NIBL-E

A BASIC interpreter for the Elektor SC/MP system

A BASIC interpreter for the SC/MP has been available for some time. However, this can only be used in systems where page Ø is available for storing the interpreter program. In the Elektor SC/MP system, part of page Ø is used for the monitor program. Even so, an adapted version of the interpreter CAN be incorporated into the Elektor system — as described in this article.

(D. Hendriksen)

The BASIC interpreter for the SC/MP is known as NIBL. This is an abbreviation of National's Industrial BASIC Language.

This interpreter program occupies nearly 4K bytes, or one page in a SC/MP system. It would be asking too much to expect a complete BASIC interpreter in this area; for this reason, NIBL is derived from Tiny BASIC. Consequently, only whole numbers can be used in calculations, and the number range is limited: only numbers between −32767 and +32767 are permitted. Furthermore, 'scientific' calculations are outside the scope of NIBL; fortunately, they are not really essential.

Looking on the positive side, NIBL has some capabilities that are not included in Tiny BASIC. In fact, NIBL is more powerful in some ways than more sophisticated BASIC dialects. This is especially true of the IF ... THEN ... statement and the DO ... UNTIL loop. NIBL is intended for self-contained SC/MP systems, where the interpreter can be started by operating the 'reset' key.

The programs can be stored in pages 1 ... 7. As mentioned above, page Ø is normally occupied by the NIBL interpreter itself. Part of page 1 is used as 'scratch-pad memory' by the interpreter, so some RAM must be reserved in this area.

After starting the interpreter program (by means of the 'reset' key), NIBL will first check to see whether a program is present in page 2. If so, it will run this program immediately; if not, it will prepare page 1 to receive a program and wait until this is entered. If a different page is to be used, this can be specified by using the PAGE= (n) command, where n is 1 ... 7.

Fitting NIBL into the Elektor SC/MP system

If NIBL is to be used in the Elektor system, some modifications are required. Page Ø is not available for the interpreter, since this area is used in part by 'Elbug'. Something's got to

move, and in this case it's the interpreter.

Fortunately, the SC/MP's CPU structure makes it a relatively easy matter to move a program. Normally, only instructions relating to pointer manipulations need changing. There are, of course, exceptions to this rule ... and NIBL is one of them. It not only uses the three pointers: in the course of the program, some data-bits are also used to determine addresses. As a result of all this, the NIBL version described here contains some 300 modifications with respect to the original.

Placing Elbug on page Ø offers both advantages and disadvantages. The main disadvantage is that NIBL has to be moved; the main advantage is that the cassette routines in the monitor program can be used for storing programs on tape. In the Elektor version, there is no need for a paper-tape reader/puncher; in the original version of NIBL, some further modifications would be required to obtain the same easy cassette storage facility.

Modifications

It was decided to move the interpreter program to page 1. Admittedly, this costs one page of program memory — leaving six pages for the user. The possibility was considered of moving the interpreter out past the program memory — 'above' page 7 — but this would require a large number of additional modifications.

When the interpreter is moved, its 'scratch-pad memory' will also move up one page, to page 2. Therefore, RAM must be available at the top of this page. The interpreter program itself can be stored in EPROM. This is cheaper than using a complete 4K RAM card and, furthermore, the interpreter is then always available for immediate use. The RAM area at the top of page 2 must consist of at least 2K bytes. This is sufficient for a BASIC program of approximately 60 lines — more than enough for the first experimental programs.

