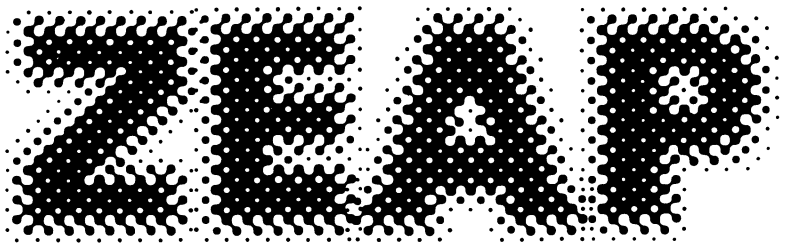
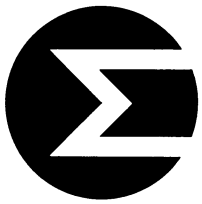


Z80 EDITOR ASSEMBLER PACKAGE FOR THE NASCOM 1 COMPUTER



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PREFACE

This manual is laid out in two complementary parts.

Sections 1 to 3 describe the ZEAP package informally and are designed to be read in order.

The appendices following provide a useful reference section, and define all the elements of ZEAP formally, directing the user to the appropriate section in the first half of the manual where more information and examples are to be found.

Those familiar with the workings of micro-computer assemblers and BASIC-type line editors may find it easier to read the appendices first, although this is not recommended to those who do not fully understand the terms used.

The reader should not be dismayed, however. ZEAP is easy to use and yet powerful enough for his requirements.

If information or guidance is required on the Z80 Assembly Language itself, you are advised to consult the Mostek or Zilog Z80 Assembly Language manual. Other publications which may prove helpful include:

The Z80 Microcomputer Handbook by William Barden
(Published by Howard W Sams & Co., Inc.)

Z80 Instruction Handbook by Nat Wadsworth
(Published by Scientific Computer Consultants Inc.)

Z80 Programming for Logic Design by Adam Osborne et al
(Published by Osborne & Associates Inc.)

NOTATION

The following notation is used in this manual:

£	hexadecimal number
(x)	x is optional
(x)...	x is optional and may be repeated indefinitely

In general, output from ZEAP is underlined whereas user input is not.

1. INTRODUCTION

ZEAP (Z-80 Editor/Assembler Package) is a memory resident text editor and symbolic assembler designed for use with the NASCOM 1 microcomputer.

The assembler translates mnemonic codes as defined in the Z-80 microcode language into executable machine instructions, allowing user control over memory allocation, and symbolic names for MPU registers and instruction or data addresses. It incorporates comprehensive syntax checking and error message generation, and allows object code to be generated on cassette tape or stored directly in memory.

The editor allows for entry, examination, correction and permanent storage of source programs which are held in memory during editing and assembly.

The memory resident nature of ZEAP allows entry, assembly, testing, correction and re-assembly of source programs without the necessity of using cassette tape at any stage, since editor, assembler, source program and object program may reside in memory simultaneously. This makes ZEAP very easy and quick to use.

1.1 AIMS OF ZEAP

ZEAP was produced with the intention of providing a compact editor/assembler package for the NASCOM 1 microcomputer. The following requirements were laid down during the design of the package:

* Minimum memory requirements
* Minimum extra hardware requirements
* Maximum compatibility with existing assemblers
* Ability to edit, assemble, execute and then re-edit the program with the minimum use of external storage (eg. cassette tape)
* Ability to store source programs on cassette tape and then re-load them at a later stage
* Ability to store more than one source program at a time in memory
* Maximum use of NASBUG sub-routines
* Ability to drive an ASCII terminal attached to the UART
* Ability to generate object code in NASBUG format, to be subsequently loaded using NASBUG's LOAD function

The result is an editor/assembler package requiring 5K bytes of user RAM (1K basic + 4K expansion kit), of which ZEAP uses under 3K bytes, leaving 2K bytes spare for source programs and object code.

The ZEAP editor provides the following functions:

* Fully dynamic source buffer allocation
* Insertion, deletion and replacement of lines
* Context editing of individual lines
* String searching
* Automatic line number generation for block entry of source programs
* Complete resequencing of source program line numbers
* Loading and dumping of source programs to and from cassette tape
* Listing of selected source program lines on the screen or on an ASCII terminal

* Self checking checksum for easy detection of hardware faults or user program malfunction

The ZEAP assembler provides the following functions:

* Full range of options including control of source listing, object generation and error processing

* Numbered error messages pin-pointing the exact cause of the error

* Object generation in NASBUG format onto cassette tape, or directly to memory

* Formatted source listing on the screen or on an ASCII terminal

The editor, assembler, source program and optional object program may all reside in memory at the same time, enabling maximum ease of entry, assembly, testing, correction and re-assembly of source programs with minimum use of external storage.

The assembler source code follows closely that defined in the ZILOG assembler, the differences being noted in section 1.2.

Editor operation is described in section 2, while the assembler's function is defined in section 3.

It should be noted that because of the commitment to minimum memory requirements, error checking of user input is kept to an absolute minimum. Failure to follow the instructions precisely will thus in some cases result in unpredictable errors or ZEAP itself becoming corrupted. Limits, formats, arguments, etc must be adhered to precisely.

1.2 COMPARISON WITH THE ZILOG ASSEMBLER

The operation of the ZEAP assembler is very similar in most respects to the ZILOG Z80 assembler. The following differences should be noted, however:

* Expressions may contain only the operators "+" and "-", and no parenthetical grouping is allowed. Expressions may be enclosed in parentheses to represent memory addresses. Evaluation is from left to right. A leading "-" is allowed.

* Hexadecimal numbers must be preceded by a "£". The "H" suffix form is not supported. The default number base is decimal. Octal and binary numbers are not supported.

* Labels must begin in the first column at the source line, directly after the single space following the sequence number. Only one label is permitted on a line. The use of a ":" suffix to indicate a label is not supported. Statements without labels must leave the first column blank, except for comments, which may begin in the first column with a ";".

* The following assembler directives (pseudo-ops) are not supported:

  MACRO
  ENDM
  COND
  ENDC
  DEFL
  END

* A single ASCII character code may be included in an expression by preceding it with a double quote sign, e.g. "A = £41. This facility replaces the DEFB 's' assembler directive.

* Fields and/or expressions may be separated by one or more spaces and/or commas. The space and the comma are syntactically equivalent in all contexts within the assembly language.

1.3 MACHINE REQUIREMENTS

ZEAP uses under 3K bytes of memory, not including source program storage. Thus a minimum of 4K bytes of memory is required in addition to the basic NASCOM 1.

With a cassette recorder the user can store source programs on cassette tape for reloading at a later time. The assembler can output NASBUG format object code to tape which can be subsequently loaded using NASBUG's LOAD function.

ZEAP contains routines to drive an ASCII terminal attached to the UART for hard copy or source listings. However, this item is entirely optional and ZEAP will function perfectly without it.

The minimum system is:

A working basic NASCOM 1
A television or monitor
A minimum of 4K bytes of additional memory
A cassette recorder

2 THE ZEAP EDITOR

The ZEAP editor provides the means by which source programs may be entered, examined and altered by the user.

2.1 EDITOR OPERATION

After ZEAP has been loaded, control is passed to the editor as described in APPENDIX A.

The editor prompt will be displayed (":") indicating that the ZEAP editor is ready to accept editor commands.

The editor is a line editor in which source lines are identified by line numbers (sequence numbers), each line of source code being identified with a unique number. The editor also has powerful context editing capabilities not normally available with this type of editor.

A sequence number may be any decimal number from 1 to 9999. Leading zeros may be omitted. The sequence number is always followed by a single space to separate it from the actual source line, eg.

```
1000 SAMPLE LINE
```

The actual source line is "SAMPLE LINE". The source line itself may of course contain leading spaces, eg.

```
2000   ANOTHER LINE
```

The space after "2000" is the separator, but the next two spaces are part of the source line.

A line of source code may be entered by typing a sequence number, followed by a space, followed by the source line, followed by the New Line key. The editor stores the line of source code in memory and prompts (":") for the next editor command.

The source program is sorted automatically in ascending sequence number order. Thus

```
:20 THIS IS THE THIRD LINE
:10 THIS IS THE FIRST LINE
:12 THIS IS THE SECOND LINE
:
```

would cause the lines to be stored in the order indicated.

Typing a sequence number directly followed by a New Line causes that line to be deleted. Thus

```
:12
```

would cause line 12 to be deleted.

Typing the sequence number of a line which already exists followed by a new source line causes the old line to be replaced by the new line. Thus

```
:20 THIS IS NOW THE SECOND LINE
:
```

would cause line 20 to be replaced with the indicated text.

Thus all requirements for inserting, deleting and changing lines of source code are provided by the above techniques.

In addition to the above facilities, there are a number of commands for examining and manipulating the source program. To take full advantage of NASBUG's command decoding routines, these commands have been implemented with single letter mnemonic codes. These commands are described below in section 2.2.

All source lines are stored in an area of memory called the EDIT BUFFER. All editor commands operate on the information contained in the Edit Buffer. The size of the source program is limited only by the amount of memory available.

At all times during ZEAP operation the address of first free memory location is displayed in hexadecimal in the top right hand corner of the screen. This address is that of the first location not used by ZEAP for the source program and the symbol table. It is also the default origin address for the assembler. Care must be taken that this number does not exceed the address of the highest memory location.

Any time before the New Line key is depressed, a line may be edited using the Backspace key as described in the NASCOM 1 Software Notes. In addition, the character "!" (Shift "1") may be used to delete the entire line. When "!" is depressed, a "!" will appear on the screen at the current cursor position, indicating that the line has been deleted, and the editor prompt ":" is displayed ready for the next user input, eg.

```
:50 THIS LINE IS WRONK!      ("!" key pressed)
:                            (prompt displayed)
```

In this case, line 50 would not have been entered into the Edit Buffer.

At any time when ZEAP is in the process of displaying information (eg. when listing or assembling the source program) the user may interrupt the process by depressing the "!" key. ZEAP will immediately abandon its current processing and display the editor prompt ":" to indicate that it is ready to process editor commands.

Alternatively the "?" key (Shift "/") may be used under the same circumstances to temporarily hold the execution of ZEAP so that the contents of the screen can be examined at length. When the user wishes to resume execution, depressing any key will restart ZEAP where it left off, and processing will continue. In summary:

"!" Delete line; abandon execution
"?" Hold execution (resumed by pressing any key)

Error messages from the ZEAP editor are of the form

ERROR nn

where nn is the error number. An explanation of ZEAP error codes is given in Appendix B. The most common editor message is

ERROR 99

meaning that the last line of user input was illegal or unrecognisable as an editor command or line of source code.

If the first character of an input line is blank, the line is ignored by the editor.

2.2 ZEAP EDITOR COMMANDS

The following discussion is independent of any knowledge of the Z80 assembly language, and therefore the source lines shown are not suitable for assembly by the ZEAP assembler.

"V" Suppose the following lines are entered:

```
:20 LINE 2
:10 LINE 1
:30 LINE 3
:
```

The user can examine the contents of part or all of the Edit Buffer using the "V" editor command. ("V" is a mnemonic for VDU List). Thus

```
:V 10 10
0010 LINE 1
:V 10 20
0010 LINE 1
0020 LINE 2
:V 20
0020 LINE 2
0030 LINE 3
:V
0010 LINE 1
0020 LINE 2
0030 LINE 3
:
```

Also note

```
:V 5 15
0010 LINE 1
:V 1 9
:V 20 10
:V 1000
:
```

The last three commands cause no display.

In summary:

V m n	Display lines m to n inclusive
V m	Display lines from m to the end of the buffer
V	Display the entire contents of the source buffer

The space following "V" is optional, but if both m and n are specified, they must be separated by one or more spaces.

