M. David Johnson
http://www.bds-soft.com
info@bds-soft.com

Printer Operations Routines
for the
ML Foundation System

by M. David Johnson

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Abstract

The Printer Operations Routines are presented, as a subsystem of the ML Foundation System, to run on top of the ML Foundation Core, and to provide the ability to send text to the printer via the Color Computer's RS-232 "BitBanger" port.

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This paper and its associated code are available online at:

http://www.bds-soft.com/cocoPapers.php .

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Introduction

The Printer Operations Routines provide to the ML Foundation System the ability to send individual characters, 8-bit bytes, 16-bit words, unsigned five-digit decimal numbers, and zero-terminated character strings to the CoCo’s serial printer connected to the RS-232 “BitBanger” port.

The Routines, as presented here, occupy memory locations $7300 - $73FF (Located in the 2024PrinterCode folder on the BDS Software website). But moving them to other memory locations is not difficult. For another testing situation, I re-assembled the routines to memory locations $7F00 - $7FFF (Located in the 2024PrinterCodeHigh folder on the BDS Software website), and they worked fine there as well.

They have been successfully tested on VCC 2.1.0.7 but have not been tested with a physical serial printer (mostly because I don’t have one).

This paper and its associated code are available online at:

http://www.bds-soft.com/cocoPapers.php .

Enjoy!

M.D.J. 2024/05/01
info@bds-soft.com

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General Methodology

In this paper, the Assembly Language Programming and Listings were prepared using Disk EDTASM+ 01.00.00.

Please note that the “number” handling routines, like the ML Foundation Core itself, only deal with 8-bit and 16-bit Unsigned Integers. The handling of Signed Integers, Multiword Integers, Floating Point Numbers, Complex Numbers, etc. is left for sometime in the future when I may be working on some application that requires such.

The programs and routines are presented in order of memory location.

The individual programs and routines are fairly well structured internally, but are located at $7300, an address which was convenient to other code I was developing at the time. You may find it more convenient to relocate the code to some other location more convenient to your own projects.

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As I mentioned in the Introduction, they worked fine at $7F00 as well. In fact, I used them at $7F00 to develop BIPPDBUG.ASM, a Register Contents and System State Reporter which appears at the end of this paper, just before the Appendices (Also located in the 2024PrinterCodeHigh folder on the BDS Software website).

I do most (“99.44%” [yes that’s an Ivory Soap reference from 150 years ago]), I say most of my CoCo development on Vcc on a Windows 11 machine. With this Reporter, I can run the program in the Vcc Screen while having it report its status at various points on the Vcc “Bitbanger” printer.

For much of such reporting, I just LDA a selected location number (e.g. #1, #2, etc. - representing wherever that LDA statement is located in the program) and then just do a JSR BPDBGA to learn whether the program run reached that location or not.

In other cases, I can LDD a given value in the program and JSR BPDBGD to have it report whether that value is what I expected, or something else.

Note that the PC Register is reported correctly, but that report isn’t particularly useful because it’s always $76A1, the instruction right after the PSHU PC. Sigh! Another entry for the “TODO: Someday” list.

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You will also note that I have left small sections of unused memory between the various routines in the interests of the debugging and revising processes.

Please also note that these routines require the presence of LSYSVR.BIN and DECMAL.BIN, two routines written during some continuing Maze Game development. For reference, these two routines are presented at the end of this document; after the TESTER.BAS code and before BIPPDBUG.ASM.

The code is all fairly well commented and should thus be reasonably easy to follow and understand.

Minimal Testing is recorded in this paper; just enough to assure that the routines worked as expected. Try them out: Test them for yourself. I'll appreciate any comments or suggestions.

=====

PTPCHR.ASM: Routine to Put a Character To the Printer

```
                   00100 *****
                   00110 *
                   00120 * PTPCHR.ASM
                   00130 * MDJ 2024/04/07
                   00140 *
                   00150 * PUT CHARACTER TO PRINTER
                   00160 *
                   00170 * USES THE BUILT-IN
                   00180 * ROM BASIC UART CODE
                   00190 *
                   00200 * ENTRY CONDITIONS:
                   00210 * A = CHAR CODE
                   00220 *
                   00230 * EXIT CONDITIONS:
                   00240 * NONE
                   00250 *
                   00260 *****
                   00270
                   00280 * RAMROM TRIGGER ADDRESS
          FFDE     00290 RAMROM  EQU     $FFDE
                   00300
                   00310 * ALLRAM TRIGGER ADDRESS
          FFDF     00320 ALLRAM  EQU     $FFDF
                   00330
                   00340 * ROM PRINTER UART ROUTINE
          A2BF     00350 PUART   EQU     $A2BF
                   00360
7300               00370         ORG     $7300
                   00380
7300 34   06       00390 PTPCHR  PSHS    A,B
                   00400
7302 F7   FFDE     00410         STB     RAMROM  SET RAMROM MODE
7305 BD   A2BF     00420         JSR     PUART   PUT CHAR TO
PRINTER
7308 F7   FFDF     00430         STB     ALLRAM  SET ALLRAM MODE
                   00440
730B 35   06       00450         PULS    A,B
                   00460
730D 39            00470 ENDCHK  RTS
                   00480
730E               00490 SPARE   RMB     17
731F               00500 ENDCH2  RMB     1
```

```
               00510
0000           00520              END
```

PTCRLF.ASM: Routine to Put a Carriage Return To the Printer (The Line Feed is Automatic)

```
                   00100 *****
                   00110 *
                   00120 * PTCRLF.ASM
                   00130 * MDJ 2024/04/08
                   00140 *
                   00150 * SEND A CRLF TO THE PRINTER
                   00160 *
                   00170 * ENTRY CONDITIONS:
                   00180 * NONE
                   00190 *
                   00200 * EXIT CONDITIONS:
                   00210 * NONE
                   00220 *
                   00230 *****
                   00240
                   00250 * EXTERNAL ROUTINE
          7300     00260 PTPCHR  EQU     $7300   PUT CHAR TO PRINTER
                   00270
7320               00280         ORG     $7320
                   00290
7320 34   02       00300 PTCRLF  PSHS    A
                   00310
7322 86   0D       00320         LDA     #$0D    CARRIAGE RETURN
7324 BD   7300     00330         JSR     PTPCHR  PUT TO PRINTER
                   00340
                   00350 * COCO DOES AUTOMATIC LF TO PRINTER
                   00360 * DON'T NEED THIS "LF" CODE
                   00370 *        LDA     #$0A    LINE FEED
                   00380 *        JSR     PTPCHR  PUT TO PRINTER
                   00390
7327 35   02       00400         PULS    A
                   00410
7329 39            00420 ENDCHK  RTS
                   00430
732A               00440 SPARE   RMB     21
733F               00450 ENDCH2  RMB     1
                   00460
          0000     00470         END
```