Since the interpreter is on page 1,

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1000   08 08 08 C4 20 36 C4 1C 32 C4 21 35 C4 20 31 C4      1400   CB FD BA FD BA FD 90 DF C4 20 37 C2 FD 33 C3 FF
1010   FF C9 00 C9 01 C4 03 CA F6 C4 02 31 C4 30 35 B9      1410   DB FE 9C 04 C4 0D 90 B2 C3 FD E3 FF CA EA C3 FD
1020   02 01 A9 02 C1 80 E4 0D 98 19 BA F6 C4 FF C9 00      1420   94 11 C4 00 03 FB FC CB 03 C4 00 FB FD CB 02 90
1030   C9 01 C4 0D C9 FF 35 02 F4 10 E4 80 98 05 E4 80      1430   0A 90 B4 C3 FD CB 02 C3 FC CB 03 C3 FF 94 0D C4
1040   35 90 E9 C4 00 CA F4 CA F5 C4 58 CA FB C4 1C E4      1440   00 03 FB FE CB FE C4 00 FB FF CB FF C4 00 CB 01
1050   FA C4 00 CA EA 01 C4 00 CA 80 AA EA 01 C4 34 60      1450   CB 00 CA EB 04 C4 00 FB FC 02 C3 FC F3 FC CB C3
1060   9C F4 C4 50 CA FD C4 7A CA FF C4 6A CA FC C4 A6      1460   FD F3 FD CB FD 02 C3 03 F3 03 CB 03 C3 02 F3 02
1070   CA F9 C4 8A CA FE C2 FB 33 C2 FA 37 C7 01 01 C7      1470   CB 02 C3 01 F3 01 CB 01 C3 00 F3 00 CB 00 03 C3
1080   01 33 CA FB 40 D4 1F DC 10 37 CA FA 40 D4 E0 E4      1480   01 FB FE CB 01 C3 00 FB FF CB 00 94 11 02 C3 01
1090   20 98 2F E4 A0 98 07 E4 C0 98 E1 3F 90 D8 C2 F9      1490   F3 FE CB 01 C3 00 F3 FF CB 00 90 08 90 93 C3 FC
10A0   E4 D6 9C 04 C4 0A 90 60 E4 D6 33 CA EA C4 20 37      14A0   DC 01 CB FC AA EB E4 10 9C AE C2 EA 94 0D C4 00
10B0   01 C2 FB CF 01 C2 FA CF 01 C2 EA 33 CA F9 40 37      14B0   03 FB FC CB FC C4 00 FB FD CB FD BA FD BA FD 90
10C0   90 BA CA E7 C5 01 E4 20 98 FA C5 FF C2 FA 37 CA      14C0   DB C4 20 37 C2 FD 33 C7 FD 01 C3 01 CA 80 02 40
10D0   EC C2 FB 33 CA ED C7 01 01 BA E7 40 D4 7F E5 01      14D0   F4 01 01 C3 02 CA 80 33 CA FD C4 10 37 C4 75 33
10E0   9C 07 40 94 F1 90 95 90 8D C2 E7 01 C5 80 C2 ED      14E0   3F C5 01 E4 20 98 FA C1 FF 03 FC 5B 94 05 03 FC
10F0   33 C2 EC 37 90 CA 24 20 37 C2 F9 33 C7 FF 01 C7      14F0   E6 94 12 C5 FF C2 FB 33 C2 FA 37 C3 00 CA FA C3
1100   FF 33 CA F9 40 37 90 B8 90 41 C2 FC E4 7A 98 1C      1500   01 CA FB 90 D5 01 C1 00 03 FC 5B 94 05 03 FC E6
1110   AA FC AA FC 33 C4 20 37 C2 F4 98 0A 35 CB FF 35      1510   94 E1 C4 20 37 CA FD 33 02 40 70 CB FF C4 02 02
1120   31 CB FE 31 90 C1 C4 FF CB FF 90 BB C4 0A 90 1B      1520   F2 FB CA FB C4 00 F2 FA CA FA 90 AE C4 20 37 AA
1130   C5 01 E4 20 98 FA E4 2D 98 04 E4 37 9C 01 3F C4      1530   FD 33 C3 FE 01 C2 80 CB FE 02 40 F4 01 01 C2 80
1140   04 90 08 C2 FC E4 6A 9C 04 C4 09 90 40 BA FC BA      1540   CB FF 90 96 C4 01 90 12 C4 02 90 0E C4 03 90 0A
