The C compiler inputs the C source modules and converts the C language into machine language. If description errors are detected in the C source module, compiling errors are output.

If there are no compiling errors, the object module files are output. To correct and check the programs at the assembly language level, assembler source module files can be output. If you want to output assembler source module files, specify the -A or -SA option in the specification for creating assembler module files when compiling (for information about the options, see **CHAPTER 5 COMPILER OPTIONS**).

Figure 1-5. C Compiler Function



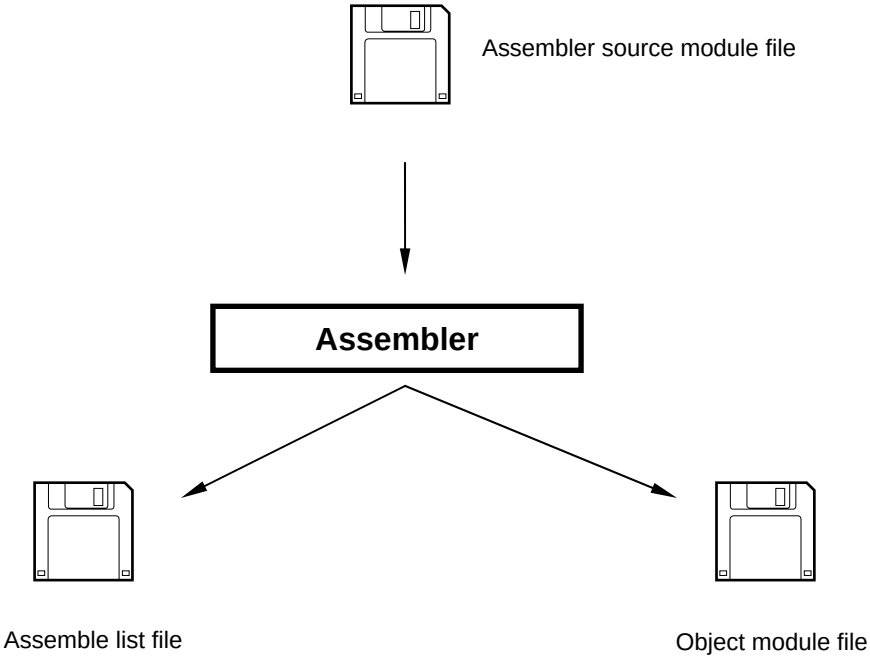
1.2.3 Assembler

Assembling is performed by using the assembler included in the RA78K4 Assembler Package (sold separately).

The assembler is the program that inputs an assembler source module file and translates assembly language into machine language. If description errors were discovered in the source module, the assemble errors are output.

If there are no assemble errors, the output is the object module file that includes machine language information and location information such as at which address each machine language code should be placed in memory. In addition, information during assembly is output as an assemble list file.

Figure 1-6. Assembler Function



1.2.4 Linker

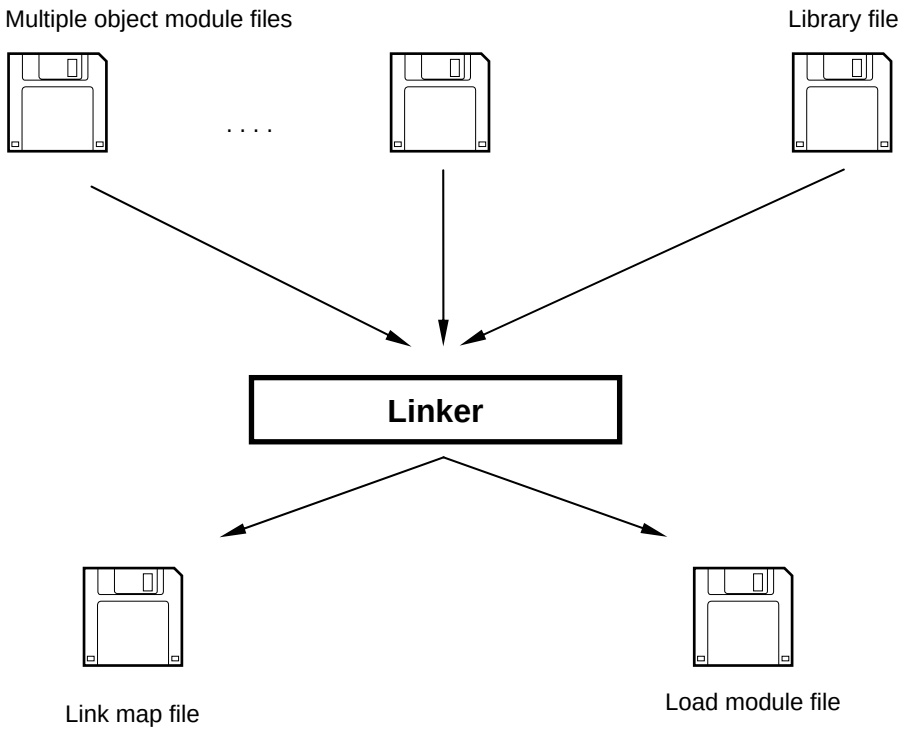
Linking is performed by using the linker included in the RA78K4 Assembler Package (sold separately).

The linker inputs multiple object module files output by the compiler or object module files output by the assembler, and links them to the library files (even if there is one object module, linking must be performed). One load module file is output.

In this case, the linker determines the location addresses of relocatable segments in the input module. This determines the values of relocatable symbols and external reference symbols, and embeds the correct values in the load module file.

The linker outputs the linking information as a link map file.

Figure 1-7. Linker Function



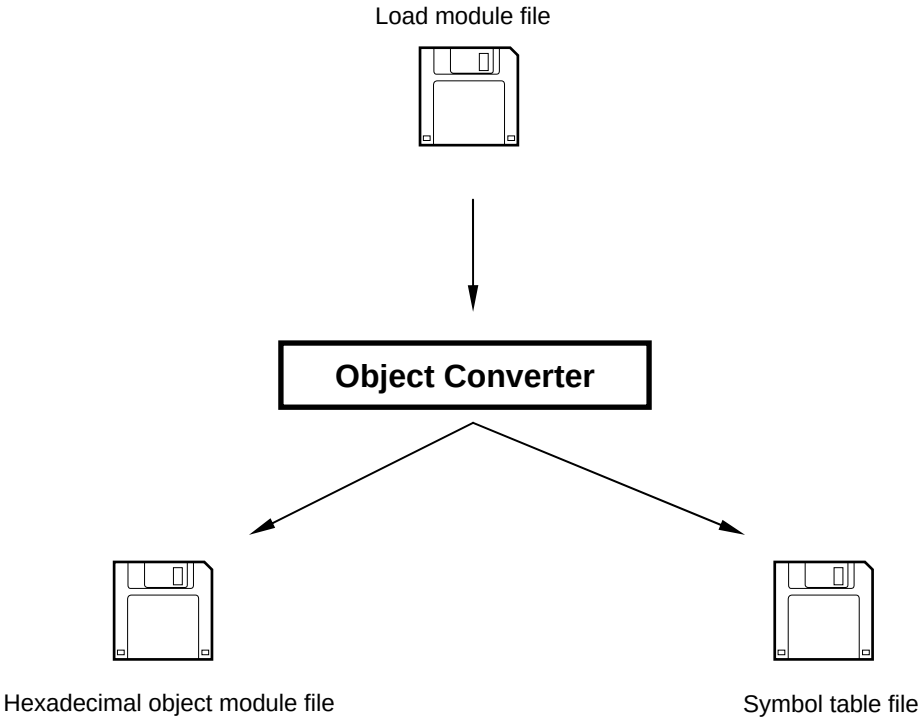
1.2.5 Object converter

The object converter uses the converter included in the RA78K4 Assembler Package (sold separately).

The object converter inputs a load module file output by the linker and converts its file format. The result is output as an intel-standard hexadecimal object module file.

Symbol information is output as a symbol table file.

Figure 1-8. Object Converter Function



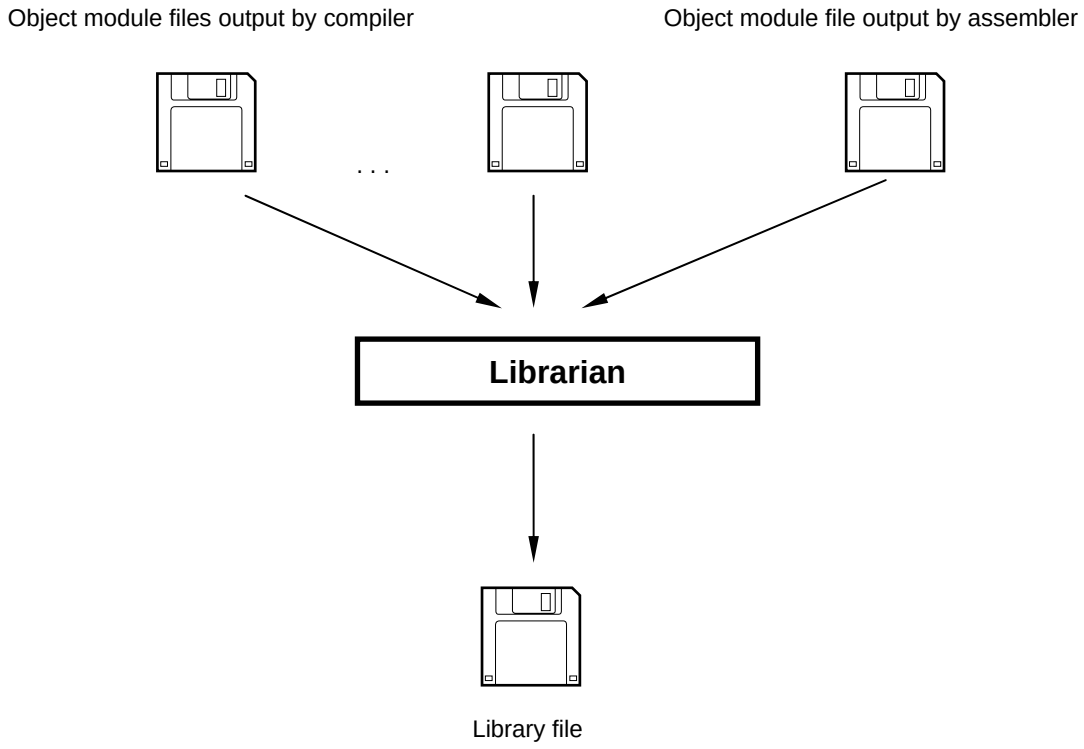
1.2.6 Librarian

Clearly defined modules having a general interface are formed into a library for convenience. By creating the library, many object modules form one file and become easy to handle.

The linker has functions to extract only the needed modules from the library file and link them. Therefore, if multiple modules are registered in one library file, the names of the module files needed when linking no longer have to be individually specified.

The librarian is used to create and update library files. The librarian uses the librarian included in the RA78K4 Assembler Package (sold separately).

Figure 1-9. Librarian Function

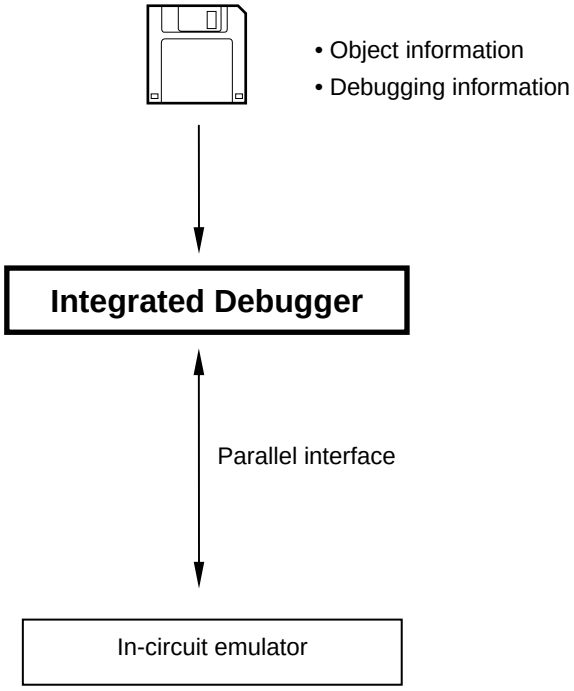


1.2.7 Debugger

Source debugging using a graphical user interface becomes possible by loading the load module files output by the linker into the IE (in-circuit emulator) by using the ID78K4, ID78K4-NS (78K4 Series integrated debugger).

To debug, the -G option specifying the output of debugging information is specified when the target source program is compiled (-G is the default option). By making this specification, the symbols and line numbers needed in debugging are added to the object module. For information on the compiler options, see **CHAPTER 5 COMPILER OPTIONS**.

Figure 1-10. Debugger Function

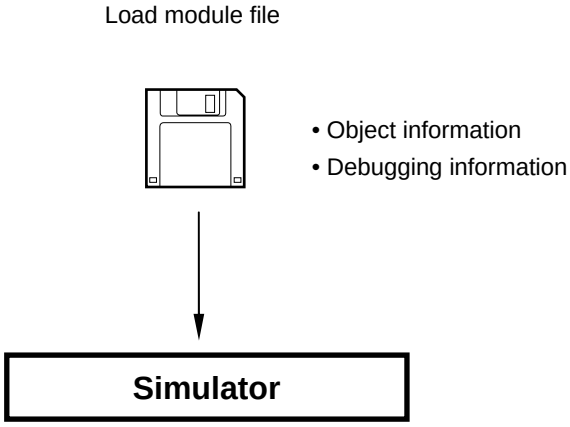


1.2.8 System simulator

Source debugging using a graphical user interface becomes possible by downloading the load module files output from the linker by using the SM78K4 (78K4 Series system simulator).

SM78K4 is software that has the same operating image as the ID78K4, ID78K4-NS and performs simulations on the host machine. In addition to simulating machine instructions in the SM78K4, the on-chip peripherals for the devices and the interrupts can be simulated. Since external parts and procedures are provided to construct dummy target systems, the programs including the operation of the target system are debugged at an early stage independent of hardware development.

Figure 1-11. Simulator Function

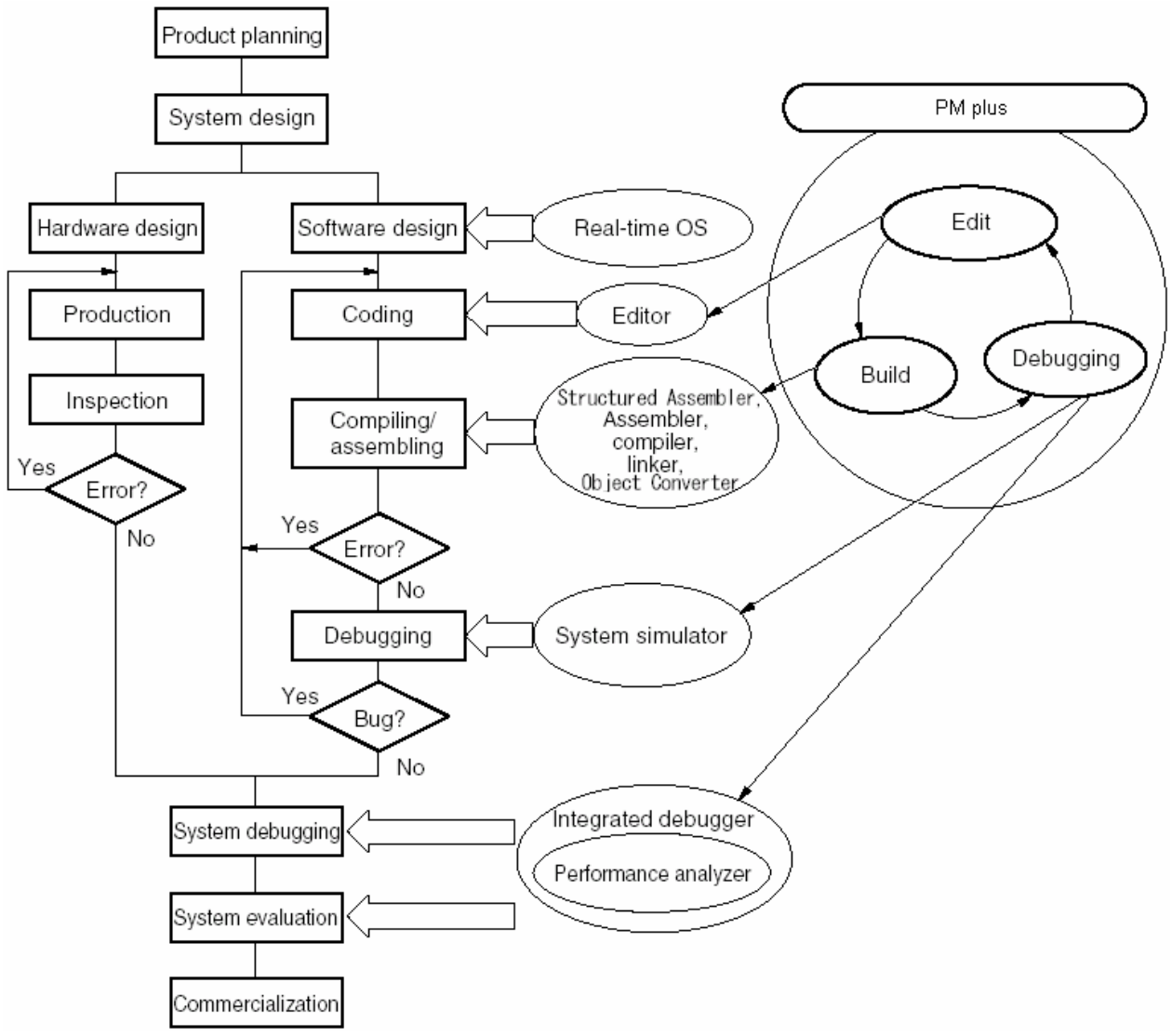


1.2.9 PM plus

PM plus is software that uses the DLL files added to CC78K4 and is able to start CC78K4 on Windows 98/Me/2000/XP or Windows NT 4.0. Editing the source, automatically creating the MAKEFILE, and compiling to linking can be performed from the startup screen of PM plus. Thus, editing to debugging can be performed using GUI images.

PM plus is included to the RA78K4 Assembler Package. The installer for the RA78K4 Assembler Package is used to install and to make the settings. If CC78K4 will be started from PM plus, install the RA78K4 Assembler Package before installing the compiler.

Figure 1-12. PM plus Function



Remark Build analyzes and executes the make file to create the executable file. The dependency relationships described in the make file basically remove unused assembling, compiling, and linking and can create efficient executable files.

CHAPTER 2 PRODUCT OVERVIEW AND INSTALLATION

This chapter explains the procedure to install the files stored in the supply media of the CC78K4 to the user development environment (host machine) and the procedure to uninstall them from the user development environment.

2.1 Host Machines and Supply Media

This C compiler supports the development environments listed in Table 2-1.

Table 2-1. Supply Media and Recording Formats for C Compiler

Host Machine	OS	Supply Media	Recording Format
PC-9800 Series	Japanese Windows (98/Me/2000/XP/NT 4.0)[Note]	CD-ROM	Standard Windows installer supported
IBM PC/AT™ and compatibles	Japanese Windows (98/Me/2000/XP/NT 4.0)[Note] English Windows (98/Me/2000/XP/NT 4.0)[Note]		
HP9000 Series 700™	HP-UX™ (Rel. 10.20 or later)	CD-ROM	cp command
SPARCstation™ Family	SunOS™ (Rel. 4.1.4 or later) Solaris™ (Rel. 2.5.1 or later)		

Note PM plus is required if the C compiler is used on Windows. The C compiler can be started up from the DOS prompt (Windows 98/Me) or command prompt (Windows 2000/XP/INT 4.0) if PM plus is not used.

2.2 Installation

2.2.1 Installation of Windows version

The procedure for installing to the host machine the files provided in the CC78K4's supply media is described below.

(1) Starting up Windows

Power on the host machine and peripherals and start Windows.

(2) Set supply media

Set the CC78K4's supply media in the appropriate drive (CD-ROM drive) of the host machine. The setup programs will start automatically. Perform the installation by following the messages displayed in the monitor screen.

Caution If the setup program does not start automatically, execute SETUP.EXE in the CC78K4\DISK1 folder.

(3) Confirmation of files

Using Windows Explorer, etc., check that the files contained in the CC78K4's supply media have been installed to the host machine.

For the details of each folder, refer to **2.4.1 Windows version directory configuration**.

2.2.2 Installation of UNIX® version

Install the UNIX version with the following procedure. Installation to /nectools is assumed here.

(1) Login

Log in to the host machine.

(2) Directory selection

Go to the install directory.

```
% cd /nectools
```

(3) Setting of supply media

Set the CD-ROM in the CD-ROM drive and close the tray.

(4) Execute the cp command to copy the files from the CD-ROM (copy the files after checking that the CD-ROM has been set in the CD-ROM drive).

(5) Add /nectools/bin to the environmental variable PATH.

2.3 Installation of Device Files

2.3.1 Installation of Windows version

Use the device file installer to install the device files. The device file installer is installed at the same time as the CC78K4.

2.3.2 Installation of UNIX version

Either specify the directory for device files with the -y option (example: -y/nectools/dev), or copy the device files to a directory with the compiler execution format (example: /nectools/bin).

2.4 Directory Configuration

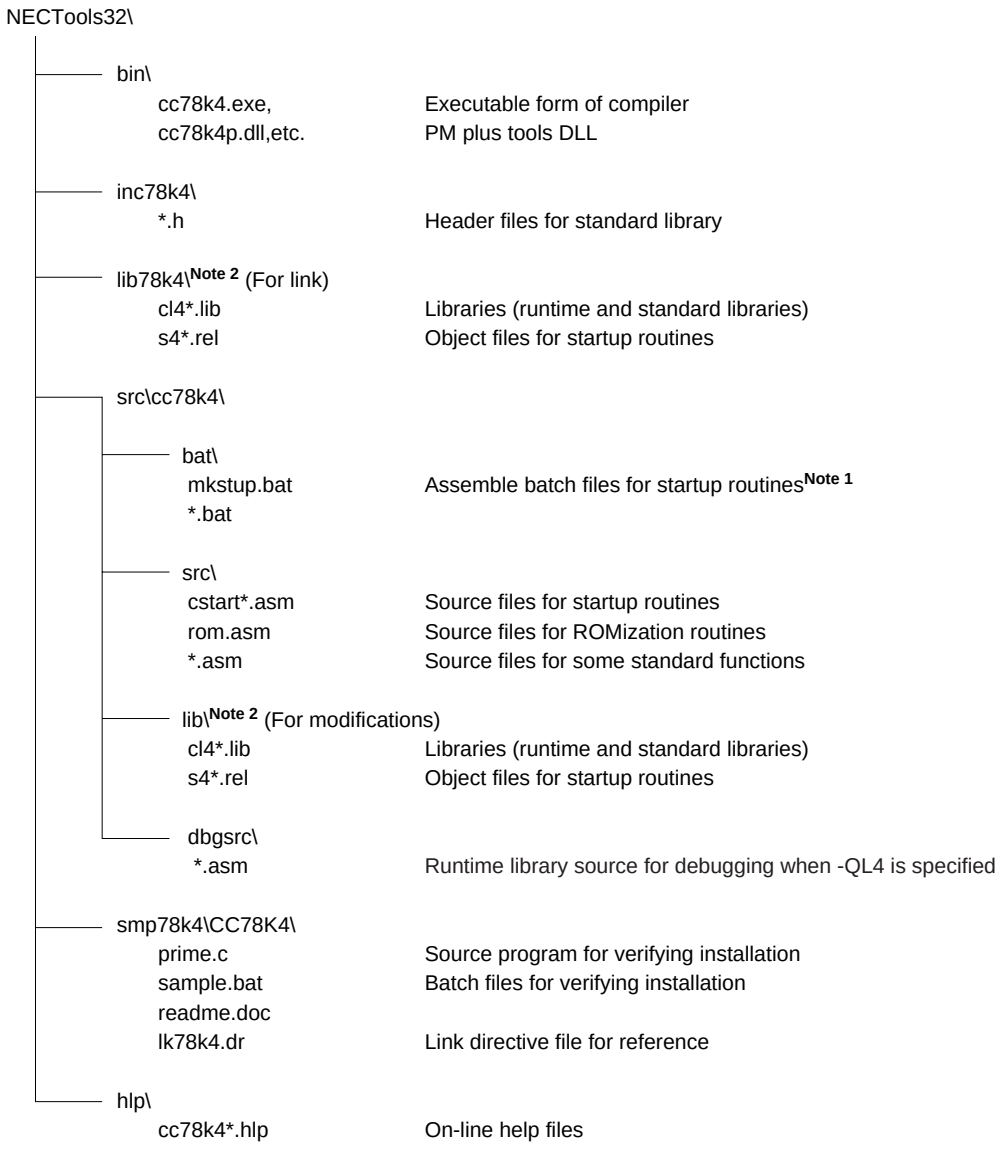
2.4.1 Windows version directory configuration

The standard directory displayed during installation is “NECTools32” of the Windows system. The configuration under the install directory is as follows. Note that the drive and install directory can be changed during installation.

When performing MAKE operation with PM plus, perform installation of tools (CC78K4, RA78K4) to the same drive and directory.

The descriptions in this manual assume installation to the standard directory with “NECTools32”, which is the default program name, according to the setup program default directions.

Figure 2-1. Windows Version Directory Configuration



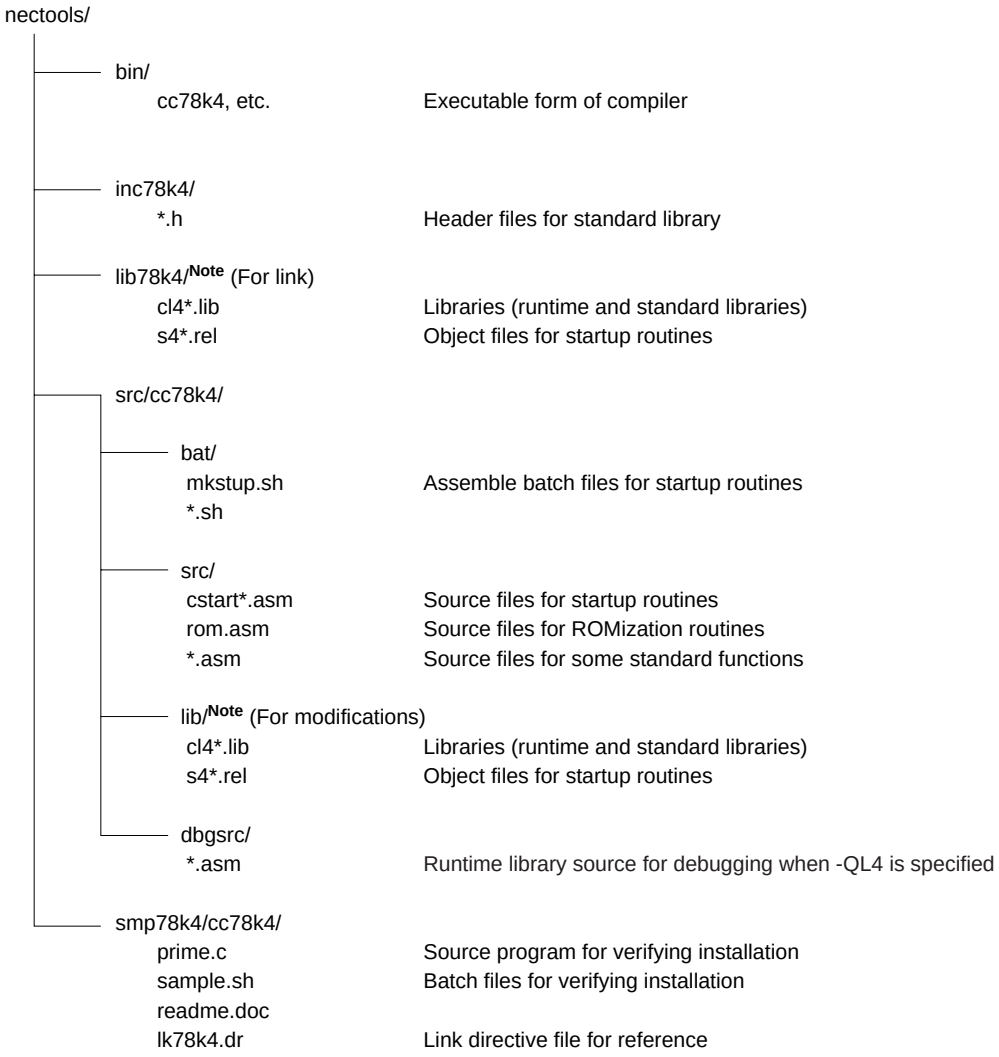
Notes 1. This batch file cannot be used in PM plus. To use the batch file, run it from the DOS prompt (Windows 98/Me) or command prompt (Windows 2000/XP/NT 4.0).

2. The startup routines and libraries in the lib78k4 directory are identical to those in the src\cc78k4 directory. If a startup routine is modified, change the source in the src\cc78k4 directory. Since assembled files by the batch file are stored in src\cc78k4\lib, copy lib78k4 directory and link.

2.4.2 UNIX version directory configuration

The file organization when the cp command was used for installation to /nectools is shown below.

Figure 2-2. UNIX Version Directory Configuration



Note The startup routines and libraries in the lib78k4 directory are identical to those in the src/cc78k4 directory. If a startup routine is modified, change the source in the src/cc78k4 directory. Since assembled files by the batch file are stored in src/cc78k4/lib, copy lib78k4 directory and link.

2.5 Uninstallation Procedure

2.5.1 Uninstallation of Windows version

The procedure for uninstalling the files installed to the host machine is described below.

(1) Windows startup

Power on the host machine and peripherals and start Windows.

(2) Opening Control Panel window

Press the Start button and select [Settings]-[Control Panel] to open the <Control Panel> window.

(3) Opening of <Add/Remove Programs Properties> window

Double-click the [Add/Remove Programs] icon in the <Control Panel> window to open the <Add/Remove Programs Properties> window.

(4) Deletion of CC78K4

After selecting “NEC CC78K4 78K/IV C Compiler Vx.xx” from the list of installed software displayed in the <<Install/Uninstall>> tab in the <Add/Remove Programs Properties> window, click the Add/Remove... button.
When the <System Setting Change> window is opened, click the Yes button.

(5) Confirmation of files

Using Windows Explorer, etc., check that the files installed to the host machine have been uninstalled. For the details of each folder, refer to **2.4.1 Windows version directory configuration**.

2.5.2 Uninstallation of UNIX version

Delete the files copied in **2.2.2 Installation of UNIX version** with the rm command.

2.6 Environment Settings

2.6.1 Host machine (for PC-9800 Series and IBM PC/AT compatibles)

The CC78K4 handles 32 bits and runs on models equipped with the i386™ CPU or later versions.

Since handling 32 bits is implemented by using DOS Extender, it is designed to run on the following operating systems.

Windows 98/Me/2000/XP/NT 4.0
DOS prompt in Windows 98/Me
Command prompt in Windows 2000/XP/NT 4.0

2.6.2 Environment variables

Set the following environment variables for EWS or DOS prompt (Windows 98/Me) or command prompt (Windows 2000/XP/NT 4.0) operation.

Table 2-2. Environment Variables

Environment Variable	Description
PATH	Specifies the directory where the executable form of the compiler is located.
TMP	Specifies the directory where temporary files are created (only valid for PC-9800 Series and IBM PC/AT compatibles).
LANG78K	Specifies the kanji code (2-byte code) in the source files. sjis Shift JIS (Default for PC-9800 Series, IBM PC/AT compatibles, and HP9000 Series 700) euc EUC (Default for SPARCstation) none No 2-byte codes
INC78K4	Specifies the directory where the standard header files of the compiler are located. (required only for EWS)
LIB78K4	Specifies the directory where the compiler's libraries are located. (required only for EWS)

Specification Example

For PC-9800 Series and IBM PC/AT compatibles

```
PATH = %PATH%;C:\NECTools32\bin
set TMP = C:\
set LANG78K = sjis
```

For HP9000 Series 700 and SPARCstation

Example using csh

```
set path = ($path /nectools/bin)
setenv LANG78K  euc
setenv INC78K4  /nectools/inc78k4
setenv LIB78K4  /nectools/lib78k4
```

Example using sh

```
PATH = $PATH:/nectools/bin
LANG78K = euc
INC78K4 = /nectools/inc78k4
LIB78K4 = /nectools/lib78k4
export PATH LANG78K INC78K4 LIB78K4
```

2.6.3 File organization

The table below lists the contents of each directory. The files for PC-9800 Series and IBM PC/AT compatibles are described. The directory structure and file organization are the ones obtained when the installer was used.

Remark Some of the file extensions differ in UNIX.

Table 2-3. File Organization (* = alphanumeric symbols)

Directory Name	File Name	Description
BIN\	cc78k4.exe	Compiler
	cc78k4.msg	Message file
	*.hlp	Help files
	*.dll	DLL files
INC78K4\	*.h[Note 1]	Header files for standard library
SRC\CC78K4\BAT\[Note 2]	mkstup.bat	Assemble batch files for startup routines
	reprom.bat	For updating rom.asm
	*.bat[Note 3]	Batch files for updating standard functions (partial)
SRC\CC78K4\SRC	cstart*.asm[Note 4]	Source files for startup routines
	rom.asm	Source files for ROMization routine
	*.asm[Note 5]	Source files for standard functions (partial)
SRC\CC78K4\DBGSRC	*.asm	Runtime library source for debugging when -QL4 is specified
HLP	*.hlp	On-line help file

Notes 1. See **10.2 Headers** in the **Language manual (U15556E)**.

2. The batch files in this directory cannot be used in PM plus. Use these batch files only when the source must be revised.

3. Refer to the contents in **Table 8-1 BAT Directory Contents**.

4. * = B | E | N (B: when the boot area is specified, E: when the flash area is specified, N: when the standard libraries are not used)

5. Refer to the contents in **Table 8-2 SRC Directory Contents**.

2.6.4 Library files

These files consist of standard libraries, runtime libraries, and startup routines.

Table 2-4 lists the directory contents.

Table 2-4. Library Files

Directory Name	File Name			File Role
	Normal	Boot Area	Flash Area	
LIB78K4\	CL4S.LIB	CL4S.LIB	CL4SE.LIB	Library (runtime and standard libraries)[Note 1]
	CL4SO.LIB	CL4SO.LIB	CL4SOE.LIB	
	CL4SR.LIB	CL4SR.LIB	CL4SRE.LIB	
	CL4.LIB	CL4.LIB	CL4E.LIB	
	CL4M.LIB	CL4M.LIB	CL4ME.LIB	
	CL4MR.LIB	CL4MR.LIB	CL4MRE.LIB	
	CL4O.LIB	CL4O.LIB	CL4OE.LIB	
	CL4OP.LIB	CL4OP.LIB	CL4OPE.LIB	
	CL4P.LIB	CL4P.LIB	CL4PE.LIB	
	CL4PR.LIB	CL4PR.LIB	CL4PRE.LIB	
	CL4R.LIB	CL4R.LIB	CL4RE.LIB	
	CL4SF.LIB	CL4SF.LIB	CL4SFE.LIB	
	CL4SFR.LIB	CL4SFR.LIB	CL4SFRE.LIB	
	CL4F.LIB	CL4F.LIB	CL4FE.LIB	
	CL4FR.LIB	CL4FR.LIB	CL4FRE.LIB	
	CL4MF.LIB	CL4MF.LIB	CL4MFE.LIB	
	CL4MFR.LIB	CL4MFR.LIB	CL4MFRE.LIB	
	S4.REL	S4B.REL	S4E.REL	Object files for startup routines[Note 2]
	S4C.REL	S4CB.REL	S4CE.REL	
	S4CL.REL	S4CLB.REL	S4CLE.REL	
	S4CLP.REL	S4CLPB.REL	S4CLPE.REL	
	S4CP.REL	S4CPB.REL	S4CPE.REL	
	S4L.REL	S4LB.REL	S4LE.REL	
	S4LP.REL	S4LPB.REL	S4LPE.REL	
	S4M.REL	S4MB.REL	S4ME.REL	
	S4MC.REL	S4MCB.REL	S4MCE.REL	
	S4MCL.REL	S4MCLB.REL	S4MCLE.REL	
	S4ML.REL	S4MLB.REL	S4MLE.REL	
	S4P.REL	S4PB.REL	S4PE.REL	
	S4S.REL	S4SB.REL	S4SE.REL	
	S4SL.REL	S4SLB.REL	S4SLE.REL	

Notes 1. The rules for naming libraries are given below.

```
cl4<model><i/f><align><float><pascal><flash>.lib
```

<model>

None	Large model (when compiler option -ML is specified)
m	Medium model (when compiler option -MM is specified)
s	Small model (when compiler option -MS is specified)

<i/f>

None	Use the function interface that conforms to the CC78K4 V2.00 specification (when compiler option -ZO is not specified)
o	Use the function interface that conforms to the CC78K4 V1.00 specification (when compiler option -ZO is specified)

Remark This option is valid only for the large/small model. It is not specified for the medium model.

<align>

None	When compiler options -RP/-RA are not specified
p	When compiler options -RP/-RA are specified

Remark This option is valid only for the large model. It is not specified for the small/medium model.

<float>

None	Standard library and runtime library (floating-point library is not used)
f	For floating-point library

<pascal>

None	When normal function interface is used
r	When pascal function interface is used (when compiler option -ZR is specified)

<flash>

None	Normal/for boot area
e	For flash memory area

Notes 2. The rules for naming startup routines are given below.

```
s4<model><loc><lib><align><flash>.rel
```

<model> (memory model)

None	Large model (when compiler option -ML is specified)
m	Medium model (when compiler option -MM is specified)
s	Small model (when compiler option -MS is specified)

<loc>

None	When compiler option -CS15 is specified
c	When compiler option -CS0 is specified

Remark This option is valid only for the large/medium model. It is not specified for the small model.

<lib>

None	When standard library functions are not used
l	When standard library functions are used

<align>

None	When compiler options -RP/-RA are not specified
p	When compiler options -RP/-RA are specified

Remark This option is valid only for the large model. It is not specified for the small/medium model.

<flash>

None	Normal
b	For boot area
e	For flash memory area

CHAPTER 3 PROCEDURE FROM COMPILING TO LINKING

This chapter uses the CC78K4 and the RA78K4 Assembler Package to describe the procedure from compiling to linking.

By actually performing the processes from compiling to linking of the ‘prime.c’ sample program following the execution procedure given in this chapter, you can become familiar with the operations of compiling, assembling, and linking (see **APPENDIX A SAMPLE PROGRAMS** for information about the sample program).

How to execute on PM plus is described for the PC-9800 Series and IBM PC/AT compatible machines. For other machines, how to execute from the command line is described (for information on installation, see **2.2 Installation**).

3.1 PM plus

This section describes the user interface when the CC78K4 is started in PM plus included in the RA78K4 Assembler Package. If the CC78K4 is started from PM plus, CC78K4P.DLL included in CC78K4 is referenced.

3.1.1 Position of CC78K4P.DLL (tools DLL)

The tools DLL file, such as the CC78K4P.DLL file, is needed to run the Windows version of the 78K4 Series C compiler (CC78K4) from PM plus in Windows 98/Me/2000/XP or Windows NT 4.0.

3.1.2 Execution environment

This environment conforms to PM plus.

The display mode switches between Japanese and English according to the operating system (Windows English version/Japanese version).

3.1.3 CC78K4 option setting menu

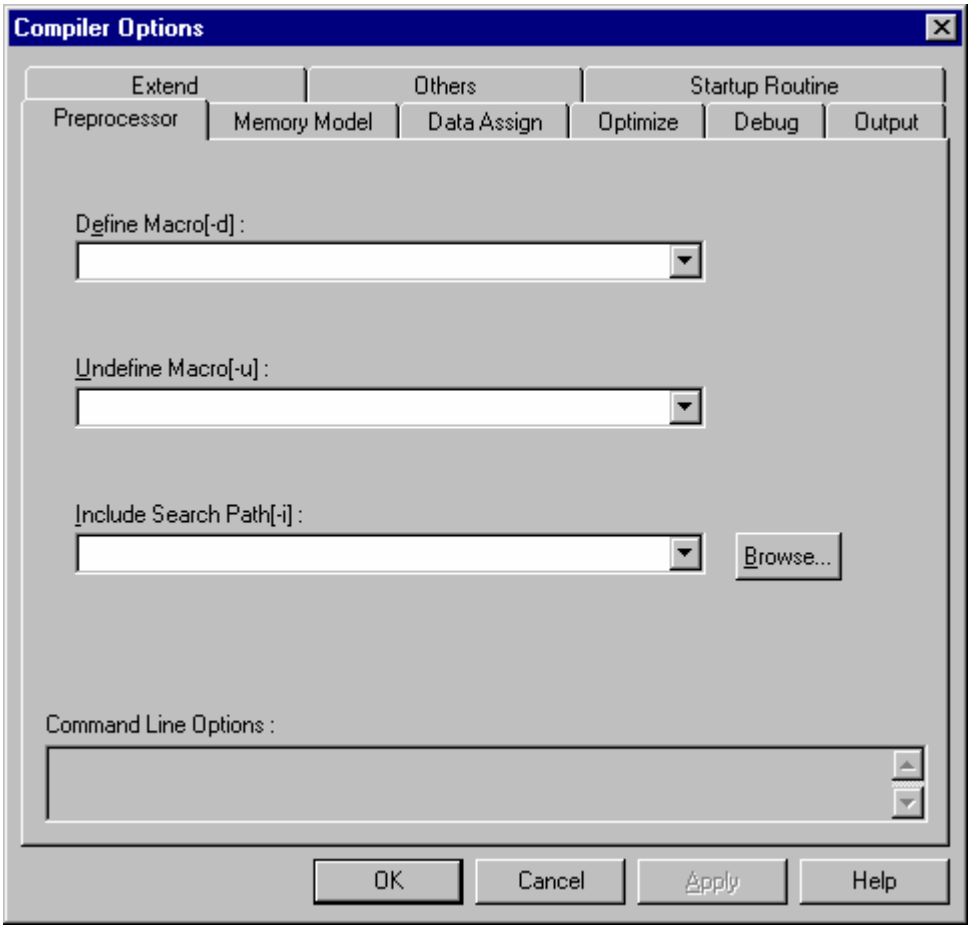
(1) Option menu items

The item "Compiler Options…" is added to the [Tools] menu in PM plus by the tools DLL file included in the CC78K4 C Compiler Package.

(2) Compiler Options dialog box

Select the [Compiler Options…] menu under [Tools] in PM plus to call the option setting function for the tools DLL.

The <Compiler Options> dialog box is shown below.

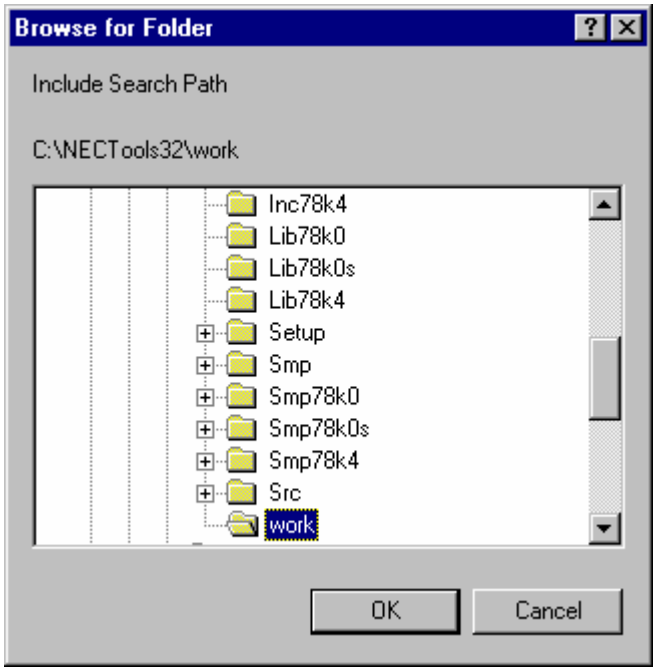


(3) Browse for Folder dialog box

In the <Compiler Options> dialog box, when the Browse... button is clicked for the following path settings, the following dialog box appears.

Only the folders can be specified in this dialog box.

