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

Machine Language Made BASIC

Part VI: I Draw the Line

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This article will discuss and use a routine that executes the BASIC LINE command in machine language. The execution of this command will not be faster in machine language than it is in BASIC, since the LINE command itself is a machine language routine whether it is called from a BASIC or a machine language program.

The machine language *program*, however, will run more quickly than the BASIC program because all addition and subtraction functions use registers A and B rather than FP1 and FP2. Also, the computer does not have to parse (read each character of) the program to check for a wrong command or a syntax error.

Finding the point where a machine language routine stops reading the BASIC program and actually starts executing the command is one of the major difficulties in implementing ROM routines. Sometimes we need to add a small, but necessary, subroutine like the SCALE subroutine in last month's article, because we have skipped a portion of the ROM routine.

```
          Subroutine                  Description
$959A LDB      $B2                    foreground color
TST     $C2                           1 = PSET; 0 = PRESET
BNE     $95A2                         branch if PSET
LDB     $B3                           background color
$95A2 STB      $B4                    color to use
LDA     #$55
MUL                                   to fill one byte
STB     $B5                           color byte
RTS
```

Figure 1

I have included a subroutine at Address $959A that uses the foreground or background colors to either PSET or PRESET. The subroutine is shown in Figure 1.

The TST command checks the CC register to see whether or not a number is equal to zero, and can also check to see if a signed number is positive or negative. You can then branch accordingly.

This routine works because PRESET works invisibly, like drawing a red line on a red background: It's there; you just can't see it. This subroutine was not part of the PSET routine we used last month, and it is not part of the LINE routine used in this article. We must skip the routine because the program looks at BASIC for the proper syntax during the ROM PSET and LINE routines. Our routine must start after this process.

If you are going to use a lot of color changes and LINE PRESETs in your program, you may want to include this subroutine just before the LINE routine. However, you may find it easier to enter the proper color number (#$0, #$55, #$AA, or #$FF) into Location $B5 prior to the LINE routine. Entering the background color number will PRESET; any other color number will PSET. See what happens if you put color number other than these in Location $B5.

The BASIC LINE command requires an old x_1,y_1 and a new x_2,y_2. In machine language, these coordinates are located at the following locations:

	Location
x_1	$BD/BE
y_1	$BF/C0
x_2	$C3/C4
y_2	$C5/C6

These locations are two bytes long, so your program could use registers X or

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Y as well as registers A or B to load the locations.

Again, we must scale these locations or our program will work only in PMODE 4. We have already used the routine at $931D to scale x_1,y_1 at $BD and $BF, but to scale x_2 and y_2, we must load Stack U with the actual location of the x_2 coordinate and perform a JSR $9320. The entire scaling routine is as follows:

JSR $931D	scales x_1,y_1
LDU #$C3	x_2 starts at $C3
JSR $9320	scales x_2,y_2

Normally, this routine should be done just before executing the LINE routine at $94A1. Anything necessary in registers A or B must be saved prior to using the scale routine.

The program in this article is in PMODE 3 and uses all available colors. It draws a line pattern in the following colors and order — cyan, magenta, orange and magenta — on a buff background (Color Set 1). To see Color Set 0, change the '1' in Line 190 to a '0'. Instead of using the subroutine at Address $959A, the program puts the color number directly into Location $B5 (lines 210, 420, 630 and 840). When it has done this, press any key to interrupt execution of the program.

Before entering this program, set Location $FF/100 to #$2000. This moves the *EDTASM+* buffer up to Location $2000, well beyond graphics but below the ORG address of the program. If you run the program from BASIC, clear enough memory by using CLEAR 200, &H3000-1.

(Questions or comments concerning this tutorial may be directed to the author at Route 2, Box 216 C, Mason, WI 54846-9302. Please enclose an SASE when requesting a reply.) □

Listing 1: BASLINE

```
1Ø PMODE 3,1:PCLS:SCREEN 1,1
2Ø COLOR 6,5
3Ø FOR X=Ø TO 92 STEP 4
4Ø LINE(22Ø-X,96-X)-(128-X,4+X),
PSET
5Ø NEXT
6Ø COLOR 7,5
7Ø FOR X=Ø TO 92 STEP 4
8Ø LINE(128-X,4+X)-(36+X,96+X),P
SET
9Ø NEXT
1ØØ COLOR 8,5
11Ø FOR X=Ø TO 92 STEP 4
12Ø LINE(36+X,96+X)-(128+X,188-X
),PSET
13Ø NEXT
14Ø COLOR 7,5
15Ø FOR X=Ø TO 92 STEP 4
16Ø LINE(128+X,188-X)-(22Ø-X,96-
X),PSET
17Ø NEXT
18Ø GOTO 18Ø
```