PTPBYT.ASM: Routine to Put an 8-bit Unsigned Byte To the Printer As Two Hexadecimal Digits

```
                   00100 *****
                   00110 *
                   00120 * PTPBYT.ASM
                   00130 * MDJ 2024/04/08
                   00140 *
                   00150 * PUTS AN 8-BIT UNSIGNED NUMBER
                   00160 * TO THE PRINTER AS TWO
                   00170 * HEXADECIMAL DIGITS
                   00180 *
                   00190 * ENTRY CONDITIONS:
                   00200 * A = THE 8-BIT NUMBER
                   00210 *
                   00220 * EXIT CONDITIONS:
                   00230 * NONE
                   00240 *
                   00250 *****
                   00260
                   00270 * SCRATCHPAD VARIABLES
                   00280 * THE 8-BIT NUMBER
          0076     00290 L0076   EQU     $0076
                   00300
                   00310 * THE HIGH NIBBLE
          0077     00320 L0077   EQU     $0077
                   00330
                   00340 * THE LOW NIBBLE
          00F3     00350 L00F3   EQU     $00F3
                   00360
                   00370 * EXTERNAL ROUTINE
          7300     00380 PTPCHR  EQU     $7300
                   00390
7340               00400         ORG     $7340
                   00410
7340 34   02       00420 PTPBYT  PSHS    A
                   00430
                   00440 * SAVE THE NUMBER
7342 97   76       00450         STA     L0076
                   00460
                   00470 * DIVIDE BY 16
7344 44            00480         LSRA
7345 44            00490         LSRA
```

```
7346 44           00500          LSRA
7347 44           00510          LSRA
                  00520
                  00530 * SAVE THE HIGH NIBBLE
7348 97   77      00540          STA     L0077
                  00550
                  00560 * MULTIPLY BY 16
734A 48           00570          LSLA
734B 48           00580          LSLA
734C 48           00590          LSLA
734D 48           00600          LSLA
                  00610
                  00620 * SAVE TEMP RESULT
734E 97   F3      00630          STA     L00F3
                  00640
                  00650 * GET THE NUMBER AGAIN
7350 96   76      00660          LDA     L0076
                  00670
                  00680 * SUBTRACT TEMP RESULT
7352 90   F3      00690          SUBA    L00F3
                  00700
                  00710 * SAVE LOW NIBBLE
7354 97   F3      00720          STA     L00F3
                  00730
                  00740 * IS LOW NIBBLE <= 9
7356 81   09      00750          CMPA    #9
                  00760
                  00770 * GO IF NO
7358 22   04      00780          BHI     LBL001
                  00790
                  00800 * ADD ZERO OFFSET
                  00810 * NOTE THAT THIS IS #112
                  00820 * IN SCREEN CODE
735A 8B   30      00830          ADDA    #48
735C 20   02      00840          BRA     LBL002
                  00850
                  00860 * ADD "A" OFFSET
735E 8B   37      00870 LBL001  ADDA    #55
                  00880
                  00890 * SAVE LOW NIBBLE CHAR
7360 97   F3      00900 LBL002  STA     L00F3
                  00910
                  00920 * GET HIGH NIBBLE
7362 96   77      00930          LDA     L0077
                  00940
                  00950 * IS HIGH NIBBLE <= 9
7364 81   09      00960          CMPA    #9
```

```
                   00970
                   00980 * GO IF NO
7366 22   04       00990         BHI     LBL003
                   01000
                   01010 * ADD ZERO OFFSET
                   01020 * NOTE THAT THIS IS #112
                   01030 * IN SCREEN CODE
7368 8B   30       01040         ADDA    #48
736A 20   02       01050         BRA     LBL004
                   01060
                   01070 * ADD "A" OFFSET
736C 8B   37       01080 LBL003  ADDA    #55
                   01090
                   01100 * PUT HIGH NIBBLE CHAR
                   01110 * TO THE PRINTER
736E BD   7300     01120 LBL004  JSR     PTPCHR
                   01130
                   01140 * GET LOW NIBBLE CHAR
7371 96   F3       01150         LDA     L00F3
                   01160
                   01170 * PUT LOW NIBBLE CHAR
                   01180 * TO THE PRINTER
7373 BD   7300     01190         JSR     PTPCHR
                   01200
7376 35   02       01210         PULS    A
                   01220
7378 39            01230 ENDCHK  RTS
                   01240
7379               01250 SPARE   RMB     6
737F               01260 ENDCH2  RMB     1
                   01270
          0000     01280         END
```

PTPBYTSP.ASM: Routine to Put an 8-bit Unsigned Byte To the Printer As Two Hexadecimal Digits Followed by a Single Space

```
                   00100 *****
                   00110 *
                   00120 * PTPBYTSP.ASM
                   00130 * MDJ 2024/04/08
                   00140 *
                   00150 * PUTS AN 8-BIT UNSIGNED NUMBER
                   00160 * TO THE PRINTER AS TWO
                   00170 * HEXADECIMAL DIGITS,
                   00180 * FOLLOWED BY A SPACE
                   00190 *
                   00200 * ENTRY CONDITIONS:
                   00210 * A = THE 8-BIT NUMBER
                   00220 *
                   00230 * EXIT CONDITIONS:
                   00240 * NONE
                   00250 *
                   00260 *****
                   00270
                   00280 * EXTERNAL ROUTINES
          7300     00290 PTPCHR  EQU     $7300
          7340     00300 PTPBYT  EQU     $7340
                   00310
7380               00320         ORG     $7380
                   00330
7380 34   02       00340 PTBYTS  PSHS    A
                   00350
7382 BD   7340     00360         JSR     PTPBYT  PUT THE BYTE
7385 86   20       00370         LDA     #$20    SPACE
7387 BD   7300     00380         JSR     PTPCHR  PUT THE SPACE
                   00390
738A 35   02       00400         PULS    A
                   00410
738C 39            00420 ENDCHK  RTS
                   00430
738D               00440 SPARE   RMB     2
738F               00450 ENDCH2  RMB     1
                   00460
          0000     00470         END
```

PTPS00.ASM: Routine to Put a Zero-Terminated String To the Printer

```
                    00100 *****
                    00110 *
                    00120 * PTPS00.ASM
                    00130 * MDJ 2024/04/08
                    00140 *
                    00150 * PRINTS A NULL-TERMINATED
                    00160 * STRING ($00) TO THE
                    00170 * PRINTER
                    00180 *
                    00190 * THE NUL IS NOT COUNTED
                    00200 * AS PART OF THE STRING
                    00210 * AND IS NOT PRINTED
                    00220 *
                    00230 * ENTRY CONDITIONS:
                    00240 * X = START ADDRESS
                    00250 *     OF THE STRING
                    00260 *
                    00270 * EXIT CONDITIONS:
                    00280 * NONE
                    00290 *
                    00300 *****
                    00310
                    00320 * EXTERNAL ROUTINE
          7300      00330 PTPCHR  EQU     $7300
                    00340
7390                00350         ORG     $7390
                    00360
7390 34   12        00370 PTPS00  PSHS    A,X
                    00380
7392 A6   80        00390 LBL001  LDA     ,X+     GET A CHARACTER
7394 27   05        00400         BEQ     LBL002  GO IF NUL ($00)
7396 BD   7300      00410         JSR     PTPCHR  GO PRINT
CHARACTER
7399 20   F7        00420         BRA     LBL001  RETURN FOR NEXT
CHARACTER
                    00430
739B 35   12        00440 LBL002  PULS    A,X
                    00450
739D 39             00460 ENDCHK  RTS
                    00470
```

```
739E              00480 SPARE   RMB     1
739F              00490 ENDCH2  RMB     1
                  00500
          0000    00510         END
```

PTPWRD.ASM: Routine to Put a 16-bit Unsigned Word To the Printer As Four Hexadecimal Digits

```
                   00100 *****
                   00110 *
                   00120 * PTPWRD.ASM
                   00130 * MDJ 2024/04/08
                   00140 *
                   00150 * PUTS A 16-BIT UNSIGNED NUMBER
                   00160 * TO THE PRINTER AS FOUR
                   00170 * HEXADECIMAL DIGITS
                   00180 *
                   00190 * ENTRY CONDITIONS:
                   00200 * D = THE 16-BIT NUMBER
                   00210 *
                   00220 * EXIT CONDITIONS:
                   00230 * NONE
                   00240 *
                   00250 *****
                   00260
                   00270 * EXTERNAL ROUTINE
          7340     00280 PTPBYT  EQU     $7340
                   00290
73A0               00300         ORG     $73A0
                   00310
73A0 34   06       00320 PTPWRD  PSHS    A,B
                   00330
                   00340 * SAVE THE LOW BYTE
73A2 34   04       00350         PSHS    B
                   00360
                   00370 * PRINT THE HIGH BYTE
73A4 BD   7340     00380         JSR     PTPBYT
                   00390
                   00400 * RESTORE THE LOW BYTE
                   00410 * BUT INTO REGISTER A
73A7 35   02       00420         PULS    A
                   00430
                   00440 * PRINT THE LOW BYTE
73A9 BD   7340     00450         JSR    PTPBYT
                   00460
73AC 35   06       00470         PULS    A,B
```

```
                        00480
73AE 39                 00490 ENDCHK  RTS
                        00500
73AF                    00510 SPARE   RMB     0
73AF                    00520 ENDCH2  RMB     1
                        00530
           0000         00540         END
```

PTPWRDSP.ASM: Routine to Put a 16-bit Unsigned Word To the Printer As Four Hexadecimal Digits Followed by a Single Space

```
                    00100 *****
                    00110 *
                    00120 * PTPWRDSP.ASM
                    00130 * MDJ 2024/04/08
                    00140 *
                    00150 * PUTS A 16-BIT UNSIGNED NUMBER
                    00160 * TO THE PRINTER AS FOUR
                    00170 * HEXADECIMAL DIGITS,
                    00180 * FOLLOWED BY A SPACE
                    00190 *
                    00200 * ENTRY CONDITIONS:
                    00210 * D = THE 16-BIT NUMBER
                    00220 *
                    00230 * EXIT CONDITIONS:
                    00240 * NONE
                    00250 *
                    00260 *****
                    00270
                    00280 * EXTERNAL ROUTINES
          7300      00290 PTPCHR  EQU     $7300
          73A0      00300 PTPWRD  EQU     $73A0
                    00310
73B0                00320         ORG     $73B0
                    00330
73B0 34   06        00340 PTWRDS  PSHS    A,B
                    00350
73B2 BD   73A0      00360         JSR     PTPWRD  PUT THE WORD
73B5 86   20        00370         LDA     #$20    SPACE
73B7 BD   7300      00380         JSR     PTPCHR  PUT THE SPACE
                    00390
73BA 35   06        00400         PULS    A,B
                    00410
73BC 39             00420 ENDCHK  RTS
                    00430
73BD                00440 SPARE   RMB     2
73BF                00450 ENDCH2  RMB     1
```

```
         00460
0000     00470         END
```