"U" When a source program has been entered by the user using the ZEAP editor, it is useful to be able to store all or part of it on cassette tape. This is achieved by the "U" editor command ("U" is a mnemonic for UART List). Its syntax is the same as that of the "V" command. Its operation is identical except that each line displayed is also output to the UART in a format which allows the line to be reloaded subsequently by the editor. Thus

```
:U
0010 LINE 1
0020 LINE 2
0030 LINE 3
:
```

would cause those lines displayed to be stored on an attached cassette recorder.

There is no identifiable Load command provided with ZEAP. Loading of source programs stored on tape using the "U" editor command is performed simply by switching the cassette recorder on while the editor prompt is displayed. ZEAP scans both the keyboard and the UART input during editor operation, and so source lines input from tape will be interpreted as if they had been entered manually. Thus playing back the above tape when the ZEAP editor prompt is displayed would cause the following display:

```
:0010 LINE 1
:0020 LINE 2
:0030 LINE 3
:
```

and the three lines would be entered into the Edit Buffer as if they had been typed on the keyboard.

If the user attaches an ASCII terminal (teletype or equivalent) to the UART the "U" editor command can be used to obtain hard copy of all or part of the source program. The output of the "U" editor command is formatted with both NASBUG New Line characters and ASCII Carriage Return and Line Feed characters to support this facility. Thus, with an attached ASCII terminal

```
:U 10 20
0010 LINE 1
0020 LINE 2
:
```

and the two lines displayed are also printed on the terminal.

"I" The ZEAP editor provides a convenient facility for the manual entry of blocks of source code, namely the "I" editor command("I" is a mnemonic for Auto Input). If the user enters

```
:I 40
```

the editor responds

```
:0040
```

and any input up to the New Line key is interpreted as Line 40. Suppose the following is typed:

```
:0040 LINE 4
:0050
```

After New Line is depressed the editor increments the sequence number by 10 and displays the new sequence number, ready for the entry of the next line of code, and so on:

```
:0050 LINE 5
:0060 LINE 6
:0070
```

Note that the necessary space following the sequence number is inserted by ZEAP, so that the user need not type it.

It is possible to edit the sequence number using the Backspace key. Entering these backspaces, followed by 95, followed by a space at this stage would result in the display

```
:0095
```

and then line 95 could be entered

```
:0095 LINE 7
:0105
```

Note that the increment of 10 is applied to the sequence number of the last line entered, and not of the last line displayed by ZEAP.

Exit from Auto Input mode (which is the name given to the above behaviour) is achieved by typing "!" (Shift "1") which deletes the current line and causes the usual editor prompt to be displayed, thus:

```
:0105 !          (user types "!")
:
```

Note that if it had existed prior to the above sequence of commands, line 105 would not have been deleted. Only the line of entry displayed would be deleted. To delete line 105, it would be necessary to enter the number 105 followed by the New Line key, not the "!" key as above.

If the number after the "I" is omitted, the editor displays

```
:0010
```

initially.

If a second number is typed after the "I", it is used as the sequence number increment. It must be less than 100. Thus:

```
:I 100 3
0100                (New line pressed)
0103                (New line pressed)
0106 !              ("!" pressed)
:
```

So in summary

I	Enter Auto Input mode at line 10 with increments of 10
I s	Enter Auto Input mode at line s with increments of 10
I s i	Enter Auto Input mode at line s with increments of i

"X" Deleting a block of source code is made easier by the "X" editor command("X" is a mnemonic for eXpunge). "X"must always be followed by two numbers, separated by a space, which are the sequence numbers of the first and last lines to be deleted. All lines between and including these lines are deleted. Thus

```
:V
0010 LINE 1
0020 LINE 2
0030 LINE 3
0040 LINE 4
0050 LINE 5
0060 LINE 6
0095 LINE 7
:X 36 70
:V
0010 LINE 1
0020 LINE 2
0030 LINE 3
0095 LINE 7
:X 95
     ERROR 99
:X 95 95
:V
0010 LINE 1
0020 LINE 2
0030 LINE 3
:
```

Note that an attempt to use X with only one line number produced an error message.

To delete the entire edit buffer, the user should enter

```
:X 1 9999
:
```

This command does the job of a NEW or CLEAR utility in similar editors.

In summary

X m n Delete lines m to n inclusive

"Z" The limitation of line replacement as a method of correcting minor mistakes is clear from the following example:

```
:40 ILNE 4
:
```

To interchange the "I" and the "L" requires that the whole line be re-entered. A powerful alternative is provided in the ZEAP editor. Entering

```
:Z 40
```

causes the following two lines to be displayed:

```
:0040 ILNE 4
  ↑
```

ZEAP has now entered Edit mode. The arrow under the first digit of the sequence number is the cursor. The user can advance the pointer to the position where the correction is to be made by depressing the space bar appropriately. After pressing it six times the display is:

```
:0040 ILNE 4
      ↑                    (6 spaces typed)
```

Now the offending letter "L" can be deleted by typing "<" (shift ","), thus

```
:0040 INE 4
      ↑                    ("<" typed)
```

Note that all the characters to the right of the cursor have been moved up to fill the gap left by the deleted "L" Now, using the backspace key, the cursor can be positioned under the "I", before which an L is to be inserted:

```
:0040 INE 4
      ↑                    (Backspace typed)
```

Now to make room for the L the ">" (shift ".") is used:

```
:0040  INE 4
       ↑
```

Note that all the characters above and to the right of the cursor are shifted one place right to make room for the insertion. Finally typing "L" will give

```
:0040 LINE 4
       ↑
```

The "L" is inserted at the position of the cursor, which is then advanced one place.

Now that editing is completed, the New Line key is pressed to signify that fact

```
:0040 LINE 4
:
```

The cursor arrow disappears, and the editor prompts for the next command. The new line 40 is entered just as if it had been typed manually.

The space and backspace keys cause the cursor to move one place right or left respectively. Moving the cursor beyond the limits of the bottom line of the screen will have unpredictable effects. These keys cannot be used to enter spaces or delete characters in the line being edited as they do in normal editor operation. The ">" and "<" keys must be used for these purposes, respectively.

The ">" (insert) key causes all characters above and to the right of the cursor to be shifted one place right to allow insertion of text. Repeated depressions cause more space to be left. Characters shifted off the right hand end of the line are lost. The cursor remains where it is.

The "<" (delete) key causes the character above the cursor to be deleted and all characters to the right of the deleted character to be moved one place left to fill the gap left by the deleted character. Repeated depressions cause more characters to be deleted. Spaces enter from the right hand end of the line. The cursor remains where it is.

The New Line key causes Edit mode to be terminated, and the edited line is interpreted as a line of source code entry.

The "!" key causes Edit mode to be abandoned.
The edited line is ignored and the original version of it remains intact in the Edit Buffer.

Depressing any other key causes the appropriate character to replace the character currently above the cursor, and the cursor is advanced one place to the right.

A space may be entered into the line being edited by depressing the "<", ">" and space keys in sequence.

In Edit mode the sequence number itself can also be edited. Thus

```
:Z 40
:0040 LINE 4
      ↑
```

Typing two spaces followed by a "7" gives

```
:0070 LINE 4
   ↑                          (space space "7" typed)
```

Now typing New Line gives

```
:0070 LINE 4
:
```

And now

```
:V
0010 LINE 1
0020 LINE 2
0030 LINE 3
0040 LINE 4
0070 LINE 4
:
```

Note that the original line still exists, so

```
:40                           (deletes line 40)
:V
0010 LINE 1
0020 LINE 2
0030 LINE 3
0070 LINE 4
:
```

In summary

Z y	edit line y

and then the following keys may be used:

Space	cursor right
Backspace	cursor left
">"	insert
"<"	delete
New Line	leave Edit mode
"!"	abandon Edit mode
other	replace current character

"F" The "F" editor command ("F" is a mnemonic for Find) enables the user to find the first and thereafter subsequent occurences of any string of up to six characters in the source program. Thus

```
:25 ABC
:55 ABCDEF
:V
0010 LINE 1
0020 LINE 2
0025 ABC
0030 LINE 3
0055 ABCDEF
0070 LINE 4
:F/ABCD/
:0055 ABCDEF
  ↑
```

In this example the string "ABCD" is found in line 55, which is displayed and Edit mode is entered automatically. The "/" character is used as a delimiter. Any non-blank character may be used. In the examples that follow it is assumed that Edit mode was left immediately after the display of the cursor arrow by typing New Line, so that no change occured to the edited line.

```
:0055 ABCDEF
:F*ABC*
:0025 ABC
:F
:0055 ABCDEF
:FT
:0025 ABC
:
```

The command "F" above causes the next occurence of the last mentioned string to be found. The command "FT" (a mnemonic for Find from the Top) causes the search to be restarted from the beginning of the Edit Buffer. If no occurence of the string is found, the editor merely prompts for the next line of input.

In summary:

F/string/	finds first occurence of "string"
F	finds next occurence of last "string"
FT	finds first occurence of last "string"

"R" The "R" editor command ("R" is a mnemonic for Resequence) allows the entire source program to be remembered. Thus

```
:V
0010 LINE 1
0020 LINE 2
0025 ABC
0030 LINE 3
0055 ABCDEF
0070 LINE 4
:R 100
:V
0100 LINE 1
0110 LINE 2
0120 ABC
0130 LINE 3
0140 ABCDEF
0150 LINE 4
:
```

Only the order of the source lines is maintained. The first line is given the line number entered after the "R", and subsequent lines are numbered sequentially in increments of 10. The arguments are the same as for the "I" editor command.

In summary

R	Resequence program starting with sequence number 10 in increments of 10
R s	Resequence program starting with sequence number s in increments of 10
R s i	Resequence program starting with sequence number s in increments of i

"P" The "P" editor command allows object code generated by the assembler under the MEMORY option to be placed at a physical address different from the logical address of the assembly, to facilitate generation of ROM based programs. A single hexadecimal argument must be supplied (the default is zero) which specifies the amount to be added to the logical address to obtain the physical address where the object code is to be stored. Thus

```
:P 4000
```

will cause the following program to be placed physically at location £4000.

```
     ORG    0
     JP     START
XX   DEFS   30
     etc.
```

Note that the object code is only stored in memory if the MEMORY assembler option is on. Object code stored in memory with any non-zero offset is unsuitable for

direct execution. It must first be moved to the logical address of the assembly.

"Q" The "Q" editor command allows both the rate at which information is displayed on the screen, and the pause at the end of a line of listing sent to the UART, to be controlled. The format is

:Q ccdd

where ccdd is a 4 digit hexadecimal number (with no space between cc and dd), and cc is the delay to be inserted between each character sent to the VDU, and dd the delay to be inserted after a carriage return when either the "U" editor command or the "TTY" assembly option is in operation. A value of 0 signifies no delay. A value of 1 signifies a delay of about 7½ milliseconds, and so on - dd should be set to at least £80 when the "U" editor command is being used to save the source program on tape.

"N" The "N" editor command returns control to NASBUG ("N" is a mnemonic for NASBUG). ZEAP can be re-entered by following the procedure described in APPENDIX A, at which point the editor prompt will be displayed thus

:

The contents of the Edit Buffer will be intact.

"O" "A" Two editor commands, "O" and "A" are documented in section 3, since their use is related to assembler operation.

A formal account of the editor commands is given in APPENDIX C.

3 THE ZEAP ASSEMBLER

The ZEAP assembler translates the source program, entered by the user into the Edit Buffer using the ZEAP editor, into executable Z80 microcode instructions which may be stored in memory for immediate execution, or on tape for subsequent use.