1150   FC 33 C4 20 37 C3 01 94 06 C4 00 CA F4 90 88 35      1550   C4 04 90 06 C4 05 90 02 C4 06 CA EB C4 20 37 BA
1160   C3 00 31 C4 01 CA F4 90 F4 C2 F2 94 04 C4 08 90      1560   FD BA FD 33 03 C3 FE FB 00 CA EF C3 FF FB 01 CA
1170   1C C4 01 CA F4 3F C4 1F 37 C4 C1 33 C5 01 E4 22      1570   EE E3 FF 01 C3 FF E3 01 50 E2 EE CA EA C2 EE DA
1180   98 DB E4 2F 98 05 E4 0D 3F 90 EB C4 07 90 35 C4      1580   EF 98 02 C4 80 E4 80 01 BA EB 9C 05 40 90 2B 90
1190   20 37 AA FD AA FD 33 C4 0A CB FE C4 00 CB FF C4      1590   B1 BA EB 9C 05 40 E4 80 90 20 BA EB 9C 04 C2 EA
11A0   05 CA E7 C4 FF CB 05 C3 FD 94 13 C4 2D CB 04 C4      15A0   90 18 BA EB 9C 05 40 DA EA 90 0F BA EB 9C 07 40
11B0   00 03 FB FC CB FC C4 00 FB FD CB FD 90 9F C4 20      15B0   DA EA E4 80 90 04 C2 EA E4 80 94 04 C4 01 90 02
11C0   CB 04 90 99 90 57 AA FD AA FD 31 C4 20 35 AA E7      15C0   C4 00 CB FE C4 00 CB FF C4 10 37 C4 F5 33 3F 90
11D0   01 C1 01 DC 30 C1 80 C1 F0 D9 FC 98 0A C4 1F CA      15D0   BE C2 EF DA EE 98 02 90 B6 C5 01 E4 0D 9C FA C4
11E0   FA C4 33 CA FB 90 DB C4 1F 37 C4 C1 33 C2 F5 9C      15E0   12 37 C4 83 33 3F 90 A7 C4 01 90 06 C4 02 90 02
11F0   06 C1 04 3F C2 E7 01 C5 80 C1 00 3F C5 FF 94 FB      15F0   C4 03 CA EB C4 20 37 BA FD BA FD 33 BA EB 9C 0E
1200   C4 50 CA FD C2 F5 9C BA C4 20 3F 90 B5 C4 1F 37      1600   C3 01 D3 FF CB FF C3 00 D3 FE CB FE 90 D8 BA EB
1210   C4 C1 33 C4 0D 3F C4 0A 3F 90 A7 C4 05 CA EB C2      1610   9C 0E C3 01 DB FF CB FF C3 00 DB FE CB FE 90 C6
1220   EB CA EA C4 1F 37 C4 C1 33 C4 0D 3F C4 0A 3F C4      1620   C7 01 E4 FF CB FF C7 01 E4 FF CB FF 33 CA FD 90
1230   1F 35 C4 3B 31 BA EB 98 06 C5 01 94 FC 90 F6 C5      1630   B5 C2 F1 31 CA F1 C2 F0 35 CA F0 3F C2 F4 98 01
1240   01 3F C1 FF 94 F9 C2 EA E4 0E 98 0D C4 1F 35 C4      1640   3F C4 03 CA EB C4 12 37 C4 1E 33 3F AA FD AA FD
1250   3B 31 C5 01 3F C1 FF 94 F9 C2 F4 98 4D C4 20 3F      1650   33 C4 20 37 C4 00 CB FF CB FE CA EB C5 01 E4 20
1260   C4 41 3F C4 54 3F C4 20 37 AA FD AA FD 33 C2 F7      1660   98 FA C5 FF C1 00 03 FC 3A 94 09 03 FC F6 94 13
1270   CB FF C2 F8 CB FE C4 31 CA FB C4 1E CA FA 90 99      1670   90 32 90 BB 03 FC 0D 94 2B 03 FC FA 94 02 90 24
1280   C4 1E 90 99 C2 F4 98 22 C1 00 D4 80 9C 1C 06 D4      1680   02 F4 0A 01 C4 04 CA EA CA EB C3 FE 02 F3 FE CB
1290   20 98 ED C1 FF E4 0D 9C 08 C5 01 CA F7 C5 02 CA      1690   FE C3 FF F3 FF CB FF BA EA 9C EF C3 FE 58 CB FE
12A0   F8 C4 1C CA FA C4 86 CA FB 3F C4 00 CA F4 C4 50      16A0   C5 01 90 C0 C2 EB 9C 87 C4 05 90 97 C5 01 E4 20
12B0   CA FD C4 1C CA FA C4 1C CA FA C4 A6 CA F9 90 8E      16B0   98 FA C5 FF 03 FC 3A 94 05 03 FC F6 94 21 C2 FB