PTPDEC.ASM: Routine to Put a 16-bit Unsigned Word To the Printer As Five Decimal Digits

```
                   00100 *****
                   00110 *
                   00120 * PTPDEC.ASM
                   00130 * MDJ 2024/04/08
                   00140 *
                   00150 * PUTS A 16-BIT UNSIGNED NUMBER
                   00160 * TO THE PRINTER AS FIVE
                   00170 * DECIMAL DIGITS
                   00180 *
                   00190 * ENTRY CONDITIONS:
                   00200 * D = THE 16-BIT NUMBER
                   00210 *
                   00220 * EXIT CONDITIONS:
                   00230 * NONE
                   00240 *
                   00250 *****
                   00260
                   00270 * EXTERNAL VARIABLES
                   00280 * THE DECIMAL DIGITS
          5910     00290 DIGIT4  EQU     $5910
          5911     00300 DIGIT3  EQU     $5911
          5912     00310 DIGIT2  EQU     $5912
          5913     00320 DIGIT1  EQU     $5913
          5914     00330 DIGIT0  EQU     $5914
                   00340
                   00350 * EXTERNAL ROUTINES
          5930     00360 DECMAL  EQU     $5930
          7300     00370 PTPCHR  EQU     $7300
                   00380
73C0               00390         ORG     $73C0
                   00400
73C0 34   06       00410 PTPDEC  PSHS    A,B
                   00420
73C2 BD   5930     00430         JSR     DECMAL  DO THE
CONVERSTION
73C5 B6   5910     00440         LDA     DIGIT4  PRINT THE
RESULTS
73C8 BD   7300     00450         JSR     PTPCHR
```

```
73CB B6   5911     00460          LDA     DIGIT3
73CE BD   7300     00470          JSR     PTPCHR
73D1 B6   5912     00480          LDA     DIGIT2
73D4 BD   7300     00490          JSR     PTPCHR
73D7 B6   5913     00500          LDA     DIGIT1
73DA BD   7300     00510          JSR     PTPCHR
73DD B6   5914     00520          LDA     DIGIT0
73E0 BD   7300     00530          JSR     PTPCHR
                   00540
73E3 35   06       00550          PULS    A,B
                   00560
73E5 39            00570 ENDCHK   RTS
                   00580
73E6               00590 SPARE    RMB     9
73EF               00600 ENDCH2   RMB     1
                   00610
          0000     00620          END
```

PTPDECSP.ASM: Routine to Put a 16-bit Unsigned Word To the Printer As Five Decimal Digits Followed by a Single Space

```
                   00100 *****
                   00110 *
                   00120 * PTPDECSP.ASM
                   00130 * MDJ 2024/04/08
                   00140 *
                   00150 * PUTS A 16-BIT UNSIGNED NUMBER
                   00160 * TO THE PRINTER AS FIVE
                   00170 * DECIMAL DIGITS, FOLLOWED BY
                   00180 * A SPACE
                   00190 *
                   00200 * ENTRY CONDITIONS:
                   00210 * D = THE 16-BIT NUMBER
                   00220 *
                   00230 * EXIT CONDITIONS:
                   00240 * NONE
                   00250 *
                   00260 *****
                   00270
                   00280 * EXTERNAL ROUTINES
          7300     00290 PTPCHR  EQU     $7300
          73C0     00300 PTPDEC  EQU     $73C0
                   00310
73F0               00320         ORG     $73F0
                   00330
73F0 34   06       00340 PTDECS  PSHS    A,B
                   00350
73F2 BD   73C0     00360         JSR     PTPDEC  PUT THE DECIMAL
73F5 86   20       00370         LDA     #$20    SPACE
73F7 BD   7300     00380         JSR     PTPCHR  PUT THE SPACE
                   00390
73FA 35   06       00400         PULS    A,B
                   00410
73FC 39            00420 ENDCHK  RTS
                   00430
73FD               00440 SPARE   RMB     2
73FF               00450 ENDCH2  RMB     1
```

```
               00460
0000           00470            END
```

