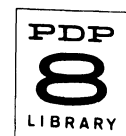


- 1. IDENTIFICATION
- 1.1 Digital-8-35-S-A
- 1.2 680 5-Bit Character Assembly Subroutines
- 1.3 November 17, 1965





## 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 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 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:

T5SKP	/SKIP ON CLOCK FLAG
SKP	/TEST FOR NEXT INTERRUPT CAUSE
JMP T5DIS	/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:

Mnemonic	Clock 1	Clock 2	Clock 3	Clock 4
T5SKP	6421	6431	6441	6451
TT5ON	6424	6434	6444	6454
TT5OFF	6422	6432	6442	6452

## 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 T5SOF or T5SIR 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  $\mu$ sec minimum time, and 42  $\mu$ sec 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  $\mu$ sec are used by the pseudo instructions; if a character is available, 37.5  $\mu$ sec are used; and if the end of the storage area is reached, a maximum of 48  $\mu$ sec 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.
T5INIT		/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.

No. of Lines	5-Bit 50 Baud	5-Bit 75 Baud
32	20.0%	30.0%
64	35.1%	52.7%
96	50.3%	75.5%
128	65.5%	98.3%

#### 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  $11.85n + 120 \mu\text{sec}$ . 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

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

###### 10.3.2 List of Pseudo Operations

Operation	Meaning	Times (User's) Min.	Av.	Max.
T5INIT	Initialize	N.A.		
T5SOF	Skip if output free	24	-	42
T5SIR	Skip if input ready	15	37.5	48



10.4 Program Listing

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

TTI=6402 /TELETYPE INPUT COMMAND  
TTO=6404 /TELETYPE OUTPUT COMMAND  
TTCL=6411 /CLEAR LINE REGISTER  
ITRL=6414 /READ LINE REGISTER  
TTSL=6412 /SET LINE REGISTER, CLR AC  
IT5ON=6424 /TURN CLOCK ON  
IT5OFF=6422 /TURN CLOCK OFF  
T5SKP=6421 /SKIP ON CLOCK FLAG  
TTINCR=6401 /INCREMENT LINE REGISTER

/680 LINE MULTIPLEXER  
/LIST OF ITEMS  
T5IBF=7200  
T5OBF2=7000  
T5OBF=6600  
T5IN=5600  
TT5PG0=145  
T5AX1=10  
T5AX2=11  
T5AX3=12  
T5AX4=13  
IT5BGN=5200  
TCHAR=177

\*TT5PG0

0145	0000	T5INFL,	0	/INPUT READY FLAG
0146	7177	T5BFL,	T5IBF-1	/TO RESET INPUT BUFFER POINTER
0147	0000	T5NL,	0	/-NUMBER OF LINES
0150	5400	T5SOUT,	T5OUTS	/SKIP IF OUTPUT FREE
0151	5423	T5SIN,	T5INS	/SKIP IF INPUT READY
0152	5447	T5G0,	T5GOS	/INITIALIZE ROUTINE
0153	6600	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 RESET BIT COUNTER
0164	5600	T5K3,	T5IN	/RESET INPUT TTI POINTER
0165	7776	T5K5,	-2	/FOR SUBTRACTION
0166	0400	T5K6,	400	/TO RESET 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	T5K9A,	T5OBF-1	/FOR CLEARING
0173	5237	T5K9B,	T5CM1A	/TO AVOID OUTPUTTING
0174	5361	T5K9C,	JMP T5CM10	/TO SET OUTPUT BUFFER FROM DOUBLE BUFFER
0175	5221	T5K9D,	T5COM	/FOR NORMAL RETURN
0176	7000	T5K9E,	NOP	/TO DO INPUT ONLY

\*T15BGN  
 /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	/GET LINK
5204	3370	DCA T5SVLK	/SAVE LINK
5205	1000	TAD Z 0	/ INTERRUPT ADDRESS
5206	3371	DCA T5SV0	/ SAVE ADDRESS
5207	6414	TTRL	/READ LINE NUMBER
5210	3372	DCA T5SVLN	/SAVE LINE NUMBER
5211	6424	T15ON	/TO CLEAR CLOCK FLAG ONLY
5212	6001	T5DIS2, ION	/RE-ENABLE PROGRAM INTERRUPT
5213	1171	TAD T5K9	/STARTING LINE-1
5214	6413	T1SL+1	/SET LINE REGISTER, CLR AC
5215	5564	JMP I Z T5K3	SET LINE REGISTER, CLR AC

/2ND LEVEL INTERRUPT

5216	6424	T5DIS3, T15ON	/CLEAR CLOCK FLAG
5217	6001	ION	/RE-ENABLE PROGRAM INTERRUPT
5220	5400	JMP I Z 0	/RETURN TO THE MAIN PROGRAM