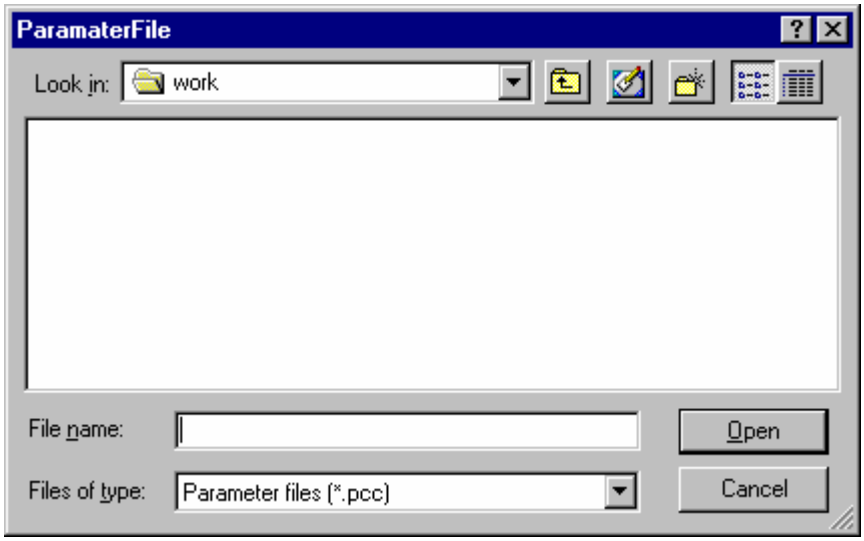
- Include file path
- Object module file output path
- Assembler module file output path
- Error list file output path
- Cross-reference list file output path
- Preprocessor list file output path
- Temporary file path



When the Browse... button is clicked in the parameter file specification, the following dialog box appears.

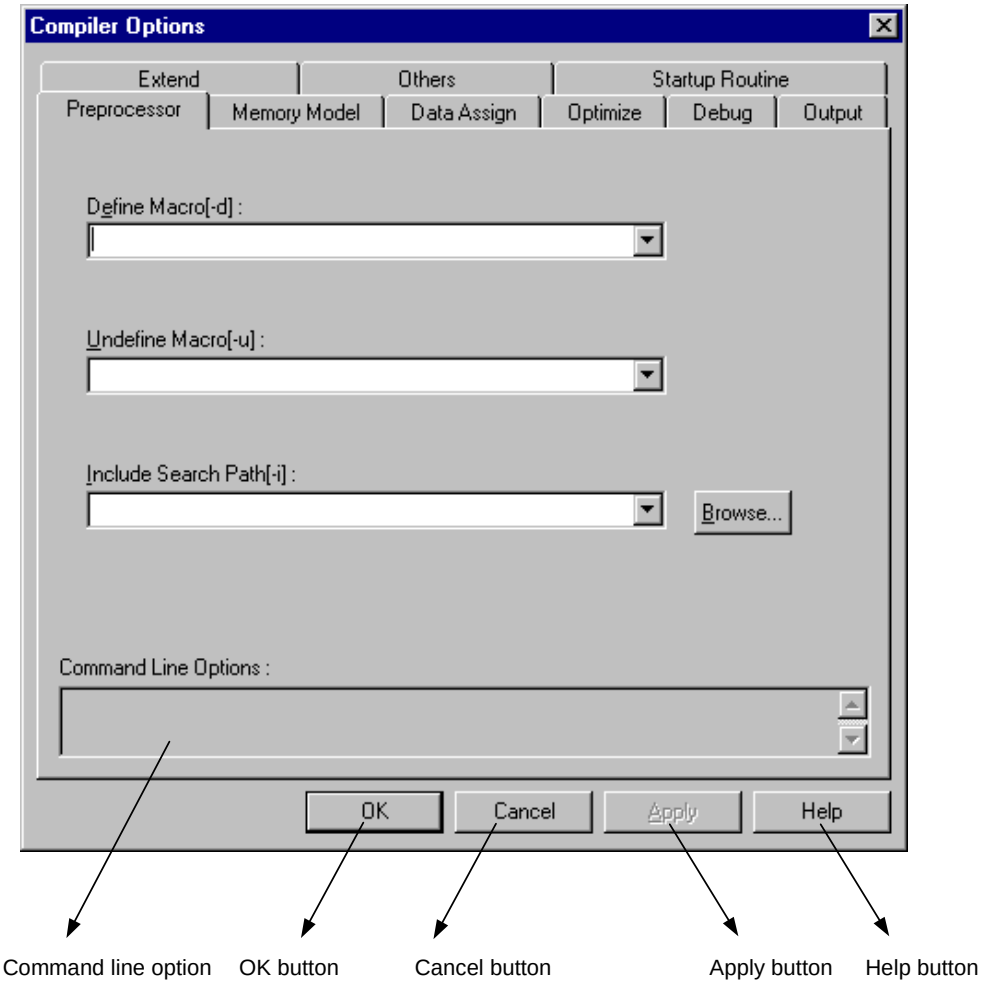
This dialog box is as follows.

Current directory: Project file directory
File type: Parameter file (*.pcc)



3.1.4 Description of each part of <Compiler Options> dialog box

Each part of the <Compiler Options> dialog box is described.



- **[OK] button**

  The settings edited in this dialog box are set, and the <Compiler Options> dialog box closes. If a source file is selected in this source list, the options are set for this file. If nothing is selected, the options are set for all of the source files.

- **[Cancel] button**

  The options are not set, and the dialog box closes. The ESC key has the same effect as the [Cancel] button no matter where the focus is in the dialog box.

- **[Apply] button**

  This button is effective only when option settings have been changed.

  The edited contents in this dialog box are applied and the <Compiler Options> dialog box remains displayed.

- **[Help] button**

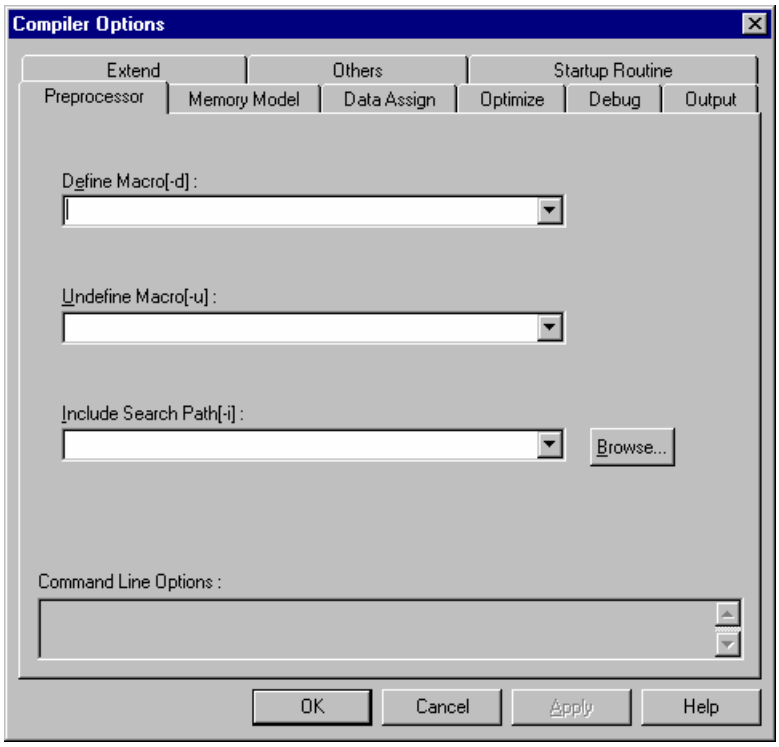
  The help file for this dialog box opens.

- Command Line Options:
  The option character string currently set is displayed.
  The option character string entered in [Other Options:] of <Others> dialog box is reflected and displayed in real time.
  Nothing can be input in this display area. Even though the default option of the CC78K4 is the “specified” state (i.e., a check box is checked, etc.), nothing is displayed in this area by default.
  Options that do not fit in the option character display area can be checked by scrolling with the  button.

- Setting of compiler options
  The compiler options are divided into the following nine options and set respectively. Each setting screen is displayed by clicking the corresponding tab at the top of the dialog box.

  Preprocessor (default)
  Memory Model
  Data Assign
  Optimize
  Debug
  Output
  Extend
  Others
  Startup Routine

(1) Screen when “Preprocessor” is selected

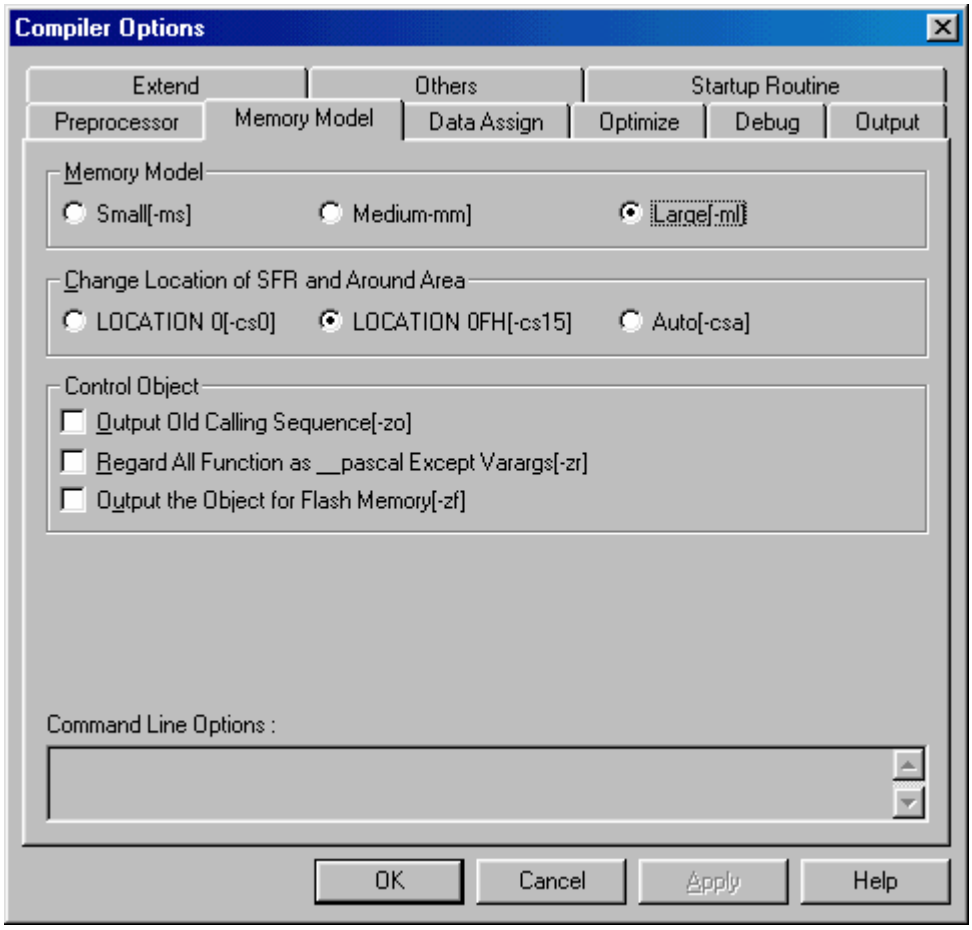


- Define Macro[-d]:
  The macro name and definition name specified by the -D option is input to the combo box.
  For the macro name, multiple macro definitions can be performed at once by delimiting with ‘,’.

- Undefine Macro[-u]:
  The macro name specified by the -U option is input to the combo box.
  For the macro name, multiple macro definitions can be invalidated at once by delimiting with ‘,’.

- Include Search Path[-i]:
  The directory that contains include files specified by the -I option is input to the combo box.
  Multiple directories can be specified at once by delimiting with ‘,’.
  The [Browse..] button can also be used for specification.
  Unexisted path cannot be specified.

(2) Screen when “Memory Model” is selected

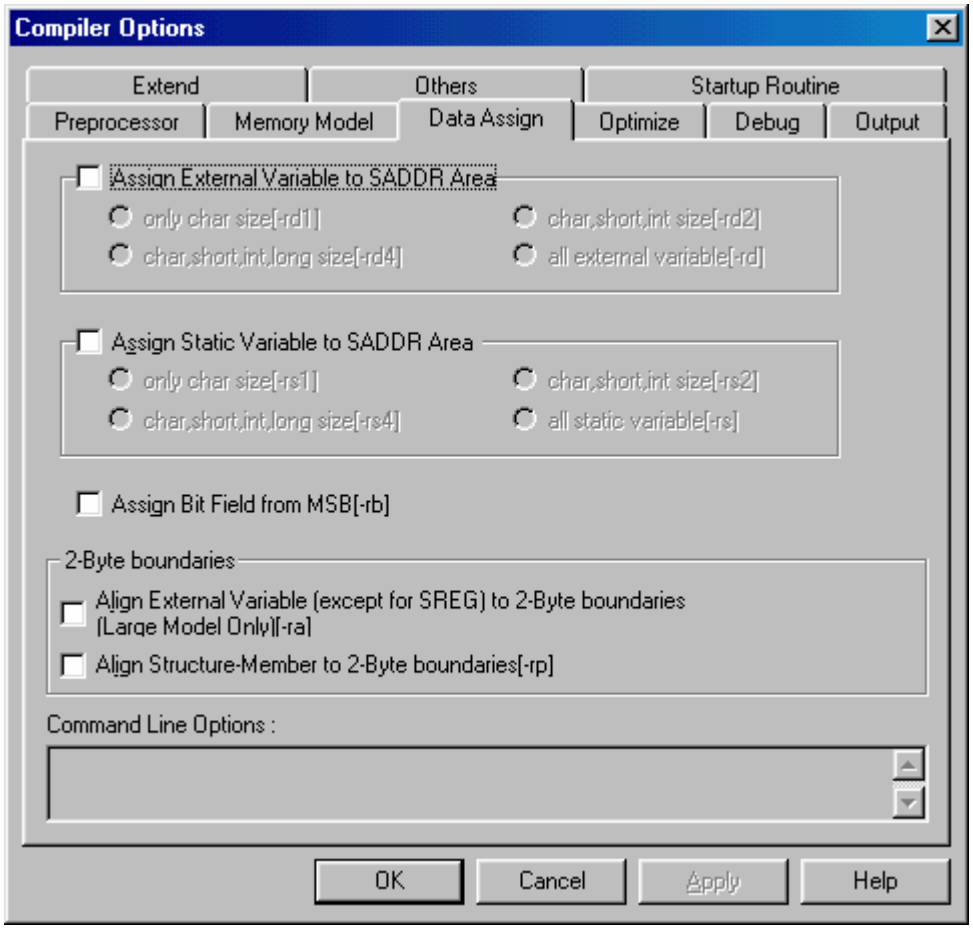


- Memory Model
  Select the memory model option to be used by clicking a radio button: -MS, -MM, or -ML (small, medium, or large).

- Change Location of SFR and Around Area
  Select the location option to be used by clicking a radio button: -CS0, -CS15, or -CSA (LOCATION0, 0FH, or 0AH) to instruct the location of the saddr area to the compiler.

- Control Object
  Output Old Calling Sequence[-zo]
  Select this check box to enable the -ZO option.
  Regard All Function as _ _pascal Except Varargs[-zr]
  Select this check box to enable the -ZR option.
  Output the Object for Flash Memory[-zf]
  Select this check box to enable the -ZF option.

(3) Setting screen when “Data Assign” is selected



- Assign External Variable to SADDR Area
  Select the check box to validate the -RD option.
  The type of external variable to be assigned to the saddr area is selected by clicking a radio button.

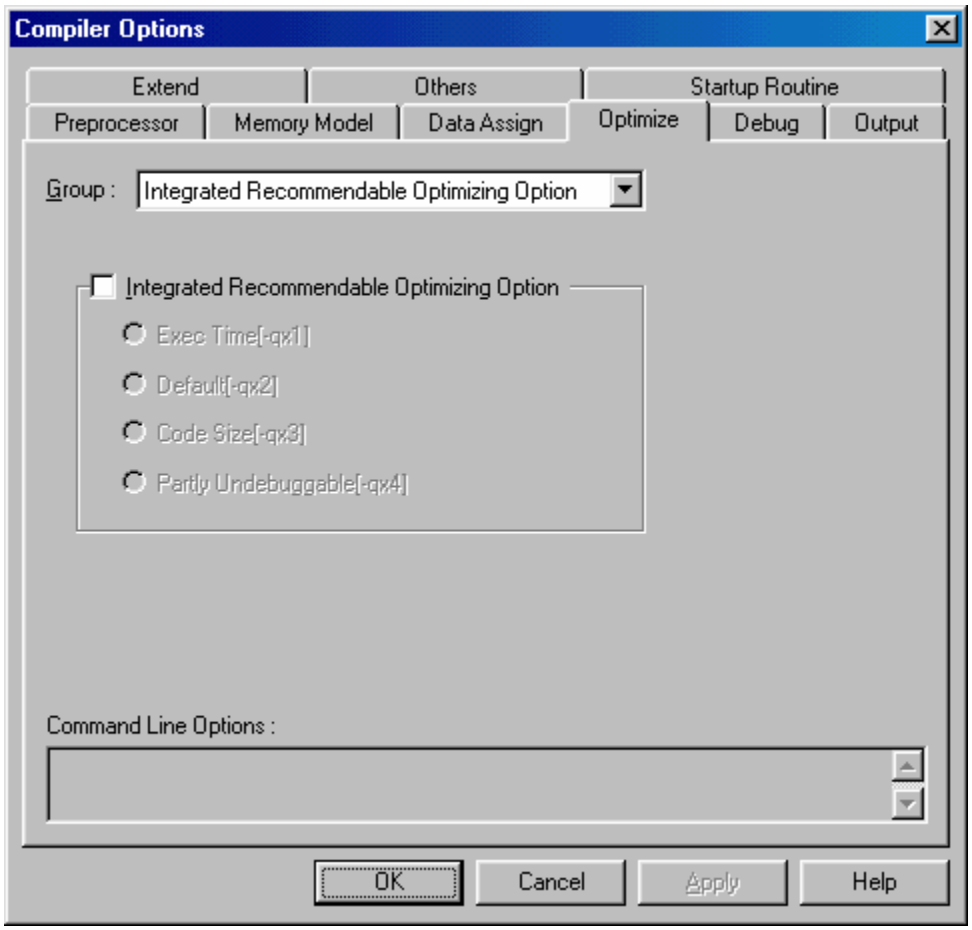
- Assign Static Variable to SADDR Area
  Select the check box to validate the -RS option.
  The type of static variable to be assigned to the saddr area is selected by clicking a radio button.

- Assign Bit Field from MSB[-rb]
  Select the check box to validate the -RB option.

- 2-Byte boundaries
  Align External Variable (except for SREG) to 2-Byte boundaries (Large Model Only) [-ra]
  - Select the check box to validate the -RA option.
  Align Structure-Member to 2-Byte boundaries [-rp]
  - Select the check box to validate the -RP option.

(4) Screen when “Optimize” is selected

(a) When “Integrated Recommendable Optimizing Option” is selected in the [Group:] drop-down list box



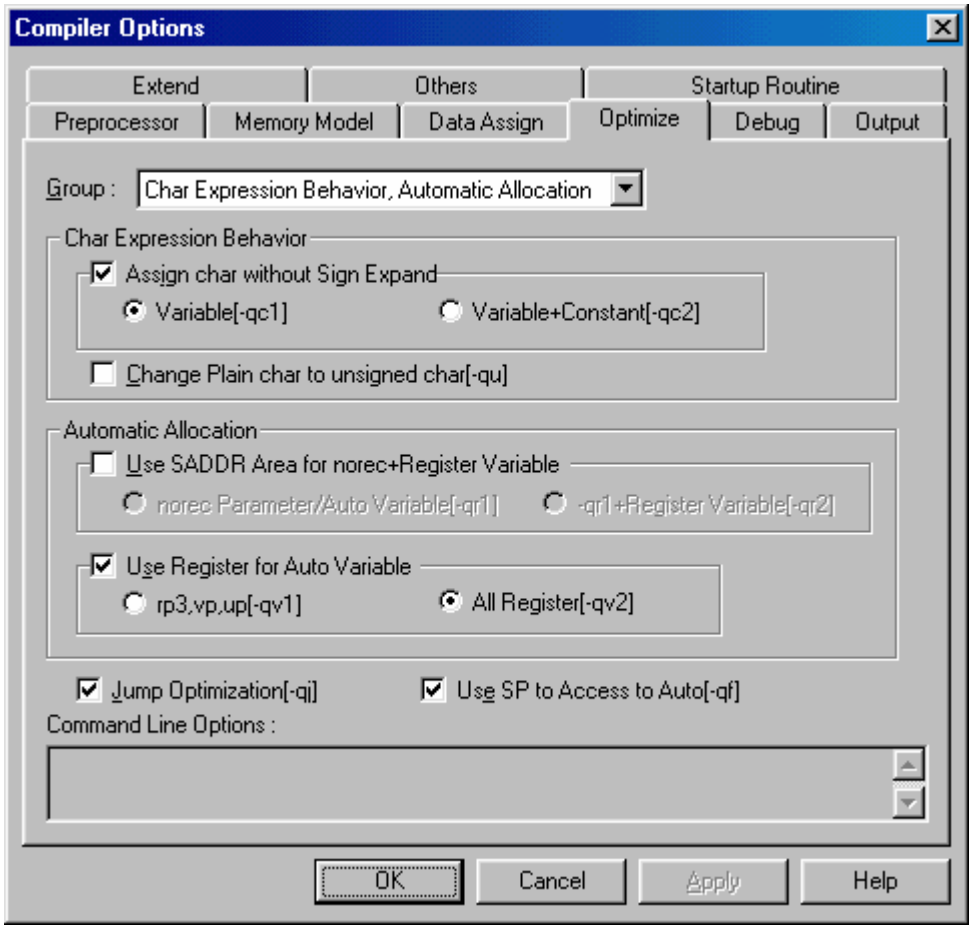
- Integrated Recommendable Optimizing Option

  The “Integrated Recommendable Optimizing Option” integrates optimization options according to purpose, instead of specifying them individually. Accordingly this option makes the optimization option easier to set.

  There are four settings: “Exec Time [-qx1]”, “Default [-qx2]”, “Code Size [-qx3]”, and “Parity Undebuggable [-qx4]”. Their meanings are as follows.

Exec Time[-qx1]:	-QX1 option. Select this option when the efficiency of executing speed is important.
Default[-qx2]:	-QX2 option. Select this option when both the efficiency of executing speed and the efficiency of object code size are equally important.
Code Size[-qx3]:	-QX3 option. Select this option when the efficiency of object code size is important.
Partially Undebuggable[-qx4]:	Select this option to place an emphasis especially on the object code size when the -QX4 option is used, in order to reduce the code size more than when -QX3 is used. However, debugging may be partially restricted at the optimized location of the code. To validate the -QX option, select the check box, and select each of the above patterns by clicking the corresponding radio button.

(b) When "Char Expression Behavior, Automatic Allocation" is selected in the [Group:] drop-down list box



- Char Expression Behavior

  Assign char without Sign Expand

  Select this check box to validate the -QC option (not to extend general integer) and select a variable to be assigned by clicking a radio button. Select the type of non sign-expanded char operation by clicking a radio button.

  Change Plain char to unsigned char[-qu]

  Select this check box to validate the -QU option.

- Automatic Allocation

  Use SADDR Area for norec + Register Variable

  Select this check box to validate the -QR option and select a variable to be assigned by clicking a radio button.

  Use Register for Auto Variable[-qv]

  Select this check box to validate the -QV option and select a variable to be assigned by clicking a radio button.

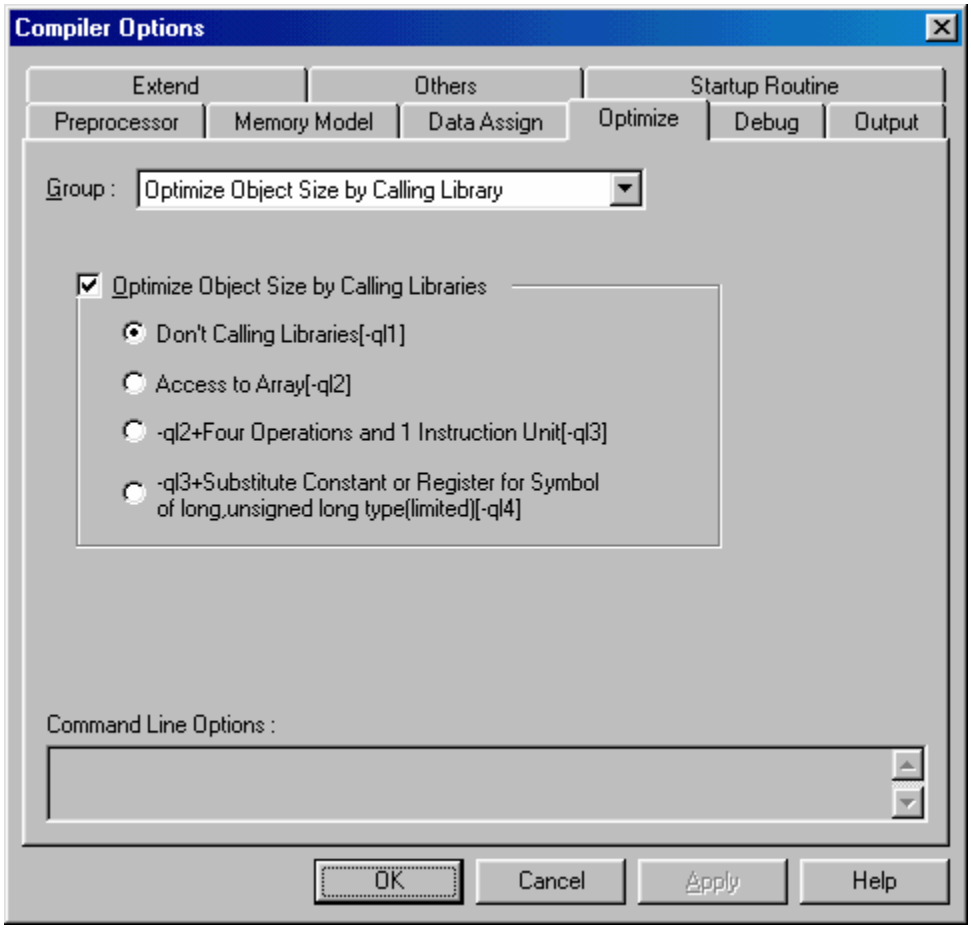
- Jump Optimization[-qj]

  Select this check box to validate the -QJ option.

- Use SP to Access to Auto[-gfj]

  Select this check box to validate the -QF option.

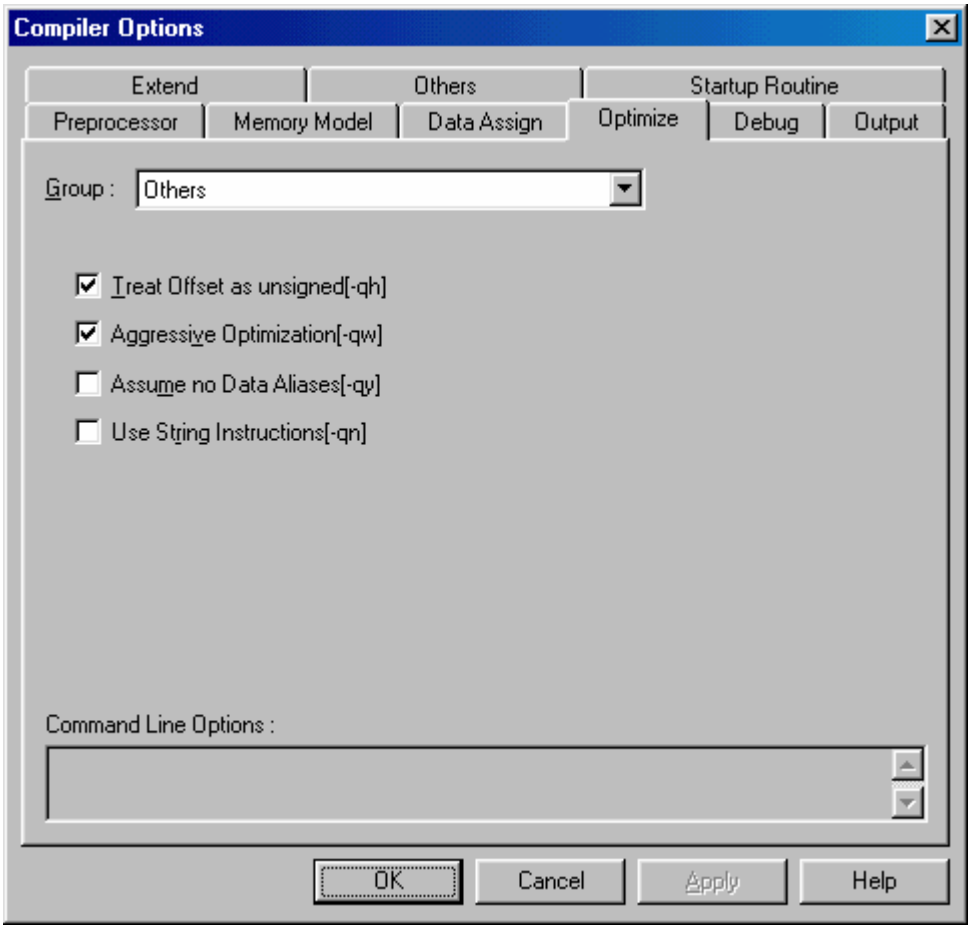
(c) When "Optimize Object Size by Calling Library" is selected in the [Group:] drop-down list box



- Optimize Object Size by Calling Libraries

  Select this check box to validate the -QL option and specify the level of the object size priority optimization by clicking a radio button. When the number n of -QLn becomes greater, the object code size becomes smaller, and accordingly the executing speed becomes slower.

(d) When "Others" is selected in the [Group:] drop-down list box



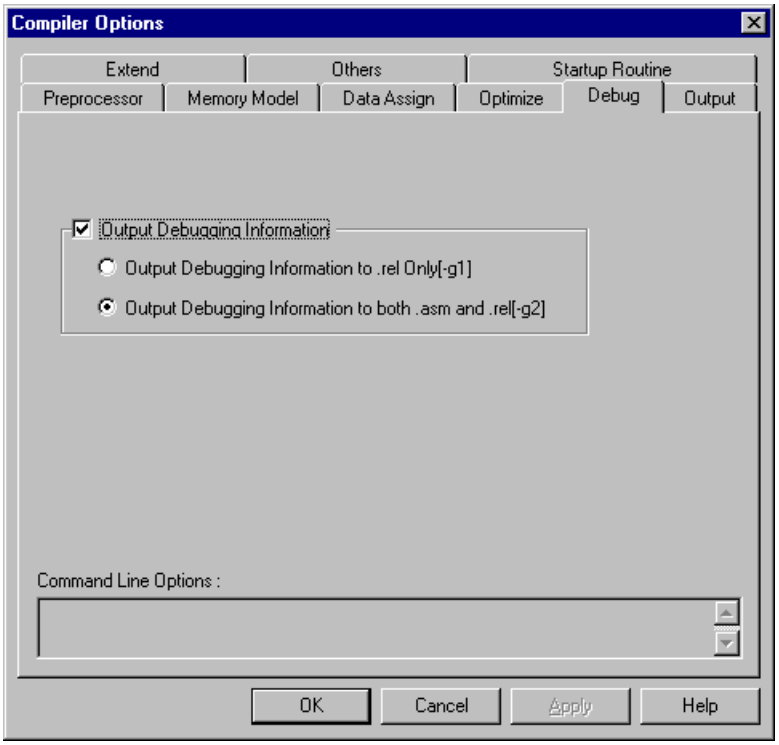
- Treat Offset as unsigned[-qh]
  Select the check box to validate the -QH option.

- Aggressive Optimization[-qw]
  Select the check box to validate the -QW option.

- Assume no Data Aliases[-qy]
  Select the check box to validate the -QY option.

- Use String Instructions[-qn]
  Select the check box to validate the -QN option.

(5) Screen when “Debug” is selected

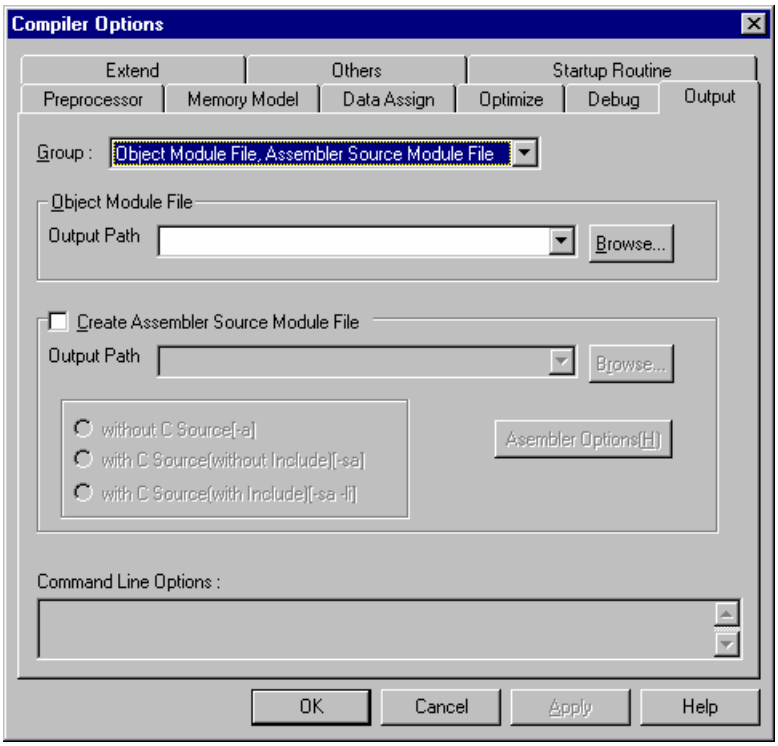


- Output Debugging Information

  Select this check box to validate the -G option and select a file that should output debug information by checking a radio button. If [Debug] is disabled by a PM plus option, it is not possible to perform settings in the <Debug> dialog box, and debug information is not output.

(6) Screen when “Output” is selected

(a) When “Object Module File, Assembler Source Module File” is selected in the [Group:] drop-down list box

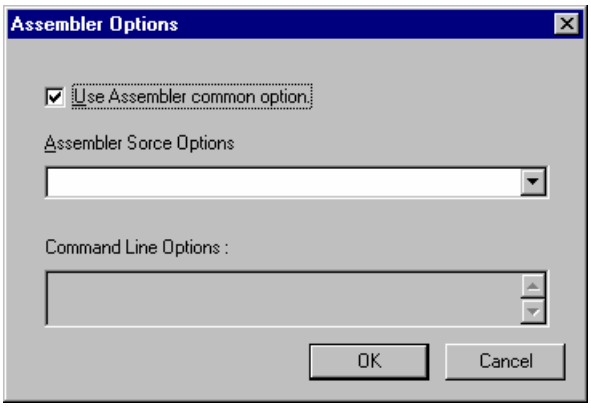


- Object Module File
  To specify an object module file output path, input the path name in the combo box. Specification is also possible using the [Browse…] button.
  When universal options are specified in PM plus, processing is always performed assuming that the path name is specified.
  When the source file is specified, processing is performed as a path name if a path exists, and as a file name if no path exists.

- Create Assembler Source Module File
  To enable the -A/-SA/-LI options, select this check box, and select with/without C source to attach to the assembler source module file and with/without include file contents by clicking the appropriate radio button.
  To specify the output path of the assembler source module file, input the path name in the combo box. Specification is also possible using the [Browse…] button.
  When universal options are specified in PM plus, processing is always performed assuming that the path name is specified.
  When the source file is specified, processing is performed as a path name if a path exists, and as a file name if no path exists.

- [Assembler Options[H]] button
  Specify assembler options for the assembler source module file.
  If no option is specified, processing is performed assuming that all assembler options have been specified.

- <Assembler Options> dialog box
  When the [Assembler Options[H]] button under the <Output> tab in the <Compiler Options> dialog box is clicked, the following dialog box appears.



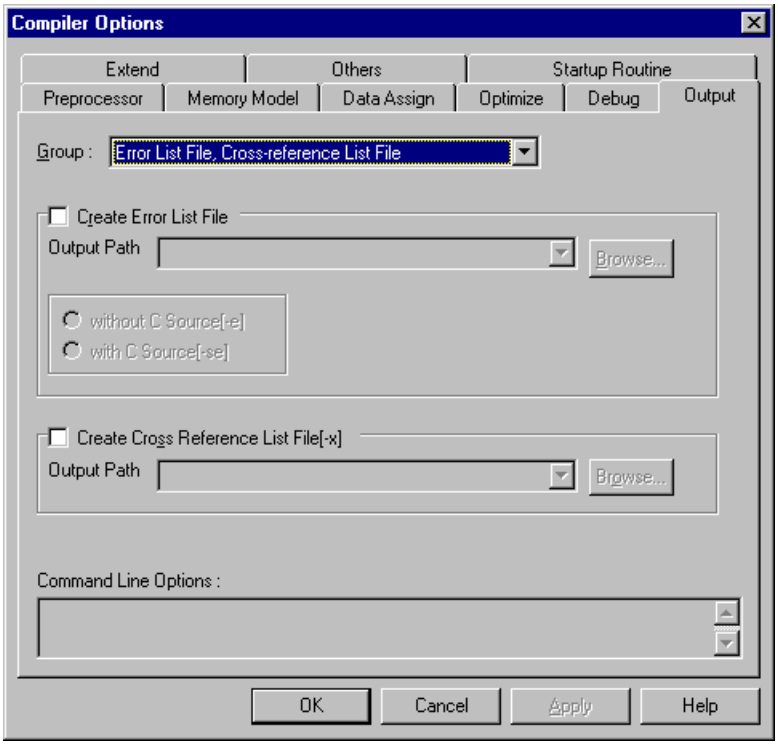
- Use Assembler common option
  Select this check box to enable all the options set in the <Assembler Options> dialog box.

- Assembler Source Options
  To enable options for the output assembler source of the compiler, input a character string including the option name in the combo box.
  Past inputs can be selected by clicking the button at the right of the combo box.

Caution Do not describe chip type specification (-C), device file specification (-Y), and parameter file specification (-F) because they are set separately with this tools DLL.

- Command Line Options:
  This edit box is a read-only box.
  The option character strings that are currently set are displayed.
  If the character strings do not all fit in the box, they can be viewed by scrolling with the button.
  All the character strings specified by setting a button or inputting in a box are immediately displayed in this edit box.
  Assembler common options and output assembler options are displayed as the option character strings.

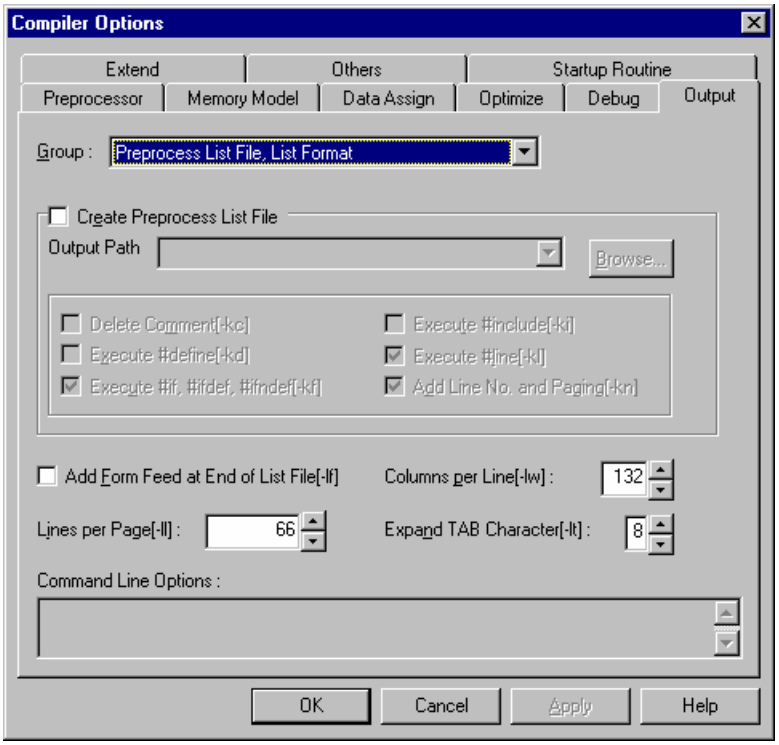
(b) When "Error List File, Cross-reference List File" is selected in the [Group:] drop-down list box



- Create Error List File
  Select this check box to enable the -E/-SE option. Also select whether or not to attach the C source to the error list by clicking the appropriate radio button.
  To specify the error list file output path, input the path name in the combo box. Specification is also possible using the [Browse…] button.
  When universal options are specified, processing is always performed assuming that the path name is specified.
  When the source file is specified, processing is performed as a path name if a path exists, and as a file name if no path exists.

- Create Cross Reference List File[-x]
  Select this check box to enable the -X option. To specify the cross-reference list file output path, input the path name in the combo box. Specification is also possible using the [Browse…] button.
  When universal options are specified, processing is always performed assuming that the path name is specified.
  When the source file is specified, processing is performed as a path name if a path exists, and as a file name if no path exists.

(c) When "Preprocess List File, List Format" is selected in the [Group:] drop-down list box



- Create Preprocess List File
  Select this check box to validate the -P option and the specification for the following preprocess list files.

  Delete Comment[-kc]
  Select this check box to validate the -KC option.
  Execute #define[-kd]
  Select this check box to validate the -KD option.
  Execute #if, #ifdef, #ifndef[-kf]
  Select this check box to validate the -KF option.
  Execute #include[-ki]
  Select this check box to validate the -KI option.
  Execute #line[-kl]
  Select this check box to validate the -KL option.
  Add Line No. and Paging[-kn]
  Select this check box to validate the -KN option.

To specify the preprocess list file output path, input the path name in the combo box. Specification is also possible using the [Browse…] button.
When universal options are specified, processing is always performed assuming that the path name is specified.
When the source file is specified, processing is performed as a path name if a path exists, and as a file name if no path exists.

- Add Form Feed at End of List File[-lf]
  Select this check box to validate the -LF option.

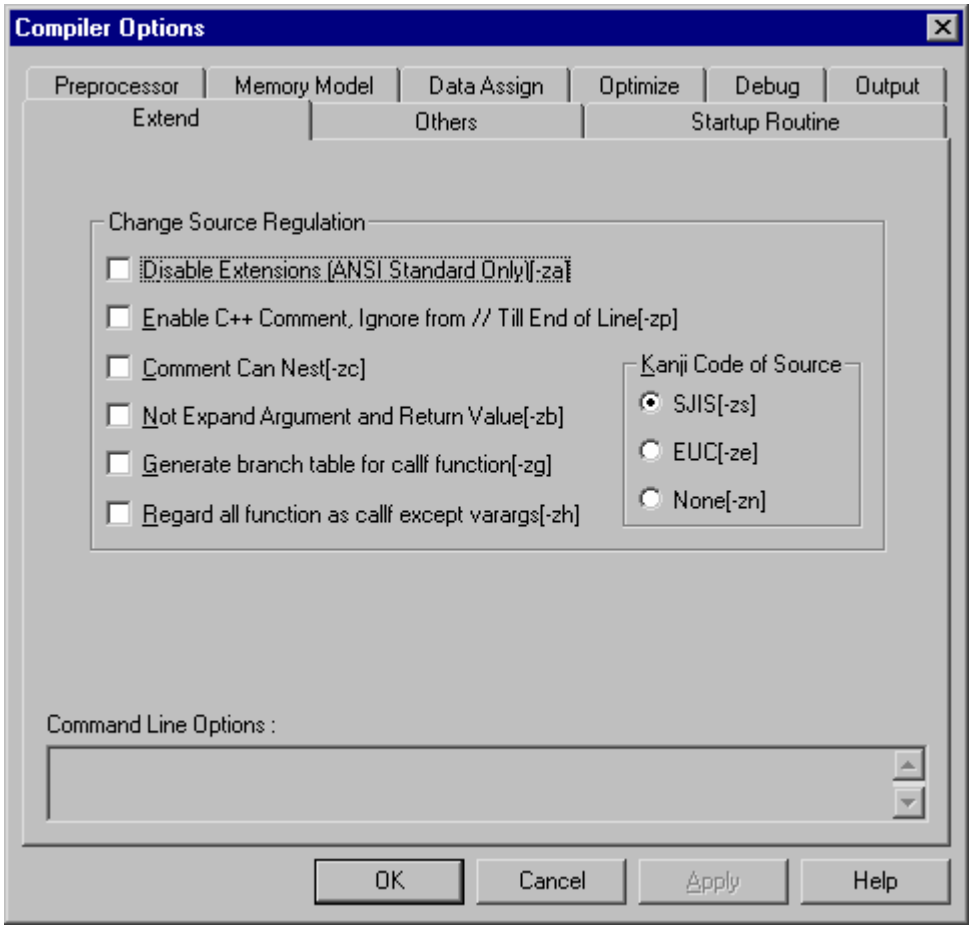
- List setting
  The list is output in the following format specified when the output option of each list is set.

  Columns per Line[-lw]:
  Specifies the number of characters in one line by using the -LW option. To increase/decrease the number of characters in the box, click  button.

  Lines per Page[-ll]:
  Specifies the number of lines in one page by using the -LL option. To increase/decrease the number of characters in the box, click  button.