3.1 ASSEMBLER OPERATION

"A" The assembler is entered from the editor by using the editor command "A"("A"is a mnemonic for Assemble). Since the portion of the Edit Buffer to be assembled can be selected in the same way as for the "V" and "U" editor commands, it is possible to store several source programs in the Edit Buffer simultaneously, provided that each occupies a continuous block of the Edit Buffer, ie. programs do not overlap.

Suppose a complete program is stored in the Edit Buffer in lines 2000 to 2999. The command

```
:A 2000 2999
```

will cause assembly of this program. If only one program is stored, simply entering

```
:A
```

will assemble all lines in the source program. Similarly

```
:A 5000
```

would assemble from line 5000 to the end of the edit buffer.

When the assembly is complete, and all output is finished, control is returned to the ZEAP editor, and the editor prompt is displayed ready for the next command.

In summary

A m n	assembles from lines m to n inclusive
A m	assembles from line m to the end of the Edit Buffer
A	assembles the entire Edit Buffer contents

3.2 EXPRESSIONS

Wherever the form "exp" is encountered an expression involving label symbols and/or constants is expected. The occurrence of register and/or label symbols must be in accordance with the semantics laid down in APPENDIX F. Such an expression is always evaluated using 16 bit integer two's complement arithmetic. Expressions may be formed using the following elements:

label symbol	a symbolic name of one to six characters, starting with a letter and thereafter consisting of letters and/or numbers, which appears in the label field of a source program. The value of the symbol is that associated with it by its appearance in the label field of some source statement (see section 3.3).
decimal integer content	a decimal number between 0 and 65535. Larger numbers will be truncated to 16 bits.
hexadecimal integer constant	a "£" sign followed by one to four hexadecimal digits (0-9, A-F) interpreted as an unsigned hexadecimal number. Larger numbers will be truncated to 16 bits.
ASCII code value	a double quote character followed by a single character, whose ASCII code value is used (bit 7 = 0).
location counter	the character "$" which represents the value of the location counter at the beginning of assembly of the current line (or current expression in the case of a DEFB or DEFW assembler direction; see section 3.5). This is the address at which the current instruction (or expression) is being assembled.

Any number of elements of the above kind may be combined with "+" and "-" signs to make the expression. A leading "-" sign is allowed. No parenthetical grouping is allowed. Expressions may be enclosed entirely in parentheses to represent memory addresses, in accordance with the semantics defined in APPENDIX F.

Here are some examples:

```
TABLE+3
START-$
£80+"A-1
END-BEG+1
-273
"Z-"A+1
BIMUNZ+BIMUNZ
```

Expressions may not contain embedded blanks or commas. A missing operator is interpreted as a "+". A missing operand is interpreted as a zero. For example:

```
12ABC    is interpreted as    12+ABC
3+-4     is interpreted as    3+0-4
```

3.3 SOURCE STATEMENT SYNTAX

Each line of the source program must be one of the following:

i) a Z80 instruction
ii) a ZEAP assembler direction
iii) a comment

The first character of a source line is the character directly after the single space following the sequence number. The last character of a source line is the last non-blank character entered before the New Line key is pressed.

3.3.1 LABELS

If the source line is type (i) or (ii), an optional label may be present. The label must be a symbolic name of one to six characters starting in the first column, the first character being a letter, and subsequent characters being letters or numbers with no embedded spaces. Examples are:

```
START
END
TABLE
LI
P3B
```

The following symbols are improperly formed:

```
113P
P4:
LP Q
```

A label must be followed by one or more spaces and/or commas. If present, it must start in the first column of the source statement (ie. the first character of the label must be the first character of the source line). If no label is present the first character of the source line must be a space or a comma, unless the statement is type (iii), a comment.

In case (i), the label is given the value of the location counter prior to the assembly of the rest of the statement, ie. its value is the address at which the statement is assembled. In this way the location of any instruction or sequence of instructions can be represented symbolically and referred to elsewhere in the program, eg. in a JP or CALL instruction.

In case (ii), the label is given the value as defined in section 3.5 and Appendix D. In this way the address of a data table or literal string for display on the screen can represented symbolically and referred to elsewhere in the program, eg. in a LD HL, exp instruction.

Each label defined must be unique within the program being assembled. Each label symbol referenced in the program must appear in the label field of some source statement. The following symbolic names are reserved by ZEAP for registers and condition codes:

A, B, C, D, E, H, I, L, M, P, R, Z,
AF, BC, DE, HL, IX, IY, NC, NZ, PE, PO, SP

3.3.2 INSTRUCTION FORMAT

Each source statement of type (i) or (ii) consists of up to four fields which are:

(optional) label field
instruction mnemonic or assembler directive
(optional) operand field
(optional) comment field

Each field must be separated from the next by one or more spaces and/or commas. If the first character of the source line is a space or a comma, no label is assumed to be present. If the first character of the source line is ";" the line is assumed to be a comment (see section 3.3. below).

The instruction mnemonic or assembler directive must be present. It may be any mnemonic listed in Appendix F, or any directive mnemonic documented in section 3.5 and Appendix D.

The operand field may or may not be present according to the syntax of the statement. In case (i) it must follow the definition given for the appropriate instruction in Appendix F. In case (ii) it must follow the definition given for the appropriate assembler directive in section 3.5 and Appendix D. If the field contains more than one operand, each operand must be separated from the next by one or more spaces and/or commas.

The comment field is optional. It must begin with ";" and ends at the end of the line. Any characters after the ";" are ignored by the assembler, except that they are reproduced literally in the assembly listing. The ";" may follow directly after the preceding field, with no intervening spaces or commas.

Although the assembler interprets the entire operand field, only the first 17 characters of the operand and/or comment fields are displayed on the assembly listing on the screen. For this reason it is suggested that the full line comment facility (see section 3.3.3 below) be utilised so that the assembly listing is complete. The operand field itself will rarely if ever need to be longer than 17 characters.

3.3.3 COMMENT LINES

A comment line must begin with a ";", and all characters thereafter will be ignored by the assembler, except that they will appear on the assembly listing. The first 29 characters will be displayed on the assembly listing on the screen.

3.4 ASSEMBLER OPTIONS

"O" The "O" editor command allows various options to be set which define the output required from the assembler (O is a mnemonic for Options). The "O" may be followed by a single hexadecimal mask defining which options are ON and which are OFF. This mask is obtained by adding up the option codes of those options desired ON. Thus

```
:O 1A
```

would set assembler options MEMORY, TAPE and PASS 2 on, and NO LIST and TTY off (1A = 10 + 08 + 02 Hex). If no number follows the "O" all assembler options are set to the default values (ie. all off).

In summary:

O x	set assembler options from mask x
O	set all assembler options off

Appendix E contains a full account of each assembler option.

3.5 ASSEMBLER DIRECTIVES

The six assembler directives supported by ZEAP give the user the ability to control the generation of object code addresses, and to generate tables or liberal strings.

DEFB, DEFW and DEFM all cause the generation of object code for one or more bytes, words (double-bytes) and ASCII characters respectively.

EQU allows the direct assignment of an expression value to a symbolic name.

ORG and DEFS alter the assembly address ("$") so that assembler programs may be assembled at any address, and to allow for space for storage of intermediate results and other variable information.

A full account of the assembler directives is given in Appendix D.

Sonderzeichen für Assembler:

; als diesem Zeichen Kommentar, der nicht übersetzt wird

£ Hinter dieses Zeichen kann ein Hex Zeichen gesetzt werden (neue Adresse)

$ Zeichen in Assembler Beschreibung für Assembler Adresse gibt bei Sprung adressen d zur Zeit gültigen wer die Adresse an

3.6 ASSEMBLY LISTING

A line of assembly listing takes the following form:

aaaa cccccccc ssss bbbbbb mmmm ppppppppppppppppp

The explanation of the fields is as follows:

aaaa	4 digit hexadecimal address of the instruction being assembled, except in a DEFB, DEFW or DEFM assembler directive, where it is the address of the first byte of code generated, and in a EQU, ORG or DEFS assembler directive, where it is the value of the expression in the operand field.
cccccccc	2 to 8 hexadecimal digits representing the object code for the instruction, except in a DEFB, DEFW or DEFM assembler directive it contains only the first byte or word generated as appropriate.
ssss	4 digit sequence number of the current source line.
bbbbbb	1 to 6 character label of the current source line. If no label is present, this field is left blank.
mmmm	2 to 4 character instruction mnemonic or assembler directive.
ppp.....	Operand and comment fields directly from source line.

If the source line is a comment (first character ";"), fields aaaa and cccccccc are left blank, and the comment is copied directly after the sequence number.

If the line contains an error, field cccccccc will contain

```
ERROR nn
```

and no object code is generated. A truncation error is reported on the following line, but the object generation is not suppressed.

Since the assembler formats the listing, there is no need to tabulate source programs. The fields of each source statement will be correctly formatted by the assembler. For example the source line

```
0040 BIM LD A,1
```

would appear in the assembly listing as

```
aaaa 3E01     0040 BIM    LD   A,1
```

where aaaa is the current value of the location counter ("$").

3.7 OBJECT GENERATION

3.7.1 TAPE OBJECT

If the TAPE assembler option is on , object code is output through the UART to an attached cassette recorder in NASBUG format. Any block of object code in which the number of bytes generated is not an exact multiple of eight (the length of a NASBUG record) is padded out with random data. Provided the object code is generated in strict address order this will cause no trouble to the user.

Object code generated in this manner can be loaded using NASBUG's "L" command as if the data had been saved using "D". The user should make a note of the execution address of his program from the source listing so that he may correctly begin execution of his program.

The tape LED is used by ZEAP in the same way as it is by NASBUG, and may be used as a direct or indirect indication to start the cassette recorder as described in the NASCOM 1 documentation.

3.7.2 MEMORY OBJECT

If the MEMORY assembler option is on, object code is assembled direct to memory. Object instructions and data are written as they are assembled to the appropriate memory address. Great care must be exercised when using this option, as NO CHECK is made that object code is not overwriting the Edit Buffer or ZEAP itself, or even that there is RAM at the address where the object code is being written. If no ORG assembler directive appears in the source program, assembly will begin at the first available byte of RAM not being used by ZEAP, as displayed in the corner of the screen, but the user should bear in mind that the object program may overflow available memory with no warning.

A program so assembled may be executed by entering NASBUG using the ZEAP "N" editor command and executing the object code using NASBUG's "E" command. The object program should set the stack pointer to a free area of memory if the stack is to be used, so that ZEAP's own stack does not overflow.

If the object program works incorrectly it may be necessary to reload ZEAP from tape, and enter the source program again. For this reason it is recommended that the source program be saved on tape before testing an object program, in case valuable data is lost and has to be typed in again.

APPENDIX A

ZEAP OPERATION

ZEAP should be loaded from the tape provided. First the loader should be loaded using the "L" command. This will cause a short program to be placed at location £0C50. Object code for this program is given in the latter part of Appendix I. Zeap itself is then loaded by executing from £0C50. Any lines containing a check sum error will be scrolled up on the screen and may be corrected from the object code listing in Appendix I.

ZEAP loads at £1000 and is about 2.82K bytes in length. The area from £0F00 to £0FFF is used as ZEAP's register storage and stack space. The source buffer begins directly after ZEAP. The area from £0C50 to £0EFF is not used by ZEAP, and may therefore contain programs or other user information.

To execute ZEAP enter:

```
>EF00
```

If the "N" editor command is used to return to NASBUG, ZEAP may be re-entered by entering:

```
>EF00
```

provided that it has not been corrupted. In this case the edit buffer will be intact but the assembler options will have been reset.

A limit on the memory used for source program storage can be imposed, eg. to stop the edit buffer from overflowing higher than £3000 enter:

```
>EF00 3000
```

when executing ZEAP. The default setting is the last limit specified (or £5000 initially).

