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:

\[ 435_8 + 7n \]

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-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 \( 26_8 \) registers must be reserved.

3.4.4 The tag T5OBFR 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 T5OBF must be defined as an area equal in length to T5OBFR. It is used for double-buffering the output characters to allow maximum output rate.

3.4.6 The tag T5IBF 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 T5IN 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:

<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>T5SKP</td>
<td>6421</td>
<td>6431</td>
<td>6441</td>
<td>6451</td>
</tr>
<tr>
<td>TT5ON</td>
<td>6424</td>
<td>6434</td>
<td>6444</td>
<td>6454</td>
</tr>
<tr>
<td>TT5OFF</td>
<td>6422</td>
<td>6432</td>
<td>6442</td>
<td>6452</td>
</tr>
</tbody>
</table>

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:

4. USAGE

4.2 Calling Sequence

The pseudo command T5INIT must be executed before the instruction TT5ON and also before either of the other pseudo commands TT5OFF or TT5IR 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 (T5INIT)

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 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 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 TTCHAR 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 TTCHAR 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-B) 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.
TT5ON  /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:

```
T5SIR  /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 (T5SIR)
If the pseudo operation T5SIR 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 (T5SOF)
The user presents the pseudo operation T5SOF 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 \( n \) is the number of lines, the 5-bit subroutines require an average time of 

\[ 11.85n + 120 \mu \text{sec}. \]

Clock flags (at 50 baud) occur every 2500 \( \mu \text{sec}. \)

9.4.2 75 Baud Rate

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

1667 \( \mu \text{sec}. \)

10. PROGRAM

10.3 List of Items and Pseudo Commands

10.3.1 List of Items

<table>
<thead>
<tr>
<th>Operation</th>
<th>Meaning</th>
<th>Times (User's)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TT5BGN</td>
<td>Start of subroutine, must be equated to the start of a page. Area includes 2 pages.</td>
<td></td>
</tr>
<tr>
<td>T5AX1</td>
<td>Autoindex register.</td>
<td></td>
</tr>
<tr>
<td>T5AX2</td>
<td>Autoindex register.</td>
<td></td>
</tr>
<tr>
<td>T5AX3</td>
<td>Autoindex register.</td>
<td></td>
</tr>
<tr>
<td>T5AX4</td>
<td>Autoindex register.</td>
<td></td>
</tr>
<tr>
<td>TT5PG0</td>
<td>Start of constant area in page 0.</td>
<td></td>
</tr>
<tr>
<td>T5OBF</td>
<td>Start of output buffer (Length = 2n).</td>
<td></td>
</tr>
<tr>
<td>T5OBF</td>
