1. IDENTIFICATION

1.1 PDP-8 Maindec 826-A

1.2 680 8-Bit Character Exerciser

1.3 November 8, 1965

PDP
8
LIBRARY

2. ABSTRACT

The 680 8-Bit Character Exerciser program further verifies correct operation of the 680 DCS system. This test assumes that the Teletype lines are full duplex. However, if the line outputs are jumpered to the line inputs, the test does verify that the input characters are received as transmitted.

3. REQUIREMENTS

3.1 Storage

3.1.1 Exerciser Program

	ADDRESS 0		
Concurrent Output Test	1200_8	to	1377_8
Output Data Table	1400_8	to	1535_8
Concurrent Input Test	1600_8	to	1616_8
Output Switch Register Routine	2000_8	to	2074_8
Output Buffer	2200	to	2377_8
Input Buffer	2400	to	2577_8
Interrupt Routine	0001	to	0004

3.1.2 Character Assembly Subroutines (List of Items)

TT8BGN	(Start of Subroutines)	3000_8	to	3376_8
T8IN	(TTI Area)	3377_8	to	4177_8
T8IBF	(Input Buffer)	4200_8	to	4577_8
T80BF	(Output Buffer)	4600_8	to	4777_8
T80BF2	(Second Output Buffer)	5000_8	to	5177_8
TT8PG0	(Page 0 Constants)	0126_8	to	0144_8
TTCHAR	(Character Register)	0177_8		
T8AX1	(Autoindex)	14		
T8AX2	(Autoindex)	15		
T8AX3	(Autoindex)	16		

3.2 Subprograms and/or Subroutines

Digital-8-35-S-B, 680 8-Bit Character Assembly Subroutines

3.3 Equipment

Minimum Configuration PDP-8
680 DCS hardware (including a 110 Baud Clock)

3.4 Miscellaneous

The 110 Baud Clock in CLOCK 2.

4. USAGE

4.1 Loading

4.1.1 If the Binary Loader beginning at address 7777 is in memory, see Section 4.1.2. Otherwise the RIM Loader and/or the Binary Loader must be loaded into memory.

4.1.2 The 680 8-Bit Character Exerciser may now be loaded into memory as follows:

Set 7777_8 in the SWITCH REGISTER
Press the LOAD ADDRESS key
Place the Character Exerciser in the keyboard reader
Press START
Engage the keyboard reader

4.3 Switch Settings (See Section 4.4)

4.4 Start up and/or Entry

4.4.1 Concurrent Output Test

Set the SWITCH REGISTER to 1200

Press the LOAD ADDRESS key.

Set the SWITCH REGISTER equal to the lowest line number to be tested.

Press START; the processor halts at address 1202.

Set the SWITCH REGISTER equal to the number of lines to be tested. works OK for 2 lines higher nos not tested.

Press CONTINUE; the program outputs a fixed message on all the lines selected.

4.4.2 Concurrent Input Test

Set the SWITCH REGISTER to 1600.

Press the LOAD ADDRESS key.

Response to keyboard key slow or not present. Reducing no of lines as below, works OK. Response slows down as no. of lines increases.

Press START; the program scans 128 lines for input and retransmits characters received on the same line as they are received.

Note that the 680 8-Bit Character Assembly subroutines as currently coded will not process 128 lines at 110 Baud. Therefore, it is necessary to do the following before running the Concurrent Input Test:

Set the SWITCH REGISTER to 1616.
Press the LOAD ADDRESS key.
Set the SWITCH REGISTER equal to the number of lines on the system.
Press the DEPOSIT key.
The Concurrent Input Test may be run as above.

4.4.3 Output the contents of the SWITCH REGISTER.

Set the SWITCH REGISTER to 2000.

Press the LOAD ADDRESS key.

Set the SWITCH REGISTER to the line number to be tested.

Press START; the processor halts at address 2002.

Set SWITCH REGISTER bits 4 through 11 equal to the character to be transmitted, and SW0 as follows:

SW0 - down: Do not test for input.
SW0 - up: Wait for input and verify that it is the same character as transmitted.

Press CONTINUE; the program transmits a carriage return, line feed, the contents of the AC switches 64 times, and then repeats.

Note that since the input is two characters behind the output, (due to the double buffering of the Character Assembly Subroutines), SW0 may not be changed from 0 to a 1 once the program is running. It may, however, be changed from a 1 to a 0 and switches 4 through 11 may be altered at any time.

4.5 Errors In Usage

Hardware malfunctions detected by the program result in a processor halt. The following is a list of these error halts and their meanings:

4.5.1 Address 0002 Not Clock Interrupt

Either an interrupt was received from a device other than Teletype Clock 2 or the IOT 6431 did not skip after an interrupt from Clock 2.

4.5.2 Address 1312 Data Error

The processor halts with a line number displayed in the AC, indicating that a data error has occurred on that line. Press CONTINUE and the processor halts at address 1315 with the character that should have been received in the AC. Press CONTINUE again and the processor halts with the character that is received in the AC.

4.5.3 Address 2060 Data Error (Output AC Switches Routine)

Processor halts with the character transmitted in the AC. This could be a carriage return, a line feed, or the code contained in the SWITCH REGISTER. Press CONTINUE, and the processor halts with the character that is displayed in the AC.

4.5.4 Detection of an Open Input Line.

If the data error halt at address 1312 is consistently executed with a specific line number and the character received is always 0, it indicates that the input line is in a constant "SPACE" or open line state.

4.5.5 Detection of a Constant "MARK"

The 680 Character Exerciser was written with the assumption that the Teletype lines being tested are full duplex. Also, the program assumes that any input received during the Concurrent Output Test is due to the fact that the line outputs are tied to line inputs. Therefore, if there is no input on a line or any of the lines, the program does not consider it an error. Assuming the test is operating with inputs tied to outputs, the only way to be sure that a line is transmitting and receiving is to open the input line in order to force a data error.

Note that this procedure is also likely to display any errors in translating line numbers; i.e., input line 17 is opened and the processor does not halt. The line is then closed again and an error is indicated on line 37. The malfunction is probably in the decoding of line 17.