APPENDIX B

ZEAP ERROR CODES

ERROR 00 CORE FULL

The source line just entered would cause an overflow of the edit buffer. The source line was not entered into the buffer. However, if the line was to replace an existing line, the original line was deleted.

ERROR 01 RESEQUENCE OVERFLOW

During the execution of a RESEQUENCE editor command the line number became greater than 9999. The source file is resequenced starting with line 1 in steps of 1.

ERROR 02 AUTO INPUT OVERFLOW

In AUTO-INPUT mode the line number became greater than 9999. AUTO-INPUT mode is abandoned.

ERROR 03 NON-EXISTENT LINE

An attempt was made to edit a non-existent line with the "Z" editor command.

ERROR 10 UNRECOGNISABLE STATEMENT

A label is more than 6 characters, or a mnemonic is more than 4 characters or omitted. The statement is ignored.

ERROR 20 UNKNOWN MNEMONIC

The op-code field contains an unrecognisable mnemonic. The statement is ignored.

ERROR 21 CONTEXT ERROR

The combination of op-code and operand types encountered is illegal or a mnemonic is too short. The statement is ignored.

ERROR 22 INDEX REGISTER ERROR

IX or IY is used where only HL is permitted, or in a JP (IX) or JP (IY) instruction, the displacement is non-zero. The statement is ignored.

ERROR 23 TRUNCATION ERROR

An 8 bit operand is greater than 255 or less than -128 or an index register displacement value is greater than 127 or less than -128, or a relative branch offset is greater than 129 or less than -126, or a bit number in a BIT, SET or RES instruction is greater than 7 or less than 0, or an address in an RST instruction is illegal, or the mode in an IM instruction is not 0, 1 or 2. The value in question is truncated and assembly of the statement continues.

ERROR 24 TOO MANY REGISTERS

A register symbol appears in an assembler directive operand, or more than one register appears in an instruction operand. The statement is ignored.

ERROR 25 REGISTER MISMATCHED

The combination of first and second operand types is illegal. The statement is ignored.

ERROR 26 ILLEGAL CHARACTER

The operands field contains a character whose meaning is unassigned in the syntax of the assembly language. The statement is ignored.

ERROR 27 ILLEGAL OPERAND

The combination of a register and a label or constant in this context is illegal. The statement is ignored.

ERROR 28 PARENTHESIS ERROR

A left parenthesis occurs in an assembler directive operand, or more than one left parenthesis occurs in an instruction operand. The statement is ignored.

ERROR 30 LABEL NOT FOUND

A symbol in an expression does not occur in the label field of any statement in the source code. The statement is ignored.

ERROR 31 LABEL REDEFINED

The symbol in the label field has previously appeared in a label field, or is a register name. The label is ignored and the rest of the statement is assembled.

ERROR 40 DIRECTIVE ERROR

In an assembler directive, too few or too many operands appear. The statement is ignored.

ERROR 41 ILLEGAL FORWARD REFERENCE

A label symbol in an EQU, ORG or DEFS assembler directive is defined after the directive is encountered. The statement is ignored.

ERROR 50 ERRORS IN ASSEMBLY

There were errors flagged in the previous assembly.

ERROR 90 CHECKSUM ERROR

Part of ZEAP has been corrupted due to hardware errors or user tampering. If ZEAP is not reloaded, unpredictable errors may occur.

ERROR 99 ILLEGAL COMMAND

An unrecognisable editor command or an ill-formed source code line was entered. The input line is ignored.

APPENDIX C

ZEAP EDITOR COMMANDS

The following symbols are used. All numbers are decimal unless otherwise stated.

- y sequence number (ie. source line number)
- m first sequence number to which command is applied (default 1)
- n last sequence number to which command is applied (default 9999)
- s starting sequence number (default 10)
- i increment (default 10)
- x hexadecimal option mask
- h hexadecimal number

Numbers are separated from the command letter and from each other by one or more spaces.

If n is explicitly specified then m must be also.
If i is explicitly specified then s must be also.

A m n ASSEMBLE SOURCE PROGRAM (ASSEMBLE)

Causes assembly of the indicated portion of the source program, with the options defined by the last SET ASSEMBLER OPTIONS command in effect. See section 3 for more details.

I s i ENTER AUTO-INPUT MODE (AUTO-INPUT)

Causes the ZEAP editor to enter AUTO-INPUT mode. The number s is displayed, followed by a space. The user may then enter a line of source code terminated by the New Line key, whereupon that line of code is entered into the edit buffer, i is added to s, and the new sequence number is displayed. The user may continue to enter source code as long as the sequence number remains less than 10000.

Exit from AUTO-INPUT mode is achieved by entering the line delete character, "!" (shift "1"). The editor then prompts for the next command.

N RETURN TO NASBUG (NASBUG)

Causes ZEAP to return control to NASBUG, allowing any of NASBUG's monitor commands to be used, for example to alter any of ZEAP's internal registers in accordance with Appendix G, or to execute a program assembled in memory.

Provided the area of memory used by ZEAP is unchanged during NASBUG operation, ZEAP may be re-entered with the edit buffer intact, in accordance with the procedure described in Appendix A.

F/string/FIND STRING (FIND)
FT

Searches for a specified string in the edit buffer, and if found, opens the line containing it for editing.

The form "F/string/" is used to search from the beginning of the edit buffer for a character string of up to six characters. The "/" represents a delimeter character, which may be any character, except space, but which must follow directly after the "F". If the second delimeter is omitted or the string is more than six characters long the command is treated as an "FT" command (described below). If the string is found, the line containing it is displayed and opened for editing (see EDIT SOURCE LINE). If the string is not found the ZEAP editor prompts for the next command.

The form "F" is used to search for the string specified in the most recent "F/string/" command, starting from the last occurence of that string found, instead of from the beginning of the edit buffer. Otherwise it is identical to the "F/string/" command described above.

The form "FT" is used to search for the string specified in the most recent "F/string/" command, starting from the beginning of the edit buffer. Otherwise it is identical to the "F/string/" command described above.

O x SET ASSEMBLER OPTIONS (OPTIONS)

Sets assembler options specified by the hexadecimal number x. The options and their hexadecimal codes are as follows. See section 3.4 for more details.

+ 01	SUPPRESS SOURCE LISTING (NO LIST)
+ 02	OBJECT CODE TO MEMORY (MEMORY)
+ 04	SOURCE LISTING TO TTY (TTY)
+ 08	OBJECT CODE TO TAPE (TAPE)
+ 10	FORCE SECOND PASS (PASS 2)
+ 20	ADJUST RELATIVE JUMP OFFSETS (ADJUST REL)

Initially all options are off.

R s i RESEQUENCE SOURCE CODE (RESEQUENCE)

Remembers all the statements in the edit buffer so that the first line is given the number s, and subsequent lines s+i s+2i, etc. as for the "I" editor command.

U m n LISTING TO UART (SAVE)

Causes the indicated portion of the source program to be output to the UART, and simultaneously displayed on the screen.

The output through the UART is formatted to drive either a cassette tape recorder, so that any portion of the source program may be stored permanently and loaded subsequently by ZEAP, or an ASCII terminal to obtain a hard copy listing of any portion of the source program.

V m n LISTING TO VDU (LIST)

Causes the indicated portion of the source program to be displayed on the screen.

X m n BLOCK DELETE (DELETE)

Causes all source lines numbered m to n inclusive to be deleted. Both m and n must be specified.

Z y EDIT SOURCE LINE (EDIT)

Displays line y and opens for edit. The following keys are available for specified functions:

Space	Move pointer right
Backspace	Move pointer left
">"(Shift".")	Insert
"<"(Shift",")	Delete
New line	Leave edit
"!" (Shift "1")	Abandon edit

P h SET MEMORY OFFSET (OFFSET)

Set to h the number to be added to the logical assembly address to obtain the physical location of the object code in memory when the MEMORY assembler option is on.

Q h SET I/O RATES (RATES)

Set the inter-character delay to cc hex and the end of line delay (for use with the U editor command and TTY assembler option) to dd hex, where h = ccdd.

APPENDIX D
ASSEMBLER DIRECTIVES

label EQU exp (; comment) EQUATE SYMBOL

The label is given the value of the 16 bit expression in the operand field. All symbols appearing in the expression must have been previously defined. No object code is generated. The label may not be redefined.

label ORG exp (; comment) SET ORIGIN

The location counter ($) is given the value of the 16 bit expression in the operand field. All symbols appearing in the expression must have been previously defined. No object code is generated. Assembley continued at the new origin. If a label is present, it is given the value of the expression.

(label) DEFS exp (; comment) DEFINE SPACE

The location counter ($) is increased by the value of the 16 bit expression in the operand field. All symbols appearing in the expression must have been previously defined. No object code is generated. Assembly continues after a block of memory of length exp . If a label is present, it is given the original value of the location counter ($).

(label) DEFB exp (,exp).... (; comment) DEFINE BYTE

For each 16 bit expression one byte of code is generated with the value of that expression. Expressions may contain forward references. If a label is present, it is given the value of the address of the first byte of code generated.

(label) DEFW exp (, exp).... (; comment) DEFINE WORD

For each 16 bit expression two bytes of code are generated with the value of that expression, the low order 8 bits occupying the first byte and the high order 8 bits the second. Expression may contain forward references. If a label is present, it is given the value at the address of the first byte of code generated.

(label) DEFM /string/ (; comment) DEFINE MESSAGE

The "/" may be any character except blank or comma. For each character after the first delimeter until the second delimeter or the end of the line is encountered, one byte of code is generated having the value of the ASCII code for that character, with bit 7 zero. Any characters may appear between the delimeters. Characters after the second occurence of the delimeter are ignored. If a label is present, it is given the value of the address of the first byte of code generated.

APPENDIX E
ASSEMBLER OPTIONS

Assembler options are set by the OPTIONS editor command. All assembler options must be explicitly specified as on or off, and remain in effect until the next OPTIONS editor command is issued, or until ZEAP is reloaded. All assembler options are initially off, and are all switched off whenever ZEAP is re-entered.

Assembler options are selected as ON by adding the hexadecimal option codes of the desired assembler options together. Thus the TTY and PASS 2 assembler options would be selected as on by entering the command "O 14". If no mask is specified, all options are set to the default off state.

+01 SUPPRESS SOURCE LISTING (NO LISTING)

During the second pass, no source listing will be displayed on the screen. Lines containing errors will, however, still be displayed.

+02 OBJECT CODE TO MEMORY (MEMORY)

During the second pass, the object code will be assembled directly into memory. No check is made to see that the object code is not overwriting parts of ZEAP and/or the edit buffer, nor that there is read/write memory at the address where code is being written. See section 3.7 for more details.

+04 SOURCE LISTING TO TTY (TTY)

During the second pass, any source listing will be listed on an ASCII terminal attached to the UART. If the NO LIST assembler option is on, only those lines containing errors will be listed. The output from the UART is not suitable for storage on cassette tape.

This assembler option may not be used in conjunction with the TAPE assembler option, described below.

+08 OBJECT CODE TO TAPE (TAPE)

During the second pass, the object code will be dumped in NASBUG format to a cassette tape recorder attached to the UART. The object program may be subsequently loaded using NASBUG's LOAD function, and executed under NASBUG control. No object code is written to memory (unless the MEMORY assembler option is on) so that object code cannot overwrite ZEAP or the edit buffer.

This assembler option may not be used in conjunction with the TTY assembler option, described above.

+10 FORCE SECOND PASS (PASS 2)

Normally if errors are detected during the first pass, the second pass is supressed. If this assembler option is on, however, the second pass will be executed regardless.