  Expand TAB Character[-lt]:
  Specifies the length of tab character by using the -LT option. To increase/decrease the number of characters in the box, click  button.

(7) Screen when “Extend” is selected



- Change Source Regulation

Disable Extensions (ANSI Standard Only)[-za]

Select this check box to validate the -ZA option.

Enable C++ Comment, Ignore from // Till End of Line[-zp]

Select this check box to validate the -ZP option.

Comment Can Nest[-zc]

Select this check box to validate the -ZC option.

Not Expand Argument and Return Value[-zb]

Select this check box to validate the -ZB option.

Generate branch table for callf function[-zg]

Select this check box to validate the -ZG option.

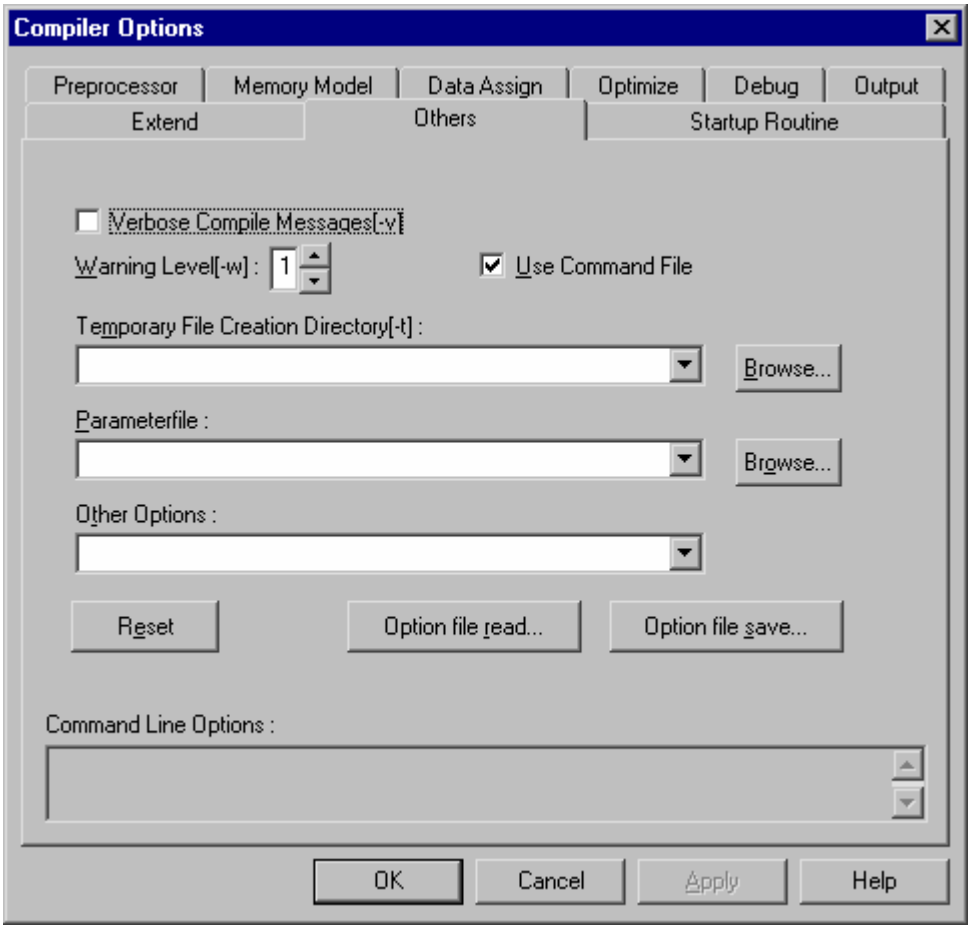
Regard all function as callf except varargs[-zh]

Select this check box to validate the -ZH option.

Kanji Code of Source

Select the type (SJIS/EUC/None) of Kanji code used in the comment of the source by selecting the appropriate radio button.

(8) Screen when “Others” is selected



- Verbose Compile Messages[-v]
  Select this check box to enable the -V option.

- Warning Level[-w]:
  Use the button to change the -W option level.

- Temporary File Creation Directory[-t]:
  Input the directory in which to store the temporary files specified with the -T option in the combo box.

- Parameterfile:
  Input the parameter file name specified with the -F option in the combo box.
  Past inputs can be selected by clicking the button at the right of the combo box.

- Other Options:
  If a compiler option other than the various option specification items must be specified, input that option in the combo box.
  Past inputs can be selected by clicking the button at the right of the combo box.

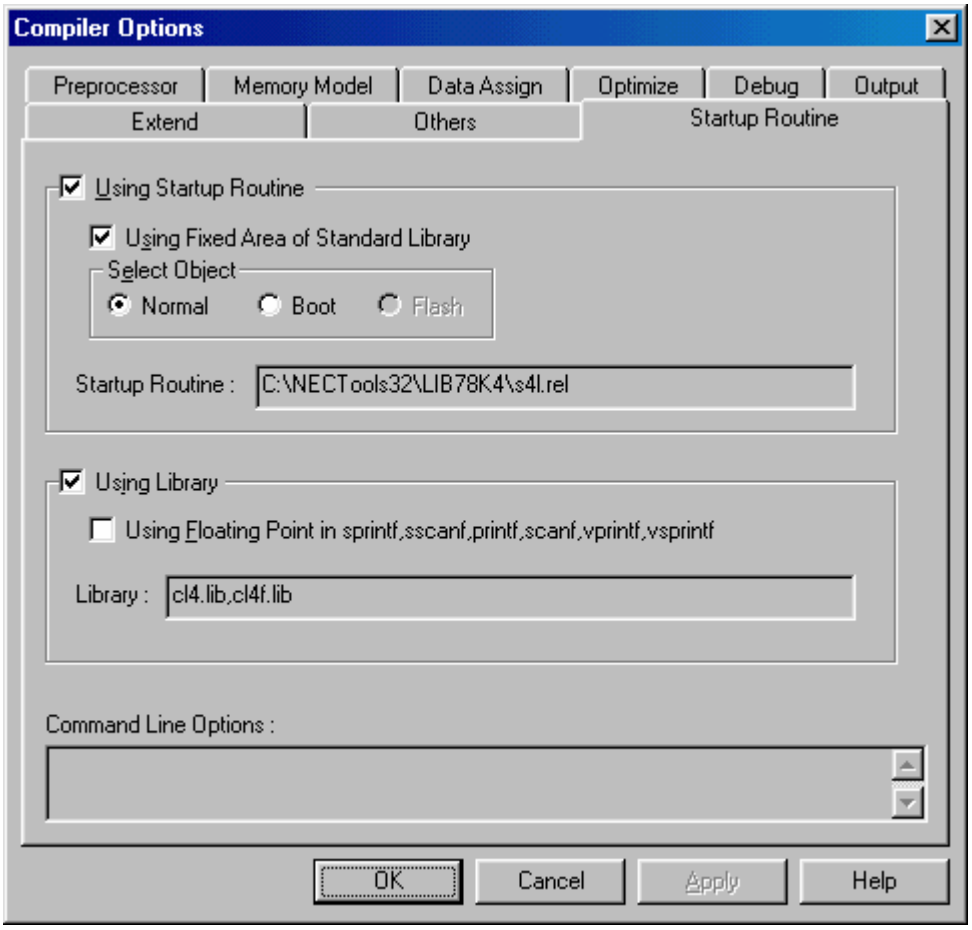
- [Reset] button
  Clicking this button sets the default option settings.

- [Option file read…] button
  Clicking this button causes the option information file containing the option settings to be read.

- [Option file save…] button
  This button is enabled only when information has been set with the [OK] button or the [Apply] button. Option settings are saved as an option information file.

- Use Command File
  By selecting this check box, the option character string is output to the command file, so awareness of restrictions on the length of the option character string is not required. This check box is selected by default.

(9) Screen when “Startup Routine” is selected



<Startup Routine> dialog box settings cannot be performed when a source is specified.

- Using Startup Routine
  Select this check box to use the standard startup routine provided for this C compiler.

  - Using Fixed Area of Standard Library
    Select this check box to use the fixed area used by the standard library.

  - Select Object
    Select the desired startup routine for the normal, boot, or flash area by clicking the corresponding radio button.

    If the [Output the Object for Flash Memory[-zf]] check box under the <Memory Model> tab is not selected, the startup routine for the normal or boot areas can be selected, and if the check box is selected, only the startup routine for the flash area can be selected.

  - Startup Routine:
    Indicates the file name of the startup routine to be used.

- Using Library

  Select this check box to use the standard library provided for this C compiler.

  - Using Floating Point in sprintf,sscanf,printf,scanf,vprintf,vsprintf

    Select this check box to use the sprintf, sscanf, printf, scanf, vprintf, and vsprintf functions supporting floating points.

    If the [Output Old Calling Sequence[-zo]] or [Regard All Function as _ _pascal Except Varargs[-zr]] option is specified, the sprintf, sscanf, printf, scanf, vprintf, and vsprintf functions supporting floating points cannot be used.

  - Library:

    Displays the file name of the library to be used.

3.2 Procedure from Compiling to Linking (When Not Using Flash Memory Self Rewrite Mode)

3.2.1 MAKE from PM plus

The MAKE method using PM plus with a PC-9800 Series or IBM PC/AT compatible is described below.

PM plus is a software program used for the integrated management of tools as the core of the development environment. Using PM plus enables handling application programs and environment settings as projects. Program creation using an editor, source management, compilation, and debugging can be performed as a continuous series of operations.

3.2.2 Starting up PM plus

When the development tool packages are correctly installed, the [NECTools32] menu is created in the Programs folder displayed from the Start button, and PM plus and other programs are registered in this menu.

Click [PM plus] from the menu to start up PM plus.

3.2.3 Creating project

Register a project first to start a series of development operations using PM plus.

To register a project, first create the workspace in which that project is managed. For the procedure to create a workspace, refer to the **PM plus Ver. 5.10 User's Manual (U16569E)**.

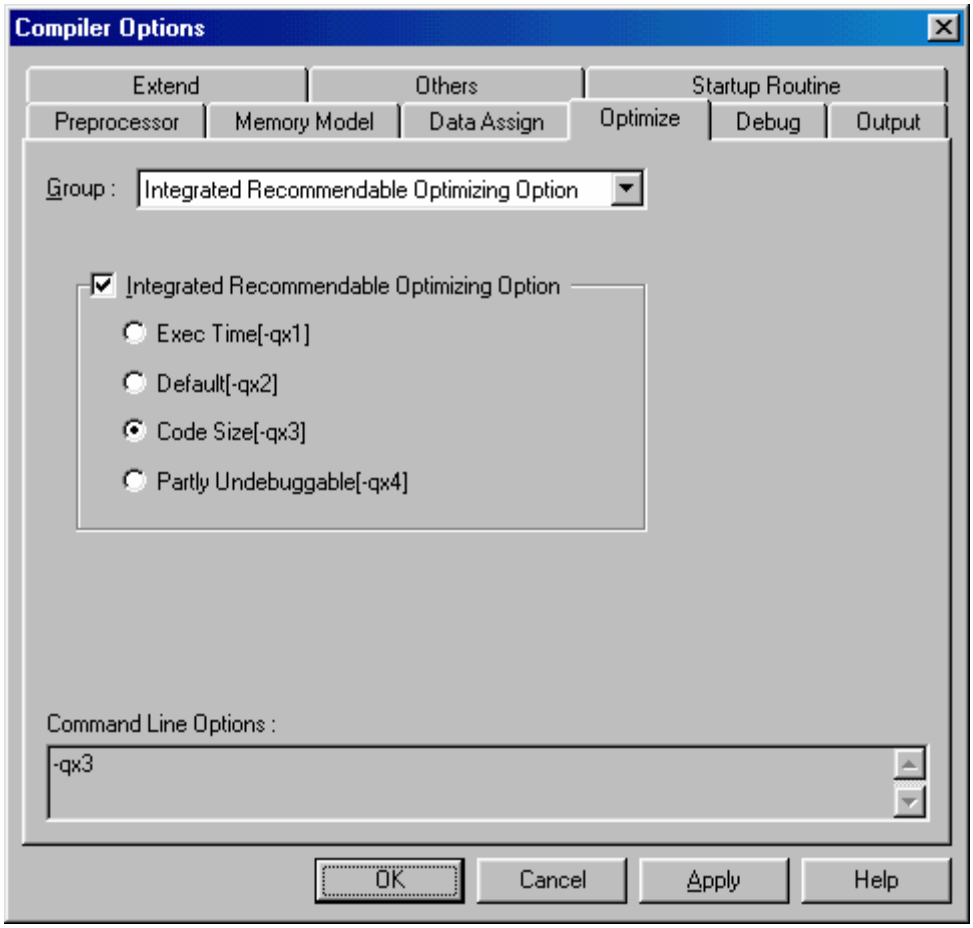
3.2.4 Setting compiler and linker options

A minimum number of options are set for build in the MAKE file created automatically upon completion of project creation. Project-specific options are set in the [Tools] menu.

If the [Compiler Options…] in the [Tools] menu is selected, the <Compiler Options> dialog box appears.

An example changing the Optimize option from default [-QCFHJLVW] to Code Size[-qx3] is shown below.

Figure 3-1. Selection of Optimize Options



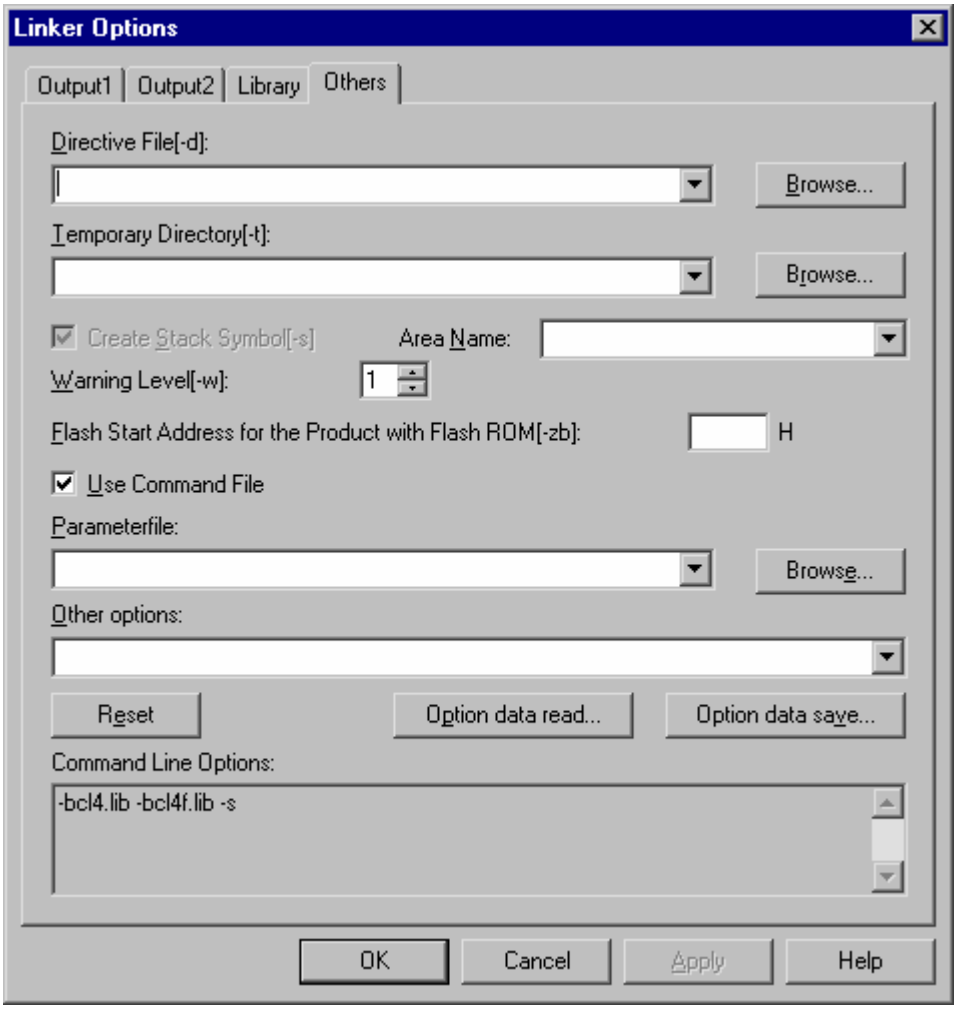
If “Using Startup Routine” is selected in the <<Startup Routine>> tab of the <Compiler Options> dialog box, the standard startup routine for this compiler gets linked before all sources (not displayed to the <Linker Options> dialog box).

When “Using Library” is selected, the standard library for this compiler gets linked behind all libraries.

If C source is included in the source file settings, stack symbol automatic generation option -S is automatically specified to the linker.

The name of the startup routine file does not affect the load module file name.

Figure 3-2. Linker Options Dialog Box



3.2.5 Building project

Projects are built with the set options.

Building of an entire project is done by selecting [Build] from the [Build] menu, or by clicking the  button on the tool bar. PM plus MAKE is started up by the automatically created MAKE file.

Upon completion of build, a message dialog box appears. Check that build has been completed normally.

Caution The contents displayed in the <Output> window during build are saved as the "Project file name + .plg" file name to the project directory.

3.2.6 Compiling to linking in command line (for DOS prompt and EWS)

(1) When parameter file is not used

The command below is used to start the CC78K4, assembler, and linker in a command line. Assembling is not needed when there is no assembler description in C source. In this case, link the object module file output from a C compiler (Δ: space).

```
>[path name]CC78K4[Δ option] Δ C source name[Δ option]
>[path name]RA78K4[Δ option] Δ assembler source name[Δ option]
>[path name]LK78K4 object module name[Δ option]
```

Caution To link libraries created by users, be sure to specify the libraries attached to the compiler and the floating point libraries at the end of the library list.
To use the sprintf, sscanf, printf, scanf, vprintf, and vsprintf functions supporting floating points, specify the floating point libraries attached to the compiler and the libraries attached to the compiler, in this order.
To use the sprintf, sscanf, printf, scanf, vprintf, and vsprintf functions not supporting floating points, specify the libraries attached to the compiler and the floating point libraries attached to the compiler, in this order.
Also, specify the startup routine attached to the C compiler before the user programs. The library and object module file specification order during linking is shown below.

(Library specification order)
When using sprintf, sscanf, printf, scanf, vprintf, and vsprintf functions not supporting floating points
1. User program library file (specified with -B option)
2. Library file attached to C compiler (specified with -B option)
3. Floating point library file attached to C compiler (specified with -B option)
When using sprintf, sscanf, printf, scanf, vprintf, and vsprintf functions supporting floating points
1. User program library file (specified with -B option)
2. Floating point library file attached to C compiler (specified with -B option)
3. Library file attached to C compiler (specified with -B option)

(Specification order of other files)
1. Object file of startup routine attached to CC78K4
2. Object module file of user program

The following shows an example of linking C source s1.c and assembler source s2.asm.

```
C>cc78k4 –c4038 s1.c -e -a -iC:\nectools32\inc78k4 –yC:\nectools32\dev
C>ra78k4 –c4038 s2.asm -e -yC:\nectools32\dev
C>lk78k4 s41.rel s1.rel s2.rel -bC:\nectools32\lib78k4\cl4.lib -s
-osample.lmf -yC:\nectools32\dev
```

Remark When specifying multiple compiler options, delimit between compiler options by a space. It does not matter whether a description is written in uppercase or lowercase (non case sensitive). For detailed information, see **CHAPTER 5 COMPILER OPTIONS**.

The -i option specification, -b option path specification, and -y option specification can be omitted depending on the condition. For details, see **CHAPTER 5 COMPILER OPTIONS** and **RA78K4 Assembler Package Operation User's Manual (U16708E).**

(2) When parameter file is used

When multiple options are input in starting a compiler, assembler, or linker, the same specification may be repeated several times if sufficient information for startup has not been specified in the command line. In such cases, a parameter file should be used.

Specify the parameter file specification option in the command line when using a parameter file.

Caution Parameter files cannot be specified by means of the option setting of PM plus.

The following shows the startup method for a compiler, assembler, and linker by using a parameter file.

```
>[path name]CC78K4 Δ -F parameter file name
>[path name]RA78K4 Δ -F parameter file name
>[path name]LK78K4 Δ -F parameter file name
```

The following shows a usage example.

Example

```
C>cc78k4  -Fpara.pcc
C>ra78k4  -Fpara.pra
C>lk78k4  -Fpara.plk
```

Parameter files are created by an editor. All options and output file names that should be specified in a command line can be written.

The following shows examples of creating parameters by the editor.

(Contents of para.pcc)

```
-c4038 s1.c -e -a -iC:\nectools32\inc78k4 -yC:\nectools32\dev
```

(Contents of para.pra)

```
-c4038 s2.asm -e -yC:\nectools32\dev
```

(Contents of para.plk)

```
s41.rel s1.rel s2.rel -bC:\nectools32\lib78k4\cl4.lib -s -osample.lmf
-yC:\nectools32\dev
```

The -i option specification, -b option path specification, and -y option specification can be omitted depending on the condition. For details, see **CHAPTER 5 COMPILER OPTIONS** and **RA78K4 Assembler Package Operation User's Manual (U16708E).**

3.3 Compiling to Linking (When Using Flash Memory Self Rewrite Mode)

This function is available only for the device having the flash memory self rewriting function.

3.3.1 Compiling to linking via PM plus

PM plus is used on the PC-9800 Series and the IBM PC/AT compatibles to illustrate the MAKE technique.
Be sure to compile to link in the following order.

(1) Compiling to linking program for boot area

(a) Creating a project

Create a project for the boot area and register the source file.

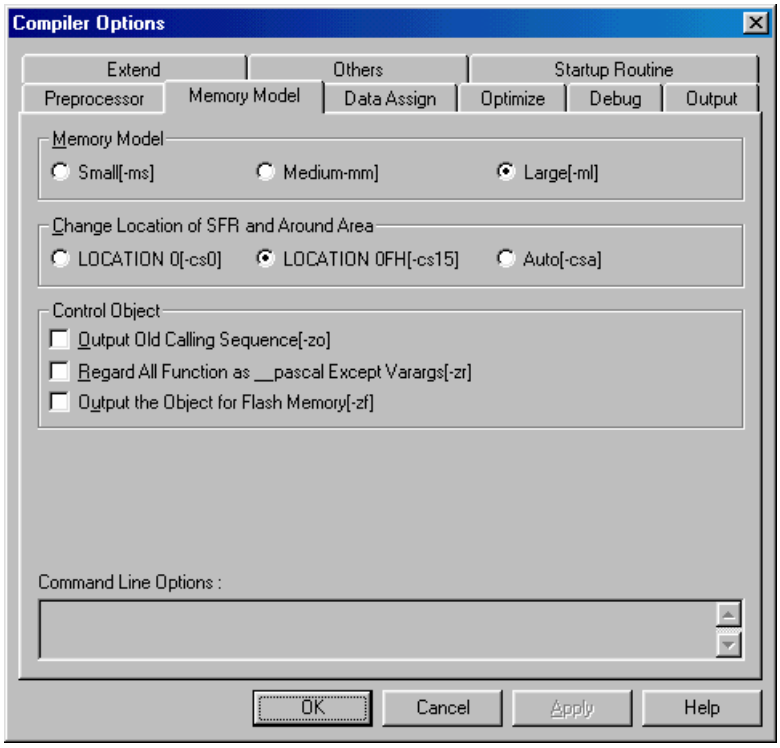
(b) Setting compiler, linker, and object converter options

A minimum number of options are set for build in the MAKE file created automatically upon completion of project creation. Project-specific options are set in the [Tools] menu.
If the [Compiler Options…] in the [Tools] menu is selected, the <Compiler Options> dialog box appears.

<1> Setting compiler option

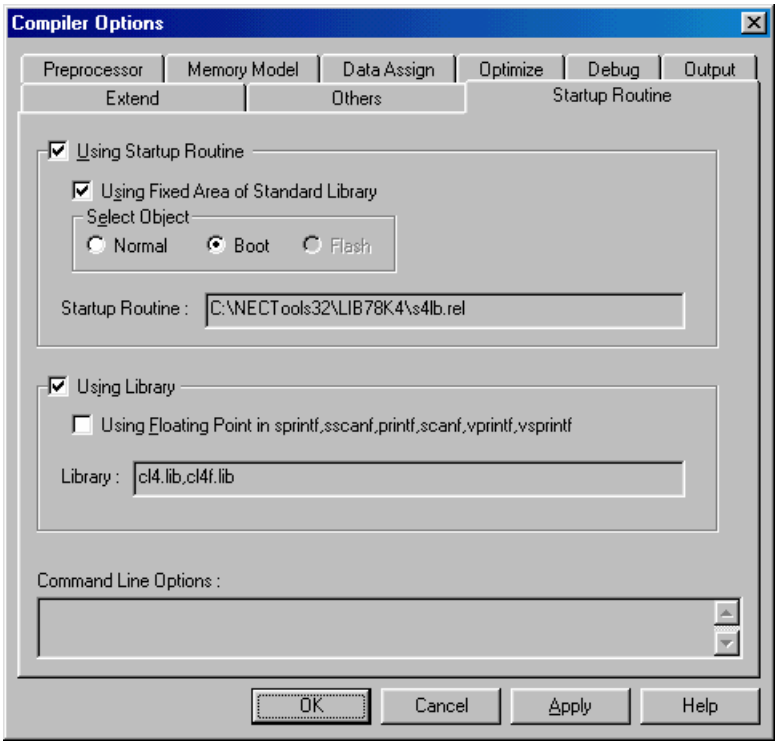
Do not specify the -ZF option in the <<Memory Model>> tab.

Figure 3-3. Compiler Options Dialog Box



Select “Boot” in the [Select Object] box under the <<Startup Routine>> tab.

Figure 3-4. Selection of Boot Area Object



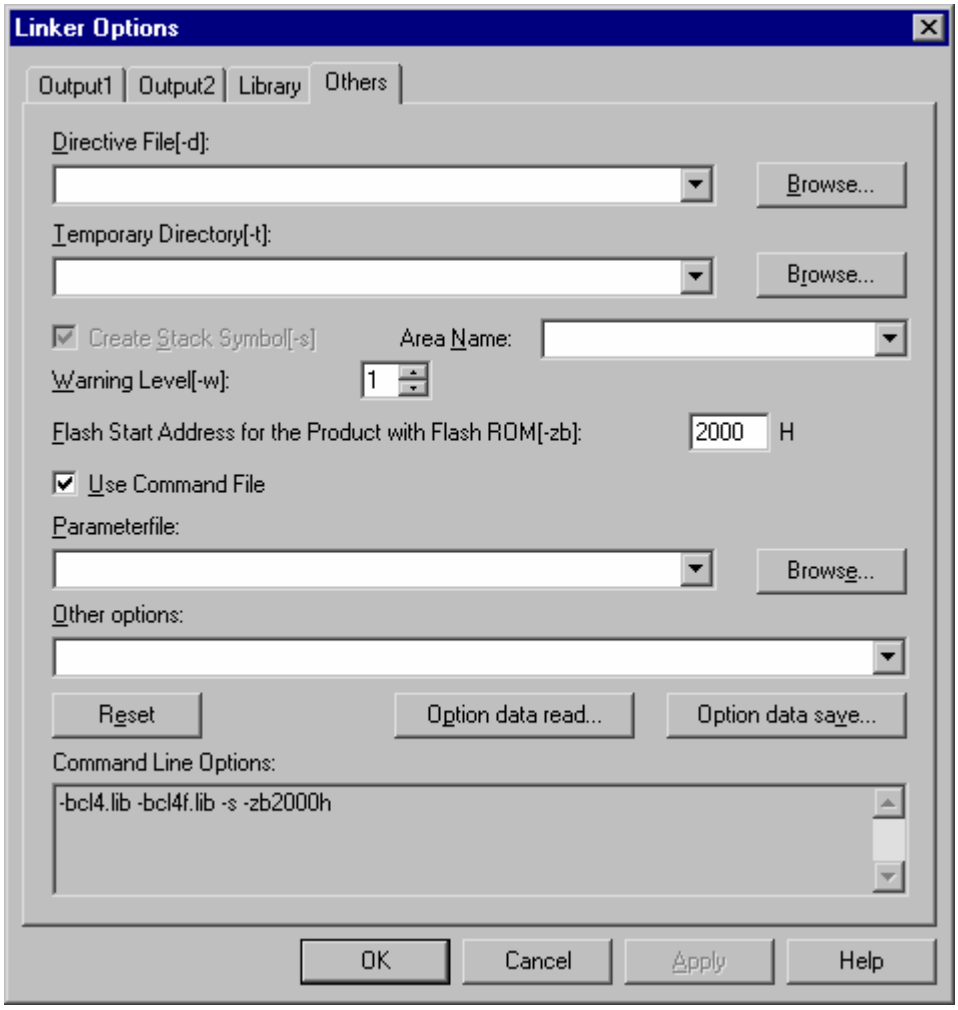
<2> Setting linker option

Specify flash start address specification option -ZB and then click the [OK] button.

Since "Using Startup Routine" and "Using Library" check boxes are selected under the <<Startup Routine>> tab, it is not necessary to specify the startup routine and library in the <Linker Options> dialog box.

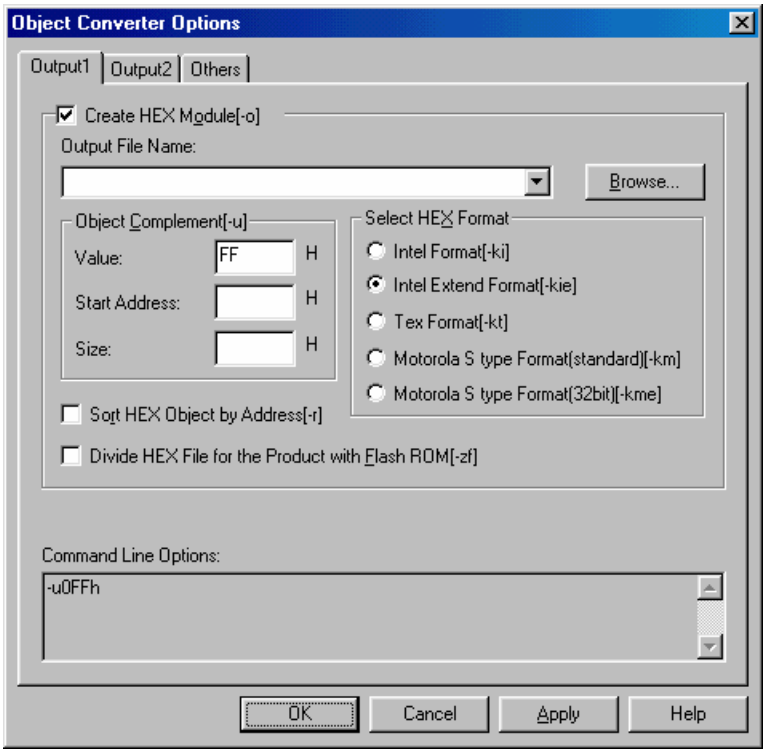
Also, since C source (boot.c) is included in the source file specification, stack symbol automatic generation option -S is automatically set.

Remark For information about the linker options, refer to **RA78K4 Assembler Package Operation User's Manual (U16708E)**.



<3> Setting object converter option

Do not specify the object converter option -ZF.



Caution After the program for boot area is compiled and object-converted, write in the HEX file (e.g. boot.hex) with a flash programmer. After writing, be sure to save the load module file (e.g. boot.lmf) and HEX file created in the above procedure. Do not build the program for boot area again.

(c) Building project

Projects are built with the set options.

Build of an entire project is done by selecting [Build] from the [Build] menu, or by clicking the  button on the tool bar. PM plus MAKE is started up by the automatically created MAKE file.

Upon completion of build, a message dialog box appears. Check that build has been completed normally.

Caution The contents displayed in the <Output> window during build are saved as the "Project file name + .plg" file name to the project directory.

(2) Compiling to linking program for flash area

(a) Creating a project

Create a project for the flash area and register the source file.

(b) Setting compiler, linker, and object converter options

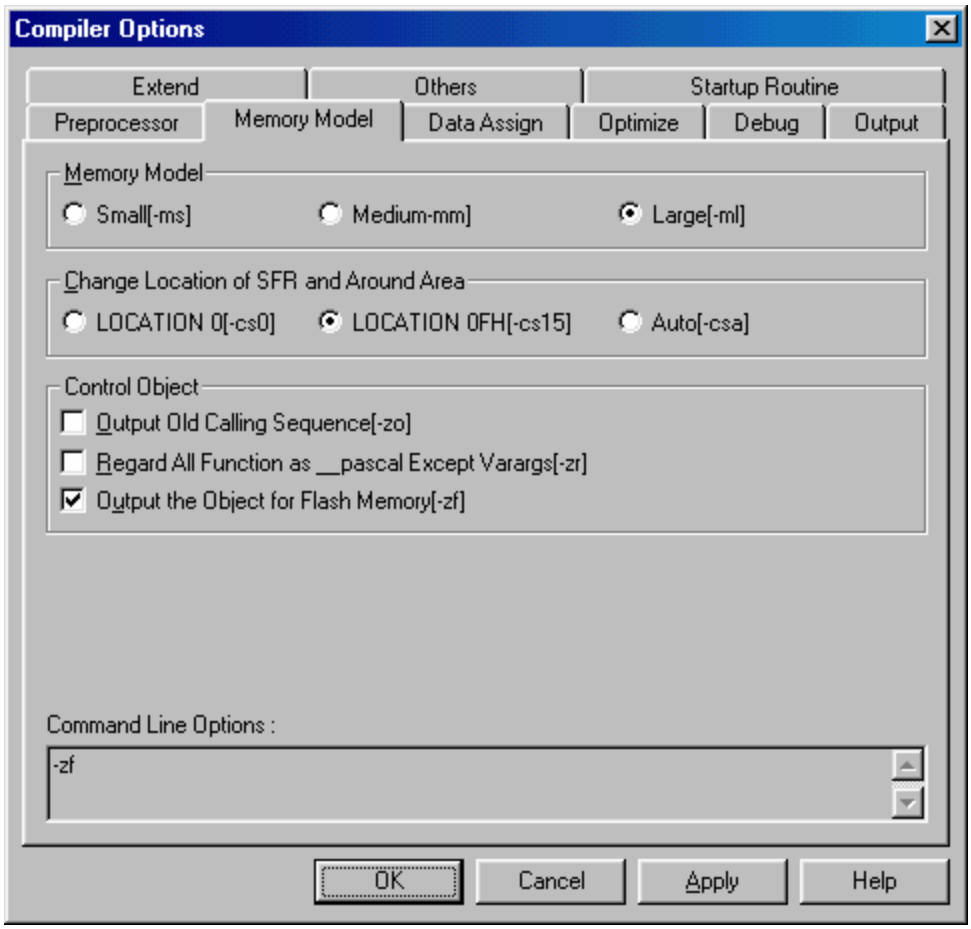
A minimum number of options is set for build in the MAKE file created automatically upon completion of project creation. Project-specific options are set in the [Tools] menu.

If the [Compiler Options…] in the [Tools] menu is selected, the <Compiler Options> dialog box appears.

<1> Setting compiler option

Specify the -ZF option in the <<Memory Model>> tab.

Figure 3-5. Compiler Options Dialog Box



Flash is automatically selected in the [Select Object] box under the <<Startup Routine>> tab.

<2> Setting linker option

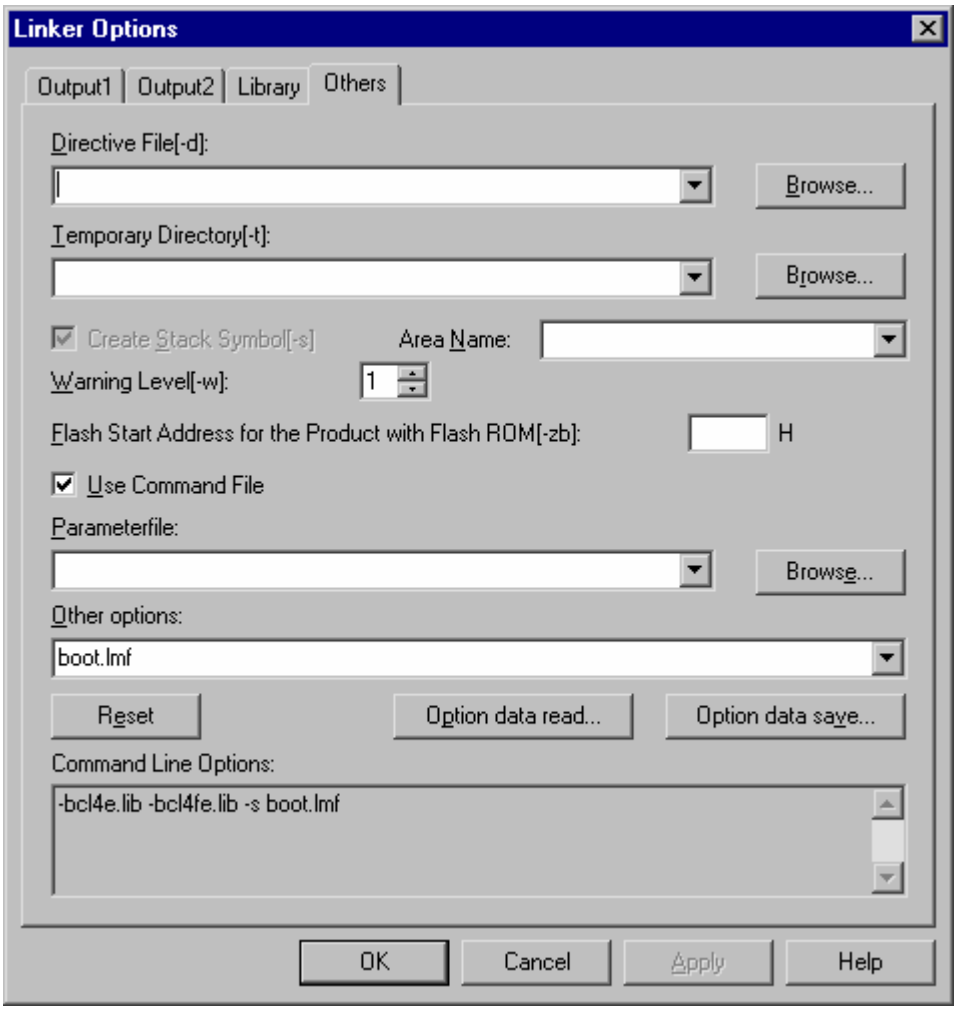
Specify the load module file for the boot area to be linked and then click the [OK] button.

Since the "Using Startup Routine" and "Using Library" check boxes are selected under the <<Startup Routine>> tab in the <Compiler Options> dialog box, it is not necessary to specify the startup routine and library in the <Linker Options> dialog box.

Also, since C source (flash.c) is included in the source file specification, stack symbol automatic generation option -S is automatically set.

Remark For information about the linker options, refer to **RA78K4 Assembler Package Operation User's Manual (U16708E).**

Figure 3-6. Linker Options Dialog Box



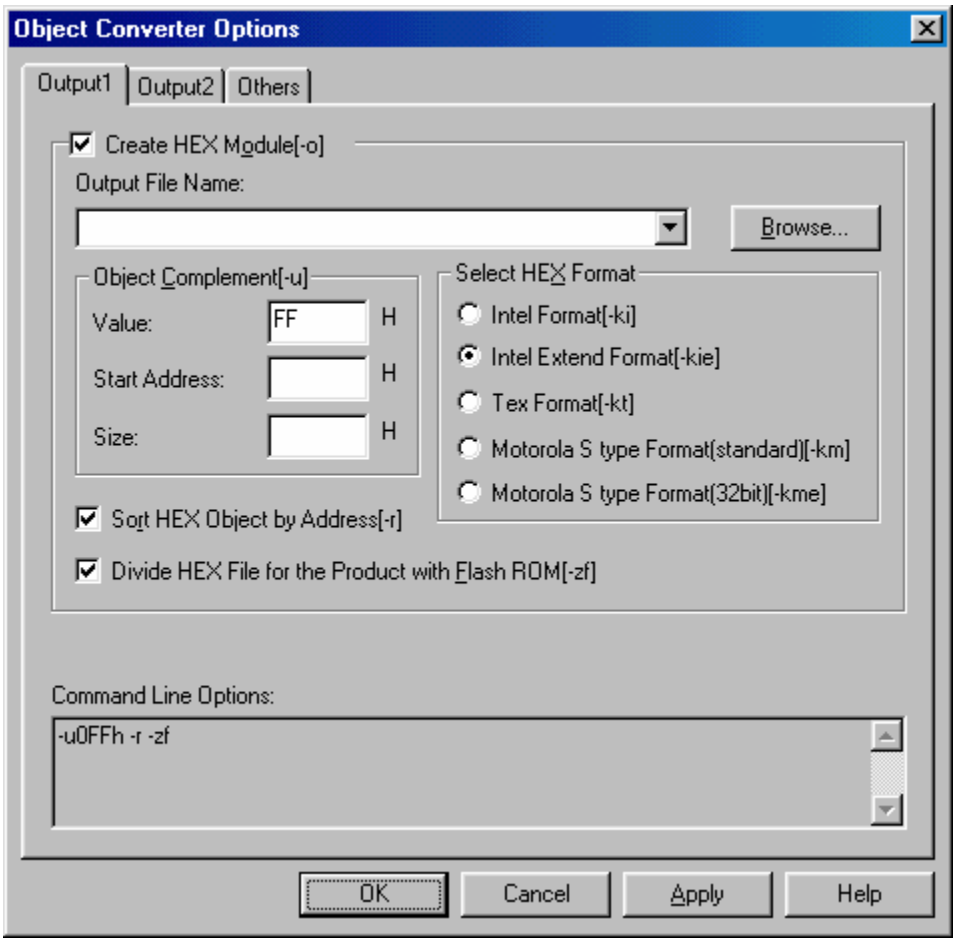
<3> Setting object converter option (for flash area)

Be sure to specify the object converter option -ZF.

By specifying the -ZF option, HEX file for boot area (e.g. flash.hxb) and HEX file for flash area (e.g. flash.hxf) are output.

The flash.hxb and the boot.hex that is generated when the program for boot area is built have the same contents. However, when the HEX file for boot area is already written and the program for flash area is built again, it is recommended to confirm that there is no difference in the saved boot.hex and the created flash.hxb.

Figure 3-7. Object Converter Options Dialog Box



(c) Building project

Projects are built with the set options.

Build of an entire project is done by selecting [Build] from the [Build] menu, or by clicking the  button on the tool bar. PM plus MAKE is started up by the automatically created MAKE file.

Upon completion of build, a message dialog box appears. Check that build has been completed normally.

Caution The contents displayed in the <Output> window during build are saved as the "Project file name + .plg" file name to the project directory.

3.3.2 Compiling to linking in command line (for DOS prompt and EWS)

(1) When parameter file is not used

The command below is used to start the CC78K4, assembler, and linker in a command line. Assembling is not needed when there is no assembler description in C source. In this case, link the object module file output from a C compiler (Δ: space).

```
>[path name]CC78K4[Δ option] Δ C source name[Δ option]
>[path name]RA78K4[Δ option] Δ assembler source name[Δ option]
>[path name]LK78K4[Δ option] object module name, etc.[Δ option]
```

The following shows examples of compiling and linking the C source for boot area and the C source for flash area.

(a) Compiling to linking, object-converting program for boot area

Examples

<1> Compiling program for boot area

```
C> cc78k4 –cf4943 boot.c -iC:\nectools32\inc78k4 -yC:\nectools32\dev
```

<2> Linking program for boot area

```
C> lk78k4 s41b.rel boot.rel -bC:\nectools32\lib78k4\cl4.lib -s
   -oboot.lmf -zb2000h -yC:\nectools32\dev
```

<3> Object-converting program for boot area

```
C> oc78k4 boot.lmf -u0FFh -oboot.lmf -yC:\nectools32\dev
```

Caution After the program for boot area is compiled and object-converted, write in the HEX file (e.g. boot.hex) with a flash programmer. After writing, be sure to save the load module file (e.g. boot.lmf) and HEX file created in the above procedure. Do not build the program for boot area again.

(b) Compiling to linking program for flash area

Examples

<4> Compiling program for flash area

```
C> cc78k4 –cf4943 flash.c -zf -iC:\nectools32\inc78k4
   -yC:\nectools32\dev
```

<5> Linking program for flash area

```
C> lk78k4 boot.lmf s4le.rel flash.rel -bC:\nectools32\lib784\
   cl4e.lib -s -oflash.lmf -yC:\nectools32\dev
```

<6> Object-converting program for flash area

```
C> oc78k4 flash.lmf -u0FFh -r -oflash.lmf -yC:\nectools32\dev
```

Caution By specifying the -ZF option when object-converting, HEX file for boot area (e.g. flash.hxb) and HEX file for flash area (e.g. flash.hxf) are output. The flash.hxb and the boot.hex that is generated when the program for boot area is built have the same contents. However, when the HEX file for boot area is already written and the program for flash area is built again, it is recommended to confirm that there is no difference in the saved boot.hex and the created flash.hxb.