4.6 Recovery from Such Errors

Pressing CONTINUE causes the program to proceed. It is possible that an error halt will leave some of the output lines in a "SPACE" condition. If this happens, any Teletypes that are tied to these outputs will run freely until the program continues. Also, in the process of opening lines to test for transmitting and receiving, it is possible to get the input of a line out of sequence with the output. In this case, it is necessary that the test be restarted.

5. Restrictions

The Character Assembly Subroutines scan the lines in even multiples of eight lines. Therefore, it is possible that an error could be indicated on a line or lines that have not been selected to be run, i.e., the Output SWITCH REGISTER Routine, if line 1 is selected to be run, the inputs of lines 2, 3, 4, 5, 6, 7 and 10_8 should be placed in the "MARK" state.

6. DESCRIPTION

6.1 Discussion

6.1.1 General

The 680 8-Bit Character Exerciser transmits and/or receives ASCII Teletype data at the line speed of Teletype clock 2 and verifies correct operation of the 680 DCS hardware. The program allows parameters to exercise up to 128 lines and includes three modes of test: Concurrent Output, Concurrent Input, and Output the Switch Register.

6.1.2 Test Descriptions

6.1.2.1 Concurrent Output Test

The Concurrent Output Test will accept parameters to transmit on from 1 to 128 lines. The program assumes that all of the lines selected are full duplex and that any input is due to an output line jumpered to an input line. The following message is transmitted on all lines selected:

THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG'S BACK
0123456789 ! " # $ % ' ( ) * + ¯ . / : ; < = > ? @ [\ ] ↑ ←

If input is received on any of the lines selected, the program verifies that the characters received are received in the same order that they are transmitted. Also, since the input is tested almost independently of the output, it is possible to jumper input lines to output lines in any configuration that is desired, including and/or other than 1 for 1.

6.1.2.2 Concurrent Input Test

The Concurrent Input Test initializes to scan all 128 lines for input. When a character is received on a line, the program transmits the character received on the same line. (See Section 4.4.2.)

6.1.2.3 Output the Switch Register Routine

This routine transmits the code contained in SWITCH REGISTER bits 4 through 11 on the line specified by the contents of the SWITCH REGISTER when the routine is started. The program transmits a carriage return, line feed, the contents of the SWITCH REGISTER 64 times, and then repeats. If SWITCH REGISTER bit 0 is a 1, the program transmits a character, waits for it to be input, and then verfies that the output and the input are equal. Since the input is two characters behind the output, (due to the double buffering of output characters in the Character Assembly Subroutines) the compare mode must be selected at the time the processor halts at address 2003.