12C0   AA F4 C2 E9 35 C2 E8 31 C4 6A CA FC C4 8A CA FE      16C0   33 C2 FA 37 C3 00 CA FA C3 01 CA FB 90 A4 C4 02
12D0   C4 7A CA FF 3F 90 A7 90 A9 C1 00 E4 80 94 18 C4      16D0   02 F2 FB CA FB C4 00 F2 FA CA FA 90 95 90 0B 01
12E0   20 37 AA FD AA FD 33 C5 01 CB FF C5 01 CB FE C5      16E0   C4 20 37 AA FD AA FD 33 C4 00 CB FF 40 CB FE C5
12F0   01 C4 01 CA F5 90 DE C4 00 CA F5 C4 12 37 C4 83      16F0   01 C1 00 03 FC 3A 94 D6 03 FC F6 94 02 90 CF 01
1300   33 3F 90 D1 90 D1 C4 1F 37 C4 C1 33 06 D4 20 98      1700   C3 FF CB 01 C3 FE CB 00 C4 02 CA EA 02 C3 FE F3
1310   E6 C5 01 E4 0D 98 05 E4 0D 3F 90 F0 C4 0D 3F C4      1710   FE CB FE C3 FF F3 FF CB FF D4 80 9C 34 BA EA 9C
1320   0A 3F 02 C4 4B CA FB C4 1C CA FA 90 AC C4 20 37      1720   EB 02 C3 FE F3 00 CB FE C3 FF F3 01 CB FF D4 80
1330   BA FD BA FD 33 02 C3 FE F3 00 CB FE C3 FF F3 01      1730   9C 1F 02 C3 FE F3 FE CB FE C3 FF F3 FF CB FF D4
1340   CB FF 90 BE C4 20 37 BA FD BA FD 33 03 C3 FE FB      1740   80 9C 0E 02 40 F3 FE CB FE C4 00 F3 FF CB FF 94
1350   00 CB FE C3 FF FB 01 CB FF 90 A7 C4 20 37 C2 FD      1750   9E C4 06 90 88 90 84 C4 20 35 C4 D6 31 C4 00 CA
1360   33 03 C4 00 FB FE CB FE C4 00 FB FF CB FF 90 D2      1760   E7 C4 1F 37 C4 C1 33 C2 F4 98 08 C4 3F 3F C4 20
1370   90 92 C4 20 37 C2 FD 33 C3 FF E3 FD CA EA C3 FF      1770   3F 90 03 C4 3E 3F C4 1F 37 C4 76 33 3F C4 C1 33
1380   94 0D 03 C4 00 FB FE CB FE C4 00 FB FF CB FF C3      1780   40 98 F3 E4 0A 98 EF 40 E4 0D 98 50 40 E4 5F 98
1390   FD 94 0D 03 C4 00 FB FC CB FC C4 00 FB FD CB FD      1790   41 40 E4 08 98 36 40 E4 15 98 0F 40 E4 03 9C 1A
13A0   C4 00 CB 00 CB 01 CB 02 CB 03 C4 10 CA EB C3 FF      17A0   C4 5E 3F C4 43 3F C4 0E 90 A9 C4 5E 3F C4 55 3F
13B0   1F CB FF C3 FE 1F CB FE 06 94 11 02 C3 02 F3 FC      17B0   C4 0D 3F C4 0A 3F 90 9F 90 9B 40 CD 01 AA E7 3F
13C0   CB 02 C3 03 F3 FD CB 03 90 02 90 A4 02 C3 03 1F      17C0   48 9C B3 C4 0D 01 40 3F 90 12 90 87 C4 20 3F C4
13D0   CB 03 C3 02 1F CB 02 C3 01 1F CB 01 C3 00 1F CB      17D0   08 3F C2 E7 98 A0 BA E7 C5 FF 90 9A 40 CD 01 C4
13E0   00 BA EB 9C C9 90 02 90 85 C2 EA 94 0D 03 C4 00      17E0   0A 3F C4 20 35 C4 D6 31 90 CE C4 20 37 C2 FD 33
13F0   FB 00 CB 00 C4 00 FB 01 CB 01 C3 00 CB FC C3 01      17F0   C3 FF 35 01 C3 FE 31 CA EF C1 00 CB FE C4 00 CB
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Elbug must be used to start the program. The normal hex-I/O start procedure is used; since the desired program is on page 1, the initial command is 'ru1000ru'.