Listing 2: BINLINE

```
                    ØØ1ØØ *  $FF/1ØØ=#$2ØØØ
3ØØØ                ØØ11Ø         ORG    $3ØØØ
3ØØØ C6    Ø3       ØØ12Ø START   LDB    #3
3ØØ2 BD    9628     ØØ13Ø         JSR    $9628
3ØØ5 C6    Ø1       ØØ14Ø         LDB    #1      PAGE 1
3ØØ7 BD    9653     ØØ15Ø         JSR    $9653
3ØØA BD    9542     ØØ16Ø         JSR    $9542   PCLS
3ØØD C6    Ø1       ØØ17Ø         LDB    #1      GRAPHICS SCREEN
3ØØF BD    95AA     ØØ18Ø         JSR    $95AA
3Ø12 C6    Ø1       ØØ19Ø         LDB    #1      COLOR SET 1
3Ø14 BD    9682     ØØ2ØØ         JSR    $9682
3Ø17 C6    55       ØØ21Ø COLOR1  LDB    #$55    CYAN
3Ø19 D7    B5       ØØ22Ø         STB    $B5
3Ø1B 5F             ØØ23Ø LINE1   CLRB
3Ø1C 86    DC       ØØ24Ø LOOP1   LDA    #22Ø
3Ø1E 17    ØØA7     ØØ25Ø         LBSR   SUBT
3Ø21 97    BE       ØØ26Ø         STA    $BE     X1 LOCATION
3Ø23 86    6Ø       ØØ27Ø         LDA    #96
3Ø25 17    ØØAØ     ØØ28Ø         LBSR   SUBT
3Ø28 97    CØ       ØØ29Ø         STA    $CØ     Y1 LOCATION
3Ø2A 86    8Ø       ØØ3ØØ         LDA    #128
3Ø2C 17    ØØ99     ØØ31Ø         LBSR   SUBT
3Ø2F 97    C4       ØØ32Ø         STA    $C4     X2 LOCATION
3Ø31 86    Ø4       ØØ33Ø         LDA    #4
3Ø33 17    ØØ97     ØØ34Ø         LBSR   ADN
3Ø36 97    C6       ØØ35Ø         STA    $C6     Y2 LOCATION
3Ø38 34    Ø4       ØØ36Ø         PSHS   B
3Ø3A 17    ØØ95     ØØ37Ø         LBSR   LINE
```

```
3Ø3D 35    Ø4     ØØ38Ø          PULS   B
3Ø3F CB    Ø4     ØØ39Ø          ADDB   #4
3Ø41 C1    5C     ØØ4ØØ          CMPB   #92      END OF LINE1 YET?
3Ø43 23    D7     ØØ41Ø          BLS    LOOP1
3Ø45 C6    AA     ØØ42Ø COLOR2   LDB    #$AA     MAGENTA
3Ø47 D7    B5     ØØ43Ø          STB    $B5
3Ø49 5F           ØØ44Ø LINE2    CLRB
3Ø4A 86    8Ø     ØØ45Ø LOOP2    LDA    #128
3Ø4C 8D    7A     ØØ46Ø          BSR    SUBT
3Ø4E 97    BE     ØØ47Ø          STA    $BE      X1 LOCATION
3Ø5Ø 86    Ø4     ØØ48Ø          LDA    #4
3Ø52 8D    79     ØØ49Ø          BSR    ADN
3Ø54 97    CØ     ØØ5ØØ          STA    $CØ      Y1 LOCATION
3Ø56 86    24     ØØ51Ø          LDA    #36
3Ø58 8D    73     ØØ52Ø          BSR    ADN
3Ø5A 97    C4     ØØ53Ø          STA    $C4      X2 LOCATION
3Ø5C 86    6Ø     ØØ54Ø          LDA    #96
3Ø5E 8D    6D     ØØ55Ø          BSR    ADN
3Ø6Ø 97    C6     ØØ56Ø          STA    $C6      Y2 LOCATION
3Ø62 34    Ø4     ØØ57Ø          PSHS   B
3Ø64 8D    6C     ØØ58Ø          BSR    LINE
3Ø66 35    Ø4     ØØ59Ø          PULS   B
3Ø68 CB    Ø4     ØØ6ØØ          ADDB   #4
3Ø6A C1    5C     ØØ61Ø          CMPB   #92      END OF LINE2 YET?
3Ø6C 23    DC     ØØ62Ø          BLS    LOOP2
3Ø6E C6    FF     ØØ63Ø COLOR3   LDB    #$FF     ORANGE
3Ø7Ø D7    B5     ØØ64Ø          STB    $B5
3Ø72 5F           ØØ65Ø LINE3    CLRB
