1. IDENTIFICATION
1.1 Digital-8-35-S-B
1.2 680 8-Bit Character Assembly Subroutines
1.3 November 8, 1965
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 TTBG0 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 TBAX1, TBAX2, and TBAX3 must be defined.

3.4.3 The tag TTBPG0 must be defined as the start of an area in memory page 0 where the necessary Teletype constants can be stored. An area of 178 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 T8OBFB 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:

- TBS 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:

<table>
<thead>
<tr>
<th>Mnemonic</th>
<th>Clock 1</th>
<th>Clock 2</th>
<th>Clock 3</th>
<th>Clock 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBSKP</td>
<td>6421</td>
<td>6431</td>
<td>6441</td>
<td>6451</td>
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<td>TTBonjour</td>
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<tr>
<td>TTOFF</td>
<td>6422</td>
<td>6432</td>
<td>6442</td>
<td>6452</td>
</tr>
</tbody>
</table>

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 TBAX1, TBAX2, and TBAX3 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-8-35-5-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
TBINIT / INITIALIZE SUBRoutines
SLN / STARTING LINE NUMBER
ION / ENABLE INTERRUPTS
TBON / TURN ON CLOCK
```

NOTE: Following these lines of coding it is necessary that the user wait 8 clock interrupts before using the pseudo-instruction TBOSF. 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 TTECHAR / FOR OUTPUT SUBROUTINE
TAD LINE NO / GET LINE NUMBER
TBOSF / 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:

```
TBISR / CHECK FOR INPUT
JMP -.1 / WAIT FOR A CHARACTER
DCA SAVLIN / SAVE LINE NUMBER
TAD TTECHAR / 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 TBSOF adds start and stop bits to the output characters and places them in the second output buffer (TBOBF2). Eventually, the interrupt subroutine transfers the characters from the second output buffer to the first output buffer (TBOBF). 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 TBOBF 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 (TBSIR)

If the pseudo operation TBSIR 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 (TBSOF)

The user presents the pseudo operation TBSOF 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.

<table>
<thead>
<tr>
<th>No. of Lines</th>
<th>8-Bit 110 Baud</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>34.1 %</td>
</tr>
<tr>
<td>64</td>
<td>57.7 %</td>
</tr>
<tr>
<td>96</td>
<td>81.3 %</td>
</tr>
<tr>
<td>128</td>
<td>104.9 %</td>
</tr>
</tbody>
</table>

9.4 Timing Equations

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

10. PROGRAM

10.3 List of Items and Pseudo Commands

10.3.1 List of Items

- **T8BGN**: /BEGINNING OF SUBROUTINE. MUST BE /EQUATED TO START OF A PAGE. (AREA /INCLUDES TWO PAGES).
- **T8AX1**: /AUTOINDEX REGISTER.
- **T8AX2**: /AUTOINDEX REGISTER.
- **T8AX3**: /AUTOINDEX REGISTER.
- **T8PG0**: /START OF CONSTANT AREA IN PAGE 0. /(LENGTH 17B REGISTERS.)
- **T8OBF**: /START OF OUTPUT BUFFER. (LENGTH = \( n \).)
- **T8OBF2**: /START OF SECOND OUTPUT BUFFER. /(LENGTH = \( n \).)
- **T8IBF**: /START OF INPUT BUFFER. (LENGTH = 2\( n \).)
- **T8IN**: /START OF TTI AREA. (LENGTH = 3\( n + 1 \).)
- **TTCHAR**: /CHARACTER AREA PAGE 0. (SINGLE REGISTER.)

