The third in a series of tutorials for the beginner to intermediate machine language programmer

Machine Language Made BASIC

Part III: What a Dump!

By William P. Nee

Dumps are simply programs that transfer images from the screen to paper by way of a printer. The programs shown in Listings 1 and 2 are for a seven-dot printer that adds 128 to the total value of the dots used for graphic printing. Listing 1 is the BASIC version and Listing 2 is a machine language version.The seven dots in a column have a value of 1, 2, 4, 8, 16, 32, and 64, starting from the top. The values of the dots you want to print are added together and then added to 128. The total value is sent to the printer as a CHR$ value. Printer commands used in this program are:

```
CHR$(18) - set for graphics
CHR$(27); CHR$(16) - position the
print head
CHR$(0); CHR$(50) - 50 spaces over
CHR$(30) - end graphics mode
```

Check your printer manual for any changes to these CHR$.

Location $6F tells the computer which device will display or receive information as follows:

$6F	Device
-2(#$FE)	printer
-1(#$FF)	tape recorder
0	screen
1 - 15	disk

Locations $BA and BB give the location of beginning graphics — usually at $600, or $E00 with disk.

The BIT command is a quick way to test each bit in a byte and branch accordingly. We will check each bit to see if it is a zero, and we'll branch if it is. The BIT command ANDs a number in registers A or B with any other number you select; but unlike the AND command, the number in registers A or B remains unchanged — only the values of the condition codes (CC) register are affected. The CC register is the register to which all branches look to see if the conditions for a branch have been met (plus, minus, equal, zero, etc.). The rules for AND are:

```
0 AND 0 = 0
0 AND 1 = 0
1 AND 0 = 0
1 AND 1 = 1
```

Another way to think of this is: any number AND 0 = 0, any number AND 1 = the same number.

Now, how do we test the left bit (Bit 7) in Register A to see if it is a 0 or a 1? We must BITA with the number 128. This is easier to see when written in the binary format (Base 2):

```
let Register A = 149 = 10010101
    BITA with #128   = 10000000
    CC register      = 10000000
```

Since the result is not 0, the CC register will not be set to 0 and a BEQ (Branch if EQual to 0) will not execute, so the program will continue with its next command. If you continue to BITA with 64, 32, 16, 8, 4, 2 and 1, you can check each bit and branch accordingly.

Since the printer can type a column seven bytes high, this program will look at the left bit in each of the seven stacked bytes, then the next bit over, and the next, etc., until reaching the right bit (Bit 0).

If a bit is 1, the value of the CHR$ to be printed is increased by the dot's value according to its location in the column:

Dot	Value
1	1
2	2
3	4
4	8
5	16
6	32
7	64

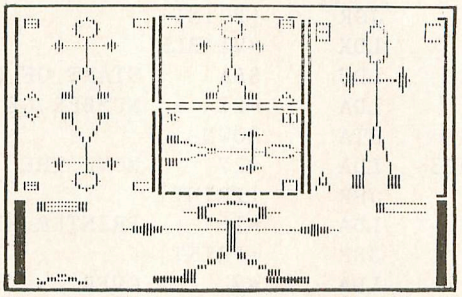
Bill Nee bucked the "snowbird" trend by retiring to Wisconsin from a banking career in Florida. He spends the long, cold winters writing programs for his CoCo.

Finally, 128 is added to the total value and the result is sent to the printer as a CHR$ (value). The routine at $A002 sends the value in Register A to whatever device is indicated by Location $6F. The brackets around PRINT in the program mean to use the values in $A002 and $A003 as the JSR address. Those values may differ in various Color Computer models, but the $A002 should remain the same.

The end of the program uses CLR $6F to set Location $6F to 0, the device number for the screen. CLR is the fastest command available to set any memory byte or single-byte register such as A, B or CC to 0. CLRA executes more quickly and uses less memory than LDA #0.

In one portion of the program we used LBNE (Long Branch if Not Equal) instead of BNE. This is because a regular Branch can only move backward -128 spaces or forward +127 spaces (remember "signed" numbers?); a Long Branch can branch anywhere in the program but consumes a little more memory. Use the regular branch whenever possible; *EDTASM+* will let you know if a Long Branch is necessary. It *is* good, though, to use JSR when referring to ROM routines.

The BASIC program for the "dump" takes advantage of the BASIC PPOINT command to see if each bit in the seven-byte column is set or not. If it is set, the value of the CHR$ is increased and 128 is added to the total value. The resulting character is sent to the printer.



Sample printout using a Radio Shack DMP-105

The PPOINT method could have been used in the machine language program, but it is still a slow command. We will, however, use this command in future articles to write programs involving graphics.

