1. IDENTIFICATION

1.1 Digital-8-35-S-B

1.2 680 8-Bit Character Assembly Subroutines

1.3 November 8, 1965

PDP-8
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2. ABSTRACT

The 680 Data Communication System 8-Bit Character Assembly Subroutines concentrate Teletype data by assembling serial-bit data into 8-bit characters and present the user with data similar to that obtained by using a 630 DCS and scanner. They also add start and stop bits to 8-bit characters and transmit them in serial-bit fashion. Full duplex lines are assumed, but the subroutines will work with half duplex if the user handles the expected echo.

3. REQUIREMENTS

3.1 Storage

The subroutines as presently coded occupy 400 octal locations plus space for internal buffering of the input and output characters and for the TTI instructions. In addition, space is used in memory page 0 and a limited number of autoindex registers are used as explained below. Within the limits described, the program can be placed anywhere in the first 4K of PDP-8 memory. The total amount of memory used including the autoindex registers and the locations in page 0 is as follows:

$$422_8 + 7n$$

where n is the number of Teletype lines to the next even multiple of eight lines if the number of lines is not already an even multiple of eight.

3.2 Subprograms and/or Subroutines

Digital-8-35-S-A
680 5-Bit Character Assembly Subroutines

for reference or in the event the user's requirements include a mixture of 5-bit and 8-bit lines.

3.3 Equipment

Minimum configuration PDP-8
680 Data Communication System hardware

3.4 Miscellaneous

3.4.1 The tag TT8BGN must be defined as the address of the start of the Teletype subroutines. It can be defined as anywhere in memory, but must be equated to the start of a PDP-8 memory page.

3.4.2 Three autoindex registers called T8AX1, T8AX2, and T8AX3 must be defined.

3.4.3 The tag TT8PG0 must be defined as the start of an area in memory page 0 where the necessary Teletype constants can be stored. An area of 17_8 registers must be reserved.

3.4.4 The tag T8OBF must be defined as the start of the area reserved for outputting the Teletype characters. It must be equal in length to the number of lines (even multiple of 8) attached to the particular set of subroutines. It can be anywhere in memory and need not start at the beginning of a memory page.

3.4.5 The tag T8OBF2 must be defined as an area equal in length to T8OBF. It is used for double-buffering the output characters to allow maximum output rate.

3.4.6 The tag T8IBF must be defined as the area for storing incoming Teletype characters and line numbers. It must be equal in length to twice the number of lines attached to the particular set of subroutines.

3.4.7 The tag T8IN must be defined as the start of the area used by the subroutines for generating the appropriate number of TTI instructions. It must be equal in length to three times the number of lines plus one register. Here again it need not be defined as the start of a memory page.

3.4.8 The tag TTCHAR must be defined as a single register in page 0.

3.4.9 In the interrupt service routine the following set or sets of instructions must appear:

```
T8S KP                  /SKIP ON CLOCK FLAG
SKP                     /TEST FOR NEXT INTERRUPT CAUSE
JMP    T8DIS            /JUMP TO APPROPRIATE CLOCK INTERRUPT
                        /ROUTINE
```

Because of the speed necessary for Teletype handling, the checks for clock interrupts should be the first ones in the interrupt service interrogation loop; the link bit and accumulator contents should not be saved prior to interrogation of the appropriate clock flag. If necessary for other interrupts, the link and accumulator contents should be saved only after all clock interrupts have been checked.

3.4.10 Clock IOT's

The IOT's to test the clock for the 1 state, turn the clock on, and turn the clock off must be given the correct octal definitions:

Mnemonic	Clock 1	Clock 2	Clock 3	Clock 4
T8SKP	6421	6431	6441	6451
TT8ON	6424	6434	6444	6454
TT8OFF	6422	6432	6442	6452

4. USAGE

4.2 Calling Sequence

The pseudo command T8INIT must be executed before the instruction TT8ON and also before either of the other pseudo commands T8SOF or T8SIR is executed. (See Section 4.4.1, 4.4.2 and 4.4.3 for definitions of the pseudo commands.)

4.3 Switch Settings

None

4.4 Start up and/or Entry

Three pseudo commands for using this set of subroutines are provided to the main program. They are defined as jumps to subroutines and their definitions and instructions are included in the package. These are the only commands necessary in the main program for gathering and outputting the Teletype characters. The user should note that no subroutines are included for packing or unpacking of the characters by word or even line number.

4.4.1 Teletype Initialize (T8INIT)

This command (which must be used only once in the main program) assumes that the user enters with the number of lines in the accumulator and that the register following the initialize command

contains the first line number for this type of Teletype line. This subroutine initializes all of the buffer areas, counters, and pointers, and generates the proper number of TTI instructions.

4.4.2 Skip if Output Free (T8SOF)

This instruction skips the next register in memory and transmits the character contained in register TTCHAR if the indicated output line is free. If the output line is not free, the instruction does not skip. The instruction requires that the line number over which the character is to be transmitted be in the accumulator at the time the instruction is issued. The pseudo command takes 24 μsec minimum time, and 42 μsec maximum time. The accumulator will be cleared when exiting from the command.

4.4.3 Skip if Input Ready (T8SIR)

This instruction skips the next location in memory and returns with the line number in the accumulator and the character placed at TTCHAR if an input character is available. If no character is available, the instruction does not skip and the accumulator is -1. Only the low order eight bits of the character at TTCHAR should be used, as additional bits representing the stop codes are also present in the character.

If no character is available, 15 μsec are used by the pseudo instructions; if a character is available, 37.5 μsec are used; and if the end of the storage area is reached, a maximum of 48 μsec is used by the instruction.