7. METHODS (Not Applicable)

8. FORMAT (Not Applicable)

9. EXECUTION TIME (Not Applicable)

10. PROGRAM

10.4 Program Listing

```
                /8BIT CHARACTER ASSEMBLY SUBROUTINES
                /TYPE 680 TELETYPE LINE MULTIPLEXER
                /LMH  7-8-65,  8 BIT

                T8BGN=3000
                T8PG0=126
                T80BF=4600
                T8IBF=4200
                T80BF2=5000
                T8AX1=14
                T8AX2=15
                T8AX3=16
                TCHAR=177
                T8IN=3377

                TTI=6402                /TELETYPE INPUT COMMAND
                TTO=6404                /TELETYPE OUTPUT COMMAND
                TCL=6411 /CLEAR LINE REGISTER
                TRL=6414 /READ LINE REGISTER
                TSL=6412 /SET LINE REGISTER, CLR AC
                T8ON=6434               /TURN CLOCK ON
                T8OFF=6432              /TURN CLOCK OFF
                T8SKP=6431              /SKIP ON CLOCK FLAG
                TINCR=6401              /INCREMENT LINE REGISTER

                *T8PG0
0126  0000      T8INFL,   0             /INPUT READY FLAG
0127  4177      T8BFK,    T8IBF-1       /TO RESET INPUT BUFFER POINTER
0130  0000      T8NL,     0             /-NUMBER OF LINES
0131  4600      T8K7,     T80BF         /K FOR 1ST OUTPUT BUFFER
0132  0021      T8K8,     T8COM         /TO ENTER COMMON ROUTINE
0133  0151      T8SOUT,   T8OUTS        /SKIP IF OUTPUT FREE
0134  0200      T8SIN,    T8INS         /SKIP IF INPUT READY
0135  0224      T8GO,     T8GOS         /INITIALIZE ROUTINE
0136  0344      T8IES,    T8SE          /SKIP IF EITHER LINE READY
0137  4600      T8OUTK,   T80BF         /POINTER TO FIRST OUTPUT BUFFER
0140  5000      T8OTK2,   T80BF2        /POINTER TO 2ND OUTPUT BUFFER
0141  5000      T8K36,    T80BF2        /K FOR 2ND OUTPUT BUFFER
0142  7770      T8CNT1,   -10           /HOLD MAJOR LOOP COUNTER
0143  0000      T8CNT2,   0             /MINOR LOOP COUNTER
0144  0000      T8CNT3,   0             /COUNTER FOR INPUT BUFFER
                *T8BGN
                /MULTIPLE LEVEL INTERRUPT ROUTINE
                /ALLOWS MULTIPLE LEVEL INTERRUPT TO THIS ROUTINE
                /AND UNLIMITED OTHERS
```

```
3000  2334  T8DIS,   ISZ I8LC                /LEVEL COUNTER
3001  5216            JMP I8DIS3 /2ND LEVEL INTERRUPT
3002  3335            DCA I8SA                /SAVE ACCUMULATOR
3003  7010            RAR                     /GET LINK
3004  3336            DCA I8SVLK /SAVE LINK
3005  1000            TAD Z 0                 /INTERRUPT ADDRESS
3006  3337            DCA I8SV0               /SAVE ADDRESS
3007  6414            TTRL                    /RD LINE NUMBER
3010  3340            DCA I8SVLN /SAVE LINE NUMBER
3011  6434            TT8UN                   /TO CLEAR FLAG ONLY
3012  6001  T8DIS2,   ION                     /RE-ENABLEPROGRAM INTERRUPT
3013  1350            TAD I8K9                /STARTING LINE-1
3014  6413            TTSL+1                  /SET LINE REGISTER, CLEAR AC
3015  5741            JMP I T8K1 /JUMP TO TTI LOOP

                /2ND LEVEL INTERRUPT
3016  6434  T8DIS3,   TT8UN                   /CLEAR CLOCK FLAG
3017  6001            ION                     /RE-ENABLE PROGRAM INTERRUPT
3020  5400            JMP I Z 0               /RETURN TO THE MAIN PROGRAM

                /RETURN FROM INPUT TTI LOOP
3021  1342  T8COM,   TAD I8MNC               /MINOR COUNTER, NUMBER OF LINES/8
3022  3143            DCA Z T8CNT2            /MINOR LOOP COUNTER
3023  1343            TAD I8LN                /LINE NUMBER
3024  6413            TTSL+1                  /SET LINE NUMBER
3025  1537  T8COM0,   TAD I Z I8OUTK          /OUTPUT WORD
3026  7450            SNA                     /SOMETHING TO TRANSMIT
3027  5323            JMP I8COM8 /SEE IF WORD AVAILABLE
3030  6405            TTO+1                   /INCR. LINE REGISTER AND OUTPUT
3031  3537            DCA I Z I8OUTK          /STORE WORD
3032  1414  T8COM1,   TAD I Z I8AX1           /PICK UP CHARACTER ASSEMBLY WORD
3033  7110            CLL RAR                 /PUT BIT 11 IN LINK
3034  7430            SZL                     /CHARACTER NOT COMPLETED
3035  5301            JMP I8COM6 /STORE CHARACTER
3036  7200            CLA                     /CLEAR AC FOR TAD
3037  2137  T8COM3,   ISZ Z I8OUTK           /UPDATE OUTPUT ADDR
3040  2140            ISZ Z I8UIK2            /UPDATE 2ND BUFFER ADDRESS
3041  2014            ISZ Z I8AX1             /UPDATE FOR NEXT INPUT LINE
3042  2014            ISZ Z I8AX1             /UPDATE FOR NEXT INPUT LINE
3043  2143            ISZ Z T8CNT2            /ARE ONE-EIGHTH OF LINES CHECKED?
3044  5225            JMP I8COM0 /CHECK NEXT LINE

3045  6414  T8COM4,   TTRL                    /READ LINE NUMBER
3046  3343            DCA I8LN                /SAVE LINE NUMBER
3047  2142            ISZ Z T8CNT1            /HAVE ALL LINES BEEN CHECKED
3050  5263            JMP I8COM5 /RESET AND DISMISS
3051  1344            TAD I8K2                /-10
3052  3142            DCA Z T8CNT1            /RESET MAJOR LOOP COUNTER
3053  1345            TAD I8K3                /I8IN+1
3054  3014            DCA Z I8AX1             /RESET INPUT LINE POINTER
3055  1350            TAD I8K9                /STARTING LINE-1
3056  3343            DCA I8LN                /RESET LINE NUMBER
3057  1131            TAD Z T8K7              /T8OBF
3060  3137            DCA Z I8OUTK            /RESET OUTPUT LINE POINTER
3061  1141            TAD Z T8K36             /T8OBF2
