

Microsoft® CREF

Cross-Reference Utility

for 8086 and 8088 Microprocessors

Microsoft Corporation

System Requirements

The Microsoft CREF Cross-Reference Utility requires:

24K bytes of memory minimum:
 14K bytes for code
 10K bytes for run space

Disk drive(s):

1 disk drive if and only if output is sent to the same physical disk from which the input was taken. The Microsoft CREF Cross-Reference Utility does not allow time to swap disks during operation on a one-drive configuration. Therefore, two disk drives is a more practical configuration.

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CHAPTER 1

INTRODUCTION

1.1 FEATURES OF MS-CREF

The Microsoft CREF Cross-Reference Utility can help you in debugging your assembly language programs. MS-CREF outputs an alphabetical listing of all the symbols to a special file created by your assembler. With this listing, you can quickly locate all occurrences of any symbol in your source program by line number.

The cross-reference listing produced by MS-CREF gives you symbol locations, speeding your search and allowing faster debugging.

The MS-CREF listing is used with the symbol table produced by your assembler.

The symbol table listing shows the value, type, and length of each symbol. This information is needed to correct erroneous symbol definitions or uses.

1.2 OVERVIEW OF MS-CREF OPERATION

MS-CREF produces a file with cross-references for symbolic names in your program.

First, you must create a cross-reference file with the assembler. Then, MS-CREF converts this cross-reference file (which has the filename extension .CRF) into an alphabetical listing of the symbols in the file. The cross-reference listing file is given the default filename extension .REF.

Beside each symbol in the listing, MS-CREF lists the line numbers where the symbol occurs in the source program. The line numbers are listed in ascending sequence. The line number where the symbol is defined is indicated by a pound sign (#).

Figure 1 illustrates the MS-CREF operation.

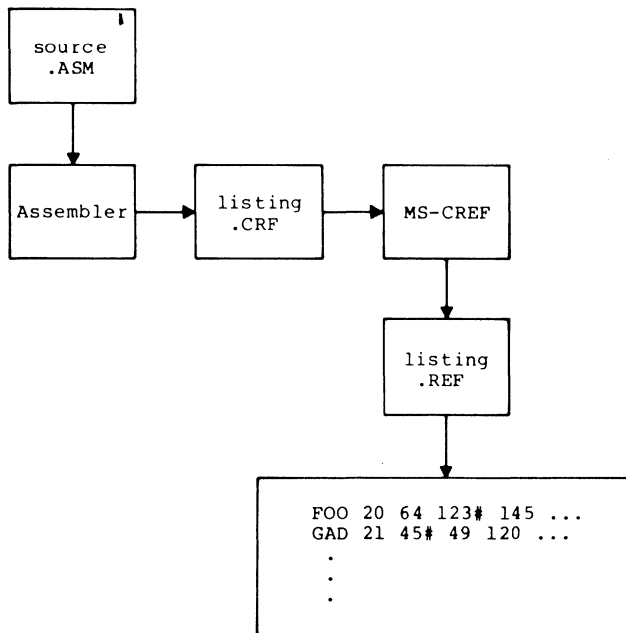


Figure 1. MS-CREF Operation

CHAPTER 2

RUNNING MS-CREF

Running MS-CREF requires two types of commands: a command to start MS-CREF and answers to command prompts. You type all the commands to MS-CREF on a command line or in response to MS-CREF prompts. Command characters can be used to assist you while giving commands to MS-CREF.

Before you can use MS-CREF to create the cross-reference listing, you must first create a cross-reference file using your assembler. This step is described in the next section.

2.1 HOW TO CREATE A CROSS-REFERENCE FILE

A cross-reference file is created during an assembly session. To create a cross-reference file, use the Microsoft Macro Assembler and answer the fourth command prompt with the name of the cross-reference file you want to create.

The fourth assembler prompt is:

Cross-reference [NUL.CRF]:

If you do not type a filename in response to this prompt, or if you use the default response, the assembler will not create a cross-reference file. Therefore, you must type a filename if you want to create a cross-reference file.

