INTERNATIONAL ATOMIC ENERGY AGENCY
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INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS
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CABLE: CENTRATOM - TELEX 460392-I

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COLLEGE ON MICROPROCESSORS:

TECHNOLOGY AND APPLICATIONS IN PHYSICS

7 September - 2 October 1981

SOLUTIONS TO EXERCISES ON THE ASSEMBLER AND LINKER

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SOLUTION No. 6.1

ICTP COLLEGE ON MICROPROCESSORS

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PRACTICAL WORK SESSIONS

DSPLAY consists mainly of a nested loop. The inner loop is responsible for the horizontal controls and the outer loop for the vertical ones. First a vertical count is set to 23 which is the maximum number in a channel, and some blanks are output to center the display. (If the maximum number in a channel would be bigger than 23 we would have to introduce scaling, but the principle of the display program would remain unchanged). Now the horizontal count, which counts the number of channels is reset to 0 and a pointer to the histogram is initialized to the first channel. Then the content of the channel is compared to the vertical count and a cross is printed if it is bigger or equal to the vertical count. Otherwise we print a blank. The pointer and the horizontal count are incremented and we go on with the next channel. As soon as the horizontal counter tells us that 29 channels are printed a <CR>, <LF> is send and a full line is completed. In order to start the next line we have to decrement the vertical count and to reset the horizontal controls. Also the blanks have to be printed. If the vertical count reaches 0 the histogram is finished and DSPLAY returns to the calling program.


```
1                                                                CROSS ASSEMBLER FOR MOTOROLA 68C
 CUFOM MODULE NAME, ENTRY POINTS, EXTERNAL SYMBOLS               VERS. 1.0, RUN AT CERN'S CDC COF
0
0
0     NAME OF MODULE : MAIN
0     PROGRAM TYPE   : MAINPROGRAM, ENTRY POINT IS : MAIN
0     EXTERNAL REFER.: DSPLAY

0     S E C T I O N S:
      ----------------
0        PROGRAM SECTION       : 0004 IS HIGHEST ADDRESS USED,  ENTRY POINTS ARE:
                                  -NONE-
0        DATA SECTION          : 001C IS HIGHEST ADDRESS USED,  ENTRY POINTS ARE:
                                  HIST
```

```
1                                                                CROSS ASSEMBLER FOR MOTOROLA 68C
                                                                 VERS. 1.0, RUN AT CERN'S CDC COF

 LINE  ADDR  CODE  EXTENSIONS    .    S O U R C E  -  S T A T E M E N T

    1  0000                              NAM     MAIN
    2  0000                              OPT     REL
    3  0000                              DSCT
    4                                    XDEF    HIST
    5                                    XREF    DSPLAY
    6  0000  01 02 03 04 05 06  HIST     FCB     1,2,3,4,5,6,7,8,9,10
    7  000A  0B 0C 0D 0E 0F 10           FCB     11,12,13,14,15,16,17,18,19,20
    8  0014  15 16 17 16 15 14           FCB     21,22,23,22,21,20,19,18,17
    9  0080                              PSCT
   10  0000  BD    0000*        MAIN    JSR     DSPLAY
   11  0003  20    FE           STOP    BRA     STOP
   12  0005                              END     MAIN
1                                                                CROSS ASSEMBLER FOR MOTOROLA 68C
 IDENTIFIER CROSS REFERENCE.                                     VERS. 1.0, RUN AT CERN'S CDC COF

 DSPLAY           EXT     2/05       2/10
 HIST     00000000 REL    2/04       2/06
 MAIN     00000000 REL    2/01       2/10       2/12
 STOP     00000003 REL    2/11       2/11

0END OF ASM 6800-    0.428 CP SECONDS ASSEMBLY TIME.
1
```

```
1                                                                CROSS ASSEMBLER FOR MOTOROLA 68C
 CUFOM MODULE NAME, ENTRY POINTS, EXTERNAL SYMBOLS               VERS. 1.0, RUN AT CERN'S CDC COF
0
```

```
:UFOM MODULE NAME, ENTRY POINTS, EXTERNAL SYMBOLS          CROSS ASSEMBLER FOR MOTOROLA 68C
                                                          VERS. 1.0, RUN AT CERN'S CDC COM

     NAME OF MODULE : DSPLAY
     PROGRAM TYPE   : SUBPROGRAM
     EXTERNAL REFER.: HIST

     S E C T I O N S:
     ----------------
        PROGRAM SECTION       : 0027 IS HIGHEST ADDRESS USED,  ENTRY POINTS ARE:
                                 DSPLAY
```



```
LINE  ADDR  CODE  EXTENSIONS    .    S O U R C E  -  S T A T E M E N T

   1  0000                          NAM     DSPLAY
   2                          *   PROGRAM TO DISPLAY A HISTOGRAM OF 29 CHANNELS
   3                          *   ON A CRT SCREEN.
   4                          *
   5                          *
   6                          *   INITIALIZE SCREEN
   7                          *
   8  0000                          OPT     REL,MEX
   9                                XREF    HIST
  10                                XDEF    DSPLAY
  11                                INSERT
  12                          MON   MACR
  13                                SWI
  14                                FCB     \0