3062  3140            DCA Z I8UIK2            /RESET 2ND BUFFER POINTER
```

```
3063  6002  T8COM5,  IOF                    /TURN OFF INTERRUPT
3064  7240            STA                    /-1
3065  1334            TAD T8LC               /LEVEL COUNTER
3066  3334            DCA T8LC               /RESTORE LEVEL COUNTER
3067  1334            TAD T8LC               /LEVEL COUNTER
3070  /700    SMA CLA              /RESTORE AC ETC
3071  5212            JMP T8DIS2 /CHECK INPUT AGAIN, ETC.
3072  1340            TAD T8SVLN /LINE NUMBER
3073  6413    TTSL+1               /SET LINE REGISTER, CLR AC
3074  1336            TAD T8SVLK /PICK UP LINK
3075  /104            CLL RAL                /RESTORE LINK
3076  1335            TAD T8SA               /RESTORE ACCUMULATOR
3077  6001            ION                    /ENABLE INTERRUPT
3100  5737            JMP I T8SV0            /RETURN TO MAIN PROGRAM
3101  7112  T8COM6,  CLL RTR                /REMOVE START CODE
3102  3415            DCA I Z T8AX2          /STORE CHARACTER
3103  6414            TTRL                   /READ LINE NUMBER
3104  3415            DCA I Z T8AX2          /STORE LINE NUMBER
3105  1014            TAD Z T8AX1            /PICK UP ADDRESS POINTER
3106  1346            TAD T8K5               /-2
3107  3014            DCA Z T8AX1            /RESET POINTER
3110  3414            DCA I Z T8AX1          /ZERO STATUS AND COUNTER WORD
3111  1347            TAD T8K6               /WORD TO RESTORE ASSEMBLY WORD
3112  3414            DCA I Z T8AX1          /RESET CHARACTER ASSEMBLY WORD
3113  2126            ISZ Z T8INFL           /SET INPUT READY FLAG
3114  2144            ISZ Z T8CNT3           /HAS END OF BUFFER BEEN REACHED
3115  5237            JMP T8COM3 /UPDATE REGISTERS
3116  1127  T8COM7,  TAD Z T8BFK           /T8IBF-1
3117  3015            DCA Z T8AX2            /RESET INPUT BUFFER ADDRESS
3120  1130            TAD T8NL               /LENGTH OF BUFFER, NUMBER OF LINES
3121  3144            DCA Z T8CNT3           /RESET LENGTH COUNTER
3122  5237            JMP T8COM3 /UPDATE REGISTERS
3123  1540  T8COM8,  TAD I Z T8OIK2         /PICK UP DOUBLE-BUFFERED WORD
3124  7440            SZA                    /NOTHING TO SEND
3125  5330            JMP .+3                /SEND NEW WORD
3126  6401            TTINCR                 /INCREMENT LINE REGISTER
3127  5232            JMP T8COM1 /CONTINUE FOR INPUT
3130  6405            TTO+1                  /INCR. LINE REGISTER AND OUTPUT
3131  3537            DCA I Z T8OUTK         /STORE WORD
3132  3340            DCA IZ T8OTK2         /ZERO 2ND WORD
3133  5232            JMP T8COM1 /CONTINUE FOR INPUT

              /CONSTANTS
3134  7777  T8LC,    -1                     /INTERRUPT LEVEL COUNTER
3135  0000  T8SA,    0                      /SAVE ACCUMULATOR
3136  0000  T8SVLK,  0                      /SAVE LINK
3137  0000  T8SV0,   0                      /SAVE PROGRAM COUNTER
3140  0000  T8SVLN,  0                      /SAVE LINE NUMBER
3141  3377  T8K1,    T8IN                   /START OF TTI SERIES
3142  0000  T8MNC,   0                      /MINOR LOOP COUNTER, NO OF LINES/8
3143  0000  T8LN,    0                      /LINE NUMBER
3144  7770  T8K2,    -10                    /TO RESET MAJOR LOOP COUNTER
3145  3400  T8K3,    T8IN+1                 /TO RESET INPUT LINE POINTER
3146  7776  T8K5,    -2                     /FOR SUBTRACTION
3147  2000  T8K6,    2000                   /TO RESET 8-BIT ASSEMBLY WORD
3150  0000  T8K9,    0                      /STARTING LINE-1
```

```
                /PSEUD OPERATIONS
                /SKIP IF OUTPUT IS FREE AND TRANSMIT CHARACTER AT TTCHAR
                /OTHERWISE DONT
                /LINE NUMBER MUST BE IN AC.  24US MIN. 42US MAX.
                T8SOF=JMS I Z T8SOUT
3151  0000      T8OUTS,    0
3152  0370                 AND T8K10              /177
3153  1371                 TAD T8SL               /-STARTING LINE NO.
3154  1141                 TAD Z T8K36            /OUTPUT BUFFER ADDR
3155  3372                 DCA T8WA               /WORK AREA
3156  1772       TAD I T8WA            /OUTPUT CHARACTER
3157  7640       SZA CLA               /SKIP IF FREE
3160  5751       JMP I T8OUTS          /EXIT
3161  1177       TAD Z TTCHAR          /PICK UP CHARACTER
3162  0373       AND T8K11                      /8 BITS ONLY
3163  1374       TAD T8K12                      /1400 FOR STOP CODE
3164  7104       CLL RAL               /CREATE START CODE
3165  3772       DCA I T8WA            /STORE CHARACTER IN TABLE
3166  2351       ISZ T8OUTS            /INDEX EXIT
3167  5751       JMP I T8OUTS          /EXIT
3170  0177      T8K10,      177                 /FOR LINE NUMBER
3171  0000      T8SL,       0                   /-STARTING LINE NUMBER
3172  0000      T8WA,       0                   /WORK AREA
3173  0377      T8K11,      377                 /FOR EIGHT BIT CODE
3174  1400      T8K12,      1400                /FOR STOP CODE
                *TT8BGN+200
                /SKIP IF CHARACTER AVAILABLE AND RETURN WITH LINE NO. IN AC, CH
                /OTHERWISE DO NOT SKIP. 15 US MIN, 48 US MAX, 37.2US NORMAL IF
                T8SIR=JMS I Z T8SIN
3200  0000      T8INS,      0
3201  6002       IOF
3202  7240       CLA CMA               /SET AC TO -1 FOR TAD
3203  1126       TAD Z T8INFL          /INPUT FLAG COUNTER
3204  7510       SPA                   /SOMETHING AVAILABLE
3205  5221       JMP T8INON                    /EXIT