TESTER.ASM: Program to Test the Printer Operations Routines

```
                   00100 *****
                   00110 *
                   00120 * TESTER.ASM
                   00130 * MDJ 2024/04/08
                   00140 *
                   00150 * TESTING FOR MLF
                   00160 * PRINTER CODE
                   00170 *
                   00180 * ASSEMBLE AS TESTER.BIN
                   00190 *
                   00200 *****
                   00210
                   00220 * EXTERNAL VARIABLE
          0088     00230 CURPOS  EQU     $0088
                   00240
                   00250 * GENERAL EXTERNAL ROUTINES IN MLF
          400E     00260 VIDCLS  EQU     $400E
          40D7     00270 CRLF    EQU     $40D7
          4142     00280 POLCAT  EQU     $4142
          420A     00290 PRTS00  EQU     $420A
                   00300
                   00310 * PRINTER-SPECIFIC EXTERNAL ROUTINES
          7300     00320 PTPCHR  EQU     $7300   PUT CHARACTER
TO PRINTER
          7320     00330 PTCRLF  EQU     $7320   PUT CRLF TO
PRINTER
          7340     00340 PTPBYT  EQU     $7340   PUT BYTE TO
PRINTER
          7380     00350 PTBYTS  EQU     $7380   PUT BYTE +
SPACE TO PRINTER
          7390     00360 PTPS00  EQU     $7390   PUT 0TERM
STRING TO PRINTER
          73A0     00370 PTPWRD  EQU     $73A0   PUT WORD TO
PRINTER
          73B0     00380 PTWRDS  EQU     $73B0   PUT WORD +
SPACE TO PRINTER
          73C0     00390 PTPDEC  EQU     $73C0   PUT DECIMAL TO
PRINTER
          73F0     00400 PTDECS  EQU     $73F0   PUT DECIMAL +
SPACE TO PRINTER
                   00410
6000               00420         ORG     $6000
```

```
                   00430
6000 34   36       00440 TESTER  PSHS    A,B,X,Y
                   00450
6002 16   0193     00460         LBRA    LBL001
                   00470
6005      0000     00480 TESTID  FDB     $0000   TEST #0
IDENTIFIER
                   00490
6007      50       00500 MSG001  FCC     'PRINTER TEST #0:'
          52
          49
          4E
          54
          45
          52
          20
          54
          45
          53
          54
          20
          23
          30
          3A
6017      00       00510         FCB     0
6018      54       00520 MSG002  FCC     'TEST WAS SUCCESSFUL.'
          45
          53
          54
          20
          57
          41
          53
          20
          53
          55
          43
          43
          45
          53
          53
          46
          55
          4C
          2E
602C      00       00530         FCB     0
```

```
                   00540 *
'XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX'
602D      50       00550 MSG003  FCC     'PRESS ANY KEY TO
CONTINUE.'
          52
          45
          53
          53
          20
          41
          4E
          59
          20
          4B
          45
          59
          20
          54
          4F
          20
          43
          4F
          4E
          54
          49
          4E
          55
          45
          2E
6047      00       00560         FCB     0
6048      50       00570 MSG004  FCC     'PRESS ANY KEY TO
EXIT.'
          52
          45
          53
          53
          20
          41
          4E
          59
          20
          4B
          45
          59
          20
          54
          4F
```

```
        20
        45
        58
        49
        54
        2E
605E    00      00580           FCB     0
605F    50      00590 MSG005    FCC     'PTPCHR TEST:'
        54
        50
        43
        48
        52
        20
        54
        45
        53
        54
        3A
606B    00      00600           FCB     0
606C    50      00610 MSG006    FCC     'PTCRLF TEST:'
        54
        43
        52
        4C
        46
        20
        54
        45
        53
        54
        3A
6078    00      00620           FCB     0
6079    50      00630 MSG007    FCC     'PTPBYT TEST:'
        54
        50
        42
        59
        54
        20
        54
        45
        53
        54
        3A
6085    00      00640           FCB     0
6086    50      00650 MSG008    FCC     'PTPBYTSP TEST:'
```

```
          54
          50
          42
          59
          54
          53
          50
          20
          54
          45
          53
          54
          3A
6094      00       00660        FCB     0
6095      50       00670 MSG009 FCB     'PTPS00 TEST:'
          54
          50
          53
          30
          30
          20
          54
          45
          53
          54
          3A
60A1      00       00680        FCB     0
60A2      50       00690 MSG010 FCC     'PTPWRD TEST:'
          54
          50
          57
          52
          44
          20
          54
          45
          53
          54
          3A
60AE      00       00700        FCB     0
60AF      50       00710 MSG011 FCC     'PTPWRDSP TEST:'
          54
          50
          57
          52
          44
          53
          50
          20
          54
          45
          53
          54
          3A
60BD      00       00720          FCB     0
60BE      50       00730 MSG012   FCC     'PTPDEC TEST:'
          54
          50
          44
          45
          43
          20
          54
          45
          53
          54
          3A
60CA      00       00740          FCB     0
60CB      50       00750 MSG013   FCC     'PTPDECSP TEST:'
          54
          50
          44
          45
          43
          53
          50
          20
          54
          45
          53
          54
          3A
60D9      00       00760          FCB     0
60DA      54       00770 MSG014   FCC     'TESTING IS COMPLETE:'
          45
          53
          54
          49
          4E
          47
          20
          49
          53
          20
          43
          4F
          4D
          50
          4C
          45
          54
          45
          3A
60EE      00       00780         FCB     0
                   00790 *
'XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX'
60EF      54       00800 MSG015  FCC     'THIS IS A STRING TO
PUT TO THE PRINTER
.'
          48
          49
          53
          20
          49
          53
          20
          41
          20
          53
          54
          52
          49
          4E
          47
          20
          54
          4F
          20
          50
          55
          54
          20
          54
          4F
          20
          54
          48
          45
          20
          50
          52
          49
          4E
          54
          45
          52
          2E
6116      00        00810         FCB     0
6117      54        00820 MSG016  FCC     'THIS IS ALSO SUCH A
STRING.'
          48
          49
          53
          20
          49
          53
          20
          41
          4C
          53
          4F
          20
          53
          55
          43
          48
          20
          41
          20
          53
          54
          52
          49
          4E
          47
          2E
6132      00        00830         FCB     0
6133      48        00840 MSG017  FCC     'HOLDING.'
          4F
          4C
          44
          49
          4E
          47
          2E
613B      00        00850         FCB     0
613C      45        00860 MSG018  FCC     'END OF RUN.'
          4E
          44
          20
          4F
          46
          20
          52
          55
          4E
          2E
6147      00        00870          FCB     0
6148      50        00880 MSG019   FCC     'PREFIX/POSTFIX TEST'
          52
          45
          46
          49
          58
          2F
          50
          4F
          53
          54
          46
          49
          58
          20
          54
          45
          53
          54
615B      00        00890          FCB     0
615C      54        00900 MSG020   FCC     'THIS IS THE PREFIXED
TEXT '
          48
          49
          53
          20
          49
          53
          20
          54
          48
          45
          20
          50
          52
          45
          46
          49
          58
          45
          44
          20
          54
          45
          58
          54
          20
6176      00        00910          FCB     0
6177      20        00920 MSG021   FCC     ' AND THIS IS THE
POSTFIXED TEXT.'
          41
          4E
          44
          20
          54
          48
          49
          53
          20
          49
          53
          20
          54
          48
          45
          20
          50
          4F
          53
          54
          46
          49
          58
          45
          44
          20
          54
          45
          58
          54
          2E
6197      00        00930          FCB     0
                    00940
                    00950 * GENERAL SETUP OF SCREEN
```

```
6198 BD   400E     00960 LBL001  JSR     VIDCLS
619B 8E   0400     00970         LDX     #$0400
619E 9F   88       00980         STX     CURPOS
61A0 8E   6007     00990         LDX     #MSG001
61A3 BD   420A     01000         JSR     PRTS00
61A6 BD   40D7     01010         JSR     CRLF
61A9 BD   7320     01020         JSR     PTCRLF
61AC BD   7320     01030         JSR     PTCRLF
61AF 8E   6007     01040         LDX     #MSG001
61B2 BD   7390     01050         JSR     PTPS00
61B5 BD   7320     01060         JSR     PTCRLF
                   01070
                   01080 * PTPCHR TEST
61B8 BD   40D7     01090         JSR     CRLF
61BB 8E   605F     01100         LDX     #MSG005
61BE BD   420A     01110         JSR     PRTS00
61C1 BD   40D7     01120         JSR     CRLF
61C4 8E   602D     01130         LDX     #MSG003
61C7 BD   420A     01140         JSR     PRTS00
61CA BD   40D7     01150         JSR     CRLF
61CD BD   641C     01160         JSR     LBL002
                   01170
                   01180 *LBLCHK  LDX      #MSG017
                   01190 *        JSR      PRTS00
                   01200 *        JSR      CRLF
                   01210 *LBLHLD  BRA      LBLHLD
                   01220
61D0 86   4D       01230         LDA     #$4D    "M"
61D2 BD   7300     01240         JSR     PTPCHR
61D5 86   44       01250         LDA     #$44    "D"
61D7 BD   7300     01260         JSR     PTPCHR
61DA 86   4A       01270         LDA     #$4A    "J"
61DC BD   7300     01280         JSR     PTPCHR
                   01290
61DF 8E   6018     01300         LDX     #MSG002
61E2 BD   420A     01310         JSR     PRTS00
61E5 BD   40D7     01320         JSR     CRLF
                   01330
                   01340 * PTCRLF TEST
61E8 BD   40D7     01350         JSR     CRLF
61EB 8E   606C     01360         LDX     #MSG006
61EE BD   420A     01370         JSR     PRTS00
61F1 BD   40D7     01380         JSR     CRLF
61F4 8E   602D     01390         LDX     #MSG003
61F7 BD   420A     01400         JSR     PRTS00
61FA BD   40D7     01410         JSR     CRLF
61FD BD   641C     01420         JSR     LBL002
```

```
                    01430
6200 BD   7320      01440           JSR     PTCRLF
6203 86   4D        01450           LDA     #$4D     "M"
6205 BD   7300      01460           JSR     PTPCHR
6208 86   44        01470           LDA     #$44     "D"
620A BD   7300      01480           JSR     PTPCHR
620D 86   4A        01490           LDA     #$4A     "J"
620F BD   7300      01500           JSR     PTPCHR
6212 BD   7320      01510           JSR     PTCRLF
6215 86   4A        01520           LDA     #$4A     "J"
6217 BD   7300      01530           JSR     PTPCHR
621A 86   4D        01540           LDA     #$4D     "M"
621C BD   7300      01550           JSR     PTPCHR
621F 86   44        01560           LDA     #$44     "D"
6221 BD   7300      01570           JSR     PTPCHR
6224 BD   7320      01580           JSR     PTCRLF
                    01590
6227 8E   6018      01600           LDX     #MSG002
622A BD   420A      01610           JSR     PRTS00
622D BD   40D7      01620           JSR     CRLF
                    01630
                    01640 * PTPBYT TEST
6230 BD   40D7      01650           JSR     CRLF
6233 8E   6079      01660           LDX     #MSG007
6236 BD   420A      01670           JSR     PRTS00
6239 BD   40D7      01680           JSR     CRLF
623C 8E   602D      01690           LDX     #MSG003
623F BD   420A      01700           JSR     PRTS00
6242 BD   40D7      01710           JSR     CRLF
6245 BD   641C      01720           JSR     LBL002
                    01730
6248 86   01        01740           LDA     #$01
624A BD   7340      01750           JSR     PTPBYT
624D 86   3A        01760           LDA     #$3A
624F BD   7340      01770           JSR     PTPBYT
6252 86   47        01780           LDA     #$47
6254 BD   7340      01790           JSR     PTPBYT
6257 86   C9        01800           LDA     #$C9
6259 BD   7340      01810           JSR     PTPBYT
                    01820
625C BD   7320      01830           JSR     PTCRLF
625F 8E   6018      01840           LDX     #MSG002
6262 BD   420A      01850           JSR     PRTS00
6265 BD   40D7      01860           JSR     CRLF
                    01870
                    01880 * PTPBYTSP TEST
6268 BD   40D7      01890           JSR     CRLF
```

```
626B 8E   6086     01900          LDX     #MSG008
626E BD   420A     01910          JSR     PRTS00
6271 BD   40D7     01920          JSR     CRLF
6274 8E   602D     01930          LDX     #MSG003
6277 BD   420A     01940          JSR     PRTS00
627A BD   40D7     01950          JSR     CRLF
627D BD   641C     01960          JSR     LBL002
                   01970
6280 86   01       01980          LDA     #$01
6282 BD   7380     01990          JSR     PTBYTS
6285 86   3A       02000          LDA     #$3A
6287 BD   7380     02010          JSR     PTBYTS
628A 86   47       02020          LDA     #$47
628C BD   7380     02030          JSR     PTBYTS
628F 86   C9       02040          LDA     #$C9
6291 BD   7380     02050          JSR     PTBYTS
                   02060
6294 BD   7320     02070          JSR     PTCRLF
6297 8E   6018     02080          LDX     #MSG002
629A BD   420A     02090          JSR     PRTS00
629D BD   40D7     02100          JSR     CRLF
                   02110
                   02120 * PTPS00 TEST
62A0 BD   40D7     02130          JSR     CRLF
62A3 8E   6095     02140          LDX     #MSG009
62A6 BD   420A     02150          JSR     PRTS00
62A9 BD   40D7     02160          JSR     CRLF
62AC 8E   602D     02170          LDX     #MSG003
62AF BD   420A     02180          JSR     PRTS00
62B2 BD   40D7     02190          JSR     CRLF
62B5 BD   641C     02200          JSR     LBL002
                   02210
62B8 8E   60EF     02220          LDX     #MSG015
62BB BD   7390     02230          JSR     PTPS00
62BE BD   7320     02240          JSR     PTCRLF
62C1 8E   6117     02250          LDX     #MSG016
62C4 BD   7390     02260          JSR     PTPS00
                   02270
62C7 BD   7320     02280          JSR     PTCRLF
62CA 8E   6018     02290          LDX     #MSG002
62CD BD   420A     02300          JSR     PRTS00
62D0 BD   40D7     02310          JSR     CRLF
                   02320
                   02330 * PTPWRD TEST
62D3 BD   40D7     02340          JSR     CRLF
62D6 8E   60A2     02350          LDX     #MSG010
62D9 BD   420A     02360          JSR     PRTS00
```

```
62DC BD  40D7    02370       JSR    CRLF
62DF 8E  602D    02380       LDX    #MSG003
62E2 BD  420A    02390       JSR    PRTS00
62E5 BD  40D7    02400       JSR    CRLF
62E8 BD  641C    02410       JSR    LBL002
                 02420
62EB CC  1234    02430       LDD    #$1234
62EE BD  73A0    02440       JSR    PTPWRD
62F1 CC  5678    02450       LDD    #$5678
62F4 BD  73A0    02460       JSR    PTPWRD
62F7 CC  9ABC    02470       LDD    #$9ABC
62FA BD  73A0    02480       JSR    PTPWRD
62FD CC  DEF0    02490       LDD    #$DEF0
6300 BD  73A0    02500       JSR    PTPWRD
                 02510
6303 BD  7320    02520       JSR    PTCRLF
6306 8E  6018    02530       LDX    #MSG002
6309 BD  420A    02540       JSR    PRTS00
630C BD  40D7    02550       JSR    CRLF
                 02560
                 02570 * PTPWRDSP TEST
630F BD  40D7    02580       JSR    CRLF
6312 8E  60AF    02590       LDX    #MSG011
6315 BD  420A    02600       JSR    PRTS00
6318 BD  40D7    02610       JSR    CRLF
631B 8E  602D    02620       LDX    #MSG003
631E BD  420A    02630       JSR    PRTS00
6321 BD  40D7    02640       JSR    CRLF
6324 BD  641C    02650       JSR    LBL002
                 02660
6327 CC  1234    02670       LDD    #$1234
632A BD  73B0    02680       JSR    PTWRDS
632D CC  5678    02690       LDD    #$5678
6330 BD  73B0    02700       JSR    PTWRDS
6333 CC  9ABC    02710       LDD    #$9ABC
6336 BD  73B0    02720       JSR    PTWRDS
6339 CC  DEF0    02730       LDD    #$DEF0
633C BD  73B0    02740       JSR    PTWRDS
                 02750
633F BD  7320    02760       JSR    PTCRLF
6342 8E  6018    02770       LDX    #MSG002
6345 BD  420A    02780       JSR    PRTS00
6348 BD  40D7    02790       JSR    CRLF
                 02800
                 02810 * PTPDEC TEST
634B BD  40D7    02820       JSR    CRLF
634E 8E  60BE    02830       LDX    #MSG012
```

```
6351 BD   420A     02840         JSR     PRTS00
6354 BD   40D7     02850         JSR     CRLF
6357 8E   602D     02860         LDX     #MSG003
635A BD   420A     02870         JSR     PRTS00
635D BD   40D7     02880         JSR     CRLF
6360 BD   641C     02890         JSR     LBL002
                   02900
6363 CC   1234     02910         LDD     #$1234  =  4660 DECIMAL
6366 BD   73C0     02920         JSR     PTPDEC
6369 CC   5678     02930         LDD     #$5678  = 22136 DECIMAL
636C BD   73C0     02940         JSR     PTPDEC
636F CC   9ABC     02950         LDD     #$9ABC  = 39612 DECIMAL
6372 BD   73C0     02960         JSR     PTPDEC
6375 CC   DEF0     02970         LDD     #$DEF0  = 57072 DECIMAL
6378 BD   73C0     02980         JSR     PTPDEC
                   02990
637B BD   7320     03000         JSR     PTCRLF
637E 8E   6018     03010         LDX     #MSG002
6381 BD   420A     03020         JSR     PRTS00
6384 BD   40D7     03030         JSR     CRLF
                   03040
                   03050 * PTPDECSP TEST
6387 BD   40D7     03060         JSR     CRLF
638A 8E   60CB     03070         LDX     #MSG013
638D BD   420A     03080         JSR     PRTS00
6390 BD   40D7     03090         JSR     CRLF
6393 8E   602D     03100         LDX     #MSG003
6396 BD   420A     03110         JSR     PRTS00
6399 BD   40D7     03120         JSR     CRLF
639C BD   641C     03130         JSR     LBL002
                   03140
639F CC   1234     03150         LDD     #$1234  =  4660 DECIMAL
63A2 BD   73F0     03160         JSR     PTDECS
63A5 CC   5678     03170         LDD     #$5678  = 22136 DECIMAL
63A8 BD   73F0     03180         JSR     PTDECS
63AB CC   9ABC     03190         LDD     #$9ABC  = 39612 DECIMAL
63AE BD   73F0     03200         JSR     PTDECS
63B1 CC   DEF0     03210         LDD     #$DEF0  = 57072 DECIMAL
63B4 BD   73F0     03220         JSR     PTDECS
                   03230
63B7 BD   7320     03240         JSR     PTCRLF
63BA 8E   6018     03250         LDX     #MSG002
63BD BD   420A     03260         JSR     PRTS00
63C0 BD   40D7     03270         JSR     CRLF
                   03280
                   03290 * PREFIX/POSTFIX TEST
63C3 BD   40D7     03300         JSR     CRLF
```

```
63C6 8E   6148      03310           LDX     #MSG019
63C9 BD   420A      03320           JSR     PRTS00
63CC BD   40D7      03330           JSR     CRLF
63CF 8E   602D      03340           LDX     #MSG003
63D2 BD   420A      03350           JSR     PRTS00
63D5 BD   40D7      03360           JSR     CRLF
63D8 BD   641C      03370           JSR     LBL002
                    03380
63DB 8E   615C      03390           LDX     #MSG020
63DE BD   7390      03400           JSR     PTPS00
63E1 CC   D431      03410           LDD     #$D431  = 54321 DECIMAL
63E4 BD   73C0      03420           JSR     PTPDEC
63E7 8E   6177      03430           LDX     #MSG021
63EA BD   7390      03440           JSR     PTPS00
                    03450
63ED BD   7320      03460           JSR     PTCRLF
63F0 8E   6018      03470           LDX     #MSG002
63F3 BD   420A      03480           JSR     PRTS00
63F6 BD   40D7      03490           JSR     CRLF
                    03500
                    03510 * COMPLETION OF TESTING
63F9 BD   40D7      03520           JSR     CRLF
63FC 8E   60DA      03530           LDX     #MSG014
63FF BD   420A      03540           JSR     PRTS00
6402 BD   40D7      03550           JSR     CRLF
6405 8E   6048      03560           LDX     #MSG004
6408 BD   420A      03570           JSR     PRTS00
640B BD   40D7      03580           JSR     CRLF
640E BD   641C      03590           JSR     LBL002
6411 8E   613C      03600           LDX     #MSG018
6414 BD   7390      03610           JSR     PTPS00
6417 BD   7320      03620           JSR     PTCRLF
                    03630
641A 20   0A        03640           BRA     LBL003
                    03650
641C 34   03        03660 LBL002  PSHS    A,CC
641E BD   4142      03670 LBLA02  JSR     POLCAT
6421 27   FB        03680           BEQ     LBLA02
6423 35   03        03690           PULS    A,CC
6425 39             03700           RTS
                    03710
6426 35   36        03720 LBL003  PULS    A,B,X,Y
                    03730
6428 39             03740 ENDCHK  RTS
                    03750
6429                03760 SPARE   RMB     0
6429                03770 ENDCH2  RMB     0
```

```
                03780
0000            03790               END
```