4.4.4 Skip if Either Input is Ready (T8SIE)

This command is used when more than one type of Teletype line is being used. As presently coded, it assumes that two are being used, that one is an 8-bit line, and one is a 5-bit line. It skips if a character is available from either of the two types of lines being used and presents the user with the line number in the accumulator and the character in location TTCHAR. If no character is available, 37.5 μsec are used; if a character is available, 60 μsec are used; if the end of a buffer area is found, a maximum of 70.5 μsec is used. As stated, the command assumes that two types of lines are being used. However, if a single type of line at two different speeds is used, the instructions, which occupy approximately 10 locations, can easily be changed to reference the correct set of subroutines.

> NOTE: Since the pseudo operation references the pseudo-operation T5SIR, the user can expect an assembly error if the 8-bit subroutines are not assembled with the 5-bit subroutines. However, assuming that the user's requirements include only 8-bit lines and that the operation T8SIE would not be used, the error may either be ignored or the coding for T8SIE be deleted from the ASCII tape.

5. RESTRICTIONS

5.1 Status Active Registers

The autoindex registers defined as T8AX1, T8AX2, and T8AX3 must not be disturbed after the pseudo operation T8INIT.

6. DESCRIPTION

6.1 Discussion

These subroutines are designed to accumulate 8-bit Teletype characters to and from multiple Teletype lines connected to a PDP-8. They handle input data in serial-bit format and present the user

with character and line identification. The user presents the routines with line identification and character format data, and the routines transmit the information in serial-bit format.

Most of the PDP-8 memory is available for data buffering and for packing. A large proportion of the time however is used in buffering the Teletype lines themselves. Assuming even minor data handling is necessary before transmission (possibly to a larger computer), present estimates indicate the user cannot handle 128 8-bit lines at 110 baud. Exact timing information is shown in Section 9. The user should note that the programming described involves the handling of the Teletype lines only and does not include any packing or unpacking of words, lines, or messages. The main program communicates with the Teletype subroutines via a group of pseudo commands which are described fully in Section 4.4 with examples of their usage in Section 6.2.

If the user's requirements include a mixture of 8-bit and 5-bit lines, it is necessary that the 5-bit Character Assembly Subroutines (Digital-8-35-S-A) be included with the user's programs.

6.2 Examples and/or Applications

6.2.1 To initialize the subroutines, coding similar to the following should appear in the user's program:

```
TAD       NUMLIN      /GET NUMBER OF LINES
T8INIT                /INITIALIZE SUBROUTINES
SLN                   /STARTING LINE NUMBER
ION                   /ENABLE INTERRUPTS
TT8ON                 /TURN ON CLOCK
```

NOTE: Following these lines of coding it is necessary that the user wait 8 clock interrupts before using the pseudo-instruction T8SOF. Otherwise, the first character transmitted will be erroneous.

6.2.2 To output a character, coding similar to the following should appear:

```
TAD       CHARAC      /GET OUTPUT CHARACTER
DCA       TTCHAR      /FOR OUTPUT SUBROUTINE
TAD       LINE NO     /GET LINE NUMBER
T8SOF                 /OUTPUT, SKIP IF FREE

JMP       OUTNA       /OUTPUT NOT FREE
CONTINUE              /CHARACTER ACCEPTED, CONTINUE
```

6.2.3 To test for an input character available, coding similar to the following should appear:

```
T8SIR                 /CHECK FOR INPUT
JMP       .-1         /WAIT FOR A CHARACTER
DCA       SAVLIN      /SAVE LINE NUMBER
TAD       TTCHAR      /GET CHARACTER INPUT
AND       THREE7      /377, CLEAR STOP BIT
```

7. METHODS

7.1 Discussion

7.1.1 Input Character Assembly

The 8-bit Character Assembly Interrupt Subroutine executes a TTI instruction for each line selected every clock interrupt. The program then scans one eighth of the character assembly words to see if a full input character has been assembled for any of the lines. If a fully assembled character is found, the program stores the character and line number in the input buffer, zeros the TTI status word, and sets the TTI character assembly word to 2000. Note that bit 1 of the character assembly word is initially set to a 1 and the rest of the character assembly word is zeros. As the character is assembled, the character assembly word is shifted one bit position to the right for the start bit and each data bit. When the link can be set to a 1 by a RTR, the character is fully assembled.

7.1.2 Output Character Handling

Initially, the pseudo operation T8SOF adds start and stop bits to the output characters and places them in the second output buffer (T8OBF2). Eventually, the interrupt subroutine transfers the characters from the second output buffer to the first output buffer (T8OBF). One eighth of the lines are scanned for output every clock interrupt. That is, for any one line one bit may be output every eight clock interrupts. The first output buffer location for a line is tested for zero or non-zero. If it is non-zero the program outputs one bit of that location and stores the remaining information back in the first output buffer. If the T8OBF location is zero, the second output buffer is tested for zero or non-zero. The second buffer location in the zero state indicates no new output. If the location is non-zero, the program outputs one bit, stores the remaining bits in the first output buffer, and zeros the second output buffer.

8. FORMAT

8.1 Input Data (T8SIR)

If the pseudo operation T8SIR skips, the input data is the following format:

8.1.1 Accumulator contains line number.

8.1.2 The lower eight bits of the register TTCHAR contain the input character.

8.3 Output Data (T8SOF)

The user presents the pseudo operation T8SOF with output characters in the following format:

8.3.1 The lower eight bits of register TTCHAR contain the output character.

8.3.2 The accumulator contains the number of the line on which the character is to be output.

9. EXECUTION TIME

9.1 Minimum

9.2 Maximum

9.3 Average

The table below indicates the percentages of machine time used for 110 baud 8-bit systems and is as accurate as is presently possible. Any additional features which may be required for the Teletype handling would add appreciably to the times shown:

TIMING TABLE

Numbers indicate the percentage of available machine time used in the average case.

No. of Lines	8-Bit 110 Baud
32	34.1 %
64	57.7 %
96	81.3 %
128	104.9 %

9.4 Timing Equations

Where n = the number of lines, the 8-bit subroutines require an average time of 8.38n+119.5 μsec. Clock flags (at 110 baud) occur every 1135 μsec.

