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PDP8-PROGRAMMING 1
THE KV8/I STORAGE SCOPE AND H306 JOYSTICK

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The KV8/I storage scope and H306 joystick

by

A.E. Brouwer & C.L. Pippel

Preface

This report is the first in a series entitled "PDP8-PROGRAMMING". This series will contain reports on PDP8 software and programming aspects of PDP8 hardware.

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Summary

This description includes all information about the KV8/I scope and H 306 joystick available to us, but only insofar as relevant to the programmer. It includes the results of several experiments, conducted by us. For a description of the hardware we refer to the appropriate publications of DEC and Tektronix.

0. Introduction

The KV8/I storage scope - interfaced with the PDP8/I computer - is a data storage and display instrument. It has a screen of 21×16.2 cm on which figures composed of points, straight lines and circular arcs can be drawn.

Normally the figure remains visible until it is erased (under program control or by pushing the ERASE button). However, by manually adjusting the intensity to 'write thru', one can inhibit the storage of a figure as it is being displayed. [Something like this can be done also under program control by drawing long vectors with short vector timing.]

The H 306 joystick is a device consisting of an interrupt bar and a stick that controls the motion of a small ellipse, called cursor. The ellipse can be made visible on the screen. The position of the cursor can be determined by the program.

1. The screen

The screen is addressed by two coordinates, X and Y, where $-512_{10} \leq \leq X,Y \leq 511_{10}$ (i.e. X and Y are ten bit two's complement values). However, only points with $|X| \leq$ ca. 280_{10} and $|Y| \leq$ ca. 360_{10} correspond to a spot on the screen. The point (0,0) is the center of the screen. [Since the corners of the screen are rounded and the focus along the border is not too well, we advise not to use points with $|X| > 270_{10}$ or $|Y| > 350_{10}$. These numbers may vary from installation to installation, but if you find significant discrepancies, yours is probably badly regulated.]

To draw a picture on the screen one generally performs the following

actions:

- select the appropriate mode
- specify coordinates
- execute function (e.g. draw line, circle, point, etc.).

The precise action of the instructions involved is dependent on the values of several registers and flip-flops in the display-logic. Therefore, before describing the instructions we first consider these registers and flip-flops.

2. The flags

Two flags are connected to the skip and interrupt bus: the ready flag of the scope (RF) and the cursor flag. The cursor flag becomes 1 when the interrupt bar is hit; it is cleared by the program and by pushing START.
Instructions:

- SNC = 6051 — skip (the next sequential instruction) when the cursor flag is not up.
- CCF = 6052 — clear the cursor flag.

The ready flag becomes 1 after the completion of certain actions by the scope (as will be described later), and is cleared by the program - explicitly or by initiating certain actions - any by pushing START.
Instructions:

- SRF — skip (the next sequential instruction) when the RF is up.
- CRF — clear the RF.

[The instructions LDX, LDY, EXC, EXL clear the RF and set it again when the scope is ready. Pushing the ERASE button does not clear the RF, but after the erasure of the display the flag is set.]

3. The registers

The logic of the scope contains a.o. four analog registers, a 10-bit digital register and a number of flip-flops.

Analog registers:

3.1. XSH and YSH (X resp. Y sample and hold register)

In point mode they hold the (X,Y) coordinates of the point. In linear vector mode they hold ΔX and ΔY. In circular vector mode they hold the (X,Y) coordinates of the centre of the circle. They are not disturbed in cursor mode, but their drift is specified as being not more than 30 positions/sec.

3.2. XINTH, YINTH (X resp. Y integrate and hold register).

They hold the (X,Y) coordinates in vector mode and are not disturbed in point or cursor mode. Their drift is specified as being not more than 6 positions/sec.

Digital registers and flip-flops:

3.3. D-register

The D-register is a 10-bit register, that is used with each transfer of information from the CPU to the scope-logic. It is loaded from AC2-11 by the instructions (binary): "110 000 11x 1xx", i.e. by LDX, LDY, EXC, EXL and LDA.

3.4. AB, PT flip-flops

The AB and PT flip-flops determine the mode of operation of the scope:

PT	AB	
0	0	: incremental vector mode
0	1	: absolute vector mode
1	0	: point mode
1	1	: cursor mode

The PT flip-flop is loaded from AC2 by the instructions (binary): "110 000 110 x1x", i.e. by SAC, LDF, EXC and EXL. The AB flip-flop is loaded from AC3 by the same instructions.

3.5. L/S, VC flip-flops

The L/S and VC flip-flops determine the timing of a vector (short vector 250 μs, long vector 4.05 ms, or vector continue). The L/S flip-flop is loaded by the binary instructions: "110 000 110 x1y" with the value: (¬AC4) & (y∨AC6). The VC flip-flop is loaded from AC7 by EXC and EXL. It is cleared by SAC and LDF.

4. The A/D conversion

To convert an analog value into a digital one, we have to compare repeatedly that analog value against a variable digital trial value; a skip-type instruction tells which one was the largest. The analog values that can be read out are: XINTH, YINTH, XSH, YSH, XCUR (the X coordinate of the cursor) and YCUR.

4.1. Instructions for A/D conversion

To compare an analog value with a digital one the following three actions are required:

- select analog source, i.e. specify which analog source value is to be converted,
- specify digital value,
- perform test.

These actions are performed resp. by the instructions SAC, LDA and SDA described below.

4.1.1. SAC

SAC (=6062) selects the analog source to be tested according to bits 2,3 and 6 of the AC.

AC2	AC3	AC6	source
0	0	0	XINTH
0	0	1	YINTH
0	1	0	XINTH
0	1	1	YINTH
1	0	0	XSH

1	0	1	YSH
1	1	0	XCUR
1	1	1	YCUR

Also SAC performs a LDF, i.e. loads PT and AB with AC2 resp. AC3.

Remark: In addition to SAC the analog source is (re)selected by the instructions LDF, EXC and EXL, i.e. by "110 000 110 x1y" according to the bits 2,3 and 6 of the AC:

```
register pair:  if AC2 = 0
                   then INTH
                   else  if AC3 = 0
                            then SH
                            else CUR;

coordinate:     if y = 0 ∧ AC6 = 0
                   then X
                   else Y;
```

In other words: EXC acts like SAC, but LDF and EXL always select the Y-source.

4.1.2. LDA

LDA (=6074) loads the D register from AC2 - 11; this value will be converted to a voltage and tested against the selected source. Since this conversion takes some time, you have to wait some time, e.g. 50 µs, before executing the SDA instruction, but there is no flag indicating that the conversion has been completed.

Remarks:

The following sequence of instructions has the same effect (as LDA):

```
LDX          / load X
SRF          / wait for flag
JMP .-1
```

In this case we wait about twice as long as necessary, however.

- DEC specifies a delay of 50 µs after LDA, before executing SDA. We found, however, that a delay of 18 µs is sufficient on each of the KV8/I's available to us (on one of them even 1.5 µs was

enough). In the routine of 4.2 this means that the instruction CLA CLL CML can be replaced by CLA CLL IAC RTL, reducing the execution time to about 0.5 ms.

4.1.3. SDA

Finally the instruction SDA (=6073) actually performs the test. It skips when the digital trial value was too large. Note that AC2 is a sign bit, i.e. 1000 < 1777 < 0000 < 0777.

4.2. A/D conversion routine

```
/DEC-08-FISA-PA(L)
/KV ANALOG TO DIGITAL CONVERSION SUBROUTINE
/CALL AS JMS ADCONV WITH SOURCE SELECTION CODE IN AC:
/0000 OR 0400 FOR X INTEGRATOR
/0040 OR 0440 FOR Y INTEGRATOR
/1000 FOR X SAMPLE AND HOLD REGISTER
/1040 FOR Y SAMPLE AND HOLD REGISTER
/1400 FOR X CURSOR
/1440 FOR Y CURSOR
/EXITS WITH FULL 2'S COMPLEMENT ANS IN AC
/REQUIRES 25 CONSECUTIVE IN PAGE REGISTERS (DECIMAL)
/APPROXIMATE 900 US TO COMPLETE THE CONVERSION WORST CASE

ADCONV,         0
        SAC
        CLA CLL CML RTR          /2000 IN AC
        DCA     TEST     /INITIALIZE TRIAL BIT REGISTER
        TAD     K7000    /INITIALIZE PARTIAL CONVERSION REGISTER
RC1,    DCA     TEMP     /SAVE PARTIAL CONVERSION
        TAD     TEST
        CLL RAR
        DCA     TEST     /ADVANCE TRIAL BIT
        TAD     TEMP
        SZL
        JMP I   ADCONV   /EXIT WHEN TRIAL BIT OVERFLOWS LINK
        TAD     TEST
        LDA
        CLA CLL CML
        RAR
        SNL
        JMP     .-2      /WAIT 54 US
K7000,  NOP
        TAD     TEMP
        SDA
        TAD     TEST     /SKIPPED IF TRIAL TOO LARGE
        JMP     RC1      /CONTINUE
TEMP,   7000             /PARTIAL CONVERSION
TEST,   2000             /TRIAL BIT
$
```

5. The instructions

octal value	mnemonic	description
5.1. device number 05		
6050	-	No operation, i.e. delay of 4.25 µs
6051	SNC	Skip when cursor flag is low
6052	CCF	Clear cursor flag
6053	-	No operation
6064	-	No operation
6055	-	Identical with 6051
6056	-	Identical with 6052
6057	-	No operation
5.2. device number 06		
6060	-	No operation
6061	-	No operation
6062	SAC	Select analog comparator Select analog source according to AC2, AC3 and AC6. (4.1.1). Select mode of operation according to AC2 and AC3 (see LDF). Clear the Vector Continue (VC) flip-flop.
6063	LDF	Load Format Select the mode of operation (3.4) according to AC2 and AC3: AC2 AC3 0 0 incremental vector mode 0 1 absolute vector mode 1 0 point mode 1 1 cursor mode also the analog source is selected (see SAC 4.1.1). Clear the Vector Continue flip-flop.

If cursor mode is selected the cursor is displayed.