Remark When specifying multiple compiler options, delimit between compiler options by a space. It does not matter whether a description is written in uppercase or lowercase (non case sensitive). For detailed information, see **CHAPTER 5 COMPILER OPTIONS**.

The -i option specification, -b option path specification, and -y option specification can be omitted depending on the condition. For details, see **CHAPTER 5 COMPILER OPTIONS** and **RA78K4 Assembler Package Operation User's Manual (U16708E)**.

Caution When linking a library created by a user or a floating-point library, be sure to specify the library attached to the CC78K4 at the end of the library line. When linking a program for flash area and a program for boot area, specify the load module file for boot area in the beginning, and specify the startup routine for flash area before the user program.
The following shows the library and object module file specification orders when linking.

(Library specification order)
When using sprintf, sscanf, printf, scanf, vprintf, and vsprintf functions not supporting floating points

1. **User program library file (specified with -B option)**
2. **Library file attached to C compiler (specified with -B option)**
3. **Floating point library file attached to C compiler (specified with -B option)**

When using sprintf, sscanf, printf, scanf, vprintf, and vsprintf functions supporting floating points

1. **User program library file (specified with -B option)**
2. **Floating point library file attached to C compiler (specified with -B option)**
3. **Library file attached to C compiler (specified with -B option)**

Specify the library for boot area when linking the program for boot area, and the library for flash area when linking the program for flash area.

(Specification order of other files)

1. **Load module file for boot area of user program**
2. **Startup routine object module file for flash area attached to CC78K4**
3. **Object module file for flash area of user program**

(2) When parameter file is used

When multiple options are input in starting a compiler, assembler, or linker, the same specification may be repeated several times if sufficient information for startup has not been specified in the command line. In such cases, a parameter file should be used.

Specify the parameter file specification option in the command line when using a parameter file.

Caution Parameter files cannot be specified by means of the option setting of PM plus.

The following shows the startup method for a compiler, assembler, and linker by using a parameter file.

```
>[path name]CC78K4 Δ-F parameter file name
>[path name]RA78K4 Δ-F parameter file name
>[path name]LK78K4 Δ-F parameter file name
```

The following shows a usage example.

Example

```
C>cc78k4  -Fpara.pcc
C>lk78k4  -Fpara.plk
```

Parameter files are created by Editor. All options and output file names that should be specified in a command line can be written.

The following shows examples of creating parameters by Editor.

(Contents of para.pcc)

```
-cf4943 boot.c -iC:\nectools32\inc78k4 -yC:\nectools32\dev
```

(Contents of para.pra)

```
s4lb.rel boot.rel -bC:\nectools32\lib78k4\cl4.lib -s -oboot.lmf -zb2000h
-yC:\nectools32\dev
```

Remark The -i option specification, -b option path specification, and -y option specification can be omitted depending on the condition. For details, see **CHAPTER 5 COMPILER OPTIONS** and **RA78K4 Assembler Package Operation User's Manual (U16708E)**.

3.4 I/O Files of C Compiler

The CC78K4 inputs the C source module files written in the C language. These are converted into machine language and output as object module files.

After compiling, the assembler source module files are output so that the user can check and revise the contents at the assembly language level. Based on the compiler options, the list files such as the preprocess list, cross-reference list, and error list are output.

If there is a compiler error, the error message is output to the console and the error list file. If errors occur, various files other than an error list file cannot be output.

The CC78K4 I/O files are shown below.

Table 3-1. I/O Files of C Compiler

Type	File Name	Description	Default File Type
Input Files	C source module file	• Source file written in the C language • File created by the user	C
	Include file	• File referenced by a C source module file • File written in the C language • File created by the user	H
	Parameter file	• File created by the user when the user wants to specify multiple commands that cannot be specified in the command line when the C compiler is run	PCC
Output Files	Object module file	• Binary image file containing machine language information, relocatable information related to the location address of the machine language, and symbol information	REL
	Assembler source module file	• ASCII image file of the object code output by the compiler	ASM
	Preprocess list file	• List file output by the preprocess instructions such as #include • ASCII image file	PPL
	Cross-reference list file	• List file containing the function name and variable name information used in the C source module file	XRF
	Error list file	• List file containing the source file and compiler error messages	ECC CER HER ER[Note]
I/O File	Temporary file	• Intermediate file for compiling • The file is renamed to an appropriate name when compiling ends without error and is deleted when compiling ends in error.	$nn (file name fixed)

Note The following four file types are available for error list files.

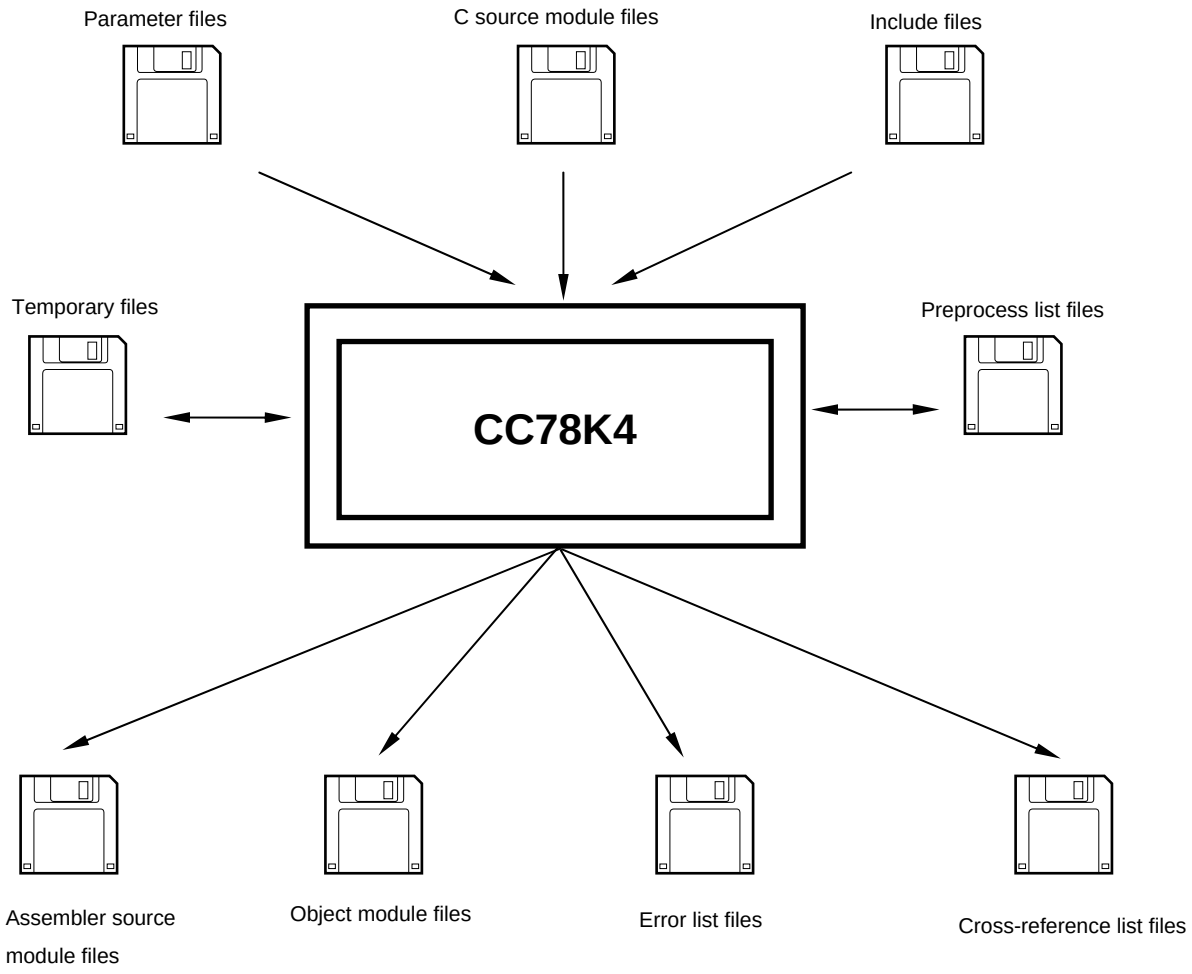
CER: Error list files with C source corresponding to *.C' files (output by specifying the -SE option)

HER: Error list files with C source corresponding to *.H' files (output by specifying the -SE option)

ER: Error list files with C source corresponding to files other than the above (output by specifying the -SE option)

ECC: Error list files without C source corresponding to all of the source files (output by specifying the -E option)

Figure 3-40. I/O Files of C Compiler



Remark If there are compiling errors, a variety of files other than the error list and cross reference files cannot be output.

A temporary file is renamed to an appropriate name when the compiling ends without error. If compiling ends in error, the temporary files are deleted.

3.5 Execution Start and End Messages

(1) Execution start message

When the CC78K4 starts, the execution start message is displayed on the console.

```
78K/IV Series C Compiler Vx.xx  [xx xxx xxxx]
   Copyright (C) NEC Electronics Corporation xxxx,xxxx
```

(2) Execution end message

If compiler errors were not detected in the compilation result, the compiler outputs the following message to the console and returns control to the operating system.

```
Target chip : uPD784xxx
Device file : Vx.xx

Compilation complete,    0 error(s) and    0 warning(s) found.
```

If compiler errors were detected in the compilation result, the compiler outputs the error messages and the number of errors to the console and returns control to the operating system.

```
PRIME.C(18) : W745 Expected function prototype
PRIME.C(20) : W745 Expected function prototype
PRIME.C(26) : W622 No return value
PRIME.C(37) : W622 No return value
PRIME.C(44) : W622 No return value

Target chip : uPD784xxx
Device file : Vx.xx

Compilation complete,    0 error(s) and    5 warning(s) found.
```

If a fatal error was detected where the compiling process cannot continue during compilation, the compiler outputs a message to the console, stops compilation, and returns control to the operating system.

An example that outputs an error is shown below.

```
   C>cc78k4 –c4038 -e prime.c -s

   78K/IV Series C Compiler Vx.xx  [xx xxx xxxx]
     Copyright (C) NEC Electronics Corporation xxxx,xxxx

 A018 Option is not recognized '-s'
 Please enter ‘ CC78K4  -- ‘ , if you want help messages.
 Program aborted.
          :
          :
          :
```

In this example, since a nonexistent compiler option was input, an error results and the compiler stops.

If the compiler outputs error messages and stops the compilation, find the sources of these error messages in **CHAPTER 9 ERROR MESSAGES** and correct.

4.1 Optimization Method

Optimization is performed to create efficient object module files in the CC78K4. **Table 4-1 Optimization Methods** lists the supported optimization methods.

Table 4-1. Optimization Methods (1/2)

Phase		Contents	Example
Syntax Analyzer	<1>	Execute during constant computations compilation.	a=3*5; → a=15;
	<2>	True or false decision based on partial evaluation of a logical expression	0 && (a || b) → 0 1 || (a && b) → 1
	<3>	Offset calculations of pointers, arrays, etc.	Calculate the offsets during compilation.
Code Generator	<4>	Register management	Effectively use unused registers.
	<5>	Use the special instructions of the target CPU.	a=a+1; → Use the inc instruction. Use the move instruction to substitute array elements.
	<6>	Use short instructions.	If there is an instruction with the same operation, use the instruction with fewer bytes. mov a, #0 or xor a, a (differs depending on the device)
	<7>	Change long jump instructions to short jump instructions.	The intermediate code that was output is reprocessed.
Optimizer	<8>	Delete common partial expressions.	a=b+c; → a=b+c; d=b+c+e; d=a+e;

	<9>	Move outside an instruction loop.	for (i=0; i<10; i++)
			{
			...
			a=b+c;
			...
			}
			↓
			a=b+c;
			for (i=0; i<10; i++)
			{
			...
			...
			}

	<10>	Delete unused instructions.	a=a; → Delete After a=b;, a is not referenced → Delete (a is an automatic variable)
	<11>	Delete copies.	a=b; c=a+d; → c=b+d; a is not referenced any more (a is an automatic variable).
	<12>	Change the calculation order in an expression.	The calculation whose result remains in the register as valid before other calculations is executed.

Table 4-1. Optimization Methods (2/2)

Phase		Contents	Example
Optimizer	<13>	Memory device allocation (temporary variables)	Variables used locally are allocated to registers.
	<14>	Peephole optimization	Replacement of special patterns Examples a*1 → a, a+0 → a
	<15>	Decrease the strength of the calculation.	Examples a*2 → a+a, a<< 1
	<16>	Memory device allocation (register variables)	Data is allocated to rapidly accessible memory. Examples Registers, saddr (only when -QR is specified)
	<17>	Jump optimization (-QJ option)	Consecutive jump instructions are combined into one instruction.
	<18>	Register allocation (-QV/-QR/-RS/-RD options)	Variables are automatically allocated to registers.

Remark <1> to <7> are performed regardless of the optimization option specifications.
The optimizations in <8> to <13>, <17>, and <18> are performed when optimization options are specified.
Future support is planned for the optimizations in <8> to <13>.
<14> and <15> are performed regardless of the optimization option specifications.
<16> is performed when there are register declarations in the C source program. However, the saddr area is only allocated when the -QR option is specified.
For information about the optimization options, see **CHAPTER 5 COMPILER OPTIONS**.

4.2 ROMization Function

ROMization means that the initial values, such as the initial values of external variables, are placed in the ROM. These values are copied to RAM when the system is executed.

The CC78K4 provides startup routines with the processing of programs in ROM as samples. For ROMization, using the startup routines in ROM eliminates the problem of describing ROMization processes for startup.

For information about the startup routines, see **8.3 Startup Routines**.

How to store a program on ROM is described below.

4.2.1 Linking

During linking, the startup routine, object module files, and libraries are linked. The startup routine initializes the object program.

(1) s4*.rel: Startup routine (when stored on ROM)
The copy routine for the initialization data is included, and the beginning of the initial data is indicated.
The label _@cstart (symbol) is added to the start address.

(2) cl4*.lib: Library attached to CC78K4. The library files of the CC78K4 include the following two libraries.

<1> Runtime library
@@ is added to the symbol head of the runtime library name. For the special library cstart, however, _@ is added to the symbol head.

<2> Standard library
_ is added to the symbol head of the standard library name.

(3) *.lib: Library created by a user. _ is added to the symbol head.

Caution The CC78K4 provides various kinds of startup routines and libraries. For details of startup routine, refer to CHAPTER 8 STARTUP ROUTINES. For details of libraries, refer to 2.6.4 Library files.

CHAPTER 5 COMPILER OPTIONS

When the C compiler is started, the compiler options can be specified. The compiler options provide instructions for compiler operation and indicate the information required beforehand in program execution.

The compiler options are not specified individually, but multiple options can be simultaneously specified. The user selects the compiler options to match the objectives and to perform the tasks efficiently.

5.1 Specifying Compiler Options

Compiler options can be specified in the following ways.

(1) Specified in the command line when the C compiler starts.
(2) Specified in the <Compiler Options> dialog box of PM plus.
(3) Specified in the parameter file.

For the specification methods for the compiler options described above, see **CHAPTER 3 PROCEDURE FROM COMPILING TO LINKING**.

Specify the suboption or file name after a compiler option without inserting a blank, such as a space. Spaces are required between the compiler options.

Example (Δ: blanks such as spaces)

```
CC78K4Δ-c4038Δprime.cΔ-aprime.asmΔ-qx3
```

5.2 Prioritization of Compiler Options

For the compiler options shown in the following table, the prioritization is explained in a case where two or more options along the vertical axis and options along the horizontal axis are simultaneously specified.

Table 5-1. Prioritization of Compiler Options

	-NO	-G	-P	-NP	-D	-U	-A	-E	-X	--	-SA
-R	×									×	
-Q	×									×	
-G	×									×	
-K			Δ	×						×	
-D						O				×	
-U					O					×	
-SA							×			×	
-LW			Δ				Δ	Δ	Δ	×	
-LL			Δ				Δ	Δ	Δ	×	
-LT			Δ				Δ	Δ	Δ	×	
-LF			Δ				Δ	Δ	Δ	×	
-LI										×	Δ

← Horizontal axis

↑

Vertical axis

[Location marked by ×]

If an option in the horizontal axis is specified, the option in the vertical axis becomes invalid.

[Location marked by Δ]

If an option in the horizontal axis is not specified, the option in the vertical axis becomes invalid.

[Location marked by O]

The option specified last out of an option in the horizontal axis and an option in the vertical axis has priority.

Example 1 `C>cc78k4 –c4038 -e sample.c -no -r -g`

The -RD and -G options become invalid.

Example 2 `C>cc78k4 –c4038 -e sample.c -p -k`

Since the -P option is specified, the -K option is valid.

Example 3 `C>cc78k4 –c4038 -e sample.c -utest -dtest=1`

Since the -D option is specified last, the -U option becomes invalid, and the -D option has priority.

As with the -O and -NO options, the option specified last has priority even if N can be added before the option name.

Example 4 `C>cc78k4 –c4038 -e sample.c -o -no`

Since the -NO option is specified last, the -O option becomes invalid, and the -NO option has priority.

Options not described in **Table 5-1 Prioritization of Compiler Options** are not particularly affected by other options. However, if the help specification option "- -" was specified, all of the option specifications become invalid. The help specification option cannot be specified in PM plus. To reference help in PM plus, press the help button in each option dialog box of PM plus.

5.3 Descriptions of Compiler Options

This section describes each compiler option in detail.

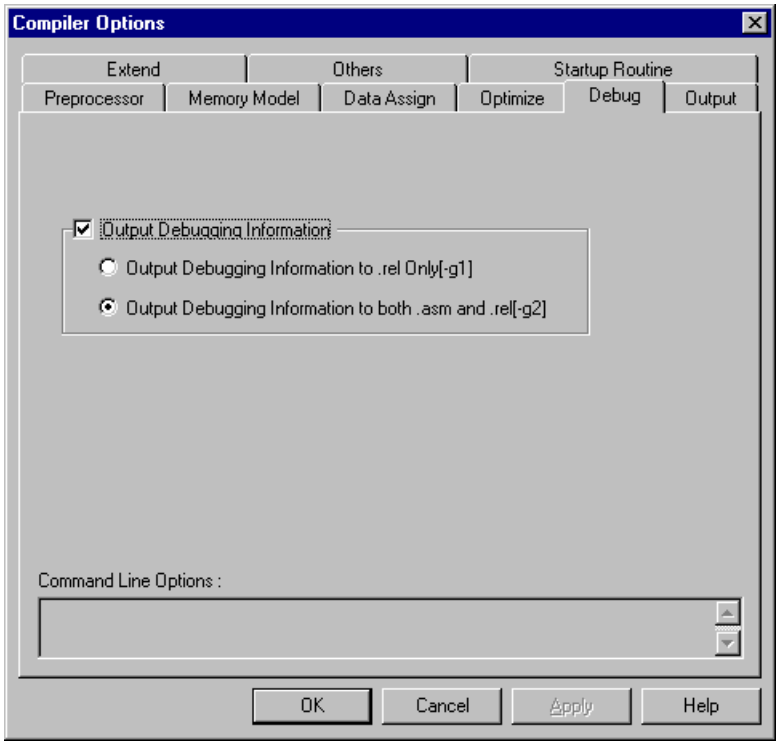
This example illustrates starting the CC78K4 in the command line. To start in PM plus, specify the command, device type specification, and options left out of the C source in the <Compiler Options> dialog box.

Example In command line

```
C>cc78k4  -c4038  prime.c  -g
```

Example When using PM plus

Figure 5-1. Compiler Options Dialog Box



(1) Device type specification (-C)

-C	Device type specification

Description format	-C device-type
Default interpretation	None

[Function]

The -C option specifies the target device designated for compilation.

[Application]

Be sure to specify this option. The C compiler compiles for the specified target device and generates the object code for it.

[Description]

Refer to the advice about use in the supplemental product materials of the device file for the target devices that can be specified by the -C option and the corresponding device type.

When CC78K4 is used, device files are required. Use the device file by copying it to the BIN directory or to the DEV directory.

[Caution]

The -C option cannot be omitted. However, if the following description is in the C source, the specification can be omitted from the command line.

```
#pragma    pc (device type)
```

If different devices were specified in the C source and the command line, the device in the command line has priority.

It is not necessary for this option to be set by the compiler option when PM plus is used, because the setting of this option is determined by the project setting.

-C	Device type specification

[Use Example]

The specification is made in the command line. The target device is the μPD784038.

```
C>cc78k4  -c4038  prime.c
```

This specification is made in the C source and the compiler is started.

```
#pragma         pc(4038)
#define TRUE    1
#define FALSE   0
#define SIZE    200

char    mark[SIZE+1];

main() {
        int i,  prime,  k,  count;
         ⋮
```

Therefore, the target device specification can be omitted from the command line.

```
C>cc78k4  prime.c
```

-C	Device type specification

Different devices are specified in the C source and the command line and the compiler is started.

C source

```
#pragma         pc(4038)
#define TRUE    1
#define FALSE   0
#define SIZE    200

char    mark[SIZE+1];

main() {
      int i,  prime,  k,  count;
```

Command line

```
C>cc78k4  -c4026  prime.c
```

After the command line is executed, compiling is executed as follows.

```
78K/IV Series C Compiler Vx.xx  [xx xxx xxxx]
   Copyright (C) NEC Electronics Corporation xxxx,xxxx

 SAMPLE\PRIME.C(1) : W832 Duplicated chip specifier
 sample\prime.c(18): W745 Expected function prototype
 sample\prime.c(20): W745 Expected function prototype
 sample\prime.c(26): W622 No return value
 sample\prime.c(37): W622 No return value
 sample\prime.c(44): W622 No return value

 Target chip : uPD784026
 Device file : Vx.xx

 Compilation complete,    0 error(s) and    6 warning(s) found.
```

The target device specification in the command line has priority.

(2) Object module file creation specification (-O/-NO)

-O/-NO	Object module file creation specification

Description formats	-O [output-file-name] -NO
Default interpretation	-O [input-file-name.rel]

[Function]

The -O option specifies the output of the object module file. In addition, the output destination or output file name is specified.

The -NO option specifies not to output the object module file.

[Application]

If you want to change the output destination or the output file name of the object module file, specify the -O option.

If only the output of the assembler source module file is the target for compilation, specify the -NO option. Consequently, the compilation time is reduced.

[Description]

If there is a compilation error even when the -O option is specified, the object module file is not output.

If the drive name is omitted when the -O option is specified, the object module file is output to the current drive.

If both the -O and -NO options are simultaneously specified, the last specified one is valid.

[Cautions]

To change the output destination when using PM plus, specify the new output destination in the <<Output Path>> combo box in the <<Object Module File>> area under the <<Output>> tab.

When individual options are specified, the output file name can also be changed.

Specify the file name or the output destination in the <<Output File>> combo box under the <<Output>> tab.

[Use Example]

Both the -NO and -O options are specified (-O has priority) in this example.

```
C>cc78k4  -c4038  prime.c  -no  -o
```

(3) Memory assignment specification (-R/-NR, -RD/-NR, -RS/-NR, -RA/-NR, -RP/-NR, -RB/-NR)

-R/-NR	Memory assignment specification

Description formats	-R [process-type] (Multiple specifications are possible) -NR
Default interpretation	-NR

[Function]

The -R option specifies how to assign a program to the memory.

The -NR option invalidates the -R option.

[Application]

If you want to specify how to assign a program to the memory, specify the -R option.

[Description]

The process types that can be specified by the -R option are shown below. Process type specification cannot be omitted. Otherwise, an abort error (A012) occurs.

Process type	Function
B	Assigns a bit field from the most significant bit (MSB).
D[n] (n = 1, 2, 4)	Assigns an external variable/external static variable (except for the const-type variable) automatically to the saddr area, irrespective of whether there is an sreg declaration or not.
S[n] (n = 1, 2, 4)	Assigns a static auto variable automatically to the saddr area, irrespective of whether there is an sreg declaration or not.
A	Assigns an external variable of 2 bytes or more (except the variable assigned to saddr) as 2-byte alignment. In addition, treats a structure as Non-packing.
P	Treats a structure as Non-packing.

Remark Multiple process types can be specified.

When the -NR option is specified, the process types are interpreted as follows.

Process type	Function
B	Assigns a bit field from the least significant bit (LSB).
D	Does not automatically assign any variable to the saddr area.
S	Does not automatically assign any variable to the saddr area.
A	Does not execute 2-byte alignment. In addition, treats a structure as packing.
P	Treats a structure as packing.

[Use Example]

```
C>cc78k4  -c4038 -rds
```

-RD/-NR Memory assignment specification

Description formats	-RD [n] (n = 1, 2, 4) -NR
Default interpretation	-NR

[Function]

The -RD option specifies the automatic assignment of an external variable/external static variable (except for the const-type variable) to the saddr area.

The -NR option invalidates the -RD option.

[Application]

If you want to automatically assign an external variable/external static variable (except for the const-type variable) to the saddr area irrespective of whether there is an sreg declaration or not, specify the -RD option.

[Description]

Variables to be assigned change depending on the value of n.

Value of n	Variable types to be assigned
1	char, unsigned char
2	char, unsigned char, short, unsigned short, int, unsigned int, enum, pointer (to data of small model and medium model)
4	char, unsigned char, short, unsigned short, int, unsigned int, enum, pointer (to data of small model and medium model), long, unsigned long, pointer (to function of medium model and large model)
Omitted	All variables (including structures and unions)

The sreg-declared variable is automatically assigned to the saddr area irrespective of -RD option specification.

The variable that is referenced by means of an extern declaration is processed as are to be assigned to the saddr area.

The variable assigned to the saddr area by specifying this option is handled in a similar way to an sreg variable.

-RS/-NR	Memory assignment specification

Description formats	-RS [n] (n = 1, 2, 4) -NR
Default interpretation	-NR

[Function]

The -RS option specifies the automatic assignment of a static auto variable to the saddr area.

The -NR option invalidates the -RS option.

[Application]

If you want to automatically assign a static auto variable to the saddr area irrespective of whether there is an sreg declaration or not, specify the -RS option.

[Description]

Variables to be assigned change depending on the value of n.

Value of n	Variable types to be assigned
1	char, unsigned char
2	char, unsigned char, short, unsigned short, int, unsigned int, enum, pointer (to data of small model and medium model)
4	char, unsigned char, short, unsigned short, int, unsigned int, enum, pointer (to data of small model and medium model), long, unsigned long, pointer (to function of medium model and large model)
Omitted	All variables (including structures and unions)

The sreg-declared variable is automatically assigned to the saddr area irrespective of -RS option specification.

The variable that is referenced by means of an extern declaration is processed as are to be assigned to the saddr area.

The static auto variable that is assigned to the saddr area by specifying this option is handled in a similar way to an sreg-declared auto variable.

(4) Optimization specification (-Q/-NQ)

-Q/-NQ	Optimization specification

Description formats	-Q [optimization-type] (If multiple types are specified, specify them consecutively) -NQ
Default interpretation	-QCFHJLVW

[Function]

The -Q option specifies calling the optimization phase to generate efficient objects.

The -NQ option invalidates the -Q option.

[Application]

If you want to improve the execution speed of the objects and reduce the code size, specify the -Q option. If the -Q option is specified and you want to perform multiple optimizations simultaneously, specify the optimization types consecutively. For details, see **Table 5-2 Optimization Types**.

[Description]

Table 5-2 lists the optimization types that can be specified by the -Q option.

Table 5-2. Optimization Types (1/2)

Optimization Type	Process Description
No specification	Regarded as the -QCFHJLVW specification.
U	Regards the char with no qualifier as a unsigned char to improve code efficiency
C[n] (n = 1, 2)	By executing char calculations without integral promotion, the code becomes more efficient. Integral promotion indicates an ANSI-C rule that is set so that a calculation for a type smaller than an integer (char, short) is converted to int[Note]. The scope changes depending on the value of n as follows. If n is omitted, it is interpreted as n = 1. 1: Only variables are not integral-promoted 2: Neither variables nor constants are integral-promoted
R[n] (n = 1, 2)	Adds a register variable to a register and assigns it to the saddr area. The scope of assigning register variable changes depending on the value of n as follows. If n is omitted, it is interpreted as n = 2. 1: Assigns norec argument and auto variable to the saddr area 2: Assigns norec argument, auto variable, and register variable to the saddr area
J	Optimize jump instructions.
X[n] (n = 1 to 4)	Assigns the optimization options automatically according to the priority of speed/code size. The assigned option differs depending on the value of n as follows. If n is omitted, it is interpreted as n = 2. 1: Speed precedence. Regarded as the -QCFHJVW option specification. 2: Default. Regarded as the -Q option specification. 3: Code size precedence. Regarded as the -QCFHJL3VW option specification. 4: Code size precedence. Regarded as the -QCFHJL4VW option specification (debugging is partially restricted).
F	SP and not the UUP register is used as the frame pointer (register used to access function arguments and automatic variables on the stack). By using an empty UUP register in a register variable, the execution speed and the code efficiency improve. If the -QF option is not specified, the UUP register is used as the frame pointer.
H	Improve the code efficiency by calculating the array and pointer offsets without signs. If this option is used, note that the following restrictions apply. • An object accessed by using an array element or a pointer can only be 64 KB or smaller. • Offset calculations are not possible in the negative direction.

-Q/-NQ Optimization specification

Table 5-2. Optimization Types (2/2)

Optimization Type	Process Description
W	Outputs an efficient code and design for the effective use of the registers by changing the execution order in an expression (i.e., changing the execution order of the right subexpression and the left subexpression in an expression with two terms). However, if the option is not included (although within the scope of the standard, since the ANSI-C standard omits some of the operators and does not set the execution order), the result of the execution sometimes differs. According to the ANSI-C standard, this is not a problem in a properly written source.
V[n] (n = 1, 2)	Automatically assigns an automatic variable to a register and the saddr area. If the R sub-option is also specified, the automatic register is assigned to a register and the saddr area; otherwise, the variable is assigned only to a register. If the -ZO option is not specified, the automatic variable is also assigned to a parameter. The range of automatic assignment differs as follows, depending on the value of n. If n is omitted, it is interpreted as n = 2. 1: Assigns the variable to only rp3, vp, and up. 2: Assigns the variable to all registers.
N	Generates a code using a block transfer instruction.

Y	Enhances the code efficiency because compiling is executed on the assumption that a data alias is missing.
	If the direct address of the entity and an indirect access using a pointer indicating the entity are described in together in the same function when this option is used, an illegal code may be generated.
	(Example of illegal code)
	`int i,j;`
	`int *p = &i;`
	`void main()`
	`{`
	`*p = 2;`
	`i = 1;`
	`j = *p;` /* 2 is assigned to j when -QY is specified and 1 is assigned when -QY is not specified */
	`}`

L[n] (n = 1 to 4)	The constant code pattern is replaced with a library. The scope changes depending on the value of n as follows. If n is omitted, it is interpreted as n = 1. 1: No replacement 2: Access code to array (valid only when large model is used) 3: Arithmetic operation in 1-instruction units in addition to 2 4: Code assigning a symbol or constant of long or unsigned long type, or a register (debugging is restricted because the return address from the execution routine changes) in addition to 3

-Q/-NQ	Optimization specification

Note When the -QC option is specified in the CC78K4, the types of constants and character constants are handled in the following way.

0 to 127, 0x00 to 0x7F, 00 to 0177	char type
128 to 255, 0x80 to 0xFF, 0200 to 0377	unsigned char type
0U to 255U	unsigned char type
'\0' to '\377'	char type

However, when the -QU option is specified, character constants in the range from '\200' to '\377' are handled as unsigned char type constants and have the values from +128 to +255.

The constant added – (minus) is treated as follows.

–0 to 128	char type
From –129	int type

If the result of constant or variable calculation is overflow, cast either the constant or variable to a type capable of representing the calculation result. Changing the data type can be avoided by casting. When the -QC1 option is specified, constant calculation is sign-extended.

(Example) When -QC2 option is specified

```
int  i;

i = (int)20 * 20;        /* 400 */
```

Multiple optimization types can be specified.

If the -Q option or optimization types are omitted, the optimization is identical to when the -QCFHJLVW option is specified.

To delete a portion of the default options specify the options other than the options you want to delete (Example -QF is specified → Deletes -QCHJLVW).

If both the object module file and the assembler source module file are not output, the -Q option other than -QU becomes invalid.

If both the -Q and -NQ options are simultaneously specified, the last specified one is valid.

If several -Q options are simultaneously specified, the last specified one is valid.

-Q/-NQ	Optimization specification

[Use Example]

Optimize so that a char without modifier is regarded as unsigned.

```
C>cc78k4  -c4038  prime.c  -qu
```

If both the -QC and -QR options are specified as below, the -QC option becomes invalid, and the -QR option is validated.

```
C>cc78k4  -c4038  prime.c  -qc  -qr
```

If you want to validate both the -QC and -QR options, input the following command.

```
C>cc78k4  -c4038  prime.c  -qcr
```

(5) Debugging information output specification (-G/-NG)

-G/-NG	Debugging information output specification

Description formats	-G [n] (n = 1, 2) -NG
Default interpretation	-G2

[Function]

The -G option specifies the addition of debugging information to the object module file.

The -NG option invalidates the -G option.

[Application]

If the -G option is not specified, the line numbers and symbol information needed in the object module file to be input to the debugger are not output. Therefore, in source level debugging, all of the modules to be linked are compiled by specifying the -G option.

[Description]

The operation differs depending on the value of n as follows.

Value of n	Function
Omitted	Regarded as n = 2.
1	Adds debug information (information starting with $DGS or $DGL) to the object module file only. No debug information is added to the assembler source module file. This option makes it easier to reference an assembler file. Source debugging of object files is available since debug information is added to them.
2	Adds debug information to the object module file and the assembler source module file.

If both -G and -NG are simultaneously specified, the last specified one is valid.

If both the object module file and the assembler source module file are not output, the -G option becomes invalid.

[Use Example]

The -G option is specified.

```
C>cc78k4  -c4038  prime.c  -g
```

(6) Preprocess list file creation specification (-P, -K)

-P	Preprocess list file creation specification

Description formats	-P [output-file-name]
Default interpretation	Nothing (no file is output)

[Function]

The -P option specifies the output of the preprocess list file. In addition, the output destination or output file name is specified. If the -P option is omitted, no preprocess list file is output.

[Application]

If you want to output the source file after preprocess processing is executed according to the -K option process type, or want to change the output destination or the output file name of the preprocess list file, specify the -P option.

[Description]

If the output file name is omitted when the -P option is specified, the preprocess list file name becomes “input-file-name.ppl”.

If the drive name is omitted when the -P option is specified, the preprocess list file is output to the current drive.

[Cautions]

To change the output destination when using PM plus, specify the new output destination in the <<Output Path>> combo box in the <<Create Preprocess List File>> area under the Output tab.

When individual options are specified, the output file name can also be changed.

Specify the file name or the output destination in the <<Output File>> combo box under the <<Output>> tab.

[Use Example]

The preprocess list file sample.ppl is output.

```
C>cc78k4  -c4038  prime.c  -psample.ppl
```

-K	Preprocess list file creation specification

Description formats	-K [process-type] (Multiple specifications are possible)
Default interpretation	-KFLN

[Function]

The -K option specifies the processing for the preprocess list.

[Application]

This option is specified when comments are deleted and definition expansions are referenced when the preprocess list file is output.

[Description]

The process types that can be specified by the -K option are listed below.

Table 5-3. Process Types of -K Option

Process Type	Description
Omitted	Same as specifying FLN
C	Delete comments
D	#define expansion
F	Conditional compilations of #if, #ifdef, and #ifndef
I	#include expansion
L	#line processing
N	Line number and paging processing

Remark Multiple process types can be specified.

If the -P option is not specified, the -K option becomes invalid.

If several -K options are simultaneously specified, the last specified one is valid.

-K	Preprocess list file creation specification

[Use Example]

Comments are deleted from the preprocess list prime.ppl, and line number and paging processing are performed.

```
C>cc78k4  -c4038  prime.c  -p  -kcn
```

prime.ppl is referenced.

```
/*
 78K/IV Series C Compiler VX.XX Preprocess List
 Date: XX XXX XXXX Page:   1

 Command   : -c4038 prime.c –p -kcn
 In-file   : prime.c
 PPL-file  : prime.ppl
 Para-file :
 */

    1 : #define TRUE    1
    2 : #define FALSE   0
    3 : #define SIZE    200
    4 :
    5 : char    mark[SIZE+1];
    6 :
    7 : main()
    8 : {
                ⋮
/*
 Target chip : uPD784038
 Device file : VX.XX
*/
```

(7) Preprocess specification (-D, -U, -I)

-D	Preprocess specification

Description formats	-D macro-name [=definition-name] [, macro-name [=definition-name]]... (Multiple specifications are possible)
Default interpretation	Only the macro definitions in a C source module file are valid.

[Function]

The -D option specifies the same macro definition as the #define statement in the C source.

[Application]

Specify this option when you want to replace all of the macro names for the specified constants.

[Description]

By delimiting each definition by a comma ‘,’, multiple macro definitions are made at one time.

Spaces are not allowed before and after ‘=’ and ‘,’.

If the definition name is omitted, the name is defined as ‘1’.

If the same macro name was specified in both the -D and -U options, the last specified one is valid.

[Use Example]

```
C>cc78k4  -c4038  prime.c  -dTEST,TIME=10
```

-U	Preprocess specification

Description formats	-U macro-name [, macro-name]... (Multiple specifications are possible)
Default interpretation	A macro definition specified with -D is valid.

[Function]

The -U option disables macro definitions similar to the #undef statement in the C source.

[Application]

Specify this option to invalidate the macro name defined by the -D option.

[Description]

By delimiting each macro name by a comma ‘,’, multiple macro definitions can be disabled at one time. Spaces are not allowed before and after a comma ‘,’.

A macro definition that can be disabled by the -U option is one that has been defined by the -D option. A macro name defined by #define in a C source module file or a system macro name of the compiler cannot be disabled by the -U option.

If the same macro name is specified by both the -D and -U options, the last specified one is valid.

[Use Example]

The same macro name is specified by the -D and -U options. In this example, the TEST macro is disabled.

```
C>cc78k4  -c4038  prime.c  -dTEST  -uTEST
```

-I	Preprocess specification

Description format	-I directory [, directory]...	(Multiple specifications are possible)
Default interpretation	Directory with source file[Note 1]	
	Directory specified by environment variable INC78K4	
	C:\NECTools32\INC78K4[Note 2]	

[Function]

The -I option specifies input of the include files specified by the #include statement in the C source from the specified directory.

[Application]

Specify this option when you want to search for the include files from a certain directory.

[Description]

By using a comma ‘,’ to delimit, multiple directories can be specified at one time.

Spaces cannot be inserted before and after a comma ‘,’.

If multiple directories are specified after -I, or if the -I option is specified multiple times, the files specified by #include are searched for in the specified order.

The search sequence is as follows.

- Directory with source file[Note 1]
- Directory specified with -I option
- Directory specified with environment variable INC78K4
- C:\NECTools32\INC78K4[Note 2]

Notes 1. If the include file name is specified with “ ” (double quotation marks) in the #include statement, directories with source files are searched first. If the include file name is specified with < >, search is not performed.

2. This is an example of when the CC78K4 is installed to C:\NECTools32 (Windows version).

[Use Example]

The -I option is specified.

```
C>cc78k4  -c4038  prime.c  -ib:,b:\sample
```

(8) Assembler source module file creation specification (-A, -SA)

-A	Assembler source module file creation specification

Description formats	-A [output-file-name]	
Default interpretation	No assembler source module file is output.	
Output file	*.asm	(*: alphanumeric symbols)

[Function]

The -A option specifies the output of the assembler source module file. In addition, the output destination or output file name is specified.

[Application]

If you want to change the output destination or the output file name of the assembler source module file, specify the -A option.

[Description]

A disk file name or device file name can be specified as the file name.

If the output file name is omitted when the -A option is specified, the assembler source module file name becomes “input-file-name.asm”.

If the drive name is omitted when the -A option is specified, the assembler source module file is output to the current drive.

If both the -A and -SA options are simultaneously specified, the -SA option is ignored.

[Caution]

To change the output destination when using PM plus, specify the new output destination in the <<Output Path>> combo box in the <<Create Assembler Source Module File>> area under the <<Output>> tab, and select “without C Source[-a]”.

When individual options are specified, the output file name can also be changed.

Specify the file name or the output destination in the <<Output File>> combo box under the <<Output>> tab.

[Use Example]

The assembler source module file sample.asm is created.

```
C>cc78k4  -c4038  prime.c  -asample.asm
```

The assembler source module file is output to the printer.

```
C>cc78k4  -c4038  prime.c -aprn
```

-SA	Assembler source module file creation specification

Description formats	-SA [output-file-name]
Default interpretation	No assembler source module file is output.
Output file	*.asm (*: alphanumeric symbols)

[Function]

The -SA option adds the C source as a comment to the assembler source module file. In addition, the output destination or output file name is specified.

[Application]

If you want to output the assembler source module file and the C source module file together, specify the -SA option.

[Description]

A disk file name or device file name can be specified as the file name.

If the output file name is omitted when the -SA option is specified, the assembler source module file name becomes “input-file-name.asm”.

If the drive name is omitted when the -SA option is specified, the assembler source module file is output to the current drive.

If both the -SA and -A options are simultaneously specified, the -SA option is ignored.

The C source in an include file is not added to the comments in the output assembler source module. However, if the -LI option is specified, the C source in the include file is also added to the comments.

[Caution]

To change the output destination when using PM plus, specify the new output destination in the <<Output Path>> combo box in the <<Create Assembler Source Module File>> area under the <<Output>> tab, and select either “with C Source[without Include][-sa]” or “with C Source[with Include][-sa -li]”.

When individual options are specified, the output file name can also be changed.

Specify the file name or the output destination in the <<Output File>> combo box under the <<Output>> tab.

-SA	Assembler source module file creation specification

[Use Example]

The -SA option is specified.

```
C>cc78k4  -c4038  prime.c  -sa
```

prime.asm is referenced.

```
; 78K/IV Series C Compiler Vx.xx Assembler Source
;                                        Date:xx xxx xxxx Time:xx:xx:xx

; Command   : -c4038 prime.c -sa
; In-file   : prime.c
; Asm-file  : prime.asm
; Para-file :

$CHGSFR(15)
$PROCESSOR(4038)
$DEBUG
$NODEBUGA
$KANJICODE SJIS
$TOL_INF        03FH, 0230H, 02H, 08021H, 00H

$DGS    FIL_NAM, .file,        03BH,   0FFFEH, 03FH,   067H,   01H,   00H
$DGS    AUX_FIL, prime.c
$DGS    MOD_NAM, prime,        00H,    0FFFEH, 00H,    077H,   00H,   00H

            :

        EXTRN   @@isrem
        PUBLIC  _mark
        PUBLIC  _main
        PUBLIC  _printf
        PUBLIC  _putchar

            :

@@CODE  CSEG
_main:
$DGL    1,19
        push    uup
        push    rp3
        push    vvp
        push    ax
??bf_main:
; line     9 :  int i, prime, k, count;
; line    10 :
; line    11 :  count = 0;
$DGL    0,4
        subw    ax,ax
        movw    [sp+0],ax       ; count
; line    12 :
; line    13 :  for ( i = 0 ; i <= SIZE ; i++)
```

-SA Assembler source module file creation specification

```
$DGL    0,6
        subw    rp3,rp3
?L0003:
        cmpw    rp3,#0C8H       ; 200
        bgt     $?L0004
; line    14 :          mark[i] = TRUE;
$DGL    0,7
        movw    de,rp3
        mov     a,#01H  ; 1
        mov     _mark[de],a
        incw    rp3
        br      $?L0003

            :

        END


; Target chip : uPD784038
; Device file : Vx.xx
```

The C source is appended as a comment.

(9) Error list file creation specification (-E, -SE)

-E	Error list file creation specification

Description formats	-E [output-file-name]	
Default interpretation	No error list file is output.	
Output file	*.ecc	(*: alphanumeric symbols)

[Function]

The -E option specifies the output of the error list file. In addition, the output destination or output file name is specified.

[Application]

If you want to change the output destination or the output file name of the error list file, specify the -E option.

[Description]

A disk file name or device file name can be specified as the file name.

If the output file name is omitted when the -E option is specified, the error list file name becomes “input-file-name.ecc”.

If the drive name is omitted when the -E option is specified, the error list file is output to the current drive.

If the -W0 option is specified, warning messages are not output.

[Cautions]

To change the output destination when using PM plus, specify the new output destination in the <<Output Path>> combo box in the <<Create Error List File>> area under the <<Output>> tab and select “without C Source[-e]”.

When individual options are specified, the output file name can also be changed.

Specify the file name or the output destination in the <<Output File>> combo box under the <<Output>> tab.