10. PROGRAM

10.3 List of Items and Pseudo Commands

10.3.1 List of Items

```
TT8BGN      /BEGINNING OF SUBROUTINE. MUST BE
            /EQUATED TO START OF A PAGE. (AREA
            /INCLUDES TWO PAGES).
T8AX1       /AUTOINDEX REGISTER.
T8AX2       /AUTOINDEX REGISTER.
T8AX3       /AUTOINDEX REGISTER.
TT8PG0      /START OF CONSTANT AREA IN PAGE 0.
            /(LENGTH 17₈ REGISTERS.)
T8OBF       /START OF OUTPUT BUFFER. (LENGTH = n.)
T8OBF2      /START OF SECOND OUTPUT BUFFER.
            /(LENGTH = n.)
T8IBF       /START OF INPUT BUFFER. (LENGTH = 2n.)
T8IN        /START OF TTI AREA. (LENGTH = 3n+1.)
TTCHAR      /CHARACTER AREA PAGE 0. (SINGLE REGISTER.)
```

10.3.2 List of Pseudo Command

Command		Times (users) Minimum	Average	Maximum
T8INIT	Initialize		-	
T8SOF	Skip if output free	24	-	42
T8SIR	Skip if input ready	15	37.5	48
T8SIE	Skip if either input ready	37.5	60.0	70.5

10.4 Program Listing

```
CARRET  0264
CLRFLG  0101
CODES   0126
DELAY   0641
ENDCOD  0137
FIVE    1052
INPTS   0073
KCCLT1  6402
KCCLT2  6422
KCCLT3  6442
KCCLT4  6462
KCCLT5  6112
KNOW    0041
KRRLT1  6406
KRRLT2  6426
KRRLT3  6446
KRRLT4  6466
KRRLT5  6116
KRSLT1  6404
KRSLT2  6424
KRSLT3  6444
KRSLT4  6464
KRSLT5  6114
KSFLT1  6401
KSFLT2  6421
KSFLT3  6441
KSFLT4  6461
KSFLT5  6111
K10     0107
K5      0110
K6      0111
K64     0652
LFCODE  0136
LNFEED  0306
LPOINR  0046
MACT    0125
MACTV   0260
MDFX    0050
MDFX1   0051
MRUPT   0253
OUTALL  0200
OUTCDS  0323
OUTIN   0400
OUTPTS  0065
OUTR    0446
RETCOD  0135
RPOINR  0112
RUPTST  0006
SEVEN   0651
SKIPS   0052
SPACE   0134
STLOOP  0225
SWITCH  0600
SWLOOP  0616
SWOUTR  0631
SWSKIP  0636
TCFLT1  6412
TCFLT2  6432
TCFLT3  6452
TCFLT4  6472
TCFLT5  6122
TLSLT1  6416
TLSLT2  6436
TLSLT3  6456
TLSLT4  6476
TLSLT5  6126
TPCLT1  6414
TPCLT2  6434
TPCLT3  6454
TPCLT4  6474
TPCLT5  6124
TSFLT1  6411
TSFLT2  6431
TSFLT3  6451
TSFLT4  6471
TSFLT5  6121
WAITI   0241
WHO     0020
WHOIS   0027
WHORU   1000
WHOSTR  0045
WHWAIT  1022
WRUCOD  1051
WRULOP  1004
```

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

                TT8BGN=3000
                TT8PG0=126
                T80BF=4600
                T81BF=4200
                T80BF2=5000
                T8AX1=14
                T8AX2=15
                T8AX3=16
                TTCHAR=177
                T81N=3377

                TTI=6402                /TELETYPE INPUT COMMAND
                TTO=6404                /TELETYPE OUTPUT COMMAND
                TTCL=6411 /CLEAR LINE REGISTER
                TTRL=6414 /READ LINE REGISTER
                TTSL=6412 /SET LINE REGISTER, CLR AC
                TT8ON=6434              /TURN CLOCK ON
                TT8OFF=6432             /TURN CLOCK OFF
                T8SKP=6431              /SKIP ON CLOCK FLAG
                TTINCR=6401             /INCREMENT LINE REGISTER

                *TT8PG0
0126  0000  T81NFL,   0                /INPUT READY FLAG
0127  4177  T8REK,    T81RF-1         /TO RESET INPUT BUFFER POINTER
0130  0000  T8NL,     0               /-NUMBER OF LINES
0131  4600  T8K7,     T80BF           /K FOR 1ST OUTPUT BUFFER
0132  3021  T8K8,     T8COM           /TO ENTER COMMON ROUTINE
0133  3151  T8SOUT,   T80UTS          /SKIP IF OUTPUT FREE
0134  3200  T8SIN,    T81NS           /SKIP IF INPUT READY
0135  3224  T8GO,     T8GOS           /INITIALIZE ROUTINE
0136  3344  T81ES,    T8SE            /SKIP IF EITHER LINE READY
0137  4600  T80UTK,   T80BF           /POINTER TO FIRST OUTPUT BUFFER
0140  5000  T80TK2,   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