Once started in this way, the first thing the interpreter does is look for a program on page 3 (not page 2: everything has been moved up one page!). If it finds a program there (stored in ROM), this will be run immediately. This first program can, if necessary, run over more than one page. However, as when programming in machine language, a pointer change will then be required; when programming in NIBL, this is achieved by entering the instruction PAGE = PAGE + 1. The interpreter will 'read' this as an instruction to continue the program on the first line of the next page.

Obviously, this is a useful feature — not only when running an initial program that is stored in ROMs, but also when programs are stored in RAM. To achieve this latter capability, some further modifications in the original NIBL interpreter program proved necessary.

The problem is that the original NIBL version not only looks for a program in page 2: it also requires that this program is stored in ROM. If the program is stored in RAM, the interpreter refuses to run it! Not only that, it also blocks any programs stored on any of the other pages at the same time.

The reason for this 'mulishness' is that NIBL, on finding a program on page 2, proceeds to write an 'end-of-program' indication at the top of each page — or tries to, at least. This indication consists of 'Carriage Return' (ØD), followed by

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1800  FF C2 EF 31 40 35 90 B0 C4 20 37 C2 FD 33 C7 FE
1810  01 C7 FF CA EA C7 FF 33 CA FD C2 EA 37 40 CB 00
1820  90 C6 90 A6 C4 20 37 C2 FD 33 C3 01 CA F7 C3 00
1830  CA F8 C2 F1 33 C2 F0 37 C4 04 CA E7 C7 01 E4 0D
1840  98 04 AA E7 90 F6 C2 E7 E4 04 9C 02 CA E7 C2 E7
1850  01 C2 F2 94 06 D4 7F CA F2 90 18 C5 03 40 02 F4
1860  FC 01 C5 01 E4 0D 98 0B 40 02 F4 FF 01 90 F3 90
1870  AF 90 AF 40 DA E7 98 F7 C4 7A CA FF C4 6A CA FC
1880  C4 8A CA FE 40 98 60 94 10 C1 00 C9 80 C5 01 94
1890  F8 C1 00 94 F4 C9 80 90 4E C1 FE CA EA C4 FF C9
18A0  FE C4 50 C9 FF C5 01 94 FC C1 00 94 F8 35 CA EE
18B0  35 31 CA EF 31 C2 EF 02 70 C4 00 F2 EE E2 EE D4
18C0  F0 98 03 C4 00 01 C4 FF C9 80 C5 FF 94 FA C1 01
18D0  E4 50 98 04 C1 00 90 F0 C2 EA C9 00 C4 0D C9 01
18E0  40 9C 04 C4 02 90 8A C2 E7 98 84 C2 F1 31 C2 F0
18F0  35 C2 F3 33 C2 F2 37 C2 F7 CF 01 C2 F8 CF 01 C2
1900  E7 CF 01 C5 01 CF 01 E4 0D 9C F8 90 DC C4 10 37
1910  C4 75 33 3F 90 CF BA FD BA FD 33 C4 20 37 C3 00
1920  CA EF C3 01 CA EE 90 E5 C2 FF 01 40 E4 7A 9C 04
1930  C4 0F 90 E0 C2 EF DA EE 98 06 BA FF BA FF 90 CD
1940  40 33 C4 20 37 C3 FF 35 C3 FE 31 90 C0 C2 EF D4
1950  F7 07 90 B9 90 BE C4 20 37 AA FD 0A AF FD 33 06 CB
1960  FE C4 00 CB FF 90 EB C2 EE 37 C2 EF 33 C7 FF 3F
1970  C4 20 36 C4 1C 32 90 DA C2 FF E4 8A 9C 04 C4 0A
1980  90 D2 AA FF AA FF 33 C4 20 37 35 CB FF 35 31 CB
1990  FE 31 90 BE C2 E9 37 C2 E8 33 C3 00 94 02 90 07
19A0  C3 02 01 C7 80 90 F3 C7 02 AA FD AA FD 33 01 C4
19B0  20 37 CB FF 40 CB FE 90 D9 C5 01 E4 0D 9C FA 3F
19C0  C2 FD 33 C4 20 37 C3 03 CB FE C3 02 CB FF 90 C2
19D0  90 AE C4 08 CA EB C2 E5 01 C2 E4 CA E9 C2 E5 02
19E0  70 01 C2 E4 02 F2 E9 CA E4 BA EB 9C F0 40 02 F4
19F0  07 01 C2 E4 02 F4 07 1E CA E4 AA E6 98 03 40 CA
1A00  E5 C2 FD 33 C4 20 37 C4 01 CB 00 C4 00 CB 01 C3
1A10  FE CB 02 C3 FF CB 03 C3 FC CB 04 C3 FD CB 05 C2
1A20  E4 CB FE C2 E5 EF FF D4 7F CB FF C7 06 33 CA FD
1A30  90 9C 90 9C AA FF AA FF 33 C4 20 37 C4 00 CB FF
1A40  C4 01 CB FE 90 EA C2 FE E4 A6 9C 04 C4 0A 90 E2
1A50  E4 A6 31 CA F1 C4 20 35 CA F0 C2 FD 33 C4 20 37
1A60  C3 F9 CD 01 C3 FC CD 01 C3 FD CD 01 C3 FE CD 01
1A70  C3 FF CD 01 C2 F1 CD 01 C2 F0 CD 01 35 C2 F1 31
1A80  CA FE C7 FC 33 CA FD 90 A7 C2 FE E4 8A 9C 04 C4
1A90  0B 90 BB E4 8A 31 CA F1 C4 20 35 CA F0 C2 FD 33
1AA0  C4 20 37 C7 FF E1 F9 98 04 C4 0C 90 A1 E1 F9 01
1AB0  C2 80 02 F1 FC CA 80 CB 00 C6 01 C2 80 F1 FD CA
1AC0  80 CB 01 C6 FF C1 FA CB 02 C1 FB CB 03 C1 FD 94
1AD0  10 C4 04 CA EB C7 01 E4 FF CB FF BA EB 9C F6 90