You may also specify which drive or device you want the file saved on, and the filename extension (if different from .CRF). If you assign a filename extension other than .CRF, you must specify the filename extension when naming the file in response to the first MS-CREF prompt. (Refer to Section 2.2, "How to Start MS-CREF," for a description of MS-CREF prompts.)

You are now ready to use MS-CREF to convert the cross-reference file produced by the assembler into a cross-reference listing.

2.2 HOW TO START MS-CREF

MS-CREF may be started two ways. By the first method, you type the commands as answers to individual prompts. By the second method, you type all commands on the line used to start MS-CREF.

Summary of Methods to Start MS-CREF

=====

Method 1 CREF

Method 2 CREF <crffile>,<listing>

=====

2.2.1 Method 1: Prompts

To start MS-CREF using prompts, type:

CREF

MS-CREF will be loaded into memory. Then, MS-CREF displays two text prompts that appear one at a time. You answer the prompts to command MS-CREF to convert a cross-reference file into a cross-reference listing.

Command Prompts

Cross reference [.CRF]:

Type the name of the cross-reference file you want MS-CREF to convert to a cross-reference listing. The filename is the name you specified when you directed the assembler to produce the cross-reference file.

MS-CREF assumes that the filename extension is .CRF. If you do not specify a filename extension when you type the cross-reference filename, MS-CREF will look for a file with the name you specify and the filename extension .CRF. If your cross-reference file has a different extension, specify that extension when typing the filename.

Refer to Chapter 4, "Format of MS-CREF Compatible Files," for a description of what MS-CREF expects to see in the cross-reference file. You will need this information only if your cross-reference file was not produced by a Microsoft assembler.

Listing [crffile.REF]:

Type the name you want the cross-reference listing file to have. MS-CREF will automatically give the cross-reference listing the filename extension .REF.

If you want your cross-reference listing to have the same filename as the cross-reference file but with the filename extension .REF, simply press the <RETURN> key when the Listing: prompt appears. If you want your cross-reference listing file to be named anything else, or to have any other filename extension, you must type a response following the Listing: prompt.

If you want the listing file placed on a drive or device other than the default drive, specify that drive or device when typing your response to the Listing: prompt.

2.2.2 Method 2: Command Line

To start MS-CREF using the command line, type:

```
CREF <crffile>,<listing>
```

MS-CREF will be loaded into memory. Then, MS-CREF converts your cross-reference file into a cross-reference listing.

The entries following CREF are responses to the command prompts. The <crffile> and <listing> fields must be separated by a comma.

where: <crffile> is the name of the cross-reference file produced by your assembler. MS-CREF assumes that the filename extension is .CRF. You may override this default by specifying a different extension. If the file named for the <crffile> does not exist, MS-CREF will display the message:

```
Fatal I/O Error 110
```

```
in File: <crffile>.CRF
```

MS-CREF will be aborted and the operating system prompt will appear.

<listing> is the name of the file you want to contain the cross-reference listing of symbols in your program.

To select the default filename and extension for the listing file, type a semicolon after the <crffile> name. Refer to the "Command Characters" section for more information on how to use the semicolon.

Examples:

```
CREF FUN;
```

This example causes MS-CREF to process the cross-reference file FUN.CRF and to produce a listing file named FUN.REF.

To give the listing file a different filename, extension, or destination, simply specify it when you type the command line.

CREF FUN,B:WORK.ARG

This example causes MS-CREF to process the cross-reference file named RUN.CRF and to produce a listing file named WORK.ARG, which will be placed on the disk in drive B:.

2.3 COMMAND CHARACTERS

MS-CREF provides two command characters.

Semicolon Use a single semicolon (;), followed immediately by a carriage return, at any time after responding to the Cross reference: prompt to select the default response to the Listing: prompt. This feature saves time and overrides the need to answer the Listing: prompt.