3206  3126       DCA Z T8INFL          /RESTORE FLAG COUNTER
3207  2223       ISZ T8CNT4            /END OF BUFFER? STARTS AT -N-1
3210  5215       JMP .+5               /GET CHARACTER
3211  1130       TAD Z T8NL            /-NUMBER OF LINES
3212  3223       DCA T8CNT4            /RESET COUNTER
3213  1127       TAD Z T8BFK           /BUFFER ADDRESS-1
3214  3016       DCA Z T8AX3           /RESET ADDRESS
3215  1416       TAD I Z T8AX3         /PICK UP CHARATER
3216  3177       DCA Z TTCHAR          /STORE CHARACTER
3217  1416       TAD I Z T8AX3         /PICK UP LINE NUMBER
3220  2200       ISZ T8INS                     /INDEX EXIT
3221  6001      T8INON,     ION
3222  5600       JMP I T8INS           /EXIT

3223  0000      T8CNT4,     0                   /-NO OF LINES
                /INITIALIZATION
                /ENTER WITH NUMBER OF LINES IN AC
                /FORMAT                T8INIT
                /                      1ST LINE NO.

                T8INIT=JMS I Z T8GO
3224  0000      T8GOS,      0
```

```
3425  0321      AND T8K14                       /377
3426  3130      DCA Z T8NL              /STORE NUMBER OF LINES
3427  1130      TAD Z T8NL              /NUMBER OF LINES
3430  0322      AND T8K15                       /7
3431  7640      SZA CLA                 /MULTIPLE OF 8?
3432  1323      TAD T8K16                       /10
3433  1130      TAD Z T8NL              /NUMBER OF LINES
3434  0324      AND T8K17                       /370
3435  7041      CIA                     /-TWO'S COMP NUMBER OF LINES
3436  3130      DCA Z T8NL              /-N, CONSTANT
3437  1130      TAD Z T8NL              /-N
3440  3144      DCA Z T8CNT3            /INPUT COUNTER
3441  1326      TAD T8K20                       /T8IN-1
3442  3014      DCA Z T8AX1             /TO STORE ITI TABLE
3443  1327      TAD T8K21                       /T8OBF-1
3444  3015      DCA Z T8AX2             /TO CLEAR OUTPUT AREA
3445  1343      TAD T8K37                       /T8OBF2-1
3446  3016      DCA Z T8AX3             /TO CLEAR DOUBLE BUFFER
3447  1130      TAD Z T8NL              /-N
3450  3223      DCA T8CNT4              /FOR COUNTING
3451  1330  T8GO2,      TAD T8K22                       /ITI+INCR
3452  3414      DCA I Z T8AX1           /STORE ITI
3453  3414      DCA I Z T8AX1           /ZERO STATUS AND COUNTER WORD
3454  1331      TAD T8K23                       /ASSEMBLY RESET WORD
3455  3414      DCA I Z T8AX1           /RESET ASSEMBLY WORD
3456  3415      DCA I Z T8AX2           /ZERO OUTPUT WORD
3457  3416      DCA I Z T8AX3           /CLEAR DOUBLE BUFFER
3460  2223      ISZ T8CNT4              /COUNTER
3461  5251      JMP T8GO2                       /DO NEXT LINE
3462  1332      TAD T8K24                       /JMP I Z T8K8
3463  3414      DCA I Z T8AX1           /STORE FINAL JUMP
3464  1130      TAD Z T8NL              /-N
3465  7012      RTR                     /DIVIDE BY 4
3466  7010      RAR                     /DIVIDE BY 8
3467  0333      AND T8K25                       /17
3470  1334      TAD T8K26                       /7760, MAKE NUMBER NEGATIVE
3471  3735      DCA I T8K27             /T8MNC
3472  7240      STA                     /-1
3473  3223      DCA T8CNT4              /SET COUNTER TO SKIP 1ST TIME
3474  1127      TAD Z T8IBF             /T8IBF-1
3475  3015      DCA Z T8AX2             /SET INPUT BUFFER POINTER
3476  1336      TAD T8K28                       /-10
3477  3142      DCA Z T8CNT1            /MAJOR LOOP COUNTER
3500  1337      TAD T8K30                       /T8IN+1
3501  3014      DCA Z T8AX1             /SET ITI POINTER
3502  1131      TAD Z T8K7              /T8OBF
3503  3137      DCA Z T8OUTK            /1ST OUTPUT BUFFER POINTER
3504  1141      TAD Z T8K36             /T8OBF2
3505  3140      DCA Z T8OTK2            /2ND OUTPUT BUFFER POINTER
3506  7240      STA                     /-1
3507  1624      TAD I T8GOS             /STARTING LINE NO.
3510  3740      DCA I T8K33             /T8K9, STARTING LINE NO. -1
3511  1740      TAD I T8K33             /T8K9
3512  7040      CMA                     /MAKE NEGATIVE
3513  3741      DCA I T8K34             /T8SL, -STARTING LINE NO.
3514  3126      DCA Z T8INFL            /CLEAR INPUT FLAG COUNTER
3515  7240      STA                     /-1
3516  3742      DCA I T8K35             /T8LC, RESET INTERRUPT LEVEL COUNTER
```

```
3217  2224    ISZ T8GUS                       /INDEX EXIT
3220  5624    JMP I T8GOS         /EXIT

            /CONSTANTS
3221  0377  T8K14,      377                   /FOR LINE NUMBER
3222  0007  T8K15,      7                     /FOR EVEN MULTIPLE OF 8
3223  0010  T8K16,      10                    /FOR EVEN MULTIPLE OF 8
3224  0370  T8K17,      370                   /FOR EVEN MULTIPLE OF 8
3225  0001  T8K18,      1                     /FOR COMPLEMENTING
3226  3376  T8K20,      T8IN-1                /FOR STORING TTI'S
3227  4577  T8K21,      T8OBF-1               /FOR OUTPUT AREA
3230  6403  T8K22,      TTI+1                 /TTI + INCREMENT
3231  2000  T8K23,      2000                  /ASSEMBLY RESET WORD
3232  5532  T8K24,      JMP I Z T8K8          /FOR FINAL JUMP
3233  0017  T8K25,      17                    /FOR -N/8
3234  7760  T8K26,      7760                  /FOR MAKING NEGATIVE
3235  3142  T8K27,      T8MNC                 /FOR -N/8
3236  7770  T8K28,      -10                   /FOR MAJOR LOOP COUNTER
3237  3400  T8K30,      T8IN+1                /FOR TTI POINTER
