1. IDENTIFICATION

1.1 Digital-8-35-S-A

1.2 680 5-Bit Character Assembly Subroutines

1.3 November 17, 1965
2. ABSTRACT

These subroutines concentrate Teletype data by assembling serial-bit data into 5-bit characters and presenting the user with data similar to that obtained by using a 630 and scanner. They also add start and stop bits to 5-bit characters and transmit them in serial-bit fashion. Full duplex lines are assumed, but the subroutines can operate 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:

\[ 435 \times 8 + 7n \]

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-8-35-5-S-B

680 8-Bit Character Assembly Subroutines for reference or when 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

1 to 128 5-bit Teletype lines

3.4 Miscellaneous

3.4.1 The tag TT5BGN must be defined as the address of the start of the Teletype subroutines. It can be defined as anywhere in memory, but must be equivalent to the start of a PDP-8 memory page.

3.4.2 Four autoindex registers called T5AX1, T5AX2, T5AX3, and T5AX4 must be defined.

3.4.3 The tag TT5PG0 must be defined as the start of an area in memory page 0 where the necessary Teletype constants can be stored. An area of 26\( \times 8 \) registers must be reserved.

3.4.4 The tag T5OBF 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 T5OBF2 must be defined as an area equal in length to T5OBF. It is used for double-buffering the output characters to allow maximum output rate.

3.4.6 The tag T51BF 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 TSIN 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:

TSSKP /SKIP ON CLOCK FLAG
SKP /TEST FOR NEXT INTERRUPT CAUSE
JMP TSDIS /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 a 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>TSSKP</td>
<td>6421</td>
<td>6431</td>
<td>6441</td>
<td>6451</td>
</tr>
<tr>
<td>TTSON</td>
<td>6424</td>
<td>6434</td>
<td>6444</td>
<td>6454</td>
</tr>
<tr>
<td>TTSOFF</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 TSINIT must be executed before the instruction TTSON and also before either of the other pseudo commands TSOFF or TSSIR is executed (See Sections 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 the characters by word or even line number.

4.4.1 Teletype Initialize (TSINIT)

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 (T5SOF)

This instruction skips the next register in memory and transmits the character contained in register TCHARS 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 is cleared when exiting from the command.

4.4.3 Skip if Input Ready (T5SIR)

This instruction skips the next location in memory and returns with the line number in the accumulator and the character placed at TCHARS if an input character is available. If no character is available, the instruction does not skip and the contents of the accumulator equal −1. Only the low order 5 bits of the character at TCHARS should be used, as additional bits representing the stop codes are also present in the character. The user should note that the bit structure of the character is reversed from DEC's standard Teletype code. (For example, the character 0 does not appear as 15 in the low order 5 bits, but as 26. This special consideration may be important if the user is setting up any necessary conversion tables.) 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 are used by the instruction.

5. RESTRICTIONS

5.1 Status Active Registers

The autoindex registers defined as T5AX1, T5AX2, T5AX3, and T5AX4 must not be disturbed after the pseudo operation T5INIT.

6. DESCRIPTION

6.1 Discussion

These subroutines are designed to accumulate 5-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 they 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 mainly in buffering the Teletype lines themselves. Assuming only minor data handling is necessary before transmission (possibly to a larger computer), present estimates indicate that the user could handle 128 5-bit lines at 50 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 mixed speeds of 5-bit lines, these subroutines must be duplicated for each line speed. Or, if a mixture of 5-bit and 8-bit lines is required, it is necessary that the 8-Bit Character Assembly Subroutines (Digital-8-35-S-8) be included with the user's programs and the 5-Bit Character Assembly Subroutines.
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.
TSINIT /INITIALIZE SUBROUTINES.
SLN /STARTING LINE NUMBER.
ION /ENABLE INTERRUPTS.
TTSON /TURN ON CLOCK.
```

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.
T5SOF /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:

```
TSSIR /CHECK FOR INPUT.
JMP .-1 /WAIT FOR A CHARACTER.
DCA SAVLIN /SAVE LINE NUMBER.
TAD TTCHAR /GET CHARACTER INPUT.
AND THREE7 /37, CLEAR STOP BIT.
```

7. METHODS

7.1 Discussion

7.1.1 Input Character Assembly

The 5-Bit Character Assembly Interrupt Subroutine executes a TTI instruction for each line selected every clock interrupt. The program then scans one fourth of the TTI character assembly words for fully assembled input characters. When an assembled input character is found, the program shifts off the start bit, stores the character and line number in the input buffer, zeros the TTI status word and resets the character assembly word to 0400. Note that bit 3 is initially set to a 1 and the rest of the character assembly word is zero. As the input character is assembled bit by bit, the character assembly word is shifted one position to the right for the start bit, each data bit, and the stop bit. When the bit that was initially in the character assembly word can be set into the link by a RTR, the character is fully assembled.

7.1.2 Output Character Handling

Initially, the pseudo operation T5SOF adds start and stop bits to the output characters and places the characters in the second output buffer (T5OBF2). Eventually, the interrupt subroutine transfers the characters from the second output buffer to the first output buffer (T5OBF). In the interrupt subroutine, the program outputs on one eighth of the lines selected every clock interrupt. That is, for any one line the program outputs a data bit every eight clock interrupts. If the first output buffer location for a line is zero, there is no output on that line. After 56 clock interrupts (7 bit times), the program halts the output process and utilizes each of the next four interrupts (one half bit time) to scan one fourth of the second
output buffer for new output characters. Again, if the second output buffer location for a line is zero, there is no output. When a location is found that is non-zero, the character is placed in the first output buffer and the second output buffer location is set to zero.

8. FORMAT

8.1 Input Data (TSSIR)

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

8.1.1 The accumulator contains the line number.

8.1.2 The lower five bits of the register TTCHAR contain the input character. (See NOTE in Section 8.3)

8.3 Output Data (TSSOF)

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