                *TT8BGN
                /MULTIPLE LEVEL INTERRUPT ROUTINE
                /ALLOWS MULTIPLE LEVEL INTERRUPT TO THIS ROUTINE AND UNLIMITED OTHERS
3000  2334  T8DIS,    ISZ T8LC                /LEVEL COUNTER
3001  5216            JMP T8DIS3 /2ND LEVEL INTERRUPT
3002  3335            DCA T8SA                /SAVE ACCUMULATOR
3003  7010            RAR                     /GET LINK
3004  3336            DCA T8SVLK /SAVE LINK
3005  1000            TAD .-.                 /INTERRUPT ADDRESS
3006  3337            DCA T8SVP               /SAVE ADDRESS
3007  6414            TTRL                    /RD LINE NUMBER
3010  3340            DCA T8SVLN /SAVE LINE NUMBER
3011  6434            TT8ON                   /TO CLEAR FLAG ONLY
3012  6001  T8DIS2,   ION                     /RE-ENABLEPROGRAM INTERRUPT
3013  1350            TAD T8K9                /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,   TT8ON                   /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 T8MNC               /MINOR COUNTER, NUMBER OF LINES/8
3022  3143            DCA Z T8CNT2            /MINOR LOOP COUNTER
3023  1343            TAD T8LN                /LINE NUMBER
3024  6413            TTSL+1                  /SET LINE NUMBER
3025  1537  T8COM0,   TAD I Z T8OUTK          /OUTPUT WORD
3026  7450            SNA                     /SOMETHING TO TRANSMIT
3027  5323            JMP T8COM8 /SEE IF WORD AVAILABLE
3030  6405            TTO+1                   /INCR. LINE REGISTER AND OUTPUT
3031  3537            DCA I Z T8OUTK          /STORE WORD
3032  1414  T8COM1,   TAD I Z T8AX1           /PICK UP CHARACTER ASSEMBLY WORD
3033  7110            CLL RAR                 /PUT BIT 11 IN LINK
3034  7430            SZL                     /CHARACTER NOT COMPLETED
3035  5301            JMP T8COM6 /STORE CHARACTER
3036  7200            CLA                     /CLEAR AC FOR TAD
3037  2137  T8COM3,   ISZ Z T8OUTK           /UPDATE OUTPUT ADDR
3040  2140            ISZ Z T8OTK2            /UPDATE 2ND BUFFER ADDRESS
3041  2014            ISZ Z T8AX1             /UPDATE FOR NEXT INPUT LINE
3042  2014            ISZ Z T8AX1             /UPDATE FOR NEXT INPUT LINE
3043  2143            ISZ Z T8CNT2            /ARE ONE-EIGHTH OF LINES CHECKED?
3044  5225            JMP T8COM0 /CHECK NEXT LINE