+20 ADJUST RELATIVE JUMP OFFSETS (ADJUST REL)

Different standards in implementing the JR and similar instructions by different manufacturers. The assembler normally expects the argument to a relative jump instruction to be an expression which is the offset from the location of the current instruction to the destination, eg.

```
      JR Z,3      ;  BRANCH ROUND LD INSTRUCTION
      LD (SWITCH), A
      RET
```

or, more conveniently

```
      JR Z, RETURN - $
      LD (SWITCH), A
RETURN RET
```

The ADJUST REL assembler option causes the assembler to automatically subtract the value of $ from the argument of each relative jump instruction, so that the presentation of the source code is in line with absolute jump and call instructions. Thus with the ADJUST REL assembler option set, the following code now achieves the desired result

```
      JR Z, RETURN
      LD (SWITCH), A
RETURN RET
```

or

```
      JR $+3
      LD (SWITCH), A
      RET
```

Note that the first two examples would probably give a truncation error if the ADJUST REL assembler option is set. The convention adopted must be fixed throughout the whole program.

APPENDIX F

INSTRUCTION SET

The executable instruction set is defined in the ZILOG publication Z80-CPU Technical Manual, and in the MOSTEK publication Z80 Micro Computer Devices Technical Manual. For a full explanation of the instruction set one should have these manuals together with the assembly language programming manuals published by either company. A summary of the executable mnemonics is set out below.

EXECUTABLE INSTRUCTIONS

ADC	HL,SS	ADD WITH CARRY REG. PAIR SS TO HL
ADC	A,S	ADD WITH CARRY OPERAND S TO ACC.
ADD	A,N	ADD VALUE N TO ACC.
ADD	A,R	ADD REG. R TO ACC.
ADD	A,(HL)	ADD LOCATION (HL) TO ACC.
ADD	A,(IX+D)	ADD LOCATION(IX+D) TO ACC
ADD	A,(IY+D)	ADD LOCATION (IY+D) TO ACC.
ADD	HL,SS	ADD REG. PAIR SS TO HL
ADD	IX,PP	ADD REG. PAIR PP TO IX
ADD	IY,RR	ADD REG. PAIR RR TO IY
AND	S	LOGICAL 'AND' OF OPERAND S AND ACC.
BIT	B,(HL)	TEST BIT B OF LOCATION (HL)
BIT	B,(IX+D)	TEST BIT B OF LOCATION (IX+D)
BIT	B,(IY+D)	TEST BIT B OF LOCATION (IY+D)
BIT	B,R	TEST BIT B OF REG. R
CALL	CC,NN	CALL SUBROUTINE AT LOCATION NN IF CONDITION CC IF TRUE
CALL	NN	UNCONDITIONAL CALL SUBROUTINE AT LOCATION NN
CCF		COMPLEMENT CARRY FLAG
CP	S	COMPARE OPERAND S WITH ACC.
CPD		COMPARE LOCATION (HL) AND ACC.DECREMENT HL AND BC
		UNTIL CB=0
CPDR		COMPARE LOCATION(HL) AND ACC. DECREMENT HL AND BC, REPEAT
CPI		COMPARE LOCATION (HL) AND ACC. INCREMENT HL AND DECREMENT BC
CPIR		COMPARE LOCATION (HL) AND ACC. INCREMENT HL, DECREMENT BC REPEAT
		UNTIL BC=0
CPL		COMPLEMENT ACC. (1'S COMP)
DAA		DECIMAL ADJUST ACC.
DEC	M	DECREMENT OPERAND M
DEC	IX	DECREMENT IX
DEC	IY	DECREMENT IY
DEC	SS	DECREMENT REG. PAIR SS
DI		DISABLE INTERRUPTS
DJNZ	E	DECREMENT B AND JUMP RELATIVE IF B=0
EI		ENABLE INTERRUPTS
EX	(SP),HL	EXCHANGE THE LOCATION (SP) AND HL
EX	(SP),IX	EXCHANGE THE LOCATION (SP) AND IX
EX	(SP),IY	EXCHANGE THE LOCATION (SP) AND IY
EX	AF,AF'	EXCHANGE THE CONTENTS OF AF AND AF'
EX	DE,HL	EXCHANGE THE CONTENTS OF DE AND HL
EXX		EXCHANGE THE CONTENTS OF BC, DE, HL WITH CONTENTS OF BC', DE',
		HL', RESPECTIVELY
HALT		HALT (WAIT FOR INTERRUPT OR RESET)
IM	0	SET INTERRUPT MODE 0
IM	1	SET INTERRUPT MODE 1
IM	2	SET INTERRUPT MODE 2

```
LD     SP,IX     LOAD SP WITH IX
LD     SP,IY     LOAD SP WITH IY
LDD              LOAD LOCATION (DE) WITH LOCATION (HL),DECREMENT DE, HL AND BC
LDDR             LOAD LOCATION (DE) WITH LOCATION (HL), DECREMENT DE, HL AND BC;
                 REPEAT UNTIL BC=0
LDI              LOAD LOCATION (DE) WITH LOCATION (HL), INCREMENT DE, HL,
                 DECREMENT BC
LDIR             LOAD LOCATION (DE) WITH LOCATION (HL), INCREMENT DE, HL,
                 DECREMENT BC AND REPEAT UNTIL BC=0
NEG              NEGATE ACC. (2'S COMPLEMENT)
NOP              NO OPERATION
OR     S         LOGICAL 'OR' OR OPERAND S AND ACC.
OTDR             LOAD OUTPUT PORT (C) WITH LOCATION (HL) DECREMENT HL AND B,
                 REPEAT UNTIL B=0
OTIR             LOAD OUTPUT PORT (C) WITH LOCATION (HL), INCREMENT HL, DECREMENT
                 B, REPEAT UNTIL B=0
OUT    (C),R     LOAD OUTPUT PORT (C) WITH REG. R
OUT    (N),A     LOAD OUTPUT PORT (N) WITH ACC.
OUTD             LOAD OUTPUT PORT (C) WITH LOCATION (HL), DECREMENT HL AND B
OUTI             LOAD OUTPUT PORT (C) WITH LOCATION (HL), INCREMENT HL AND
                 DECREMENT B
POP    IX        LOAD IX WITH TOP OF STACK
POP    IY        LOAD IY WITH TOP OF STACK
POP    QQ        LOAD REG. PAIR QQ WITH TOP OF STACK
PUSH   IX        LOAD IX ONTO STACK
PUSH   IY        LOAD IY ONTO STACK
PUSH   QQ        LOAD REG. PAIR QQ ONTO STACK
RES    B,M       RESET BIT B OF OPERAND M
RET              RETURN FROM SUBROUTINE
RET    CC        RETURN FROM SUBROUTINE IF CONDITION CC IS TRUE
RETI             RETURN FROM INTERRUPT
RETN             RETURN FROM NON MASKABLE INTERRUPT
RL     M         ROTATE LEFT THROUGH CARRY OPERAND M
RLA              ROTATE LEFT ACC. THROUGH CARRY
RLC    (HL)      ROTATE LOCATION (HL) LEFT CIRCULAR
RLC    (IX+D)    ROTATE LOCATION (IX+D) LEFT CIRCULAR
RLC    (IY+D)    ROTATE LOCATION (IY+D) LEFT CIRCULAR
RLC    R         ROTATE REG. R LEFT CIRCULAR
RLCA             ROTATE LEFT CIRCULAR ACC.
RLD              ROTATE DIGIT LEFT AND RIGHT BETWEEN ACC. AND LOCATION (HL)
RR     M         ROTATE RIGHT THROUGH CARRY OPERAND M
RRA              ROTATE RIGHT ACC. THROUGH CARRY
RRC    M         ROTATE OPERAND M RIGHT CIRCULAR
RRCA             ROTATE RIGHT CIRCULAR ACC.
RRD              ROTATE DIGIT RIGHT AND LEFT BETWEEN ACC. AND LOCATION (HL)
RST    P         RESTART TO LOCATION P
SBC    A,S       SUBTRACT OPERAND S FROM ACC. WITH CARRY
SBC    HL,SS     SUBTRACT REG. PAIR SS FROM HL WITH CARRY
SCF              SET CARRY FLAG (C=1)
SET    B,(HL)    SET BIT B OF LOCATION (HL)
SET    B,(IX+D)  SET BIT B OF LOCATION (IX+D)
SET    B,(IY+D)  SET BIT B OF LOCATION (IY+D)
SET    B,R       SET BIT B OF REG. R
SLA    M         SHIFT OPERAND M LEFT ARITHMETIC
SRA    M         SHIFT OPERAND M RIGHT ARITHMETIC
SRL    M         SHIFT OPERAND M RIGHT LOGICAL
SUB    S         SUBTRACT OPERAND S FROM ACC.
XOR    S         EXCLUSIVE 'OR' OPERAND S AND ACC.
```

```
IN    A,(N)       LOAD THE ACC. WITH INPUT FROM DEVICE N
IN    R,(C)       LOAD THE REG. R WITH INPUT FROM DEVICE (C)
INC   (HL)        INCREMENT LOCATION (HL)
INC   IX          INCREMENT IX
INC   (IX+D)      INCREMENT LOCATION (IX+D)
INC   IY          INCREMENT IY
INC   (IY+D)      INCREMENT LOCATION (IY+D)
INC   R           INCREMENT REG. R
INC   SS          INCREMENT REG. PAIR SS
IND               LOAD LOCATION (HL) WITH INPUT FROM PORT (C), DECREMENT HL AND B
INDR              LOAD LOCATION (HL) WITH INPUT FROM PORT (C), DECREMENT HL AND
                  DECREMENT B, REPEAT UNTIL B=0
INI               LOAD LOCATION (HL) WITH INPUT FROM PORT (C); AND INCREMENT HL
                  AND DECREMENT B
INIR              LOAD LOCATION (HL) WITH INPUT FROM PORT (C), INCREMENT HL AND
                  DECREMENT B, REPEAT UNTIL B=0
JP    (HL)        UNCONDITIONAL JUMP TO (HL)
JP    (IX)        UNCONDITIONAL JUMP TO (IX)
JP    (IY)        UNCONDITIONAL JUMP TO (IY)
JP    CC,NN       JUMP TO LOCATION NN IF CONDITION CC IS TRUE
JP    NN          UNCONDITIONAL JUMP TO LOCATION NN
JP    C,E         JUMP RELATIVE TO PC+E IF CARRY=1
JR    E           UNCONDITIONAL JUMP RELATIVE TO PC+E
JP    NC,E        JUMP RELATIVE TO PC+E IF CARRY=0
JR    NZ,E        JUMP RELATIVE TO PC+E IF NON ZERO (Z=0)
JR    Z,E         JUMP RELATIVE TO PC+E IF ZERO (Z=1)
LD    A,(BC)      LOAD ACC. WITH LOCATION (BC)
LD    A,(DE)      LOAD ACC. WITH LOCATION (DE)
LD    A,I         LOAD ACC. WITH I
LD    A,(NN)      LOAD ACC. WITH LOCATION NN
LD    A,R         LOAD ACC. WITH REG. R
LD    (BC),A      LOAD LOCATION (BC) WITH ACC.
LD    (DE),A      LOAD LOCATION (DE) WITH ACC.
LD    (HL),N      LOAD LOCATION (HL) WITH VALUE N
LD    DD,NN       LOAD REG. PAIR DD WITH VALUE NN
LD    HL,(NN)     LOAD HL WITH LOCATION (NN)
LD    (HL),R      LOAD LOCATION (HL) WITH REG. R
LD    I,A         LOAD I WITH ACC.
LF    IX,NN       LOAD IX WITH VALUE NN
LD    IX,(NN)     LOAD IX WITH LOCATION (NN)
LD    (IX+D),N    LOAD LOCATION (IX+D) WITH VALUE N
LD    (IX+D),R    LOAD LOCATION (IX+D) WITH REG. R
LD    IY,NN       LOAD IY WITH VALUE NN
LD    IY,(NN)     LOAD IY WITH LOCATION (NN)
LD    (IY+D),N    LOAD LOCATION (IY+D) WITH VALUE N
LD    (IY+D),R    LOAD LOCATION (IY+D) WITH REG. R
LD    (NN),A      LOAD LOCATION (NN) WITH ACC.
LD    (NN),DD     LOAD LOCATION (NN) WITH REG. PAIR DD
LD    (NN),HL     LOAD LOCATION (NN) WITH HL
LD    (NN),IX     LOAD LOCATION (NN) WITH IX
LD     (NN),IY    LOAD LOCATION (NN) WITH (IY)
LD     R,A        LOAD R WITH ACC.
LD     R,(HL)     LOAD REG. R WITH LOCATION (HL)
LD     R,(IX+D)   LOAD REG. R WITH LOCATION (IX+D)
LD     R,(IY+D)   LOAD REG. R WITH LOCATION (IY+D)
LD     R,N        LOAD REG. R WITH VALUE N
LD     R,R'       LOAD REG. R WITH REG. R'
LD     SP,HL      LOAD SP WITH HL
```

