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68000 Assembler Package Overview Manual

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SECTION 1
User License, Warranty and Support

License:

The Quelo 68000 Assembler Package (PRODUCT) is licensed for single use. This would ordinarily be for use on a single machine, but may be used by a single person on more than one machine (e.g. the software consultant who may need to work in various locations). Multiple use requires the purchase of multiple copies or a multiple use license in the case of a multiuser system.

Copies of the software may be made for backup purposes, but not for any kind of distribution. The documentation may NOT be copied.

Use of the software implies acceptance of these license terms.

Warranty and Disclaimer:

The complexity of this PRODUCT makes it impossible to guarantee that the software is error free. However, Quelo will provide error corrections in a timely manner, given that sufficient information is available to identify the problem.

Quelo cannot be responsible for misuse of the PRODUCT or for the quality of software developed using the PRODUCT. The user is expected to be familiar with the 68000/68010 instruction set, basic assembly language concepts, relocation and linking.

Registration and Support:

The software distribution media come with a registration card. Please fill out the card and return it promptly to Quelo. Support and update notices will only be provided to registered users.

Each package is assigned a registration number which appears on the card and the distribution media. This number and the purchaser's name will be required for support. Names, addresses and phone numbers for support are provided on a sheet of paper separate from this document.
SECTION 2
Package Contents

Programs:

DATE - Set date (for CP/M only).
M68K - The Macro Pre-Processor.
A68K - The 68000/68010 Assembler.
QLIB - The Object Librarian.
QLINK - The Linker/Locator.
QSYM - The Symbol Report Generator.
   Module Summary.
   Symbol Table Listing.
   Cross Reference.
   Memory Map.
IMAGE - The HEX to Memory Image Converter.
SPLIT - The HEX File Even/Odd Splitter.

Documentation:

68000 Assembler Package Overview Manual (this document).
68000 Assembler and Macro Pre-Processor Manual.
Linker and Object Librarian Manual.
System Dependent Supplement.
READ.ME file on distribution disk.

Example Files:

This example demonstrates the software configuration tracking facilities of the package. See the Linker and Object Librarian Manual, Section 1, under Running the Linker.

LT30.A68    Main program.
LT31.A68    Configuration list.
LT32.A68    Output utilities.
LT33.LNK    The link specification.
LT34.LNK    Link specification for CP/M-68K.

This next example demonstrates the object librarian. See the Linker and Object Librarian Manual, Section 6, under Object Librarian Demonstration.

QT33.LIB    The library specification.

This example may be used to exercise the macro pre-processor. See the 68000 Assembler and Macro Pre-processor Manual, Section 7.

MACRO.M68    Macros and macro calls.
Changes Since Previous Release 4.2:

- The object librarian has been added to the package.
- The new binary relocatable object format has been implemented. Complex expressions may be passed on to the linker for evaluation. The object format is generalized to be processor independent. Quelo is using it for other processors as well as the 68000. Each object file begins with an ASCII header which can be viewed via the users terminal. Header information includes the information supplied with the assembler IDNT directive.
- Some program names and file extension names have been changed. This serves two purposes, to avoid confusion between the old and new package releases and to emphasize the processor independence of some of the programs. Only the assembler and macro pre-processor are now specific to the 68000.

Program Name:

<table>
<thead>
<tr>
<th>Old</th>
<th>New</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A68K.COM</td>
<td>L68K.COM</td>
<td>68000/68010 assembler</td>
</tr>
<tr>
<td>DATE.COM</td>
<td>QLINK.COM</td>
<td>linker</td>
</tr>
<tr>
<td>IMAGE.COM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M68K.COM</td>
<td>QSYM.COM</td>
<td>symbol report generator</td>
</tr>
<tr>
<td>QLIB.COM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S68K.COM</td>
<td>SPLIT.COM</td>
<td>split HEX file</td>
</tr>
</tbody>
</table>

File Extension:

<table>
<thead>
<tr>
<th>Old</th>
<th>New</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>.A68</td>
<td>.L68</td>
<td>assembler source file</td>
</tr>
<tr>
<td>.ERR</td>
<td>.LST</td>
<td>macro processing error file</td>
</tr>
<tr>
<td>.EVM</td>
<td>.LTX</td>
<td>even HEX file from SPLIT</td>
</tr>
<tr>
<td>.HEX</td>
<td>.M68</td>
<td>linker output file</td>
</tr>
<tr>
<td>.IMG</td>
<td>.PRN</td>
<td>binary file from IMAGE</td>
</tr>
<tr>
<td>.LIB</td>
<td>.RPT</td>
<td>librarian specification file</td>
</tr>
<tr>
<td>Change</td>
<td></td>
<td>linker specification file</td>
</tr>
<tr>
<td>Change</td>
<td>.A68</td>
<td>linker and librarian list file</td>
</tr>
<tr>
<td>Change</td>
<td>.R68</td>
<td>binary object file</td>
</tr>
<tr>
<td>Change</td>
<td>.M68</td>
<td>macro pre-processor source file</td>
</tr>
<tr>
<td>Change</td>
<td>.ODD</td>
<td>odd HEX file from SPLIT</td>
</tr>
<tr>
<td>Change</td>
<td>.PRN</td>
<td>assembler list file</td>
</tr>
<tr>
<td>Change</td>
<td>.RPT</td>
<td>symbol report file</td>
</tr>
<tr>
<td>Change</td>
<td>.S68</td>
<td>symbol report generator source file</td>
</tr>
</tbody>
</table>

- For CP/M, date access operations are now directed to the currently logged in drive, rather than drive A: as before.
• The linker now accesses library files.

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LINK libfile</td>
<td>load entire library</td>
</tr>
<tr>
<td>LINK libfile()</td>
<td>search library for needed modules</td>
</tr>
<tr>
<td>LINK libfile(mod7,mod4)</td>
<td>load specific modules from library</td>
</tr>
<tr>
<td>LINK modfile</td>
<td>load module</td>
</tr>
<tr>
<td>LINK modfile()</td>
<td>load module only if needed</td>
</tr>
</tbody>
</table>

• The OPT directive option PCF has been added to force PC relative addressing on forward references. This option is useful for software development for systems that require PC relative addressing.

• "A" or "a" entered at the console will abort the program and close files (formerly control C).

• The memory limitations of SPLIT and IMAGE have been eliminated.

• The assembler supports local symbols defined as an offset from an external symbol. The offset is limited to the range -32768...32767.

```assembly
XREF xsym
xoff EQU xsym + 4
```

• The special lines used for communication of information from M68K to A68K now begin with a tilde, rather than an asterisk. This eliminates the confusion sometimes encountered with user comments.
SECTION 3
Program Invocation Command Lines

Lower Case Considerations:

Unless otherwise instructed, the various programs in the assembler package will convert lower case characters in user defined symbols to upper case characters. If it is desired that lower case be distinct from upper case, the lower case command line option. -L, should be invoked each time the following programs are used: M68K, A68K, QLIB and QLINK. Failure to do this consistently will probably result in undefined symbol error messages.

Even when the lower case option is selected, lower case will still be treated the same as upper case for assembler instruction mnemonics, assembler and linker directives and librarian commands. The option only affects user defined symbols, including module names specified with the assembler and linker IDNT directives and referenced in the linker LINK directive and in the librarian ADD, COPY and DELETE commands.

Command Line Contents:

Program command lines consist of three basic kinds of information. First is the name of the program to execute. This is used only by the operating system. The other two kinds of information may appear in any order.

One kind is the input/output specification. There must be exactly one of these for most programs. None or more than one will result in an error message and program termination.

The other kind selects program options. A leading hyphen (dash or minus sign) distinguishes an option from an input/output specification. There may be any number of options in the command line, including none. With few exceptions, most program options can be run together following a single hyphen. Command line items are delimited by spaces. Therefore, option selections and input/output specifications may not have embedded spaces.

For example: A68K -L -S LT30, LPT: = LT30

"A68K" is the name of the 68000 assembler program for the operating system to load and execute.

"-L" and "-S" are program option selections. "-SL" would have the same effect.

"LT30, LPT: = LT30" is the input/output specification to be described below.

Quelo Input/Output Specification (Three Formats):

Input/output specifications may appear in one of three basic forms. In all forms at least one input must be specified. More than one input usually means the concatenation of files or devices to make up a single input. The exception would be in programs which require more than one distinct input. Note that programs which recognize something in a file such as an END directive will terminate processing even though all entries in an input list have not been processed.
The "short" form shown above contains no output specification. All required output file names are derived from the first entry in a list of one or more input file or device names.