6064 LDX Load X

6065 LDY Load Y

effect:

- the ready flag is cleared
- AC2-11 is loaded into the D-register. This number is converted into a voltage V. Then XSH (resp. YSH) is loaded with:
  if AB = 0 then V else V-XINTH (resp. YINTH), provided that the mode is different from cursor mode.
- The ready flag is raised after 100 ± 30 µs (according to DEC) or 164 µs (on our installation).

6066 EXC Execute

6067 EXL Execute long

effect:

- The ready flag is cleared
- AC2-11 is loaded into the D-register. These bits determine the function to be executed:
  AC2 & AC3 select the mode of operation (see LDF and 3.4) and AC2, AC3 and AC6 select the analog source (see SAC 4.1.1).
  AC4 & AC6 select the value for the L/S flip-flop:
  EXC: L/S is cleared unless AC4 = 0 and AC6 = 1 and set otherwise.
  EXL: L/S is set unless AC4 = 1 and cleared otherwise.
  AC5 has no significance

AC7 is loaded into VC. When VC = 1 the stroke timer (ST) is disabled and the function is executed continually.

if AC9 = 1 the display is erased. The RF is set after 0.5 ± 0.1 sec.

if AC10 = 1 the analog registers XSH, YSH, XINTH and YINTH are reset to zero. The reset holds on for the duration of the ST or VC.

If in cursor mode, the cursor is displayed. (visible as a small non-stored ellipse, independent of AC11).

If in point mode, a point is drawn at the (XSH,YSH) position; AC11 determines its visibility. XSH, YSH, XINTH and YINTH are not changed. {The use of invisible points is not very clear.}

If in vector mode, a vector is drawn beginning at (XINTH,YINTH).

If AC11 = 1 it will be visible else invisible.

If AC8 = 1 it will be a circular vector with centre (XSH,YSH) else it will be a linear vector going to (XINTH+XSH,YINTH+YSH).

If L/S = 1 it will be long, otherwise short. The timing is set by ST (Stroke Timer) and is 250 ± 5 µs for short vectors and 4.05 ms for long vectors. (Long vector timing lasts exactly 2700 machine

cycles of 1.5 µs each; short vector timing is 1/16th of this.)

- The ready flag is set after:
  0.5 ± 0.1 sec if AC9 = 1 (erase).
  25 ± 5 µs if AC2 + AC7 ≥ 1 (point mode, cursor mode or continuous mode).
  275 ± 5 µs if L/S = 0 (short vector).
  4.08 ms if L/S = 1 (long vector).
  (First the Execute Delay Timer (XDT, 24 ± 5 µs) is activated. Then if in vector mode, the ST is activated unless it is disabled by VC.)

Remarks:

- The ERASE - button.
  Pushing the ERASE-button on the panel at the right-hand side of the scope has the following effect:
  - The display is erased, provided that the previous time it was erased (either by hand or by the program) was at least ca. 0.4 sec. earlier.
  - When ready, the RF is set.

  Note:
  RF is not cleared by pushing the ERASE-button. If the scope was executing another operation while the ERASE-button was pushed, or initiated a new operation thereafter, RF will be set when the erase is completed (not sooner or later).

- EXC and EXL never change XSH and YSH unless AC10 = 1 (reset). ERASE (both manual and by program) does not change XSH, YSH, XINTH and YINTH. During the drawing of a vector XINTH and YINTH always point to the position where the beam is writing.

- A long vector should be drawn if the coordinate distance is more than 40_8 = 32 positions; when short vectors are drawn over long distances they do not remain visible, i.e. they are only visible at the moment they are drawn. Also long vectors should not be longer than 1000_8 = 512

positions, and not too short, since in the latter case the line becomes awfully thick. However, if the vector is drawn invisible, then it is advisable to use two short vectors with the same (!) destination instead of one long vector. [One vector (short or long) will generally not reach its destination; but we found that two short vectors suffice. Moreover, two short vectors take less time to draw than one long vector].

- When a circular vector is drawn, the angular velocity is 1 degree/45 μs.

5.3. device number 07

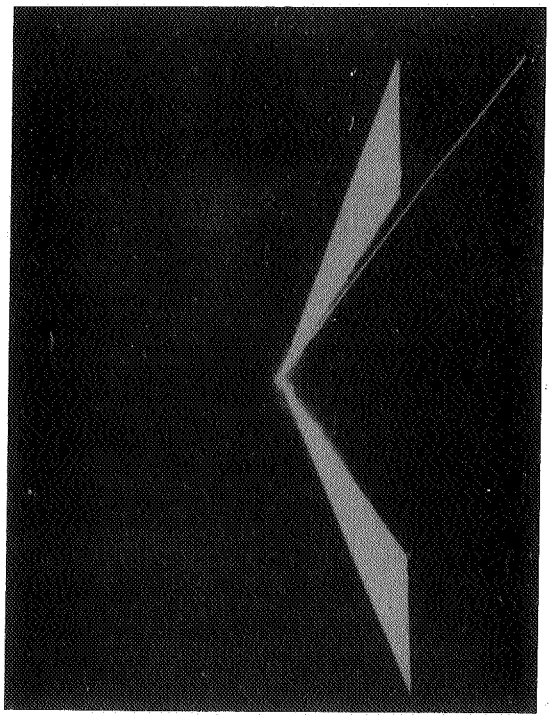
6070	-	No operation
6071	SRF	Skip on ready flag high
6072	CRF	Clear ready flag
6073	SDA	Skip if digital value larger than analog source
6074	LDA	Load digital to analog converter (see 4.1.2)
6075	-	SRF LDA
6076	-	CRF LDA
6077	-	SDA LDA

6. Examples

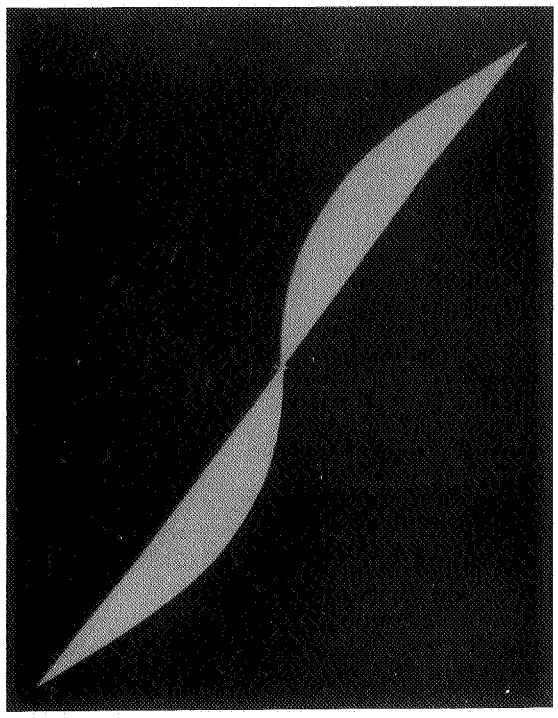
6.1. The program

```
        TAD     (400
        LDF             /ABSOLUTE
AGAIN,  CLA
        LDX             /XSH:=-XINTH
        WAIT
        LDY             /YSH:=-YINTH (=+OR- YO)
        WAIT
        TAD     (441    /LONG VISIBLE ABSOLUTE STRAIGHT LINE
        EXC             /TO THE ORIGIN
        WAIT
I1,     TAD     (200
I2,     LDX
I3,     WAIT
        TAD     (441
        EXC             /TO (200 ,+OR-YO)
        WAIT
        JMP     AGAIN
WAIT=JMS .
0;SRF;JMP .-1;CLA;JMP I  .-4
$
```

will draw the following figure:



i.e. a pair of lines symmetric w.r.t. the X-axis, approaching each other (because of the drift of the YSH).



Likewise, when the instructions labeled I1, I2, I3 are removed the figure at the left is drawn.

6.2. The program

```
START,  CLA CLL CML IAC RTL
        EXC
        WAITSC
        TAD     (-1000
        DCA     CX
LOOP0,  TAD     (-1000
        DCA     CY
        ISZ     CX
        SKP
        JMP     RDY
LOOP,   TAD     CX
        TAD     (400
        LDX
        WAITSC
        ISZ     CY
        SKP
        JMP     LOOP0
        TAD     CY
        TAD     (400
        LDY
        WAITSC
        TAD     (1001
        EXC
        WAITSC
        JMP     LOOP
RDY,    CLA
        JMP I   (7600
CX,     0
CY,     0
WAITSC=JMS I    [.
0;SRF;JMP .-1;CRF;CLA;JMP I .-5
$
```

fills a large square with points. The reader is invited to execute this program and examine its results closely. We found the lines X = 0 and Y = 0 missing, this phenomenon being more clearly visible on some installations than on others. (When you see a massive square, retry with lower intensity.)

6.3. The execution of one of the instructions LDX, LDY and LDA while a Vector Continue operation is being done, or the execution of a scope IOT while the RF cleared by the previous operation is still down, can give all kinds of peculiar effects and should therefore be avoided in general.

However, one useful application is the sequence

```
TAD   X
LDX                 / load X
CLA  STL
RAR
SNA
JMP  .-2            / wait a short time
TAD   Y
LDY
```

```
        SRF
        JMP  .-1        / wait the usual time
        TAD  FORMAT
        EXC
```

This loads X and Y correctly and reduces the execution time with about 0.1 ms, that is, with up to 30%.

6.4. The angular velocity of a circular vector

Independent of the radius, a circular vector is drawn at a rate of 1° per 45 μs. This implies:

1. To draw an arc of N degrees, set CNT to $-10_{10} * N$;
   start the arc with
   ```
   TAD [31; EXC; SRF; JMP .-1;
   ```
   and wait with
   ```
   ISZ CNT; JMP .-1; LDF; CLA.
   ```
   (Remember that LDF stops Vector Continue.)
2. ```
   TAD [51; EXC; SRF; JMP .-1
   ```
   gives an arc of exactly 90° since long vector timing is 90 * 45 μs = = 4.05 ms.
3. ```
   TAD [11; EXC; SRF; JMP .-1
   ```
   gives an arc of $5\frac{5}{8}$ degrees.