PSEUDO INSTRUCTIONS

ORG	NN	SETS LOCATION COUNTER (LC) TO NN
EQU	NN	ASSIGNS VALUE NN TO LABEL
DEFS	E	INCREMENTS LC BY VALUE OF EXPRESSION E
DEFB	E(,E)...	DEFINES BYTE(S) AS E
DEFW	E(,E)...	DEFINES WORD(S) AS E
DEFM	/S/	ASSIGNS STRING S TO LABEL

APPENDIX G

ZEAP INTERNAL REGISTERS

The contents of a number of memory locations used by ZEAP may be of interest to the user. The user is cautioned to use these registers only as directed. Any uses other than those documented below may cause unpredictable results.

All 16 bit values are stored with the least significant 8 bits first.

£FO9 - £FOA BUFP

This 16 bit value is the address of the edit buffer. The first two bytes of the edit buffer itself contain a 16 bit value which is one more than the address at the end of the edit buffer. Thus if BUFP contained £1BOD and £1BOD - £1BOE contained £1B83, then the extent of the edit buffer would be £1BOD to £1B82, and could be dumped under NASBUG control using

>D 1BOD 1B82

or

>W IBOD 1B83 (using B-Bug or NASBUG 4)

£F22 - £F23 OUTCH

This 16 bit value is the address of the external output routine. It is initially set to the NASBUG entry point, SRLOUT. The user may substitute the address of a routine which outputs the ASCII character contained in register A. All registers must be preserved through this routine, except AF. A routine for driving a high speed parallel printer might be substituted for example. All output from the "U" editor command and under the TTY assembler option is routed through OUTCH, but output from the TAPE assembler option is directly through SRLOUT.

APPENDIX H

ASCII CODE TABLE

All values in hexadecimal. Bit 7 (parity) is zero.

NUL 00	DLE 10	20	0 30	@ 40	P 50	` 60	p 70
SOH 01	DC1 11	! 21	1 31	A 41	Q 51	a 61	q 71
STX 02	DC2 12	" 22	2 32	B 42	R 52	b 62	r 72
ETX 03	DC3 13	£ 23	3 33	C 43	S 53	c 63	s 73
EOT 04	DC4 14	$ 24	4 34	D 44	T 54	d 64	t 74
ENQ 05	NAK 15	% 25	5 35	E 45	U 55	e 65	u 75
ACK 06	SYN 16	& 26	6 36	F 46	V 56	f 66	v 76
BEL 07	ETB 17	' 27	7 37	G 47	W 57	g 67	w 77
BS 08	CAN 18	(28	8 38	H 48	X 58	h 68	x 78
HT 09	EM 19	) 29	9 39	I 49	Y 59	i 69	y 79
LF 0A	SUB 1A	* 2A	: 3A	J 4A	Z 5A	j 6A	z 7A
VT 0B	ESC 1B	+ 2B	; 3B	K 4B	[5B	k 6B	{ 7B
FF 0C	FS 1C	, 2C	< 3C	L 4C	\ 5C	l 6C	| 7C
CR 0D	GS 1D	- 2D	= 3D	M 4D	] 5D	m 6D	} 7D
SO 0E	RS 1E	. 2E	> 3E	K 4E	↑ 5E	n 6E	~ 7E
SI 0F	VS 1F	/ 2F	? 3F	O 4F	← 5F	o 6F	DEL 7F

The following control codes are used by NASBUG:

1D	Backspace
1E	Clear screen
1F	New line

APPENDIX I

OBJECT CODE LISTING

Location 100E, 100F, 1010 & 1011 contain the Ascii equivalent of your copy no. If you enter ZEAP manually from the listing below, please substitute the correct Ascii values for your copy number.

1. ZEAP LISTING

```
ZEAP 1.0 (C) 1979 SIGMA ACCOUNTING & MGMT SERVICES LTD
-------------------------------------------------------
01/19/79  2105 HRS                                PAGE   1

 LOC  0  1  2  3  4  5  6  7    8  9  A  B  C  D  E  F
0F00 C3 09 18 1A 18 1A 18 00 - 50 0D 1B 00 00 00 00 10
0F10 00 A0 20 20 20 20 20 20 - A0 00 00 10 1B 00 00 00
0F20 0B C3 22 13 80 00 00 00 - 32 0F 56 0F 21 10 F2 11
0F30 57 12 56 70 16 55 66 16 - 4E 00 00 52 78 16 4F 4E
0F40 16 41 14 19 46 9C 16 58 - 4E 17 5A E8 16 49 D5 17
0F50 50 5E 16 51 56 16 00 68 - 17 91 20 2C 98 3B 00 82
0F60 2B 29 27 C0 24 A0 23 22 - 80 00                 Stack Reverse
1000 C3 09 18 5A 45 41 50 20 - 20 20 31 2E 31 2F 30 30
1010 30 30 20 20 20 20 46 52 - 45 45 20 4D 45 4D 20 41
1020 54 80 00 01 4C 44 60 83 - 78 04 F4 3E 04 B1 0A 04
1030 E5 1A 04 F3 3A 14 EC 57 - 14 EE 5F 03 00 83 40 04
1040 F4 06 03 62 F2 21 04 F3 - 2A 03 6A F2 31 04 E2 F9
1050 14 F3 7B 03 0C F2 01 14 - F3 4B 03 73 E2 22 14 8C
1060 43 04 E0 32 03 31 E0 02 - 03 65 E0 12 13 C9 A0 14
1070 D2 B0 13 C4 A8 14 D2 B8 - 13 6C E0 47 13 6E E0 4F
1080 01 4A 52 F8 18 03 09 F8 - 20 02 50 F2 C3 03 06 F2
1090 C2 43 E3 E9 01 50 55 53 - 48 8F C5 02 4F 50 8F C1
10A0 01 43 41 4C 4C F2 CD 05 - 06 F2 C4 02 50 83 B8 03
10B0 F4 FE 03 CC 2F 13 C9 A1 - 14 D2 B1 13 C4 A9 14 D2
10C0 B9 02 43 C6 3F 81 45 51 - D5 00 02 58 68 E8 08 03
10D0 64 E2 EB 03 6B E2 E3 03 - D8 D9 02 C9 FB 01 49 4E
10E0 43 80 04 04 8C 03 03 60 - F5 DB 14 E7 78 13 00 E7
10F0 40 13 C9 A2 14 D2 B2 13 - C4 AA 14 D2 BA 12 4D FE
1100 46 81 44 45 46 C2 04 84 - D7 05 84 CD 03 84 D3 02
1110 03 43 80 05 04 8C 0B 02 - 4A 4E 5A F8 10 02 41 C1
1120 27 02 C9 F3 11 53 42 43 - 62 8C 42 04 60 83 98 05
1130 F4 DE 02 55 42 83 90 04 - F4 D6 0A 4C 41 83 20 0A
1140 52 41 83 28 0B 4C 83 38 - 0A 45 54 7A 83 C0 02 43
1150 C6 37 01 52 45 D4 C9 04 - 86 C0 14 C9 4D 14 CE 45
1160 0B 53 7A 83 80 0A 4C 43 - 83 00 04 C1 07 0B 83 10
1170 03 C1 17 13 C4 6F 0A 52 - 43 83 08 04 C1 0F 0B 83
1180 18 03 C1 1F 13 C4 67 02 - 53 54 FC C7 01 4F 52 83
1190 B0 03 F4 F6 83 C7 01 02 - 55 54 75 E0 D3 14 67 80
11A0 41 14 C9 A3 14 C4 AB 12 - 54 49 D2 B3 13 44 D2 BB
11B0 01 41 44 44 60 83 80 05 - F4 C6 04 62 8C 09 03 43
11C0 60 83 88 05 F4 CE 14 62 - 8C 4A 02 4E 44 83 A0 04
11D0 F4 E6 01 58 4F 52 83 A8 - 04 F4 EE 09 42 49 54 7A
11E0 83 40 11 4E 45 C7 44 02 - 4F D0 00 01 48 41 4C D4
11F0 76 00 80 00 01 C8 26 02 - CC 62 01 C1 60 02 C6 68
1200 01 C4 22 02 C5 64 01 C2 - 20 02 C3 30 01 DA 2C 01
```