8.3.1 The lower five bits of the 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.

NOTE: As mentioned in Section 4.4.3, the bit structure of the 5-bit codes is reversed from standard. These subroutines present the user with this reversed code and similarly expect the user to present them with the reversed code.

9. EXECUTION TIME

9.1 Minimum

9.2 Maximum

9.3 Average

The table below indicates the percentages of machine time used for two speeds of 5-bit systems and is as accurate as 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>5-Bit 50 Baud</th>
<th>5-Bit 75 Baud</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>20.0%</td>
<td>30.0%</td>
</tr>
<tr>
<td>64</td>
<td>35.1%</td>
<td>52.7%</td>
</tr>
<tr>
<td>96</td>
<td>50.3%</td>
<td>75.5%</td>
</tr>
<tr>
<td>128</td>
<td>65.5%</td>
<td>98.3%</td>
</tr>
</tbody>
</table>
9.4 Timing Equations

9.4.1 50 Baud Rate

Where \( n \) = the number of lines, the 5-bit subroutines require an average time of 
\( 11.85n + 120 \) \( \mu \)sec. Clock flags (at 50 baud) occur every 2500 \( \mu \)sec.

9.4.2 75 Baud Rate

The percentages for 75 baud are merely \( 1.5 \times 50 \) baud rate. Clock flags occur every 
1667 \( \mu \)sec.

10. PROGRAM

10.3 List of Items and Pseudo Commands

10.3.1 List of Items

<table>
<thead>
<tr>
<th>TT5BGN</th>
<th>Start of subroutine, must be equated to the start of a page. Area includes 2 pages.</th>
</tr>
</thead>
<tbody>
<tr>
<td>T5AX1</td>
<td>Autoindex register.</td>
</tr>
<tr>
<td>T5AX2</td>
<td>Autoindex register.</td>
</tr>
<tr>
<td>T5AX3</td>
<td>Autoindex register.</td>
</tr>
<tr>
<td>T5AX4</td>
<td>Autoindex register.</td>
</tr>
<tr>
<td>TT5PG0</td>
<td>Start of constant area in page 0.</td>
</tr>
<tr>
<td>T5OBF</td>
<td>Start of output buffer (Length = n).</td>
</tr>
<tr>
<td>T5OBF2</td>
<td>Start of second output buffer (Length = n).</td>
</tr>
<tr>
<td>T5IBF</td>
<td>Start of input buffer (Length = 2n).</td>
</tr>
<tr>
<td>T5IN</td>
<td>Start of TTI area (Length = 3n + 11).</td>
</tr>
<tr>
<td>TTCHAR</td>
<td>Character area page 0 (Single register).</td>
</tr>
</tbody>
</table>

10.3.2 List of Pseudo Operations

<table>
<thead>
<tr>
<th>Operation</th>
<th>Meaning</th>
<th>Times (User's)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Min.</td>
</tr>
<tr>
<td>T5INIT</td>
<td>Initialize</td>
<td>N.A.</td>
</tr>
<tr>
<td>T5SOF</td>
<td>Skip if output free</td>
<td>24</td>
</tr>
<tr>
<td>T5SIR</td>
<td>Skip if input ready</td>
<td>15</td>
</tr>
</tbody>