6.5. List of useful codes

For some codes COD the effect of TAD COD; EXC is listed.

code	effect
0	invisible short incremental vector
1	visible short incremental vector
401	visible short absolute vector
441	visible long absolute vector
2	reset
4	erase
6	erase and reset
26	erase; continuous reset
42	reset for 4 ms

1001	visible point
11	$5\frac{5}{8}^{\circ}$ arc
51	90° arc
31	start circular arc (clockwise)
1400	display cursor
1422	reset; display cursor

7. PRFIG

```
                /PRFIG
                /PRFIG DISPLAYS A FIGURE COMPOSED OF (IN)VISIBLE INCREMENTAL
                /VECTORS. EACH VECTOR CAN BE DRAWN IN ONE OF THE FOLLOWING DIRECTIONS:
                /0:     0,DX
                /1:     DX,DX
                /2:     DX,0
                /3:     DX,-DX
                /4:     0,-DX
                /5:     -DX,-DX
                /6:     -DX,0
                /7:     -DX,DX
                /CALLING SEQUENCE:
                /       JMS PRFIG
                /       ARG1
                /       ARG2
                /        .
                /        .
                /       ARGN
                /ARG1 CONTAINS THE NEGATIVE VALUE OF THE NUMBER OF VECTORS TO BE DRAWN,
                /THE OTHER CONTAINS THE CODE OF THE VECTORS.
                /THREE VECTORS ARE CODED IN ONE ARGUMENT, ARG[3:5],ARG[6:8] AND
                /ARG[9:11] DETERMINE THE DIRECTION OF THE VECTORS. STROKE I (0'LE'I'LE'
                /2) IS VISIBLE IFF ARG[I]=1.

0200  0000  PRFIG,  0
0201  7440          SZA
0202  3310          DCA     DX
0203  6214          RDF
0204  1377          TAD     (CDF CIF
0205  3235          DCA     EXFIG   /PREPARE A PROPER RETURN
0206  1600          TAD I   PRFIG
0207  3240          DCA     CTR     /COUNTS VECTORS
0210  7346  LPFIG,  CLA CLL CMA RTL /AC:=-3
0211  3241          DCA     CTR1    /COUNTS THE STROKES
0212  2200          ISZ     PRFIG   /SELECT NEXT PARAMETER
0213  1600          TAD I   PRFIG
0214  0376          AND     (7000
0215  3242          DCA     VIS     /VISIBILITY BITS
0216  1600          TAD I   PRFIG
0217  3243          DCA     ARG     /TAKE ARGUMENT
0220  1243  AGFIG,  TAD     ARG
0221  7104          CLL RAL         /SELECT
0222  7006          RTL             /NEXT STROKE
0223  3243          DCA     ARG
0224  1243          TAD     ARG
0225  0376          AND     (7000   /ISOLATE DIRECTION CODE
0226  4244          JMS     STROKE  /DRAW THE VECTOR
0227  2240          ISZ     CTR     /ALL VECTORS DONE?
```

```
 50   0230  7410          SKP
 51   0231  5235          JMP     EXFIG   /YES
 52   0232  2241          ISZ     CTR1    /SELECT NEXT ARGUMENT?
 53   0233  5220          JMP     AGFIG   /NO
 54   0234  5210          JMP     LPFIG   /YES
 55   0235  6203  EXFIG,  CDF CIF
 56   0236  2200          ISZ     PRFIG
 57   0237  5600          JMP I   PRFIG
 58
 59                 /COUNTERS
 60   0240  0000  CTR,    0
 61   0241  0000  CTR1,   0
 62
 63   0242  0000  VIS,    0
 64   0243  0000  ARG,    0
 65
 66                 /THE ROUTINE STROKE COMPUTES THE DESTINATION COORDINATES AND DISPLAYS
 67                 /THE VECTOR. THE VECTOR IS DRAWN VISIBLE IFF VIS[0] IS 1.
 68                 / AC[0:2] DETERMINE THE DIRECTION OF THE STROKE.
 69
 70   0244  0000  STROKE, 0
 71   0245  3275          DCA     A       /DIRECTION CODE
 72   0246  4311          JMS     WAITSC  /WAIT FOR FLAG
 73   0247  6063          LDF
 74   0250  7332          CLA CLL CML RTR /2000
 75   0251  4300          JMS     DECOD   /AC BECOMES 0,-DX OR DX
 76   0252  3277          DCA     Y0      /Y-COORDINATE OF THE DESTINATION POINT
 77   0253  4300          JMS     DECOD   /AC BECOMES 0,-DX OR DX
 78   0254  3276          DCA     X0      /X-COORDINATE OF THE DESTINATION POINT
 79   0255  1276          TAD     X0
 80   0256  6064          LDX             /LOAD X COORDINATE
 81   0257  7320          CLA CLL CML
 82   0260  7004          RAL
 83   0261  7420          SNL
 84   0262  5260          JMP     .-2     /WAIT A MOMENT
 85   0263  1277          TAD     Y0
 86   0264  6065          LDY             /LOAD Y COORDINATE
 87   0265  4311          JMS     WAITSC  /WAIT FOR FLAG
 88   0266  1242          TAD     VIS
 89   0267  7104          CLL RAL
 90   0270  3242          DCA     VIS     /UPDATE VIS
 91   0271  7004          RAL             /ROTATE BIT INTO THE AC
 92   0272  6066          EXC             /EXECUTE SHORT INCREMENTAL VECTOR
 93   0273  7300          CLA CLL
 94   0274  5644          JMP I   STROKE
 95
 96   0275  0000  A,       0
 97   0276  0000  X0,      0
 98   0277  0000  Y0,      0
 99
100                 /DECOD IS USED TO COMPUTE THE PROPER RELATIVE COORDINATES FROM
101                 /THE DIRECTION CODE OF STROKE(WHICH IS CONTAINED IN A).
102                 /INPUT-OUTPUT BEHAVIOUR:
103                 /AC[0:2]+A      AC
104                 /0000            0
105                 /1000            DX
106                 /2000            DX
107                 /3000            DX
108                 /4000            0
109                 /5000           -DX
110                 /6000           -DX
111                 /7000           -DX
112
113   0300  0000  DECOD,  0
114   0301  1275          TAD     A
115   0302  7104          CLL RAL
116   0303  7640          SZA CLA
117   0304  1310          TAD     DX
118   0305  7430          SZL
119   0306  7041          CIA
```

```
 120   0307  5700          JMP I   DECOD
 121
 122                 /PARAMETER DECOD,STROKE,PRFIG
 123   0310  0000    DX,     0
 124
 125   0311  0000    WAITSC, 0
 126   0312  7200            CLA
 127   0313  6071            SRF
 128   0314  5313            JMP     .-1
 129                         /CRF
 130   0315  5711            JMP I   WAITSC
 131
 132                 /SETPNT DEFINES THE X,Y INTH REGISTERS BY DRAWING A SHORT INVISIBLE
 133                 /ABSOLUTE VECTOR TO THE POINT (C0,C1). WHEN THE LENGTH OF THE
 134                 /VECTOR IS GREATER THAN 40 THE ROUTINE SHOULD BE CALLED TWICE.
 135                 /THIS IS FASTER AND MORE ACCURATE THAN DRAWING ONE INVISIBLE
 136                 /LONG VECTOR.
 137
 138   0316  0000    SETPNT, 0
 139   0317  4311            JMS     WAITSC  /WAIT FOR FLAG
 140   0320  1375            TAD     (400    /ABSOLUTE
 141   0321  6063            LDF
 142   0322  7200            CLA
 143   0323  1337            TAD     C0
 144   0324  6064            LDX             /LOAD X COORDINATE
 145   0325  7201            CLA IAC
 146   0326  7004            RAL
 147   0327  7420            SNL
 148   0330  5326            JMP     .-2     /WAIT A MOMENT
 149   0331  7104            CLL RAL         /CLEAR AC,BUT SAVE THE LINK
 150   0332  1340            TAD     C1
 151   0333  6065            LDY             /LOAD Y COORDINATE
 152   0334  4311            JMS     WAITSC  /WAIT FOR FLAG
 153   0335  6066            EXC             /EXECUTE
 154   0336  5716            JMP I   SETPNT
 155
 156                 /PARAMETERS SETPNT
 157   0337  0000    C0,     0
 158   0340  0000    C1,     0
 159   0375  0400
 160   0376  7000
 161   0377  6203
 162                 $$
 163
A       0275    AGFIG   0220    ARG     0243    CTR     0240    CTR1    0241
C0      0337    C1      0340    DECOD   0300    DX      0310    EXFIG   0235
LPFIG   0210    PRFIG   0200    SETPNT  0316    STROKE  0244    VIS     0242
WAITSC  0311    X0      0276    Y0      0277


A           71    96#   114
AGFIG       42#   53
ARG         41    42    45    46    64#
CTR         33    49    60#
CTR1        35    52    61#
C0         143   157#
C1         150   158#
DECOD       75    77   113#  120
DX          28   117   123#
EXC         92   153
EXFIG       31    51    55#
LDF         73   141
LDX         80   144
LDY         86   151
LPFIG       34#   54
PRFIG       26#   32    36    37    40    56    57
```

```
SETPNT      138#  154
SRF         127
STROKE       48    70#   94
VIS          39    63#   88    90
WAITSC       72    87   125#  130   139   152
X0           78    79    97#
Y0           76    85    98#
°L0375      140
°L0376       38    47
°L0377       30
```