<td>Start of second output buffer (Length = 2n).</td>
<td></td>
</tr>
<tr>
<td>T5IBF</td>
<td>Start of input buffer (Length = 2n).</td>
<td></td>
</tr>
<tr>
<td>T5IN</td>
<td>Start of TT1 area (Length = 3n + 11).</td>
<td></td>
</tr>
<tr>
<td>TTCHAR</td>
<td>Character area page 0 (Single register).</td>
<td></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>T5INIT</td>
<td>Initialize</td>
<td>N.A.</td>
</tr>
<tr>
<td>TSSSOF</td>
<td>Skip if output free</td>
<td>24</td>
</tr>
<tr>
<td>TSSIR</td>
<td>Skip if input ready</td>
<td>15, 37.5, 48</td>
</tr>
</tbody>
</table>
10.4 Program Listing

/TYPE 680 TELETYPE LINE MULTIPLEXER
/CHARACTER ASSEMBLY ROUTINE
/LMH 910/15/65 5 BIT

TII=6402 /TELETYPE INPUT COMMAND
ITII=6404 /TELETYPE OUTPUT COMMAND
ITCL=6411 /CLEAR LINE REGISTER
ITRL=6414 /READ LINE REGISTER
ITSL=6412 /SEI LINE REGISTER, CLR AC
IT50N=6424 /TURN CLOCK ON
IT50F=6426 /TURN CLOCK OFF
IT5SKP=6421 /SKIP ON CLOCK FLAG
ITINC=6401 /INCREMENT LINE REGISTER

/680 LINE MULTIPLEXER
/LIST OF ITEMS
T51BF=7200
T50BF2=7200
T55BF=6600
T5IN=5600
IT5seq=145
T5AX1=10
T5AX2=11
T5AX3=12
T5AX4=13
IT5BUN=5200
TICCHAR=177

*IT5POF
0145 0000 T5INFL, 0 /INPUT READY FLAG
0146 7177 T5BFK, T5IBF-1 /TO RESET INPUT BUFFER POINTER
0147 2000 T5NL, 0 /-NUMBER OF LINES
0150 5400 T5OUT, T5OUTS /SKIP IF OUTPUT FREE
0151 5423 T5IN, T5INS /SKIP IF INPUT READY
0152 5447 T500, T50OS /INITIALIZE ROUTINE
0153 5600 T5OUTK, T50BF /POINTER TO 1ST OUTPUT BUFFER
0154 7774 T5CN1, -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 T5K5, T50BF2 /2ND OUTPUT BUFFER
0161 0000 T5CNT5, 0 /OUTPUT COUNTER
0162 0000 T5CNT6, 0 /7 BIT COUNTER
0163 7774 T5K5, -10 /TO RESEI BIT COUNTER
0164 5602 T5K3, T510 /RESEI INPUT TII POINTER
0165 7776 T5K5, -2 /FOR SUBINACIUN
0166 0400 T5K6, 400 /TO RESEI 5 BIT ASSEMBLY WORD
0167 6600 T5K7, T50BF /K FOR ISI OUTPUT BUFFER
0170 5221 T5K8, T5COM /TO ENTER COMMON ROUTINE
0171 0000 T5K9, 0 /LINE NUMBER -1
0172 6577 T5K5A, T50BF-1 /FOR CLEARING
0173 5257 T5K5B, T5CM1A /TO AVOID OUTPUTING
0174 5361 T5K5C, JMP T5CM10 /TO SEI OUTPUT BUFFER FROM DOUBLE BUFFER
0175 5221 T5K5D, T5COM /FOR NORMAL RETURN
0176 7000 T5K5E, 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 7018 RAR  /GEI LINK
5204 3370 DCA T5SVLk  /SAVE LINK
5205 1000 IAD Z 0  / INTERRUPT ADDRESS
5206 3371 DCA T5SV0  / SAVE ADDRESS
5207 6414 ITAL  /READ LINE NUMBER
5208 3572 DCA T5SVN  /SAVE LINE NUMBER
5209 6424 T150N  /TO CLEAR CLOCK FLAG ONLY
5210 6301 T5DIS2, ION  /RE-ENABLE PROGRAM INTERRUPT
5211 1171 IAD T5K9  /STARTING LINE-1
5212 5413 TISL+1  /SEI LINE REGISTER, CLR AC
5213 5554 JMP I Z T5K3  /SEI LINE REGISTER, CLR AC

/2ND LEVEL INTERRUPT
5214 6424 T5UISS, ION  /CLEAR CLOCK FLAG
5215 6001 ION  /RE-ENABLE PROGRAM INTERRUPT
5216 5400 JMP I Z 0  /RETURN TO THE MAIN PROGRAM

/RETURN FROM INPUT TI1 LOOP
5217 1373 T5COM, IAD T5MNC  /NO. OF LINES/B
5218 3155 DCA Z T5CNI2  /MINOR LOOP COUNTER
5219 2373 IAD T5LN  /LINE NUMBER