If you use the semicolon, MS-CREF gives the listing file the filename of the cross-reference file and the default filename extension .REF.

Example:

Cross reference [.CRF]: FUN;

MS-CREF will process the cross-reference file named FUN.CRF and output a listing file named FUN.REF.

CONTROL-C Use <CONTROL-C> at any time to abort the MS-CREF session. If you make a mistake (for example, typing the wrong filename or incorrectly spelling a filename), you must press <CONTROL-C> to exit MS-CREF, and then restart MS-CREF. If the error has been typed but you have not pressed the <RETURN> key, you may delete the erroneous characters, but for that line only.

2.4 FORMAT OF CROSS-REFERENCE LISTINGS

The cross-reference listing is an alphabetical list of all the symbols in your program. Each page begins with the title of the program or program module. Then the symbols are listed. Following each symbol name is a list of the line numbers where the symbol occurs in your program. The line number for the definition has a pound sign (#) appended to it.

An example of a cross-reference listing appears in the next section.

2.4.1 Example Of Cross-Reference Listing

MS-CREF	(vers no.)	(date)						
ENTX	PASCAL entry for initializing programs<--comes from TITLE directive							
Symbol	Cross-Reference		# is definition)		Cref-1			
AAAXQQ	37#	38						
BEGHQQ	83	84#	154	176				
BEGOQQ	33	162						
BEGXQQ	113	126#	164	223				
CESXQQ	97	99#	129					
CLNEQQ	67	68#						
CODE	37	182						
CONST. . . .	104	104	105	110				
CRCXQQ	93	94#	210	215				
CRDXQQ	95	96#	216					
CSXEQQ	65	66#	149					
CURHQQ	85	86#	155					
DATA	64#	64	100	110				
DGROUP	110#	111	111	111	127	153	171	172
DOSOFF	98#	198	199					
DOSXQQ	184	204#	219					
ENDHQQ	87	88#	158					
ENDOQQ	33#	195						
ENDUQQ	31#	197						
ENDXQQ	184	194#						
ENDYQQ	32#	196						
ENTGQQ	30#	187						
ENTXCM	182#	183	221					
FREXQQ	169	170#	178					
HDRFQQ	71	72#	151					
HDRVQQ	73	74#	152					
HEAP	42	44	110					
HEAPBEG. . . .	54#	153	172					
HEAPLOW. . . .	43	171						
INIUQQ	31	161						
MAIN_STARTUP	109#	111	180					
MEMORY	42	48#	48	49	109	110		
PNUXQQ	69	70	150					
RECEQQ	81	82#						

REFEQQ 77 78#
 REPEQQ 79 80#
 RESEQQ 75 76# 148
 ENTX PASCAL entry for initializing programs

Symbol Cross-Reference (# is definition) Cref-2

SKTOP. 59#
 SMLSTK 135 137#
 STACK. 53# 53 60 110
 STARTMAIN. . . 163 186# 200
 STKBQQ 89 90# 146
 STKHQQ 91 92# 160

CHAPTER 3

ERROR MESSAGES

All errors cause MS-CREF to abort. Control is returned to the operating system.

All error messages are displayed in the following format:

```
Fatal I/O Error <error number>  
in File: <filename>
```

where: <filename> is the name of the file where the error occurs.

<error number> is one of the numbers in the following list of errors:

Number	Error
101	Hard data error Unrecoverable disk I/O error
101	Device name error Illegal device specification (for example, X:FOO.CRF)
103	Internal error Report to Microsoft Corporation
104	Internal error Report to Microsoft Corporation
105	Device offline Disk drive door open, no printer attached, or similar device is offline.
106	Internal error Report to Microsoft Corporation
108	Disk full
110	File not found
111	Disk is write protected
112	Internal error Report to Microsoft Corporation
113	Internal error Report to Microsoft Corporation
114	Internal error Report to Microsoft Corporation
115	Internal error Report to Microsoft Corporation

CHAPTER 4

FORMAT OF MS-CREF COMPATIBLE FILES

MS-CREF will process files other than those generated by Microsoft's assembler, as long as the file conforms to the valid MS-CREF format.