= <input 1>,<input 2>,<input 3>...

The above "intermediate" form also contains no output specification, but implies that only the first (primary) output is to be derived from the first input entry. The remaining outputs will be directed to the "NUL:" device (bitbucket). The leading equal sign distinguishes the "intermediate" form from the "short" form.

<output 1>,<output 2>... = <input 1>,<input 2>...

The above "full" form includes an explicit list of output files or devices. Those outputs omitted from the list will be directed to the "NUL:" device. When an output file name is not specified, but the drive and/or file type is, the name will be taken from the first entry in the input list.

For both inputs and outputs, the file type will be set to a default if not explicitly specified. The default depends on the particular program being used. For outputs, the drive will be taken from the first entry in the input list if not explicitly specified.

The following formats are suitable for input specification:

d:filename.typ
d:filename
filename.type
filename
CON: the console
TTY: the console

The following formats are suitable for output specification:

d:filename.type
d:filename
filename.type
d:.typ
d: drive alone
filename file name alone
.typ file type alone
null- treated as NUL:
CON: the console
TTY: the console
LST: the printer
LPT: the printer
NUL: the bit bucket

The drive letter may range from "A" to "P" or from "a" to "p". An "@" may also be used to specify the currently logged-in drive.
Program Input/Output Summary:

\[
<\text{output 1}>, <\text{output 2}>, <\text{output 3}>= <\text{input 1}>, <\text{input 2}>, ...
\]

<table>
<thead>
<tr>
<th></th>
<th>M68K</th>
<th>A68K</th>
<th>QLIB</th>
<th>QLINK</th>
<th>QSYM</th>
</tr>
</thead>
<tbody>
<tr>
<td>output 1 (primary)</td>
<td>assembler source</td>
<td>relocatable object module</td>
<td>listing</td>
<td>HEX load module</td>
<td>various symbol reports</td>
</tr>
<tr>
<td></td>
<td>.A68</td>
<td>.LTX</td>
<td>.LST</td>
<td>.HEX</td>
<td>.RPT</td>
</tr>
<tr>
<td>output 2</td>
<td>errors and symbol table</td>
<td></td>
<td>listing</td>
<td>symbols and cross reference data</td>
<td>listing</td>
</tr>
<tr>
<td></td>
<td>.ERR</td>
<td>.PRN</td>
<td>.SYM</td>
<td>.LST</td>
<td></td>
</tr>
<tr>
<td>output 3</td>
<td>source with macros</td>
<td></td>
<td>library specification</td>
<td>symbols and cross reference data</td>
<td>symbols and cross reference data</td>
</tr>
<tr>
<td></td>
<td>.M68</td>
<td>.A68</td>
<td>.LIB</td>
<td>.SYM</td>
<td>.SYM</td>
</tr>
<tr>
<td>&quot;include&quot; input</td>
<td>source with macros</td>
<td></td>
<td>link specification</td>
<td>link specification</td>
<td>symbols and cross reference data</td>
</tr>
<tr>
<td></td>
<td>.M68</td>
<td>.A68</td>
<td>.LIB</td>
<td>.LNK</td>
<td>.SYM</td>
</tr>
<tr>
<td>object input/output</td>
<td></td>
<td></td>
<td>object module or library</td>
<td>object module or library</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.LTX</td>
<td>.LTX</td>
<td></td>
</tr>
</tbody>
</table>

Note that "include" inputs are specified with the INCLUDE directives recognized by M68K, A68K, QLIB and QLINK. "object" inputs are specified with the LINK directive recognized by QLINK. "object" inputs and outputs are specified with the CREATE, UPDATE, EXTRACT, ADD and COPY commands recognized by QLIB.

Listing and Report Page Formatting:

The LLEN and PLEN directives may be used in A68K and QLINK to establish listing page format. Page format information is passed from A68K, QLIB and QLINK to QSYM in the .SYM symbol table and cross reference data file. This information may be overridden by using the "-F" option when running QSYM to produce the various symbol reports. Page title information is also passed to QSYM in a similar manner and may be overridden by using the "-H" option.

Page breaks are normally accomplished via the ASCII formfeed character. However, indicating a negative bottom margin in the PLEN directive or the QSYM "-F" option will cause blank lines to be issued for page breaks instead of a formfeed.