5220 6413 TITSL+1  /SEI LINE NUMBER
5221 1553 T5CML, IAD I Z T5OUIK  /OUTPUT WORD
5222 7450 SHA  /CHARACTER AVAILABLE
5223 5351 JMP T5COM3  /NOTHING TO TRANSMIT
5224 6405 T5U+1  /INCREMENT AND TRANSMIT
5225 3553 DCA I Z T5OUIK  /RESTORE CHARACTER
5226 2153 T5CML1, ISZ Z T5OUIK  /UPDATE OUTPUT POINTER
5227 2155 ISZ Z T5CNI2  /ARE ONE-EIGHTH OF LINES DONE
5228 5225 JUMP T5COM2  /CHECK NEXT OUTPUT LINE
5229 6414 ITIL  /READ LINE NUMBER
5230 5375 DCA T5LN  /SAVE LINE NUMBER
5231 1374 T5CMI1A, IAD T5MNC  /NO OF LINES/4
5232 3155 DCA T5CNI2  /MINOR LOOP COUNTER
5233 2101 T5CML1, IAD I Z T5AXI  /ADVANCE FOR NEXT INPUT
5234 1410 IAD I Z T5AX1  /CHARACTER ASSEMBLY WORD
5235 7112 GLL RTN  /PUT BIT 10 IN LINK
5236 4500 SIZ  /CHARACTER NOT COMPLETED
5237 5326 JMP T5COM6  /STORE CHARACTER
5238 7260 CLA  /CLEAR AC FOR IAD
5239 7800 T5CM3, NUP  /OR JMP T5CM10
5240 2102 T5CM1, IAD I Z T5AX1  /UPDATE FOR NEXT INPUT LINE
5241 2376 ISZ T5LNO  /UPDATE LINE NUMBER
5242 2155 ISZ T5CHI2  /ARE ONE-FOURTH OF LINES
5243 5241 JMP T5CM2  /CHECK NEXT LINE
5244 2154 T5CM4, ISZ T5CNI1  /HAVE ALL INPUT LINES BEEN
5245 5310 JMP T5CM5  /RESET AND DISMISS
5246 11S4 IAD Z T5K3  /T5IN
5267 3010  DCA Z T5AX1  /RESET ITI POINTER
5269 1171  IAD Z T5K9  /START LINE-1
526A 7291  IAC  /SEI TO FIRST LINE
526B 5575  DCA I5LN2  /RESET LINE NUMBER
526C 1577  IAD Z T5KL0  /-4
526D 5545  DCA T5CN11  /INPUT CHECK COUNTER
526E 2165  ISZ Z T5CN15  /HAVE ALL OUTPUT LINES BEEN
526F 551D  JMP T5COM5  /RESEI AND DISMISS
5270 1165  IAD Z T5K5  /-2
5271 3165  DCA Z T5CN15  /RESEI COUNTER
5272 1171  IAD Z T5K9  /START LINE-1
5273 5575  DCA I5LN  /RESEI LINE NUMBER
5274 2165  ISZ Z T5CN16  /ENDING 7TH BIT?
5275 5555  JMP T5COM9  /NO RESEI NORMALLY
5276 1165  IAD Z T5K5  /-10
5277 556D  DCA Z T5CN16  /RESEI COUNTER
5278 2165  ISZ Z T5CN15  /ADD 1 TO COUNTER
5279 1172  IAD Z T5K9A  /T50BF-1
527A 3213  DCA Z T5AX4  /OUTPUT POINTER
527B 1160  IAD Z T5K36  /T50BF2
527C 5153  DCA T5OUTH  /2ND BUFFER POINTER
527D 1173  TAD Z T5K9B  /SPECIAL ADDRESS, T5CMIA
527E 5150  DCA Z T5K6  /RESEI ADDRESS
527F 5170  TAD Z T5K9C  /JMP T5CM10
5280 1174  DCA I5COM3  /SEI TO DO OUTPUT
5281 3247  DCA I5COM5,  /IOF
5282 7240  STA  -1
5283 1366  IAD I5LC  /LEVEL COUNTER
5284 5356  DCA I5LC  /RESEI LEVEL COUNTER
5285 1366  IAD I5LC  /LEVEL COUNTER
5286 7709  SMA CLA  /RESEI AC, ETC.
5287 5212  JMP I5DIS2  /CHECK INPUT AGAIN, ETC.
5288 1372  TAD I5VLN  /LINE NUMBER
5289 6413  TSL+1  /SEI LINE REGISTER, CLR AC
528A 1370  IAD T5VLK  /PICK UP LINK
528B 7104  CLL RAL  /RESEI LINK
528C 1367  IAD I5SA  /RESEI AC
528D 6001  ION  /RE-ENABLE PROGRAM INTERRUPT
528E 5771  JMP I I5SV0  /RETURN TO THE MAIN PROGRAM
528F 7112  I5COM6,  /RESEI START CODE
5290 7202  CL RIX
5291 3411  DCA I Z T5AX2  /STORE CHARACTER
5292 1376  IAD I5LN2  /LINE NUMBER
5293 3411  DCA I Z T5AX2  /STORE LINE NUMBER
5294 101D  IAD Z T5AX1  /I1I POINTER
5295 1165  IAD Z T5K5  /-2