3045  6414  T8COM4,   TTRL                    /READ LINE NUMBER
3046  3343            DCA T8LN                /SAVE LINE NUMBER
3047  2142            ISZ Z T8CNT1            /HAVE ALL LINES BEEN CHECKED
3050  5263            JMP T8COM5 /RESET AND DISMISS
3051  1344            TAD T8K2                /-10
3052  3142            DCA Z T8CNT1            /RESET MAJOR LOOP COUNTER
3053  1345            TAD T8K3                /T8IN+1
3054  3014            DCA Z T8AX1             /RESET INPUT LINE POINTER
3055  1350            TAD T8K9                /STARTING LINE-1
3056  3343            DCA T8LN                /RESET LINE NUMBER
3057  1131            TAD Z T8K7              /T8ORF
3060  3137            DCA Z T8OUTK            /RESET OUTPUT LINE POINTER
3061  1141            TAD Z T8K36             /T8ORF2
3062  3140            DCA Z T8OTK2            /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  7700       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  7104            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 T80TK2          /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 T80UTK          /STORE WORD
3132  3340            DCA IZ T80TK2          /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 SUBTTACTION
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 SKIP
                /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
```

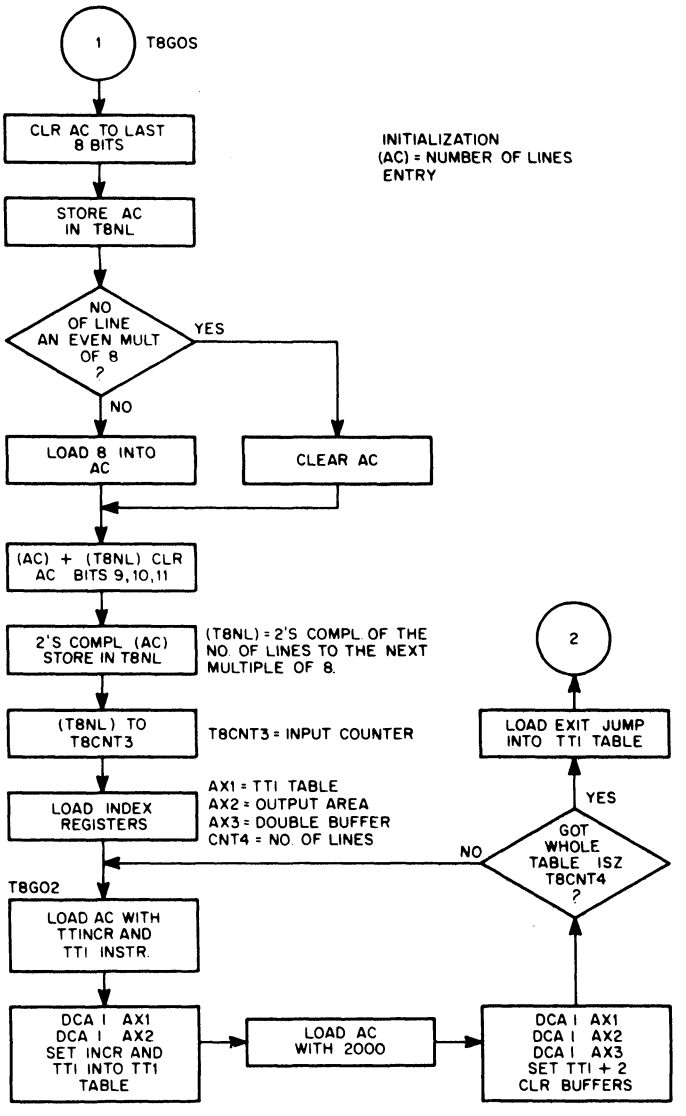
```
3161  1177      TAD Z TTCHAR    /PICK UP CHARACTER
3162  0373      AND T8K11               /8 BITS ONLY
3163  1374      TAD T8K12               /1400 FOR STOP CODE
3164  7104      CLL RAL         /CREATE START CODE
3165  3772      DCA I T8WA      /STORE CHAPACTER IN TABLE
3166  2351      ISZ T8OUTS      /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
            *TT8RGN+200
            /SKIP IF CHARACTER AVAILABLE AND RETURN WITH LINE NO. IN AC
            /CHAR AT TTCHAR
            /OTHERWISE DO NOT SKIP. 15 US MIN, 48 US MAX, 37.5US NORMAL
            /IF READY
            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 T8BFR     /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
3225  0321      AND T8K14               /377
3226  3130      DCA Z T8NL      /STORE NUMBER OF LINES
3227  1130      TAD Z T8NL      /NUMBER OF LINES
3230  0322      AND T8K15               /7
3231  7640      SZA CLA         /MULTIPLE OF 8?
3232  1323      TAD T8K16               /10
3233  1130      TAD Z T8NL      /NUMBER OF LINES
3234  0324      AND T8K17               /370
3235  7041      CIA             /-TWO'S COMP NUMBER OF LINES
3236  3130      DCA Z T8NL      /-N, CONSTANT
3237  1130      TAD Z T8NL      /-N
3240  3144      DCA Z T8CNT3    /INPUT COUNTER
```

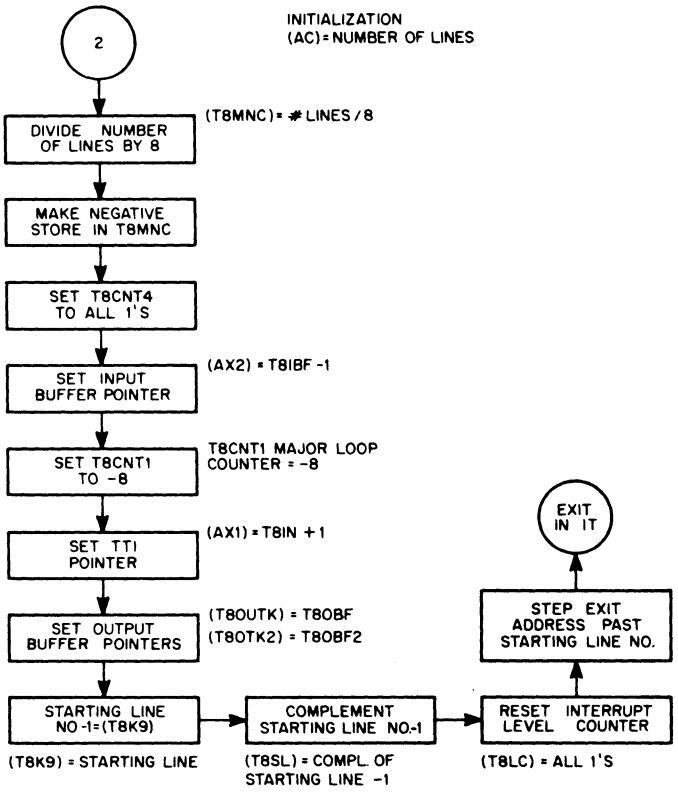
```
3241  1326        TAD T8K20               /T8IN-1
3242  3014        DCA Z T8AX1       /TO STORE TTI TABLE
3243  1327        TAD T8K21               /T8OBF-1
3244  3015        DCA Z T8AX2       /TO CLEAR OUTPUT AREA
3245  1343        TAD T8K37               /T8OBF2-1
3246  3016        DCA Z T8AX3       /TO CLEAR DOUBLE BUFFER
3247  1130        TAD Z T8NL        /-N
3250  3223        DCA T8CNT4        /FOR COUNTING
3251  1330  T8G02,      TAD T8K22                 /TTI+INCR
3252  3414        DCA I Z T8AX1     /STORE TTI
3253  3414        DCA I Z T8AX1     /ZERO STATUS AND COUNTER WORD
3254  1331        TAD T8K23               /ASSEMBLY RESET WORD
3255  3414        DCA I Z T8AX1     /RESET ASSEMBLY WORD
3256  3415        DCA I Z T8AX2     /ZERO OUTPUT WORD
3257  3416        DCA I Z T8AX3     /CLEAR DOUBLE BUFFER
3260  2223        ISZ T8CNT4        /COUNTER
3261  5251        JMP T8G02               /DO NEXT LINE
3262  1332        TAD T8K24               /JMP I Z T8K8
3263  3414        DCA I Z T8AX1     /STORE FINAL JUMP
3264  1130        TAD Z T8NL        /-N
3265  7012        RTR               /DIVIDE BY 4
3266  7010        RAR               /DIVIDE BY 8
3267  0333        AND T8K25               /17
3270  1334        TAD T8K26               /7760, MAKE NUMBER NEGATIVE
3271  3735        DCA I T8K27       /T8MNC
3272  7240        STA               /-1
3273  3223        DCA T8CNT4        /SET COUNTER TO SKIP 1ST TIME
3274  1127        TAD Z T8BFX       /T8IBF-1
3275  3015        DCA Z T8AX2       /SET INPUT BUFFER POINTER
3276  1336        TAD T8K28               /-10
3277  3142        DCA Z T8CNT1      /MAJOR LOOP COUNTER
3300  1337        TAD T8K30               /T8IN+1
3301  3014        DCA Z T8AX1       /SET TTI POINTER
3302  1131        TAD Z T8K7        /T8OBF
3303  3137        DCA Z T8OUTK      /1ST OUTPUT BUFFER POINTER
3304  1141        TAD Z T8K36       /T8OBF2
3305  3140        DCA Z T8OTK2      /2ND OUTPUT BUFFER POINTER
3306  7240        STA               /-1
3307  1624        TAD I T8GOS       /STARTING LINE NO.
3310  3740        DCA I T8K33       /T8K9, STARTING LINE NO. -1
3311  1740        TAD I T8K33       /T8K9
3312  7040        CMA               /MAKE NEGATIVE
3313  3741        DCA I T8K34       /T8SL, -STARTING LINE NO.
3314  3126        DCA Z T8INFL      /CLEAR INPUT FLAG COUNTER
3315  7240        STA               /-1
3316  3742        DCA I T8K35       /T8LC, RESET INTERRUPT LEVEL COUNTER
3317  2224        ISZ T8GOS               /INDEX EXIT
3320  5624        JMP I T8GOS       /EXIT