TESTER.BAS: Control Program to Initiate and Run The TESTER.ASM's .BIN File Which Tests The Printer Operations Routines

```
1000 '*****
1010 '*
1020 '* TESTER.BAS
1030 '* MDJ 2024/04/08
1040 '*
1050 '* TESTING FOR MLF
1060 '* PRINTER CODE
1070 '*
1120 '* SAVE TO DISK AS
1130 '* TESTER.BAS
1140 '*
1150 '*****
1160 '

2000 'SETUP MEMORY
2010 CLEAR 200,&H4000
2020 PRINT
2030 PRINT "WORKING *";
2040 '

2500 LOADM "MLBASE.BIN"
2510 LOADM "LSYSVR.BIN"
2520 LOADM "DECMAL.BIN"
2530 PRINT "*";
2440 '

2600 LOADM "PTPCHR.BIN"
2610 LOADM "PTCRLF.BIN"
2620 LOADM "PTPBYT.BIN"
2630 PRINT "*";
2640 '

2650 LOADM "PTPBYTSP.BIN"
2660 LOADM "PTPS00.BIN"
2670 LOADM "PTPWRD.BIN"
2680 PRINT "*";
```

```
2690 '

2760 LOADM "PTPWRDSP.BIN"
2770 LOADM "PTPDEC.BIN"
2780 LOADM "PTPDECSP.BIN"
2790 PRINT "*";
2800 '

3000 LOADM "TESTER.BIN"
3010 PRINT "*";
3020 '

5000 PRINT:PRINT
5010 PRINT "READY THE PRINTER."
5020 PRINT "PRESS ANY KEY TO CONTINUE."
5030 A$ = INKEY$
5040 IF A$ = "" GOTO 5030
5050 '

6000 EXEC &H6000
6010 '

7000 PRINT
7010 PRINT "RUN COMPLETE."
7020 '

32767 END
```