  15                                ENDM
  16
  17                          DSPLAY MON    19              SEND (CR),(LF)
  18  0000  3F                      SWI
  19  0001  13                      FCB 19
  20                                ENDM
  21                          *
  22                          *   PRINT HISTO
  23                          *
  24  0002  86    17                LDAA    #23             MAXIMUM NUMBER IN A SINGLE CHANNEL
  25  0004  C6    19          NEWLIN LDAB   #25             NUMBER OF SPACES
  26                                MON     10              PRINT SPACES
  27  0006  3F                      SWI
  28  0007  0A                      FCB 10
  29                                ENDM
  30  0008  CE    FFFF*             LDX     #HIST-1
  31  000B  5F                      CLRB
  32  000C  5C                LOOP  INCB                    LOOP PRINTS 1 LINE
  33  000D  C1    1E                CMPB    #30             FIRST LINE DONE ?
  34  000F  27    11                BEQ     NEXT            YES
  35  0011  08                      INX
  36  0012  36                      PSHA
  37  0013  A1    00                CMPA    0,X             DO I HAVE TO PRINT A CROSS?
  38  0015  2E    04                BGT     BLANK           NO
  39  0017  86    58                LDAA    #'X
  40  0019  20    02                BRA     OUT
  41  001B  86    20          BLANK LDAA    #$20
  42                          OUT   MON     6               PRINT SPACE OR *
  43  001D  3F                      SWI
  44  001E  06                      FCB 6
  45                                ENDM
  46  001F  32                      PULA
  47  0020  20    EA                BRA     LOOP
  48                          NEXT  MON     19              SEND (CR),(LF)
  49  0022  3F                      SWI
  50  0023  13                      FCB 19
```



```
LINE  ADDR  CODE  EXTENSIONS    .    S O U R C E  -  S T A T E M E N T

   1                          ENDM
   2  0024  4A                      DECA
   3  0025  26    DD                BNE     NEWLIN
   4  0027  39                      RTS
   5  0028                          END
```



```
 IDENTIFIER CROSS REFERENCE.

 BLANK    0000001B REL     2/38        2/41
 DSPLAY   00000000 REL     2/01        2/10        2/17
 HIST              EXT     2/09        2/30
 LOOP     0000000C REL     2/32        2/47
 MON               MAC     2/12        2/17        2/26        2/42        2/48
 NEWLIN   00000004 REL     2/25        3/03
 NEXT     00000022 REL     2/34        2/48
 OUT      0000001D REL     2/40        2/42

0END OF ASM 6800-    0.864 CP SECONDS ASSEMBLY TIME.
1
*EOR
```

```
1
 PAGE 1          30/08/81   18.26.51.            CUFOM LINKAGE EDITOR (1.1)

 ==0==>  "" LINKED (VERSION 1.1) ON CDC/NOS/BE ( 30/08/81 ).


 ---------- FROM "CMAIN" ----------------------------------------------


 ==1==>  FROM MODULE  MAIN
 ==1==>
 ==1==>  CROSS ASSEMBLER FOR MOTOROLA 6800 PROCESSOR,  VERS. 1.0
 ==1==>  RUN AT CERN'S CDC COMPUTER CENTRE   30/08/81  18.24.17.
           RELOCATABLE SECTION  3   SIZE=0002D(    45)   OFFSET=00000   PROGRAM
           RELOCATABLE SECTION  1   SIZE=0001D(    29)   OFFSET=00000   DATA
             DEFINED IN SECTION  1                       OFFSET=00000   HIST

 ---------- FROM "CDSPLAY" --------------------------------------------


 ==1==>  FROM MODULE  DSPLAY
 ==1==>
 ==1==>  CROSS ASSEMBLER FOR MOTOROLA 6800 PROCESSOR,  VERS. 1.0
 ==1==>  RUN AT CERN'S CDC COMPUTER CENTRE   30/08/81  18.25.30.
             DEFINED IN SECTION  3                     OFFSET=00005   DSPLAY


 >>>>>> 0 ERROR  DETECTED IN INPUT MODULES <<<<<<<<
```



```
1PAGE 1          30/08/81   18.33.41.            CUFOM -> MOTOROLA  TRANSLATOR (1.1)

 THE CONTROL CARD PARAMETERS ARE
 -------------------------------

 OPTION INPUT  FILE IS-  OPTIONS
 CUFOM  INPUT  FILE IS-  CDISP
 BINARY OUTPUT FILE IS-  BDIS
 LIST   OUTPUT FILE IS-  LDISP


 THE SECTION ORIGINS ARE SPECIFIED AS FOLLOWS
 --------------------------------------------

     1     SECTION(1,GENERAL    ,04DATA)=0000.
     2     SECTION(3,RELOCATABLE,07PROGRAM)=001D.
1PAGE 2          30/08/81   18.33.41.            LOAD MAP FOR CUFOM -> MOTOROLA  TRANSLATOR (1

 MODULE    ENTRY       SECTION          ADDRESSES :        PROCESSOR COMMENTS
 NAME      NAME     TYPE AND NAME  MEMORY  ORIGIN  LISTING

                                                           LINKED (VERSION 1.1) ON CDC/NOS/BE ( 3
                                                           FROM MODULE  MAIN.

                                                           CROSS ASSEMBLER FOR MOTOROLA 6800 PROC
                                                           RUN AT CERN'S CDC COMPUTER CENTRE   30
           HIST       G  DATA      000000  000000  000000  FROM MODULE  DSPLAY.

                                                           CROSS ASSEMBLER FOR MOTOROLA 6800 PROC
                                                           RUN AT CERN'S CDC COMPUTER CENTRE   30
           DSPLAY     R  PROGRAM   000022  000022  000000

 NO TRANSFER ADDRESS SPECIFIED FOR THIS MODULE


 >>>>>> 0 ERROR  DETECTED IN CUFOM INPUT FILE <<<<<<<<
```