8. Character generators

8.1. A two-page character generator

```
 2                /PS/8 HANDLER FOR KV8/I COMPUTER DISPLAY.
 3                /USES TWO PAGES OF CORE AND DISPLAYS THE COMPLETE
 4                /ASCII CHARACTER SET.(SORRY THAT BACK ARROW,↑ AND
 5                /SQUARE BRACKETS ARE BAD).
 6                /WRITTEN BY FLOOR ANTHONI, BIOMEDICAL LABS OF THE
 7                /NATIONAL RESEARCH ORGANISATION, TNO, RYSWYK, HOLLAND.
 8                /MODIFIED BY AEB, MC, AMSTERDAM
 9
10                *5600
11                /THIS PAGE CONSISTS OF A NORMAL PS8 HANDLER ENTRY
12
13   5600  0000  DPL,    0               /ENTRY POINT
14   5601  7200          CLA             /JUST TO BE SURE
15   5602  5245          JMP DPLTEM      /BECOMES 0 AFTER THE FIRST TIME
16   5603  6214          RDF             /PICK UP THE RETURN FIELD.
17   5604  1256          TAD DPLCIF      /+6203
18   5605  3242          DCA DPLXIT      /CREATE RETURN
19   5606  1600          TAD I DPL       /FIELD OF BUFFER
20   5607  0276          AND C70
21   5610  1256          TAD DPLCIF      /+6203
22   5611  3254          DCA DPLCDF
23   5612  7330          CLA CLL CML RAR /AC=4000
24   5613  1600          TAD I DPL       /CHECK FOR READ OR WRITE
25   5614  2200          ISZ DPL
26   5615  0320          AND C7700       /NO. OF PAGES TO WRITE
27   5616  7550          SPA SNA         /READ IS BAD, NUMB OF PAGES
28   5617  5240          JMP DPLERR      /MUST BE >0
29   5620  7041          CIA
30   5621  3250          DCA DPLWC       /WORDCOUNT =DOUBLE PAGES
31   5622  1600          TAD I DPL       /GET BUFFER ADDRESS
32   5623  2200          ISZ DPL         /FOR CORRECT RETURN
33   5624  3247          DCA DPLCA       /AND USE AS ADDRESS POINTER
34
35
36                /HERE COMES THE PROGRAM MAIN FRAME:UNPACK THE CHARS
37                /FROM THE BUFFER AND DISPLAY THEM.
38
39   5625  4253  DPLGET, JMS GETBUF      /PICK UP A CHAR
40   5626  3246          DCA DPLTM
41   5627  4253          JMS GETBUF      /NEXT CHARACTER
42   5630  7112          CLL RTR
43   5631  7012          RTR
44   5632  1246          TAD DPLTM       /+4 M.S.BITS
45   5633  7012          RTR
46   5634  7012          RTR
47   5635  4644          JMS I DISP      /AND DISPLAY
48   5636  2250          ISZ DPLWC       /WORDCOUNT OVERFLOW?
49   5637  5225          JMP DPLGET      /NOT YET
```

```
 50   5640  2200  DPLERR, ISZ DPL          /IN CASE OF ERROR AC<0=HARD ERR.
 51   5641  2200          ISZ DPL
 52   5642  7402  DPLXIT, HLT              /CDF CIF TO RETURN FIELD
 53   5643  5600          JMP I DPL
 54                /IN THE FOLLOWING LOCATIONS A ONCE ONLY CODE FIXES
 55                /THE INDIRECT ADDRESSES USED IN THIS PROGRAM,
 56                /FOR RELOCATABILITY.
 57
 58   5644  0132  DISP,   DPLDIS-DPLTEM-1 /BECOMES POINTER TO DPLDIS
 59   5645  4245  DPLTEM, JMS .
 60   5646  1244  DPLTM,  TAD DISP
 61   5647  1245  DPLCA,  TAD DPLTEM
 62   5650  3244  DPLWC,  DCA DISP
 63   5651  0002          2                /DISPLAYWORD FOR TAB(=SPACE)
 64   5652  3202          DCA DPL+2        /CLEAR THE JUMP
 65   5653  4644  GETBUF, JMS I DISP       /WAIT FOR ERASE THE FIRST TIME
 66   5654  5203  DPLCDF, JMP DPL+3        /POINTS TO FIELD OF BUF
 67   5655  1647          TAD I DPLCA
 68   5656  6203  DPLCIF, CDF CIF 0                /HANDLERS ALWAYS IN FIELD 0
 69   5657  2247          ISZ DPLCA
 70   5660  3245          DCA DPLTEM
 71   5661  1245          TAD DPLTEM
 72   5662  4644          JMS I   DISP     /INTERRUPTS WERE INHIBITED FOR 19.5 US
 73   5663  1245  GET3,   TAD     DPLTEM
 74   5664  0357          AND     C7400
 75   5665  6031          KSF
 76   5666  5653          JMP I GETBUF
 77   5667  7200          CLA
 78                /↓N MEANS: SKIP THIS BUFFER
 79                /ANY OTHER CHAR: SKIP ALL REMAINING BUFFERS
 80   5670  6034          KRS
 81   5671  1275          TAD     DPLGO
 82   5672  7650          SNA CLA
 83   5673  6032          KCC
 84   5674  5240          JMP DPLERR       /NORMAL RETURN
 85
 86   5675  7562  DPLGO,  -216
 87   5676  0070  C70,    70
 88                *DPL+100
 89                /HERE COMES THE LIST WITH DISPLAYWORDS
 90                /ONE FOR EACH CHARACTER. THE TWO LS.BITS CODE FOR
 91                /THE MASK TO TAKE.
 92                LISTC=.
 93   5700  0002          0002             /SPACE
 94   5701  2403          2403             /°
 95   5702  0123          0123             /"
 96   5703  5071          5071             /#
 97   5704  5355          5355             /$
 98   5705  6145          6145             /↑
 99   5706  3171          3171             /^
100   5707  0023          0023             /'
101   5710  0110          0110             /(
102   5711  0204          0204             /)
103   5712  0374          0374             /*
104   5713  5001          5001             /+
105   5714  6003          6003             /,
106   5715  1001          1001             /-
107   5716  2003          2003             /.
108   5717  0300          0300             //
109   5720  7700  C7700,   7700             /0,ALSO USEFUL CONSTANT
110   5721  6011          6011             /1
111   5722  1731          1731             /2
112   5723  1715          1715             /3
113   5724  3405          3405             /4
114   5725  3215          3215             /5
115   5726  1375          1375             /6
```

```
116   5727  2300          2300            /7
117   5730  1775          1775            /8
118   5731  1755          1755            /9
119   5732  2203          2203            /:
120   5733  4203          4203            /;
121   5734  0700          0700            /<
122   5735  1011          1011            /=
123   5736  0414          0414            />
124   5737  1563          1563            /?
125   5740  3771          3771            /°
126   5741  3625          3625            /A
127   5742  3175          3175            /B
128   5743  0371          0371            /C
129   5744  7602          7602            /D
130   5745  1371          1371            /E
131   5746  1361          1361            /F
132   5747  1762          1762            /G
133   5750  1465          1465            /H
134   5751  4311          4311            /I
135   5752  7202          7202            /J
136   5753  4060          4060            /K
137   5754  0071          0071            /L
138   5755  5104          5104            /M
139   5756  5014          5014            /N
140   5757  7400  C7400,  7400            /O,ALSO USEFUL CONSTANT
141   5760  1761          1761            /P
142   5761  7410          7410            /Q
143   5762  3436          3436            /R
144   5763  1355          1355            /S
145   5764  4301          4301            /T
146   5765  0475          0475            /U
147   5766  4300          4300            /V
148   5767  5210          5210            /W
149   5770  0314          0314            /X
150   5771  0304          0304            /Y
151   5772  2700          2700            /Z
152   5773  0161          0161            /[
153   5774  0014          0014            /BACKSLASH
154   5775  0605          0605            /]
155   5776  1467          1467            /↑
156   5777  0170          0170            /BACK ARROW
157               /THIS IS THE ACTUAL DISPLAY ROUTINE WHICH CHECKS FOR
158               /SPECIAL CHARACTERS, IGNORES NOTHING FOR HONEST DISPLAY
159               /(CONTROL CHARS WILL BE VISUALISED), CREATES AN INTEN-
160               /SIFY WORD AND SEARCHES THE MASKS. IT THEN HAPPENS
161               /TO DISPLAY THE CHARACTER.
162
163   6000  0000  DPLDIS, 0               /ENTER WITH CHAR IN AC, 8 BIT
164   6001  5301         JMP SAVE1        /FIRST TIME ONLY CODE,BECOMES AND 377
165   6002  7450         SNA              /IGNORE BLANKS
166   6003  5600         JMP I DPLDIS
167   6004  1347         TAD M215
168   6005  7450         SNA              /CR?
169   6006  5324         JMP CR           /YES
170   6007  7001         IAC              /CTRL FORM?
171   6010  7450         SNA
172   6011  5336         JMP FORM         /YES
173   6012  1237         TAD C2           /LINEFEED?
174   6013  7450         SNA
175   6014  5327         JMP LF           /YES
176   6015  1350         TAD BASE1        /CREATE POINTER