3240  3150  T8K33,      T8K9                  /FOR STARTING LINE-1
3241  3171  T8K34,      T8SL                  /-STARTING LINE NO.
3242  3134  T8K35,      T8LC                  /FOR INTERRUPT LEVEL COUNTER
3243  4777  T8K37,      T8OBF2-1              /FOR DOUBLE BUFFER
            /SKIP IF CHARACTER AVAILABLE FROM EITHER OF TWO TYPES OF LINES
            /OTHERWISE DO NOT SKIP.  31.5US MIN, 70.5US MAX, 60US NORMAL
            /IF READY
            T8SIE=JMS I Z T8IES
3244  0000  T8SE,       0
3245  4534    T8SIR                 /CHECK 8-BIT CODE
3246  5351    JMP .+3               /CHECK 5-BIT CODE
3247  2344    ISZ T8SE              /INDEX EXIT
3250  5744    JMP I T8SE            /EXIT
3251  3377    T5SIR                 /CHECK 5-BIT CODE
3252  5744    JMP I T8SE            /EXIT
3253  2344    ISZ T8SE              /INDEX EXIT
3254  5744    JMP I T8SE            /EXIT
            PAUSE

            /TYPE 680 TELETYPE LINE MULTIPLEXER 8 BIT
            /EXERCISER
            /KFN    10/15/65

            /START AT 1200
            /WITH STARTING LINE NUMBER IN SWITCHES
            /COMPUTER WILL HALT
            /SET SWITCHES = TO NUMBER OF LINES
            /CONTINUE
            /PROGRAM WILL RUN UNTIL AN ERROR
            /IS DETECTED OR UNTIL STOP

            /INTERRUPT ROUTINE

            *0001
0001  6431  INRUPT,      T8SKP                 /WAS IT 8 BIT CLOCK
0002  7402    HLT                   /NO, UNKNOWN INTERRUPT
0003  5404    JMP I .+1                       /YES, PROCESS INTERRUPT
0004  3000    T8DIS                 /TT8BGN
```

```
                *1200
1200  7604  DCSTST,    CLA OSR             /GET STARTING LINE
1201  3230    DCA STRLIN                    /SAVE IT
1202  7402    HLT                           /HALT, WAIT NUMBER OF LINES
1203  7604    CLA OSR                       /GET NO OF LINES
1204  3334    DCA NUMLIN                    /SAVE IT
1205  1334    TAD NUMLIN                    /NO LINES
1206  7041    CIA                           /2'S COMPLEMENT
1207  3335    DCA LINDEX                    /SAVE FOR COUNTING
1210  1335    TAD LINDEX                    /SET UP
1211  3350    DCA NDEX                      /INDICES
1212  1336    TAD OUTDEX                    /FOR INITIAL
1213  1250    TAD STRLIN                    /SET UP OF
1214  3011    DCA Z 11                      /INPUT AND
1215  1340    TAD INPDEX                    /OUTPUT BUFFERS
1216  1250    TAD STRLIN
1217  3012    DCA Z 12
1220  1342  DCBFLP,     TAD CHARAC          /ADDRESS OF CHAR TABLE
1221  3411    DCA I Z 11                    /TO OUTPUT BUFFER
1222  1342    TAD CHARAC                    /ADDRESS TO COMPARE
1223  3412    DCA I Z 12                    /CHAR TO INPUT BUFFER
1224  2350    ISZ NDEX                      /GOT ALL LINES
1225  5220    JMP DCBFLP                    /NO
1226  1334    TAD NUMLIN                    /SET NO OF LINES IN AC

1227  4535    TSINIT                        /INITIALIZE TTY
1230  0000  STRLIN,     0                   /STARTING LINE NUMBER
1231  6434    TTSON                         /TURN CLOCK ON
1232  6001    ION                           /TURN INTERRUPTS ON
1233  3350    DCA NDEX                      /GET IN SYNC
1234  2350    ISZ NDEX
1235  5234    JMP .-1
1236  7200    CLA
1237  1250    TAD STRLIN                    /FORM START OF
1240  1337    TAD OUTDEX+1                  /OUTPUT BUFFER
1241  3343    DCA CUROUT
1242  1250    TAD STRLIN                    /GET FIRST LINE NO.
1243  3344    DCA CURLIN
1244  1335    TAD LINDEX
1245  3350    DCA NDEX
1246  1743  OTLOOP,     TAD I CUROUT        /GET POINTER FOR NEXT OUTPUT
1247  3345    DCA SAVCUR
1250  1745    TAD I SAVCUR                  /GET NEXT OUTPUT CHARACTER
1251  3177    DCA Z TTCHAR
1252  1344    TAD CURLIN                    /GET LINE NUMBER
1253  4533    TSSOF                         /CHECK FOR FREE OUTPUT
1254  7410    SKP                           /OUTPUT NOT FREE
1255  2743    ISZ I CUROUT                  /ADD 1 TO CHARACTER POINTER
1256  1743    TAD I CUROUT
1257  7041    CIA                           /HAS CURRENT
1260  1346    TAD LSTCHR                    /LINE REACHED
1261  7440    SZA                           /THE END OF OUTPUT
1262  5265    JMP .+3                       /NO
1263  1342    TAD CHARAC                    /YES RESET POINTER
1264  3743    DCA I CUROUT                  /TO FIRST CHARACTER
1265  2343    ISZ CUROUT                    /ADVANCE TO NEXT LINE
1266  2344    ISZ CURLIN                    /ADVANCE TO NEXT LINE
```

```
1267  7200    CLA                     /CLEAR FOR TAD
1270  2350    ISZ NDEX                /TESTED ALL LINED FOR FREE
1271  5246    JMP OTLOOP              /NO, TRY NEXT LINE
1272  4534  INLOOP,     TSSIR                 /ANY INPUT AVAILABLE
1273  5236    JMP STRLIN+6            /NO, OUTPUT AGAIN
1274  3344    DCA CURLIN              /YES, SAVE LINE NO,
1275  1344    TAD CURLIN
1276  1341    TAD INPDEX+1            /FIND INPUT POINTER
1277  3343    DCA CUROUT              /FOR THE LINE
1300  1743    TAD I CUROUT            /GET INPUT POINTER
1301  3345    DCA SAVCUR
1302  1177    TAD ITCHAR              /GET NEXT INPUT CHARACTER
1303  0347    AND LSTCHR+1            /37
1304  7041    CIA
1305  1745    TAD I SAVCUR            /CHARACTER INPUT
1306  7450    SNA                     /EQUAL CHARACTER EXPECTED
1307  5322    JMP INCINP              /YES, INCREMENT POINTER
1310  7200    CLA
1311  1344    TAD CURLIN              /LINE NUMBER TO AC
1312  7402    HLT                     /HALT