10.3.2 List of Pseudo Command

<table>
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<tr>
<th>Command</th>
<th>Minimum</th>
<th>Times (users)</th>
<th>Average</th>
<th>Maximum</th>
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<td>T8INIT</td>
<td>Initialize</td>
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<tr>
<td>T8SOF</td>
<td>Skip if output free</td>
<td>24</td>
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<td>42</td>
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<td>T8SIR</td>
<td>Skip if input ready</td>
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<td>37.5</td>
<td>48</td>
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<td>Skip if either input ready</td>
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/8BRT CHARACTER ASSEMBLY SUBROUTINES
/TYPE 6802 TELETYPING LINE MULTIPLEXER
/LMH 7-A-45, 8 BRT

TRACG=3400
TRACO=126
TBCBF=4696
TRACF=4264
TBCFB=5AFF
TRAX1=14
TRAX2=15
TRAX3=16
TRACR=177
TBN=3377

TTC=6402 /TELETYPING INPUT COMMAND
TTO=6404 /TELETYPING OUTPUT COMMAND
TTCR=6411 /CLEAR LINE REGISTER
TTCR=6414 /READ LINE REGISTER
TTCR=6412 /SET LINE REGISTER, CLR AC
TRACN=6474 /TURN CLOCK ON
TRACN=6473 /TURN CLOCK OFF
TBSK=6471 /SKIP ON CLOCK FLAG
TBCR=6441 /INCREMENT LINE REGISTER

126   0000  TINFL,   0   /INPUT READY FLAG
127   4177  TRVPK,  TRVF-1   /TO RESET INPUT RUFFER POINTER
130   0000  TNL,   0   /NUMBER OF LINES
131   4600  TRK,  TRXF   /FOR 1ST OUTPUT BUFFER
132   3021  TRB,  TRX0   /TO ENTER COMMON ROUTINE
133   3151  TRSN,  TRNS   /SKIP IF OUTPUT FREG
134   3200  TRSN,  TRINS   /SKIP IF INPUT READY
135   3224  TRC,  TRC0   /INITIALIZE ROUTINE
136   3344  TRES,  TRES   /SKIP IF EITHER LINE READY
137   4600  TRONT,  TRON   /POINTER TO FIRST OUTPUT BUFFER
140   5000  TRONT2,  TRONT2   /POINTER TO 2ND OUTPUT BUFFER
141   5000  TRONT2,  TRONT2   /1K FOR 2ND OUTPUT BUFFER
142   7770  TRCNT1,  -1W   /MAJOR LOOP COUNTER
143   0000  TRCNT2,  -&   /MINOR LOOP COUNTER
144   0000  TRCNT3,  -&   /COUNTER FOR INPUT BUFFER

/MULTIPLE LEVEL INTERRUPT ROUTINE
/ALLOW MULTIPLE LEVEL INTERRUPT TO THIS ROUTINE AND UNLIMITED OTHERS

028   2334  TRDIS,  ISZ TBLG   /LEVEL COUNTER
029   5216  JMP TANIS3 /2ND LEVEL INTERRUPT
030   3335  DCA TASA   /SAVE ACCUMULATOR
031   7810  RAR   /GET LINK
032   3336  DCA TRSVLK /SAVE LINK
033   1200  TAN 2   /INTERRUPT ADDRESS
034   3337  DCA TRSVA   /SAVE ADDRESS
035   6414  TRTL   /LM LINE NUMBER
036   3340  DCA TRSVL /SAVE LINK
037   6434  TTRN   /TO CLEAR FLAG ONLY
038   6011  TANIS2,  TAN   /HE-FN4ALE PROGRAM INTERRUPT
039   1350  TAN TAK9   /STARTING LINE-1
6413 TSSL+1 /SFT LINE REGISTER, CLR AC
5741 JMP 1 T8K1 /JUMP TO TTI LOOP

/2ND LEVEL INTERRUPT
4434 T8DI53, TRON /CLEAR CLOCK FLAG
4501 T8N /RE-ENABLE PROGRAM INTERRUPT
5400 JMP 1 Z D /RETURN TO THE MAIN PROGRAM