</table>
10.4 Program Listing

/TYPE 680 TELETYPING LINE MULTIPLEXER
/CHARACTER ASMABLY ROUTINE
/LMH 910/15/65 5 BIT

TTY=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
IT5ON=6424 /TURN CLOCK ON
IT5OFF=6422 /TURN CLOCK OFF
T5KP=6421 /SKIP ON CLOCK FLAG
TINCR=6401 /INCREMENTS LINE REGISTER

/680 LINE MULTIPLEXER
/LIST OF ITEMS
T5IBF=7200
T5OBF=7200
T5IBF=6600
T5IN=5600
T5P=145
T5AXI=10
T5AX2=11
T5AX3=12
T5AX4=13
T5BUN=5200
T5HAR=177

*T5P=0
0145 0000 T5INFL, 0 /INPUT READY FLAG
0146 7177 T5BF, T5IBF-1 /TO RESEI INPUT BUFFER POINTER
0147 0000 T5NL, 0 /NUMBER OF LINES
0150 5400 T5OUT, T5OUTS /SKIP IF OUTPUT FREE
0151 5423 T5IN, T5INS /SKIP IF INPUT READY
0152 5447 T5O, T5OS /INITIALIZE ROUTINE
0153 5600 T5OUTK, T5OBF /POINTER TO 1ST OUTPUT BUFFER
0154 7774 T5CNT1, -4 /HOLDS MAJOR LOOP COUNTER
0155 0000 T5CNT2, 0 /MINOR LOOP COUNTER
0156 0000 T5CNT3, 0 /COUNTER FOR INPUT BUFFER
0157 0177 T5K10, 177 /FOR ANDING
0160 7000 T5K36, T5OBF2 /2ND OUTPUT BUFFER
0161 0000 T5CNT5, 0 /OUTPUT COUNTER
0162 0000 T5CNT6, 0 /7 BIT COUNTER
0163 7770 T5K2, -10 /TO RESEI BIT COUNTER
0164 5602 T5K5, T5IN /RESEI INPUT T1I POINTER
0165 7776 T5K3, -2 /FOR SUBACTION
0166 0400 T5K4, 400 /TO RESEI 5 BIT ASSEMBLY WORD
0167 6600 T5K7, T5OBF /K FOR 1ST OUTPUT BUFFER
0170 5221 T5K8, T5COM /TO ENTER COMMON ROUTINE
0171 0000 T5K9, 0 /LINE NUMBER -1
0172 6577 T5K10, T5OBF-1 /FOR CLEARING
0173 5231 T5K9, T5CM1A /TO AVOID OUTPUTING
0174 5361 T5K10, JMP T5CM10 /TO SEI OUTPUT BUFFER FROM DOUBLE BUFFER
0175 5221 T5K9, T5COM /FOR NORMAL RETURN
0176 7000 T5K9, NOP /TO DO INPUT ONLY
*IT5BuN
/MULTIPLE LEVEL INTERRUPT ROUTINE
/ALLOWS MULTIPLE LEVEL INTERRUPT TO THIS ROUTINE
/AND UNLIMITED

5200 2366 T5DIS, ISZ T5LC / LEVEL COUNTER
5201 5216 JMP T5DIS3 /2ND LEVEL INTERRUPT
5202 3367 DCA T5SA / SAVE ACCUMULATOR
5203 7010 RAR /SEI LINK
5204 3370 DCA T5SVL /SAVE LINK
5205 1000 TAD Z 0 / INTRERRUPT ADDRESS
5206 3671 DCA T5SV0 / SAVE ADDRESS
5207 6414 ITAL /READ LINE NUMBER
5210 3372 DCA T5SVLN /SAVE LINE NUMBER
5211 6424 T5ON /T0 CLEAR CLOCK FLAG ONLY
5212 6001 T5DIS2, IQN /RE-ENABLE PROGRAM INTERRUPT
5213 1171 TAD T5K9 /STARTING LINE-1
5214 5413 ITSL+1 /SEI LINE REGISTER, CLR AC
5215 5554 JMP I Z T5K3 /SEI LINE REGISTER, CLR AC

/2ND LEVEL INTERRUPT
5216 6424 T5DIS3, IT5ON /CLEAR CLOCK FLAG
5217 6001 IQN /RE-ENABLE PROGRAM INTERRUPT
5218 5400 JMP I Z 0 /RETURN TO THE MAIN PROGRAM

/RETURN FROM INPUT III LOOP
5221 1373 TSCOM, TAD T5MC /NO. OF LINES/8