-E	Error list file creation specification

[Use Example]

The -E option is specified.

```
C>cc78k4  -c4038  prime.c  -e
```

The error list file is referenced.

```
prime.c(   18) : W745 Expected function prototype
prime.c(   20) : W745 Expected function prototype
prime.c(   26) : W622 No return value
prime.c(   37) : W622 No return value
prime.c(   44) : W622 No return value

Target chip : uPD784038
Device file : Vx.xx

Compilation complete,    0 error(s) and    5 warning(s) found.
```

-SE	Error list file creation specification

Description formats	-SE [output-file-name]
Default interpretation	No error list file is output.
Output files	*.cer: Error list for *.C files (*: alphanumeric symbols) *.her: Error list for *.H files *.er: Error list for files other than *.C and *.H files

[Function]

The -SE option adds the C source module file to the error list file. In addition, the output destination or output file name is specified.

[Application]

If you want to output the error list file and the C source module file together, specify the -SE option.

[Description]

A disk file name or device file name can be specified as the file name.

If the output file name is omitted when the -SE option is specified, the error list file name becomes 'input-file-name.cer'.

If the drive name is omitted when the -SE option is specified, the error list file is output to the current drive.

The directory and the file name cannot be specified for include files. If the file type of the include file is 'H,' the error list file with the file type of 'her' is output to the current drive. It the file type of the include file is 'C,' the error list file with the file type of 'cer' is output. In all other cases, the error list file with the 'er' file type is output.

If there weren't any errors, the C source is not added. In this case, the error list file is not created for the include file.

If the -W0 option is specified, warning messages are not output.

[Cautions]

To change the output destination when using PM plus, specify the new output destination in the <<Output Path>> combo box in the <<Create Error List File>> area under the <<Output>> tab and select "with C Source[-se]".

When individual options are specified, the output file name can also be changed.

Specify the file name or the output destination in the <<Output File>> combo box under the <<Output>> tab.

-SE	Error list file creation specification

[Use Example]

The -SE option is specified.

```
C>cc78k4  -c4038  prime.c  -se
```

prime.cer is referenced.

```
/*
78K/IV Series C Compiler VX.XX Error List       Date:XX XXX XXXX Time:XX:XX:XX

Command   : -c4038  prime.c  -se
In-file   : prime.c
Err-file  : prime.cer
Para-file :
*/

#defineTRUE    1
#defineFALSE   0
#defineSIZE    200

char   mark[SIZE+1];
main()
{
               ⋮
                        prime = i + i + 3;
                        printf("%6d",prime);
*** WARNING W745 Expected function prototype
                        count++;
                                if((count%8) == 0) putchar('\n');
*** WARNING W745 Expected function prototype
                        for ( k = i + prime ; k <= SIZE ; k += prime)
               ⋮
```

(10) Cross-reference list file creation specification (-X)

-X	Cross-reference list file creation specification

Description formats	-X [output-file-name]	
Default interpretation	No cross-reference list file is output.	
Output file	*.xrf	(*: alphanumeric symbols)

[Function]

The -X option specifies the output of the cross-reference list file. In addition, the output destination or output file name is specified. The cross-reference list file is valuable for checking the referencing frequency, definition, and referenced point of a symbol.

[Application]

If you want to output the cross-reference list file or want to change the output destination or the output file name of the cross-reference list file, specify the -X option.

[Description]

A disk file name or a device file name can be specified as the file name.

If the output file name is omitted when the -X option is specified, the cross-reference list file name becomes ‘input-file-name.xrf’.

The cross-reference file is created even if a compile error except for fatal errors (F101, abort errors other than A024) occurs. In such a case, however, the file contents are not guaranteed.

[Cautions]

To change the output destination when using PM plus, specify the new output destination in the <<Output Path>> combo box in the <<Create Cross Reference List File[-x]>> area under the <<Output>> tab.

When individual options are specified, the output file name can also be changed.

Specify the file name or the output destination in the <<Output File>> combo box under the <<Output>> tab.

[Use Example]

The -X option is specified.

```
C> cc78k4  -c4038  prime.c  -x
```

-X	Cross-reference list file creation specification

prime.xrf is referenced.

```
78K/IV Series C Compiler VX.XX Cross reference List          Date:XX XXX XXXX Page: 1

Command   : -c4038  prime -x
In-file   : prime.c
Xref-file : prime.xrf
Para-file :

ATTRIB  MODIFY  TYPE    SYMBOL     DEFINE   REFERENCE

EXTERN          array   mark          5      14     16     22
EXTERN          func    main          7
REG1            int     i             9      13     13     13      14     15     15
     15      16      17      17
                                              21
REG1            int     prime         9      17     18     21      21
REG1            int     k             9      21     21     21      22
AUTO1           int     count         9      11     19     20      25
EXTERN          func    printf       28      18     25
EXTERN          func    putchar      39      20
REG1            pointer s            29      36
PARAM
PARAM           int     i            30      35
REG1            int     j            32      35
REG1            pointer ss           33      36
REG1            char    c            40      43
PARAM
REG1            char    d            42      43
                #define TRUE          1      14
                #define FALSE         2      22
                #define SIZE          3       5     13     15     21

 Target chip : uPD784038
 Device file : VX.XX
```

(11) List format specification (-LW, -LL, -LT, -LF, -LI)

-LW	List format specification

Description format	-LW [number-of-characters]	
Default interpretation	-LW132	(For console output, this becomes 80 characters)

[Function]

The -LW option specifies the number of characters in one line of each type of list file.

[Application]

If you want to change the number of characters in one line of each list file, specify the -LW option.

[Description]

The range of the number of characters that can be specified by the -LW option is as follows and does not include terminators (CR, LF).

$72 \leq$ number of characters printed in one line ≤ 132

If the number of characters is omitted, the number of characters in one line becomes 132 characters (If output to the console, there is a maximum of 80 characters).

If the list file specification specifies nothing, the -LW option is invalid.

[Use Example]

The cross-reference list file when the -LW option is omitted is output to “file-name.xrf”.

```
C> cc78k4  -c4038  prime.c  -x
```

-LL	List format specification

Description format	-LL [number-of-lines]
Default interpretation	-LL66 (For console output, this becomes 65,535 lines)

[Function]

The -LL option specifies the number of lines on one page of each type of list file.

[Application]

If you want to change the number of lines in one page in each type of list file, specify the -LL option.

[Description]

The range of the number of lines that can be specified by the -LL option is as follows.

20 ≤ number of lines printed on one page ≤ 65,535

If -LL0 is specified, there is no page break.

If the number of lines is omitted, the number of lines on one page becomes 66 lines (If output to the console, this becomes 65,535).

If the list file specification specifies nothing, the -LL option is invalid.

[Use Example]

The number of lines on one page of the cross-reference list file is set to 20 lines.

```
C> cc78k4  -c4038  prime.c  -x  -ll20
```

-LT	List format specification

Description format	-LT [number-of-characters]
Default interpretation	-LT8

[Function]

The -LT option indicates the basic number of characters for outputting a horizontal tabulation (HT) code in the source module file, replacing it with several blanks (spaces) in each list (tabulation processing).

[Application]

If few characters are specified in one line in each list by the -LW option, few blanks will result from an HT code, so specify the -LT option to reduce the number of characters.

[Description]

The range of the number of characters that can be specified by the -LT option is as follows.

$0 \leq$ number of specifiable characters ≤ 8

If the -LT0 is specified, the tabulation processing is not performed, and the tab codes are output.

If the number of characters is omitted, the number of expansion characters of a tab becomes 8 characters.

If the list file specification specifies nothing, the -LT option is invalid.

[Use Example]

The -LT option is omitted.

```
C> cc78k4  -c4038  prime.c  -p
```

The blanks based on the HT code are set to one (1).

```
C> cc78k4  -c4038  prime.c  -p  -lt1
```

-LF	List format specification

Description format	-LF
Default interpretation	None

[Function]

The -LF option specifies adding the new page break code at the end of each list file.

[Description]

If the list file specification specifies nothing, the -LF option is invalid.

[Use Example]

The -LF option is specified.

```
C> cc78k4  -c4038  prime.c  -a  -lf
```

-LI	List format specification

Description format	-LI
Default interpretation	None

[Function]

The -LI option adds the C source of the include file to the assembler source module file with C source comments.

[Description]

If the -SA option is not specified, this option is ignored.

[Use Example]

The -LI option is specified.

```
C> cc78k4  -c4038  prime.c  -sa  -li
```

(12) Warning output specification (-W)

-W	Warning output specification

Description format	-W [level]
Default interpretation	-W1

[Function]

The -W option specifies the output of warning messages to the console.

[Application]

This option specifies whether to output warning messages to the console. Detailed messages can also be output.

[Description]

The levels of the warning message are given below.

Table 5-4. Warning Message Levels

Level	Description
0	Do not output warning messages.
1	Output normal warning messages.
2	Output detailed warning messages.

If the -E or -SE option is specified, the warning messages are output to the error list file.

Level 0 indicates not to output warning messages to the console and the error list file (when -E or -SE is specified).

[Use Example]

The warning messages when the -W option is omitted are referenced.

```
C> cc78k4  -c4038  prime.c
```

(13) Execution state display specification (-V/-NV)

-V/-NV	Execution state display specification

Description formats	-V
	-NV
Default interpretation	-NV

[Function]

The -V option outputs the execution state of the current compilation to the console.

The -NV option invalidates the -V option.

[Application]

Specify this option to execute compiling while continuing to output the execution state of the compilation to the console.

[Description]

The phase name and function names in the process are output.

If both the -V and -NV options are simultaneously specified, the last specified one is valid.

[Use Example]

The -V option is specified.

```
C> cc78k4  -c4038  prime.c  -v
```

(14) Parameter file specification (-F)

-F	Parameter file specification

Description format	-F file-name
Default interpretation	The options and the input file name can be input only from the command line.

[Function]

The -F option specifies the input of the options or input file name from the specified file.

[Application]

When sufficient information for starting a compiler cannot be specified in a command line because multiple options are input while compiling, specify the -F option.

When specifying options repeatedly for compilation, describe the options in the parameter file and specify the -F option.

[Description]

Parameter file nesting is not allowed.

The number of characters that can be described in a parameter file is not limited.

Spaces and tabs delimit the options or input file names.

The options or input file names described in the parameter file are expanded at the location of the parameter file specification in the command line.

The prioritization of the expanded options is that the last specified one is valid.

Characters described after the ';' and '#' are interpreted as comments until the end of the line.

[Caution]

This option cannot be used when using PM plus (an error occurs).

[Use Example]

Contents of parameter file prime.pcc

```
; parameter file
prime.c  -c4038  -aprime.asm  -e  -x
```

prime.pcc is used in the compilation.

```
C> cc78k4  -fprime.pcc
```

(15) Temporary file creation directory specification (-T)

-T	Temporary file creation directory specification

Description format	-T directory
Default interpretation	The files are created in the drive and directory specified by the environment variable TMP. If not specified in a Windows-based system, the files are created in the current drive and current directory. If UNIX-based, they are created in /tmp.

[Function]

The -T option specifies the drive and directory where the temporary files are created.

[Application]

The location for creating the temporary files can be specified.

[Description]

Even if there are temporary files that have been created previously, if a file is not protected, it is overwritten the next time it is created.

A temporary file expands in memory to the required memory size. If the required memory size is no longer available, the temporary file is created in the specified directory and the memory contents are written to the file. Accesses to subsequent temporary files are to files not in memory.

The temporary files are deleted when compilation ends. By pressing CTRL-C, the files are deleted when compilation stops.

[Use Example]

This specifies output of the temporary files to the TMP directory.

```
C> cc78k4  -c4038  prime.c  -ttmp
```

(16) Help specification (--/-?/-H)

--/-?/-H	Help specification

Description formats	--, -?, -H
Default interpretation	Nothing is displayed

[Function]

The --, -?, and -H options display brief explanations of the options and the help messages such as the default options on the console (valid only in the command line[Note]).

Note Do not specify this option in PM plus. To reference help in PM plus, press the help button in the <Compiler Options> dialog box.

[Application]

The option and its description are displayed. Refer to them when running the C compiler.

[Description]

If the --, -?, or -H option is specified, all of the other compiler options become invalid.

When viewing the continuation of a displayed help message, press the return key. To exit the display before the end, press any character other than the return key, and then press the return key.

[Use Example]

The -H option is specified.

```
C> cc78k4  -H
```

(17) Memory model specification (-MS/-MM/-ML)

-MS/-MM/-ML	Memory model specification

Description formats	-MS
	-MM
	-ML
Default interpretation	-ML

[Function]

These options specify one of the following memory models for compiling:

-MS: Small model
-MM: Medium model
-ML: Large model

[Application]

The program area and data area can be changed.

[Description]

The small model is 64 KB with a program area and a data area combined.
The medium model is 1 MB with a program area of 1 MB and a data area of 64 KB.
The large model is 16 MB with a program area of 1 MB and a data area of 16 MB.
All the above data areas include a stack area.

[Use Example]

To specify the small model

```
C> cc78k4 -c4038 prime.c -ms
```

To specify the medium model

```
C> cc78k4 -c4038 prime.c -mm -cs15
```

(18) Location function specification (-CS)

-CS	Location function specification

Description formats	-CS [n]	(n: Location address)
Default interpretation	Small model:	Locates saddr area at FD20H to FFFFH.
	Medium model:	Locates saddr area at FFD20H to FFFFFH.
	Large model:	Locates saddr area at FFD20H to FFFFFH.

[Function]

The -CS option specifies a location function.

The location function is used to change the addresses of the internal data areas (internal RAM area and SFR area) of the 78K4 Series.

[Application]

When -CS0 is specified, mapping when the LOCATION 0 instruction is executed is specified for the internal data area.

When -CS15 or -CS0FH is specified, mapping when the LOCATION OFH instruction is executed is specified.

When -CSA is specified, the linker performs checking related to mapping of the internal data area.

[Description]

If 0, 15, or A is selected as the location address, the location of the saddr area can be specified as shown in Table 5-5.

If an option other than -CS0 is specified with the small model, a warning is output and the specification is ignored.

If an option other than -CSA is specified with the medium model, a warning is output and the specification is ignored.

Table 5-5. Address Specified for Location Function

Type Specification	Explanation
0	Locates saddr area at addresses FD20 to FFFFH.
15/0FH	Locates saddr area at addresses FFD20 to FFFFFH.
A	The compiler does not check mapping. Instead, the linker checks mapping.

[Use Example]

To specify addresses FD20H to FFFFH for saddr area

```
C> cc78k4 -c4038 prime.c -mm -cs0
```

To specify addresses FFD20H to FFFFFH for saddr area

```
C> cc78k4 -c4038 prime.c -ml -cs15
```

(19) Function expansion specification (-Z/-NZ)

-Z/-NZ	Function expansion specification

Description format	-Z [type] (If multiple types are specified, specify them consecutively) -NZ
Default interpretation	-NZ

[Function]

The -Z option enables the processing for type specification.

The -NZ option invalidates the -Z option.

Types must not be omitted, otherwise, an abort error (A012) will occur.

[Application]

The functions for processing by the following type specifications are available for the 78K Series expansion functions.

[Description]

The type specifications of the -Z option are as follows.

Table 5-6. Type Specifications of -Z Option (1/2)

Type Specification	Description
Omitted	Regarded as -NZ specification.
O	Outputs code of interface between functions of old specification (CC78K4 V1.00 or before).
P	The characters after "//" until the line return are interpreted as a comment.
C	Nested comments "/* */" are allowed.
S[Note]	Interprets the type of kanji in comments as SJIS code.
E[Note]	Interprets the type of kanji in comments as EUC code.
N[Note]	Interprets comments as not containing kanji codes.
B	char-/unsigned char-type argument and return value are not int-extended.

Note S, E, and N cannot be specified simultaneously.

-Z/-NZ Function expansion specification

Table 5-6. Type Specifications of -Z Option (2/2)

Type Specification	Description
A	Functions not in the ANSI standard are illegal. The ANSI-compliant portion of the functions are valid. Specifically, the following tasks are performed. The following are no longer reserved words. callt, callf noauto, norec, sreg, bit, boolean, #asm, #endasm The trigraph sequence (3-character representation) becomes valid. The compiler-defined macro _ _STDC_ _ is 1. The following warning is output for a char type bit field. (W787 Bit field type is char) If -W2 is specified, the following warnings are output for the -QC, -ZP, and -ZC options. (W029 '-QC' option is not portable) (W031 '-ZP' option is not portable) (W032 '-ZC' option is not portable) If –W2 is specified, the following warning is output for each #pragma statement. (W849 #pragma statement is not portable) If –W2 is specified, the following warning is output for an _ _asm statement and the assemble output is performed. (W850 Asm statement is not portable) If -W2 is specified, the following error is output for an #asm to #endasm block. (F801 Undefined control, etc.)
R	Automatically adds a pascal function modifier.
F	Outputs object from flash.
G	Creates a branch table for callf function.
H	Automatically adds a callf function modifier.

[Use Example]

The -ZC and -ZP options are specified.

```
C> cc78k4  -c4038  prime.c  -zpc
```

(20) Device file search path (-Y)

-Y	Device file search path

Description format	-Y
Default interpretation	Normal search path only

[Function]

The -Y option first searches the path specified as the search path for reading device files. If it does not exist, the normal paths are searched.

The normal search paths are as follows.

(1) <..\dev> (for the path where cc78k4.exe started)
(2) Path where CC78K4 started
(3) Current directory
(4) PATH environment variable

[Application]

If the device file is not installed in the normal search path, but in a special directory, the path is specified by this option.

[Caution]

When using PM plus, a directory is determined when registering a device file at “Device Name:” in the <Project Setup> dialog box. Therefore, it is not necessary to specify this option when setting an option with this compiler.

[Use Example]

The -Y option is specified.

```
C> cc78k4  -c4038  -ya:\tmp\dev
```

CHAPTER 6 C COMPILER OUTPUT FILES

The CC78K4 outputs the following files.

- Object module file
- Assembler source module file
- Preprocess list file
- Cross-reference list file
- Error list file

6.1 Object Module File

The object module file is a binary image file containing C source program compilation results.

If the debug data output option (-G) has been specified, the object module file will also contain debug data.

6.2 Assembler Source Module File

The assembler source module file is an ASCII image list of C source program compilation results, and is a source module file in assembly language that corresponds to the target C source program.

It can also include the C source program to this file as comments by setting the assembler source module file creation specification option (-SA).

[Output format]

```
      ; 78K/IV Series C Compiler V(1)x.xx Assembler Source
      ;                                                  Date:(2)xxxxx Time:(3)xxxxx

      ; Command     :(4)-c4038 prime.c –sa
      ; In-file     :(5)prime.c
      ; Asm-file    :(6)prime.asm
      ; Para-file   :(7)

  (8) $CHGSFR(15)
      $PROCESSOR((9)4038)
  (10)$DEBUG
  (11)$NODEBUGA
  (12)$KANJICODE SJIS
  (13)$TOL_INF        03FH, 0230H, 02H, 08021H, 00H

  (14)$DGS    FIL_NAM, .file,         03BH,   0FFFEH, 03FH,   067H,   01H,    00H
            :
  (15)        EXTRN   @@isrem
            :
      ; line (16)1 : (17)#define  TRUE    1
      ; line (16)2 : (17)#define  FALSE   0
      ; line (16)3 : (17)#define  SIZE    200
            :
  (15)_main:
  (18)$DGL    1,19
  (15)        push    uup
  (15)        push    rp3
  (15)        push    vvp
  (15)        push    ax
            :
  (19)??bf_main:
            :

      ; Target chip : (20)uPD784038
      ; Device file : (21)Vx.xx
```

[Description of output items] (1/2)

Item Number	Description	Number of Columns	Format
(1)	Version number	4 (fixed)	Displayed in “x.yz” format
(2)	Date	11 (fixed)	System date (Displayed in “DD Mmm YYYY” format)
(3)	Time	8 (fixed)	System time (Displayed in “HH:MM:SS” format)
(4)	Command line	—	Outputs the command line contents following “CC78K4”. Contents after column 80 are output beginning at column 15 on the next line. A semicolon (;) is output to column 1. One or more white-space characters or tabs are replaced by a single white-space character.
(5)	C source module file name	Number of characters enabled by OS	Outputs the specified file name. If the file type is omitted, ‘.c’ is attached as the file type (extension). Contents after column 80 are output beginning at column 15 on the next line. A semicolon (;) is output to column 1.
(6)	Assembler source module file name	Number of characters enabled by OS	Outputs the specified file name. If the file type is omitted, ‘.asm’ is attached as the file type (extension). Contents after column 80 are output beginning at column 15 on the next line. A semicolon (;) is output to column 1.
(7)	Parameter file contents	—	Outputs the parameter file contents. Contents after column 80 are output beginning at column 15 on the next line. A semicolon (;) is output to column 1. One or more white-space characters or tabs are replaced by a single white-space character.
(8)	SFR relocation information	—	Outputs SFR relocation information. $CHGSFR (n) n = 0, 15 0: Locates sfr area at FF00H to FFFFH. 15: Locates sfr area at FFF00H to FFFFFH. $CHGSFRA A: Compiler does not check mapping. Instead, linker checks it.
(9)	Device type	Maximum 6 (variable)	This character string is specified via the –C option. See the documentation describing device files.
(10)	Debug data	Maximum 8 (variable)	Outputs DEBUG control. Output is either $DEBUG or $NODEBUG.
(11)	Debug information control of assembler	9 (fixed)	Outputs NODEBUGA control. Output is $NODEBUGA.
(12)	Kanji type information	Maximum 15 (variable)	Outputs the Kanji code type. Output is $KANJICODE SJIS, $KANJICODE EUC, or $KANJICODE NONE.
(13)	Tool information	37 (fixed)	Outputs tool information, version number, error information, specified options, etc. (information starts with $TOL_INF).
(14)	Symbol information	—	Outputs symbol information (information starts with $DGS). This information is output only when the debug data output option has been specified. Even then, it is not output if the –G1 option has been specified.
(15)	Assembler source	—	Outputs an assembler source file containing the compilation results.
(16)	Line number	4 (fixed)	Outputs the C source module file’s line numbers as right-aligned decimal value with zeros suppressed.
(17)	C source	—	This is the input C source image. Contents after column 80 are output beginning at column 16 on the next line. A semicolon (;) is output to column 1.

[Description of output items] (2/2)

Item Number	Description	Number of Columns	Format
(18)	Line number information	—	Line number for line number entry (information starts with $DGL) This information is output only when the debug data output option has been specified. Even then, it is not output if the –G1 option has been specified.
(19)	Labels for symbol information creation	Maximum 34 (variable)	Outputs function label information (information starts with ??). This information is output only when the debug data output option has been specified.
(20)	Target device for this compiler	Maximum 15 (variable)	Displays the target device as specified via command line option -C or the source file.
(21)	Device file version	6 (fixed)	Displays the version number of the input device file.

6.3 Error List File

An error list file contains messages regarding any errors and warnings that occurred during compilation.

The C source program can be added to the error list by specifying a compiler option. An error list file that contains a C source program can be used as a C source module file by revising the C source program and deleting comments, such as the list header.

6.3.1 Error list file with C source

[Output format]

```
 /*
 78K/IV Series C Compiler V (1) x.xx Error List                  Date:(2) xxxxx Time:(3) xxxxx

 Command     : (4) –c4038 prime.c -se
 C-file      : (5) prime.c
 Err-file    : (6) prime.cer
 Para-file   : (7)
 */

(8)#define     TRUE   1
(8)#define     FALSE  0
(8)#define     SIZE   200

(8) char       mark[SIZE +1];

(8) main()
(8){
(8)     int i, prime, k, count;
(8)     cont = 0;
 ***ERROR (9) F711 (10) Undeclared ‘cont’ ; function ‘main’
(8)     for (i = 0 ; i <= SIZE ; i++)
(8)             mark[i] = TRUE;
(8)     for (i = 0 ; i<= SIZE ; i++) {
(8)             if (mark[i]) {
                            prime = i + i + 3;
                            printf ("%6d", prime);
 ***WARNING (9)W745 (10)Expected function prototype
                  ⋮
 /*
 (11) Target chip: uPD784038
 (12) Device file: Vx.xx
 Compilation complete, (13) 1 error(s) and  (14) 5 warning(s) found.
 */
```

[Description of output items]

Item Number	Description	Number of Columns	Format
(1)	Version number	4 (fixed)	Displayed in “x.yz” format
(2)	Date	11 (fixed)	System date (Displayed in “DD Mmm YYYY” format)
(3)	Time	8 (fixed)	System time (Displayed in “HH:MM:SS” format)
(4)	Command line	—	Outputs the command line contents following “CC78K4”. Contents after column 80 are output beginning at column 13 on the next line. One or more white-space characters or tabs are replaced by a single white-space character.
(5)	C source module file name	Number of characters enabled by OS (variable)	Outputs the specified file name. If the file type is omitted, ‘.c’ is attached as the file type (extension). Contents after column 80 are output beginning at column 13 on the next line.
(6)	Error list file name	Number of characters enabled by OS (variable)	Outputs the specified file name. If the file type is omitted, ‘.cer’ is attached. Contents after column 80 are output beginning at column 13 on the next line.
(7)	Parameter file contents	—	Outputs the parameter file contents. Contents after column 80 are output beginning at column 13 on the next line. One or more white-space characters or tabs are replaced by a single white-space character.
(8)	C source	—	This is the input C source image. Contents after column 80 are not wrapped to the next line.
(9)	Error message number	4 (fixed)	Outputs error numbers in the “#nnn” format. “F” is output if "#" is an error and “W” is output if it is a warning. "nnn" (the error number) is displayed as a three-digit decimal number. (No zero suppression)
(10)	Error message	—	See **CHAPTER 9 ERROR MESSAGES**. Contents after column 80 are not wrapped to the next line.
(11)	Target device for this compiler	Maximum 15 (variable)	Displays the target device as specified via command line option -C or the source file.
(12)	Device file version	6 (fixed)	Displays the version number of the input device file.
(13)	Number of errors	4 (fixed)	Outputs a right-aligned decimal value with zeroes suppressed.
(14)	Number of warnings	4 (fixed)	Outputs a right-aligned decimal value with zeroes suppressed.

6.3.2 Error list file with error message only

[Output format]

```
(1) prime.c((2) 18) :  (3) W745  (4) Expected function prototype
(1) prime.c((2) 20) :  (3) W745  (4) Expected function prototype
(1) prime.c((2) 26) :  (3) W622  (4) No return value
(1) prime.c((2) 37) :  (3) W622  (4) No return value
(1) prime.c((2) 44) :  (3) W622  (4) No return value

Target chip :(7) uPD784038
Device file :(8) Vx.xx

Compilation complete,  (5) 0 error(s) and  (6) 5 warning(s) found.
```

[Description of output items]

Item Number	Description	Number of Columns	Format
(1)	C source module file name	Number of characters enabled by OS	Outputs the specified file name. If the file type is omitted, '.c' is attached as the file type (extension).
(2)	Line number	5 (fixed)	Outputs a right-aligned decimal value with zeros suppressed.
(3)	Error message number	4 (fixed)	Outputs the error message number in "#nnn" format. "F" is output if "#" is an error and "W" is output if it is a warning. "nnn" is the error number.
(4)	Error message	—	See **CHAPTER 9 ERROR MESSAGES**.
(5)	Number of errors	4 (fixed)	Outputs a right-aligned decimal value with zeroes suppressed.
(6)	Number of warnings	4 (fixed)	Outputs a right-aligned decimal value with zeroes suppressed.
(7)	Target device for this compiler	Maximum 15 (variable)	Displays the target device as specified via command line option -C or the source file.
(8)	Device file version	6 (fixed)	Displays the version number of the input device file.

6.4 Preprocess List File

The preprocess list file is an ASCII image file that contains results of C source program preprocessing only.

When specifying the -K option, a preprocess list file can be used as a C source module file unless “N” has been specified as the processing type. When the -KD option is specified, the list with #define expansion is output.

[Output format]

When PAGEWIDTH = 80

```
 /*
 78K/IV Series C Compiler V (1) x.xx Preprocess List    Date:(2) xxxxx Page:(3) xxx


 Command     : (4) –c4038 prime.c -p -lw80
 In-file     : (5) prime.c
 PPL-file    : (6) prime.ppl
 Para-file   : (7)
 */


   (8) 1 : (9)#define TRUE    1
   (8) 2 : (9)#define FALSE   0
   (8) 3 : (9)#define SIZE    200
   (8) 4 : (9)
   (8) 5 : (9) char    mark[SIZE+1];
   (8) 6 : (9)


/*
(10) Target chip: uPD784038
(11) Device file: Vx.xx
*/
```

[Description of output items]

Item Number	Description	Number of Columns	Format
(1)	Version number	4 (fixed)	Displayed in “x.yz” format
(2)	Date	11 (fixed)	System date (Displayed in “DD Mmm YYYY” format)
(3)	Number of pages	4 (fixed)	Outputs a right-aligned decimal number with zeros suppressed.
(4)	Command line	—	Outputs the command line contents following “CC78K4”. Contents that exceed the line length are output beginning at column 13 on the next line. One or more white-space characters or tabs are replaced by a single white-space character.
(5)	C source module file name	Number of characters enabled by OS	Outputs the specified file name. If the file type is omitted, ‘.c’ is attached as the file type (extension). Contents that exceed the line length are output beginning at column 13 on the next line.
(6)	Preprocess list file name	Number of characters enabled by OS	Outputs the specified file name. If the file type is omitted, “.ppl” is attached. Contents that exceed the line length are output beginning at column 13 on the next line.
(7)	Parameter file contents	—	Outputs the parameter file contents. Contents that exceed the line length are output beginning at column 13 on the next line. A semicolon (;) is output to column 1. One or more white-space characters or tabs are replaced by a single white-space character.
(8)	Line number	5 (fixed)	Outputs a right-aligned decimal value with zeros suppressed.
(9)	C source	—	This is the input C source. Contents that exceed the line length are output beginning at column 9 on the next line.
(10)	Target device for this compiler	Maximum 15 (variable)	Indicates the target device that is specified by a command line option or in a source file
(11)	Device file version	6 (fixed)	Displays the version number of the input device file.

6.5 Cross-Reference List File

Cross-reference list files contain lists of identifiers such as declarations, definitions, referenced functions, and variables. They also include other information, such as attributes and line numbers. These are output in the order they are found.

[Output format]

When PAGEWIDTH = 80

```
 78K/IV Series C Compiler V (1) x.xx Cross reference List Date:(2) xxxxx Page:(3) xxx

 Command     : (4) –c4038 prime.c -x -lw80
 In-file     : (5) prime.c
 Xref-file   : (6) prime.xrf
 Para-file   : (7)
 Inc-file    : [n] (8)

 ATTRIB     MODIFY  TYPE        SYMBOL     DEFINE         REFERENCE

(9) EXTERN  (10)   (11) array  (12) mark  (13) 5   (14) 14   (14)16  (14) 22
(9) EXTERN  (10)   (11) func   (12) main  (13) 7
(9) REG1    (10)   (11) int    (12) i     (13) 9   (14) 13  (14) 13  (14) 13  (14) 14
                                                   (14) 15  (14) 15  (14) 15  (14) 16
                                                   (14) 17  (14) 17  (14) 21
(9) REG1    (10)   (11) int    (12) prime (13) 9   (14) 17  (14) 18  (14) 21  (14) 21
(9) REG1    (10)   (11) int    (12) k     (13) 9   (14) 21  (14) 21  (14) 21  (14) 22
(9) AUTO1   (10)   (11) int    (12) count (13) 9   (14) 11  (14) 19  (14) 20  (14) 25
                                    ⋮
(15) Target chip: uPD784038
(16) Device file: Vx.xx
```

[Description of output items] (1/2)

Item Number	Description	Number of Columns	Format
(1)	Version number	4	Displayed in “x.yz” format
(2)	Date	11 (fixed)	System date (Displayed in “DD Mmm YYYY” format)
(3)	Number of pages	4 (fixed)	Outputs a right-aligned decimal number with zeros suppressed.
(4)	Command line	—	Outputs the command line contents following “CC78K4”. Contents that exceed the line length are output beginning at column 13 on the next line. One or more white-space characters or tabs are replaced by a single white-space character.
(5)	C source module file name	Number of characters enabled by OS	Outputs the specified file name. If the file type is omitted, ‘.c’ is attached as the file type (extension). Contents that exceed the line length are output beginning at column 13 on the next line.
(6)	Cross-reference list file name	Number of characters enabled by OS	Outputs the specified file name. If the file type is omitted, “.xrf” is attached. Contents that exceed the line length are output beginning at column 13 on the next line.
(7)	Parameter file contents	—	Outputs the parameter file contents. Contents that exceed the line length are output beginning at column 13 on the next line. One or more white-space characters or tabs are replaced by a single white-space character.
(8)	Include file	Number of characters enabled by OS	Outputs the file name specified in the C source. “n” is a number starting with “1” that indicates the include file number. Contents that exceed the line length are output beginning at column 13 on the next line. This line is not output when there is no include file.
(9)	Symbol attribute	6 (fixed)	Displays the symbol attributes. An external variable is displayed as EXTERN, an external static variable as EXSTC, an internal static variable as INSTC, an auto variable as AUTOnn, a register variable as REGnn (where nn is the scope value, a numerical value that begins with "1"), an external typedef declaration as EXTYP, an internal typedef declaration as INTYP, a label as LABEL, a structure or union tag as TAG, a member as MEMBER, and a function parameter as PARAM.
(10)	Symbol qualifier attributes	6 (fixed)	Displays the symbol qualifier attributes (left-aligned). A const variable is displayed as CONST, a volatile variable as VLT, a callt function as CALLT, a callf function as CALLF, a noauto function as NOAUTO, a norec function as NOREC, an sreg-bit variable as SREG, an sfr variable as RWSFR, a read-only sfr variable as ROSFR, a write-only sfr variable as WOSFR, an interrupt function as VECT, an sreg1-boolean1 variable as SREG1, an RTOS interrupt handler as OSVECT, and a task function for RTOS as TASK.
(11)	Symbol type	7 (fixed)	Displays the symbol type. Types include char, int, short, long, and field. “u” is added at the start for unsigned type. Additional types include void, float, double, ldouble (long double), func, array, pointer, struct, union, enum, bit, inter, and #define.
(12)	Symbol name	15 (fixed)	If the symbol name exceeds 15 characters and fit into a line, that name is output as it is. If it exceeds 15 characters and one line, the excess is output from column 23 on the next line and items 13 and 14 are output from column 39 on the next line.
(13)	Symbol definition line number	7 (fixed)	This outputs the line number and file name defined for the symbol, and is displayed as: line number (five-digit): include file number

[Description of output items] (2/2)

Item Number	Description	Number of Columns	Format
(14)	Symbol reference line number	7 (fixed)	This outputs the line number and file name that reference the symbol, and is displayed as: line number (five-digit): include file number If the line contents exceed the line length, the remaining contents are output beginning at column 47 of the next line.
(15)	Target device for this compiler	Maximum 15 (variable)	Displays the target device as specified via command line option -C or the source file.
(16)	Device file version	6 (fixed)	Displays the version number of the input device file.

7.1 Efficient Operation (EXIT Status Function)

When the compilation ends, the CC78K4 returns the top error level generated during compilation to the operating system as the EXIT status.

The EXIT status is shown below.

- Ends normally: 0
- WARNING: 0
- FATAL ERROR: 1
- ABORT: 2

If PM plus is not used and the CC78K4 is started in the command line, efficient operation can be further improved by using the status in a batch file.

[Use Example]

```
cc78k4 –c4038 %1
IF ERRORLEVEL 1 GOTO ERR
cc78k4 –c4038 %2
IF ERRORLEVEL 1 GOTO ERR
GOTO EXIT
:ERR
echo Some error found.
:EXIT
```

[Description]

- When the C source passed to %1 was compiled, a fatal error was generated. Essentially, the process continues after an error message was output. But using the 1 returned in the EXIT status, execution can be stopped without processing the next C source in %2.

7.2 Setting Up Development Environment (Environment Variables)

The CC78K4 supports the following environment variables.

- PATH: Search path for executable forms
- INC78K4: Search path for include files
- TMP: Search path for temporary files
- LANG78K: Type of kanji code (can be specified by -ZE, -ZS, or -ZN option)
  (euc: EUC code, sjis: shift JIS code, none: no 2-byte codes)
- LIB78K4: Search path for libraries

[Use Example] (When using DOS prompt)

```
;AUTOEXEC.BAT
PATH C:\nectools32\bin;c:\bat;c:\cc78k4;c:\tool
VERIFY ON
BREAK ON
SET INC78K4=c:\nectools32\inc78k4
SET LIB78K4=c:\nectools32\lib78k4
SET TMP=c:\tmp
SET LANG78K=sjis
```

[Description]

- Executable files are searched in the sequence of c:\nectools32\bin, c:\bat, c:\cc78k4, c:\tool by path specification.
- Include files are searched from c:\nectools32\inc78k4.
  In the Windows version, if no setting is made, search is performed from C:\NECTools32\INC78K4 (if the CC78K4 is installed to C:\NECTools32).
- Library files are searched from c:\nectools32\lib78k4 during linking.
  In the Windows version, if no setting is made, search is performed from C:\NECTools32\LIB78K4 (if the CC78K4 is installed to C:\NECTools32).
- Temporary files are created in c:\tmp.
- Shift JIS code is used as kanji code.

[Caution]

Do not set environment variables when using PM plus.

7.3 Interrupting Compilation

If compiling was started from the command line, the compilation can be interrupted by the command key input (CTRL-C). If ‘break on’ was specified, control returns to the operating system unrelated to the timing of the key input. And for ‘break off,’ control returns to the operating system only when the screen is displayed. Then all of the open temporary files and output files are deleted.

If you want to stop a build (MAKE) in PM plus, select “Stop build” in the [Build] menu in the PM plus window, or click the  button in the tool bar. When building in PM plus, command key input is not accepted.

CHAPTER 8 STARTUP ROUTINES

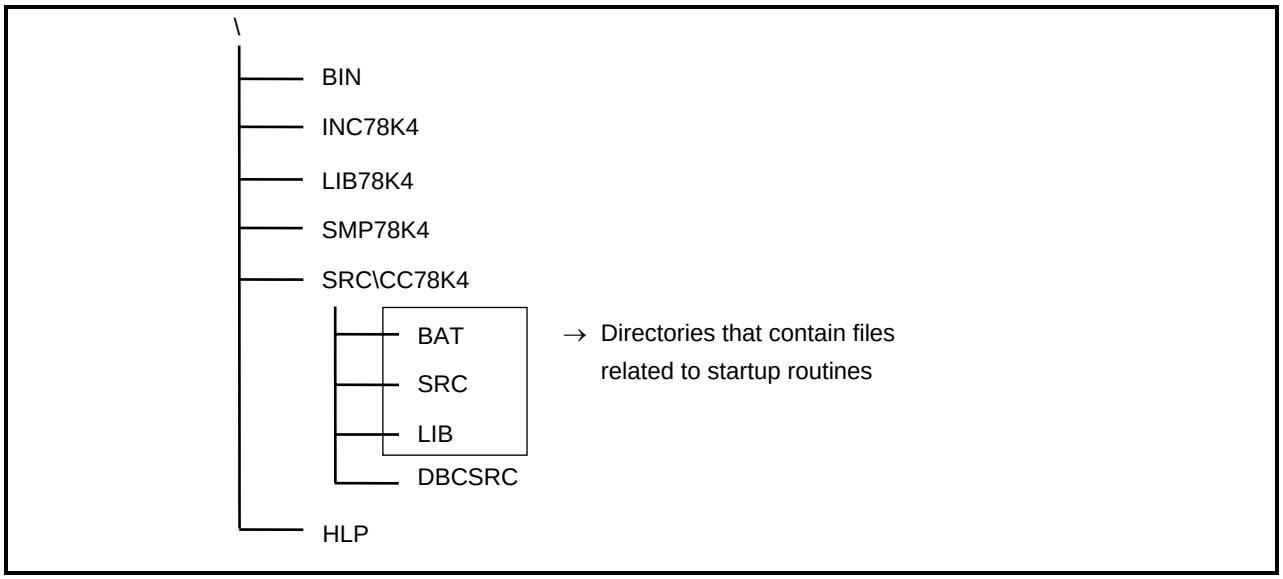
To execute a C language program, a program is needed to activate ROMization for inclusion in the system and the user program (main function). This program is called the startup routine.

To execute a program written by a user, a startup routine must be created for that program. The CC78K4 provides the object files of the startup routines that include the processing required before program execution and the source files (assembly source) of the startup routines that the user can adapt to the system. By linking the object file of the startup routine to the user program, an executable program can be created even if the user does not describe the execution preprocess.

This chapter describes the contents, uses, and improvements of the startup routines.

8.1 File Organization

The files related to a startup routine are stored in the directory SRC\CC78K4 of the compiler package.



The contents of the directory that has files related to the startup routine below SRC\CC78K4 are explained next.

The LIB directory contains the object files of the startup routines and the assembled library sources. An object file can be linked to a program for any target device in the 78K4 Series. If no particular revisions are needed, link the unmodified object files that are already available. If mkstup.bat (mkstup.sh) offered by the CC78K4 is executed, this object file can be overwritten. For the file contents, see **2.6.4 Library files**.

8.1.1 BAT directory contents

A batch file in this directory cannot be used in PM plus.

Use these batch files only when the source, such as for a startup routine, must be modified.

The device files (d4025.78k) in the BAT directory are not for development, and are used when a batch file for updating library, etc., is started. Therefore, other optional device files are required for development.

Table 8-1. BAT Directory Contents

Batch File Name	Description
mkstup.bat	Assemble batch file for startup routine
reprom.bat	Batch file for updating rom.asm[Note 1]
repgetc.bat	Batch file for updating getchar.asm
repputc.bat	Batch file for updating putchar.asm
repputcs.bat	Batch file for updating _putchar.asm
repselo.bat	Batch file for updating setjmp.asm and longjmp.asm (the compiler reserved area is saved)[Note 2]
repselon.bat	Batch file for updating setjmp.asm and longjmp.asm (the compiler reserved area is not saved)[Note 2]
repvect.bat	Batch file for updating vect*.asm

Notes 1. Since ROMization routines are in the library, the library is also updated by this batch file.

2. The setjmp and longjmp that save the compiler reserved area (saddr area secured for KREG××, etc.), and the setjmp and longjmp that do not save the compiler reserved area (only the registers are saved) are created.

8.1.2 SRC directory contents

The SRC directory contains the assembler sources of the startup routines, ROM routines, error processing routines, and standard library functions (a portion). If the source must be modified to conform to the system, the object files for linking can be created by modifying this assembler source and using a batch file in the BAT directory to assemble.

Table 8-2. SRC Directory Contents

Startup Routine Source File Name	Description
cstart.asm[Note]	Source file for startup routine (when standard library is used)
cstartn.asm[Note]	Source file for startup routine (when standard library is not used)
rom.asm	Source file for ROMization routine
_putchar.asm	_putchar function
putchar.asm	putchar function
getchar.asm	getchar function
longjmp.asm	longjmp function
setjmp.asm	setjmp function
vectxx.asm	Vector source for each interrupt (xx: vector address)
def.inc	For setting library according to type
macro.inc	Macro definition for each typical pattern
vect.inc	Start address of flash memory area branch table
library.inc	Selection of library assigned to boot area explicitly

Note A file name with n added is a startup routine that does not have standard library processing. Use only if the standard library will not be used. cstartb*.asm is a startup routine for boot area and cstarte*.asm is a startup routine for flash memory area.

8.2 Batch File Description

8.2.1 Batch files for creating startup routines

The mkstup.bat (mkstup.sh in UNIX) in the BAT directory is used to create the object file of a startup routine.

The assembler in the RA78K4 Assembler Package is required for mkstup.bat (mkstup.sh). Therefore, if PATH is not specified, specify it and run.

How to use this file is described next.

[How To Use]

Execute the following command line in the src\cc78k4\bat directory containing mkstup.bat (mkstup.sh).

```
mkstup device-type[Note]
```

Note Refer to the document related to device files.