/RETURN FROM INPUT TTI LOOP
1342 T8COM, TAN T8MNC /MINOR COUNTER, NUMBER OF LINES A
5143 DCA Z T8CNT2 /MINOR LOOP COUNTER
1343 TAN T8LN /LINE NUMBER
4413 T8SL+1 /SFT LINE NUMBER
1537 T8COMA, TAN 1 Z T8OUTK /OUTPUT WORD
7450 SNA /SOMETHING TO TRANSMIT
5333 JMP T8COM8 /SEE IF WORD AVAILABLE
4405 T8N+1 /INCR. LINE REGISTER AND OUTPUT
7537 DCA 1 Z T8OUTK /STORE WORD
1414 T8COM1, TAN 1 Z T8X1 /PICK UP CHARACTER ASSEMBLY WORD
7110 CBL RAR /PUT RIT 1 IN LINK
7430 S2L /CHARACTER NOT COMPLETE
5391 JMP T8COM6 /STORE CHARACTER
7290 CLA /CLEAR AC FOR TAN
2177 T8COM3, ISF 2 T8OUTK /UPDATE OUTPUT ADDR
2148 ISF 2 T8OK2 /UPDATE 2ND BUFFER ADDRESS
2162 ISF 2 T8AX1 /UPDATE FOR NEXT INPUT LINE
2214 ISF 2 T8AX1 /UPDATE FOR NEXT INPUT LINE
2143 ISF 2 T8NT2 /ARE ONE-EIGHTH OF LINES CHECKED?
4229 T8COM0 /CHECK NEXT LINE

6444 T8COM4, TTRL /RELOAD LINE NUMBER
3343 DCA T8LN /SAVE LINE NUMBER
2142 ISF 2 T8NT1 /HAVE ALL LINES BEEN CHECKED
5213 JMP T8COM5 /RESET AND DISMISS
1344 TAN T8K2 /-10
3142 DCA 2 T8CNT1 /RESET MAJOR LOOP COUNTER
1345 TAN T8K3 /TRTP+1
3342 DCA 2 T8AX1 /RESET INPUT LINE POINTER
1350 TAN T8K9 /STARTING LINE-1
3343 DCA T8LN /RESET LINE NUMBER
1137 TAN 2 T8K7 /TPROF
3140 DCA 2 T8OUTK /RESET OUTPUT LINE POINTER
1141 TAN 2 T8K3A /TROF2
3140 DCA 2 T8OK2 /RESET 2ND BUFFER POINTER
602 T8COM5, IOF /TURN OFF INTERRUPT
7400 STA /
1334 TAN T8LC /LEVEL COUNTER
3334 DCA T8LC /RESTORE LEVEL COUNTER
1334 TAN T8LC /LEVEL COUNTER
7700 SMA CLA /RESTORE AC ETC
5212 JMP T8D152 /CHECK INPUT AGAIN, ETC.
7340 TAN T8SVLN /LINE NUMBER
4413 T8SL+1 /SFT LINE REGISTER, CLR AC
1336 TAN T8SVLK /PICK UP LINK
7104 CBL RAL /RESTORE LINK
1335 TAN T8SA /RESTORE ACCUMULATOR
4081 T8M /EMARL INTERRUPT
803 ✐ 233 7837 /JMP T85VM /RETURN TO MAIN PROGRAM
3102 7112 T8COM6, /CPL RTF /REMOVES START CODE
3103 7145 DCA 1 7 TRAX2 /STORE CHARACTER
3104 6414 TTLR /READ LINE NUMBER
3105 7145 DCA 1 7 TRAX2 /STORE LINE NUMBER
3106 1014 TAN 2 TRAX1 /PICK UP ADDRESS POINTER
3107 1346 TAN TRAK /-?
3108 3014 DCA 2 TRAX1 /RESET POINTER
3109 7414 DCA 1 2 TRAX1 /ZERO STATUS AND COUNTER WORD
3110 1347 TAN TRAK /WORD TO RESTORE ASSEMBLY WORD
3111 7414 DCA 1 2 TRAX1 /RESET CHARACTER ASSEMBLY WORD
3112 2126 ISZ 2 TAILFL /SFT INPUT READY FLAG
3113 2144 ISZ 2 TBCTN3 /HAS END OF BUFFER BEEN REACHED
3114 ✐ 237 /JMP TACOM3 /UPDATE REGISTERS
3115 ✐ 237 T8COM7, TAN 2 T8PRK /TRIF=1
3116 3015 DCA 2 TRAX2 /RESET INPUT BUFFER ADDRESS
3117 1130 TAN TRAM /LENGTH OF BUFFER, NUMBER OF LINES
3118 3144 DCA 2 TBCTN3 /RESET LENGTH COUNTER
3119 ✐ 237 /JMP TACOM3 /UPDATE REGISTERS
3120 ✐ 237 T8COM8, TAN 2 T8OTPK /PICK UP DOUBLE-RUFFRED WORD
3121 7440 S2A /NOTHING TO SEND
3122 5330 JMP *.3 /SFULL NEW WORD
3123 4401 TTTNC /INCREMENT LINE REGISTER
3124 ✐ 232 /JMP TACOM1 /CONTINUE FOR INPUT
3125 ✐ 232 T8COM9, TAN 2 T8OTP /INCkek LINE REGISTER AND OUTPUT
3126 ✐ 232 T8COM10, DCA 1 2 T8OUTK /STORE WORD
3127 ✐ 232 T8COM11 /JMP TACOM1 /CONTINUE FOR INPUT