            /CONSTANTS
3321  0377  T8K14,       377               /FOR LINE NUMBER
3322  0007  T8K15,       7                 /FOR EVEN MULTIPLE OF 8
3323  0010  T8K16,       10                /FOR EVEN MULTIPLE OF 8
3324  0370  T8K17,       370               /FOR EVEN MULTIPLE OF 8
3325  0001  T8K18,       1                 /FOR COMPLEMENTING
3326  3376  T8K20,       T8IN-1            /FOR STORING TTI'S
3327  4577  T8K21,       T8OBF-1           /FOR OUTPUT AREA
```

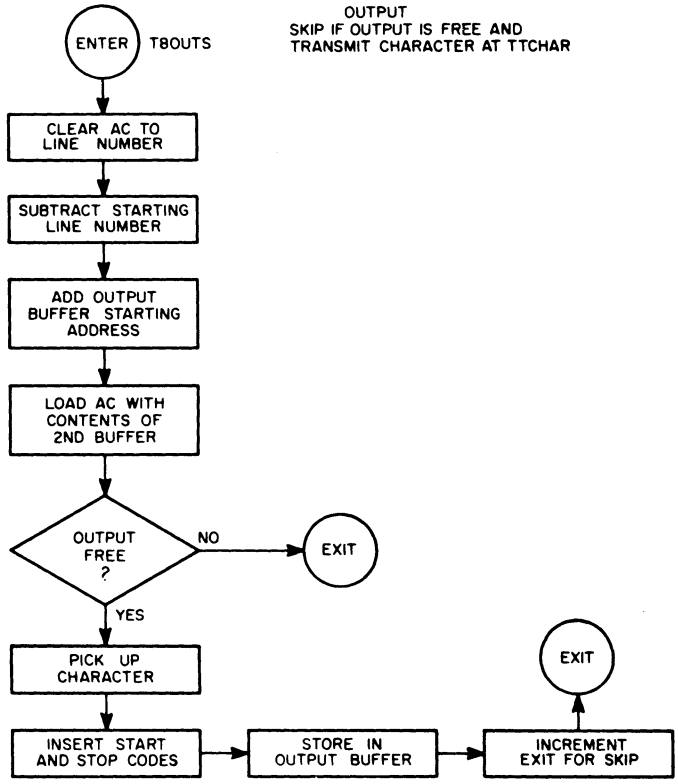
```
3330  6403  T8K22,      TTI+1              /TTI + INCREMENT
3331  2000  T8K23,      2000               /ASSEMBLY RESET WORD
3332  5532  T8K24,      JMP I Z T8K8       /FOR FINAL JUMP
3333  0017  T8K25,      17                 /FOR -N/8
3334  7760  T8K26,      7760               /FOR MAKING NEGATIVE
3335  3142  T8K27,      T8MNC              /FOR -N/8
3336  7770  T8K28,      -10                /FOR MAJOR LOOP COUNTER
3337  3400  T8K30,      T8IN+1             /FOR TTI POINTER
3340  3150  T8K33,      T8K9               /FOR STARTING LINE-1
3341  3171  T8K34,      T8SL               /-STARTING LINE NO.
3342  3134  T8K35,      T8LC               /FOR INTERRUPT LEVEL COUNTER
3343  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
            T8SIF=JMS I Z T8IES
3344  0000  T8SE,       0