5296 301D  DCA I Z T5AX1  /RESEI POINTER
5297 1365  DCA I Z T5AX1  /ZERO STATUS AND COUNTER
5298 1166  IAD Z T5K6  /WORD TO RESTORE ASSEMBLY WB
5299 3410  DCA I Z T5AX1  /RESEI CHARACTER ASSEMBLY WB
529A 2145  ISZ Z T5INFL  /SEI INPUT READY FLAG
529B 2156  ISZ Z T5CN13  /HAS END OF BUFFER BEEN READ
529C 5247  JMP I5COM3  /CONTINUE
529D 514E  15COM7,  /I5LB-1
529E 3011  IAD Z T5FK  /RESEI INPUT BUFFER ADDRESS
529F 1147  IAD T5NL  /-NUMBER OF LINES
52A0 3146  DCA Z T5AX6  /RESEI LENGTH COUNTER
52A1 5247  JMP I5COM3  /CONTINUE
5351 6441 T5COM3, I/IINCR /INCREMENT LINE NUMBER
5352 5232 JMP T5COM1 /CONTINUE
5353 1167 T5COM9, TAD Z T5K7 /T50BF
5354 3153 DCA Z T50UIK /RESET OUTPUT POINTER
5355 1175 TAD Z T5KSD /NORMAL ADDRESS, T5COM
5356 3170 DCA Z T5KB /RESET ADDRESS
5357 1176 TAD Z T5K9E /NOP
5358 5307 JMP T5COM5-1 /CONTINUE
5359 1553 T5CMI0, T AD I Z T5OUTK /2ND BUFFER CHARACTER
5360 3413 DCA I Z T5AX4 /STORE IN 1ST BUFFER
5361 3553 DCA I T50UTK /CLEAR 2ND BUFFER
5362 2153 JSZ T5OUTK /UPDATE POINTER
5363 5525 JMP T5COM3+1 /CONTINUE
5366 7777 T5LC, -1 /INTERRUPT LEVEL COUNTER
5367 0000 T5SA, 0 /SAVE ACCUMULATOR
5368 0000 T5SLK, 0 /SAVE LINK
5369 2002 T5PV0, 0 /SAVE PROGRAM COUNTER
5370 0003 T5SPLN, 0 /SAVE LINE NUMBER
5371 0000 T5MNC, 0 /-NO OF LINES/8
5372 0203 T5MC02, 0 /-NO OF LINES/4
5373 7500 T5LH, 0 /LINE NUMBER FOR OUTPUT
5374 0000 T5LN, 0 /LINE NUMBER FOR INPUT
5375 7774 T5K2A, -4 /TO RESET MAJOR LOOP COUNTER
5376 0000 T5SOF', 0 /PSEUDO-OPERATIONS
*IT5BN+200
/SKIP IF OUTPUT IS FREE AND TRANSMIT CHARACTER AT ICHAR,
/DON'T SKIP LINE NUMBER MUST BE IN AC. 24US MIN., 42US MAX.
T5SOF-JMS I Z T55OUT
5400 0000 T5OUTS, 0
5401 2157 AND Z T5K10 /177
5402 1217 TAD T5SL /STARTING LINE NUMBER
5403 1160 TAD Z T5K36 /OUTPUT BUFFER ADDRESS
5404 0220 DCA I5WA /WORK AREA
5405 1520 TAD I I5WA /OUTPUT CHARACTER
5406 7640 SZA CLA /SKIP IF FREE
5407 5640 JMP I T5OUTS /EXIT
5410 1177 TAD Z TICCHAR /PICK UP CHARACTER
5411 0221 ANU I5K11 /5 BITS ONLY
5412 1222 TAD T5K12 /140 FOR STOP CODE
5413 7104 CLL RAL /CREATE START CODE
5414 5620 DCA I I5WA /STORE CHARACTER IN TABLE
5415 2200 ISZ T5OUTS /INDEX EXIT
5416 5600 JMP I T5OUTS /EXIT
5417 0000 T5SL, 0 /-STARTING LINE NUMBER
5420 0000 I5WA, 0 /WORK AREA
5421 0037 T5K11, 37 /FOR 5 BIT CODE
5422 0040 T5K12, 40 /FOR STOP CODE
5423 0000 T5INS, 0
5424 6002 I0F
5425 7240 CLA CMA /SET AC FOR TAD-1
DCA Z T5INFL
TAD Z T5INFL
ANPUE FLAG COUNTER-1

SPA /SOMETHING AVAILABLE

JMP T5INON /EXIT

DCA Z T5INFL
/RESTORE FLAG COUNTER

ISZ T5CNT4
/END OF BUFFER? START AT

JMP .+5
GET CHARACTER

TAD Z T5NL
/-NUMBER OF LINES

DCA T5CNT4
/RESET COUNTER

DCA Z T5AX3
/RESET ADDRESS

TAD I Z T5AX3
/PICK UP CHARACTER

DCA Z TICHR
/STORE CHARACTER

TAD I Z T5AX3
/PICK UP LINE NO.

ISZ T5INS
/INDEX EXIT

JMP I T5INS
/EXIT

T5CNT4, 0
/-NUMBER OF LINES

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

T5INIT=JMS I Z T5GO

T5GOUS, 0

AND I 5K14
/377