/CONSTANTS
3134 7777 T8LC, -1 /INTERRUPT LEVEL COUNTER
3135 ✐ 230 T8SA, /SAVE ACCUMULATOR
3136 ✐ 230 T8SLK, /SAVE LINK
3137 ✐ 230 T8SA, /SAVE PROGRAM COUNTER
3138 ✐ 230 T8VA, /SAVE LINE NUMBER
3139 ✐ 230 T8K1, T8IN /START OF TTI SERIES
3140 ✐ 230 T8MC, /MINOR LOOP COUNTER, NO. OF LINES/B
3141 ✐ 230 T8IN, /LINd NUMBER
3142 7777 T8K2, -1 /TO RESET MAJOR LOOP COUNTER
3143 3400 T8K3, T8IN+1 /TO RESET INPUT LINE POINTER
3144 7776 T8K4, -2 /FOR SUBTRACTION
3145 2000 T8K6, /TO RESET 8-BIT ASSEMBLY WORD
3146 2000 T8K9, /STARTING LINE=1

/PSEUD OPERATIONS
/IF OUTPUT IS FREE AND TRANSMIT CHARACTER AT TTCHAR
/OTHERWISE DONT SKIP
/LINE NUMBER MUST BE IN AC. 24US MIN, 42US MAX.
TASOF ✐ JMS T8ASOUT