[Use Example]

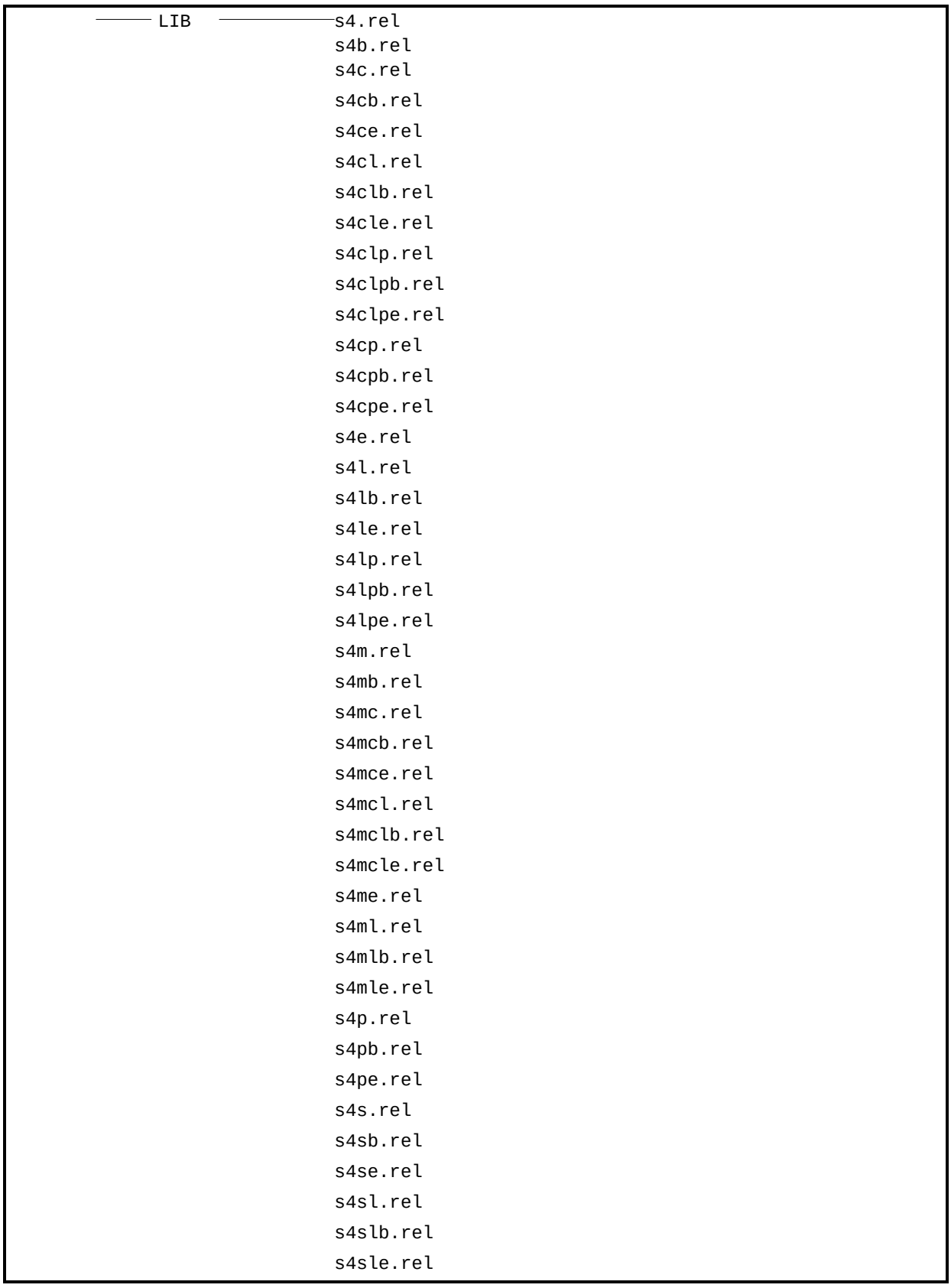
The startup routine to be used is created when the target device is the μPD784038Y.

```
mkstup  4038Y
```

The mkstup.bat (mkstup.sh) batch file is stored in the form that overwrites the object file of the startup routine in the LIB directory at the same level as the BAT directory as shown below.

The startup routine that is required to link the object file is output to each directory.

The names of the object files created in LIB are shown below.



8.3 Startup Routines

8.3.1 Overview of startup routines

A startup routine makes the preparations needed to execute the C source program written by the user. By linking to a user program, a load module file that achieves the objective can be created.

(1) Function

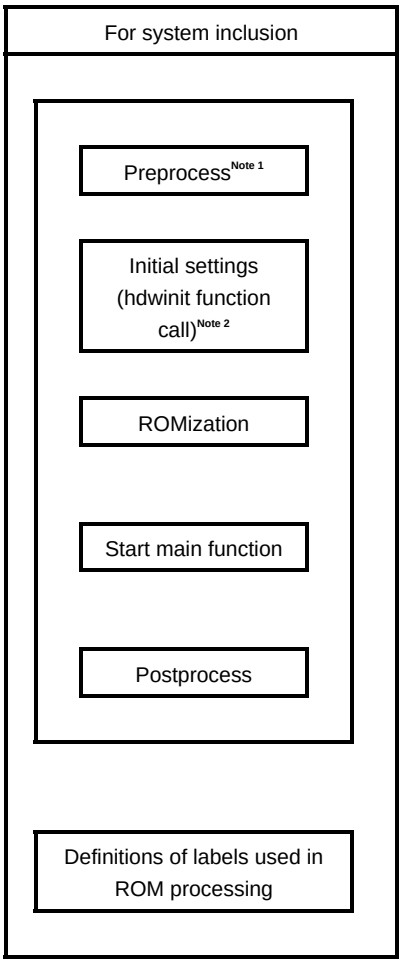
Memory initialization, ROMization for inclusion in the system, and the starting and ending processes for the C source program are performed.

ROMization: The initial values of the external variables, static variables, and sreg variables defined in the C source program are located in ROM. However, the variable values cannot be rewritten; only placed in ROM as is. Therefore, the initial values located in ROM must be copied to RAM. This process is called a ROMization. When a program is written to ROM, it can be run by a microcontroller.

(2) Configuration

Table 8-4 shows the programs related to the startup routines and their configurations.

Table 8-4. Startup Routine Overview



Notes 1. If the standard library is used, the processing related to the library is performed first. Files that do not have an 'n' appended at the end of the name in the startup routine source file are processed in relation to the standard library. Files with the appended 'n' are not processed.

2. The hdwinit function is a function created when needed by the user as the function to initialize a peripheral device (sfr). By creating the hdwinit function, the timing of the initial settings can be sped up (the initial settings can be made in the main function). If the user does not create the hdwinit function, the process returns without doing anything.

cstart.asm and cstartn.asm have nearly identical contents.

Table 8-5 shows the differences between cstart.asm and cstartn.asm.

Table 8-5. Differences Between Startup Routine Sources

Type of Startup Routine	Uses Library Processing
cstart.asm	Yes
cstartn.asm	No

(3) Uses of startup routines

Table 8-6 lists the names of the object files for the source files provided by the CC78K4.

Table 8-6. Correspondence Between Source Files and Object Files

File Type	Source File	Object File
Startup routine	cstart*.asm[Notes 1, 2]	s4*.rel[Notes 2, 3]
ROM file	rom.asm	Included in library

Notes 1. *: If the standard library is not used, 'n' is added. If used, the character is not added.

2. 'b' is startup routine for boot area, and 'e' is that for flash area.

3. *: If a fixed area in the standard library is used, 'l' is added.

rom.asm defines the label indicating the final address of the data copied by ROMization. The object of the rom.asm is included in the library.

8.3.2 Description of sample program (cstart.asm)

This section uses cstart.asm and rom.asm as examples to describe the contents of the startup routines. A startup routine consists of the preprocessing, initial settings, ROMization processing, starting the main function, and postprocessing.

Remark cstart is called in the format added _@ to its head.

(1) Preprocessing

Preprocessing in cstart.asm is described in <1> to <6> (see below).

[cstart.asm preprocessing]

```
         NAME    @cstart

$INCLUDE (def.inc)           <1> Including include files

                             <2> Library switch

BRKSW    EQU     1      ;brk,sbrk,calloc,free,malloc,realloc function use
EXITSW   EQU     1      ;exit,atexit function use
RANDSW   EQU     1      ;rand,srand  function use
DIVSW    EQU     1      ;div         function use
LDIVSW   EQU     1      ;ldiv        function use
FLOATSW  EQU     1      ;floating point  variable use

PUBLIC  _@cstart,_@cend      <3> Symbol definitions
$_IF(BRKSW)
    PUBLIC  _@BRKADR,_@MEMTOP,_@MEMBTM
$ENDIF
$_IF(EXITSW)
    PUBLIC  _@FNCTBL,_@FNCENT
$ENDIF
                :
                             <4> External reference declaration of symbol for stack resolution
    EXTRN   _main,_@STBEG,_hdwinit
$_IF(EXITSW)
    EXTRN   _exit
$ENDIF
                             <5> External reference declaration of label for ROMization processing
    EXTRN   _?R_INIT,_?R_INIS,_?R_INS1,_?DATS,_?DATS1
$_IF(MEDIUM AND (LOC_0=0))
    EXTRN   _?DATA_F
$ELSE
    EXTRN   _?DATA
$ENDIF
                :
                             <6> Securing area for standard library
$_IF(MEDIUM AND (LOC_0=0))
@@ DATAM DSEG    PAGE64K
$_ELSEIF(LARGE AND TWO_ALN)
```

```
@@ DATA  DSEG    UNITP
$ELSE
@@ DATA  DSEG
$ENDIF

$_IF(EXITSW)
$_IF(SMALL)
_@FNCTBL:   DS  2*32
$ELSE
_@FNCTBL:   DS  3*32
$ENDIF
_@FNCENT:   DS  2
                :
$ENDIF
```

<1> Including include files

def.inc → For setting library according to the type.

<2> Library switch

If standard libraries in comments are not used, by changing the EQU definition to 0, the space secured for the processing of unused libraries and for use by the library can be conserved. The default is set to use everything (In a startup routine without library processing, this processing is not performed).

<3> Symbol definitions

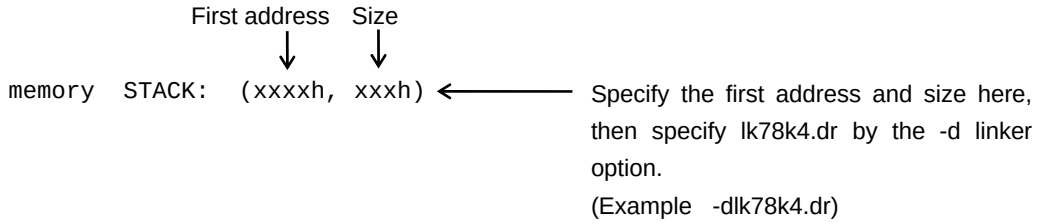
The symbols used when using the standard library are defined.

<4> External reference declaration of symbol for stack resolution

- The public symbol (_@STBEG) for stack resolution is an external reference declaration. _@STBEG has the value of the last address in the stack area + 1.
- _@STBEG is automatically generated by specifying the symbol generation option (-S) for stack resolution in the linker. Therefore, always specify the -S option when linking. In this case, specify the name of the area used in the stack. If the name of the area is omitted, the RAM area is used, but the stack area can be located anywhere by creating a link directive file. For memory mapping, refer to the user's manual of the target device.
- An example of a link directive file is shown below. The link directive file is a text file created by the user in an ordinary editor (for details about the description method, refer to **RA78K4 Assembler Package Operation User's Manual (U16708E)**).

[Example when -sSTACK is specified in linking]

Create lk78k4.dr (link directive file). Since ROM and RAM are allocated as default operations by referencing the memory map of the target device, it is not necessary to specify ROM and RAM allocations unless they should be changed. For link directive, refer to lk78k4.dr in the smp78k4\cc78k4 directory.



<5> External reference declaration of label for ROMization processing

The label for ROMization processing is defined in the postprocessing section.

<6> Securing area for standard library

The area used when using the standard library is secured.

(2) Initial settings

The initial settings in cstart.asm are described in <7> to <13>.

[Initial settings in cstart.asm]

```
@@VECT00    CSEG    AT  0H                  <7> Reset vector setting
            DW  _@cstart

@@LBASE CSEG    BASE
_@cstart:
$_IF(LOC_0)
    LOCATION    0H                          <8> Location setting
$ELSE
    LOCATION    0FH
$ENDIF

$_IF(LARGE)
    SEL RB0
$ELSE
    SEL RB7
$_IF(LOC_0)
    MOV A,#00H                              <9> Initialization of general-purpose registers
$ELSE
    MOV A,#0FH
$ENDIF
    MOV V,A
    MOV U,A
    MOV T,A
$_IF(SMALL)
    MOV W,A
$ENDIF
    SEL RB6
$_IF(LOC_0)
    MOV A,#00H
$ELSE
    MOV A,#0FH
$ENDIF
    MOV V,A
    MOV U,A
    MOV T,A
$_IF(SMALL)
    MOV W,A
$ENDIF
    SEL RB0                                 <10> Register bank setting
                :
```

```
$_IF(LOC_0)
    MOV A,#00H
$ELSE
    MOV A,#0FH
$ENDIF
    MOV V,A
    MOV U,A
    MOV T,A
$_IF(SMALL)
    MOV W,A
$ENDIF
$ENDIF

    MOVG    SP,#_@STBEG                         <11> SP (stack pointer) setting
$_IF(SMALL)
    CALL    !_hdwinit                           <12> Hardware initialization function call
$ELSE
    CALL    !!_hdwinit                          <12> Hardware initialization function call
$ENDIF

$_IF(BRKSW OR EXITSW OR RANDSW OR FLOATSW)  <13> Setting default value for standard library
    SUBW    AX,AX
$ENDIF
$_IF(BRKSW OR FLOATSW)
$_IF(SMALL)
    MOVW    !_errno,AX      ;errno <- 0
$ELSE
    MOVW    !!_errno,AX     ;errno <- 0
$ENDIF
$ENDIF
$_IF(EXITSW)
$_IF(SMALL)
    MOVW    !_@FNCENT,AX        ;FNCENT <- 0
$ELSE
    MOVW    !!_@FNCENT,AX       ;FNCENT <- 0
$ENDIF
$ENDIF

$_IF(RANDSW)
$_IF(SMALL)
    MOVW    !_@SEED+2,AX
    MOVW    !_@SEED,#1      ;SEED <- 1
$ELSE
    MOVW    !!_@SEED+2,AX
    MOVW    !!_@SEED,#1     ;SEED <- 1
```

```
$ENDIF
$ENDIF
                :
```

<7> Reset vector setting

The segment of the reset vector table is defined as follows. The first address of the startup routine is set.

```
@@VECT00     CSEG   AT  0H
             DW     _@cstart
```

<8> Location setting

Set LOCATION 0H/0FH in accordance with the setting of compiler option -CS.

<9> Initialization of general-purpose registers

Initialize the registers of register banks 0 to 7 as follows.

If the small model is specified, initialize the V, U, T, and W registers once after reset. If the medium model is specified, initialize the V, U, and T registers once after reset. These registers hold their default values during program execution (the operation is not guaranteed if the user rewrites these registers in the middle of execution).

The W register when the medium model is specified and all the above registers when the large model is specified are always changed during program execution and therefore do not have to be initialized.

Small model (-MS):	Set V, U, T, and W to 0.
Location 0H (-CS0) with medium model (-MM):	Set V, U, and T to 0.
Location 0FH (-CS14) with medium model (-MM):	Set 0FH to V, U, and T.

<10> Register bank setting

Register bank RB0 is set as the work register.

<11> Stack pointer (SP) setting

_@STBEG is set in the stack pointer.

_@STBEG is automatically generated by specifying the symbol generation option (-S) for stack resolution in the linker.

<12> Hardware initialization function call

The hdwinit function is created when needed by the user as the function for initializing a peripheral device (SFR). By creating this function, initial settings can be made to match the user's objectives.

If the user does not create the hdwinit function, the process returns without doing anything.

<13> Setting default value for standard library

Execute initialization necessary for using the standard library.

(3) ROMization processing

The ROMization processing in cstart.asm is described.

[ROMization processing]

```
;************************************
;ROM DATA COPY
;************************************
;copy external variables having initial value  <14> ROMization processing
$_IF(SMALL)
        MOVW    DE,#_@INIT
        MOVW    HL,#_@R_INIT
$ENDIF
$_IF(MEDIUM)
        MOVW    DE,#_@INIT
        MOVG    WHL,#_@R_INIT
$ENDIF
$_IF(LARGE)
        MOVG    TDE,#_@INIT
        MOVG    WHL,#_@R_INIT
$ENDIF
LINIT1:
$_IF(SMALL)
        CMPW    HL,#_?R_INIT
$ELSE
        SUBG    WHL,#_?R_INIT
$ENDIF
        BE      $LINIT2
$_IF(MEDIUM OR LARGE)
        ADDG    WHL,#_?R_INIT
$ENDIF
        MOV     A,[HL+]
        MOV     [DE+],A
        BR      $LINIT1
LINIT2:
               :
               :
```

In ROMization processing, the initial values of the external variables and the sreg variables stored in ROM are copied to RAM. The variables to be processed have the six types (a) to (f) shown in the following example.

(Example)

```
char    c = 1;                  (a) External variable with initial value
int      i;                     (b) External variable without initial value[Note]
_ _sreg int    si = 0;          (c) sreg variable with initial value
_ _sreg char   sc;              (d) sreg variable without initial value[Note]
_ _sreg1 int   si1 = 0;         (e) sreg1 variable with initial value
_ _sreg1 char  sc1;             (f) sreg1 variable without initial value[Note]

main ()
{
                ⋮
}
```

Note The external variables without initial value and sreg variables without initial value are not copied, and zeros are written directly to RAM.

- Figure 8-1 shows the ROMization processing for (a) External variable with initial value.
  The initial value of the variable (a) is placed in @@R_INIT segment in the ROM by the compiler. The ROMization processing copies this value to the @@INIT segment in RAM (the same processes are performed for the variable (c) or (e)).

- The first and last labels in the @@R_INIT segment are defined by _@R_INIT and _?R_INIT. The first and last labels in the @@INIT segment are defined by _@INIT and _?INIT.

- The variables (b), (d), and (f) are not copied, but zeros are directly placed in the segment determined by the RAM (see **Table 8-8 RAM Area for Initial Values (Copy Destination)**). Tables 8-7 and 8-8 show the segment names of the ROM and RAM areas where the variables (a) to (f) are placed, and the first and last labels of the initial values in each segment.

Figure 8-1. ROMization Processing

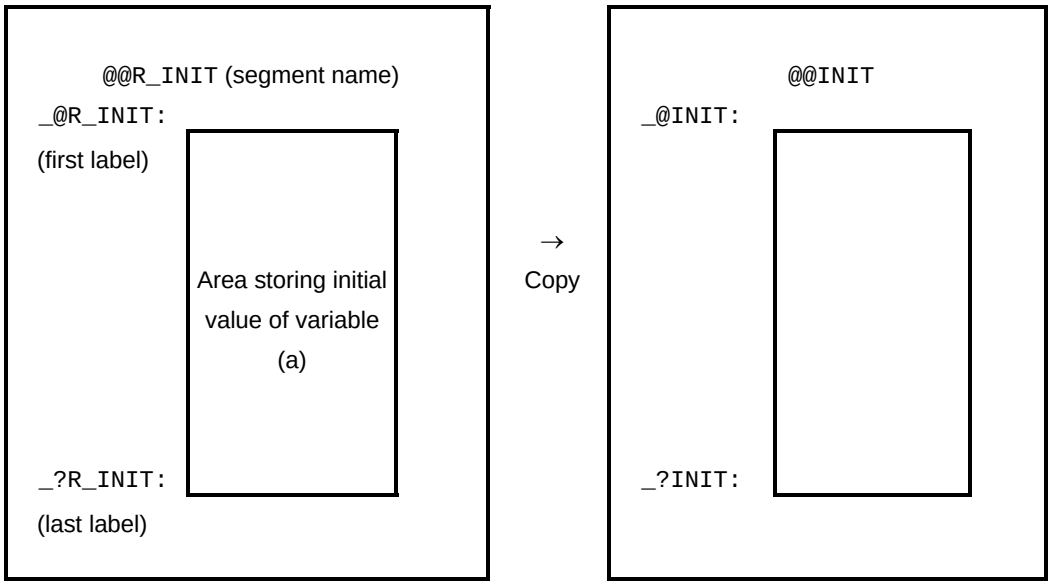


Table 8-7. ROM Area for Initial Values

Variable Type	Segment	First Label	Last Label
External variable with initial value (a)	@@R_INIT	_@R_INIT	_?R_INIT
sreg variable with initial value (c)	@@R_INIS	_@R_INIS	_?R_INIS
sreg1 variable with initial value (e)	@@R_INS1	_@R_INS1	_?R_INS1

Table 8-8. RAM Area for Initial Values (Copy Destination)

Variable Type	Segment	First Label	Last Label
External variable with initial value (a)	@@INIT	_@INIT	_?INIT
External variable without initial value (b)	@@DATA	_@DATA	_?DATA
sreg variable with initial value (c)	@@INIS	_@INIS	_?INIS
sreg variable without initial value (d)	@@DATS	_@DATS	_?DATS
sreg1 variable with initial value (e)	@@INIS1	_@INIS1	_?INIS1
sreg1 variable without initial value (f)	@@DATS1	_@DATS1	_?DATS1

(4) Starting main function and postprocessing

Starting the main function and postprocessing in cstart.asm are described in <15> to <17>.

[Starting main function and postprocessing]

```
$_IF(SMALL)
        CALL    !_main          ;main();  <15> Starting main function
$ELSE
        CALL    !!_main         ;main();  <15> Starting main function
$ENDIF

$_IF(EXITSW)
        SUBW    AX,AX
$_IF(SMALL)
        CALL    !_exit          ;exit(0); <16> Starting exit function
$ELSE
        CALL    !!_exit         ;exit(0); <16> Starting exit function
$ENDIF
$ENDIF
        BR      $$
;
_@cend:
                                          <17> Definitions of segments and labels used in
$_IF(LARGE AND TWO_ALN)                        ROMization processing
@@R_INIT        CSEG    UNITP
$_ELSEIF(SMALL)
@@RSINIT        CSEG    BASE
$ELSE
@@R_INIT        CSEG
$ENDIF
_@R_INIT:
$_IF(SMALL)
@@RSINIS        CSEG    BASE
_@R_INIS:
@@RSINS1        CSEG    BASE
_@R_INS1:
$ELSE
@@R_INIS        CSEG
_@R_INIS:
        :
$_IF(SMALL)
@@CODES CSEG    BASE
@@CALFS CSEG    FIXEDA
$ELSE
@@CODE  CSEG
```

```
@@CALF  CSEG    FIXED
$ENDIF
$_IF(MEDIUM AND (LOC_0=0))
@@CNSTM CSEG    PAGE64K
$_ELSEIF(LARGE AND TWO_ALN)
@@CNST  CSEG    UNITP
$_ELSEIF(LARGE)
@@CNST  CSEG
$ELSE
@@CNSTS CSEG    BASE
$ENDIF
@@CALT  CSEG    CALLT0
@@BITS  BSEG    SADDR2
@@BITS1 BSEG    SADDR
;
        END
```

<15> Starting main function

The main function is called.

<16> Starting exit function

The exit function is called if needed.

<17> Definitions of segments and labels used in ROMization processing

The segments and labels used in each variable (a) to (f) (see **8.3.2 (3) ROMization processing**) in ROMization processing are defined. A segment indicates the area that stores the initial value of each variable. A label indicates the first address in each segment.

The ROMization processing file rom.asm is described. The relocatable object file of rom.asm is in the library.

```
$INCLUDE (def.inc)
;
              :
        NAME    @rom

        PUBLIC  _?R_INIT,_?R_INIS,_?R_INS1
$_IF(SMALL OR LARGE)
        PUBLIC  _?INIT,_?DATA
$ENDIF
        PUBLIC  _?INIS,_?DATS
        PUBLIC  _?INIS1,_?DATS1

$_IF(LARGE AND TWO_ALN)
@@R_INIT        CSEG    UNITP   ;       <1> Definition of labels used in ROMization processing
$_ELSEIF(SMALL)
@@RSINIT        CSEG    BASE
```

```
$ELSE
@@R_INIT        CSEG
$ENDIF
_?R_INIT:
$_IF(SMALL)
@@RSINIS        CSEG    BASE
_?R_INIS:
@@RSINS1        CSEG    BASE
_?R_INS1:
$ELSE
@@R_INIS        CSEG
_?R_INIS:
@@R_INS1        CSEG
_?R_INS1:
$ENDIF
$_IF(LARGE AND TWO_ALN)
@@INIT  DSEG    UNITP
_?INIT:
@@DATA  DSEG    UNITP
_?DATA:
$_ELSEIF(SMALL OR LARGE)
@@INIT  DSEG
_?INIT:
@@DATA  DSEG
_?DATA:
$ENDIF
@@INIS  DSEG    SADDR2
_?INIS:
@@DATS  DSEG    SADDR2
_?DATS:
@@INIS1 DSEG    SADDR
_?INIS1:
@@DATS1 DSEG    SADDR
_?DATS1:
$ENDIF
;
        END
```

<1> Definition of labels used in ROMization processing

The labels used for each variable (a) to (f) (see **8.3.2 (3) ROMization processing**) in ROMization processing, are defined. These labels indicate the last address of the segment storing the initial value of each variable.

8.3.3 Revising startup routines

The startup routines provided by the CC78K4 can be revised to match the target system actually being used. The essential points about revising these files are explained in this section.

(1) When revising startup routine

The essential points about revising a startup routine source file are described. After revising, use the batch file mkstup.bat (mkstup.sh) in the src\cc78k4\bat directory to assemble the revised source file (cstart*.asm) (*: alphanumeric symbols).

• Symbols used in standard library functions

If the library functions listed in Table 8-9 are not used, the symbols corresponding to each function in the startup routine (cstart.asm) can be deleted. However, since the exit function is used in the startup routine, _@FNCTBL and _@FNCENT cannot be deleted (if the exit function is deleted, these symbols can be deleted). The symbols in the unused library functions can be deleted by changing the library switch.

Table 8-9. Symbols Used in Library Functions

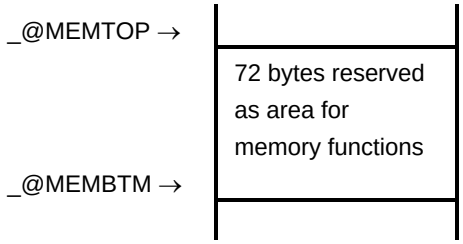
Library Function Name	Symbols Used
brk sbrk strtol strtoul malloc calloc realloc free	_errno _@MEMTOP _@MEMBTM _@BRKADR
exit	_@FNCTBL _@FNCENT
rand srand	_@SEED
div	_@DIVR
ldiv	_@LDIVR
strtok	_@TOKPTR
atof strtod Mathematical function Floating-point runtime library	_errno

• Area used in memory functions

If the size of the area used by a memory function is defined by the user, this is explained in the following example.

Example) If you want to reserve 72 bytes for use by memory functions, make the following changes to the initial settings of the startup routine.

```
_@MEMTOP:  DS      72
_@MEMBTM
```



If the specified size is too big to be stored in the RAM area, errors may occur when linking.
In this case, decrease the size specified as shown below, or avoid by correcting the link directive file. For correction of the link directive file, see **(2) Link directive file**.

Example) To decrease the specified size

```
_@MEMTOP:  DS      72  → Change to 40
```

(2) Link directive file

How to create a link directive file is explained. Specify a file created using the -D option when linking to match the actual target system. Heed the following cautions when creating the file (for the detailed description method for a link directive, see **RA78K4 Assembler Package Operation User's Manual (U16708E)**).

- The CC78K4 sometimes uses a portion of the short direct address area (saddr2 area) in the following compiler-specific objectives. Specifically, this area is any 32-byte area of (F)FD20H to (F)FDFFH.

  (a) Arguments or automatic variables of norec function (16 bytes)
  (b) register variable when the –qr2 option is specified (16 bytes)
  (c) Standard library task (part of the area (b)).

  Specifically, _@KREG00 is referenced when longjmp/setjmp is used.

- If the user does not use the standard library, the area (c) is not used.

The following shows an example of changing RAM size with a link directive file (lk78k4.dr). When changing memory size, do not overlap another area. Refer to the memory map of the target device to be used when changing memory size.

<lk78k4.dr>

```
                    First address  Size
memory RAM:             (0FEE00h, 20h)     → Make this size larger.
memory SDR:             (0FEE20h, 11E0h)     (also change the first address if necessary)
merge @@DATA: = EXTRAM  (0F0000h, 00100h) → Specifies the location of the segment.
```

If you want to change the location of the segment, add a merge statement. If the function to revise the compiler output section name was used, the segment can be independently located (refer to **CHAPTER 11** in **CC78K4 Language User's Manual (U15556E)**).

If the result of changing the location of a segment does not provide enough memory for the location, change the corresponding memory statement.

(3) When using RTOS

Initialization routines are respectively provided for RX78K4 and CC78K4 as samples (assembler format). Therefore, when using RX78K4 and CC78K4 in combination, changes must be performed so as to include the processing actions required for each in a single initialization routine.

Here, an example of the editing method is described by adding processing described in startup.asm (initialization routine provided for RX78K4) to cstart.asm (initialization routine provided for CC78K4). Ver. 2.40 is assumed for CC78K4.

Remark cstart.asm is a version that uses a standard library with ROMization.

<1> The following EXTRN declaration required for RX78K4 is added.

[After change]

```
EXTRN     sys_inf,?sysrt
```

<2> The EXTRN declarations of the main and exit functions described in cstart.asm are deleted. If the stack area is secured by the user (when using task stack other than initial task), the EXTRN declaration of _@STBEG is also deleted. (The _@STBEG area is automatically secured by specifying the -s option during linking.)

[Before change]

```
      EXTRN   _main,_@STBEG,_hdwinit
$_IF(EXITSW)
      EXTRN   _exit
$_ENDIF
```

[After change]

```
EXTRN _@STBEG,_hdwinit
```

The EXITSW setting locations are also changed.

[Before change]

```
EXITSW     EQU    1
```

[After change]

```
EXITSW     EQU    0
```

<3> The next location is edited (or vcttbl.asm is edited) to avoid redundancy with vector 0 of vcttbl.asm provided for RX78K4. If _@cstart is not used, change it to the symbol to be used.

[Before change]

```
@@VECT00    CSEG    AT     0H
      DW    _@cstart
```

<4> Prior to selecting the register banks, select the interrupt disabled state.

[Before change]

```
$_IF(LARGE)
      SEL     RB0
$ELSE
      SEL     RB7
```

[After change]

```
DI
$_IF(LARGE)
      SEL     RB0
$ELSE
      SEL     RB7
```

<5> If _@STBEG of the stack area is not used, change the following location.

[Before change]

```
MOVG   SP,#_@STBEG      ;SP <- stack begin address
```

<6> Describe the hardware initialization processing required for the user system to the hardware initialization function (hdwinit).

<7> When using RX78K4, delete the following location because the main and exit functions are not needed. Delete also processing that is not required for RX78K4 control, and add processing for transferring control to the RX78K4 system initialization routine.

[Before change]

```
      $_IF(SMALL)
               CALL    !_main          ;main();
      $ELSE
               CALL    !!_main         ;main();
      $ENDIF

      $_IF(EXITSW)
               SUBW    AX,AX
      $_IF(SMALL)
               CALL    !_exit          ;exit(0);
      $ELSE
               CALL    !!_exit         ;exit(0);
      $ENDIF
      $ENDIF
               BR      $$
```

[After change]

```
$_IF(LARGE)                        ; Large model
      location        0fh
      movg    tde,#sys_inf
      movw    ax,[tde]
      br      ax
$ELSE                              ; Small model
      location        0
      sel     rb7
      mov     w,#00h
      mov     t,#00h
      mov     u,#00h
      mov     v,#00h
      sel     rb6
      mov     w,#00h
      mov     t,#00h
      mov     u,#00h
      mov     v,#00h
      sel     rb5
      mov     w,#00h
      mov     t,#00h
      mov     u,#00h
      mov     v,#00h
      sel     rb4
      mov     w,#00h
```

```
      mov     t,#00h
      mov     u,#00h
      mov     v,#00h
      sel     rb3
      mov     w,#00h
      mov     t,#00h
      mov     u,#00h
      mov     v,#00h
      sel     rb2
      mov     w,#00h
      mov     t,#00h
      mov     u,#00h
      mov     v,#00h
      sel     rb1
      mov     w,#00h
      mov     t,#00h
      mov     u,#00h
      mov     v,#00h
      sel     rb0
      mov     w,#00h
      mov     t,#00h
      mov     u,#00h
      mov     v,#00h
      movw    de,#sys_inf
      movw    ax,[de]
      br      ax
#ENDIF
```

<Example of initialization routine after editing>

```
; Copyright (C) NEC Electronics Corporation 19xx, 20xx
; NEC ELECTRONICS CONFIDENTIAL AND PROPRIETARY
; All rights reserved by NEC Electronics Corporation.
; This program must be used solely for the purpose for which
; it was furnished by NEC Electronics Corporation. No Part of this
; program may be reproduced or disclosed to others, in any
; form, without the prior written permission of NEC Electronics
; Corporation.Use of copyright notice does not evidence
; publication of the program.
;====================================
;       W-1 cstart
;
;       Version x.xx xx Xxx 20xx
;====================================
        NAME    @cstart

$INCLUDE (def.inc)

;------------------------------------------------------------------------------
; declaration of symbol
;
; attention):   change to EQU value 1 -> 0  if necessary
;------------------------------------------------------------------------------
BRKSW    EQU   1       ;brk,sbrk,calloc,free,malloc,realloc function use
EXITSW   EQU   0       ;exit,atexit function use        ; Change location
RANDSW   EQU   1       ;rand,srand function use
DIVSW    EQU   1       ;div       function use
LDIVSW   EQU   1       ;ldiv      function use
STRTOKSW EQU   1       ;strtok    function use
FLOATSW  EQU   1       ;floating point variables use

        PUBLIC  _@cstart,_@cend
$_IF(BRKSW)
        PUBLIC  _@BRKADR,_@MEMTOP,_@MEMBTM
$ENDIF
$_IF(EXITSW)
        PUBLIC  _@FNCTBL,_@FNCENT
$ENDIF
$_IF(RANDSW)
        PUBLIC  _@SEED
$ENDIF
$_IF(DIVSW)
        PUBLIC  _@DIVR
```

```
$ENDIF
$_IF(LDIVSW)
        PUBLIC  _@LDIVR
$ENDIF
$_IF(STRTOKSW)
        PUBLIC  _@TOKPTR
$ENDIF
$_IF(BRKSW OR FLOATSW)
        PUBLIC  _errno
$ENDIF

;------------------------------------------------------------------------------
; external declaration of symbol for stack area
;
; _@STBEG has value of the end address +1 of compiler's stack area.
; _@STBEG is created by linker with -S option.
; Accordingly, specify the -S option when linking.
;------------------------------------------------------------------------------
        EXTRN   sys_inf,?sysrt                          ; Addition location
        EXTRN   _@STBEG,_hdwinit                        ; Change location

;------------------------------------------------------------------------------
; external declaration of label for ROMable
;------------------------------------------------------------------------------
        EXTRN   _?R_INIT,_?R_INIS,_?R_INS1,_?DATS,_?DATS1
$_IF(MEDIUM AND (LOC_0=0))
        EXTRN   _?DATA_F
$ELSE
        EXTRN   _?DATA
$ENDIF

;------------------------------------------------------------------------------
; allocation area which library uses
;
; _@FNCTBL      top address of area used in atexit function
; _@FNCENT      total number of functions registered by the atexit function
; _@SEED        sequence of pseudo-random numbers
; _@DIVR        a result of div library
; _@LDIVR       a result of ldiv library
; _@TOKPTR      pointer which strtok function uses
; _errno        errno number code
; _@MEMTOP      top address of area which memory management functions use
; _@MEMBTM      bottom address of area which memory management functions use
; _@BRKADR      break value
;------------------------------------------------------------------------------
```

```
$_IF(MEDIUM AND (LOC_0=0))
@@DATAM DSEG    PAGE64K
$_ELSEIF(LARGE AND TWO_ALN)
@@DATA  DSEG    UNITP
$ELSE
@@DATA  DSEG
$ENDIF

$_IF(EXITSW)
$_IF(SMALL)
_@FNCTBL:       DS      2*32
$ELSE
_@FNCTBL:       DS      3*32
$ENDIF
_@FNCENT:       DS      2
$ENDIF
$_IF(RANDSW)
_@SEED:         DS      4
$ENDIF
$_IF(DIVSW)
_@DIVR:         DS      4
$ENDIF
$_IF(LDIVSW)
_@LDIVR:        DS      8
$ENDIF
$_IF(STRTOKSW)
$_IF(SMALL OR MEDIUM)
_@TOKPTR:       DS      2
$ELSE
_@TOKPTR:       DS      3
$ENDIF
$ENDIF
$_IF(BRKSW OR FLOATSW)
_errno:         DS      2
$ENDIF
$_IF(BRKSW)
$_IF(SMALL OR MEDIUM)
_@BRKADR:       DS      2
_@MEMTOP:       DS      32
$ELSE
_@BRKADR:       DS      3
_@MEMTOP:       DS      48
$ENDIF
_@MEMBTM:
$ENDIF
```

```
@@VECT00        CSEG    AT      0H                      ; Change if required
        DW      _@cstart   ;

@@LBASE CSEG    BASE
_@cstart:
$_IF(LOC_0)
        LOCATION        0H
$ELSE
        LOCATION        0FH
$ENDIF

;-------------------------------------------------------------------------------
; setting the register bank RB0 as work register set
;-------------------------------------------------------------------------------
        DI                                              ; Addition location
$_IF(LARGE)
        SEL     RB0
$ELSE
        SEL     RB7
$_IF(LOC_0)
        MOV     A,#00H
$ELSE
        MOV     A,#0FH
$ENDIF
        MOV     V,A
        MOV     U,A
        MOV     T,A
$_IF(SMALL)
        MOV     W,A
$ENDIF
        SEL     RB6
$_IF(LOC_0)
        MOV     A,#00H
$ELSE
        MOV     A,#0FH
$ENDIF
        MOV     V,A
        MOV     U,A
        MOV     T,A
$_IF(SMALL)
        MOV     W,A
$ENDIF
        SEL     RB5
$_IF(LOC_0)
```

```
        MOV     A,#00H
$ELSE
        MOV     A,#0FH
$ENDIF
        MOV     V,A
        MOV     U,A
        MOV     T,A
$_IF(SMALL)
        MOV     W,A
$ENDIF
        SEL     RB4
$_IF(LOC_0)
        MOV     A,#00H
$ELSE
        MOV     A,#0FH
$ENDIF
        MOV     V,A
        MOV     U,A
        MOV     T,A
$_IF(SMALL)
        MOV     W,A
$ENDIF
        SEL     RB3
$_IF(LOC_0)
        MOV     A,#00H
$ELSE
        MOV     A,#0FH
$ENDIF
        MOV     V,A
        MOV     U,A
        MOV     T,A
$_IF(SMALL)
        MOV     W,A
$ENDIF
        SEL     RB2
$_IF(LOC_0)
        MOV     A,#00H
$ELSE
        MOV     A,#0FH
$ENDIF
        MOV     V,A
        MOV     U,A
        MOV     T,A
$_IF(SMALL)
        MOV     W,A
```

```
$ENDIF
        SEL     RB1
$_IF(LOC_0)
        MOV     A,#00H
$ELSE
        MOV     A,#0FH
$ENDIF
        MOV     V,A
        MOV     U,A
        MOV     T,A
$_IF(SMALL)
        MOV     W,A
$ENDIF
        SEL     RB0
$_IF(LOC_0)
        MOV     A,#00H
$ELSE
        MOV     A,#0FH
$ENDIF
        MOV     V,A
        MOV     U,A
        MOV     T,A
$_IF(SMALL)
        MOV     W,A
$ENDIF
$ENDIF
;-------------------------------------------------------------------------------
; setting the stack pointer
;
; _@STBEG is created by linker with -S option.
;-------------------------------------------------------------------------------
        MOVG    SP,#_@STBEG ;SP <- stack begin address  ; Change if required
$_IF(SMALL)
        CALL    !_hdwinit
$ELSE
        CALL    !!_hdwinit
$ENDIF
;-------------------------------------------------------------------------------
; errno and _@FNCENT are initialized to 0
;
; The positive error number will be set by several libraries at called them.
;-------------------------------------------------------------------------------
$_IF(BRKSW OR EXITSW OR RANDSW OR FLOATSW)
        SUBW    AX,AX
$ENDIF
```

```
$_IF(BRKSW OR FLOATSW)
$_IF(SMALL)
        MOVW    !_errno,AX          ;errno <- 0
$ELSE
        MOVW    !!_errno,AX         ;errno <- 0
$ENDIF
$ENDIF
$_IF(EXITSW)
$_IF(SMALL)
        MOVW    !_@FNCENT,AX        ;FNCENT <- 0
$ELSE
        MOVW    !!_@FNCENT,AX       ;FNCENT <- 0
$ENDIF
$ENDIF
;---------------------------------------------------------------------------
; initializing _@SEED as 1
;
; Pseudo-random sequence is decided by _@SEED value. This value can be set by
; srand function. If rand is called before srand, the random sequence will
; be the same as when srand is called with a _@SEED value as 1 at first.
;---------------------------------------------------------------------------
$_IF(RANDSW)
$_IF(SMALL)
        MOVW    !_@SEED+2,AX
        MOVW    !_@SEED,#1          ;SEED <- 1
$ELSE
        MOVW    !!_@SEED+2,AX
        MOVW    !!_@SEED,#1         ;SEED <- 1
$ENDIF
$ENDIF
;---------------------------------------------------------------------------
; setting _@MEMTOP address to _@BRKADR
;---------------------------------------------------------------------------
$_IF(BRKSW)
$_IF(SMALL)
        MOVW    !_@BRKADR,#_@MEMTOP  ;BRKADR <- #MEMTOP
$_ELSEIF(MEDIUM)
        MOVW    !!_@BRKADR,#_@MEMTOP ;BRKADR <- #MEMTOP
$ELSE
        MOVG    WHL,#_@MEMTOP
        MOVG    !!_@BRKADR,WHL       ;BRKADR <- #MEMTOP
$ENDIF
$ENDIF

;---------------------------------------------------------------------------
```

```
; ROM data copy
;--------------------------------------------------------------------------
; copy external variables having initial value
$_IF(SMALL)
        MOVW    DE,#_@INIT
        MOVW    HL,#_@R_INIT
$ENDIF
$_IF(MEDIUM)
        MOVW    DE,#_@INIT
        MOVG    WHL,#_@R_INIT
$ENDIF
$_IF(LARGE)
        MOVG    TDE,#_@INIT
        MOVG    WHL,#_@R_INIT
$ENDIF
LINIT1:
$_IF(SMALL)
        CMPW    HL,#_?R_INIT
$ELSE
        SUBG    WHL,#_?R_INIT
$ENDIF
        BE      $LINIT2
$_IF(MEDIUM OR LARGE)
        ADDG    WHL,#_?R_INIT
$ENDIF
        MOV     A,[HL+]
        MOV     [DE+],A
        BR      $LINIT1
LINIT2:
; copy external variables which doesn't have initial value
$_IF(SMALL)
        MOVW    DE,#_@DATA
        MOVW    HL,#_?DATA
$ENDIF
$_IF(MEDIUM)
        MOVW    DE,#_@DATA
$_IF(LOC_0)
        MOVW    HL,#_?DATA
$ELSE
        MOVW    HL,#_?DATA_F
$ENDIF
$ENDIF
$_IF(LARGE)
        MOVG    TDE,#_@DATA
        MOVG    WHL,#_?DATA
```

```
$ENDIF
        MOV     A,#0
LDATA1:
$_IF(SMALL OR MEDIUM)
        CMPW    HL,DE
$ELSE
        SUBG    WHL,TDE
$ENDIF
        BE      $LDATA2
$_IF(LARGE)
        ADDG    WHL,TDE
$ENDIF
        MOV     [DE+],A
        BR      $LDATA1
LDATA2:
; copy sreg variables having initial value
$_IF(SMALL)
        MOVW    DE,#_@INIS
        MOVW    HL,#_@R_INIS
$ENDIF
$_IF(MEDIUM)
        MOVW    DE,#_@INIS
        MOVG    WHL,#_@R_INIS
$ENDIF
$_IF(LARGE)
        MOVG    TDE,#_@INIS
        MOVG    WHL,#_@R_INIS
$ENDIF
LINIS1:
$_IF(SMALL)
        CMPW    HL,#_?R_INIS
$ELSE
        SUBG    WHL,#_?R_INIS
$ENDIF
        BE      $LINIS2
$_IF(MEDIUM OR LARGE)
        ADDG    WHL,#_?R_INIS
$ENDIF
        MOV     A,[HL+]
        MOV     [DE+],A
        BR      $LINIS1
LINIS2:
; copy sreg variables which doesn't have initial value
$_IF(SMALL OR MEDIUM)
        MOVW    DE,#_@DATS
```

```
        MOVW    HL,#_?DATS
$ELSE
        MOVG    TDE,#_@DATS
        MOVG    WHL,#_?DATS
$ENDIF
        MOV     A,#0
LDATS1:
$_IF(SMALL OR MEDIUM)
        CMPW    HL,DE
$ELSE
        SUBG    WHL,TDE
$ENDIF
        BE      $LDATS2
$_IF(LARGE)
        ADDG    WHL,TDE
$ENDIF
        MOV     [DE+],A
        BR      $LDATS1
LDATS2:
; copy sreg1 variables having initial value
$_IF(SMALL)
        MOVW    DE,#_@INIS1
        MOVW    HL,#_@R_INS1
$ENDIF
$_IF(MEDIUM)
        MOVW    DE,#_@INIS1
        MOVG    WHL,#_@R_INS1
$ENDIF
$_IF(LARGE)
        MOVG    TDE,#_@INIS1
        MOVG    WHL,#_@R_INS1
$ENDIF
LINIS11:
$_IF(SMALL)
        CMPW    HL,#_?R_INS1
$ELSE
        SUBG    WHL,#_?R_INS1
$ENDIF
        BE      $LINIS12
$_IF(MEDIUM OR LARGE)
        ADDG    WHL,#_?R_INS1
$ENDIF
        MOV     A,[HL+]
        MOV     [DE+],A
        BR      $LINIS11
```

```
LINIS12:
; copy sreg1 variables which doesn't have initial value
$_IF(SMALL OR MEDIUM)
        MOVW    DE,#_@DATS1
        MOVW    HL,#_?DATS1
$ELSE
        MOVG    TDE,#_@DATS1
        MOVG    WHL,#_?DATS1
$ENDIF
        MOV     A,#0
LDATS11:
$_IF(SMALL OR MEDIUM)
        CMPW    HL,DE
$ELSE
        SUBG    WHL,TDE
$ENDIF
        BE      $LDATS12
$_IF(LARGE)
        ADDG    WHL,TDE
$ENDIF
        MOV     [DE+],A
        BR      $LDATS11
LDATS12:

;-------------------------------------------------------------------------
; branches to the reset routine for system initialization of RX78K/IV
;-------------------------------------------------------------------------
$_IF(LARGE)                 ; Large model               ;
        movg    tde,#sys_inf                            ;
        movw    ax,[tde]                                ;
        br      ax                                      ;
$ELSE                       ; Small model               ;
        sel     rb7                                     ;
        mov     w,#00h                                  ;
        mov     t,#00h                                  ;
        mov     u,#00h                                  ;
        mov     v,#00h                                  ;
        sel     rb6                                     ;
        mov     w,#00h                                  ;
        mov     t,#00h                                  ;
        mov     u,#00h                                  ;
        mov     v,#00h                                  ;
        sel     rb5                                     ;
        mov     w,#00h                                  ;
        mov     t,#00h                                  ;
```

```
        mov     u,#00h                                  ;
        mov     v,#00h                                  ;
        sel     rb4                                     ;
        mov     w,#00h                                  ; Change location
        mov     t,#00h                                  ;
        mov     u,#00h                                  ;
        mov     v,#00h                                  ;
        sel     rb3                                     ;
        mov     w,#00h                                  ;
        mov     t,#00h                                  ;
        mov     u,#00h                                  ;
        mov     v,#00h                                  ;
        sel     rb2                                     ;
        mov     w,#00h                                  ;
        mov     t,#00h                                  ;
        mov     u,#00h                                  ;
        mov     v,#00h                                  ;
        sel     rb1                                     ;
        mov     w,#00h                                  ;
        mov     t,#00h                                  ;
        mov     u,#00h                                  ;
        mov     v,#00h                                  ;
        sel     rb0                                     ;
        mov     w,#00h                                  ;
        mov     t,#00h                                  ;
        mov     u,#00h                                  ;
        mov     v,#00h                                  ;
        movw    de,#sys_inf                             ;
        movw    ax,[de]                                 ;
        br      ax                                      ;
$ENDIF                                                  ;
;
_@cend:
;-------------------------------------------------------------------------------
; define segment and label used by ROMable processing
;-------------------------------------------------------------------------------
$_IF(LARGE AND TWO_ALN)
@@R_INIT        CSEG    UNITP
$_ELSEIF(SMALL)
@@RSINIT        CSEG    BASE
$ELSE
@@R_INIT        CSEG
$ENDIF
_@R_INIT:
$_IF(SMALL)
```

```
@@RSINIS        CSEG    BASE
_@R_INIS:
@@RSINS1        CSEG    BASE
_@R_INS1:
$ELSE
@@R_INIS        CSEG
_@R_INIS:
@@R_INS1        CSEG
_@R_INS1:
$ENDIF
$_IF(MEDIUM AND (LOC_0=0))
@@INITM DSEG    PAGE64K
_@INIT:
@@DATAM DSEG    PAGE64K
_@DATA:
$_ELSEIF(LARGE AND TWO_ALN)
@@INIT  DSEG    UNITP
_@INIT:
@@DATA  DSEG    UNITP
_@DATA:
$ELSE
@@INIT  DSEG
_@INIT:
@@DATA  DSEG
_@DATA:
$ENDIF
@@INIS  DSEG    SADDR2
_@INIS:
@@DATS  DSEG    SADDR2
_@DATS:
@@INIS1 DSEG    SADDR
_@INIS1:
@@DATS1 DSEG    SADDR
_@DATS1:
$_IF(SMALL)
@@CODES CSEG    BASE
@@CALFS CSEG    FIXEDA
$ELSE
@@CODE  CSEG
@@CALF  CSEG    FIXED
$ENDIF
$_IF(MEDIUM AND (LOC_0=0))
@@CNSTM CSEG    PAGE64K
$_ELSEIF(LARGE AND TWO_ALN)
@@CNST  CSEG    UNITP
```

```
$_ELSEIF(LARGE)
@@CNST  CSEG
$ELSE
@@CNSTS CSEG    BASE
$ENDIF
@@CALT  CSEG    CALLT0
@@BITS  BSEG    SADDR2
@@BITS1 BSEG    SADDR
;
        END
```

8.4 ROMization Processing in Startup Module for Flash Area

The startup modules for flash differ with the ordinary startup modules in the following points.