=====

Minimal Testing is recorded in this paper; just enough to assure that the routines worked as expected. The test results were as follows:

```
PRINTER TEST #0:
MDJ
MDJ
JMD
013A47C9
01 3A 47 C9
THIS IS A STRING TO PUT TO THE PRINTER.
THIS IS ALSO SUCH A STRING.
123456789ABCDEF0
1234 5678 9ABC DEF0
04660221363961257072
04660 22136 39612 57072
THIS IS THE PREFIXED TEXT 54321 AND THIS IS THE POSTFIXED TEXT.
END OF RUN.
=====
```

LSYSVR.ASM: System Variables For a Maze Game

```
                   00100 *****
                   00110 *
                   00120 * LSYSVR.ASM
                   00130 * MDJ 2024/03/19
                   00140 *
                   00150 * THIS CODE IS SPECIFIC TO
                   00160 * THE 2024 BIPPI'S CAVE.
                   00170 *
                   00180 * LOW MEMORY
                   00190 * SYSTEM VARIABLES
                   00200 *
                   00210 *****
                   00220
5900               00230         ORG     $5900
                   00240
                   00250 * AVATAR'S CURRENT CONDITIONS
5900               00260 STRNTH  RMB     2       CURRENT
STRENGTH (0-$FFFF)
5902               00270 SCORE   RMB     2       CURRENT SCORE
(0-$FFFF)
                   00280
                   00290 * GMOK: 1 = RUNNING; 0 = OVER
5904               00300 GMOK    RMB     1       GAME OVER FLAG
(0-1)
                   00310
                   00320 * NOTE: (68 GRANS / DISK) * (9 SECTORS
/ GRAN)
                   00330 *         = 612 SECTORS / DISK
                   00340 *       @ 4 SECTORS / MAZE SCREEN
                   00350 *         ==> 153 MAZE SCREENS PER
DISK, MAX
                   00360 *       WITH 4 DISKS MAX
                   00370 *         ==> 612 MAZE SCREENS TOTAL,
MAX (0-611)
                   00380
                   00390 * AVATAR'S CURRENT MAZE COORDINATES
                   00400 * CELL NUMBER IS ONLY COMPUTED AS
NEEDED
5905               00410 MSC     RMB     2       MAZE SCREEN
NUMBER (0-611)
5907               00420 MXC     RMB     1       X-COORDINATE
(0-14)
```

```
5908                00430 MYC     RMB     1       Y-COORDINATE
(0-5)
5909                00440 MCC     RMB     1       CELL NUMBER
(0-89)
                    00450
                    00460 * AVATAR'S NEW MAZE COORDINATES
                    00470 * CELL NUMBER IS ONLY COMPUTED AS
NEEDED
                    00480 * (DUMMIES ON STARTUP)
590A                00490 MSN     RMB     2       MAZE SCREEN
NUMBER (0-611)
590C                00500 MXN     RMB     1       X-COORDINATE
(0-14)
590D                00510 MYN     RMB     1       Y-COORDINATE
(0-5)
590E                00520 MCN     RMB     1       CELL NUMBER
(0-89)
                    00530
                    00540 * CURRENT CELL CONTENTS
                    00550 * (UNDER THE AVATAR)
590F                00560 CELLCC  RMB     1
                    00570
                    00580 * DECIMAL DIGITS GENERATED
                    00590 * BY THE DECMAL ROUTINE
5910                00600 DIGIT4  RMB     1
5911                00610 DIGIT3  RMB     1
5912                00620 DIGIT2  RMB     1
5913                00630 DIGIT1  RMB     1
5914                00640 DIGIT0  RMB     1
                    00650
                    00660 * FAKE TEXT CURSOR POSITION
5915                00670 HOLDX   RMB     1       X-COORDINATE
(0-31)
5916                00680 HOLDY   RMB     1       Y-COORDINATE
(0-15)
                    00690
                    00700 * SPARE SPACE
5917                00710 SPARE   RMB     24
592F                00720 ENDCH2  RMB     1
                    00730
          0000      00740         END
```

DECMAL.ASM: Routine to Convert a 16-bit Unsigned Number Into Five Decimal Digits

```
                   00100 *****
                   00110 *
                   00120 * DECMAL.ASM
                   00130 * MDJ 2024/03/19
                   00140 *
                   00150 * THIS CODE IS SPECIFIC TO
                   00160 * THE 2024 BIPPI'S CAVE.
                   00170 *
                   00180 * GET THE ASCII
                   00190 * REPRESENTATION
                   00200 * OF A DECIMAL
                   00210 * NUMBER BETWEEN
                   00220 * 0 AND 65535
                   00230 *
                   00240 * ENTRY CONDITIONS
                   00250 * D = NUMBER
                   00260 *
                   00270 * EXIT CONDITIONS:
                   00280 * DIGIT4 THROUGH DIGIT0
                   00290 * (IN LSYSVR.ASM) HOLD
                   00300 * THE REPRESENTATION
                   00310 *
                   00320 *****
                   00330
                   00340 * THE DECIMAL DIGITS
          5910     00350 DIGIT4  EQU     $5910
          5911     00360 DIGIT3  EQU     $5911
          5912     00370 DIGIT2  EQU     $5912
          5913     00380 DIGIT1  EQU     $5913
          5914     00390 DIGIT0  EQU     $5914
                   00400
5930               00410         ORG     $5930
                   00420
5930 34   06       00430 DECMAL  PSHS    A,B     SAVE THE NUMBER
                   00440
                   00450 * PRELOAD THE DIGITS WITH ASCII "0"
5932 86   30       00460         LDA     #$30    = DECIMAL 48 =
"0"
5934 B7   5910     00470         STA     DIGIT4
5937 B7   5911     00480         STA     DIGIT3
```

```
593A B7   5912     00490         STA     DIGIT2
593D B7   5913     00500         STA     DIGIT1
5940 B7   5914     00510         STA     DIGIT0
                   00520
5943 35   06       00530         PULS    A,B     RETRIEVE THE
NUMBER
                   00540
                   00550 * FORM DIGIT 4
5945 1083 2710     00560 LBLDG4  CMPD    #10000
5949 25   08       00570         BLO     LBLDG3
594B 7C   5910     00580         INC     DIGIT4
594E 83   2710     00590         SUBD    #10000
5951 20   F2       00600         BRA     LBLDG4
                   00610
                   00620 * FORM DIGIT 3
5953 1083 03E8     00630 LBLDG3  CMPD    #1000
5957 25   08       00640         BLO     LBLDG2
5959 7C   5911     00650         INC     DIGIT3
595C 83   03E8     00660         SUBD    #1000
595F 20   F2       00670         BRA     LBLDG3
                   00680
                   00690 * FORM DIGIT 2
5961 1083 0064     00700 LBLDG2  CMPD    #100
5965 25   08       00710         BLO     LBLDG1
5967 7C   5912     00720         INC     DIGIT2
596A 83   0064     00730         SUBD    #100
596D 20   F2       00740         BRA     LBLDG2
                   00750
                   00760 * FORM DIGIT 1
596F 1083 000A     00770 LBLDG1  CMPD    #10
5973 25   08       00780         BLO     LBLDG0
5975 7C   5913     00790         INC     DIGIT1
5978 83   000A     00800         SUBD    #10
597B 20   F2       00810         BRA     LBLDG1
                   00820
                   00830 * FORM DIGIT 0
597D CB   30       00840 LBLDG0  ADDB    #$30
597F F7   5914     00850         STB     DIGIT0
                   00860
5982 39            00870 ENDCHK  RTS
                   00880
5983               00890 SPARE   RMB     12
598F               00900 ENDCH2  RMB     1
                   00910
          0000     00920         END
```