Both programs will run for a while without printing anything since the printer buffer must be filled before printing. The buffer stores what the computer has been sending it until ready. Then it prints it all at once, rather than printing out one CHR$ at a time. Both programs also skip printing the bottom three lines of graphics. You can add your own routines if you want them. Be sure to clear space before running the machine language program from BASIC: CLEAR 200, &H3000-1.

The time difference between the two programs is amazing. The BASIC program can take up to twenty minutes to copy a graphics page, while the machine language program can do the job in about three minutes. It's a longer program, but if you're doing a lot of repetitious dumping (Christmas cards, for example) it is quite a time-saver. The machine language program is designed for PMODE 4, since we're not using a color printer.

Try experimenting with a program that dumps from top to bottom of the page rather than from left to right. This prints the picture sideways but allows you to double its size. You might also try to reverse the picture.

(Questions or comments concerning this tutorial may be addressed to the author at Route 2, Box 216C, Mason, WI 54856-9302. Please enclose an SASE when requesting a reply.) □

Listing 1: DUMPBAS

```
10 CLEAR200,&H3000-1
20 'SAMPLE GRAPHICS PROGRAM
30 PMODE 4,1:PCLS5:SCREEN1,1
40 FOR X=0 TO 254 STEP 2
50 LINE(X,0)-(255-X,191),PRESET
60 NEXT
70 FOR Y=190 TO 0 STEP -2
80 LINE(0,Y)-(255,191-Y),PRESET
90 NEXT
100 DRAW"C5BM80,60M+6,+10E5F5M+6
,-10BR6D5ND5R18NU5D5BR6E10F6NL12
F4BR16U10NL10R10"
110 DRAW"BM120,100E10F6NL12F4"
120 DRAW"BM80,130U10R18F2D6G2NL1
8BR8BU2NU8F2R14E2U8BD10BR6M+6,-1
0F5E5M+6,+10BR6U10R18F2D3G2L18"
130 'THE DUMP PROGRAM
140 'EXEC &H3000 OR -
150 PRINT#-2,CHR$(18)
160 FOR V=0 TO 182 STEP 7
170 PRINT#-2,CHR$(27);CHR$(16);C
HR$(0);CHR$(50);
180 FOR H=0 TO 255:P=0
190 FOR N=0 TO 6
200 IF PPOINT(H,V+N)<>0 THEN P=P
+2^N
210 NEXT N
220 PRINT#-2,CHR$(P+128);:NEXT H
230 PRINT#-2:NEXT V
240 PRINT#-2,CHR$(30)
```