5222 3155 DCA Z T5CNI2 /MINOR LOOP COUNTER
5223 1375 TAD T5LN /LINE NUMBER
5224 6413 ITSL+1 /SEI LINE NUMBER
5225 1553 TSCOM3, TAD I Z T5OUK /OUTPUT WORD
5226 7450 SNA /CHARACTER AVAILABLE
5227 5351 JMP TSCOM3 /NOTHING TO TRANSMIT
5230 6405 ITL+1 /INCREMENT AND TRANSMIT
5231 3553 T5COM /RESTORE CHARACTER
5232 2153 T5CM1, ISZ Z T5OUK /UPDATE OUTPUT POINTER
5233 2155 T52 T5CNI2 /ARE ONE-EIGHT OF LINES DON
5234 5225 T5COM2 /CHECK NEXT OUTPUT LINE
5235 6414 ITL /READ LINE NUMBER
5236 3375 DCA T5LN /SAVE LINE NUMBER
5237 1374 T5CM1A, TAD T5MNC /NO OF LINES/4
5240 3155 DCA T5CNI2 /MINOR LOOP COUNTER
5241 2010 TSCOM2, I Z T5AX1 /ADVANCE FOR NEXT INPUT
5242 1410 TAD I Z T5AX1 /CHARACTER ASSEMBLY WORD
5243 7112 CLL RTN /PUT BIT 10 IN LINK
5244 7450 SZZ /CHARACTER NOT COMPLETED
5245 5326 JMP TSCOM6 /STORE CHARACTER
5246 7200 CLA /CLEAR AC FOR TAD
5247 7000 TSCOM3, NOP /OR JMP T5CM0
5250 2010 ISZ Z T5AX1 /UPDATE FOR NEXT INPUT LINE
5251 2376 T5LN2 /UPDATE LINE NUMBER
5252 2155 ISZ T5CHI2 /ARE ONE-FOURTH OF LINES
5253 5241 JMP T5CM2 /CHECK NEXT LINE
5254 2154 T5CM4, ISZ T5CNI1 /HAVE ALL INPUT LINES BEEN
5255 5310 JMP T5CM5 /RESEI AND DISMISS
5256 1154 TAD Z T5K3 /T5IN
DCA Z T5A1X1 /RESET ITI POINTER
IAD Z T5K9 /START LINE-1
IAC /SET TO FIRST LINE
DCA ISLN2 /RESET LINE NUMBER
IAD Z ISLCA /-4
DCA I5CN11 /INPUT CHECK COUNTER
ISZ Z I5CN15 /HAVE ALL OUTPUT LINES BEEN
JMP T5COM5 /RESET AND DISMISS
IAD Z I5K5 /-2
DCA Z I5CN15 /RESET COUNTER
IAD Z I5K9 /START LINE-1
DCA ISLH /RESET LINE NUMBER
ISZ Z I5CN16 /ENDING 7TH BIT?
JMP T5COM9 /NO RESET NORMALLY
IAD Z I5K2 /-10
DCA Z I5CN16 /RESET COUNTER
ISZ Z I5CN15 /ADD 1 TO COUNTER
IAD Z I5K9A /T50BF-1
DCA Z I5AX4 /OUTPUT POINTER
IAD Z I5K36 /T50BF2
DCA T5OUTK /2ND BUFFER POINTER
IAD Z I5K9B /SPECIAL ADDRESS, T5CM1A
DCA Z I5K6 /RESET ADDRESS
IAD Z I5K9C /JMP T5CM10
DCA T5COM3 /SEI TO DO OUTPUT
IOP /T5COM3, 6002 TURN OFF INTERRUPT
STA /-1
IAD ISLC /LEVEL COUNTER
DCA ISLC /RESTORE LEVEL COUNTER
IAD ISLC /LEVEL COUNTER
SMA CLA /RESTORE AC, ETC.
JMP I5DIS2 /CHECK INPUT AGAIN, ETC.
IAD Z I5SVLN /LINE NUMBER
ITSL41 /SEI LINE REGISTER, CLR AC
IAD Z I5SVLK /PICK UP LINK
CLL HAL /RESTORE LINK
IAD I5SA /RESTORE AC
IOW /RE-ENABLE PROGRAM INTERRUPT
JMP I I5SV0 /RETURN TO THE MAIN PROGRAM
C LL RIR /REMOVE START CODE
RTR
DCA I Z T5AX2 /STORE CHARACTER
IAD I5LN2 /LINE NUMBER
DCA I Z T5AX2 /STORE LINE NUMBER
IAD Z I5AX1 /ITI POINTER
IAD Z I5K5 /-2
DCA Z I5AX1 /RESET POINTER
DCA I Z T5AX1 /ZERO STATUS AND COUNTER