BIPPDBUG.ASM: Routine to Report on Register Contents And System State

```
                   00100 *****
                   00110 *
                   00120 * BIPPDBUG.ASM
                   00130 * MDJ 2024/04/17
                   00140 *
                   00150 * PRINTER DEBUGGING
                   00160 * CONTROL ROUTINE
                   00170 *
                   00180 *****
                   00190
                   00200 * PRINTER ROUTINES
          7F00     00210 PTPCHR  EQU     $7F00   PUT CHARACTER
TO PRINTER
          7F20     00220 PTCRLF  EQU     $7F20   PUT CRLF TO
PRINTER
          7F40     00230 PTPBYT  EQU     $7F40   PUT BYTE TO
PRINTER
          7F80     00240 PTBYTS  EQU     $7F80   PUT BYTE +
SPACE TO PRINTER
          7F90     00250 PTPS00  EQU     $7F90   PUT 0TERM
STRING TO PRINTER
          7FA0     00260 PTPWRD  EQU     $7FA0   PUT WORD TO
PRINTER
          7FB0     00270 PTWRDS  EQU     $7FB0   PUT WORD +
SPACE TO PRINTER
          7FC0     00280 PTPDEC  EQU     $7FC0   PUT DECIMAL TO
PRINTER
          7FF0     00290 PTDECS  EQU     $7FF0   PUT DECIMAL +
SPACE TO PRINTER
                   00300
7500               00310         ORG     $7500
                   00320
7500 20   6C       00330 BPDBUG  BRA     BPDBGG
                   00340
7502      52       00350 HA      FCC     'REGA  = '
          45
          47
          41
          20
          20
          3D
          20
750A      00        00360         FCB     0
750B      52        00370 HB      FCC     'REGB  = '
          45
          47
          42
          20
          20
          3D
          20
7513      00        00380         FCB     0
7514      52        00390 HDP     FCC     'REGDP = '
          45
          47
          44
          50
          20
          3D
          20
751C      00        00400         FCB     0
751D      52        00410 HCC     FCC     'REGCC = '
          45
          47
          43
          43
          20
          3D
          20
7525      00        00420         FCB     0
7526      52        00430 HD      FCC     'REGD  = '
          45
          47
          44
          20
          20
          3D
          20
752E      00        00440         FCB     0
752F      52        00450 HX      FCC     'REGX  = '
          45
          47
          58
          20
          20
          3D
          20
```

```
7537     00      00460          FCB     0
7538     52      00470 HY       FCC     'REGY  = '
         45
         47
         59
         20
         20
         3D
         20
7540     00      00480          FCB     0
7541     52      00490 HS       FCC     'REGS  = '
         45
         47
         53
         20
         20
         3D
         20
7549     00      00500          FCB     0
754A     52      00510 HU       FCC     'REGU  = '
         45
         47
         55
         20
         20
         3D
         20
7552     00      00520          FCB     0
7553     52      00530 HPC      FCC     'REGPC = '
         45
         47
         50
         43
         20
         3D
         20
755B     00      00540          FCB     0
755C     53      00550 HSTATE   FCC     'SYSTEM STATE:'
         59
         53
         54
         45
         4D
         20
         53
         54
         41
```

```
          54
          45
          3A
7569      00       00560          FCB     0
756A      20       00570 HSPACE  FCC     '   '
          20
          20
756D      00       00580          FCB     0
                   00590
756E 20   FE       00600 BPDBGG  BRA     BPDBGG  DUMMY
                   00610
                   00620 *REPORT REGA
7570 BD   75D9     00630 BPDBGA  JSR     BPDBHA
7573 7E   76B7     00640          JMP     LBLRXX
                   00650
                   00660 *REPORT REGB
7576 BD   75ED     00670 BPDBGB  JSR     BPDBHB
7579 7E   76B7     00680          JMP     LBLRXX
                   00690
                   00700 *REPORT REGDP
757C BD   7617     00710 BPDBGR  JSR     BPDBHR
757F 7E   76B7     00720          JMP     LBLRXX
                   00730
                   00740 *REPORT REGCC
7582 BD   762D     00750 BPDBGC  JSR     BPDBHC
7585 7E   76B7     00760          JMP     LBLRXX
                   00770
                   00780 *REPORT REGD
7588 BD   7603     00790 BPDBGD  JSR     BPDBHD
758B 7E   76B7     00800          JMP     LBLRXX
                   00810
                   00820 *REPORT REGX
758E BD   7643     00830 BPDBGX  JSR     BPDBHX
7591 7E   76B7     00840          JMP     LBLRXX
                   00850
                   00860 *REPORT REGY
7594 BD   765D     00870 BPDBGY  JSR     BPDBHY
7597 7E   76B7     00880          JMP     LBLRXX
                   00890
                   00900 *REPORT REGS
759A BD   7673     00910 BPDBGS  JSR     BPDBHS
759D 7E   76B7     00920          JMP     LBLRXX
                   00930
                   00940 *REPORT REGU
75A0 BD   7689     00950 BPDBGU  JSR     BPDBHU
75A3 7E   76B7     00960          JMP     LBLRXX
                   00970
```

```
                    00980 *REPORT REGPC
75A6 BD   769F      00990 BPDBGP  JSR     BPDBHP
75A9 7E   76B7      01000         JMP     LBLRXX
                    01010
                    01020 *REPORT THE SYSTEM STATE
75AC 8E   755C      01030 BPDSTT  LDX     #HSTATE
75AF BD   7F90      01040         JSR     PTPS00
75B2 BD   7F20      01050         JSR     PTCRLF
75B5 BD   75D9      01060         JSR     BPDBHA
75B8 BD   75ED      01070         JSR     BPDBHB
75BB BD   7617      01080         JSR     BPDBHR
75BE BD   762D      01090         JSR     BPDBHC
75C1 BD   7F20      01100         JSR     PTCRLF
75C4 BD   7643      01110         JSR     BPDBHX
75C7 BD   765D      01120         JSR     BPDBHY
75CA BD   7F20      01130         JSR     PTCRLF
75CD BD   7673      01140         JSR     BPDBHS
75D0 BD   7689      01150         JSR     BPDBHU
75D3 BD   769F      01160         JSR     BPDBHP
75D6 7E   76B7      01170         JMP     LBLRXX
                    01180
                    01190 * PUT THE BYTE IN REGA
                    01200 * TO THE PRINTER
75D9 34   12        01210 BPDBHA  PSHS    A,X
75DB 8E   7502      01220         LDX     #HA
75DE BD   7F90      01230         JSR     PTPS00
75E1 BD   7F40      01240         JSR     PTPBYTS
75E4 8E   756A      01250         LDX     #HSPACE
75E7 BD   7F90      01260         JSR     PTPS00
75EA 35   12        01270         PULS    A,X
75EC 39             01280         RTS
                    01290
                    01300 * PUT THE BYTE IN REGB
                    01310 * TO THE PRINTER
75ED 34   16        01320 BPDBHB  PSHS    A,B,X
75EF 8E   750B      01330         LDX     #HB
75F2 BD   7F90      01340         JSR     PTPS00
75F5 1F   98        01350         TFR     B,A
75F7 BD   7F40      01360         JSR     PTPBYTS
75FA 8E   756A      01370         LDX     #HSPACE
75FD BD   7F90      01380         JSR     PTPS00
7600 35   16        01390         PULS    A,B,X
7602 39             01400         RTS
                    01410
                    01420 * PUT THE WORD IN REGD
                    01430 * TO THE PRINTER
7603 34   16        01440 BPDBHD  PSHS    A,B,X
```

```
7605 8E   7526     01450         LDX     #HD
7608 BD   7F90     01460         JSR     PTPS00
760B BD   7FA0     01470         JSR     PTPWRDS
760E 8E   756A     01480         LDX     #HSPACE
7611 BD   7F90     01490         JSR     PTPS00
7614 35   16       01500         PULS    A,B,X
7616 39            01510         RTS
                   01520
                   01530 * PUT THE BYTE IN REGDP
                   01540 * TO THE PRINTER
7617 34   1A       01550 BPDBHR  PSHS    A,DP,X
7619 8E   7514     01560         LDX     #HDP
761C BD   7F90     01570         JSR     PTPS00
761F 1F   B8       01580         TFR     DP,A
7621 BD   7F40     01590         JSR     PTPBYTS
7624 8E   756A     01600         LDX     #HSPACE
7627 BD   7F90     01610         JSR     PTPS00
762A 35   1A       01620         PULS    A,DP,X
762C 39            01630         RTS
                   01640
                   01650 * PUT THE BYTE IN REGCC
                   01660 * TO THE PRINTER
762D 34   13       01670 BPDBHC  PSHS    A,CC,X
762F 8E   751D     01680         LDX     #HCC
7632 BD   7F90     01690         JSR     PTPS00
7635 1F   A8       01700         TFR     CC,A
7637 BD   7F40     01710         JSR     PTPBYTS
763A 8E   756A     01720         LDX     #HSPACE
763D BD   7F90     01730         JSR     PTPS00
7640 35   13       01740         PULS    A,CC,X
7642 39            01750         RTS
                   01760
                   01770 * PUT THE WORD IN REGX
                   01780 * TO THE PRINTER
7643 34   16       01790 BPDBHX  PSHS    A,B,X
7645 34   10       01800         PSHS    X
7647 8E   752F     01810         LDX     #HX
764A BD   7F90     01820         JSR     PTPS00
764D 35   10       01830         PULS    X
764F 1F   10       01840         TFR     X,D
7651 BD   7FA0     01850         JSR     PTPWRDS
7654 8E   756A     01860         LDX     #HSPACE
7657 BD   7F90     01870         JSR     PTPS00
765A 35   16       01880         PULS    A,B,X
765C 39            01890         RTS
                   01900
                   01910 * PUT THE WORD IN REGY
```

```
                    01920 * TO THE PRINTER
765D 34   36        01930 BPDBHY  PSHS    A,B,X,Y
765F 8E   7538      01940         LDX     #HY
7662 BD   7F90      01950         JSR     PTPS00
7665 1F   20        01960         TFR     Y,D
7667 BD   7FA0      01970         JSR     PTPWRDS
766A 8E   756A      01980         LDX     #HSPACE
766D BD   7F90      01990         JSR     PTPS00
7670 35   36        02000         PULS    A,B,X,Y
7672 39             02010         RTS
                    02020
                    02030 * PUT THE WORD IN REGS
                    02040 * TO THE PRINTER
7673 36   56        02050 BPDBHS  PSHU    A,B,X,S
7675 8E   7541      02060         LDX     #HS
7678 BD   7F90      02070         JSR     PTPS00
767B 1F   40        02080         TFR     S,D
767D BD   7FA0      02090         JSR     PTPWRDS
7680 8E   756A      02100         LDX     #HSPACE
7683 BD   7F90      02110         JSR     PTPS00
7686 37   56        02120         PULU    A,B,X,S
7688 39             02130         RTS
                    02140
                    02150 * PUT THE WORD IN REGU
                    02160 * TO THE PRINTER
7689 34   56        02170 BPDBHU  PSHS    A,B,X,U
768B 8E   754A      02180         LDX     #HU
768E BD   7F90      02190         JSR     PTPS00
7691 1F   30        02200         TFR     U,D
7693 BD   7FA0      02210         JSR     PTPWRDS
7696 8E   756A      02220         LDX     #HSPACE
7699 BD   7F90      02230         JSR     PTPS00
769C 35   56        02240         PULS    A,B,X,U
769E 39             02250         RTS
                    02260
                    02270 * PUT THE WORD IN REGPC
                    02280 * TO THE PRINTER
769F 36   80        02290 BPDBHP  PSHU    PC
76A1 34   16        02300         PSHS    A,B,X
76A3 8E   7553      02310         LDX     #HPC
76A6 BD   7F90      02320         JSR     PTPS00
76A9 37   06        02330         PULU    D
76AB BD   7FA0      02340         JSR     PTPWRDS
76AE 8E   756A      02350         LDX     #HSPACE
76B1 BD   7F90      02360         JSR     PTPS00
76B4 35   16        02370         PULS    A,B,X
76B6 39             02380         RTS
```

```
                   02390
76B7 BD   7F20     02400 LBLRXX  JSR     PTCRLF
                   02410
76BA 39            02420 ENDCHK  RTS
                   02430
76BB               02440 SPARE   RMB     0
76BB               02450 ENDCH2  RMB     0
                   02460
          0000     02470         END
```