/RETURN FROM INPUT T11 LOOP

5221	1373	T5COM, TAD T5MNC	/-NO. OF LINES/8
5222	3155	DCA Z T5CNT2	/MINOR LOOP COUNTER
5223	1375	TAD T5LN	/LINE NUMBER
5224	6413	T1SL+1	/ SET LINE NUMBER
5225	1553	T5COM0, TAD I Z T5OUTK	/OUTPUT WORD
5226	7450	SNA	/CHARACTER AVAILABLE
5227	5351	JMP T5COM3	/NOTHING TO TRANSMIT
5230	6405	T10+1	/INCREMENT AND TRANSMIT
5231	3553	DCA I Z T5OUTK	/RESTORE CHARACTER
5232	2153	T5COM1, ISZ Z T5OUTK	/UPDATE OUTPUT POINTER
5233	2155	ISZ Z T5CNT2	/ARE ONE-EIGHTH OF LINES DONE
5234	5225	JMP T5COM0	/CHECK NEXT OUTPUT LINE
5235	6414	TTRL	/READ LINE NUMBER
5236	3375	DCA T5LN	/SAVE LINE NUMBER
5237	1374	T5CM1A, TAD T5MNC2	/NO OF LINES/4
5240	3155	DCA T5CNT2	/MINOR LOOP COUNTER
5241	2010	T5COM2, I SZ T5AX1	/ ADVANCE FOR NEXT INPUT
5242	1410	TAD I Z T5AX1	/CHARACTER ASSEMBLY WORD
5243	7112	CLL RTR	/ PUT BIT 10 IN LINK
5244	7430	SZL	/CHARACTER NOT COMPLETED
5245	5326	JMP T5COM6	/STORE CHARACTER
5246	7200	CLA	/CLEAR AC FOR TAD
5247	7000	T5COM3, NOP	/OR JMP T5CM10
5250	2010	ISZ Z T5AX1	/UPDATE FOR NEXT INPUT LINE
5251	2376	ISZ T5LN2	/ UPDATE LINE NUMBER
5252	2155	ISZ T5CNT2	/ARE ONE-FOURTH OF LINES
5253	5241	JMP T5COM2	/CHECK NEXT LINE
5254	2154	T5COM4, ISZ T5CNT1	/HAVE ALL INPUT LINES BEEN
5255	5310	JMP T5COM5	/RESET AND DISMISS
5256	1164	TAD Z T5K3	/T5IN