3151 ✐ 230 T8OUTS, /0
3152 ✐ 230 AND T8K10 /177
3153 ✐ 231 TAN T8SL /-STARTING LINE NO.
3154 1141 TAN 2 T8K36 /OUTPUT BUFFER ADDR
3155 ✐ 230 T8WA /WORK AREA
3156 1772 TAN 1 T8WA /OUTPUT CHARACTER
3157 ✐ 230 S2A PLA /SKIP IF FREE
3158 ✐ 230 JMP T8OUTS /EXIT
3161 1177  TAN 2 TCHAR  /PICK UP CHARACTER
3162  4373  AND TAK11  /8 BITS ONLY
3163  1374  TAN TAK12  /1400 FOR STOP CODE
3164  7194  CLL RAL  /CREATE START CODE
3165  3772  DCA 1 TWA  /STORE CHARACTER IN TABLE
3166  2351  ISZ TIVOUTS  /INDEX EXIT
3167  4751  JMP 1 TIVOUTS  /EXIT
3170  177  TAK10, 177  /FOR LINE NUMBER
3171  0000  TSL, 0  /STARTING LINE NUMBER
3172  0000  TBAW, 0  /WORK AREA
3173  377  TAK11, 377  /FOR EIGHT BIT CODE
3174  1400  TAK12, 1400  /FOR STOP CODE
3175  /TTEPN=280  /SKIP IF CHARACTER AVAILABLE AND RETURN WITH LINE NO. IN AC
3176  /CHAR AT TCHAR
3177  /OTHERWISE DO NOT SKIP. 15 US MIN, 48 US MAX, 37.5 US NORMAL
3178  /IF READY
3179  TASE=JMS 1 2 TASIN
3180  TINS, 0
3181  6902  I0F
3182  7240  CLA CMA  /SET AC TO -1 FOR TAN
3183  1126  TAN ? TINFL  /INPUT FLAG COUNTER
3184  7510  SPA  /SOMETHING AVAILABLE
3185  5221  JMP TBNON  /EXIT
3186  3126  DCA ? TINFL  /RESTORE FLAG COUNTER
3187  2223  ISZ TINNT4  /END OF BUFFER? STARTS AT -N-1
3188  5215  GET CHAR
3189  1130  TAN ? TANL  /NUMBER OF LINES
3190  7223  DCA TINNT4  /RESET COUNTER
3191  1127  TAN ? TAPY  /BUFFER ADDRESS-1
3192  716  DCA ? TBAK  /RESET ADDRESS
3193  1416  TAN 1 ? TAAK  /PICK UP CHARACTER
3194  177  DCA ? TCHAR  /STORE CHARACTER
3195  1416  TAN 1 TAAK  /PICK UP LINE NUMBER
3196  2220  ISZ TINS  /INDEX EXIT
3197  4801  TBNON, 10
3198  6600  JMP 1 TINS  /EXIT
3199  /NO OF LINES
3200  /INITIALIZATION
3201  /ENTER WITH NUMBER OF LINES IN AC
3202  /FORMAT TBNIT
3203  /1ST LINE NO.
3204  TBNIT=JMS 1 2 TAG0
3205  TACOS, 0
3206  6321  AND TAK14  /377
3207  1330  DCA ? TANL  /STORE NUMBER OF LINES
3208  1130  TAN ? TANL  /NUMREP OF LINES
3209  8322  AND TAK15  /7
3210  7440  SZA CLA  /MULTIPLE OF 8?
3211  1323  TAN TAK16  /10
3212  1130  TAN 1 TANL  /NUMBER OF LINES
3213  9324  AND TAK17  /370
3214  7041  CIA  /TWO'S COMP NUMREP OF LINES
3215  1130  DCA ? TAML  /-N, CONSTANT
3216  1130  TAN 2 TAML  /-N
3217  3144  DCA 2 TBNNT3  /INPUT COUNTER
TAN TAK29 /THIN-1
NCA 7 TAKX1 /STORE TTI TABLE
TAN TAK21 /TROF-1
TAN TAKX2 /CLEAR OUTPUT AREA
TAN TAK37 /TROF2-1
TAN TAKX3 /CLEAR DOUBLE BUFFER
N TAN 2 TANL /N
N TAN TCONT4 /FOR COUNTING
TAN TAK22 /TTI+INCR
TAN TAKX1 /STORE TTI
TAKX1 /ZERO STATUS AND COUNTER WORD
TAN TAK23 /ASSEMBLY RESET WORD
TAKX1 /RESET ASSEMBLY WORD
TAKX2 /ZERO OUTPUT WORD
TAKX3 /CLEAR DOUBLE BUFFER
TCONT4 /COUNTER
TAKX2 /DO NEXT LINE
TAN TAK24 /JMP 1 2 TAKB
TAKX1 /STORE FINAL JUMP
TAN TAKL /-V
TAK25 /DIVIDE BY 4
TAK26 /DIVIDE BY 8
TAK27 /17
TAK28 /7760, MAKE NUMBER NEGATIVE
TAKX1 /TMNC
TAK29 /-1
TAKX2 /SET COUNTER TO SKIP 1ST TIME
TAKX3 /TSAFE-1
TAKX2 /SET BUFFER POINTER
TAKX2 /-10
TAKX1 /MAJOR LOOP COUNTER
TAKX2 /TRIN+1
TAKX1 /SET TTI POINTER
TAKX1 /TROF
TAKX1 /1ST OUTPUT BUFFER POINTER
TAKX2 /TROF2
TAKX2 /2ND OUTPUT BUFFER POINTER
TAKX2 /-1
TAKX1 /STARTING LINE NO.
TAKX1 /TAK9, STARTING LINE NO. -1
TAKX1 /TAK9
TAKX1 /MAKE NEGATIVE
TAKX1 /-1
TAKX1 /CLEAR INPUT FLAG COUNTER
TAKX1 /INDEX EXIT
TAKX1 /EXIT