1AE0  02 C7 04 33 CA FD C2 F1 31 C2 F0 35 90 99 C2 EF
1AF0  98 08 C2 FE 02 F4 F9 CA FE 3F C2 FE 33 C4 20 37
1B00  C3 FF 35 C3 FE 31 90 E4 90 A1 C2 EE 35 C2 EF 31
1B10  C4 1F 37 C4 C1 33 C5 01 E4 0D 98 D0 E4 0D 3F 06
1B20  D4 20 9C F2 90 C6 C2 EE 37 C2 EF 33 C5 01 CF 01
1B30  E4 0D 9C F8 90 B6 C2 EF 33 C2 EE 37 C5 01 E4 22
1B40  98 0E E4 2F 9C 04 C4 07 90 BE E4 0D CF 01 90 EC
1B50  C4 0D CB 00 90 DE C2 FD 33 C4 20 37 C7 FF 35 C7
1B60  FF 31 C7 FF 01 C7 FF 33 CA FD 40 37 C5 01 CF 01
1B70  E4 0D 98 C0 06 C4 20 9C F3 90 B9 AA FD AA FD 33
1B80  C4 20 37 C2 F6 CB FE C4 00 CB FF 90 A7 C2 EF D4
1B90  06 98 04 C2 EF CA F6 3F C2 F6 E4 02 9C 09 C4 21
1BA0  CA E9 C4 20 CA E8 3F E4 02 01 C4 04 CA EB 40 02
1BB0  70 01 BA EB 9C F8 40 CA E9 C4 02 CA E8 3F C2 E9
1BC0  35 C2 E8 31 3F 35 01 40 35 40 1C 1C 1C 1C CA F6
1BD0  3F C2 E9 35 C2 E8 31 C4 0D C9 FF C4 FF C9 00 C9
1BE0  01 3F C2 E9 35 C2 E8 31 C1 00 E4 FF 94 12 03 C1
1BF0  01 FA EF C1 00 FA EE 94 07 C1 02 01 C5 80 90 E8
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1C00  31 CA F3 31 35 CA F2 35 C2 EF E1 01 9C 07 C2 EE
1C10  E1 00 9C 01 3F C2 F2 DC 80 CA F2 3F 12 0C 17 56
1C20  2C 25 8D 4C 1E 16 AB 1C 35 1B 97 16 30 19 15 1B
1C30  E1 18 23 4C 1E 2C 51 4C 49 53 D4 1B 97 16 AB 1C
1C40  47 19 15 1B E1 4C 49 1B BD 12 D8 8F 2F 13 05 4C
1C50  1C 2C 60 52 55 CE 11 2F 1B 97 1B BD 12 BF 12 83
1C60  2C 6D 43 4C 45 41 D2 11 2F 50 12 83 2C 86 4E
1C70  45 D7 16 AB 1C 78 4C 7A 1A 33 11 2F 19 15 1B 8C
1C80  1B 97 1B D0 12 83 2C 8B 4C 45 D4 14 E0 1C 9A 2E
1C90  2F BD 8E 35 14 C0 11 2F 12 83 2C AA C0 8E AC 2E
1CA0  2F BD 8E 35 18 07 11 2F 12 83 2C BC 49 C6 8E 35
1CB0  2C B6 54 48 45 CE 19 15 15 D0 4C 86 2C D1 55 4E
1CC0  54 49 CC 16 3B 8E 35 11 2F 19 15 19 27 1B C4 12
1CD0  83 2C D0 44 CF 16 3B 11 2F 19 77 12 83 2D 00 47
1CE0  CF 2C EB 54 CF 8E 35 11 2F 4C F6 2E 2F 53 55 C2
1CF0  8E 35 11 2F 11 09 1B 97 19 15 1B E1 11 68 12 83
1D00  2D 10 52 45 54 55 52 CE 11 2F 11 42 1B C4 12 83
1D10  2D 2A 4E 45 58 D4 16 3B 14 E0 1E 2F 11 2F 1A 88
1D20  8E 5F 19 15 1A ED 1B C4 12 83 2D 54 46 4F D2 16
1D30  3B 14 E0 1E 2F 2E 2F BD 8E 35 2E 2F 54 CF 8E 35
1D40  2D 4A 53 54 45 D0 8E 35 4D 4C 1A 33 11 2F 1A 45
1D50  14 C0 12 83 2D 67 53 54 41 D4 2E 2F BD 8E 35 19
1D60  15 19 4C 11 2F 12 83 2D 7E 50 41 47 C5 2E 2F BD
1D70  8E 35 11 2F 19 15 1B 8C 1B 97 1B BD 12 83 2D 9E
1D80  A4 8E AC 2E 2F BD 2D 8F A2 19 15 1B 35 4D 9A 2E
1D90  2F A4 8E AC 16 30 1B 55 16 30 11 2F 12 83 2D D1
1DA0  50 D2 2D A7 49 4E D4 2D AE A2 11 75 4D C1 2D BD
1DB0  A4 8E AC 2E 2F 19 15 1B 09 16 30 4D C1 8E 35 8F
1DC0  2F 2D C6 AC 4D A7 2D CB BB 4D DC 12 0C 11 2F 12
1DD0  83 2E 09 49 4E 50 55 D4 16 3B 14 E0 1D F6 16 30
1DE0  17 56 8E 35 14 C0 16 30 2E 05 AC 14 E0 1E 2F 16
1DF0  30 2E 2F AC 4D E2 2E 2F A4 8E AC 16 30 17 56 19
1E00  15 1B 25 16 30 11 2F 12 83 2E 12 45 4E C4 11 2F
1E10  12 7F 2E 26 4C 49 4E CB 8E 35 11 2F 16 30 19 15
1E20  19 66 16 30 12 83 2E 2F 52 45 CD 19 B8 12 83 12
1E30  1A 8F 2F 12 A9 8E 61 2E 3E BD 8E 61 15 43 2E 53
1E40  BC 2E 48 BD 8E 61 15 4F 2E 4F BE 8E 61 15 47 8E
1E50  61 15 4B 2E 8B BE 2E 5D BD 8E 61 15 57 8E 61 15
1E60  53 2E 6A AD 8E 8D 13 5A 4E 6F 2E 6D AB 8E 8D 2E
1E70  78 AB 8E 8D 13 2C 4E 6F 2E 81 AD 8E 8D 13 43 4E
1E80  6F 2E 8B 4F D2 8E 8D 15 EB 4E 6F 10 F5 8E AC 2E
1E90  98 AA 8E AC 13 71 4E 8F 2E A1 AF 8E AC 14 07 4E
1EA0  8F 2E 8B 41 4E C4 8E AC 15 E7 4E 8F 14 E0 1E B4
1EB0  15 2B 10 F5 16 AB 1E BA 10 F5 2E C1 A3 16 4B 10
1EC0  F5 2E CB A8 8E 35 2E 2F A9 10 F5 2E D4 C0 8E AC
1ED0  17 E9 10 F5 2E DF 4E 4F D4 8E AC 15 EF 10 F5 2E
1EE0  E9 53 54 41 D4 19 55 10 F5 2E F4 54 4F D0 1B 97
1EF0  19 93 10 F5 2F 01 4D 4F C4 8F 20 14 07 19 BF 10
1F00  F5 2F 16 52 4E C4 8F 20 19 D1 13 43 13 2C 14 07
1F10  19 BF 13 2C 10 F5 2E 2F 50 41 47 C5 1B 7A 10 F5
1F20  2E 2F A8 8E 35 2E 2F AC 8E 35 2E 2F A9 10 F5 16
1F30  30 11 8E 14 07 11 C5 16 30 10 F5 20 45 52 52 4F
1F40  D2 41 52 45 C1 53 54 4D D4 43 48 41 D2 53 4E 54
1F50  D8 56 41 4C D5 45 4E 44 A2 4E 4F 47 CF 52 54 52