Table 8-10. ROM Area Section for Initialization Data

Memory Model	Variable Type	Segment	First Label	Terminal Label
Large model (without 2-byte alignment), medium model	External variable with initial value (a)	@ER_INIT CSEG	E@R_INIT	E?R_INIT
	sreg variable with initial value (c)	@ER_INIS CSEG	E@R_INIS	E?R_INIS
	sreg1 variable with initial value (e)	@ER_INS1 CSEG	E@R_INS1	E?R_INS1
Large model (with 2-byte alignment)	External variable with initial value (a)	@ER_INIT CSEG UNITP	E@R_INIT	E?R_INIT
	sreg variable with initial value (c)	@ER_INIS CSEG	E@R_INIS	E?R_INIS
	sreg1 variable with initial value (e)	@ER_INS1 CSEG	E@R_INS1	E?R_INS1
Small model	External variable with initial value (a)	@ERSINIT CSEG BASE	E@R_INIT	E?R_INIT
	sreg variable with initial value (c)	@ERSINIS CSEG BASE	E@R_INIS	E?R_INIS
	sreg1 variable with initial value (e)	@ERSINS1 CSEG BASE	E@R_INS1	E?R_INS1

Table 8-11. RAM Area Section for Copy Destination

Memory Model	Variable Type	Segment	First Label	Terminal Label
Large model (without 2-byte alignment), medium model (location 0), small model	External variable with initial value (a)	@EINIT DSEG	E@INIT	E?INIT
	External variable without initial value (b)	@EDATA DSEG	E@DATA	E?DATA
	sreg variable with initial value (c)	@EINIS DSEG SADDR2	E@INIS	E?INIS
	sreg variable without initial value (d)	@EDATS DSEG SADDR2	E@DATS	E?DATS
	sreg1 variable with initial value (e)	@EINIS1 DSEG SADDR	E@INIS1	E?INIS1
	sreg1 variable without initial value (f)	@EDATS1 DSEG SADDR	E@DATS1	E?DATS1
Large model (with 2-byte alignment)	External variable with initial value (a)	@EINIT DSEG UNITP	E@INIT	E?INIT
	External variable without initial value (b)	@EDATA DSEG UNITP	E@DATA	E?DATA
	sreg variable with initial value (c)	@EINIS DSEG SADDR2	E@INIS	E?INIS
	sreg variable without initial value (d)	@EDATS DSEG SADDR2	E@DATS	E?DATS
	sreg1 variable with initial value (e)	@EINIS1 DSEG SADDR	E@INIS1	E?INIS1
	sreg1 variable without initial value (f)	@EDATS1 DSEG SADDR	E@DATS1	E?DATS1
Medium model (location 15)	External variable with initial value (a)	@EINITM DSEG PAGE64K	E@INIT	E?INIT_F
	External variable without initial value (b)	@EDATAM DSEG PAGE64K	E@DATA	E?DATA_F
	sreg variable with initial value (c)	@EINIS DSEG SADDR2	E@INIS	E?INIS
	sreg variable without initial value (d)	@EDATS DSEG SADDR2	E@DATS	E?DATS
	sreg1 variable with initial value (e)	@EINIS1 DSEG SADDR	E@INIS1	E?INIS1
	sreg1 variable without initial value (f)	@EDATS1 DSEG SADDR	E@DATS1	E?DATS1

- In the startup module, the following labels are added at the head of each segment in ROM area and RAM area.

  E@R_INIT, E@R_INIS, E@R_INS1, E@INIT, E@DATA, E@INIS, E@DATS, E@INIS, E@DATS1

- In the terminal module, the following labels are added at the terminal of each segment in ROM area and RAM area.

  E?R_INIT, E?R_INIS, E?R_INS1, E?INIT (medium model location 15 is E?INIT_F), E?DATA (medium model location 15 is E?DATA_F), E?INIS, E?DATS, E?INIS1, E?DATS1

- The startup module copies the contents from the first label address of each segment in ROM area to the terminal label address -1, to the area from the first label address of each segment in RAM area.

- E@DATA to E?DATA (medium model location 15 is E?DATA_F), E@DATS to E?DATS, and E@DATS1 to E?DATS1 are filled with zeros.

CHAPTER 9 ERROR MESSAGES

9.1 Error Message Format

The error message format is as follows.

```
Source-file-name (line-number) : Error-message
```

Examples

```
prime.c(8) : F712 Declaration syntax
prime.c(8) : F301 Syntax error
prime.c(8) : F701 External definition syntax
prime.c(19) : W745 Expected function prototype
```

However, the following output format is used only for the internal errors F101, F103, and F104.

```
[xxx.c <yyy> zzz] F101 Internal error
[xxx.c <yyy> zzz] F103 Intermediate file error
[xxx.c <yyy> zzz] F104 Illegal use of register
```

xxx.c: source file name, yyy: line number, zzz: message

9.2 Types of Error Messages

The following ten types of error messages are output by the compiler.

(1) Error message for a command line
(2) Error message for an internal error or memory
(3) Error message for a character
(4) Error message for a configuration element
(5) Error message for conversion
(6) Error message for an expression
(7) Error message for a statement
(8) Error message for a declaration or function definition
(9) Error message for a preprocessing directive
(10) Error message for fatal file I/O and running on an illegal operating system

9.3 List of Error Messages

It is necessary to understand the format of an error number before using the list of error messages. The error number indicates the type of error message and the compiler processing for the error.

The error number format is as follows.

```
A/F/Wnnn
```

A: ABORT

After the error message is output, the compile processing ends immediately. The object module file and the assembler source module file are not output.

F: FATAL

After the error message is output, the error portion is ignored and processing continues. The object module file and the assembler source module file are not output.

W: WARNING

After the warning message is output, processing continues. The file specified by the option is output.

nnn (3-digit number)

From 001	Error message for a command line
From 101	Error message for an internal error or memory
From 201	Error message for a character
From 301	Error message for a configuration element
From 401	Error message for conversion
From 501	Error message for an expression
From 601	Error message for a statement
From 701	Error message for a declaration or a function definition
From 801	Error message for a preprocessing directive
From 901	Error message for fatal file I/O or running on an illegal operating system

Caution If the file name contains a syntax error, the file name is added to the message. An error message is added, changed, and deleted according to the language specification of the C compiler being developed.

(1) Error message for a command line <from 001> (1/3)

A001	Message	Missing input file
	Cause	The input source file name was not specified.
	Response	“Please enter ‘cc78k4--’ if you want help message” is output. Use the --, -?, or -H option to reference the help file and input the file name correctly.
A002	Message	Too many input files
	Cause	Multiple input source file names are specified.
	Response	“Please enter ‘cc78k4--’ if you want help message” is output. Use the --, -?, or -H option to reference the help file and input the file name correctly.
A003	Message	Unrecognized string
	Cause	An item other than an option was specified on the interactive command line.
A004	Message	Illegal file name file name
	Cause	Either the format, characters, or number of characters in the specified file name are incorrect.
A005	Message	Illegal file specification
	Cause	An illegal file name was specified.
A006	Message	File not found
	Cause	The specified input file does not exist.
A007	Message	Input file specification overlapped file name
	Cause	Duplicate input file names were specified.
A008	Message	File specification conflicted file name
	Cause	Duplicate I/O file names were specified.
A009	Message	Unable to make file file name
	Cause	Since the specified output file already exists as a read-only file, it cannot be created.
A010	Message	Directory not found
	Cause	A drive or directory not existed is included in the output file name.
A011	Message	Illegal path
	Cause	An illegal path name was specified in the option setting the path name in the parameter.
A012	Message	Missing parameter ‘option’
	Cause	A required parameter is not specified.
	Response	“Please enter ‘cc78k4--’ if you want help message” is output. Use the --, -?, or -H option to reference the help file and input the parameter correctly.
A013	Message	Parameter not needed ‘option’
	Cause	An unnecessary option parameter was specified.
	Response	“Please enter ‘cc78k4--’ if you want help message” is output. Use the --, -?, or -H option to reference the help file and input the parameter correctly.
A014	Message	Out of range ‘option’
	Cause	The specified value of the option parameter is out of range.
	Response	“Please enter ‘cc78k4--’ if you want help message” is output. Use the --, -?, or -H option to reference the help file and input the value correctly.
A015	Message	Parameter is too long
	Cause	The number of characters in the option parameter exceeded the limit.

(1) Error message for a command line <from 001> (2/3)

A016	Message	Illegal parameter ‘option’
	Cause	There is a syntax error in the option parameter.
	Response	“Please enter ‘cc78k4--’ if you want help message” is output. Use the --, -?, or -H option to reference the help file and input the option correctly.
A017	Message	Too many parameters
	Cause	The total number of option parameters exceeds the limit.
A018	Message	Option is not recognized ‘option’
	Cause	An incorrect option was specified.
	Response	“Please enter ‘cc78k4--’ if you want help message” is output. Use the --, -?, or -H option to reference the help file and input the option correctly.
A019	Message	Parameter file nested
	Cause	The -F option was specified in the parameter file.
	Response	Since a parameter file cannot be specified in a parameter file, correct them so that there is no nesting.
A020	Message	Parameter file read error
	Cause	The parameter file read failed.
A021	Message	Memory allocation failed
	Cause	Memory allocation failed.
W022	Message	Same category option specified – ignored ‘option’
	Cause	Conflicting options had duplicate specifications.
	Compiler	The option specified later is validated and processing continues.
W023	Message	Incompatible chip name
	Cause	The device type in the command line and the device type in the source differ.
	Compiler	The device type in the command line has priority.
A024	Message	Illegal chip specifier on command line
	Cause	The device type in the command line is incorrect.
W027	Message	‘-MS’ or ‘-MM’ option specified - ignored ‘-CSA’
	Cause	Location function specification option -CSA is ignored because the small model (-MS) or medium model (-MM) is specified by the memory model specification option.
W028	Message	‘-MS’ option specified - ignored ‘-CS15’
	Cause	Location function specification option -CS15 is ignored because the small model (-MS) is specified by the memory model specification option.
W029	Message	‘-QC’ option is not portable
	Cause	The -QC option does not conform to the ANSI standard (for details about -QC, see **CHAPTER 5 COMPILER OPTIONS**).
W031	Message	‘-ZP’ option is not portable
	Cause	The -ZP option does not conform to the ANSI standard (for details about -ZP, see **CHAPTER 5 COMPILER OPTIONS**).
W032	Message	‘-ZC’ option is not portable
	Cause	The -ZC option does not conform to the ANSI standard (for details about -ZC, see **CHAPTER 5 COMPILER OPTIONS**).

(1) Error message for a command line <from 001> (3/3)

W033	Message	Same category option specified ‘option’
	Cause	Conflicting options had duplicate specifications.
	Response	“Please enter ‘cc78k4--’ if you want help message” is output. Use the --, -?, or -H option to reference the help file and correct the input.
W042	Message	‘-QH’ option is not portable
	Cause	The -QH option does not conform to the ANSI standard (for details about -QH, see **CHAPTER 5 COMPILER OPTIONS**).
W043	Message	‘-ZO’ option specified - ignored ‘-ZR’
	Cause	Since the old specification function interface specification option -ZO is specified, the pascal function interface specification option -ZR is ignored.
W046	Message	‘-ZF’ option specified - regarded as ‘-QL1’
	Cause	Since the flash area object creation option -ZF is specified, after -QL2 in the library replace option of constant code pattern -QL is regarded as - QL1.

(2) Error message for an internal error and memory <from 101>

F101	Message	Internal error
	Cause	An internal error occurred.
	Response	Contact support.
F102	Message	Too many errors
	Cause	The total number of FATAL errors exceeded 30.
	Compiler	Processing continues, but subsequent error messages are not output. The previous errors may have caused many errors. First, remove these previous errors.
F103	Message	Intermediate file error
	Cause	The intermediate file contains errors.
	Response	Contact support.
F104	Message	Illegal use of register
	Cause	The register is incorrectly used.
F105	Message	Register overflow : simplify expression
	Cause	The expression is too complex and no more usable registers remain.
	Response	Simplify the complex expression causing the error.
A106	Message	Stack overflow ‘overflow cause’
	Cause	The stack overflowed. The cause of the overflow is the stack or heap.
	Response	Contact support.
F108	Message	Compiler limit : too much automatic data in function
	Cause	The area allocated for the automatic variables of the function exceeded the limit of 64 KB.
	Response	Decrease the variables so that 64 KB is not exceeded.
F109	Message	Compiler limit : too much parameter of function
	Cause	The area allocated for the parameters of the function exceeded the limit of 64 KB.
	Response	Decrease the parameters so that 64 KB is not exceeded.
F110	Message	Compiler limit : too much code defined in file
	Cause	• Small model: The area allocated for the code in the file exceeded the limit of 64 KB.
		• Medium/large model: The area allocated for the code in the file exceeded the limit of 1,024 KB.
F111	Message	Compiler limit : too much global data defined in file
	Cause	• Small/medium model: The area allocated for the global variables in the file exceeded the limit of 64 KB.
		• Large model: The area allocated for the global variables in the file exceeded the limit of 16 MB.
F113	Message	Compiler limit: too many local labels
	Cause	Number of local labels in one function exceeds the process limit.
	Response	The function itself is too large. Divide it.

(3) Error message for a character <from 201>

F201	Message	Unknown character ‘hexadecimal number’
	Cause	Characters having the specified internal code cannot be recognized.
F202	Message	Unexpected EOF
	Cause	The file ended while the function was operating.
W203	Message	Trigraph encountered
	Cause	A trigraph sequence (3-character representation) appeared.
	Response	If the -ZA option was specified, since trigraph sequences are valid, this warning is not output.

(4) Error message for configuration element <from 301> (1/2)

F301	Message	Syntax error
	Cause	A syntax error occurred.
	Response	Make sure there are no description errors in the source.
F303	Message	Expected identifier
	Cause	An identifier is required for the goto statement.
	Response	Correctly describe the identifier to be specified for the goto statement.
W304	Message	Identifier truncate to ‘identifier’
	Cause	The specified identifier is too long. The character number of the identifier (including ‘_’) exceeds 250.
	Response	Shorten the length of the identifier.
F305	Message	Compiler limit : too many identifiers with block scope
	Cause	There are too many symbols having block scope in one block.
F306	Message	Illegal index , indirection not allowed
	Cause	An index is used in an expression that does not take a pointer value.
F307	Message	Call of non-function ‘variable name’
	Cause	The variable name is used as a function name.
F308	Message	Improper use of a typedef name
	Cause	The typedef name is improperly used.
F309	Message	Unused ‘variable name’
	Cause	The specified variable is declared in the source, but is never used.
F310	Message	‘Variable name’ is assigned a value which is never used
	Cause	The specified variable is used in an assignment statement, but is never used otherwise.
F311	Message	Number syntax
	Cause	The constant expression is illegal.
F312	Message	Illegal octal digit
	Cause	This is illegal as an octal digit.
F313	Message	Illegal hexadecimal digit
	Cause	This is illegal as a hexadecimal digit.
F314	Message	Too big constant
	Cause	The constant is too large and cannot be represented.

(4) Error message for configuration element <from 301> (2/2)

W315	Message	Too small constant
	Cause	The constant is too small and cannot be represented.
F316	Message	Too many character constants
	Cause	The character constant exceeds two characters.
F317	Message	Empty character constant
	Cause	The character constant ‘ ’ is empty.
F318	Message	No terminated string literal
	Cause	There is no double quote “ ” at the end of the string.
F319	Message	Changing string literal
	Cause	A character string literal is rewritten.
W320	Message	No null terminator in string literal
	Cause	The null character is not added to the character string literal.
F321	Message	Compiler limit : too many characters in string literal
	Cause	The number of characters in the character string literal exceeded 509.
F322	Message	Ellipsis requires three periods
	Cause	The compiler detected “..”, but “...” is required.
F323	Message	Missing ‘delimiter’
	Cause	The delimiter is incorrect.
F324	Message	Too many }’s
	Cause	The ‘{’ and ‘}’ are incorrectly paired.
F325	Message	No terminated comment
	Cause	The comment is not terminated by “*/”.
F326	Message	Illegal binary digit
	Cause	This is illegal as a binary digit.
F327	Message	Hex constants must have at least one hex digit
	Cause	At least one hexadecimal digit is required in a hexadecimal constant representation.
W328	Message	Unrecognized character escape sequence ‘character’
	Cause	The escape sequence cannot be correctly recognized.
F329	Message	Compiler limit : too many comment nesting
	Cause	The number of nesting levels of comments exceeded the limit of 255.
F336	Message	‘-ZO’ option specified - _ _flash keyword is not allowed
	Cause	The _ _flash keyword cannot be used because the old specification function interface option (-ZO) is specified.
W337	Message	‘-ZO’ option specified - ignored ‘__pascal’ in this file
	Cause	Since the old specification function interface specification option -ZO is specified, __pascal keyword is ignored in this file.
W340	Message	Unreferenced label ‘label name’
	Cause	The specified label has been defined, but has not been referenced even once.

(5) Error message for conversion <from 401>

W401	Message	Conversion may lose significant digits
	Cause	A long was converted into int. Be careful the value may be lost.
F402	Message	Incompatible type conversion
	Cause	An illegal type conversion took place in the assignment statement.
F403	Message	Illegal indirection
	Cause	The * operator is used in an integer type expression.
F404	Message	Incompatible structure type conversion
	Cause	The types on both sides of an assignment statement to a structure or structure pair differ.
F405	Message	Illegal lvalue
	Cause	This is an illegal left value.
F406	Message	Cannot modify a const object ‘variable name’
	Cause	A variable with the const attribute is rewritten.
F407	Message	Cannot write for read / only sfr ‘SFR name’
	Cause	Tried to write to a read-only sfr.
F408	Message	Cannot read for write/only sfr ‘SFR name’
	Cause	Tried to read a write-only sfr.
F409	Message	Illegal SFR access ‘sfr name’
	Cause	Illegal data was read from or written to an sfr.
W410	Message	Illegal pointer conversion
	Cause	A pointer and an object other than a pointer are converted.
W411	Message	Illegal pointer combination
	Cause	Different types are mixed in the same pointer combination.
W412	Message	Illegal pointer combination in conditional expression
	Cause	Different types in a pointer combination are used in a conditional expression.
F413	Message	Illegal structure pointer combination
	Cause	Pointers to structures with different types are mixed.
F414	Message	Expected pointer
	Cause	A pointer is required.

(6) Error message for an expression <from 501> (1/3)

F501	Message	Expression syntax
	Cause	The expression contained a syntax error.
F502	Message	Compiler limit : too many parentheses
	Cause	The nesting of parentheses in the expression exceeded 32.
W503	Message	Possible use of ‘variable name’ before definition
	Cause	The variable is used before a value is assigned to it.
W504	Message	Possibly incorrect assignment
	Cause	The main operators in conditional expressions, such as if, while, and do statements, are assignment operators.
W505	Message	Operator ‘operator’ has no effect
	Cause	The operator has no effect in the program. This is probably due to a description error.
F507	Message	Expected integral index
	Cause	Only an integer type expression is allowed in the index of an array.
W508	Message	Too many actual arguments
	Cause	The number of arguments specified in a function call is more than the number of parameters specified in the list of argument types or the function definition.
W509	Message	Too few actual arguments
	Cause	The number of arguments specified in a function call is fewer than the number of parameters specified in the list of argument types or the function definition.
W510	Message	Pointer mismatch in function ‘function name’
	Cause	The given arguments have different pointer types than the arguments specified in the list of argument types or the function definition.
W511	Message	Different argument types in function ‘function name’
	Cause	The argument types given in the function call do not match the list of argument types or the function definition.
F512	Message	Cannot call function in norec function
	Cause	A function is called in the norec function. A function cannot be called in a norec function.
F513	Message	Illegal structure / union member ‘member name’
	Cause	A member that is referenced in the structure and not defined is indicated.
F514	Message	Expected structure / union pointer
	Cause	The expression before the ‘→’ operator is not a pointer to a structure or a union, but is the name of a structure or a union.
	Response	Make the expression before the ‘→’ operator a pointer to a structure or a union.
W515	Message	Expected structure / union name
	Cause	The expression before the ‘.’ operator is not the name of a structure or a union, but is a pointer to a structure or a union.
	Response	Make the expression before the ‘.’ operator a structure or a union variable.
F516	Message	Zero sized structure ‘structure name’
	Cause	The size of the structure is zero.
F517	Message	Illegal structure operation
	Cause	An operator that cannot be used in a structure is used.

(6) Error message for an expression <from 501> (2/3)

F518	Message	Illegal structure / union comparison
	Cause	Two structures or unions cannot be compared.
F519	Message	Illegal bit field operation
	Cause	There is an illegal description for a bit field.
F520	Message	Illegal use of pointer
	Cause	The only operators that can be used on pointers are addition, subtraction, assignment, relational, indirection (*), and member reference (->).
F521	Message	Illegal use of floating
	Cause	An operator that cannot be used on floating-point variables is used.
W522	Message	Ambiguous operators need parentheses
	Cause	Two shift, relational, and bit logical operators appear continuously without parentheses.
F523	Message	Illegal bit, boolean type operation
	Cause	An illegal operation is performed on bit or boolean type variables.
F524	Message	'&' on constant
	Cause	A constant address is not obtained.
F525	Message	'&' requires lvalue
	Cause	The '&' operator can only be used in an expression assigned to the left value.
F526	Message	'&' on register variable
	Cause	The address of a register variable is not obtained.
F527	Message	'&' on bit, boolean ignored
	Cause	The address of a bit field, or bit or boolean type variable is not obtained.
W528	Message	'&' is not allowed array / function, ignored
	Cause	The & operator does not have to be applied to an array name or function name.
F529	Message	Sizeof returns zero
	Cause	The value of the sizeof expression becomes zero.
F530	Message	Illegal sizeof operand
	Cause	The operand of the sizeof expression must be an identifier or a type name.
F531	Message	Disallowed conversion
	Cause	Illegal casting occurred.
	Response	Check for illegal casting. This error occurs when a constant is cast to a pointer, or when an address is outside the range of the memory model.
F532	Message	Pointer on left, needs integral right : 'operator'
	Cause	Since the left operand is a pointer, the right operand must be an integral value.
F533	Message	Invalid left-or-right operand : 'operator'
	Cause	The left or right operand is illegal for the operator.
F534	Message	Divide check
	Cause	The divisor of the / operation or % operation is zero.

(6) Error message for an expression <from 501> (3/3)

F535	Message	Invalid pointer addition
	Cause	Two pointers are not added.
F536	Message	Must be integral value addition
	Cause	Only integral values can be added to a pointer.
F537	Message	Illegal pointer subtraction
	Cause	The subtraction between pointers must be for pointers having the same type.
F538	Message	Illegal conditional operator
	Cause	The conditional operator is not correctly described.
F539	Message	Expected constant expression
	Cause	A constant expression is required.
W540	Message	Constant out of range in comparison
	Cause	The constant partial expression is compared to a value outside of the range permitted by the type of the other partial expression.
F541	Message	Function argument has void type
	Cause	The argument of the function has the void type.
W543	Message	Undeclared parameter in noauto or norec function prototype
	Cause	The parameter declarations are not in the prototype declarations of the noauto or norec function.
F544	Message	Illegal type for parameter in noauto or norec function prototype
	Cause	Parameters with illegal types are declared in the prototype declarations of the noauto or norec function.
F546	Message	Too few actual argument for inline function ‘function name’
	Cause	The number of arguments specified in the function call of a function expanded inline is less than the number of parameters provided in the specifications.

(7) Error message for a statement <from 601>

F602	Message	Compiler limit : too many characters in logical source line
	Cause	The number of characters in a logical source line exceeded 2048.
F603	Message	Compiler limit : too many labels
	Cause	The number of labels exceeded 33.
F604	Message	Case not in switch
	Cause	The case statement is not described in the correct position.
F605	Message	Duplicate case ‘label name’
	Cause	The same case label is described two or more times in a switch statement.
F606	Message	Non constant case expression
	Cause	Something other than an integral constant is specified in a case statement.
F607	Message	Compiler limit : too many case labels
	Cause	The number of case labels in the switch statement exceeded 257.
F608	Message	Default not in switch
	Cause	The default statement is not described in the correct position.
F609	Message	More than one ‘default’
	Cause	The default statement is described multiple times in the switch statement.
F610	Message	Compiler limit : block nest level too depth
	Cause	The block nesting exceeded 45.
F611	Message	Inappropriate ‘else’
	Cause	There is no correspondence between if and else.
W613	Message	Loop entered at top of switch
	Cause	A while, do, or for is specified immediately after the switch statement.
W615	Message	Statement not reached
	Cause	The statement is never reached.
F617	Message	Do statement must have ‘while’
	Cause	A while is required at the end of a do.
F620	Message	Break / continue error
	Cause	The positions of the break and continue statements are incorrect.
F621	Message	Void function ‘function name’ cannot return value
	Cause	A function declared as void returns a value.
W622	Message	No return value
	Cause	A function that should return a value does not return a value.
	Response	If a value must be returned, add a return statement. If a value does not have to be returned, give the function the void type.
F623	Message	No effective code and data, cannot create output file
	Cause	Since the code and data are not valid, the output file cannot be created.

(8) Error message for a declaration and function definition <from 701> (1/5)

F701	Message	External definition syntax
	Cause	The function is not correctly defined.
F702	Message	Too many callt functions
	Cause	There are too many declarations of the callt function. A maximum of 32 callt functions can be declared.
	Response	Decrease the number of callt function declarations.
F703	Message	Function has illegal storage class
	Cause	The function is specified with an illegal storage class.
F704	Message	Function returns illegal type
	Cause	The return value of the function is an illegal type.
F705	Message	Too many parameters in noauto or norec function
	Cause	A noauto or norec function has too many parameters.
	Response	Decrease the number of parameters.
F706	Message	Parameter list error
	Cause	The function parameter list contains errors.
F707	Message	Not parameter ‘character string’
	Cause	Something other than a parameter is declared in a function definition.
W708	Message	Already declared symbol ‘variable name’
	Cause	The same variable has already been declared.
F710	Message	Illegal storage class
	Cause	The auto and register declarations are outside the function or the boolean variable is defined inside the function.
F711	Message	Undeclared ‘variable name’; function ‘function name’
	Cause	An undeclared variable is used.
F712	Message	Declaration syntax
	Cause	The declaration statement does not match the syntax.
F713	Message	Redefined ‘variable name’
	Cause	Two or more of the same variables are defined.
	Response	Set the variable definition once.
W714	Message	Too many register variables
	Cause	There are too many declarations of register variables.
	Response	Decrease the number of register variables. For the number that can be used, see **CHAPTER 11** in the **Language (U15556E)** manual.
F715	Message	Too many sreg variables
	Cause	There are too many declarations of sreg variables.
F716	Message	Not allowed automatic data in noauto function
	Cause	Automatic variables cannot be used in the noauto function.

(8) Error message for a declaration and function definition <from 701> (2/5)

F717	Message	Too many automatic data in noauto or norec function
	Cause	There are too many automatic variables in a noauto or norec function.
	Response	Decrease the number of automatic variables in a noauto or norec function. For the number that can be used, see **CHAPTER 11** in the **Language (U15556E)** manual.
F718	Message	Too many bit, boolean type variables
	Cause	There are too many bit and boolean type variables.
	Response	Decrease the number of bit, boolean, and _ _boolean type variables. For the number that can be used, see **CHAPTER 11** in the **Language (U15556E)** manual.
F719	Message	Illegal use of type
	Cause	An illegal type name is used.
F720	Message	Illegal void type for ‘identifier’
	Cause	The identifier is declared by void.
W721	Message	Illegal type for register declaration
	Cause	A register declaration is specified with an illegal type.
	Compiler	The register declaration is ignored and processing continues.
F723	Message	Illegal type for parameter in noauto or norec function
	Cause	The type of a parameter in a noauto or norec function is too big.
F724	Message	Structure redefinition
	Cause	The same structure is redefined.
W725	Message	Illegal zero sized structure member
	Cause	The area taken as a structure member is not secured.
	Response	When an array is used in the member of a structure and the index is given by a constant computation, sometimes there is overflow by the -QC2 action and the area is not secured. In this case, specify -QC1 as in -QC. -QC is included in the default options.
F726	Message	Function cannot be structure / union member
	Cause	A function cannot be a member of a structure or a union.
F727	Message	Unknown size structure / union ‘name’
	Cause	Structures or unions have undefined sizes.
F728	Message	Compiler limit : too many structure / union members
	Cause	The members in a structure or union exceeded 256.
F729	Message	Compiler limit : structure / union nesting
	Cause	The nesting of structures or unions exceeded 15.
F730	Message	Bit field outside of structure
	Cause	A bit field is declared outside of the structure.
F731	Message	Illegal bit field type
	Cause	A type other than an integral type is specified in a bit field type.
F732	Message	Too long bit field size
	Cause	The number of bit specifications in a bit field declaration exceeds the number of bits in that type.
F733	Message	Negative bit field size
	Cause	The number of bit specifications in a bit field declaration is negative.

(8) Error message for a declaration and function definition <from 701> (3/5)

F734	Message	Illegal enumeration
	Cause	The enumeration type declaration does not match the syntax.
F735	Message	Illegal enumeration constant
	Cause	The enumeration constant is illegal.
F736	Message	Compiler limit : too many enumeration constants
	Cause	The number of enumeration constants exceeded 255.
F737	Message	Undeclared structure / union / enum tag
	Cause	A tag is not declared.
F738	Message	Compiler limit : too many pointer modifying
	Cause	The number of indirection operators (*) exceeded 12 in a pointer definition.
F739	Message	Expected constant
	Cause	A variable is used in the index in an array declaration.
F740	Message	Negative subscript
	Cause	The specification of the size of an array is negative.
F741	Message	Unknown size array ‘array name’
	Cause	The size of an array is undefined.
	Response	Specify the size of the array.
F742	Message	Compiler limit : too many array modifying
	Cause	The array declaration exceeds 12 dimensions.
F743	Message	Array element type cannot be function
	Cause	An array of functions is not allowed.
W744	Message	Zero sized array ‘array name’
	Cause	The number of elements of the defined array is zero.
W745	Message	Expected function prototype
	Cause	The function prototype is not declared.
F747	Message	Function prototype mismatch
	Cause	The function prototype declaration contains errors.
	Response	Check whether the parameter and return value types match the function.
W748	Message	A function is declared as a parameter
	Cause	A function is declared as an argument.
W749	Message	Unused parameter ‘parameter name’
	Cause	The parameter is not used.
F750	Message	Initializer syntax
	Cause	The initialization does not match the syntax.
F751	Message	Illegal initialization
	Cause	The constant of an initial value setting does not match the type of the variable.
W752	Message	Undeclared initializer name ‘name’
	Cause	The initializer name is not declared.

(8) Error message for a declaration and function definition <from 701> (4/5)

F753	Message	Cannot initialize static with automatic
	Cause	The static variable cannot be initialized using an automatic variable.
F756	Message	Too many initializers ‘array name’
	Cause	There are more initial values than elements in the declared array.
F757	Message	Too many structure initializers
	Cause	There are more initial values than members in the declared structure.
F758	Message	Cannot initialize a function ‘function name’
	Cause	The function cannot be initialized.
F759	Message	Compiler limit : initializers too deeply nested
	Cause	The depth of the nesting of initialized elements exceeded the limit.
W760	Message	Double and long double are treated as IEEE 754 single format
	Cause	double and long double are handled as IEEE 754 single-precision formats.
W761	Message	Cannot declare sreg with const or function
	Cause	sreg cannot be declared with a const declaration or function.
	Compiler	An sreg declaration is ignored.
W762	Message	Overlapped memory area ‘variable name 1’ and ‘variable name 2’
	Cause	The variable name 1 and variable name 2 areas for which absolute address allocation specification is performed overlap.
W763	Message	Cannot declare const with bit, boolean
	Cause	bit and boolean type variables cannot have const declarations.
	Compiler	A const declaration is ignored.
W764	Message	‘Variable name’ initialized and declared extern-ignored extern
	Cause	An externally referenced variable without a body was initialized.
	Compiler	The extern declaration is ignored.
F765	Message	Undefined static function ‘function name’
	Cause	There was a reference to a function whose body is not in the same file and was declared static.
F766	Message	Illegal type for automatic data in noauto or norec function
	Cause	The type of the automatic variable in a noauto or norec function is large.
F767	Message	Too many _ _sreg1 variables
	Cause	There are too many declarations of _ _sreg1 variables.
F768	Message	Too many _ _boolean1 type variables
	Cause	There are too many declarations of _ _boolean1 type variables.
F770	Message	Parameters are not allowed for interrupt function
	Cause	An interrupt function cannot have arguments.
F771	Message	Interrupt function must be void type
	Cause	An interrupt function must have the void type.
F772	Message	Callt / callf / noauto / norec / __pascal are not allowed for interrupt function
	Cause	An interrupt function cannot be declared callt, callf, noauto, norec, or __pascal.

(8) Error message for a declaration and function definition <from 701> (5/5)

F773	Message	Cannot call interrupt function
	Cause	An interrupt function cannot be called.
F774	Message	Interrupt function can't use with the other kind interrupts
	Cause	An interrupt function cannot be used in other types of interrupts.
F775	Message	Cannot call rtos_task function
	Cause	RTOS task cannot be called.
F776	Message	Cannot call ret_int / ret_wup except in rtos_interrupt_handler
	Cause	ret_int / ret_wup system call cannot be called except in the RTOS_INTERRUPT handler.
F777	Message	Not call ret_int / ret_wup in rtos_interrupt_handler
	Cause	ret_int / ret_wup system call is not called in the RTOS_INTERRUPT handler.
F778	Message	Cannot call ext_tsk in interrupt function
	Cause	ext_tsk system call cannot be called in the interrupt function/interrupt handler.
W779	Message	Not call ext_tsk in rtos_task
	Cause	ext_tsk system call is not called in the RTOS task.
F780	Message	Zero width for bit field 'member name'
	Cause	Member name is specified to the member whose bit specification number of bit field declaration is 0.
W787	Message	Bit field type is char
	Cause	char type is specified for bit field type.
F788	Message	Cannot allocate a __flash function 'function name'
	Cause	The __flash function cannot be allocated.
F789	Message	'-ZF' option did not specify -cannot allocate an EXT_FUNC function 'function name'
	Cause	A flash area object creation option (-ZF) is not specified. The function specified by #pragma EXT_FUNC cannot be allocated.
F790	Message	Callt/callf/__interrupt are not allowed for EXT_FUNC function 'function name'
	Cause	The callt/callf/__interrupt declaration cannot be specified for the function specified by #pragma EXT_FUNC.
F791	Message	'-ZF' option specified –cannot allocate a callt/callf function 'function name'
	Cause	The flash area object creation option (-ZF) is specified. The callt/callf function cannot be allocated.
W792	Message	Undeclared parameter in __pascal function definition or prototype
	Cause	Parameters are not declared in __pascal function definition or prototype declaration. void must be described if there is no parameter.
W793	Message	Variable parameters are not allowed for __pascal function - ignored __pascal
	Cause	Variable parameters cannot be specified for __pascal function. __pascal keyword is ignored.
F799	Message	Cannot allocate 'variable name' out of 'address range'
	Cause	Address specification for variable names for which absolute address allocation specification is performed exceed the specifiable address range.

(9) Error message for a preprocessing directive <from 801> (1/5)

F801	Message	Undefined control
	Cause	A symbol starting with # cannot be recognized as a keyword.
F802	Message	Illegal preprocess directive
	Cause	The preprocess directive is illegal.
	Response	Check if the preprocess directive (such as #pragma) is written in front of the header of the file and if there is any error.
F803	Message	Unexpected non-whitespace before preprocess directive
	Cause	A character other than a whitespace character precedes the preprocess directive.
W804	Message	Unexpected characters following ‘preprocess directive’ directive - newline expected
	Cause	Extra characters follow the preprocess directive.
F805	Message	Misplaced else or elif
	Cause	The #if, #ifdef, and #ifndef do not correspond to #else and #elif.
F806	Message	Misplaced endif
	Cause	The #if, #ifdef, and #ifndef do not correspond to #endif.
F807	Message	Compiler limit : too many conditional inclusion nesting
	Cause	The nesting of conditional compiling exceeded 255.
F810	Message	Cannot find include file ‘file name’
	Cause	The include file was not found.
	Response	Specify the path in which an include file exists or specify a path using -i option for the environmental variable INC78K4.
F811	Message	Too long file name ‘file name’
	Cause	The file name is too long.
F812	Message	Include directive syntax
	Cause	The file name in the definition of the #include statement is not correctly enclosed by “ ” or < >.
F813	Message	Compiler limit : too many include nesting
	Cause	The nesting of the include files exceeded 8.
F814	Message	Illegal macro name
	Cause	The macro name is illegal.
F815	Message	Compiler limit: too many macro nesting
	Cause	The number of nesting macros exceeds 200.
W816	Message	Redefined macro name ‘macro name’
	Cause	The macro name is redefined.
W817	Message	Redefined system macro name ‘macro name’
	Cause	The system macro name is redefined.
F818	Message	Redeclared parameter in macro ‘macro name’
	Cause	The same identifier appears in the parameter list in the macro definition.
W819	Message	Mismatch number of parameter ‘macro name’
	Cause	The number of parameters when referencing differs from the number of parameters defined by #define.

(9) Error message for a preprocessing directive <from 801> (2/5)

F821	Message	Illegal macro parameter ‘macro name’
	Cause	The description enclosed by parentheses ( ) in the function format macro is illegal.
F822	Message	Missing) ‘macro name’
	Cause	The right parenthesis ‘)’ was not found in the same line as the #define definition in the function format macro.
F823	Message	Too long macro expansion ‘macro name’
	Cause	The actual argument during macro expansion is too long.
W824	Message	Identifier truncate to ‘macro name’
	Cause	The macro name is too long.
	Compiler	It is shortened to the displayed ‘macro name’.
W825	Message	Macro recursion ‘macro name’
	Cause	The #define definition becomes recursive.
F826	Message	Compiler limit : too many macro defines
	Cause	The number of macro definitions exceeded 10,000.
F827	Message	Compiler limit : too many macro parameters
	Cause	One macro definition had over 31 calling parameters.
F828	Message	Not allowed #undef for system macro name
	Cause	The system macro name is specified by #undef.
W829	Message	Unrecognized pragma ‘character string’
	Cause	This character string is not supported.
	Response	Check that the keywords are correct. This warning occurs if an incorrect segment was specified in the #pragma section.
F830	Message	No chip specifier : #pragma pc ( )
	Cause	There is no device specifier.
F831	Message	Illegal chip specifier : #pragma pc (device type)
	Cause	The device specifier is illegal.
W832	Message	Duplicated chip specifier
	Cause	The device specifier is duplicated.
F833	Message	Expected #asm
	Cause	There is no #asm.
F834	Message	Expected #endasm
	Cause	There is no #endasm.
W835	Message	Too many characters in assembler source line
	Cause	A line in the assembler source is too long.
W836	Message	Expected assembler source
	Cause	There is no assembler source between #asm and #endasm.