DCA Z T5NL
/NO. OF LINES

TAU Z T5NL
/NO. OF LINES

AND I 5K15
/7

SZA CLA
/MULTIPLE OF 8

TAD I 5K16
/10

TAD Z T5NL
/NO. OF LINES

AND I 5K17
/370

CIA
/TWO'S COMP. NUMBER OF LINES

DCA Z T5NL
/-N, CONSTANT

T5G01, IAD Z T5NL
/-N

DCA Z T5CNI3
/CUNIER

TAD I 5K15
/T5IN-1

DCA Z T5AX1
/TO STORE TTI TABLE

TAD I 5K21
/T50BF-1

DCA Z T5AX2
/TO CLEAR OUTPUT AREA

TAD I 5K37
/T30BF2-1

DCA Z T5AX3
/TO CLEAR DOUBLE BUFFER

TAD I 5K15
/-N

DCA Z T5CNI4
/TO CLEAR COUNTING

TAD I 5K22
/TTI+INCR

T5G02, TAD I Z T5AX1
/STORE TTI

DCA I Z T5AX1
/CLEAR STATUS WORD

TAD I Z TSK6
/ASSEMBLY RESET WORD

DCA I Z T5AX1
/RESET ASSEMBLY WORD

DCA I Z T5AX2
/ZERO OUTPUT WORD

DCA I Z T5AX3
/CLEAR DOUBLE BUFFER

ISZ T5CNT4
/COUNTER

JMP T5G02
/DO NEXT LINE

TAD I Z T5K4
/JMP I Z T5K8

DCA I Z T5AX1
/STORE FINAL JUMP

TAD Z T5NL
/-N

RTR
/-N/4
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5511  7010  RAR /-N/8
5512  3365  AND Z 15K.5 /17
5513  1566  TAU Z 15K.6 /7760, MAKE NUMBER NEGATIVE
5514  3767  DCA 1 15K.7 /15MNC
5515  1767  TAU 1 15K.7 /15MNC -N/4
5516  1767  TAU 1 15K.7 /15MNC -N/4
5517  3774  DCA 1 15K.8 /15MNC2
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 Z 15K28 /-4
5525  3154  DCA Z 15CN11 /MAJOR LOOP COUNTER
5526  1165  TAD Z 15K 5 /-2
5527  3161  DCA Z 15CN15 /OUTPUT COUNTER
5533  1164  TAD Z 15K5 /T5IN+1
5531  3018  DCA 1 15AX1 /SET TII POINTENER
5532  1167  TAD 15K7 /T50BF
5533  3153  DCA Z 150UIK /SET OUTPUT BUFFER POINTER
5534  7240  SIA /-1
5535  1647  TAU 1 15GOS /STARTING LINE NUMBER
5536  3171  DCA Z 15K 9 /STARTING LINE NO-1
5537  1171  TAD Z 15K 9 /STARTING LINE -1
5540  7340  CMA /MAKE NEGATIVE
5541  3217  DCA 15SL /STARTING LINE NUMBER
5542  3145  DCA Z 15INFL /CLEAR INPUT FLAG COUNTER
5543  7240  SIA /-1
5544  3771  DCA 1 15K 35 /T5LC, RESET INTERRUPT LEVEL
5545  2247  TISZ 15GOS /INDEX EXIT
5546  1372  TAD 15K.35A /-7
5547  3162  DCA Z 15CN16 /SEI SPECIAL 5-BIT COUNTER
5550  1175  TAD Z 15K 9D /T5CM
5551  3170  DCA Z 15K 8 /TII RETURN
5552  1175  TAD 15K 9E /NUP
5553  3775  DCA 1 15K40 /T5CM3
5554  5647  JMP I 15GOS /EXIT

/CONSTANTS

5555  0377  15K14,  377 /FOR ANDING
5556  0007  15K15,  7 /FOR EVEN MULTIPLE OF 8
5557  0010  15K16,  10 /FOR EVEN MULTIPLE OF 8
5560  0378  15K17,  370 /FOR EVEN MULTIPLE OF 8
5561  5577  15K20,  T5IN-1 /FOR STORING TII'S
5562  6577  15K21,  T50BF-1 /FOR OUTPUT AREA
5563  6403  15K22, TII+1 /TII
5564  5570  15K24, JMP I Z 15K8 /FOR FINAL JUMP
5565  0317  15K25,  17 /FOR -N/8
5566  7762  15K26, 7760 /FOR MAKING NEGATIVE
5567  5373  15K27,  T5MNC /FOR -N/8
5570  7774  15K28, -4 /FOR MAJOR LOOP COUNTER
5571  5366  15K39, T5LC /FOR INTERRUPT LEVEL COUNTER
5572  7771  15K30A, -7 /FOR 5-BIT COUNTER
5573  6777  15K37, T50BF2-1 /FOR DOUBLE BUFFER
5574  5274  15K38, 15MNC2 /FORX -N/4
5575  5247  15K40, T5CM5 /FORX SWITCH
12. REFERENCES

12.1 Other Library Programs

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