1313  7200    CLA
1314  1745    TAD I SAVCUR            /CHARACTER EXPECTED TO AC
1315  7402    HLT                     /HALT
1316  7200    CLA
1317  1177    TAD Z TICHAR            /CHARACTER RECEIVED
1320  0347    AND LSTCHR+1
1321  7402    HLT                     /HALT
1322  2743  INCINP,     ISZ I CUROUT          /ADVANCE INPUT POINTER
1323  7200    CLA
1324  1743    TAD I CUROUT            /GET INCREMENTED POINTER
1325  7041    CIA
1326  1346    TAD LSTCHR              /LINE AT END OF
1327  7440    SZA                     /INPUT CHARACTERS
1330  5272    JMP INLOOP              /NO, TEST FOR MORE INPUT
1331  1342    TAD CHARAC              /RESET INPUT POINTER
1332  3743    DCA I CUROUT            /TO FIRST CHARACTER
1333  5272    JMP INLOOP              /TEST FOR MORE INPUT

1334  0000  NUMLIN,      0                       /NUMBER OF LINES
1335  0000  LINDEX,      0                       /2'S COMPLEMENT NO OF LINES
1336  2177  OUTDEX,      BUFFR-1                 /FOR FILLING OUTPUT BUFFER
1337  2200    BUFFR                   /FOR CHECKING OUTPUT BUFFER
1340  2377  INPDEX,      INBUFR-1                /FOR FILLING INPUT BUFFER
1341  2400    INBUFR
1342  1400  CHARAC,      CODES                   /START OF 8 BIT CODES
1343  0000  CUROUT,      0                       /TEMP STORAGE BUFFER POINTER
1344  0000  CURLIN,      0                       /TEMP STORAGE CURRENT LINE NO.
1345  0000  SAVCUR,      0                       /TEMP STORAGE CHARACTER POINTER
1346  1536  LSTCHR,      NOCOD+1                 /FOR DETECTING END OF CHARACTERS
1347  0377    377                   /FOR ANDING ITCHAR
1350  0000  NDEX,        0                       /FOR COUTING

              BUFFR=2200
              INBUFR=2400
              /8 BIT CODES OUTPUT BY DCSIST
              *1400
1400  0215  CODES,       215                     /CARRIAGE RETURN
1401  0212    212                   /LINE FEED
```

```
1402  0212    212          /LINE FEED
1403  0324    324          /T
1404  0310    310          /H
1405  0305    305          /E
1406  0240    240          /SPACE
1407  0321    321          /Q
1410  0325    325          /U
1411  0311    311          /I
1412  0303    303          /C
1413  0313    313          /K
1414  0240    240          /SPACE
1415  0302    302          /B
1416  0322    322          /R
1417  0317    317          /O
1420  0327    327          /W
1421  0316    316          /N
1422  0240    240          /SPACE
1423  0306    306          /F
1424  0317    317          /O
1425  0330    330          /X
1426  0240    240          /SPACE
1427  0312    312          /J
1430  0325    325          /U
1431  0315    315          /M
1432  0320    320          /P
1433  0305    305          /E
1434  0304    304          /D
1435  0240    240          /SPACE
1436  0317    317          /0
1437  0326    326          /V
1440  0305    305          /E
1441  0322    322          /R
1442  0240    240          /SPACE
1443  0324    324          /T
1444  0310    310          /H
1445  0305    305          /E
1446  0240    240          /SPACE
1447  0314    314          /L
1450  0301    301          /A
1451  0332    332          /Z
1452  0331    331          /Y
1453  0240    240          /SPACE
304                  /D
1455  0317    317          /0
1456  0307    307          /G
1457  0247    247          /APOSTROPHE
1460  0323    323          /S
1461  0240    240          /SPACE
1462  0302    302          /B
1463  0301    301          /A
1464  0303    303          /C
1465  0313    313          /K
1466  0215    215          /CARRIAGE RETURN
1467  0212    212          /LINE FEED
1470  0260    260          /0
1471  0261    261          /1
1472  0262    262          /2
1473  0263    263          /3
```

```
1474  0264    264                     /4
1475  0265    265                     /5
1476  0266    266                     /6
1477  0267    267                     /7
1500  0270    270                     /9
1501  0271    271                     /9
1502  0240    240                     /SPACE
1503  0241    241
1504  0242    242
1505  0243    243
1506  0244    244
1507  0245    245
1510  0246    246
1511  0247    247
1512  0250    250
1513  0251    251
1514  0252    252
1515  0253    253
1516  0254    254
1517  0255    255
1520  0256    256
1521  0257    257
1522  0272    272
1523  0273    273
1524  0274    274
1525  0275    275
1526  0276    276
1527  0277    277
1530  0300    300
1531  0333    333
1532  0334    334
1533  0335    335
1534  0336    336
1535  0337  NUCOD,      33/
            /CHARACTER ECHO
            /START AT 1600
            /PROGRAM INITIALIZES FOR 128 LINES
            /PROGRAM WAITS FOR INPUTS
            /TRANSMITS
            /THE CHARACTERS RECEIVED
            /THEN WAITS FOR MORE INPUTS
            /PROGRAM RUNS UNTIL "STOP"


            /ECHO
            /INPUT CHARACTERS
            /THEN OUTPUT THEM

            *1600
1600  7200  ECHOTS,     CLA
1601  1216    TAD ONE28                       /AC=128
1602  4535    TSINIT                  /SETUP FOR 128 LINES
1603  0000  ECHLIN,     0                    /LINE NUMBER  0 STARTING LINE
1604  6434    TTSON                   /CLOCK ON
1605  6001    ION                     /ENABLE INTERRUPTS
1606  4534    TSSIR                   /SKIP IFINPUT
1607  5206    JMP .-1                 /INPUT NOT READY, WAIT
```

```
1010  3215    DCA ECHDEX          /SAVE LINE NUMBER
1011  1215    TAD ECHDEX          /GET LINE NUMBER
1012  4533    TSSOF               /OUTPUT