Listing 2: DUMPBIN

```
3000              00100         ORG    $3000
     A002         00110 PRINT   EQU    $A002    PRINT ROUTINE
3000 86  FE       00120 START   LDA    #-2      USING THE PRINTER
3002 97  6F       00130         STA    $6F
3004 86  12       00150         LDA    #18      TEXT TO GRAPHICS
3006 AD  9F A002  00160         JSR    [PRINT]
300A 8E  30CC     00170         LDX    #VTABLE
300D DE  BA       00180         LDU    $BA      START OF GRAPHICS
300F 86  1B       00190         LDA    #27      NUMBER OF ROWS
3011 B7  30CA     00200         STA    DOWN
3014 86  1B       00210 LOOP3   LDA    #27      MOVE THE
3016 AD  9F A002  00220         JSR    [PRINT]
301A 86  10       00230         LDA    #16      PRINTER HEAD
301C AD  9F A002  00240         JSR    [PRINT]
3020 86  00       00250         LDA    #0       OVER
3022 AD  9F A002  00260         JSR    [PRINT]
3026 86  32       00270         LDA    #50      50 SPACES
3028 AD  9F A002  00280         JSR    [PRINT]
302C 86  20       00290         LDA    #32      BYTES PER LINE
302E B7  30C9     00300         STA    ROW
3031 C6  08       00310 LOOP2   LDB    #8       BITS PER BYTE
3033 7F  30CB     00320 LOOP1   CLR    VALUE
3036 A6  40       00330         LDA    0,U      FIRST BIT IN THE COLUMN
3038 A5  85       00340         BITA   B,X      AND A WITH B,X
303A 27  03       00350         BEQ    NEXT2
303C 7C  30CB     00360         INC    VALUE
303F A6  C8 20    00370 NEXT2   LDA    32,U     SECOND BIT IN THE COLUMN
3042 A5  85       00380         BITA   B,X      AND A WITH B,X
3044 27  08       00390         BEQ    NEXT3
3046 B6  30CB     00400         LDA    VALUE
3049 8B  02       00410         ADDA   #2
304B B7  30CB     00420         STA    VALUE
304E A6  C8 40    00430 NEXT3   LDA    64,U     THIRD BIT IN THE COLUMN
3051 A5  85       00440         BITA   B,X      AND A WITH B,X
3053 27  08       00450         BEQ    NEXT4
3055 B6  30CB     00460         LDA    VALUE
3058 8B  04       00470         ADDA   #4
305A B7  30CB     00480         STA    VALUE
305D A6  C8 60    00490 NEXT4   LDA    96,U     FOURTH BIT IN THE COLUMN
3060 A5  85       00500         BITA   B,X      AND A WITH B,X
3062 27  08       00510         BEQ    NEXT5
3064 B6  30CB     00520         LDA    VALUE
3067 8B  08       00530         ADDA   #8
3069 B7  30CB     00540         STA    VALUE
306C A6  C9 0080  00550 NEXT5   LDA    128,U    FIFTH BIT IN THE COLUMN
3070 A5  85       00560         BITA   B,X      AND A WITH B,X
3072 27  08       00570         BEQ    NEXT6
3074 B6  30CB     00580         LDA    VALUE
3077 8B  10       00590         ADDA   #16
3079 B7  30CB     00600         STA    VALUE
307C A6  C9 00A0  00610 NEXT6   LDA    160,U    SIXTH BIT IN THE COLUMN
3080 A5  85       00620         BITA   B,X      AND A WITH B,X
3082 27  08       00630         BEQ    NEXT7
3084 B6  30CB     00640         LDA    VALUE
3087 8B  20       00650         ADDA   #32
3089 B7  30CB     00660         STA    VALUE
308C A6  C9 00C0  00670 NEXT7   LDA    192,U    SEVENTH BIT IN THE COLUMN
3090 A5  85       00680         BITA   B,X      AND A WITH B,X
3092 27  08       00690         BEQ    PRNT
3094 B6  30CB     00700         LDA    VALUE
3097 8B  40       00710         ADDA   #64
```

```
3Ø99 B7   3ØCB     ØØ72Ø          STA    VALUE
3Ø9C B6   3ØCB     ØØ73Ø PRNT     LDA    VALUE
3Ø9F 8B   8Ø       ØØ74Ø          ADDA   #128     FILL IN THE EIGHTH BIT
3ØA1 AD   9F AØØ2  ØØ75Ø          JSR    [PRINT]
3ØA5 5A            ØØ76Ø          DECB
3ØA6 26   8B       ØØ77Ø          BNE    LOOP1    FINISHED THE BYTE?
3ØA8 33   41       ØØ78Ø          LEAU   1,U      MOVE OVER TO THE NEXT BYTE
3ØAA 7A   3ØC9     ØØ79Ø          DEC    ROW      FINISHED THE ROW YET?
3ØAD 26   82       ØØ8ØØ          BNE    LOOP2
3ØAF 86   ØA       ØØ81Ø          LDA    #1Ø      CARRIAGE RETURN
3ØB1 AD   9F AØØ2  ØØ82Ø          JSR    [PRINT]
3ØB5 33   C9 ØØCØ  ØØ83Ø          LEAU   192,U    SKIP DOWN 7 ROWS
3ØB9 7A   3ØCA     ØØ84Ø          DEC    DOWN
3ØBC 1Ø26 FF54     ØØ85Ø          LBNE   LOOP3
3ØCØ 86   1E       ØØ86Ø FIN      LDA    #3Ø      BACK TO TEXT
3ØC2 AD   9F AØØ2  ØØ87Ø          JSR    [PRINT]
3ØC6 ØF   6F       ØØ88Ø          CLR    $6F      BACK TO THE SCREEN
3ØC8 39            ØØ89Ø          RTS             BACK TO BASIC
3ØC9               ØØ9ØØ ROW      RMB    1
3ØCA               ØØ91Ø DOWN     RMB    1
3ØCB               ØØ92Ø VALUE    RMB    1
3ØCC       ØØØ1    ØØ93Ø VTABLE   FDB    $ØØØ1
3ØCE       Ø2Ø4    ØØ94Ø          FDB    $Ø2Ø4
3ØDØ       Ø81Ø    ØØ95Ø          FDB    $Ø81Ø
3ØD2       2Ø4Ø    ØØ96Ø          FDB    $2Ø4Ø
3ØD4       8Ø      ØØ97Ø          FCB    $8Ø
           3ØØØ    ØØ98Ø          END    START

ØØØØØ TOTAL ERRORS
```