177   6016  3302         DCA SAVE2        /SAVE2 POINTS TO DISPLWORD OF THIS
178   6017  1702         TAD I SAVE2      /MAKE 1 BLANK START VECTOR BIT
179   6020  7110         CLL RAR
180   6021  3301  DPL6,  DCA SAVE1        /SAVE CONTAINS 11 INTENSIFY BITS AND
181   6022  7325         CLA CLL CML IAC RAL     /AC=3 MASK
182   6023  0702         AND I SAVE2      /CHAR. PICK IT UP
183   6024  7106         RTL CLL          /MULTIPLY BY 8
```

```
184   6025  7004            RAL
185   6026  1367            TAD BASE2         /CREATE POINTER TO MASKWORD
186   6027  3240            DCA DPLINS        /POINTS TO MASKWORD
187                                           /ONE GARBAGE BIT
188
189
190   6030  1357  DPL1,     TAD M13           /COUNTS 5 AND A HALF MASK WORDS
191   6031  3303            DCA COUNT
192   6032  1303  DPL2,     TAD COUNT         /WHICH HALF?
193   6033  7010            RAR               /ODD=RIGHT;EVEN=LEFT
194   6034  7620            SNL CLA
195   6035  5274            JMP DPL4          /LEFT HALF
196   6036  7410            SKP
197   6037  0002  C2,       2                 /DISPLAYWORD FOR RUBOUT (=SPACE)
198   6040  1341  DPLINS,   TAD MASK0         /INDEXED INSTRUCTION
199   6041  2240            ISZ     DPLINS
200   6042  3302  DPL3,     DCA SAVE2         /CONTAINS Y1,X1,Y0,X0
201                           /TAD    SAVE1
202                           /RAL
203                           /SPA SZL
204                           /JMP    .+3
205                           /DCA    SAVE1
206                           /JMP    DPLNOT
207   6043  1302            TAD SAVE2         /GET DELTA-X
208   6044  0360            AND C7
209   6045  1304            TAD X
210   6046  6064            LDX;WAIT
211   6047  4306
212   6050  1302            TAD SAVE2         /GET DELTA-Y
213   6051  7010            RAR
214   6052  7012            RTR
215   6053  0360            AND C7
216   6054  1305            TAD Y
217   6055  6065            LDY;WAIT
218   6056  4306
219   6057  1301            TAD SAVE1         /GET THE INTENSIFYWORD
220   6060  7104            CLL RAL           /SEPARATE NEXT BIT
221   6061  3301            DCA SAVE1
222   6062  7004            RAL               /AC=0 OR 1 (1=INTENS.BIT)
223   6063  1355            TAD C400          /SHORT VECTOR CODE
224   6064  6066            EXC;WAIT
225   6065  4306
226   6066  2303  DPLNOT,   ISZ COUNT         /ALL ELEVEN VECTORS DONE?
227   6067  5232            JMP DPL2          /NOT YET
228   6070  1360            TAD C7            /YES, MOVE X RIGHT ONE POSITION
229   6071  1304  DPL7,     TAD X
230   6072  3304            DCA X
231   6073  5600            JMP I DPLDIS      /RETURN
232
233   6074  1302  DPL4,     TAD SAVE2         /FOR LEFT HALF
234   6075  7012            RTR
235   6076  7012            RTR
236   6077  7012            RTR
237   6100  5242            JMP DPL3
238               /ONCE ONLY CODE FOR RELOCATABILITY
239
240   6101  1200  SAVE1,    TAD DPLDIS
241   6102  1350  SAVE2,    TAD BASE1
242   6103  3350  COUNT,    DCA BASE1
243   6104  1377  X,        TAD C377
244   6105  3201  Y,        DCA DPLDIS+1
245   6106  5317            JMP FORM2         /LOAD X,LOAD Y, DO VECTOR
246
247               WAIT=JMS .-1
248   6107  6071            SRF
249   6110  5307            JMP     .-1
```

```
250   6111  6072          CRF
251   6112  7200          CLA
252   6113  5706          JMP I   .-5
253
254                 /SPECIAL CHARACTERS HANDLER
255
256   6114  6031  KBTST,  KSF
257   6115  5336          JMP     FORM
258                       /KRS
259                       /TAD MCTN
260                       /SZA CLA
261   6116  5600          JMP I   DPLDIS
262                       /KCC
263   6117  7327  FORM2,  CLA CLL CML IAC RTL     /AC=6=ERASE CODE
264   6120  6066          EXC;WAIT          /ERASE
265   6121  4306
266   6122  1356  NEWP,   TAD TOP           /MOVE Y TO TOP
267   6123  3305          DCA Y
268   6124  1346  CR,     TAD LEFT          /MOVE X TO LEFT
269   6125  3304          DCA X
270   6126  5221          JMP DPL6          /DO A DUMMY SPACE BY CLEARING THE
271                                         /INTENSIFY WORD AND DOING A WILD SET
272                                         /OF MASKS.
273   6127  1357  LF,     TAD M13           /MOVE Y 1 LINE DOWN
274   6130  1305          TAD Y
275   6131  3305          DCA Y
276   6132  1305          TAD Y             /PAGE OVERFLOW?
277   6133  1356          TAD TOP           /SYMMETRIC PAGE
278   6134  7700          SMA CLA
279   6135  5600          JMP I   DPLDIS
280   6136  6071  FORM,   SRF
281   6137  5314          JMP     KBTST
282   6140  5322          JMP NEWP
283
284   6141  6000  MASK0,  6000
285   6142  0464          0464
286   6143  3200          3200
287   6144  3064          3064
288   6145  3204          3204
289   6146  7360  LEFT,   7360
290   6147  7763  M215,   -15
291   6150  7776  BASE1,  LISTC-DPLWC-32  /WILL POINT TO LISTC-26
292   6151  6202  MASK1,  6202
293   6152  3430          3430
294   6153  6264          6264
295   6154  3060          3060
296   6155  0400  C400,   0400            /ALSO USEFUL CONST.
297   6156  0534  TOP,    0534
298   6157  7765  M13,    -13
299   6160  0007  C7,     7
300   6161  3402  MASK2,  3402
301   6162  6064  C6064,  6064
302   6163  0200          0200
303   6164  3404          3404
304   6165  3032          3032
305   6166  0003  C3,     0003
306   6167  1341  BASE2,  TAD MASK0
307   6170  0177  C177,   177
308   6171  0213  MASK3,  0213
309   6172  2202          2202
310   6173  4242          4242
311   6174  6264          6264
312   6175  4440  SPACE,  4440
313   6176  7562  MCTN,   7562
314
315   6177  0370  C377,   AND C177
316               $
```

```
 317
BASE1   6150    BASE2   6167    COUNT   6103    CR      6124    C177    6170
C2      6037    C3      6166    C377    6177    C400    6155    C6064   6162
C7      6160    C70     5676    C7400   5757    C7700   5720    DISP    5644
DPL     5600    DPLCA   5647    DPLCDF  5654    DPLCIF  5656    DPLDIS  6000
DPLERR  5640    DPLGET  5625    DPLGO   5675    DPLINS  6040    DPLNOT  6066
DPLTEM  5645    DPLTM   5646    DPLWC   5650    DPLXIT  5642    DPL1    6030
DPL2    6032    DPL3    6042    DPL4    6074    DPL6    6021    DPL7    6071
FORM    6136    FORM2   6117    GETBUF  5653    GET3    5663    KBTST   6114
LEFT    6146    LF      6127    LISTC   5700    MASK0   6141    MASK1   6151
MASK2   6161    MASK3   6171    MCTN    6176    M13     6157    M215    6147
NEWP    6122    SAVE1   6101    SAVE2   6102    SPACE   6175    TOP     6156
WAIT    4306    X       6104    Y       6105


BASE1       176   241   242   291#
BASE2       185   306#
COUNT       191   192   226   242#
CR          169   268#
CRF         250
C177        307#  315
C2          173   197#
C3          305#
C377        243   315#
C400        223   296#
C6064       301#
C7          208   215   228   299#
C70          20    87#
C7400        74   140#
C7700        26   109#
DISP         47    58#   60    62    65    72
DPL          13#   19    24    25    31    32    50    51    53    64
             66    88
DPLCA        33    61#   67    69
DPLCDF       22    66#
DPLCIF       17    21    68#
DPLDIS       58   163#   166   231   240   244   261   279
DPLERR       28    50#   84
DPLGET       39#   49
DPLGO        81    86#
DPLINS      186   198#   199
DPLNOT      226#
DPLTEM       15    58    59#   61    70    71    73
DPLTM        40    44    60#
DPLWC        30    48    62#   291
DPLXIT       18    52#
DPL1        190#
DPL2        192#  227
DPL3        200#  237
DPL4        195   233#
DPL6        180#  270
DPL7        229#
EXC         224   264
FORM        172   257   280#
FORM2       245   263#
GETBUF       39    41    65#   76
GET3         73#
KBTST       256#  281
LDX         210
LDY         217
LEFT        268   289#
LF          175   273#
LISTC        92#  291
MASK0       198   284#  306
MASK1       292#
MASK2       300#
MASK3       308#
MCTN        313#
M13         190   273   298#
M215        167   290#
```

```
NEWP        266#  282
SAVE1       164   180   219   221   240#
SAVE2       177   178   182   200   207   212   233   241#
SPACE       312#
SRF         248   280
TOP         266   277   297#
WAIT        211   218   225   247#  265
X           209   229   230   243#  269
Y           216   244#  267   274   275   276
```