3345  4534      T8SIR              /CHECK 8-BIT CODE
3346  5351      JMP .+3            /CHECK 5-BIT CODE
3347  2344      ISZ T8SE                   /INDEX EXIT
3350  5744      JMP I T8SE         /EXIT
3351  3377      T5SIR              /CHECK 5-BIT CODE
3352  5744      JMP I T8SE         /EXIT
3353  2344      ISZ T8SE                   /INDEX EXIT
3354  5744      JMP I T8SE         /EXIT
            PAUSE
```

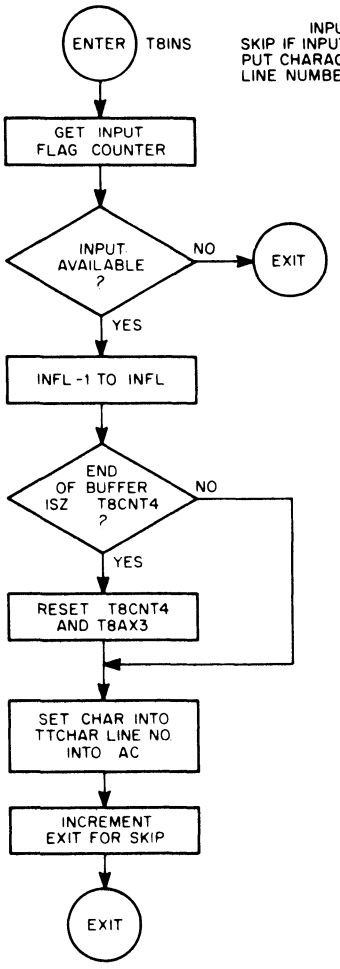
11. DIAGRAMS

11.1 Flow Charts

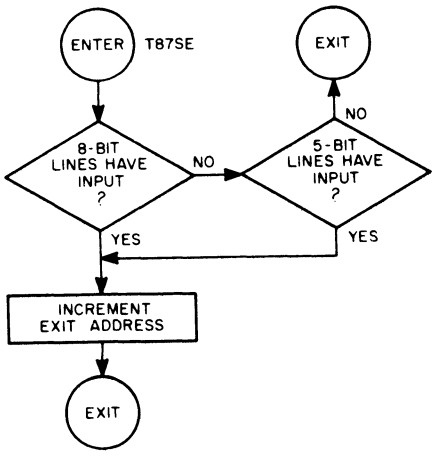


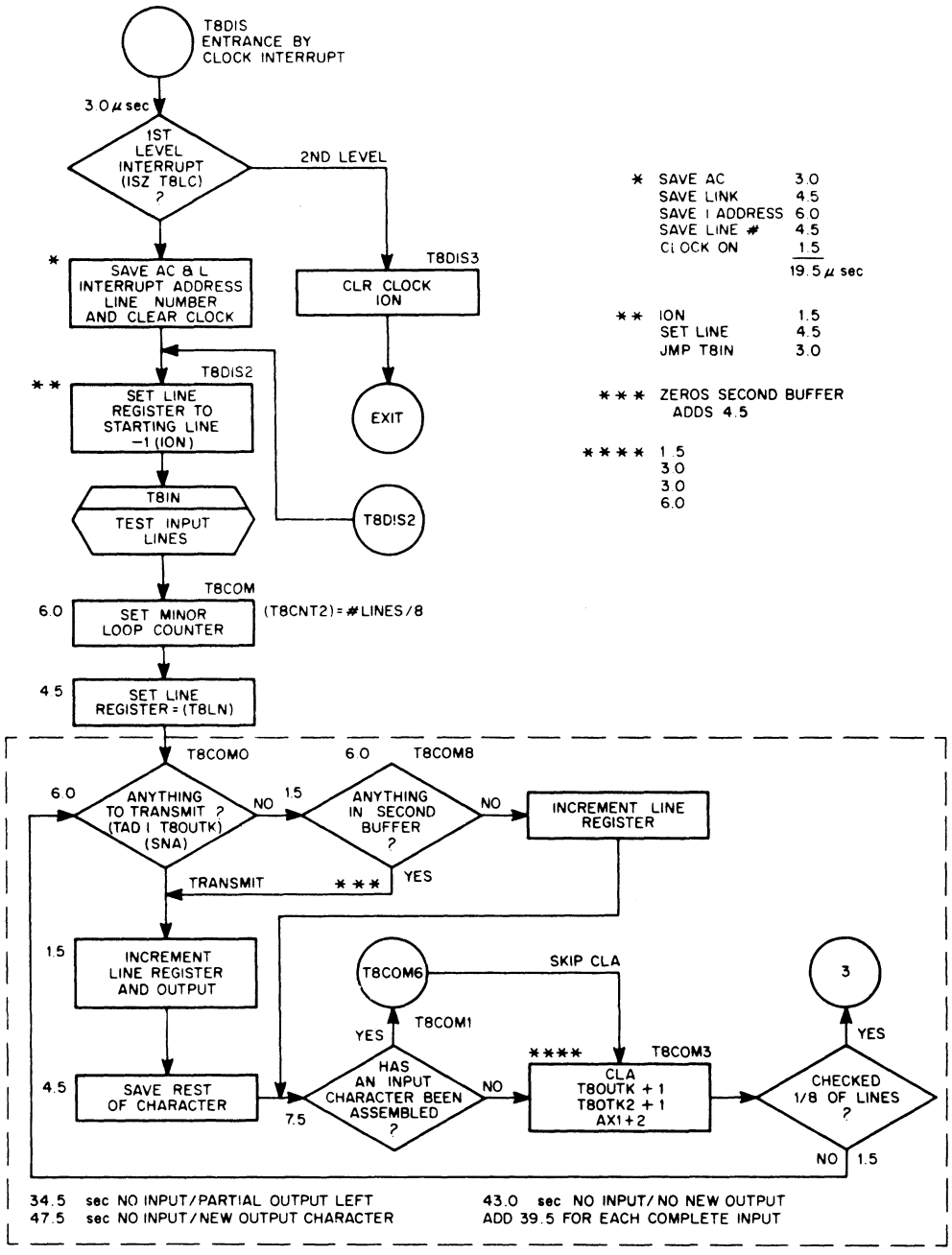

2
INITIALIZATION
(AC) = NUMBER OF LINES
DIVIDE NUMBER OF LINES BY 8
(T8MNC) = # LINES / 8
MAKE NEGATIVE STORE IN T8MNC
SET T8CNT4 TO ALL 1'S
SET INPUT BUFFER POINTER
(AX2) = T8IBF -1
SET T8CNT1 TO -8
T8CNT1 MAJOR LOOP COUNTER = -8
SET TTI POINTER
(AX1) = T8IN + 1
SET OUTPUT BUFFER POINTERS
(T8OUTK) = T8OBF
(T8OTK2) = T8OBF2
STARTING LINE NO -1=(T8K9)
(T8K9) = STARTING LINE
COMPLEMENT STARTING LINE NO-1
(T8SL) = COMPL. OF STARTING LINE -1
RESET INTERRUPT LEVEL COUNTER
(T8LC) = ALL 1'S
STEP EXIT ADDRESS PAST STARTING LINE NO.
EXIT IN IT

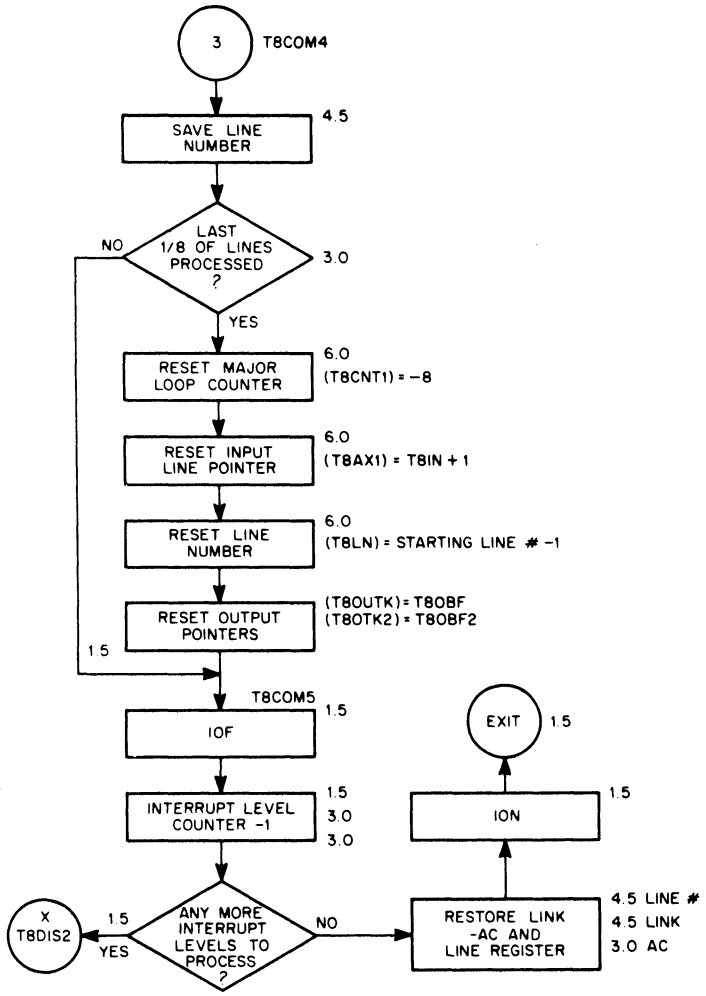

ENTER T8OUTS
OUTPUT
SKIP IF OUTPUT IS FREE AND
TRANSMIT CHARACTER AT TTCHAR
CLEAR AC TO LINE NUMBER
SUBTRACT STARTING LINE NUMBER
ADD OUTPUT BUFFER STARTING ADDRESS
LOAD AC WITH CONTENTS OF 2ND BUFFER