4.1 MS-CREF FILE PROCESSING

MS-CREF reads a stream of bytes from the cross-reference file (or source file), sorts them, then emits them as a printable listing file (the .REF file). The symbols are held in memory as a sorted tree. References to the symbols are held in a linked list.

MS-CREF keeps track of line numbers in the source file by the number of end-of-line characters it encounters. Therefore, every line in the source file must contain at least one end-of-line character (see chart below).

MS-CREF places a heading at the top of every page of the listing. The name MS-CREF uses is passed by your assembler from a TITLE (or similar) directive in your source program. The title must be followed by a title symbol (see chart below). If MS-CREF encounters more than one title symbol in the source file, it will use the last title read for all page headings. If MS-CREF does not encounter a title symbol in the file, the title line on the listing will be blank.

4.2 FORMAT OF SOURCE FILES

MS-CREF uses the first three bytes of the source file as format specification data. The rest of the file is processed as a series of records that either begin or end with a byte that identifies the type of record.

4.2.1 First Three Bytes

The PAGE directive in your assembler, which takes arguments for page length and line length, will pass the following information to the cross-reference file:

First Byte

The number of lines to be printed per page (page length range is from 1 to 255 lines).

Second Byte

The number of characters per line (line length range is from 1 to 132 characters).

Third Byte

The Page Symbol (07) that tells MS-CREF that the two preceding bytes define listing page size.

If MS-CREF does not see these first three bytes in the file, it uses default values for page size (page length is 58 lines; line length is 80 characters).

4.2.2 Control Symbols

The two tables below show the types of records that MS-CREF recognizes and the byte values and placement it uses to recognize record types.

Records have a control symbol (which identifies the record type) either as the first byte of the record or as the last byte.

Records That Begin with a Control Symbol

Byte Value*	Control Symbol	Subsequent Bytes
01	Reference symbol	Record is a reference to a symbol name (1 to 80 characters)
02	Define symbol	Record is a definition of a symbol name (1 to 80 characters)
04	End-of-line	(none)
05	End-of-file	1AH

Records That End with a Control Symbol

Byte Value*	Control Symbol	Preceding Bytes
06	Title defined	Record is title text (1 to 80 characters)
07	Page length/ line length	One byte for page length followed by one byte for line length

*For all record types, the byte value represents a control character, as follows:

- 01 Control-A
- 02 Control-B
- 04 Control-D
- 05 Control-E
- 06 Control-F
- 07 Control-G

The Control Symbols are defined as follows:

Reference symbol

Record contains the name of a symbol that is referenced. The name may be from 1 to 80 ASCII characters long. Additional characters are truncated.

Define symbol

Record contains the name of a symbol that is defined. The name may be from 1 to 80 ASCII characters long. Additional characters are truncated.

End-of-line

Record is an end-of-line symbol character only (04H or Control-D).

End-of-file

Record is the end-of-file character (1AH).

Title defined

ASCII characters of the title are to be printed at the top of each listing page. The title may be from 1 to 80 characters long. Additional characters are truncated. The last title definition record encountered is used for the title placed at the top of all pages of the listing. If a title definition record is not encountered, the title line on the listing will be left blank.

Page length/line length

The first byte of the record contains the number of lines to be printed per page (range is from 1 to 255 lines). The second byte contains the number of characters to be printed per page (range is from 1 to 132 characters). The default page length is 58 lines. The default line length is 80 characters.

The following table illustrates CRF file record contents by byte and length of record.

Summary of CRF File Record Contents

Byte Contents	Length of Record
=====	=====
01 symbol_name	2-81 bytes
02 symbol_name	2-81 bytes
04	1 byte
05 1A	2 bytes
title text 06	2-81 bytes
PL LL 07	3 bytes
=====	=====

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