8.2. A three-page character generator

```
 1                  /VSCG
 2                  /VARIABLE STROKE CHARACTER GENERATOR.
 3                  /FROM: EDGRIN (MURRAY RUBEN, 1969)
 4                  /PB, MC, 310572
 5
 6                  LOCATE=1000      /ARBITRARY
 7
 8                  *LOCATE
 9
10   1000  0000    DSPY,    0       /CALL WITH ASCII CHAR IN AC
11   1001  4766             JMS I SRCHI      /SEARCH CHAR ?
12   1002  1765             TAD I SAVE2      /CHECK FOR CONTR CHAR
13   1003  1354             TAD M240
14   1004  7710             SPA CLA
15   1005  5600    DSPYI,   JMP I DSPY       /EXIT
16   1006  1765             TAD I SAVE2
17   1007  0361    OUTCHM,  AND C77 /MASK CHARACTER TO 6 BITS
18   1010  7104             CLL RAL /*2
19   1011  1370             TAD SAR1         /ADD DISPATCH
20   1012  3347             DCA A
21   1013  1747             TAD I A /THIS IS MASK WORD
22   1014  0357             AND C7  /MASK OFF MASK BITS
23   1015  7104             CLL RAL /*2
24   1016  3350             DCA B
25   1017  1350             TAD B
26   1020  7104             CLL RAL /*4
27   1021  1350             TAD B   /*6 NOW
28   1022  1371             TAD MASKS        /6 TIMES MASK + MASK HEAD POINTER
29   1023  3351             DCA C   /PTR FOR MASK ADDRESSES
30   1024  1747             TAD I A
31   1025  7110             CLL RAR
32   1026  3350             DCA B   /SETS INTENSIFY BLANKING BITS, FIRST ALWAYS BLANKED
33   1027  2347             ISZ A
34   1030  1747             TAD I A
35   1031  3347             DCA A   /RETRIEVE CONTROL WORD
36   1032  3352             DCA H   /SETS LEFT HALF
37   1033  1352    VA,      TAD H
38   1034  7041             CIA
39   1035  3352             DCA H   /RESET HALFWORD SWITCH
40   1036  2352             ISZ H
41   1037  2351             ISZ C   /ADVANCE PTR ON ZERO H
42   1040  1347             TAD A
43   1041  7440             SZA     /TEST NEXT CONTROL BIT
44   1042  5250             JMP .+6
45   1043  1360             TAD C10
46   1044  4767             JMS I SCALE
47   1045  1345             TAD X0
48   1046  3345             DCA X0  /CHAR ADVANCE
49   1047  5600             JMP I DSPY       /EXIT
```

```
 50   1050  7104           CLL RAL
 51   1051  3347           DCA A   /NEXT CONTROL BIT IN LINK
 52   1052  7420           SNL
 53   1053  5233           JMP VA  /NOT AN EXECUTION
 54   1054  1364           TAD C6064       /INITIALIZE VOUT
 55   1055  3315           DCA VSTATE
 56   1056  1352           TAD H   /0 IF RIGHT HALF, 1 IF LEFT HALF
 57   1057  7110           CLL RAR /INTO LINK
 58   1060  1751           TAD I C /GET MASK ADDRESS
 59   1061  7420           SNL
 60   1062  5266           JMP .+4 /R,H,
 61   1063  7112           CLL RTR
 62   1064  7012           RTR
 63   1065  7012           RTR     /L,H,
 64   1066  3765           DCA I SAVE2
 65   1067  1765           TAD I SAVE2
 66   1070  7012           RTR
 67   1071  7010           RAR
 68   1072  0357           AND C7
 69   1073  4767           JMS I SCALE
 70   1074  1345           TAD X0  /ADD X MASK TO CPR
 71   1075  4312           JMS VOUT        /LOAD X ABSOLUTE
 72   1076  1765           TAD I SAVE2
 73   1077  0357           AND C7
 74   1100  4767           JMS I SCALE
 75   1101  1346           TAD Y0  /ADD Y MASK TO CPR
 76   1102  4312           JMS VOUT        /LOAD Y ABSOLUTE
 77   1103  1350           TAD B
 78   1104  7104           CLL RAL
 79   1105  3350           DCA B   /RETRIEVE NEXT BLANKING BIT INTO LINK
 80   1106  7004           RAL     /AND THEN INTO BIT 11
 81   1107  1362           TAD CEX /EXECUTE ABSOLUTE (VISIBLE) VECTOR
 82   1110  4312           JMS VOUT
 83   1111  5233           JMP VA  /BACK FOR MORE VECTORS
 84
 85   1112  0000  VOUT,    0
 86   1113  6071           6071    /WAIT FOR READY FLAG
 87   1114  5313           JMP .-1
 88   1115  6064  VSTATE,  6064    /AUTO SEQUENCED INSTRUCTION
 89   1116  2315           ISZ VSTATE      /SEQUENCE
 90   1117  7200           CLA
 91   1120  5712           JMP I VOUT
 92   1121  1363  RESET,   TAD TOP /ERASE AND RESET INT & CPR
 93   1122  6066           6066    /EXECUTE
 94   1123  3346           DCA Y0  /SET Y TO TOP
 95   1124  1355  CRLF,    TAD M14
 96   1125  4767           JMS I SCALE
 97   1126  1346           TAD Y0
 98   1127  3346           DCA Y0
 99   1130  1353  CR,      TAD MARGIN
100   1131  3345           DCA X0
101   1132  1356  SYNC,    TAD M10 /"SYNCHRONIZE"
102   1133  4767           JMS I SCALE
103   1134  1345           TAD X0
104   1135  3345  XCUTE,   DCA X0
105   1136  1354           TAD M240
106   1137  5207           JMP OUTCHM
107   1140  1355  LF,      TAD M14
108   1141  4767           JMS I SCALE
109   1142  1346           TAD Y0
110   1143  3346           DCA Y0
111   1144  5332           JMP SYNC
112
113   1145  0000  X0,      0       /X CHARACTER POSITION
114   1146  0000  Y0,      0       /Y CHARACTER POSITION
```

```
115   1147  0000  A,       0          /CONTROL WORD
116   1150  0000  B,       0          /MASK WORD
117   1151  0000  C,       0          /MASK POINTER
118   1152  0000  H,       0          /HALFWORD SWITCH
119
120   1153  7360  MARGIN,  -420
121   1154  7540  M240,    -240
122   1155  7764  M14,     -14
123   1156  7770  M10,     -10
124   1157  0007  C7,      7
125   1160  0010  C10,     10
126   1161  0077  C77,     77
127   1162  0400  CEX,     400
128   1163  0506  TOP,     506
129   1164  6064  C6064,   6064
130   1165  1230  SAVE2,   SAVE1
131   1166  1231  SRCH!,   SEARCH
132   1167  1251  SCALE,   VSCALE
133   1170  1356  SAR1,    SAR
134   1171  1303  MASKS,   MASK0-1
135
136               DLIST=.  /TABLE OF ACTIVE CONTROL CHARACTERS
137   1172  0212           212
138   1173  1140           LF        /LINE FEED
139   1174  0215           215
140   1175  1130           CR        /CARRIAGE RETUREN
141   1176  0216           216
142   1177  1124           CRLF      /NLCR (CTRL/N)
143   1200  0213           213
144   1201  1121           RESET     /ERASE (CTRL/K)
145   1202  0377           377
146   1203  1005           DSPY!     /RUBOUT (IGNORED)
147   1204  0376           376
148   1205  1005           DSPY!     /ALTMODE (IGNORED)
149   1206  0211           211
150   1207  1265           TAB       /TAB
151   1210  0237           237
152   1211  1132           SYNC      /STABILIZE (CTRL/SHIFT/0)
153   1212  0221           221
154   1213  1263           SCALE1    /ENLARGE (CTRL/Q)
155   1214  0222           222
156   1215  1262           SCALE0    /RESET FORMAT (CTRL/R)
157
158   1216  0000           0         /ZERO ENDS THE LIST
159   1217  7360  M420,    -420
160   1220  7770  CM10,    -10
161   1221  0100  C100,    100
162   1222  1171  SRCH3,   DLIST-1
163   1223  1005  DSP,     DSPY!
164   1224  1145  VX0,     X0
165   1225  1135  EXCUTE,  XCUTE
166
167   1226  0001  SCF,     1
168   1227  0000  SCT,     0
169   1230  0000  SAVE1,   0
170
171   1231  0000  SEARCH,  0         /SEARCH ROUTINE.
172   1232  3230           DCA SAVE1         /SAVE THE INPUT ASCII CHARACTER
173   1233  1222           TAD SRCH3
174   1234  3341           DCA WSP
175   1235  2341  SRCH2,   ISZ WSP /FOLLOW ALONG DOWN THE CHARACTER TABLE.
176   1236  1741           TAD I WSP         /BRING IN A LIST ELEMENT
177   1237  7450           SNA
178   1240  5631           JMP I SEARCH      /END OF TABLE FOUND AND NO MATCH*
179   1241  7041           CIA      /COMPLEMENT TO TEST.
180   1242  2341           ISZ WSP
181   1243  1230           TAD SAVE1         /NOW TEST AGAINST THE "CHAR".
182   1244  7640           SZA CLA
183   1245  5235           JMP SRCH2         /NO MATCH FOUND SO TRY AGAIN*
184   1246  1741           TAD I WSP         /"MATCH FOUND" **
```

```
185   1247  3231          DCA SEARCH      /DO DOUBLE INDIRECT JUMP
186   1250  5631          JMP I SEARCH    /FROM DLIST POINTER
187
188   1251  0000  VSCALE, 0
189   1252  3227          DCA SCT
190   1253  1226          TAD SCF
191   1254  7041          CIA
192   1255  3341          DCA WSP
193   1256  1227          TAD SCT
194   1257  2341          ISZ WSP
195   1260  5256          JMP .-2
196   1261  5651          JMP I VSCALE
197
198   1262  3226  SCALE0, DCA SCF
199   1263  2226  SCALE1, ISZ SCF
200   1264  5623          JMP I DSP
201