OUTPUT FREE ?
NO
EXIT
YES
PICK UP CHARACTER
INSERT START AND STOP CODES
STORE IN OUTPUT BUFFER
INCREMENT EXIT FOR SKIP
EXIT

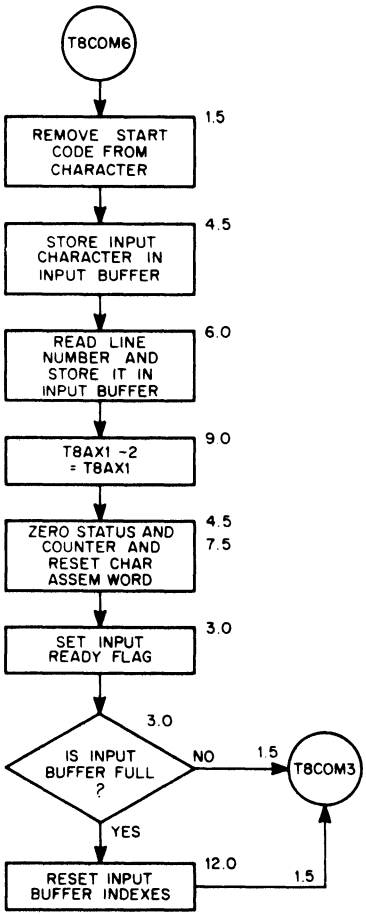


CHECK INPUT ON EITHER LINE
SKIP ON INPUT WITH CHARACTER
IN TTCHAR AND AC = LINE NUMBER




T8DIS
ENTRANCE BY
CLOCK INTERRUPT
3.0 μ sec
1ST LEVEL INTERRUPT (ISZ T8LC) ?
2ND LEVEL
T8DIS3
CLR CLOCK ION
EXIT
*
SAVE AC & L INTERRUPT ADDRESS LINE NUMBER AND CLEAR CLOCK
T8DIS2
**
SET LINE REGISTER TO STARTING LINE −1 (ION)
T8IN
TEST INPUT LINES
T8DIS2
T8COM
6.0
SET MINOR LOOP COUNTER
(T8CNT2) = #LINES/8
4.5
SET LINE REGISTER = (T8LN)
T8COMO
6.0
ANYTHING TO TRANSMIT ? (TAD I T8OUTK) (SNA)
NO
1.5
T8COM8
6.0
ANYTHING IN SECOND BUFFER ?
NO
INCREMENT LINE REGISTER
TRANSMIT
***
YES
1.5
INCREMENT LINE REGISTER AND OUTPUT
T8COM6
SKIP CLA
3
YES
T8COM1
YES
****
T8COM3
4.5
SAVE REST OF CHARACTER
HAS AN INPUT CHARACTER BEEN ASSEMBLED ?
NO
7.5
CLA
T8OUTK + 1
T8OTK2 + 1
AX1+2
CHECKED 1/8 OF LINES ?
NO
1.5
34.5 sec NO INPUT/PARTIAL OUTPUT LEFT
47.5 sec NO INPUT/NEW OUTPUT CHARACTER
43.0 sec NO INPUT/NO NEW OUTPUT
ADD 39.5 FOR EACH COMPLETE INPUT
* SAVE AC 3.0
SAVE LINK 4.5
SAVE I ADDRESS 6.0
SAVE LINE # 4.5
CLOCK ON 1.5
19.5 μ sec
** ION 1.5
SET LINE 4.5
JMP T8IN 3.0
*** ZEROS SECOND BUFFER
ADDS 4.5
**** 1.5
3.0
3.0
6.0





12. REFERENCES (Not Applicable)