IAD Z I5K6 /WORD TO RESTORE ASSEMBLY WB
DCA I Z T5AX1 /RESET CHARACTER ASSEMBLY WB
ISZ Z I5INFL /SEI INPUT READY FLAG
ISZ Z I5CN13 /HAS END OF BUFFER BEEN READ
JMP T5COM6 /CONTINUE
IAD Z T5BFK /T5BF-1
DCA Z T5AXC /RESET DUC INPUT BUFFER ADDRESS
IAD T5NL /-NUMBER OF LINES
DCA Z T5CN13 /RESET LENGTH COUNTER
JMP T5COM6 /CONTINUE
5351  6401  T5CM3,  ITINCR  /INCREMENT LINE NUMBER
5352  5232  JMP T5CM1  /CONTINUE
5353  1167  T5CM9,  TAD Z T5K7  /T50BF
5354  3153  DCA Z T5OU1K  /RESEI OUTPUT POINTER
5355  1175  TAD Z T5K9D  /NORMAL ADDRESS, T5COM
5356  3170  DCA Z T5K8  /RESET ADDRESS
5357  1176  TAD Z T5K9E  /NOP
5358  5307  JMP T5COM5-1  /CONTINUE
5361  1553  T5CM10,  T AD I Z T5OUTK  /2ND BUFFER CHARACTER
5362  3413  DCA I Z T5AX4  /STORE IN 1ST BUFFER
5363  3553  DCA I T5OU1K  /CLEAR 2ND BUFFER
5364  2153  ISZ T5OU1K  /UPDATE POINTER
5365  5250  JMP T5COM3+1  /CONTINUE

/CONSTANTS
5366  7777  T5LC,  -1  /INTERRUPT LEVEL COUNTER
5367  0002  T5SA,  0  /SAVE ACCUMULATOR
5367  0000  T5SVLK,  0  /SAVE LINK
5371  0003  T5SVO,  0  /SAVE PROGRAM COUNTER
5367  0003  T5SVLN,  0  /SAVE LINE NUMBER
5373  0000  T5MN,  0  /-# OF LINES/8
5374  0000  T5MNC,  0  /-# OF LINES/4
5375  0003  T5LN,  0  /LINE NUMBER FOR OUTPUT
5376  0000  T5LN2,  0  /LINE NUMBER FOR INPUT
5377  7774  T5keA,  -4  /TO RESET MAJOR LOOP COUNTER
/PSEUDO-OPERATIONS
*IT5BN+220
/SKIP IF OUTPUT IS FREE AND TRANSMIT CHARACTER ATITCHAR, 
/DON'T SKIP LINE NUMBER MUST BE IN AC. 24US MIN., 42US MAX. 
T5SO=JMS I Z T5SOUT
5400  2000  T5OUTS,  0  /177
5401  0157  AND Z T5K10  /STARTING LINE NUMBER
5402  1217  TAD T5SL  /OUTPUT BUFFER ADDRESS
5403  1160  TAD Z T5K6G  /INPUT BUFFER ADDRESS
5404  5220  DCA T5WA  /WORK AREA
5405  1620  TAD I T5WA  /OUTPUT CHARACTER
5406  7640  SZA CLA  /SKIP IF FREE
5407  5630  JMP I T5OUS  /EXIT
5410  1177  TAD Z ITICHAR  /PICK UP CHARACTER
5411  0221  AND I T5KI1  /5 BITS ONLY
5412  1222  TAD T5K12  /140 FOR STOP CODE
5413  7104  CLL RAL  /CREATE START CODE
5414  3620  DCA I T5WA  /STORE CHARACTER IN TABLE
5415  2230  ISZ T5OUS  /INDEX EXIT
5416  5600  JMP I T5OUS  /EXIT
5417  0000  T5SL,  0  /STARTING LINE NUMBER
5420  0000  T5WA,  0  /WORK AREA
5421  0037  T5K11,  37  /FOR 5 BIT CODE
5422  0040  T5K12,  40  /FOR STOP CODE

/SKIP IF CHARACTER AVAILABLE AND RETURN WITH LINE NUMBER INC
/CHAR AT ITICHAR. OTHERWISE DO NOT SKIP
/15US MIN., 48US MAX., 37.5US NORMAL IF READY
T5SIR=JMS I Z T5SIN
5423  0000  T5INS,  0  
5424  6002  10F