CONSTANTS

TAKX4, 377
TAKX15, 7
TAKX16, 10
TAKX17, 377
TAKX18, 1
TAKX19, 1
TAKX20, TBIN-1
TAKX21, TROF-1
FOR LINE NUMBER
FOR EVEN MULTIPLE OF 8
FOR EVEN MULTIPLE OF 8
FOR COMPLEMENTING
FOR STORING TTI'S
FOR OUTPUT AREA
3530 4403 TBK22, TTI+1 /TTI + INCREMENT
3531 2000 TBK23, 2T90 /ASSEMBLY RESET WORD
3532 5532 TBK24, JMP 1 ? TBK8 /FOR FINAL JUMP
3533 0017 TBK25, 17 /FOR -N/A
3534 7760 TBK26, 77A0 /FOR MAKING NEGATIVE
3535 3142 TBK27, TB4NC /FOR -N/A
3536 7770 TBK28, -1H /FOR MAJOR LOOP COUNTER
3537 3400 TBK30, TBIN+1 /FOR TTI POINTER
3540 3150 TBK33, TBK9 /FOR STARTING LINE-1
3541 3171 TBK34, TB5L /STARTING LINE NO.
3542 3134 TBK35, TBALC /FOR INTERRUPT LEVEL COUNTER
3543 4777 TBK37, TB0RF2-1 /FOR DOUBLE BUFFER
                  /SKIP IF CHARACT F AVAILABLE FROM EITHER OF TWO TYPES OF LINES
                  /OTHERWISE DO NOT SKIP. 31.5US MIN, 78.5US MAX, 66US NORMAL
                  /IF READY
3544 0000 TBSE, P
3545 4534 TBSI4 /CHECK 8-BIT CODE
3546 5351 JMP 1+3 /CHECK 5-BIT CODE
3547 3344 ISP TASE /INDEX EXIT
3548 5744 JMP 1 TASE /EXIT
3549 1377 T5SIW /CHECK 5-BIT CODE
3550 7544 ISP TASE /EXIT
3551 2344 /INDEX EXIT
3552 7544 JMP 1 TASE /EXIT
3553 5744 TASE /EXIT
3554 5744 TASE /EXIT
11. DIAGRAMS

11.1 Flow Charts

```
1  TB605
   CLR AC TO LAST 8 BITS
   STORE AC IN TBNL
   NO OF LINE AN EVEN MULT OF 8?
      YES
      NO
      LOAD 8 INTO AC
      CLEAR AC
      (AC) + (TBNL) CLR AC BITS 9, 10, 11
      2'S COMPL (AC) STORE IN TBNL
      (TBNL) TO TBCNT3
      2'S COMPL OF THE NO OF LINES TO THE NEXT MULTIPLE OF 8
      LOAD INDEX REGISTERS
      T602
      LOAD AC WITH TTINCRR AND TTI INSTR
      DCA I AX1
      DCA I AX2
      SET INCR AND TTI INTO TTI TABLE
      LOAD AC WITH 2000
      DCA I AX1
      DCA I AX2
      DCA I AX3
      SET TTI + 2
      CLR BUFFERS

2  LOAD EXIT JUMP INTO TTI TABLE
   OUT WHOLE TABLE ISZ TBCNT4?
   DCA I AX1
   DCA I AX2
   DCA I AX3
   SET TTI + 2
   CLR BUFFERS
```
Digital-B-35-S-B
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ENTER TBNS

GET INPUT FLAG COUNTER

INPUT AVAILABLE?

YES

INF-1 TO INF

NO

EXIT

END OF BUFFER ISZ TBCNT4?

NO

RESET TBCNT4 AND TBA3X3

YES

SET CHAR INTO TTCHAR LINE NO INTO AC

INCREMENT EXIT FOR SKIP

EXIT

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

ENTER TB75E

8-BIT LINES HAVE INPUT?

NO

5-BIT LINES HAVE INPUT?

YES

INCREMENT EXIT ADDRESS

EXIT
REFERENCES (Not Applicable)