1F60  CE 4E 45 53 D4 4E 45 58 D4 44 46 4F D2 44 49 56 BD
1F70  42 52 C5 55 4E 54 CC C4 08 CA EB 06 DC 00 07 06
1F80  D4 20 9C FB C4 57 8F 04 06 D4 20 9C F2 06 D4 FF
1F90  DC 01 07 C4 7E 8F 08 06 D4 20 98 04 C4 01 90 04
1FA0  C4 00 9C 00 CA EA 1F 01 1D 01 06 DC 01 E2 EA 07
1FB0  BA EB 9C DF 06 D4 FE 07 8F 08 40 D4 7F 01 40 3F
1FC0  90 B5 01 C4 FF 8F 17 06 DC 01 07 C4 09 CA E8 C4
1FD0  8A 8F 08 BA E8 98 10 40 D4 01 CA E9 01 1C 01 06
1FE0  DC 01 E2 E9 07 90 E8 06 D4 FE 07 3F 90 D4 01 06
1FF0  C4 19 37 C4 6F 33 3F 00 00 00 00 00 00 00 00 00
```

'FF'. If the program on page 2 was stored in ROM, no harm is done: the contents of the memory location at the top of the page cannot be altered, so the 'end-of-program' indication is not stored there. A jump to the next page for the continuation of the program is also possible, provided this continuation is also stored in ROM.

In the Elektor SC/MP system, however, programs will normally be stored in 4K RAM cards. The 'end-of-program' indication would then block every page. For this reason, NIBL-E is modified to

Table 1. Listing of the 4K NIBL-E interpreter.

Table 2. The interpreter can easily be adapted to virtually any transmission rate, by modifying the data in the nine addresses given here.

Address	Baud rate			
	110	300	600	1200
1F85	57	76	A7	3D
1F87	04	01	00	00
1F94	7E	E5	45	76
1F96	08	02	01	00
1FB9	08	06	04	02
1FC4	FF	64	25	86
1FC6	17	06	03	01
1FD0	8A	F0	50	81
1FD2	08	02	01	00

ensure that this indication is only stored at the top of all pages under condition that no initial program is found on page 3. The only page that will still be blocked, initially, is page 2. This is no problem, though: pages 3 . . . 7 provide more than enough memory space for any initial program.

Having entered and tested BASIC programs, the cassette routine in Elbug can be used for storing them on tape. When retrieving them, one minor problem remains to be resolved: unless a program is stored on page 3, any programs entered on the other pages will immediately be blocked by the interpreter, as decribed above. One further modification in the interpreter and a slightly more extensive 'start' procedure are required to cure this.

The complete program

Although the main points have already been discussed, it is perhaps a good idea to give a brief survey of the complete system.

The starting point is a complete Elektor SC/MP system, including Elbug and the associated cassette interface. The NIBL-E interpreter is located on page 1 – it can be stored in either ROM or RAM. A listing of this program is given in table 1. Page 2 must contain at least 2K of RAM, as scratch-pad memory for the interpreter; a small program can also be stored here. Extending page 2 to 4K of RAM provides space for more extensive programs.

Either ROM or RAM storage area can be included on the remaining pages (3 . . . 7), as required.

To be able to communicate with the interpreter (by means of a terminal, for instance), a small interface circuit must be included. This adapts the TTL logic levels in the SC/MP system to RS232C or V24, and vice versa; it also ensures correct polarity of the various signals. The in- and outputs from the interface can be hard-wired to the terminal, or a (standard) connector can be mounted on the p.c. board. The interface circuit and p.c.b. are described elsewhere in this issue.

A suitable terminal is the 'Elekterminal'; this can be connected to a normal TV set via the UHF/VHF modulator.

Transmission speed

In the original version, communication with the interpreter runs at a rate of 110 baud. The same is true of the NIBL-E version given in table 1. However, if it is used in conjunction with the Elekterminal, a much higher transmission rate is possible: up to 1200 baud.

Obviously, the software will have to be adapted if the transmission rate is changed. The memory locations that are affected by the transmission rate are listed in table 2; the data for the four most common transmission rates are