(9) Error message for a preprocessing directive <from 801> (3/5)

W837	Message	Output assembler source file, not object file
	Cause	There is a #asm block or _ _asm statement. Assembler source file is output instead of the object file.
	Response	Specify the -a or -sa compiler option in order to output the #asm and _ _asm statement description to the object file, and then assemble the output assembler file.
F838	Message	Duplicated pragma VECT or INTERRUPT or RTOS_INTERRUPT ‘character string’
	Cause	The #pragma VECT ‘character string’, INTERRUPT ‘character string’, or RTOS_INTERRUPT ‘character string’ is duplicated.
F839	Message	Unrecognized pragma VECT or INTERRUPT or RTOS_INTERRUPT ‘character string’
	Cause	There is an unrecognized #pragma VECT ‘character string’, INTERRUPT ‘character string’, or RTOS_INTERRUPT ‘character string’.
W840	Message	Undefined interrupt function ‘function name’- ignored BANK or SP_SWITCH specified
	Cause	The save destination is specified for an undefined interrupt function.
	Compiler	Register bank specifications or stack switching specifications are ignored.
F842	Message	Unrecognized pragma SECTION ‘character string’
	Cause	There is an unrecognized #pragma SECTION ‘character string’.
F843	Message	Unspecified start address of ‘section name’
	Cause	The correct starting address is not specified after AT in the #pragma section.
F845	Message	Cannot allocate ‘section name’ out of ‘address range’
	Cause	The specified section cannot be placed at the specified starting address.
W846	Message	Rechanged section name ‘section name’
	Cause	The same section name is duplicated and its specification is changed.
	Compiler	The section name specified last is valid and processing continues.
F847	Message	Different BANK or SP_SWITCH specified on same interrupt function ‘function name’
	Cause	A different register bank specification or stack switching specification is specified for an interrupt function with the same name.
W848	Message	Cannot allocate segment to saddr area with -CSA ‘section name’
	Cause	When -CSA is specified, a section cannot be allocated to the saddr area by specifying an address.
	Compiler	To allocate a section to the saddr area by specifying an address, specify either the -CS0 or CS15 option.
W849	Message	#pragma statement is not portable
	Cause	The #pragma statement does not conform to ANSI.
W850	Message	Asm statement is not portable
	Cause	The ASM statement does not conform to ANSI.
W851	Message	Data aligned in ‘area name’
	Cause	The segment area or structure tag is data aligned. The area name is a segment name or a structure tag.
W852	Message	Module name truncate to ‘module name’
	Cause	The specified module name is too long.
	Compiler	It is shortened to the displayed ‘module name’.

(9) Error message for a preprocessing directive <from 801> (4/5)

F853	Message	Unrecognized pragma NAME ‘module name’
	Cause	Unrecognizable characters are in the ‘module name’.
W854	Message	Undefined rtos_task ‘character string’
	Cause	The body of RTOS task is not defined.
W855	Message	Cannot assign rtos_interrupt_handler to non-maskable and software interrupt
	Cause	The non-maskable interrupt and software interrupt cannot be specified in the RTOS_INTERRUPT handler.
W856	Message	Rechanged module name ‘module name’
	Cause	Duplicate module names are specified.
W857	Message	Section name truncate to ‘section name’
	Cause	The specified section name is too long.
	Compiler	It is shortened to the displayed ‘section name’. Make the section name 8 or fewer characters.
F858	Message	Unrecognized pragma ‘pragma character string’ ‘illegal character string’
	Cause	An unrecognized #pragma ‘pragma character string’ ‘illegal character string’ has been found.
F859	Message	Cannot allocate EXT_TABLE out of 0x80 to 0xff80
	Cause	The first addresses of the flash area branch table must be 0x80 to 0xff80.
F860	Message	Redefined #pragma EXT_TABLE
	Cause	#pragma EXT_TABLE has been redefined.
F861	Message	No EXT_TABLE specifier
	Cause	The first address of the flash area branch table is not specified.
F862	Message	Illegal EXT_FUNC id specifier : out of 0x0 to 0xff
	Cause	The ID value of the function in the flash area specified by #pragma EXT_FUNC must be 0x0 to 0xff.
F863	Message	Redefined #pragma EXT_FUNC name ‘function name’
	Cause	A function name specified by #pragma EXT_FUNC has been redefined.
F864	Message	Redefined #pragma EXT_FUNC id ‘ID value’
	Cause	The ID value specified by #pragma EXT_FUNC has been redefined.
F865	Message	Out of range - cannot allocate an EXT_FUNC function ‘function name’
	Cause	The address of the flash area branch table exceeds the range. The function specified by #pragma EXT_FUNC cannot be allocated.
F866	Message	#pragma section found after C body. cannot include file containing #pragma section and without C body at the line
	Cause	There is #pragma section syntax after C body description. Subsequent files that contain #pragma section syntax and no C body (including external reference declarations of variables and functions) cannot be included.
F867	Message	#pragma section found after C body. cannot specify #include after #pragma section in this file
	Cause	There is #pragma section syntax after C body description. Hereafter, #include syntax cannot be described.
F868	Message	#include found after C body. cannot specify #pragma section after #include directive
	Cause	There is #include syntax after C body description. Hereafter, #pragma section syntax cannot be described.

(9) Error message for a preprocessing directive <from 801> (5/5)

W869	Message	‘section name’ section cannot change after C body
	Cause	Specified section cannot be changed after C body description.
W870	Message	Data aligned before ‘variable name’ in ‘section name’
	Cause	Data alignment is done before ‘variable name’ is allocated in ‘section name’.
W871	Message	Data aligned after ‘variable name’ in ‘section name’
	Cause	Data alignment is done after ‘variable name’ is allocated in ‘section name’.
F899	Message	Character string specified by #error is output
	Cause	An #error character string was specified.

(10) Error message for fatal file I/O and running on an illegal operating system <from 901> (1/2)

A901	Message	File I/O error
	Cause	A physical I/O error was generated during file input/output.
	Response	If an intermediate file is the cause, increase the conventional memory, or use EMS or XMS memory.
A902	Message	Cannot open ‘file name’
	Cause	The file cannot be opened.
	Response	Check if a device file is installed in an ordinary search path. The path can be specified by the -Y option. Refer to the description about the search path in **5.3 (20) Device file**.
A903	Message	Cannot open overlay file ‘file name’
	Cause	The overlay file cannot be opened.
A904	Message	Cannot open temp
	Cause	The input temporary file cannot be opened.
A905	Message	Cannot create ‘file name’
	Cause	A file create error was generated.
A906	Message	Cannot create temp
	Cause	A create error was generated in an output temporary file.
	Response	Check if the environmental variable TMP is specified.
A907	Message	No available data block
	Cause	A temporary file cannot be created because the drive file does not have sufficient capacity.
A908	Message	No available directory space
	Cause	A temporary file cannot be created because of insufficient directory area on the drive.
A909	Message	R/O : read / only disk
	Cause	A temporary file cannot be created because the drive is read only.
A910	Message	R/O file : read / only , file opened read / only mode
	Cause	A write error was generated by a temporary file for the following reasons. 1. A file with the same name as a temporary file already exists on the drive and it has the read-only attribute. 2. The output temporary file is opened with the read-only attribute because of internal conflicts.
A911	Message	Reading unwritten data, no available directory space
	Cause	An I/O error was generated for the following reasons. 1. EOF was passed and input proceeded. 2. The temporary file cannot be created because of insufficient directory area on the drive.
A912	Message	Write error on temp
	Cause	A write error was generated to the output temporary file.
	Response	A complex source expression (such as too deep nesting) may be the cause. Contact support.
A913	Message	Requires MS-DOS V2.11 or greater
	Cause	The operating system is not MS-DOS (Ver. 2.11 or later).
A914	Message	Insufficient memory in hostmachine
	Cause	The compiler cannot start because of insufficient memory.
	Response	Increase the free area in the conventional memory.

(10) Error message for fatal file I/O and running on an illegal operating system <from 901> (2/2)

W915	Message	Asm statement found. skip to jump optimize this function ‘function name’
	Cause	#asm block or _ _ asm statement was detected. This function does not have jump optimization. Perform the W837 response.
F922	Message	Heap overflow : please retry compile without -QJ
	Cause	A memory overflow was generated in jump optimization. Recompile without specifying -QJ.
A923	Message	Illegal device file format
	Cause	A device file in an old format was referenced.

APPENDIX A SAMPLE PROGRAMS

A.1 C Source Module File

```
#define TRUE    1
#define FALSE   0
#define SIZE    200

char    mark[SIZE+1];

main()
{
        int i, prime, k, count;

        count = 0;

        for ( i = 0 ; i <= SIZE ; i++)
                mark[i] = TRUE;
        for ( i = 0 ; i <= SIZE ; i++) {
                if (mark[i]) {
                        prime = i + i + 3;
                        printf("%6d",prime);
                        count++;
                                if((count%8) == 0) putchar('\n');
                        for ( k = i + prime ; k <= SIZE ; k += prime)
                                mark[k] = FALSE;
                }
        }
        printf("\n%d primes found.",count);
}

printf(s,i)
char *s;
int i;
{
        int j;
        char *ss;

        j = i;
        ss = s;
}
```

```
putchar(c)
char c;
{
        char d;
        d = c;
}
```

A.2 Execution Example

```
C>cc78K4 –c4026 prime.c -a -p -x -e -ng
```

```
78K/IV Series C Compiler Vx.xx  [xx xxx xxxx]
   Copyright (C) NEC Electronics Corporation xxxx,xxxx


sample\prime.c(18) : W745 Expected function prototype
sample\prime.c(20) : W745 Expected function prototype
sample\prime.c(26) : W622 No return value
sample\prime.c(37) : W622 No return value
sample\prime.c(44) : W622 No return value

Target chip : uPD784026
Device file : Vx.xx

Compilation complete,    0 error(s) and    5 warning(s) found.
```

A.3 Output List

(1) Assembler source module file

```
; 78K/IV Series C Compiler Vx.xx Assembler Source
;                                        Date:xx Jun xxxx Time:xx:xx:xx

; Command   : -c4026 prime.c -a -p -x -e -ng
; In-file   : prime.c
; Asm-file  : prime.asm
; Para-file :

$CHGSFR(15)
$PROCESSOR(4026)
$NODEBUG
$NODEBUGA
$KANJICODE SJIS
$TOL_INF        03FH, 0230H, 02H, 08021H, 00H

        EXTRN   @@isrem
        PUBLIC  _mark
        PUBLIC  _main
        PUBLIC  _printf
        PUBLIC  _putchar

@@CNST  CSEG
L0011:  DB      '%6d'
        DB      00H
L0017:  DB      0AH
        DB      '%d primes found.'
        DB      00H

@@DATA  DSEG
_mark:  DS      (201)

; line     5
; line     8

@@CODE  CSEG
_main:
        push    uup
        push    rp3
        push    vvp
        push    ax
; line    11
        subw    ax,ax
        movw    [sp+0],ax       ; count
; line    13
        subw    rp3,rp3
L0003:
        cmpw    rp3,#0C8H       ; 200
        bgt     $L0004
; line    14
        movw    de,rp3
        mov     a,#01H  ; 1
```

```
        mov     _mark[de],a
        incw    rp3
        br      $L0003
L0004:
; line    15
        subw    rp3,rp3
L0006:
        cmpw    rp3,#0C8H       ; 200
        bgt     $L0007
; line    16
        movw    de,rp3
        mov     a,_mark[de]
        cmp     a,#00H  ; 0
        be      $L0015
; line    17
        addw    de,de
        addw    de,#03H ; 3
        movw    up,de
; line    18
        push    up
        movg    whl,#L0011
        call    $!_printf
        pop     ax
; line    19
        movw    ax,[sp+0]       ; count
        incw    ax
        movw    [sp+0],ax       ; count
; line    20
        movw    bc,ax
        movw    ax,#08H ; 8
        call    !!@@isrem
        or      a,x
        bne     $L0012
        mov     x,#0AH  ; 10
        call    $!_putchar
L0012:
; line    21
        movw    ax,rp3
        addw    ax,up
        movw    vp,ax
L0014:
        cmpw    vp,#0C8H        ; 200
        bgt     $L0015
; line    22
        movw    hl,vp
        mov     a,#00H  ; 0
        mov     _mark[hl],a
        addw    vp,up
        br      $L0014
L0015:
; line    24
        incw    rp3
        br      $L0006
L0007:
```

```
; line    25
        movw    ax,[sp+0]       ; count
        push    ax
        movg    whl,#L0017
        call    $!_printf
        pop     ax
; line    26
        pop     ax
        pop     vvp
        pop     rp3
        pop     uup
        ret
; line    31
_printf:
        push    uup
        push    rp3
        push    vvp
        movg    uup,whl
; line    35
        movw    ax,[sp+11]      ; i
        movw    rp3,ax
; line    36
        movg    vvp,uup
; line    37
        pop     vvp
        pop     rp3
        pop     uup
        ret
; line    41
_putchar:
        push    rp3
        mov     r6,x
; line    43
        mov     r7,r6
; line    44
        pop     rp3
        ret
        END


; Target chip : uPD784026
; Device file : Vx.xx
```

(2) Preprocess list file

```
/*
78K/IV Series C Compiler Vx.xx Preprocess List              Date:xx xxx xxxx Page:1

Command   : -c4026 prime.c -a -p -x -e -ng
In-file   : prime.c
PPL-file  : prime.ppl
Para-file :
*/

    1 : #define TRUE    1
    2 : #define FALSE   0
    3 : #define SIZE    200
    4 :
    5 : char    mark[SIZE+1];
    6 :
    7 : main()
    8 : {
    9 :         int i, prime, k, count;
   10 :
   11 :         count = 0;
   12 :
   13 :         for ( i = 0 ; i <= SIZE ; i++)
   14 :                 mark[i] = TRUE;
   15 :         for ( i = 0 ; i <= SIZE ; i++) {
   16 :                 if (mark[i]) {
   17 :                         prime = i + i + 3;
   18 :                         printf("%6d",prime);
   19 :                         count++;
   20 :                                 if((count%8) == 0) putchar('\n');
   21 :                         for ( k = i + prime ; k <= SIZE ; k += prime)
   22 :                                 mark[k] = FALSE;
   23 :                 }
   24 :         }
   25 :         printf("\n%d primes found.",count);
   26 : }
   27 :
   28 : printf(s,i)
   29 : char *s;
   30 : int i;
   31 : {
   32 :         int j;
   33 :         char *ss;
   34 :
   35 :         j = i;
   36 :         ss = s;
   37 : }
   38 :
   39 : putchar(c)
   40 : char c;
   41 : {
   42 :         char d;
   43 :         d = c;
   44 : }
```

```
/*
 Target chip : uPD784026
 Device file : Vx.xx
*/
```

(3) Cross-reference list file

```
78K/IV Series C Compiler Vx.xx Cross reference List      Date:XX XXX XXXX Page:   1

Command   : -c4026 prime.c –a -p –x –e -ng
In-file   : prime.c
Xref-file : prime.xrf
Para-file :

ATTRIB MODIFY  TYPE    SYMBOL    DEFINE  REFERENCE

EXTERN         array   mark        5      14      16      22
EXTERN         func    main        7
REG1           int     i           9      13      13      13      14      15      15
     15      16      17    17
                                          21
REG1           int     prime       9      17      18      21      21
REG1           int     k           9      21      21      21      22
AUTO1          int     count       9      11      19      20      25
EXTERN         func    printf     28      18      25
EXTERN         func    putchar    39      20
REG1           pointer s          29      36
PARAM
PARAM          int     i          30      35
REG1           int     j          32      35
REG1           pointer ss         33      36
REG1           char    c          40      43
PARAM
REG1           char    d          42      43
               #define TRUE        1      14
               #define FALSE       2      22
               #define SIZE        3       5      13      15      21


 Target chip : uPD784026
 Device file : VX.XX
```

(4) Error list file

```
PRIME.C(   18) : W745 Expected function prototype
PRIME.C(   20) : W745 Expected function prototype
PRIME.C(   26) : W622 No return value
PRIME.C(   37) : W622 No return value
PRIME.C(   44) : W622 No return value


 Target chip : uPD784026
 Device file : VX.XX
Compilation complete,    0 error(s) and    5 warning(s) found.
```

APPENDIX B LIST OF USE-RELATED CAUTIONS

Number	Cautions
1	**[Cautions related to specification of options]** (a) When several specifications have been made for an option that does not allow multiple specifications, the last specification takes priority (is valid). (b) The type specification following the -C option must not be omitted. If it is omitted, an abort error occurs. If the -C option is not specified, be sure to enter #pragma pc (type) in the C source module file instead. During compilation, if the specified option is different from the option in the C source, the specified option takes priority. A warning message is output at that time. (c) If the help option has been specified, all other options are ignored.
2	**[Cautions related to file output destinations]** Only disk-type files can be specified as the output destination for object module files.
3	**[Cautions related to error messages]** When a syntax error has been found in a file, an error message is attached to the file name. If a device file has been specified at a prohibited location, the specified character string is output by itself. In all other cases, the drive, path, and file extension must be attached.
4	**[Cautions related to source file names]** In the CC78K4, the part except the source file name extension (primary name) is used as the module name by default. Therefore, some restrictions apply to the source file names that can be used. (a) Regarding the length of the file name, configure the file name with a primary name and extension within the range allowed by the OS, and separate the primary name and the extension with a dot (.). When using PM plus, separate the primary name and extension with a dot (.), and use ".c", ".C" as the C source extension. (b) The characters that can be used for the primary name and the extension consist of the characters allowed by the OS, except parentheses (()), semicolons (;), and commas (,). Note that a hyphen (-) cannot be used as the first character of a file name. When PM plus is used, do not specify file names or path names that include a space or square brackets ([]), or path names that include 2-byte characters, such as Chinese characters. (c) Sharp symbol (#) cannot be used for file names and path names in parameter files. (d) An error is output during linking for files that have the same name as the first 8 characters of the primary name. (e) If using the ID78K4/ID78K4-NS or SM78K4, the characters that can be used for the file name are lowercase letters (a to z), uppercase letters (A to Z), numbers (0 to 9), underscores (_), and dots (.)
5	**[Cautions related to include files]** It is not possible to define functions (excluding declarations) in an include file and then expand the file within the C source. When definitions are made within an include file, problems such as incorrect display of definition lines during source debugging may occur.

<table>
<tr><th>Number</th><th>Cautions</th></tr>
<tr><td>6</td><td>

[Cautions related to use of output assembler source]

When a C source program contains descriptions that use assembly language such as #asm blocks or _ _ asm statements, the load module file creation procedure sequence is compile, assemble, and then link. Be careful about the following points when using the assembler by outputting the assembler source to perform assembly without outputting direct objects, such as when descriptions using assembly language are used.

(a) If symbols need to be defined in the #asm block (part between #asm and #endasm) and the _ _asm statement, use a symbol of 8 or less characters beginning with the strings ?L@ (for example, ?L@01, ?L@sym, etc.). However, these symbols cannot be defined externally (PUBLIC declaration). It is not possible to define segments in the #asm block and the _ _asm statement. If a symbol of 8 or less characters beginning with the strings ?L@ is not used, the abort error A114 is output during assembly.

(b) Describe the definitions of “normal functions”, “callf functions”, and “callt and interrupt functions” by combining these into three groups.
If definitions are not described in a combination the warning message W717 is output.

(c) When using variables that are extern-ed in the #asm block in C source, EXTRN is not generated if there are no references in other C descriptions, and a link error is output. Therefore, perform EXTRN in the #asm block if no referencing is done in C.

(d) If the C source contains #asm blocks and _ _ asm statements, specify the -A or -SA compiler option to enable assembly descriptions, and assemble the output assembler source.
When using PM plus, either specify the -A/-SA options through individual option specification for sources for which only assembler source files are output, or specify the -A/-SA options through universal option specification.

(e) When using PM plus, the RA78K4 is started regardless of compiler options -O/-NO when compiler option -A or -SA is specified.

(f) When changing the segment name using the #pragma section directive, do not specify a segment having the same name as the primary name of the source file name. Otherwise, abort error A106 is output during assembly.

</td></tr>
<tr><td>7</td><td>

[Cautions when specifying compiler option -QC2]

If the -QC2 option is specified in the CC78K4, the ranges of the types of constants and character constants that can be represented are handled as follows.

–128 to +127	char type
128 to 255	unsigned char type
0U to 255U	unsigned char type
From 256	int type
To –129	int type
‘\0’ to ‘\377’	char type

When specifying the -QC2 option, the calculation results of a pair of char type constants and a pair of unsigned char type constants are handled as char types and unsigned char types, respectively. The calculation result of a char type constant and an unsigned char type constant is handled as unsigned char type.
If the calculation result overflows, cast either of the constants to a type that can represent it or specify the -QC1 or -QC (default) option simultaneously. Casting prevents the data type from changing.

</td></tr>
</table>

Number	Cautions

7	**Example)** When -QC2 option is specified
	`int i;`
	`i = 20*20 /*Negative value*/`
	`i = (int)20*20 /*400*/`
	
	Remark However, when specifying the -QU option, all char type data are handled as unsigned char type. Character constants in the range from '\200' to '\377' are handled as unsigned char type and have values from +128 to +255.

8	**[Usable assembler package]** Since long file names are supported, use of an RA78K4 earlier than Ver. 1.50 may result in errors.
9	**[Cautions when using network]** When the directory where the temporary files are created is placed in a file system shared on a network, file contention may arise, depending on the type of network software being used, and abnormal operation may result. Avoid such contention by setting the options and the environment variables. Do not use the CC78K4 in the network environment when using PM plus.

10	**[Creating link directive file]**
	
	When an area outside of the ROM or RAM area of the target device is used when linking the objects created by the compiler, or when you want to place the code or data at any specified address, create a link directive file and specify the -D option when linking.
	For information about creating link directive files, see **RA78K4 Assembler Package Operation User's Manual (U16708E)** and lk78k4.dr (in the SMP78K4 directory) equipped with the compiler.
	
	Example) When you want to place external variables without initial values (except sreg variables) from a certain C source file to the external memory.
	1. Change the section name for the external variables without initial value at the beginning of the C source.
	`#pragma section @@DATA EXTDATA`
	`⋮`
	
	Caution Initialization of the changed segment and ROMization should be performed by changing the startup routine.
	2. Create a link directive file.
	<lk78k4.dr>
	`memory EXTRAM : (0F000h, 00200h)`
	`merge EXTDATA := EXTRAM`
	
	Heed the following points when creating a link directive file.

<table>
<tr><th>Number</th><th>Cautions</th></tr>
<tr><td>10</td><td>1. When using the -S automatic generation option for stack symbols while linking, it is recommended to secure the stack area by the memory directive of the link directive file and specify its name explicitly. If the area name is omitted, it is used as the stack area in the RAM (except for the SFR area).

Example) When added to the link directive file lk78k4.dr

<pre>memory EXTRAM : (0F000h, 00200h)
memory STK : (0FB00H, 20H)
merge EXTDATA := EXTRAM</pre>
(Command line)
<pre>> lk78k4 s4l.rel prime.rel –bcl4.lib -SSTK –Dlk78k4.dr</pre>
2. The following error may be output when linking in the defined memory area.
<pre>“*** ERROR F206 Segment ‘xxx’ can’t allocate to memory-ignored.”</pre>
[Cause]
Because of insufficient space in the defined memory area, the indicated segment cannot be located.

[Response]
The response action is roughly divided into the following three steps.
1. Examine the size of a segment that cannot be located (refer to the .map file).
2. Based on the size of the segment examined in step 1, increase the size of the area where the segment is located in the directive file.
3. Specify the directive file specification option -D and link.

However, based on the type of the segment marked by an error in step 1, the method used to examine the segment size differs in the following way.

(1) When the segment is automatically generated during compilation
Examine the size of the segment by the map file that is linked and created.
(2) When the segment is created by the user
Examine the size of the segment that is not located by the assemble list file (.prn).</td></tr>
<tr><td>11</td><td>[Cautions when using va_start macro]

When -ZO is not specified, the operation of va_start macro defined in stdarg.h is not guaranteed (because the offset of the first argument differs depending on the function).</td></tr>
<tr><td>12</td><td>[Cautions when referencing special function register (SFR) constant address]

If the 16-bit SFR is referenced by a constant address reference, use the SFR name to reference it since an illegal code is generated to access in 8-bit units.</td></tr>
</table>

Number	Cautions
13	**[Startup routines and libraries]** (a) Use the provided startup routines and libraries with the same versions as the files in the executable form (cc78k4.exe or cc78k4). (b) For the floating point support functions sprintf, vprintf, and vsprintf, if the result value of a conversion that is specified with the conversion specifiers “%f”, “%e”, “%E”, “%g” or “%G” is smaller than the precision, the value is rounded down. “%f” conversion is executed even if the result value of conversion that is specified with “%g” or “%G” is greater than the precision. For functions sscanf and scanf, if no effective character is read during conversion that is specified with the conversion specifiers “%f”, “%e”, “%E”, “%g”, or “%G”, +0 is regarded as the conversion result. If the conversion result is “±”, ±0 is regarded as the conversion result. **[Prevention method]** None
14	**[-ZO option]** When the source is developed using CC78K4 Ver. 1.00 or when used with the assembler, changes must be made unless the -ZO option is specified. However, if the -ZO option is specified, the code efficiency drops and the functions in CC78K4 Ver. 2.00 and later versions are not available.
15	**[Cautions when source debugging with ID78K4, ID78K4-NS]** When calling a pascal function, the Next command operates as the same as the Step command. Return to the calling side of the function with the Return command, etc. When compiler option -ZR is specified, all functions become pascal functions. Therefore, never execute the Next command. When debugging a load module file including the object module file for which compiler option -QL4 is specified, locate the runtime library source supplied by the compiler in the current directory. If the Next or Step command is specified while this load module file is being debugged, the window of the runtime library may be displayed and the current PC may be moved to the runtime library. In this case, set a breakpoint on the line next to the C source and return to the calling function by using the Go command.
16	**[Cautions when source debugging with SM78K4]** Do not execute the Next command when calling a pascal function. Otherwise, a runaway will occur. When compiler option -ZR is specified, all functions become pascal functions. Therefore, be sure not to execute the Next command when the -ZR is specified. When debugging a load module file including the object module file for which compiler option -QL4 is specified, locate the runtime library source supplied by the compiler in the current directory. If the Next command is executed when this load module file is debugged, a hang-up may occur. Therefore, do not execute the Next command. When the Step command is specified, the window of the runtime library may appear and the current PC may be moved to the runtime library. In this case, set a breakpoint on the line next to the C source and return to the calling function by using the Go command.

Number	Cautions
17	**[When performing ROMization]** ROMization consists in placing initial values such as those of external variables that have an initial value in ROM, and then copying these values to RAM during system operation. In CC78K4, a code is generated by default for ROMization. Therefore, it is necessary to perform linking with the startup routine including ROMization during linking. The following startup routines, all including ROMization processing, are provided by the C compiler. If the flash memory self rewrite mode for is used, refer to **Table 8-7**. Startup routines: (1) When not using C standard library area: `S4.REL` (2) When using C standard library area: `S4L.REL` **[Usage example]** `C:> LK78K4 s4.REL SAMPLE.REL -S -BCL4.LIB -OSAMPLE.LMF` SAMPLE.REL: Object module file of user program S4.REL: Startup routine CL4.LIB: Runtime library, standard library The -S option is a stack symbol (_@STBEG, _@STEND) automatic generation option. **Cautions** • **Be sure to link the startup routine at the beginning.** • **When creating a library, create it separately from the library provided by the CC78K4, and specify it prior to the compiler library during linking.** • **Do not add user functions to the CC78K4 library.** • **When using a floating point library (CL4*F.LIB), it is necessary to link the startup routine including the ROMization processing to both the standard library (CL4*.LIB) and the floating point library.** When using sprintf, sscanf, printf, scanf, vprintf, and vsprintf functions supporting floating points Example) `-BMYLIB.LIB -BCL4F.LIB -BCL4.LIB` When using sprintf, sscanf, printf, scanf, vprintf, and vsprintf functions not supporting floating points Example) `-BMYLIB.LIB -BCL4.LIB -BCL4F.LIB`
18	**[Stack area symbol generation (-S)]** In CC78K4, the user cannot secure a stack area. To secure a stack area, specify the -S option during linking. When using PM plus, the S option is automatically attached when the source file specification includes the C source.
19	**[ROM code]** When ordering ROM code, specify the -R or -U object converter options , such as `–r`, `-u0FFH`. -R: Sort HEX file contents by order of addresses. -U fill value: Fill empty space in ROM code with the specified fill value.

<table>
<tr><th>Number</th><th>Cautions</th></tr>
<tr><td>20</td><td>[Help specification option]

In PM plus, compiler options --, -?, and -H, which display option descriptions, are ignored.
For help, click the help button in the <Option Setup> dialog box of each tool.</td></tr>
<tr><td>21</td><td>[-LL option specification]

When using PM plus, the maximum number that can be specified for the -LL option is 32767. If a number that exceeds 32767 is specified, specify -LL with another option.</td></tr>
<tr><td>22</td><td>[Cautions regarding symbol name length]

When using ID78K4-NS V1.11, ID78K4 V1.42, and SM78K4 V1.42 or earlier versions, do not use symbol names with more than 127 characters.</td></tr>
<tr><td>23</td><td>[Cautions when using PM plus]

(a) Parameter file created by user
When PM plus is specified for the parameter file created by the user, those contents are loaded to the parameter file created by PM plus. When creating a parameter file, be careful about the following points. Otherwise, an error will occur during build execution.
• Do not specify a file with the same name as the parameter file created by PM plus.
• Do not describe the device type specification option (-c), device file search path specification option (-y), and source file.
• No validity check is performed for the options described in the parameter file created by the user.
(b) <Assembler Options> dialog box
Do not specify the -C, -F, and -Y options and the source file, or an error will occur during build execution.
No validity check is performed for the options specified in the <Assembler Options> dialog box, so an error will occur during build execution in case of description errors.
(c) Include file dependence relationship
During checking of dependence relationships of include files during MAKE file creation with PM plus, condition statements such as #if are ignored. Therefore, include files not required for build are mistaken as required files.
If described as comments or character strings, they are correctly judged as without dependence relationship.
Example)
<pre>#if 0
#include "header1.h" /* Dependence relationship judged to exist */
#else / * ! zero */
#include "header2.h"
#endif
/*
#include "header3.h"
*/</pre>header1.h is judged as required for build during the dependence relationship check. If the header1.h file exists, header1.h gets registered to "ProjectWindow" of PM plus.
[Prevention method] None. However, this has no effect on the build processing.
(d) Project-related file settings
Compiler attribute startup routines and standard libraries can be added and deleted from the [Project] menu of PM plus or from "Add Project-Related File" displayed by right-clicking in the Project window.
Perform compiler attribute startup routine and standard library settings from the <<Startup Routine>> tab in the <Compiler Options> dialog box.
(e) File names and path names enclosed in square brackets ([ ]) cannot be handled.</td></tr>
</table>

Number	Cautions

24	**[Cautions related to prototype declaration]**
	
	If a function prototype declaration does not contain a function type specification, an error (F301, F701) results.
	Example)
	`f ( void ) ;  /* F301 : Syntax error */`
	`/* F701 : External definition syntax */`
	[Prevention method] Describe the function type.
	Example)
	`int  f ( void ) ;`

25	**[Cautions related to error message output]**
	
	If there is a spelling error in the keyword at the beginning of a line outside the function, the display position of the error line may be offset and an inappropriate error output.
	Example)
	`extren int i ; /* extern spelling error. No error results here. */`
	`/* comment */`
	`void f (void) ;`
	`[EOF]  /* Error such as F712 */`
	[Prevention method] None

26	**[Cautions related to description of comments in preprocessing directive]**
	
	In the description of preprocessing directives, when a comment is described at the same line as a function type macro either before or within a preprocessing directive, an error (F803, F814, F821, etc.) results.
	Example)
	`/* com1 */ #pragma  sfr  /* F803 */`
	`/* com2 */ #define ONE 1  /* F803 */`
	`#define /* com3 */ TWO 2  /* F814 */`
	`#ifdef /* com4 */ ANSI_C  /* F814 */`
	
	`/* com5 */ #endif`
	`#define  SUB( p1,  /* com6 */ p2 )  p2 = p1  /* F821 */`
	[Prevention method] Describe the comment after the preprocessing directive.
	Example)
	`#pragma  sfr  /* com1 */`
	`#define ONE 1  /* com2 */`
	`#define TWO 2  /* com3 */`
	`#ifdef  ANSI_C  /* com4 */`
	
	`#endif  /* com5 */`
	`#define SUB( p1,  p2 )  p2 = p1  /* com6 */`

Number	Cautions

27	**[Cautions related to use of tag for structure, union, or enum]**
	
	If the tag (for a structure, union, or enum) is used before defining it in a function prototype declaration, a warning results if condition (1) below is fulfilled, and an error results if condition (2) below is fulfilled.
	(1) If the tag is used in an argument declaration and a pointer to a structure or union is defined, warning W510 results when a function is called.
	Example)
	`void func ( int , struct st ) ;`
	
	`struct st {`
	`  char memb1;`
	`  char memb2;`
	`} st [ ] = {`
	`  { 1, 'a' } , { 2, 'b' }`
	`} ;`
	`void caller ( void ) {`
	`  func ( sizeof ( st ) / sizeof ( st[0] ) , st );  /* W510 Pointer mismatch */`
	`}`
	(2) If the tag is used in a return value type declaration of an argument declaration, and a structure, union, or enum type is specified, error F737 results.
	Example)
	`void func1( int , struct st ) ;  /* F737 Undeclared structure/union/enum tag */`
	`struct st func2 ( int ) ;  /* F737 Undeclared structure/union/enum tag */`
	`struct st {`
	`  char memb1;`
	`  char memb2;`
	`} ;`
	[Prevention method] Define the tag of the structure, union, or enum beforehand.

<table>
<tr><th>Number</th><th>Cautions</th></tr>
<tr><td>28</td><td>

[Cautions related to initialization of array, structure, or union in function]

Arrays, structures, and unions using something other than a static variable address, constant, or character string cannot be initialized.

Example)

```
void f ( void ) ;
void f ( void ) {
     char *p, *p1, *p2 ;
     char *ca[3] = { p , p1 , p2 } ;  /* Error(F750) */
}
```

[Prevention method] Describe an assignment statement and use it instead of initialization.

Example)

```
void f ( void ) ;
void f ( void ) {
     char *ca[3] ;
     char *p, *p1, *p2 ;
     ca[0] = p ; ca[1] = p1 ; ca[2] = p2 ;
}
```

</td></tr>
<tr><td>29</td><td>

[Cautions related to extern callt function]

If the address of an extern callt function is referenced by initializing the function table, etc., and the callt function is called by the same module, the assemble list is illegal and an error results during assembly.

Example)

```
callt extern void funca ( void ) ;
callt extern void funcb ( void ) ;
callt extern void funcc ( void ) ;

static void ( * const func [ ] ) ( ) = {
     funca , funcb , funcc
} ;
callf void func2 ( void ) {
     funcc ( ) ;
     funcb ( ) ;
     funca ( ) ;
}
```

[Prevention method] Separate the function table and function call module.

</td></tr>
</table>

Number	Cautions

30	**[Cautions related to functions returning a structure]**
	
	When a function returns a structure, an interrupt is generated in the process of returning a return value. If there is a call of the same function during interrupt servicing, the return value is illegal after the interrupt servicing ends.
	Example)
	`struct str {`
	`  char c ;`
	`  int i ;`
	`  long l ;`
	`} st ;`
	
	`struct str func ( ) {`
	`  /* Interrupt occurrence */`
	`  :`
	`}`
	
	`void main ( ) {`
	`  st = func ( ) ;  /* Interrupt occurrence */`
	`}`
	If the func function is called at the interrupt destination during the above servicing, st may be corrupted.
	[Prevention method] None

31	**[Cautions related to union initialization]**
	
	When, during initialization of unions having structures, unions, or arrays as members, the initializer syntax is specified with nesting, error F750 results.
	Example)
	`struct Ss {`
	`  int  d1, d2 ;`
	`} ;`
	`union Au {`
	`  struct Ss t1;`
	`} u = { { 1, 2 } } ;  /* F750  Initializer syntax */`
	[Prevention method] Do not specify the initializer of a union with nesting.
	Example)
	`struct Ss {`
	`  int  d1, d2 ;`
	`} ;`
	`union Au {`
	`  struct Ss t1;`
	`} u = { 1, 2 } ;`

Number	Cautions
32	**[Cautions related to kanji code types]** When source that includes EUC code is used on Windows, set the environmental variable LANG78K to the euc or specify the -ZE option.
33	**[Cautions when using small model]** When using the small model (-MS), note the following. In the small model, the W, V, U, and T registers of WHL, VVP, UUP, and TDE are set to 0H at startup. The codes are then generated assuming that 0H is retained (setting the W, V, U, and T register values is performed in the startup routine supplied with the CC78K4). Therefore, when describing an assembler source and linking it without using the startup routine supplied with the CC78K4, first set the W, V, U, and T registers to 0 and then take care that the W, V, U, and T registers are not corrupted in the assembler source.
34	**[Cautions when using medium model]** When using the medium model (-MM), note the following. (a) 1 MB of code and 64 KB of data can be allocated in the medium model. Data is allocated in the 64 KB of 000000H to 00FFFFH or 0F0000H to 0FFFFFH depending on the value of LOCATION. If using code segment @@CNSTS (LOCATION 0) and @@CNSTM (LOCATION 0F), be sure to allocate them in the same area as the data. (b) In the medium model, the V, U, and T registers of VVP, UUP, and TDE are set to 0H when using LOCATION 0 or 0FH when using LOCATION 15 at startup. The codes are then generated assuming that the value is retained (setting the V, U, and T register values is performed in the startup routine supplied with the CC78K4). Therefore, when describing an assembler source and linking it without using the startup routine supplied with the CC78K4, first set the V, U, and T registers to the appropriate value and then take care so that the V, U, and T registers are not corrupted in the assembler source. (c) When referencing a data address, if the lower 2 bytes of the data address are allocated to 0000H, it is judged as “equivalent” when comparing with the NULL pointer (because the medium model has a data address of only the lower 2 bytes).
35	**[Cautions when using saddr1 or saddr2 area]** A variable with the same name as a variable declared with extern sreg (using saddr2 area) in one file is not declared with _ _sreg1 (using saddr1 area) in another file. Do not do the reverse. A variable with the same name as a variable declared with extern bit, boolean, or _ _boolean (using saddr2 area) in one file is not declared with _ _boolean1 (using saddr1 area) in another file. Do not do the reverse. If the above declarations are made, the operation is not guaranteed.

APPENDIX C LIST OF RESTRICTIONS RELATED TO CC78K4

This chapter describes in detail the restrictions on the CC78K4 and how to avoid them.

Number	Overview of Restrictions
1	The initialization of an external variable declared extern within a block does not become an error. In addition, the debugging information in the assembler source is incorrect.
2	Binding a variable with the same name to a variable declared extern in the block is sometimes illegal.
3	If a type defined by typedef (typedef name) is used in a function prototype declaration or a declaration using a const or volatile type modifier, the typedef expansion is illegal, and an error results.
4	Sometimes a multidimensional array with an undefined size does not operate properly.
5	In a function returning the address of a function with arguments, those arguments cannot be referenced. There is no error when referenced, but illegal code is output.
6	The signed type bit field is handled as an unsigned bit field.
7	If the total size of the auto variable in one function exceeds 65,535 bytes when the large model is used, the output code and debug information become illegal.

C.1 Details About Restrictions and Prevention Methods

Restriction 1

The initialization of an external variable declared extern within a block does not become an error. In addition, the debugging information in the assembler source is incorrect.

[Description]

Since it is not compliant with the ANSI C language specifications, the initialization of an external variable declared extern within a block should produce an error, but the description does not become an error. The object defined as an external variable with initial value is interpreted and the code is output by the compiler.

The debugging information in the object output by the compiler is correct, but the debugging information in the assembler source is incorrect.

[Reproduced example]

```
int  i;
void  f(void) {
        extern int  i = 2;
}
```

[Prevention method] None

[Generation] Ver. 1.00 or later

Restriction 2

Binding a variable with the same name to a variable declared extern in the block is sometimes illegal.

[Description]

Binding a variable with the same name to a variable declared extern in the block is illegal in either of the following cases.

(1) When a variable declared with extern in a block and a variable declared with static after outside the block have the same name

Since no error occurs and there is no binding, illegal code is output when this variable is referenced.

[Reproduced example]

```
void  f(void) {
        extern int  i;
        i = 1;                /* Illegal code output */
}
static int  i;
```

(2) When a variable declared with extern in a block and a variable not declared with static outside the block after a variable declared with extern have the same name

There is no binding, and illegal code is output.

[Reproduced example]

```
void  f(void) {
        extern int  i;
        i = 1;                /* Illegal code output */
}
int  i;
```

(3) When a variable declared with extern in a block and a variable not declared with extern outside the block before a variable declared with extern have the same name, and an automatic variable declared in a block containing the block with the variable declared with extern has the same name

The variable outside the block and the variable declared with extern in the block are not bound, and illegal code is output.

[Reproduced example]

```
int i = 1;
void  f(void) {
        int  i;
        {
               extern int  i;
               i = 1;         /* Illegal code output */
        }
}
```

(4) A variable declared with extern in a block and a variable declared with extern in another block have the same name

There is no binding, and illegal code is output.

[Reproduced example]

```
void  f1(void) {
         extern int  i;
         i = 2;
}
void  f2(void){
         extern int  i;
         i = 3;
}
```

[Prevention method] None

[Generation] Ver. 1.00 or later

Restriction 3

If a type defined by typedef (typedef name) is used in a function prototype declaration or a declaration using a const or volatile type modifier, the typedef expansion is illegal, and an error results.

[Description]

If a type defined by typedef (typedef name) is used in a function prototype declaration or a declaration using a const or volatile type modifier, the typedef expansion is illegal, and an error may result.

[Reproduced example 1]

```
typedef int  FTYPE();

FTYPE  func;
int  func(void);                    /* F713 Redefined 'func' */
```

[Reproduced example 2]

```
typedef int  VTYPE[2];
typedef int  *VPTYPE[3];

const VTYPE  *a;
const int  (*a)[2];                 /* F713 Redefined 'a' */
volatile VPTYPE  b[2];
volatile int *volatile  b[2][3];    /* F713 Redefined 'b' */
```

[Prevention method] None

[Generation] Ver. 1.00 or later

Restriction 4

Sometimes a multidimensional array with an undefined size does not operate properly.

[Description]

Sometimes a multidimensional array with an undefined size does not operate properly.

[Reproduced example 1]

```
char  c[][3]={{1},2,3,4,5};         /* Illegal code */
```

[Reproduced example 2]

```
char  c[][2][3]={"ab","cd","ef"};   /* Error (F756) */
```

[Prevention method]

Define the size of the multidimensional array.

[Generation] Ver. 1.00 or later

Restriction 5

In a function returning the address of a function with arguments, those arguments cannot be referenced. There is no error when referenced, but illegal code is output.

[Description]

In a function returning the address of a function with arguments, those arguments cannot be referenced. There is no error when referenced, but an illegal code is output.

[Reproduced example]

```
char *c;
int  *i;
void (*f1(int *))(char *);
void (*f2(void))(char *);
void (*f3(int *))(void);

void main() {
        (*f1(i))(c);          /* Correct description (W510) */
        (*f1(i))(i);          /* Incorrect description */
        (*f2())(c);           /* Correct description (W509) */
        (*f2())();            /* Incorrect description (W509) */
        (*f3(i))();           /* Correct description (W509) */
        (*f3(i))(i);          /* Incorrect description */
}
```

W509 or W510 is output for a correct description. Nothing is output for a description that should produce a warning. However, the output code is normal.

```
void (*f4())(int p) {
       p++;                   /* Incorrect description */
}
```

An error is not output for a description that should cause an error. An illegal code is generated.

[Prevention method] None

[Generation] Ver. 1.00 or later

Restriction 6

The signed type bit field is handled as an unsigned bit field.

[Description]

The signed type bit field is handled as an unsigned bit field.

[Prevention method] None

[Generation] Ver. 1.00 or later

Restriction 7

If the total size of the auto variable in one function exceeds 65,535 bytes when the large model is used, the output code and debug information become illegal.

[Description]

If the total size of the auto variable in one function exceeds 65,535 bytes when the large model is used, the output code and debug information become illegal.

[Reproduced example] (when -ML is specified)

```
void func(long a, int b){
   int i;
   char tab1[35000];
   char tab2[35000];

   i = b;
}
```

[Prevention method] Keep the total size of the auto variable in one function to within 65,535 bytes.

[Generation] Ver. 1.00 or later

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