Line length (LLEN) is the number of characters allowed on a listing line. Page length (PLEN) is the total number of lines on a page, from perforation to perforation. Top
Program Option Summary:

<table>
<thead>
<tr>
<th></th>
<th>M68K</th>
<th>A68K</th>
<th>QLIB</th>
<th>QLINK</th>
<th>QSYM</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>global arguments</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>same effect as -SX</td>
<td>same effect as -SX</td>
<td>same effect as -SX</td>
<td>combined symbol table and cross reference reports</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>define character</td>
<td></td>
<td></td>
<td></td>
<td>compressed map</td>
</tr>
</tbody>
</table>

F(line length),(page length),(top margin),(bottom margin) | page format
---|---
HS | | | | S-records | |
HM | | | | Mostek HEX | |
HI | | | | Intel HEX | |
H(page heading title info) | module info to .SYM | module info to .SYM | module info to .SYM | S-records |
I | retain lower case | retain lower case | retain lower case | retain lower case | |
L | | | | | |
M | symbols to .ERR | symbols to .SYM | symbols to .SYM | symbols to .SYM | |
T | truncate symbols | truncate symbols | truncate symbols | truncate symbols | |
V | formfeed to .ERR | formfeed to .PRN | formfeed to .LST | formfeed to .RPT | |
X | cross reference to .SYM | cross reference to .SYM | cross reference to .SYM | cross reference to .SYM | |
Z | define symbol table size | define symbol table size | define symbol table size | define symbol table size | |
I | debug | debug | debug | debug | |

Note: The debug option shows the symbol table space to be allocated in hexadecimal at the console. Also, for A68K and QLINK the listing is produced for all passes.

The formfeed option places a formfeed at the start of listing or report files.
M68K Global Parameter Substitution:

The "-A" option to M68K allows the passing of arguments from the command line into the text being processed. When appearing outside of a macro, "\0" through "\9" reference these command line arguments.

For example:

Command line:       -Azero,one...four
M68K input line:    * \1 *** \0 *\2*\4*
(not in macro)
M68K output line:   * one *** zero **four*

Note that spaces may NOT be included in the arguments and the limit is 10 arguments. This feature can be very handy for controlling conditional assembly without having to edit the source file.

Symbol Table Size Control ("-Z" option):

The various programs will take as much memory as is available (but not more than 32766 bytes) for symbol table space or buffer space in the case of the SPLIT and IMAGE programs.

Some difficulty has been encountered in determining how much space is really available when running on the PC-Jr. For that reason the "-Z" command line option has been implemented. This option allows the user to specify symbol table space directly.

If you get an "ALLOC" error message, run the program with the "-I" option to discover how much space the program is trying to take. The value displayed is the number of bytes given in hexadecimal. Run the program again with the "-Z" option to specify a smaller amount of space. It will take some experimentation to find the maximum value that will work for a given program.

-Z <constant> where <constant> may have several forms:

Leading $ indicates HEX
trailing K indicates multiply by 1024

The following examples all represent the same value:

-16384 decimal
-Z$4000 hex
-Z16K 16 * 1024
-Z$10K 16 * 1024
SECTION 4
Listing Date-Time Stamping

Introduction:

When available, date and time information is included in listing page headings. The source of this information will vary from one system to another. Some operating systems provide time-of-day information and others do not. For those that do not, a program is provided to create and maintain a special date file.

CP/M:

CP/M releases prior to 3.0 do not have a date-time facility. For those versions, a "date" file is stored on the currently logged in drive under user 0. If the CP/M release is prior to 2.0, the user number does not apply.

Each program which uses the date file selects the currently logged in drive and user 0 prior to searching for the file. Each program may be patched to change the date drive and user number. Contact Quelo for patch information.

The date file contains no information, as the file name is the date. The name format is "mm/dd/yy.DAT". The maintenance program is called "DATE". If the date file already exists, DATE will display the date and issue a verify prompt. A "N" or "n" response will obtain the prompt for entering a new date. When only the day is to be changed, that is all that has to be entered.

If the date file does not exist, DATE immediately issues the prompt for entering the date. The program terminates with a "Y" or "y" response to the verify prompt. Invalid responses result in a repeated prompt.

MP/M:

MP/M has a built-in date-time facility, so the "date" file does not apply.