5425  7240  CLA CMA  /SET AC FOR TAD-1
5426 1145 TAD Z T51NFL   \APNUT FLAG COUNTER-1
5427 7510 SPA   /SOMETHING AVAILABLE
5430 5244 JMP T51NON   /EXIT
5431 3145 DCA Z T51NFL   /RESTORE FLAG COUNTER
5432 2246 ISZ T5CNT4   /END OF BUFFER? START AT \#n
5433 5242 JMP +5   /GET CHARACTER
5434 1147 TAD Z T5NL   /-NUMBER OF LINES
5435 3246 DCA T5CNT4   /RESET COUNTER
5436 1146 TAD Z T5BFK   /BUFFER ADDRESS-1
5437 3012 DCA Z T5AX3   /RESET ADDRESS
5440 1412 TAD I Z T5AX3   /PICK UP CHARACTER
5441 3177 DCA Z TICAR   /STORE CHARACTER
5442 1412 TAD I Z T5AX3   /PICK UP LINE NO.
5443 2223 ISZ T5INS   /INDEX EXIT
5444 6031 T5INJN,   I ON
5445 5023 JMP I T5INS   /EXIT
5446 0030 T5CNT4,   0   /-NUMBER OF LINES

/INITIALIZATION ROUTINE
/ENTER WITH NUMBER OF LINES IN AC
/FORMAT T5INIT
/ 1ST LINE NO.

T5INIT-JMS I Z T5GO

5447 2023 T5GUS,   0   /377
5450 0555 AND T5K14   /NO. OF LINES
5451 3147 DCA Z T5NL   /NO. OF LINES
5452 1147 TAD Z T5NL   /7
5453 0356 AND T5K15
5454 7640 SZX CLA   /MULTIPLE OF 8
5455 1357 TAD T5K16   /10
5456 1147 TAD Z T5NL   /NJ. OF LINES
5457 0350 AND T5K17   /370
5460 7041 CIA   /TWO'S COMP. NUMBER OF LINES
5461 3147 DCA Z T5NL   /-N, CONSTANT
5462 1147 T5G01,   TAD Z T5NL
5463 3156 DCA Z T5CNT3   /COUNTER
5464 1361 TAD T5K10   /T5IN-1
5465 3010 DCA Z T5AX1   /TO STORE TII TABLE
5466 1362 TAD T5K21   /T50BF-1
5467 3011 DCA Z T5AX2   /TO CLEAR OUTPUT AREA
5470 1373 TAD T5K37   /T30BF2-1
5471 3012 DCA T5AX3   /TO CLEAR DOUBLE BUFFER
5472 1147 TAD Z T5NL   /-N
5473 3246 DCA T5CNT4   /FOR COUNTING
5474 1363 T5G02,   TAD T5K22   /TII+INCR
5475 3410 DCA I Z T5AX1   /STORE TII
5476 3410 DCA I Z T5AX1   /CLEAR STATUS WORD
5477 1166 TAD Z T5K6   /ASSEMBLY RESET WORD
5480 3410 DCA I Z T5AX1   /RESET ASSEMBLY WORD
5481 3411 DCA I Z T5AX2   /ZERO OUTPUT WORD
5482 3412 DCA I Z T5AX3   /CLEAR DOUBLE BUFFER
5483 2246 ISZ T5CNT4   /COUNTER
5484 0274 JMP T5G02   /DO NEXT LINE
5485 1364 TAD T5K24   /JMP I Z T5K8
5486 3410 DCA I Z T5AX1   /STORE FINAL JUMP
5487 1147 TAD Z T5NL   /-N
5510 7012 RIR   /-N/4
5511 7810  RAR  /-N/8
5512 5365  ANU  T5K05  /17
5513 1366  TAU  T5K06  /7760, MAKE NUMBER NEGATIVE
5514 3767  DCA  I  T5K07  /T5MHC
5515 1767  TAU  I  T5K07  /T5MHC
5516 1767  TAU  I  T5K07  /T5MHC -N/4
5517 3774  DCA  I  T5K08  /T5MNC2
5520 7240  SIA  /-1
5521 3246  DCA  T5CN14  /SEI CNTR TO SKIP 1ST TIME
5522 1146  TAD  Z  T5BFK  /T5BF-1
5523 3811  DCA  Z  T5AX2  /SEI INPUT BUFFER POINTER
5524 1370  TAD  T5K28  /-4
5525 3154  DCA  Z  T5CNT1  /MAJOR LOOP COUNTER