202   1265  1220  TAB,    TAD CM10
203   1266  4251          JMS VSCALE
204   1267  1217          TAD M420
205   1270  3230          DCA SAVE1
206   1271  1221  TAB1,   TAD C100
207   1272  4251          JMS VSCALE
208   1273  1230          TAD SAVE1
209   1274  3230          DCA SAVE1
210   1275  1624          TAD I VX0
211   1276  7041          CIA
212   1277  1230          TAD SAVE1
213   1300  7710          SPA CLA
214   1301  5271          JMP TAB1
215   1302  1230          TAD SAVE1
216   1303  5625          JMP I EXCUTE
217
218               /THE FOLLOWING PARTS ARE THE CHARACTER TABLES FOR THE CHARACTER
219               /GENERATOR .
220
221               /CHARACTER MASK COORDINATES
222
223
224   1304  0301  MASK0,  0301    /D,J,5,^,↑,]
225   1305  2143  2143
226   1306  4145  4145
227   1307  2705  2705
228   1310  0747  0747
229   1311  0301  0301
230   1312  0701  MASK1,  0701    /L,U,V,W,X,Y,I,T,N,M,0,1,(,),[
231   1313  0706  0706
232   1314  2447  2447
233   1315  2724  2724
234   1316  2141  2141
235   1317  0147  0147
236   1320  0141  MASK2,  0141    /2,S,4,9,7,Z,$,/,\,<,>
237   1321  0747  0747
238   1322  4404  4404
239   1323  0747  0747
240   1324  0141  0141
241   1325  2127  2127
242   1326  0424  MASK3,  0424    /A,C,E,F,G,H,K,O,Q,R,P,3,6,8,L,B
243   1327  3444  3444
244   1330  4147  4147
245   1331  0701  0701
246   1332  4144  4144
247   1333  2404  2404
248   1334  2622  MASK4,  2622    /↓,B,A,,-,+,*
249   1335  4305  4305
```

```
250   1336  4503  4503
251   1337  0426  0426
252   1340  4404  4404
253
254   1341  0000  WSP,     0
255
256   1342  4525  MASK5,   4525     /°,#,=
257   1343  0503  0503
258   1344  2343  2343
259   1345  4721  4721
260   1346  2707  2707
261   1347  0141  0141
262   1350  0627  MASK6,   0627     /",',;,!,?,°,,,
263   1351  2525  2525
264   1352  4524  4524
265   1353  2323  2323
266   1354  1121  1121
267   1355  2147  2147
268                SAR=.    /CHARACTER DISPATCH TABLE
269   1356  7745  7745     /°
270   1357  6347  6347
271   1360  5603  5603     /A
272   1361  4760  4760
273   1362  7703  7703     /B
274   1363  2175  2175
275   1364  7003  7003     /C
276   1365  0170  0170
277   1366  7700  7700     /D
278   1367  3551  3551
279   1370  5603  5603     /E
280   1371  5170  5170
281   1372  5403  5403     /F
282   1373  5160  5160
283   1374  7603  7603     /G
284   1375  0176  0176
285   1376  5203  5203     /H
286   1377  4760  4760
287   1400  5201  5201     /I
288   1401  1156  1156
289   1402  7000  7000     /J
290   1403  5404  5404
291   1404  6503  6503     /K
292   1405  6172  6172
293   1406  6003  6003     /L
294   1407  0070  0070
295   1410  7401  7401     /M
296   1411  3304  3304
297   1412  7001  7001     /N
298   1413  3005  3005
299   1414  7403  7403     /O
300   1415  0370  0370
301   1416  7403  7403     /P
302   1417  4560  4560
303   1420  7603  7603     /Q
304   1421  2370  2370
305   1422  7503  7503     /R
306   1423  4572  4572
307   1424  7602  7602     /S
308   1425  6360  6360
309   1426  5001  5001     /T
310   1427  1150  1150
311   1430  7001  7001     /U
312   1431  6005  6005
313   1432  6001  6001     /V
314   1433  4011  4011
315   1434  7401  7401     /W
316   1435  6205  6205
317   1436  5001  5001     /X
318   1437  1007  1007
319   1440  6401  6401     /Y
320   1441  1330  1330
```

```
321   1442  7002  7002    /Z
322   1443  0074  0074
323   1444  7001  7001    /[
324   1445  0154  0154
325   1446  4002  4002    /\
326   1447  0044  0044
327   1450  7000  7000    /]
328   1451  3050  3050
329   1452  5404  5404    /↑
330   1453  6070  6070
331   1454  6404  6404    /B.A.
332   1455  2074  2074
333
334
335   1456  0000  0000    /SP
336   1457  7000  7000    /EXECUTE 3 "INVISIBLE" VECTOR STROKES.
337   1460  5006  5006    /°
338   1461  2046  2046
339   1462  5006  5006    /"
340   1463  3201  3201
341   1464  5245  5245    /#
342   1465  5572  5572
343   1466  7642  7642    /$
344   1467  6363  6363
345   1470  6740  6740    /↑
346   1471  1675  1675
347   1472  6760  6760    /^
348   1473  3637  3637
349   1474  4006  4006    /'
350   1475  3000  3000
351   1476  6001  6001    /(
352   1477  0124  0124
353   1500  6001  6001    /)
354   1501  1202  1202
355   1502  5204  5204    /*
356   1503  7700  7700
357   1504  5004  5004    /+
358   1505  6014  6014
359   1506  4006  4006    /,
360   1507  0030  0030
361   1510  4004  4004    /-
362   1511  0014  0014
363   1512  4006  4006    /.
364   1513  0060  0060
365   1514  4002  4002    //
366   1515  4400  4400
367   1516  7601  7601    /0
368   1517  3107  3107
369   1520  6401  6401    /1
370   1521  0456  0456
371   1522  7602  7602    /2
372   1523  1714  1714
373   1524  5503  5503    /3
374   1525  4770  4770
375   1526  6402  6402    /4
376   1527  0364  0364
377   1530  7600  7600    /5
378   1531  3434  3434
379   1532  7603  7603    /6
380   1533  0175  0175
381   1534  6002  6002    /7
382   1535  0070  0070
383   1536  5703  5703    /8
384   1537  4770  4770
385   1540  7402  7402    /9
386   1541  0364  0364
387   1542  5006  5006    /:
388   1543  1460  1460
389   1544  5006  5006    /;
```

```
 390   1545  1430  1430
 391   1546  6002  6002     /<
 392   1547  2120  2120
 393   1550  5005  5005     /=
 394   1551  5500  5500
 395   1552  6002  6002     />
 396   1553  4240  4240
 397   1554  7506  7506     /?
 398   1555  6346  6346
 399                 /THIS IS THE LAST OF THE CHARACTER DISPATCH TABLE.....
 400
 401                 /IT ALSO FINISHES THE CHARACTER GENERATOR PROGRAM.....
 402
 403                 $
 404
A       1147    B       1150    C       1151    CEX     1162    CM10    1220
CR      1130    CRLF    1124    C10     1160    C100    1221    C6064   1164
C7      1157    C77     1161    DLIST   1172    DSP     1223    DSPY    1000
DSPYI   1005    EXCUTE  1225    H       1152    LF      1140    LOCATE  1000
MARGIN  1153    MASKS   1171    MASK0   1304    MASK1   1312    MASK2   1320
MASK3   1326    MASK4   1334    MASK5   1342    MASK6   1350    M10     1156
M14     1155    M240    1154    M420    1217    OUTCHM  1007    RESET   1121
SAR     1356    SAR1    1170    SAVE1   1230    SAVE2   1165    SCALE   1167
SCALE0  1262    SCALE1  1263    SCF     1226    SCT     1227    SEARCH  1231
SRCH1   1166    SRCH2   1235    SRCH3   1222    SYNC    1132    TAB     1265
TAB1    1271    TOP     1163    VA      1033    VOUT    1112    VSCALE  1251
VSTATE  1115    VX0     1224    WSP     1341    XCUTE   1135    X0      1145
Y0      1146


A           20    21    30    33    34    35    42    51   115#
B           24    25    27    32    77    79   116#
C           29    41    58   117#
CEX         81   127#
CM10       160#  202
CR          99#  140
CRLF        95#  142
C10         45   125#
C100       161#  206
C6064       54   129#
C7          22    68    73   124#
C77         17   126#
DLIST      136#  162
DSP        163#  200
DSPY        10#   15    49
DSPYI       15#  146   148   163
EXCUTE     165#  216
H           36    37    39    40    56   118#
LF         107#  138
LOCATE       6#    8
MARGIN      99   120#
MASKS       28   134#
MASK0      134   224#
MASK1      230#
MASK2      236#
MASK3      242#
MASK4      248#
MASK5      256#
MASK6      262#
M10        101   123#
M14         95   107   122#
M240        13   105   121#
M420       159#  204
OUTCHM      17#  106
RESET       92#  144
```

```
SAR         133   268#
SAR1         19   133#
SAVE1       130   169#  172   181   205   208   209   212   215
SAVE2        12    16    64    65    72   130#
SCALE        46    69    74    96   102   108   132#
SCALE0      156   198#
SCALE1      154   199#
SCF         167#  190   198   199
SCT         168#  189   193
SEARCH      131   171#  178   185   186
SRCH1        11   131#
SRCH2       175#  183
SRCH3       162#  173
SYNC        101#  111   152
TAB         150   202#
TAB1        206#  214
TOP          92   128#
VA           37#   53    83
VOUT         71    76    82    85#   91
VSCALE      132   188#  196   203   207
VSTATE       55    88#   89
VX0         164#  210
WSP         174   175   176   180   184   192   194   254#
XCUTE       104#  165
X0           47    48    70   100   103   104   113#  164
Y0           75    94    97    98   109   110   114#
```