ZEAP 1.0 (C) 1979 SIGMA ACCOUNTING & MGMT SERVICES LTD

01/19/79 2105 HRS PAGE 2

LOC	0	1	2	3	4	5	6	7		8	9	A	B	C	D	E	F
1210	C3	66	01	4E	DA	2A	02	C3	-	2E	01	53	D0	6A	81	A4	00
1220	01	C5	24	01	CC	28	01	C9	-	6C	12	D8	62	32	D9	62	01
1230	CD	38	01	D0	36	02	C5	34	-	02	CF	32	01	D2	6E	00	60
1240	63	28	26	24	22	66	20	38	-	36	34	32	66	2E	2C	2A	6A
1250	62	64	30	68	62	64	30	38	-	3F	12	08	3F	12	38	47	12
1260	34	4B	12	44	4F	12	44	53	-	12	D9	E1	D1	E3	47	14	CB
1270	7E	20	77	23	7E	E6	7F	FE	-	70	38	32	4F	A8	0F	FE	08
1280	30	62	FE	05	38	73	08	FD	-	7E	F5	B7	20	1B	08	FE	06
1290	FD	7E	F4	38	0B	28	0C	FE	-	03	3D	30	0C	3C	28	01	3C
12A0	07	07	07	FD	77	F3	E6	C7	-	C4	18	13	18	4F	FE	20	30
12B0	30	E5	2A	30	0F	85	6F	30	-	01	24	78	08	7E	E6	0F	4F
12C0	7E	08	23	46	23	66	68	06	-	00	ED	B1	E1	47	20	15	08
12D0	CB	21	D6	10	30	FA	CB	39	-	FD	7E	F3	B1	FD	77	F3	18
12E0	1B	B8	28	18	CB	7E	23	28	-	FB	2B	23	23	7E	5F	E6	07
12F0	BA	CA	73	12	23	30	ED	D9	-	C9	FD	77	F2	E3	D5	E5	D9
1300	B7	C9	D9	E1	D1	E3	7E	FE	-	80	23	56	D5	D9	D1	7A	C9
1310	7A	F6	7F	A3	07	9F	92	C8	-	FD	CB	00	4E	C0	FD	CB	F6
1320	F6	C9	D3	01	DB	02	87	F8	-	18	FA	E5	2A	1B	0F	37	ED
1330	52	C1	D5	CD	90	13	38	04	-	23	22	1B	0F	EB	D1	B7	ED
1340	42	C5	E3	C1	C5	ED	B0	CD	-	98	13	C1	C9	21	00	00	1A
1350	D6	30	D8	FE	0A	D0	D5	54	-	5D	29	29	19	29	16	00	5F
1360	19	D1	13	18	EA	2A	0C	0C	-	3A	0B	0C	FE	02	3E	10	20
1370	03	3A	0E	0C	32	0F	0F	7C	-	B5	C0	3A	0F	0F	85	27	6F
1380	7C	CE	00	27	67	C9	23	23	-	AF	47	4F	ED	B1	3D	BE	C9
1390	2A	09	0F	5E	23	56	23	C9	-	2A	09	0F	73	23	72	C9	CD
13A0	51	00	3E	FF	B7	C8	C5	47	-	CD	35	00	CD	F6	18	10	F8
13B0	C1	C9	3E	0D	CD	0A	19	3E	-	0A	CD	0A	19	3E	1F	CD	0A
13C0	19	3A	24	0F	18	DE	C5	2B	-	E5	ED	5B	2E	0F	D5	16	00
13D0	D5	CD	88	14	CB	71	28	0D	-	CD	69	12	30	F4	CD	90	13
13E0	2A	1D	0F	18	2D	CD	02	13	-	38	F3	CB	7B	28	3D	ED	5B
13F0	1F	0F	18	37	CD	88	13	3E	-	30	CA	E3	17	23	CD	88	14
1400	30	F2	13	13	E3	CD	88	14	-	E3	CB	71	28	0A	BE	23	28
1410	F3	C1	C1	C5	C5	18	DD	CD	-	89	14	CB	71	20	F3	DD	E5
1420	E3	37	ED	52	E1	EB	2B	56	-	2B	5E	E1	C1	C1	C9	2A	09
1430	0F	CD	86	13	C8	5E	23	56	-	2B	E5	2A	0C	0C	B7	ED	52
1440	E1	3F	D0	C8	18	EB	23	B7	-	3E	A0	12	C8	2B	CD	82	14
1450	18	F4	CD	71	14	D8	E5	EB	-	CD	32	02	E1	23	CD	88	14
1460	CB	7F	11	00	08	E5	2A	18	-	0C	36	20	EB	22	18	0C	E1
1470	C9	7E	C6	01	9F	D8	5E	23	-	56	2B	E5	2A	0E	0C	ED	52

ZEAP 1.0 (C) 1979 SIGMA ACCOUNTING & MGMT SERVICES LTD

01/19/79 2105 HRS PAGE 3

LOC	0	1	2	3	4	5	6	7		8	9	A	B	C	D	E	F
1480	E1	C9	7E	12	13	CD	EC	18	-	23	7E	FE	30	38	13	FE	41
1490	38	0A	0E	C0	FE	5B	D8	0E	-	98	FE	A0	C8	0E	E0	FE	3A
14A0	D8	E5	32	69	0F	21	59	0F	-	4E	23	CB	7E	20	FA	BE	20
14B0	F8	E1	CB	61	C0	37	C9	CB	-	59	C0	06	05	CB	61	20	07
14C0	CD	82	14	10	F7	04	C9	13	-	10	FD	CD	89	14	CB	41	C8
14D0	CD	88	14	18	F8	06	00	E5	-	FD	66	F6	2E	70	E3	11	00
14E0	00	CD	89	14	FE	28	20	2D	-	E3	CB	54	20	68	CB	D4	2C
14F0	CB	98	E3	CD	88	14	38	1D	-	E3	FD	74	F6	CB	60	20	0A
1500	CB	48	20	0D	ED	53	F2	0F	-	18	07	7B	CD	14	13	FD	73
1510	F7	45	E1	18	B5	ED	53	0D	-	0F	CB	69	28	29	FE	22	20
1520	0F	CD	88	14	16	00	5F	FE	-	A0	20	18	1E	20	2B	18	13
1530	EB	FE	23	28	05	CD	4C	13	-	18	07	13	CD	5A	02	2A	13
1540	0C	EB	2B	E3	18	51	CB	71	-	28	6D	CD	C6	13	2B	E3	20
1550	3E	CB	46	3E	24	20	0E	CB	-	50	20	6A	CB	C8	7A	FE	62
1560	20	21	7B	E6	30	F5	B0	47	-	0F	0F	0F	0F	A5	E6	01	B4
1570	67	F1	CB	7C	20	06	CB	FC	-	B4	67	18	07	AC	E6	30	3E
1580	25	20	42	7D	E6	01	B2	6F	-	ED	5B	0D	0F	C3	F0	14	30
1590	06	CB	40	3E	41	20	2E	E5	-	CB	58	2A	0D	0F	20	03	19
15A0	18	03	B7	ED	52	EB	E1	CB	-	48	28	E1	CB	60	3E	27	28
15B0	14	CB	45	28	10	18	D5	CB	-	D8	E3	FE	2D	CA	F2	14	CB
15C0	49	20	C9	3E	26	C3	E3	17	-	D9	2A	1F	0F	FD	CB	00	4E
15D0	20	6F	FD	CB	01	5E	28	54	-	BF	01	0F	19	ED	43	4B	0C
15E0	ED	4B	0B	0F	5F	20	0A	04	-	05	28	1F	FD	CB	00	5E	20
15F0	20	F5	04	10	02	F1	C9	CD	-	2B	02	CD	3C	02	10	F8	CD
1600	47	16	F1	28	05	EF	2E	1F	-	00	C9	0E	00	CD	32	02	06
1610	08	7B	CD	2B	02	CD	3C	02	-	05	CC	47	16	ED	43	0B	0F
1620	01	E1	18	ED	43	4B	0C	7B	-	FD	CB	00	DE	FD	CB	01	4E
1630	28	08	E5	ED	5B	19	0F	19	-	77	E1	FD	CB	F6	5E	CC	44
1640	02	23	22	1F	0F	D9	C9	79	-	CD	44	02	C3	40	02	3A	0C
1650	0C	FD	77	01	E1	C9	2A	0C	-	0C	22	24	0F	E1	C9	2A	0C
1660	0C	22	19	0F	E1	C9	FD	CB	-	00	D6	CD	9F	13	CD	B2	13
1670	CD	2E	14	CD	BD	18	18	FB	-	E1	CD	65	13	EB	2A	09	0F
1680	23	CD	87	13	C8	73	23	72	-	EB	CD	7A	13	EB	30	F2	3E
1690	01	32	0F	0F	CD	E7	17	11	-	01	00	18	E1	E1	3A	4C	0B
16A0	FE	20	28	34	21	53	0B	01	-	09	00	ED	B9	23	21	4C	0B
16B0	11	11	0F	ED	B0	1B	3E	A0	-	12	CD	90	13	23	7E	3C	C8
16C0	22	1B	0F	23	23	E5	11	12	-	0F	1A	13	FE	A0	28	13	BE
16D0	23	28	F6	E1	7E	B7	20	EC	-	2A	1B	0F	7E	3C	C4	86	13
16E0	18	DD	E1	2A	1B	0F	18	09	-	E1	CD	2E	14	3E	03	D2	E3
15F0	17	EF	3A	00	CD	BD	18	21	-	4A	0B	36	20	23	E5	7E	E6

ZEAP 1.0 (C) 1979 SIGMA ACCOUNTING & MGMT SERVICES LTD

01/19/79 2105 HRS PAGE 4

LOC	0	1	2	3	4	5	6	7		8	9	A	B	C	D	E	F
1700	7F	77	11	40	00	19	36	5E	-	CD	3E	00	36	20	D1	D5	21
1710	79	0B	36	20	E5	B7	ED	52	-	E3	C1	FE	3E	20	09	54	5D
1720	2B	ED	B8	23	36	20	2F	FE	-	3C	20	06	62	6B	23	ED	B0
1730	2F	E1	FE	20	20	02	23	2F	-	FE	1D	20	02	2B	2F	FE	1F
1740	28	26	FE	21	CA	1A	18	B7	-	FA	FD	16	77	18	E8	E1	3A
1750	0B	0C	FE	02	20	1B	CD	2E	-	14	E5	CD	71	14	38	05	CD
1760	86	13	18	F6	D1	C3	2A	13	-	11	4B	0B	D5	CD	4C	13	C6
1770	10	20	6E	D1	CD	5A	02	2A	-	13	0C	7C	B5	28	63	22	0C
1780	0C	21	76	0B	3E	20	36	A0	-	2B	AE	E6	7F	28	F6	E5	B7
1790	ED	52	E5	08	CD	2E	14	54	-	5D	DC	86	13	CD	2A	13	08
17A0	38	24	E1	E5	19	EB	13	13	-	13	E5	2A	07	0F	AF	ED	52
17B0	38	31	CD	96	13	E1	03	ED	-	B8	12	1B	C1	E1	ED	B8	21
17C0	14	0C	ED	A8	ED	A8	2A	0C	-	0C	CD	7A	13	3E	02	38	13
17D0	22	1D	0F	18	49	FD	CB	00	-	E6	CD	65	13	22	1D	0F	18
17E0	3D	3E	99	2A	03	0F	E5	11	-	8F	0B	CD	65	14	5F	EF	45
17F0	52	52	4F	52	20	00	7B	CD	-	44	02	FD	CB	00	FE	7B	FE
1800	23	3E	A0	CC	3B	01	C3	C6	-	18	AF	32	FF	0F	3A	0B	0C
1810	FE	02	20	06	2A	0E	0C	22	-	07	0F	AF	32	FE	0F	AF	67
1820	6F	22	0C	0C	2B	22	0E	0C	-	32	00	0C	3D	32	BA	0B	2A
1830	28	0F	22	45	0C	21	E1	18	-	22	4B	0C	21	1A	18	22	05
1840	0F	22	03	0F	FD	21	FE	0F	-	FD	F9	21	00	10	01	0D	0B
1850	AF	AE	ED	A1	EA	51	18	47	-	2A	2A	0F	7E	21	10	0F	B7
1860	28	07	7E	A8	3E	90	C4	E7	-	17	70	CD	90	13	CD	88	13
1870	28	0A	23	CD	88	14	30	F5	-	13	13	18	F1	EB	22	1F	0F
1880	11	EE	0B	CD	65	14	CD	32	-	02	11	8A	0B	CD	65	14	21
1890	03	10	11	CF	0B	01	1E	00	-	ED	B0	EF	3A	00	FD	CB	00
18A0	66	28	06	2A	1D	0F	CD	32	-	02	CD	DE	01	21	1A	18	E5
18B0	3A	4B	0B	2A	2A	0F	77	FE	-	20	C8	C3	89	02	CD	52	14
18C0	C2	1A	18	CD	46	14	FD	CB	-	00	56	28	13	CD	62	14	11
18D0	8A	0B	1A	CD	0A	19	13	1A	-	B7	F2	D3	18	CD	B2	13	3E
18E0	1F	E6	7F	FE	1D	D4	3B	01	-	FE	21	28	18	3A	25	0F	FD
18F0	CB	00	56	CC	A4	13	CD	4D	-	0C	D0	FE	21	28	06	FE	3F
1900	C0	C3	3E	00	2A	05	0F	E5	-	18	D5	CD	21	0F	18	E7	CD
1910	22	13	18	E2	21	06	1F	22	-	03	0F	2A	30	01	22	45	0C
1920	E1	E1	E1	2E	0B	E5	2A	1F	-	0F	E5	CD	67	19	E1	22	1F
1930	0F	E1	CB	7D	28	04	CB	64	-	28	29	CB	5C	C4	9F	13	7C
1940	E6	0D	6F	CB	55	C4	B2	13	-	E5	21	00	00	22	0B	0F	E5
1950	CD	67	19	E1	E1	3E	50	CB	-	7D	E5	C4	E7	17	E1	CB	5C
1960	C4	D9	15	E5	C3	1A	18	CD	-	90	13	D5	DD	E1	CD	2E	14
1970	2B	22	1D	0F	23	11	8A	0B	-	06	30	3E	20	12	13	10	FC

```
ZEAP 1.0 (C) 1979 SIGMA ACCOUNTING & MGMT SERVICES LTD
-------------------------------------------------------
01/19/79  2105 HRS                                PAGE   5

 LOC   0  1  2  3  4  5  6  7    8  9  A  B  C  D  E  F
1980  11 98 0B CD 65 14 CD 52 - 14 C0 F5 30 0F E5 2A 1F
1990  0F DD 75 00 DD 74 01 DD - 23 DD 23 E1 FE 3B 28 08
19A0  06 07 CD BC 14 CC B7 14 - F5 CD 46 14 F1 D1 E5 D5
19B0  3E 10 C2 E3 17 F1 F5 21 - 00 00 E5 E5 E5 30 0B 21
19C0  9D CB CD C6 13 3E 31 D2 - E3 17 FE 3B 28 79 11 8A
19D0  0B CD 65 14 2A 1F 0F CD - 32 02 2A 2C 0F E5 16 00
19E0  D5 21 A3 0B 18 08 CD 69 - 12 3E 20 DA E3 17 CD 88
19F0  14 38 F3 CD CD 14 FD CB - EE 7E CA 89 1A 3E 40 30
1A00  C6 CD 02 13 FD CB F6 D6 - 38 DF F5 FE 03 28 3B 30
1A10  57 F5 06 05 CD D7 14 3F - 30 E3 EB 11 8A 0B CD 65
1A20  14 CD 32 02 F1 FE 01 28 - 07 38 0C ED 5B 1F 0F 19
1A30  22 1F 0F FD CB 00 9E FD - CB F8 46 28 0A FE 02 28
1A40  06 DD 75 FE DD 74 FF C3 - F7 1A 46 CD 88 14 B8 28
1A50  F6 FE A0 28 F2 CD C8 15 - FD CB F6 DE 18 ED CD 10
1A60  13 08 30 E3 FD CB F6 DE - 06 04 CD D7 14 08 7B CD
1A70  C8 15 FD CB F1 46 28 E6 - 7A CD C8 15 18 E3 CD D5
1A80  14 78 CD 69 12 3E 21 38 - 52 CB 59 28 F1 CD 02 13
1A90  38 F3 C1 E1 CB 51 28 10 - 2B 2B FD CB 01 6E 28 08
1AA0  D5 ED 5B 1F 0F ED 52 D1 - EB 7B CB 51 C4 14 13 CB
1AB0  49 C4 10 13 79 B7 7B 08 - 7A CB 41 EB E1 E5 37 F5
1AC0  3F F5 08 F5 7A B0 0C F5 - 3E CB CB 5B 28 01 F5 CB
1AD0  65 28 1A 7C CB 73 28 08 - B7 3E 22 C2 E3 17 18 05
1AE0  C1 CB 45 F5 C5 3E DD B5 - F5 CB 63 20 EC 3E ED CB
1AF0  63 C4 C8 15 F1 30 FA FD - CB 00 46 CC C6 18 FD CB
1B00  F6 76 3E 23 20 D5 31 F8 - 0F E1 C3 75 19 11 1B 00
1B10  FF
```