5526 1165  TAD  Z  T5K5  /-2
5527 3161  DCA  Z  T5CNT5  /OUTPUT COUNTER
5533 1164  TAD  Z  T5K3  /T5N+1
5534 3318  DCA  Z  T5AX1  /SEI TII POINTER
5538 1157  TAD  T5K7  /T50BF
5539 3153  DCA  Z  T5OU1K  /SEI OUTPUT BUFFER POINTER
5544 7240  SIA  /-1
5545 1647  TAD  I  T5GS0  /STARTING LINE NUMBER
5546 3171  DCA  Z  T5K9  /STARTING LINE NO-1
5547 1171  TAD  Z  T5K9  /STARTING LINE -1
5548 7240  CMA  /MAKE NEGATIVE
5549 3217  DCA  T5SL  /-STARTING LINE NUMBER
5550 3145  DCA  Z  T5INFL  /CLEAR INPUT FLAG COUNTER
5553 3240  SIA  /-1
5554 3771  DCA  I  T5K35  /T5LC, RESET INTERRUPT LEVEL
5555 2247  ISZ  T5GS0  /INDEX EXIT
5556 1372  TAD  I  T5K35A  /-7
5557 3162  DCA  Z  T5CNT6  /SEI SPECIAL 5-BIT COUNTER
5558 1175  TAD  Z  T5K9D  /T5COM
5559 3170  DCA  Z  T5K6  /TII RETURN
5560 1176  TAD  Z  T5K9E  /NUP
5563 3775  DCA  I  T5K40  /T5COM3
5564 5647  JMP  I  T5GS0  /EXIT

/CONSTANTS
5565 3377  T5K14, 377  /FOR ANDING
5566 0037  T5K15, 7  /FOR EVEN MULTIPLE OF 8
5567 0810  T5K16, 10  /FOR EVEN MULTIPLE OF 8
5568 0370  T5K17, 370  /FOR EVEN MULTIPLE OF 8
5569 5577  T5K20, T51N-1  /FOR STORAGE TII'S
5572 6577  T5K21, T50BF-1  /FOR OUTPUT AREA
5573 6483  T5K22, TII-1  /TII
5574 5573  T5K24, JMP I Z T5K8  /FOR FINAL JUMP
5575 0317  T5K25, 17  /FOR -N/8
5576 7762  T5K26, 7760  /FOR MAKING NEGATIVE
5577 5374  T5K27, T5MNC  /FOR -N/4
5578 7774  T5K28, -4  /FOR MAJOR LOOP COUNTER
5579 5366  T5K30, T5LC  /FOR INTERRUPT LEVEL COUNTER
5580 7771  T5K30A, -7  /FOR 5-BIT COUNTER
5581 6777  T5K37, T50BF-2  /FOR DOUBLE BUFFER
5582 5274  T5K38, T5MNC2  /FOR -N/4
5583 5247  T5K40, T5COM5  /FOR SWITCH
4

TSCOM2

IS INPUT CHAR FULLY ASSEMBLED?

NO

CLA

TSCOM3

NOR OR JMP TSCM10

ADVANCE INPUT POINTERS AND LINE NO.

TSCM10

PICK UP OUTPUT 2ND BUFFER PUT IT IN 1ST AND CLR 2ND BUFFER

INCREMENT 2ND BUFFER POINTER

STORE CHARACTER AND LINE NUMBER

ZERO STATUS AND COUNTER LOAD SET CHAR ASSEM FLAG

SET INPUT READY FLAG

8

TSCOM3

RESET BUFFER ADDRESS AND INDEX INPUT

NO

END OF INPUT BUFFER?

YES

7

TSCOM5

HAVE ALL LINES BEEN CHECKED FOR INPUT?

NO

RESET TTI POINTER LINE NUMBER AND INPUT CHECK

YES

LD AC WITH A NOP

RESET T5KB TO TSCOM

RESET T5KB TO TSCM10

5

TSCOM9

RESET OUTPUT BUFFER POINTER

RESET T5CN6 TO -2

ENDING 7TH BIT?

YES

(tscnt6)+1

RESET T5CN6 TSCNT + 1

RESET OUTPUT BUFFER POINTER

NO

AV4+DBF-1 TSNOUT+DBF2
12. REFERENCES

12.1 Other Library Programs
Digital-8-35-S-A
680 5-Bit Character Assembly Subroutines