8.3. A character generator using dots

```
 1                  XLIST   /OPDEF
 2                /DOTS
 3                /CHARACTER GENERATOR WITH 5*7 GRID
 4                /A.E.BROUWER, MC, A'DAM, 040673
 5
 6                BR=5
 7                HO=7
 8   0200  0000   DOTS,   0
 9   0201  7450            SNA
10   0202  5600            JMP I   DOTS     /SKIP BLANKS
11   0203  1377            TAD     (-215
12   0204  7450            SNA
13   0205  5350            JMP     CR       /CARRET
14   0206  7001            IAC
15   0207  7450            SNA
16   0210  5344            JMP     FF       /FORM FEED
17   0211  1376            TAD     (2
18   0212  7450            SNA
19   0213  5353            JMP     LF       /LINE FEED
20   0214  7001            IAC
21   0215  7450            SNA
22   0216  5357            JMP     TAB      /TABULATION
23   0217  1375            TAD     (211-340
24   0220  7100            CLL
25   0221  1270            TAD     C100
26   0222  7420            SNL
27   0223  5226            JMP     .+3      /IGNORE ALL OTHER CONTROL CHARS
28   0224  1277            TAD     C240     /RESTORE CHAR
29   0225  4230            JMS     DSPLY    /DISPLAY IT
30   0226  7200            CLA
31   0227  5600            JMP I   DOTS
32
33   0230  0000   DSPLY,  0                /IN WITH 8-BIT ASCII
34   0231  0374            AND     (77      /MASK 6 BITS
```

```
 35   0232  3336          DCA     PTR
 36   0233  1336          TAD     PTR
 37   0234  7104          CLL RAL
 38   0235  1336          TAD     PTR       /3*PTR
 39   0236  1373          TAD     (TABLE
 40   0237  3336          DCA     PTR
 41   0240  1736          TAD I   PTR       /GET THE CONTROL CODE
 42   0241  3341          DCA     WORD1     /INTO THE TRIPLE LENGTH WORD
 43   0242  2336          ISZ     PTR
 44   0243  1736          TAD I   PTR
 45   0244  3342          DCA     WORD2
 46   0245  2336          ISZ     PTR
 47   0246  1736          TAD I   PTR
 48   0247  3343          DCA     WORD3
 49   0250  1372          TAD     (-BR
 50   0251  3337          DCA     CTR1      /COUNTS COLUMNS
 51   0252  4261          JMS     COL       /DISPLAY A COLUMN
 52   0253  2337          ISZ     CTR1      /ALL COLUMNS DONE?
 53   0254  5252          JMP     .-2       /NO
 54   0255  7305          CLA CLL IAC RAL   /AC4
 55   0256  1334          TAD     X0
 56   0257  3334          DCA     X0        /INCREMENT X-COORDINATE
 57   0260  5630          JMP I   DSPLY     /EXIT
 58
 59   0261  0000  COL,    0
 60   0262  1371          TAD     (-HO
 61   0263  3340          DCA     CTR2      /COUNTS ROWS
 62   0264  4321  COL1,   JMS     ROTBIT    /ROTATE TRIPLE LENGTH WORD ONE LEFT
 63   0265  7430          SZL               /VISIBLE?
 64   0266  4301          JMS     DOT       /YES,DISPLAY A POINT
 65   0267  2335          ISZ     Y0        /INCREMENT Y-COORDINATE
 66   0270  0100  C100,   100               /PREVENT SKIPPING
 67   0271  2340          ISZ     CTR2      /ALL ROWS DONE?
 68   0272  5264          JMP     COL1      /NO
 69   0273  1371          TAD     (-HO
 70   0274  1335          TAD     Y0
 71   0275  3335          DCA     Y0        /RESET Y-COORDINATE
 72   0276  2334          ISZ     X0        /INCREMENT X-COORDINATE
 73   0277  0240  C240,   240               /PREVENT SKIPPING
 74   0300  5661          JMP I   COL
 75
 76   0301  0000  DOT,    0                 /DISPLAY A POINT
 77   0302  1334          TAD     X0
 78   0303  6064          LDX
 79   0304  4314          WAIT
 80   0305  1335          TAD     Y0
 81   0306  6065          LDY
 82   0307  4314          WAIT
 83   0310  1370          TAD     (1001     /VISIBLE POINT
 84   0311  6066          EXC
 85   0312  4314          WAIT
 86   0313  5701          JMP I   DOT
 87
 88              WAIT=JMS .
 89   0314  0000  0;SRF;JMP .-1;CLA;JMP I .-4
 90   0315  6071
 91   0316  5315
 92   0317  7200
 93   0320  5714
 94
 95   0321  0000  ROTBIT, 0
 96   0322  1343          TAD     WORD3
 97   0323  7104          RAL CLL
 98   0324  3343          DCA     WORD3
 99   0325  1342          TAD     WORD2
100   0326  7004          RAL
101   0327  3342          DCA     WORD2
102   0330  1341          TAD     WORD1
103   0331  7004          RAL
104   0332  3341          DCA     WORD1
```

```
105   0333  5721          JMP I   ROTBIT
106   0334  7400  XO,     -400
107   0335  0500  YO,     500
108   0336  0000  PTR,    0
109   0337  0000  CTR1,   0
110   0340  0000  CTR2,   0
111   0341  0000  WORD1,  0
112   0342  0000  WORD2,  0
113   0343  0000  WORD3,  0
114
115   0344  1367  FF,     TAD     (500
116   0345  3335          DCA     YO      /RESET COORDINATES
117   0346  6072          CRF             /CLEAR READY FLAG
118   0347  4314          WAIT            /AND WAIT FOR ERASE
119   0350  1366  CR,     TAD     (-400
120   0351  3334          DCA     XO      /RESET X-COORDINATE
121   0352  5600          JMP I   DOTS
122   0353  1365  LF,     TAD     (-12
123   0354  1335          TAD     YO
124   0355  3335          DCA     YO      /DECREMENT Y-COORDINATE
125   0356  5600          JMP I   DOTS
126   0357  1334  TAB,    TAD     XO
127   0360  0364          AND     (7700
128   0361  1270          TAD     C100    /RATHER LARGE TAB
129   0362  5351          JMP     CR+1
130
131   0364  7700
132   0365  7766
133   0366  7400
134   0367  0500
135   0370  1001
136   0371  7771
137   0372  7773
138   0373  0400
139   0374  0077
140   0375  7651
141   0376  0002
142   0377  7563
143               PAGE
144
145               TABLE=.
146   0400  3122  3122;3714;0574;/°
147   0401  3714
148   0402  0574
149   0403  7604  7604;4211;1370;/A
150   0404  4211
151   0405  1370
152   0406  4077  4077;7114;4554;/B
153   0407  7114
154   0410  4554
155   0411  3720  3720;3014;0504;/C
156   0412  3014
157   0413  0504
158   0414  4077  4077;7014;0574;/D
159   0415  7014
160   0416  0574
161   0417  7762  7762;3114;0602;/E
162   0420  3114
163   0421  0602
164   0422  7742  7742;2110;0402;/F
165   0423  2110
166   0424  0402
```

```
167   0425  3720  3720;3014;4762;/G
168   0426  3014
169   0427  4762
170   0430  7742  7742;0100;4376;/H
171   0431  0100
172   0432  4376
173   0433  0020  0020;3774;0400;/I
174   0434  3774
175   0435  0400
176   0436  2020  2020;1004;0176;/J
177   0437  1004
178   0440  0176
179   0441  7742  7742;0242;1202;/K
180   0442  0242
181   0443  1202
182   0444  7760  7760;1004;0200;/L
183   0445  1004
184   0446  0200
185   0447  7740  7740;4140;1376;/M
186   0450  4140
187   0451  1376
188   0452  7740  7740;4040;4376;/N
189   0453  4040
190   0454  4376
191   0455  7760  7760;3014;0776;/O
192   0456  3014
193   0457  0776
194   0460  7742  7742;2110;4414;/P
195   0461  2110
196   0462  4414
197   0463  3720  3720;3212;0674;/Q
198   0464  3212
199   0465  0674
200   0466  7742  7742;2312;4614;/R
201   0467  2312
202   0470  4614
203   0471  2121  2121;3115;0504;/S
204   0472  3115
205   0473  0504
206   0474  0040  0040;3770;0402;/T
207   0475  3770
208   0476  0402
209   0477  3760  3760;1004;0176;/U
210   0500  1004
211   0501  0176
212   0502  0346  0346;1401;4016;/V
213   0503  1401
214   0504  4016
215   0505  7750  7750;0202;0376;/W
216   0506  0202
217   0507  0376
218   0510  6145  6145;0101;2306;/X
219   0511  0101
220   0512  2306
221   0513  0141  0141;1700;2006;/Y
222   0514  1700
223   0515  2006
224   0516  6064  6064;3114;2606;/Z
225   0517  3114
226   0520  2606
227   0521  0037  0037;7014;0400;/[
228   0522  7014
229   0523  0400
230   0524  0101  0101;0101;0100;/\
231   0525  0101
232   0526  0100
233   0527  0020  0020;3017;7400;/]
234   0530  3017
```

```
235   0531  7400
236   0532  0200  0200;5770;1010;/↑
237   0533  5770
238   0534  1010
239   0535  0407  0407;0100;4020;/°
240   0536  0100
241   0537  4020
242   0540  0000  0000;0000;0000;/SPACE
243   0541  0000
244   0542  0000
245   0543  0000  0000;1370;0000;/°
246   0544  1370
247   0545  0000
248   0546  0001  0001;6000;3400;/"
249   0547  6000
250   0550  3400
251   0551  1235  1235;6007;3450;/#
252   0552  6007
253   0553  3450
254   0554  2212  2212;5532;5044;/$
255   0555  5532
256   0556  5044
257   0557  6144  6144;6106;2306;/¶
258   0560  6106
259   0561  2306
260   0562  3322  3322;3262;0040;/^
261   0563  3262
262   0564  0040
263   0565  0000  0000;0070;0000;/'
264   0566  0070
265   0567  0000
266   0570  0007  0007;0424;0400;/(
267   0571  0424
268   0572  0400
269   0573  0020  0020;2421;6000;/)
270   0574  2421
271   0575  6000
272   0576  2507  2507;0761;6124;/*
273   0577  0761
274   0600  6124
275   0601  0402  0402;0760;4020;/+
276   0602  0760
277   0603  4020
278   0604  0026  0026;0700;0000;/,
279   0605  0700
280   0606  0000
281   0607  0402  0402;0100;4020;/-
282   0610  0100
283   0611  4020
284   0612  0030  0030;1400;0000;/.
285   0613  1400
286   0614  0000
287   0615  2004  2004;0100;2004;//
288   0616  0100
289   0617  2004
290   0620  3724  3724;3114;2574;/0
291   0621  3114
292   0622  2574
293   0623  0020  0020;5774;0000;/1
294   0624  5774
295   0625  0000
296   0626  7122  7122;3114;4614;/2
297   0627  3114
298   0630  4614
299   0631  2120  2120;3114;4554;/3
300   0632  3114
301   0633  4554
302   0634  1405  1405;0227;7440;/4
303   0635  0227
304   0636  7440
```

```
 305    0637   2361   2361;3054;2562;/5
 306    0640   3054
 307    0641   2562
 308    0642   3622   3622;5114;4540;/6
 309    0643   5114
 310    0644   4540
 311    0645   0074   0074;2110;2406;/7
 312    0646   2110
 313    0647   2406
 314    0650   3322   3322;3114;4554;/8
 315    0651   3114
 316    0652   4554
 317    0653   0322   0322;3112;4474;/9
 318    0654   3112
 319    0655   4474
 320    0656   0033   0033;1540;0000;/:
 321    0657   1540
 322    0660   0000
 323    0661   0026   0026;6730;0000;/;
 324    0662   6730
 325    0663   0000
 326    0664   0002   0002;0242;1202;/<
 327    0665   0242
 328    0666   1202
 329    0667   1205   1205;0241;2050;/=
 330    0670   0241
 331    0671   2050
 332    0672   4050   4050;4240;4000;/>
 333    0673   4240
 334    0674   4000
 335    0675   0100   0100;3310;3000;/?
 336    0676   3310
 337    0677   3000
 338                  $$
 339
BR      0005    COL     0261    COL1    0264    CR      0350    CTR1    0337
CTR2    0340    C100    0270    C240    0277    DOT     0301    DOTS    0200
DSPLY   0230    FF      0344    HO      0007    LF      0353    PTR     0336
ROTBIT  0321    TAB     0357    TABLE   0400    WAIT    4314    WORD1   0341
WORD2   0342    WORD3   0343    X0      0334    Y0      0335
```

```
BR            6#   49
COL          51    59#   74
COL1         62#   68
CR           13   119#  129
CRF         117
CTR1         50    52   109#
CTR2         61    67   110#
C100         25    66#  128
C240         28    73#
DOT          64    76#   86
DOTS          8#   10    31   121   125
DSPLY        29    33#   57
EXC          84
FF           16   115#
HO            7#   60    69
LDX          78
LDY          81
LF           19   122#
PTR          35    36    38    40    41    43    44    46    47   108#
ROTBIT       62    95#  105
SRF          90
TAB          22   126#
TABLE        39   145#
```

```
WAIT        79    82    85    88#   118
WORD1       42   102   104   111#
WORD2       45    99   101   112#
WORD3       48    96    98   113#
XO          55    56    72    77    106#  120   126
YO          65    70    71    80    107#  116   123   124
°L0364     127
°L0365     122
°L0366     119
°L0367     115
°L0370      83
°L0371      60    69
°L0372      49
°L0373      39
°L0374      34
°L0375      23
°L0376      17
°L0377      11
```

The three character generators from sections 8.1 through 8.3 can be compared on the photograph below.