MS-DOS, PC-DOS:

MS-DOS has a built-in date-time facility, so the "date" file does not apply.

Portable Assembler Package:

Date-time access is up to the implementor.
SECTION 5
Flow Diagrams

Inter-Program Information Flow
Macro Pre-processor

source with macro def. and references

switches:
- A
- C
- L
- S
- T
- Z
- I

pure assembler source

command line example: M68K -S MACRO
68000 Assembler

command line example: A68K -SX LT32
Object Librarian

library specification

relocatable object modules

switches:
- B
- I
- L
- S
- T
- V
- X
- Z
- I

symbol file

listing file

library file

command line example: QLIB -SLIX QT33
Linker

LT33 .LNK

relocatable object modules

LT30 .LTX

LT31 .LTX

LT32 .LTX

QLINK

switches:

-B
-E
-HI
-HM
-HS
-I
-L
-S
-T
-V
-X
-Z
-1

hex load file

LT33 .HEX

symbol file

LT33 .SYM

listing file

LT33 .LST

command line example: QLINK -LISX LT33
Symbol Report Generator

QSYM

switches:
- A
- B
- C
- E
- F
- H
- I
- M
- S
- V
- X
- Z
- l

raw symbol and
cross reference
data

LT33
.SYM

command line example:  QSYM -IBM LT33

LT33
.RPT

module revision summary
symbol table report
cross reference report
memory map report
The SPLIT Program

SPLIT

 switches:
-2
-1

S-records

 even address
Intel hex

 odd address
Intel hex

 XYZ
.EVN

 XYZ
.ODD

command line example: SPLIT XYZ
The IMAGE Program

command line example: IMAGE XYZ
The LTXDUMP Program

command line example: LTXDUMP XYZ
APPENDIX A
CP/M-68K Executable File Generation

A link specification can be set up to generate header information for CP/M-68K executable files. As the linker only produces HEX output files, it will still be necessary to convert the HEX file into a binary image file by means of the IMAGE program.

The following link specification assumes that program segments are assembled under section 0, initialized data is assembled under section 1 and uninitialized data is placed in section 2. Note that neither the assembler nor the linker will complain if there is code generated for section 2. It is up to the user to make sure that the bss area really has no initialized data.

cpm. base equ $400
cpm. tpa equ cpm. base + $100
tseg equ 0 text section number
dseq equ 1 data section number
bss equ 2 uninitialized data
org cpm. tpa-51c
header:
dc.w $601a
dc.l data.seg-text.seg
dc.l bss.seg-data.seg
dc.l prog.end-bss.seg
dc.l 0 no symbols
dc.l 0 always zero
dc.l text.seg starting point
dc.w $ffff no relocation
text.seg:
section tseg
data.seg:
section tseg
bss.seg:
section bss
prog.end:
end text.seg
APPENDIX E
Error Messages Common To All Programs

Error Message Explanations:

Bad channel. (ABORT)
   Please report this to Quelo. (all programs)

Disk write. (ABORT)
   Probably means file or directory space is full. (all programs)

Invalid label.
   Label contains invalid characters. (assembler and linker)

Label missing.
   A label is required with the directive. (assembler and linker)

Label not permitted.
   A label is not permitted with the directive. (assembler and linker)

Object header error. (ABORT)
   A file being read as Quelo linker text does not begin with a valid header. Make sure the
   file specified by the linker LINK directive or the librarian ADD directive is really a
   linker text file. (linker and librarian)

Parser fault. (ABORT)
   Please report this to Quelo. (all programs)

Parser stack not empty.
   Might be caused by syntax errors, especially when expressions are being processed.
   (macro pre-processor, assembler, linker)

Parser stack overflow.
   Might be caused by attempting to assemble a very long string. (all programs)

QPL mismatch. (ABORT)
   Please report this to Quelo. (all programs)

QPL re-entry. (ABORT)
   Please report this to Quelo. (all programs)
QPL ufl. (ABORT)
Please report this to Quelo. (all programs)

QPL unknown function. (ABORT)
Please report this to Quelo. (all programs)

Read from closed channel. (ABORT)
Please report this to Quelo. (all programs)

Unexpected object EOF. (ABORT)
An unexpected end-of-file condition was detected during the reading of a Quelo linker text file. (linker and librarian)

Write to closed channel. (ABORT)
Please report this to Quelo. (all programs)