Appendix A
Decimal to Hexadecimal Conversions

DEC	HEX	DEC	HEX	DEC	HEX	DEC	HEX
000	00	032	20	064	40	096	60
001	01	033	21	065	41	097	61
002	02	034	22	066	42	098	62
003	03	035	23	067	43	099	63
004	04	036	24	068	44	100	64
005	05	037	25	069	45	101	65
006	06	038	26	070	46	102	66
007	07	039	27	071	47	103	67
008	08	040	28	072	48	104	68
009	09	041	29	073	49	105	69
010	0A	042	2A	074	4A	106	6A
011	0B	043	2B	075	4B	107	6B
012	0C	044	2C	076	4C	108	6C
013	0D	045	2D	077	4D	109	6D
014	0E	046	2E	078	4E	110	6E
015	0F	047	2F	079	4F	111	6F
016	10	048	30	080	50	112	70
017	11	049	31	081	51	113	71
018	12	050	32	082	52	114	72
019	13	051	33	083	53	115	73
020	14	052	34	084	54	116	74
021	15	053	35	085	55	117	75
022	16	054	36	086	56	118	76
023	17	055	37	087	57	119	77
024	18	056	38	088	58	120	78
025	19	057	39	089	59	121	79
026	1A	058	3A	090	5A	122	7A
027	1B	059	3B	091	5B	123	7B
028	1C	060	3C	092	5C	124	7C
029	1D	061	3D	093	5D	125	7D
030	1E	062	3E	094	5E	126	7E
031	1F	063	3F	095	5F	127	7F

DEC	HEX	DEC	HEX	DEC	HEX	DEC	HEX
128	80	160	A0	192	C0	224	E0
129	81	161	A1	193	C1	225	E1
130	82	162	A2	194	C2	226	E2
131	83	163	A3	195	C3	227	E3
132	84	164	A4	196	C4	228	E4
133	85	165	A5	197	C5	229	E5
134	86	166	A6	198	C6	230	E6
135	87	167	A7	199	C7	231	E7
136	88	168	A8	200	C8	232	E8
137	89	169	A9	201	C9	233	E9
138	8A	170	AA	202	CA	234	EA
139	8B	171	AB	203	CB	235	EB
140	8C	172	AC	204	CC	236	EC
141	8D	173	AD	205	CD	237	ED
142	8E	174	AE	206	CE	238	EE
143	8F	175	AF	207	CF	239	EF
144	90	176	B0	208	D0	240	F0
145	91	177	B1	209	D1	241	F1
146	92	178	B2	210	D2	242	F2
147	93	179	B3	211	D3	243	F3
148	94	180	B4	212	D4	244	F4
149	95	181	B5	213	D5	245	F5
150	96	182	B6	214	D6	246	F6
151	97	183	B7	215	D7	247	F7
152	98	184	B8	216	D8	248	F8
153	99	185	B9	217	D9	249	F9
154	9A	186	BA	218	DA	250	FA
155	9B	187	BB	219	DB	251	FB
156	9C	188	BC	220	DC	252	FC
157	9D	189	BD	221	DD	253	FD
158	9E	190	BE	222	DE	254	FE
159	9F	191	BF	223	DF	255	FF

=====

Appendix B: My CoCo Philosophy

The CoCo community enjoys a great diversity of interests.

Some choose to concentrate on hardware innovations and modifications such as interfacing with VGA and HDMI monitors, SD Card data storage, and 104-key keyboards. This interest is at least partly born of necessity, since composite monitors, floppy diskettes, and CoCo spare parts are no longer manufactured and are in increasingly short supply.

Others concentrate on expanding the software horizons of the CoCo 3, using NitrOS-9 and other operating systems to make the multitasking CoCo behave ever closer to modern Windows, Mac, and Linux machines.

Still others are devoted to emulating the CoCo on other platforms by developing emulators such as VCC, OVCC, MAME, and XRoar.

And some just love retro gaming.

My personal interest is twofold:

1. To see VCC increasingly used as a learning tool for budding software developers.

2. To see just how much I can cram into a 64K CoCo 2.

First, VCC: Today’s Grade School, Junior High, and High School students have a wealth of available learning tools. Micro-bits, Arduinos, and Raspberry Pi supermicro devices provide highly affordable entry-level introductions to computer programming and interfacing. Maker-Spaces and Innovation Centers in our schools and libraries help foster growth and experience.

But these devices do have limitations. Even these simple(?) computers can have rather steep learning curves, and their low initial cost can quickly expand as new peripherals and experimental equipment and supplies are added.

VCC is free, and can be used on any Windows computer: just download it, install it, and it runs. If you don’t own a Windows computer, your school, library, or a friend probably does. The included BASIC language is easy to learn and can readily serve as a stepping-stone towards more complex programming languages. (And, no, learning structured programming does not require a language that enforces structure. In fact, I think learning to structure your programs is actually more effective when you do so on your own.)

I prefer VCC to the other emulators for these purposes because its setup is trivial: Again, just download it, install it, and it runs. OVCC, MAME, and XRoar have their advantages, but ease of setup is not one of them. Even with their available Windows binary packages, they require pre-installation of other bits and pieces of software before they can be downloaded, installed, and run. This may not be a major problem for a reasonably adept aficionado, but it forms a significant barrier for the newbie. And, it’s the newbie whom we’re trying to reach, interest, and encourage here; the newbie who may not yet recognize even the tiniest awakening of interest in things computational.

But, for these purposes, VCC has one glaring weakness: its instruction manual is woefully terse. I would like to see VCC bundled with a selection of tutorials, manuals, and examples suited to guiding even the most newbie of newbies into the wonders of computing.

Second, The Stuffed CoCo: I’m simply fascinated by the challenge of seeing how much functional capability I can sandwich into the nooks and crannies of the 64K space. Whether it’s working in the available RAM left by the 32K ROM and the dedicated RAM that supports that ROM, or whether it’s jumping right into ALLRAM mode and just filling the entire 64K to near-overflowing; it’s an investigative gauntlet which goes right to the heart of my enchantment with puzzles in general.

It’s great fun!

M.D.J. 2021/08/29

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M.D.J. 2018/06/08

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Works Cited

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[MDJ01] Johnson, M. David. *Back To (Almost) Bare-Metal Programming*, Version 0.0.2. https://www.bds-soft.com/cocoPapers.php , 2023. Online.

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