3Ø73 86    24     ØØ66Ø LOOP3    LDA    #36
3Ø75 8D    56     ØØ67Ø          BSR    ADN
3Ø77 97    BE     ØØ68Ø          STA    $BE      X1 LOCATION
3Ø79 86    6Ø     ØØ69Ø          LDA    #96
3Ø7B 8D    5Ø     ØØ7ØØ          BSR    ADN
3Ø7D 97    CØ     ØØ71Ø          STA    $CØ      Y1 LOCATION
3Ø7F 86    8Ø     ØØ72Ø          LDA    #128
3Ø81 8D    4A     ØØ73Ø          BSR    ADN
3Ø83 97    C4     ØØ74Ø          STA    $C4      X2 LOCATION
3Ø85 86    BC     ØØ75Ø          LDA    #188
3Ø87 8D    3F     ØØ76Ø          BSR    SUBT
3Ø89 97    C6     ØØ77Ø          STA    $C6      Y2 LOCATION
3Ø8B 34    Ø4     ØØ78Ø          PSHS   B
3Ø8D 8D    43     ØØ79Ø          BSR    LINE
3Ø8F 35    Ø4     ØØ8ØØ          PULS   B
3Ø91 CB    Ø4     ØØ81Ø          ADDB   #4
3Ø93 C1    5C     ØØ82Ø          CMPB   #92      END OF LINE3 YET?
3Ø95 23    DC     ØØ83Ø          BLS    LOOP3
3Ø97 C6    AA     ØØ84Ø COLOR4   LDB    #$AA     MAGENTA
3Ø99 D7    B5     ØØ85Ø          STB    $B5
3Ø9B 5F           ØØ86Ø LINE4    CLRB
3Ø9C 86    8Ø     ØØ87Ø LOOP4    LDA    #128
3Ø9E 8D    2D     ØØ88Ø          BSR    ADN
3ØAØ 97    BE     ØØ89Ø          STA    $BE      X1 LOCATION
3ØA2 86    BC     ØØ9ØØ          LDA    #188
3ØA4 8D    22     ØØ91Ø          BSR    SUBT
3ØA6 97    CØ     ØØ92Ø          STA    $CØ      Y1 LOCATION
3ØA8 86    DC     ØØ93Ø          LDA    #22Ø
3ØAA 8D    1C     ØØ94Ø          BSR    SUBT
3ØAC 97    C4     ØØ95Ø          STA    $C4      X2 LOCATION
```

```
3ØAE 86    6Ø      ØØ96Ø          LDA     #96
3ØBØ 8D    16      ØØ97Ø          BSR     SUBT
3ØB2 97    C6      ØØ98Ø          STA     $C6      Y2 LOCATION
3ØB4 34    Ø4      ØØ99Ø          PSHS    B
3ØB6 8D    1A      Ø1ØØØ          BSR     LINE
3ØB8 35    Ø4      Ø1Ø1Ø          PULS    B
3ØBA CB    Ø4      Ø1Ø2Ø          ADDB    #4
3ØBC C1    5C      Ø1Ø3Ø          CMPB    #92      END OF LINE4 YET?
3ØBE 23    DC      Ø1Ø4Ø          BLS     LOOP4
3ØCØ BD    ADFB    Ø1Ø5Ø DONE     JSR     $ADFB    WAIT FOR INPUT
3ØC3 5F            Ø1Ø6Ø          CLRB             TEXT SCREEN
3ØC4 BD    95AA    Ø1Ø7Ø          JSR     $95AA
3ØC7 3F            Ø1Ø8Ø          SWI              RTS IF IN BASIC
3ØC8 34    Ø4      Ø1Ø9Ø SUBT     PSHS    B
3ØCA AØ    EØ      Ø11ØØ          SUBA    ,S+
3ØCC 39            Ø111Ø          RTS
3ØCD 34    Ø4      Ø112Ø ADN      PSHS    B
3ØCF AB    EØ      Ø113Ø          ADDA    ,S+
3ØD1 39            Ø114Ø          RTS
3ØD2 BD    931D    Ø115Ø LINE     JSR     $931D    SCALE X1 AND Y1
3ØD5 CE    ØØC3    Ø116Ø          LDU     #$C3     START OF X2
3ØD8 BD    932Ø    Ø117Ø          JSR     $932Ø    SCALE X2 AND Y2
3ØDB BD    94A1    Ø118Ø          JSR     $94A1    DRAW THE LINE(X1,Y1)-(X2,Y2)
3ØDE 39            Ø119Ø          RTS
           3ØØØ    Ø12ØØ          END     START

ØØØØØ TOTAL ERRORS
```