2. ZEAP LOADER PROGRAM

```
0C50  31 00 50 CD 51 00 CD 3E - 00 FE FF 20 F9 06 03 CD
0C60  3E 00 FE FF 20 F0 10 F7 - 2A 18 0C 36 20 21 8A 0B
0C70  22 18 0C CD 3E 00 B7 20 - 4E EF 1F 2E 1F 00 CD 51
0C80  00 31 33 0C C3 86 02 0E - 00 CD 3E 00 67 CD 3E 00
0C90  6F CD 3C 02 CD 3C 02 CD - 32 02 E5 21 00 08 E5 06
0CA0  08 CD 3E 00 77 CD 2B 02 - CD 3C 02 23 10 F3 CD 3E
0CB0  00 B9 F5 CD 2B 02 F1 E1 - D1 28 05 CD 40 02 18 A8
0CC0  01 08 00 ED B0 18 A1 FE - 01 28 BC 18 9B 00
```

APPENDIX J

ZEAP COMMENT FORM

COPY NO 928

To: Sigma Accounting & Management Services Ltd
c/o Nascom Microcomputers
92 Broad Street
Chesham
Bucks

Date _____

From: Name _____

Address _____

_____

_____

_____

Please tear along dotted line

Comments/Bugs (Fullest possible explanation please including listings - even if written out by hand)

NB: We regret that no correspondence can be entered into over particular queries/suggestions. The aim of the comment form is to enable your opinions, etc to be incorporated in updates.

PTO for more space

SIGMA ACCOUNTING & MANAGEMENT SERVICES LTD

Information Bulletin

Welcome to ZEAP! You have bought an extremely powerful software product which we hope you will enjoy using. It enables you to edit and assemble Z80 Assembly language programs on the NASCOM 1 computer.

It is important that you complete your software registration form and return it promptly. Only if this form is returned are we able to provide you with updates, patches or other information about ZEAP, or a replacement for a corrupted tape.

ZEAP has been extensively tested, but few packages as powerful as this are completely free of bugs. If you come across anything you believe to be a bug, please complete and return the ZEAP Comment Form in the back of your manual. We will try to take your comments into account on future updates.

Further enhancements to ZEAP are planned including a ROM based version with additional capabilities. These will be announced via your NASCOM dealer and the INMC newsletter.

If you have difficulty, please first check that you are following the correct procedures. The ZEAP manual should be read at least twice. It is a terse document. Similarly other documentation should be carefully studied. Some users have experienced difficulty because they have been accustomed to hand assembly in which abbreviations are followed and they have not used the Z80 Assembly language code in the exact manner defined - eg:

IN A, 2 instead of IN A,(2) (latter is correct)

If you cannot identify the cause of a coding error, study one of the Assembly Language manuals/books listed in the manual.

After you have loaded ZEAP into your NASCOM from the ZEAP tape, you are advised to make a back up copy by dumping ZEAP in NASBUG format (0F00 - 1B11) to another tape. Then keep your original ZEAP tape in a clean, dry, dust free and (if possible) controlled temperature environment. Do not store it near mains power points, etc. Please remember that you may make back up copies of ZEAP for your own personal use. You may not make copies for use by others, as gifts, loans, or for sale.

We hope that ZEAP will help you write some good programs easily and quickly.

6) Type in the load command (L) on your Nascom followed by hitting the "new line" key.

7) Set the output volume control on your recorder fairly low and then hit the "play" or equivalent button on your machine.

8) The loader program will now be placed in memory locations OC50 - OCCF by the Nasbug loader. As soon as the loader program has been placed in memory (ie. the LED is out), press the "stop" button on your recorder. DO NOT REWIND.

9) If you do not get valid loading of the loader program, increase the volume on your cassette slightly, rewind the tape and repeat stages 7 & 8 again. Do this as many times as is necessary (seldom more than 2 or 3) to get the volume control setting just right on your cassette. Incorrect volume setting is by far the most common reason for errors/difficulties in loading programs from cassette tapes.

10) Any errors in reading the loader program will have been scrolled up on your screen. Providing that there are only a small number of these, you can use the modify memory command (M) to patch memory by referring to the listing of the loader program object code in the ZEAP manual. However, it is best to ensure that you can load the loader program without errors since you are then much less likely to encounter loading errors when loading ZEAP itself.

11) Assuming that the loader program is now correctly located in memory and that the tape has been stopped after it, you should execute the loader program by typing in response to the Nasbug prompt:

    EC50

    The LED will come on and you should now press the "play" or equivalent button on your cassette recorder.

12) The ZEAP object code will be displayed on the bottom line of the screen in the same format as that of Nasbug with error lines being scrolled upwards. Stop the cassette immediately on completion (ie. when the LED goes out). DO NOT REWIND.

13) If there have been no error lines you may now proceed to execute ZEAP. If there have been a relatively small number and they are all contained on your screen, then they may be corrected through the modify (M) command by referring to the object code listing of ZEAP in the manual. However, if there are a large number you may then re-execute the loader program to continue reading the tape which contains a second copy of ZEAP. To do this repeat stages 11 & 12 above. However, if you have rewound the tape you will need to start from stage 6 above. Similarly if there are a significant number of errors, it is probable that the volume control setting is still incorrect. If you have followed the procedure above of starting with it set fairly low, and have moved slowly up, you should increase the volume a little bit more, and repeat from stage 6.

14) If ZEAP is ready to use, you enter it after reset by typing in:

    EF00

15) The first thing that ZEAP does is to carry out a checksum on itself to ensure that it is not corrupt. If you have followed the instructions above correctly and dealt with all of the errors concerned, and you still get a checksum error (error 90), it is almost certainly due to defective memory on your Nascom. The listing of the ZEAP object code will enable you to check this by displaying successive blocks of memory using the tabulate (T) command.

16) However, once you find that you can enter ZEAP without a checksum error, we advise you to make a back up copy in Nasbug or Be-bug format which should be the one that you normally use for loading ZEAP. Please note that ZEAP is supplied on the strict understanding that any copies you may make are solely for your own use for back up or other purposes. They may not be given, sold or lent to others.

INSTRUCTIONS FOR LOADING THE ZEAP TAPE

1) The enclosed tape contains a loader program in standard Nasbug format followed by two copies of ZEAP in a special compressed format. This tape has been created and checked individually on two separate machines. The loader program enables ZEAP to be loaded in just over 4 minutes.

2) The programs on the tape have been recorded at 1⅞ i.p.s. on a Hitachi TRQ-265R cassette recorder. The read/write heads of the machines used for recording have been specially aligned and the recording levels checked.

3) After recording the programs the tapes have been read back under program control on a different cassette recorder.

4) Only tapes passing this test without error are released. A sample of tapes are additionally read on another cassette recorder on an independent Nascom machine. These procedures ensure that providing your equipment is in good order and you follow these instructions, you will be able to load ZEAP into your Nascom without difficulty. Instructions for doing so are given below. These apply regardless of whether your monitor is Nasbug, Nasbug 4, or Be-bug.

5) After powering up your Nascom (and clearing the breakpoint if Nasbug is used), you should connect your cassette recorder and make it ready. Then place the ZEAP tape into the recorder, label side up. The tape should already be rewound.

ZEAP 1.1 - ADDENDA

1) LOADER PROGRAM

The loader program listing (P.55) shows the stack pointer as being set to £5000 in locations 0C51 and 0C52. In tapes currently being shipped (but not manuals), this has been modified to £2000 to allow the loader to operate in Nascoms with as little as 4K additional memory. If, however, your loader does not appear to work, please check the value contained in location 0C52 and change it, if necessary, from 50 to 20 by use of the Nasbug Modify (M) command before executing from 0C50.

2) OPERAND SEPARATOR

In certain circumstances an error is flagged when two operands are not separated by a comma:

```
20  ADD A B
```

results in an error whereas

```
20  ADD A,B
```

assembles correctly. Use the latter format if an error occurs.

3) SET MEMORY OFFSET (P) COMMAND

The argument to this command is a hexadecimal offset value without the pound (£) sign in front. Note that an offset in excess of available memory is likely to 'wrap round' and place the generated code elsewhere than intended. This is likely to have unpredictable results.

4) AUTO LINE NUMBER INCREMENTATION

In certain circumstances, incrementation results in a hexadecimal number being output to the screen. This will generate an error. If this occurs, exit from auto increment mode, and enter line numbers manually. This condition was experienced by a user after making several extended DEFM entries.