also included in this table. The values given are valid both for a SC/MP system with 1 MHz crystal and for a SC/MP II system with a 2 MHz crystal.

The NIBL interpreter opens the possibility of connecting a paper-tape reader to S_B. The reader-relay is controlled by the 'flag 1' output of the processor, via an output buffer. When developing NIBL-E, however, it was assumed that this facility would not be required, since the Elbug cassette routines will normally be used instead. However, it is a relatively simple matter to provide a 'paper-tape' input: the data in two addresses must be changed (1F7D becomes Ø2 and 1F8F becomes FD), and the reader is connected to the sense B input (via a parallel-to-series converter).

Storing a program on paper-tape is a simple matter: a LIST command provides simultaneous outputs to the terminal and to the puncher via flag Ø. Normally speaking, the transmission speed for a puncher should not be higher than 300 baud.

Cassette routine

BASIC programs can be stored on tape and played back with the same ease as programs in machine language. The start address for the program on page 2 is 211F (hexadecimal); all other pages simply start at the top of the page, at address PØØØ (where P is the page number).
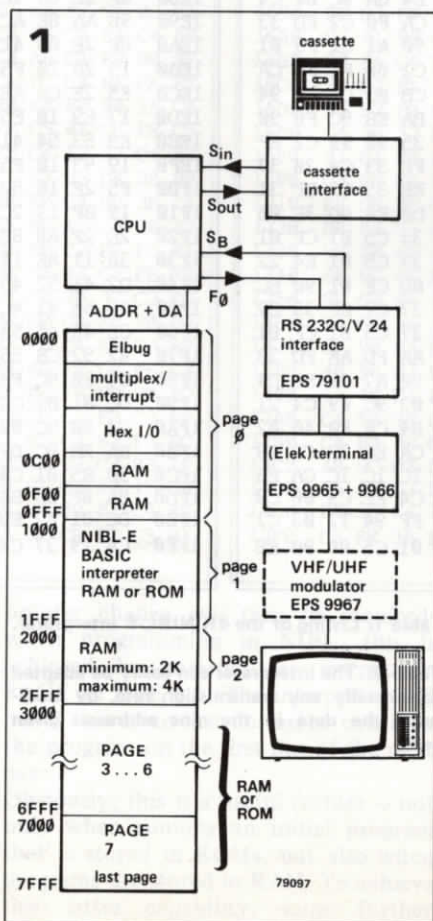
The final address can be found, once the

Figure 1. The complete system.

program has been entered, by giving the command PRINT TOP (followed, as always, by Carriage Return). The computer will respond by giving the final address plus one, as a decimal number – in other words, it gives the first address that can be used for a new program. This decimal number (minus one) must be converted to hexadecimal. With both 'begin' and 'end' address known, the Elbug cassette routine can be used to store the program on tape. The jump back to Elbug can be achieved in two ways: either operating the NRST key or giving the command LINK Ø.

The LINK command is used to call up a program that is stored in machine language; in this case, the Elbug program, starting at address ØØØØ. The LINK command can be followed by an address in either decimal or hexadecimal code. If the hexadecimal code is used, the number must be preceded by the # symbol.

Having 'dumped' the program on tape, a jump back to NIBL-E is initiated by keying in 'ru1FFØru'. By starting at this address, part of the interpreter's initial procedure is avoided – in particular, the section that might otherwise block all programs. The interpreter now prints a prompt (>), after which the current program can be developed further or a new page can be selected for a new program, using the command NEW (P) (where P is the page number). Note that the lowest page number possible is 2. If an attempt is made to select page 1, the interpreter will simply select page 2 instead.

To load a BASIC program from cassette, the routine is as follows. First, NIBL-E is started with the command ru1ØØØru. When the prompt symbol appears, the page that is to be loaded is selected: NEW (P). The next step is to jump back to Elbug: LINK Ø. The program can now be loaded in the usual way, using the ca . . . . up instruction; when loading is completed ('Elbug' appearing on the display), the jump back to NIBL-E can be executed (ru1FFØru). As soon as the prompt symbol is printed, the program can be started by giving the RUN command.

Loading NIBL-E

It is well nigh impossible to load a 4K byte program from the keyboard without introducing errors somewhere along the line. For this reason, it is the intention to include the program on an ESS record in the near future.

Using NIBL-E

Only a few NIBL commands have been mentioned in the course of this article. A more extensive summary is given in the description of the BASIC microcomputer elsewhere in this issue: furthermore, the BASIC course explains the use of virtually all possible NIBL commands.