1013  5211    JMP .-2             /NOT FREE TRY AGAIN
1014  5206    JMP ECHLIN+3        /WAIT MORE INPUT
1015  0000  ECHDEX,    0

1016  0200  ONE28,      0200
            /TRANSMIT AC SWITCHES
            /START AT 1000
            /WITH SWITCHES = LINE NUMBER
            /COMPUTER WILL HALT
            /SW0 = 0 COMPUTER WILL NOT COMPARE INPUT
            /SW0 = 1 COMPUTER COMPARES INPUT AGAINST OUTPUT
            /SW4 TO SW11 = CHARACTER TRANSMITTED
            /SW0 MAY NOT BE ALTERED ONCE RUNNING
            /SW4 TO SW11 MAY BE ALTERED
            /PROGRAM TRANSMITS CARRIAGE RETURN/LINE FEED
            /THE SW7 TO SW11 64 TIMES
            /THEN CARRIAGE RETURN LINE FEED/64 CHARACTERS
            /PROGRAM RUNS UNTIL "STOP"

            /TRANSMIT AC SWITCHES
            *2000
2000  7604  TRANSR,     CLA OSR             /GET LINE NO
2001  3205    DCA TRALIN          /TSINIT+1
2002  7402    HLT                 /WAIT FOR CHARACTER
2003  7001    IAC                 /AC=NO OF LINES (1)
2004  4535    TSINIT              /INITIALIZE TTY ROUTINES
2005  0000  TRALIN,     0                  /LINE NUMBER
2006  6434    TTSON               /TURN CLOCK ON
2007  6001    ION                 /ENABLE INTERRUPTS
2010  3271    DCA TRADEX                  /GET IN SYNC
2011  2271    ISZ TRADEX
2012  5211    JMP .-1
2013  1267    TAD K64             /-64
2014  3271    DCA TRADEX          /FOR COUNTING
2015  1272    TAD TRADEX+1        /CARRIAGE RETURN
2016  3274    DCA TRACHR          /OUTPUT CARRIAGE RETURN
2017  4232    JMS TRAOUT          /OUTPUT
2020  1273    TAD TRADEX+2        /LINE FEED
2021  3274    DCA TRACHR          /OUTPUT CHARACTERS
2022  4232    JMS TRAOUT          /OUTPUT
2023  7604    CLA OSR             /GET CHARACTER IN SWITCHES
2024  0270    AND THRE77                  /CLEAR ALL BUT LWR 8
2025  3274    DCA TRACHR          /OUTPUT CHARACTER
2026  4232    JMS TRAOUT          /OUTPUT
2027  2271    ISZ TRADEX          /OUTPUT 64 CHARACTERS
2030  5223    JMP .-5             /TEST SWITCHES AGAIN
2031  5213    JMP TRALIN+6        /OUTPUT CAR. RET./LINE FEED
2032  5232  TRAOUT,     JMP
2033  0000    DCA
2034  1274    TAD TRACHR          /GET OUTPUT CHARACTER
2035  6177    DCA TTCHAR          /FOR OUTPUTING
2036  1205    TAD TRALIN          /LINE NUMBER
2037  4533    TSSOF
2040  5233    JMP .-5             /OUTPUT NOT FREE, TRY AGAIN
```

```
2041  7604  TRASW0,     CLA OSR              /GET SWITCHES
2042  7004    RAL                  /BIT 0 TO LINK
2043  7620    SNL CLA              /0 SET
2044  5632    JMP I TRAOUT         /NO, EXIT

2045  4534  TRAWAT,     TSSIR                /SKIP IF INPUT
2046  2045    JMP.-1               /NO INPUT, WAIT
2047  7200    CLA
2050  1177    TAD TTCHAR           /GET CHARACTER
2051  0270    AND THRE77                   /CLEAR STOP BIT
2052  7041    CMA IAC
2053  1274    TAD TRACHR           /CHARACTER RECEIVED=SENT
2054  7450    SNA
2055  5632    JMP I TRAOUT         /EXIT
2056  7200    CLA
2057  1274    TAD TRACHR                   /CHARACTER SENT
2060  7402    HLT                  /HALT
2061  7200    CLA
2062  1177    TAD TTCHAR                   /CHARACTER RECEIVED
2063  0270    AND THRE77                   /TO LAST 8 BITS
2064  7402    HLT                  /HLT
2065  7200    CLA
2066  5632    JMP I TRAOUT         /EXIT

2067  7700  K64,        7700               /-64
2070  0377  THRE77,    377                /FOR ANDING
2071  0000  TRADEX,     0                  /FOR COUNTING
2072  0215    215                  /CARRIAGE RETURN
2073  0212    212                  /LINE FEED
2074  0000  TRACHR,     0                  /CHARACTER STORAGE
```

```
BUFFR   2200

CHARAC  1342
CODES   1400
CURLIN  1344
CUROUT  1343
DUBFLP  1220
DUSTST  1200
ECHDEX  1615
ECHLIN  1603
ECHOTS  1600
INBUFR  2400
INCINP  1322
INLOOP  1272
INPDEX  1340
INRUPT  0001

K64     2067
LINDEX  1335
LSTCHR  1346
NUCOD   1535
NUEX    1350
NUMLIN  1334
ONE28   1616
OILOOP  1246
OUTDEX  1336

SAVCUR  1345
SIRLIN  1230
THRE77  2070
TRACHR  2074
TRADEX  2071
TRALIN  2005

TRANSR  2000
TRAOUT  2032
TRASW0  2041
TRAWAT  2045
TTCHAR  0177
TTCL    6411
TTI     6402
TTINCR  6401
TTO     6404
TTRL    6414
TTSL    6412
TT8BGN  3000
TT8OFF  6432
TT8ON   6434
TT8PG0  0126
TTSSIR  3377
TTAX1   0014
TTAX2   0015

TTAX3   0016
TTBFK   0127
TTCNT1  0142
TTCNT2  0143
TTCNT3  0144
TTCNT4  3223
TTCOM   3021
TTCOM0  3025
TTCOM1  3032
TTCOM3  3037
TTCOM4  3045
TTCOM5  3063
TTCOM6  3101
TTCOM7  3116
TTCOM8  3123
TTDIS   3000
TTDIS2  3012
TTDIS3  3016
TTGO    0135
TTGOS   3224
TTGO2   3251
TTIBF   4200
TTIES   0136
TTIN    3377
TTINFL  0126
```

```
T0INIT  4535
T0INON  3221
T0INS   3200
T0K1    3141
T0K10   3170
T0K11   3173
T0K12   3174
T0K14   3321
T0K15   3322
T0K16   3323
T0K17   3324
T0K18   3325
T0K2    3144
T0K20   3326
T0K21   3327
T0K22   3330
T0K23   3331
T0K24   3332
T0K25   3333
T0K26   3334
T0K27   3335
T0K28   3336
T0K3    3145
T0K30   3337
T0K33   3340
T0K34   3341
T0K35   3342
T0K36   0141
T0K37   3343
T0K5    3146
T0K6    3147
T0K7    0131
T0K8    0132
T0K9    3150
T0LC    3134
T0LN    3143
T0MNC   3142
T0NL    0130
T0OBF   4600
T0OBF2  5000
T0OTK2  0140
I0OUTK  0137
I0OUTS  3151
T0SA    3135
T0SE    3344
T0SIE   4536
T0SIN   0134
T0SIR   4534
T0SKP   6431
T0SL    3171
T0SOF   4533
T0SOUT  0133
T0SVLK  3136
T0SVLN  3140
I0SV0   3137
T0WA    3172
D
```

11. DIAGRAMS (Not Applicable)

12. REFERENCES

12.1 Other Library Programs

Digital-8-35-S-B
680 8-Bit Character Assembly Subroutines