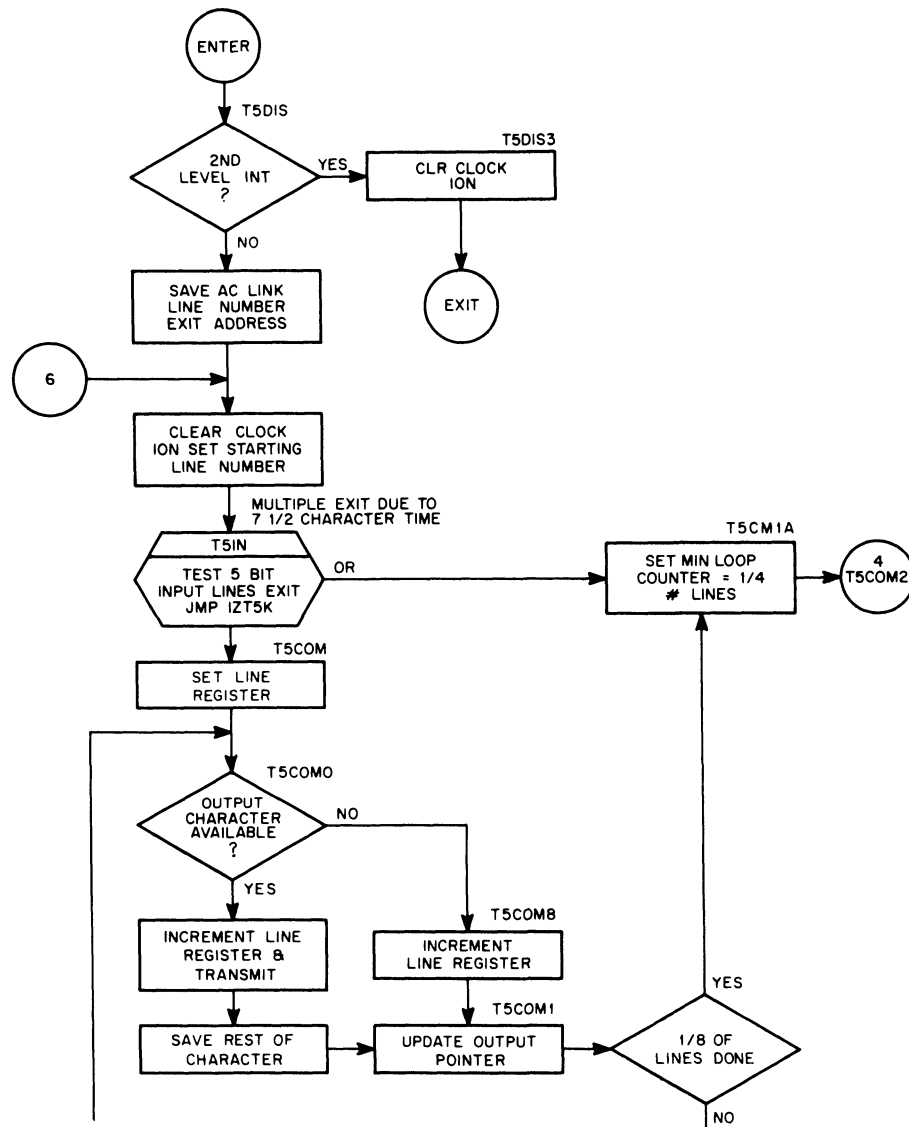
5257	3010	DCA Z T5AX1	/RESET TTI POINTER
5260	1171	TAD Z T5K9	/START LINE-1
5261	7001	IAC	/SET TO FIRST LINE
5262	3376	DCA T5LN2	/RESET LINE NUMBER
5263	1377	TAD T5K2A	/-4
5264	3154	DCA T5CN11	/INPUT CHECK COUNTER
5265	2131	ISZ Z T5CN15	/HAVE ALL OUTPUT LINES BEEN
5266	5310	JMP T5COM5	/RESET AND DISMISS
5267	1165	TAD Z T5K5	/-2
5270	3161	DCA Z T5CN15	/RESET COUNTER
5271	1171	TAD Z T5K9	/START LINE-1
5272	3375	DCA T5LN	/RESET LINE NUMBER
5273	2162	ISZ Z T5CN16	/ENDING 7TH BIT?
5274	5353	JMP T5COM9	/NO RESET NORMALLY
5275	1163	TAD T5K2	/-10
5276	3162	DCA Z T5CN16	/RESET COUNTER
5277	2161	ISZ Z T5CN15	/ADD 1 TO COUNTER
5300	1172	TAD Z T5K9A	/T50BF-1
5301	3013	DCA Z T5AX4	/OUTPUT POINTER
5302	1160	TAD Z T5K36	/T50BF2
5303	3153	DCA T5OUTK	/2ND BUFFER POINTER
5304	1173	TAD Z T5K9B	/SPECIAL ADDRESS, T5CM1A
5305	3170	DCA Z T5K8	/RESET ADDRESS
5306	1174	TAD Z T5K9C	/JMP T5CM10
5307	3247	DCA T5COM3	/SET TO DO OUTPUT
5310	6002	T5COM5, IOF	/TURN OFF INTERRUPT
5311	7240	STA	/-1
5312	1366	TAD T5LC	/LEVEL COUNTER
5313	3366	DCA T5LC	/RESTORE LEVEL COUNTER
5314	1366	TAD T5LC	/LEVEL COUNTER
5315	7700	SMA CLA	/RESTORE AC, ETC.
5316	5212	JMP T5DIS2	/CHECK INPUT AGAIN, ETC.
5317	1372	TAD T5SVLN	/LINE NUMBER
5320	6413	ITSL+1	/SET LINE REGISTER, CLR AC
5321	1370	TAD T5SVLK	/PICK UP LINK
5322	7104	CLL RAL	/RESTORE LINK
5323	1367	TAD T5SA	/RESTORE AC
5324	6001	ION	/RE-ENABLE PROGRAM INTERRUPT
5325	5771	JMP I T5SV0	/RETURN TO THE MAIN PROGRAM
5326	7112	T5COM6, C LL RTR	/ REMOVE START CODE
5327	7012	RTR	
5330	3411	DCA I Z T5AX2	/STORE CHARACTER
5331	1376	TAD T5LN2	/LINE NUMBER
5332	3411	DCA I Z T5AX2	/STORE LINE NUMBER
5333	1010	TAD Z T5AX1	/TTI POINTER
5334	1165	TAD Z T5K5	/-2
5335	3010	DCA Z T5AX1	/RESET POINTER
5336	3410	DCA I Z T5AX1	/ZERO STATUS AND COUNTER
5337	1166	TAD Z T5K6	/WORD TO RESTORE ASSEMBLY WB
5340	3410	DCA I Z T5AX1	/RESET CHARACTER ASSEMBLY WB
5341	2145	ISZ Z T5INFL	/SET INPUT READY FLAG
5342	2156	ISZ Z T5CN13	/HAS END OF BUFFER BEEN READ
5343	5247	JMP T5COM3	/CONTINUE
5344	1146	T5COM7, TAD Z T5BFK	/T51BF-1
5345	3011	DCA Z T5AX2	/RESET INPUT BUFFER ADDRESS
5346	1147	TAD T5NL	/-NUMBER OF LINES
5347	3156	DCA Z T5CN13	/RESET LENGTH COUNTER
5350	5247	JMP T5COM3	/CONTINUE

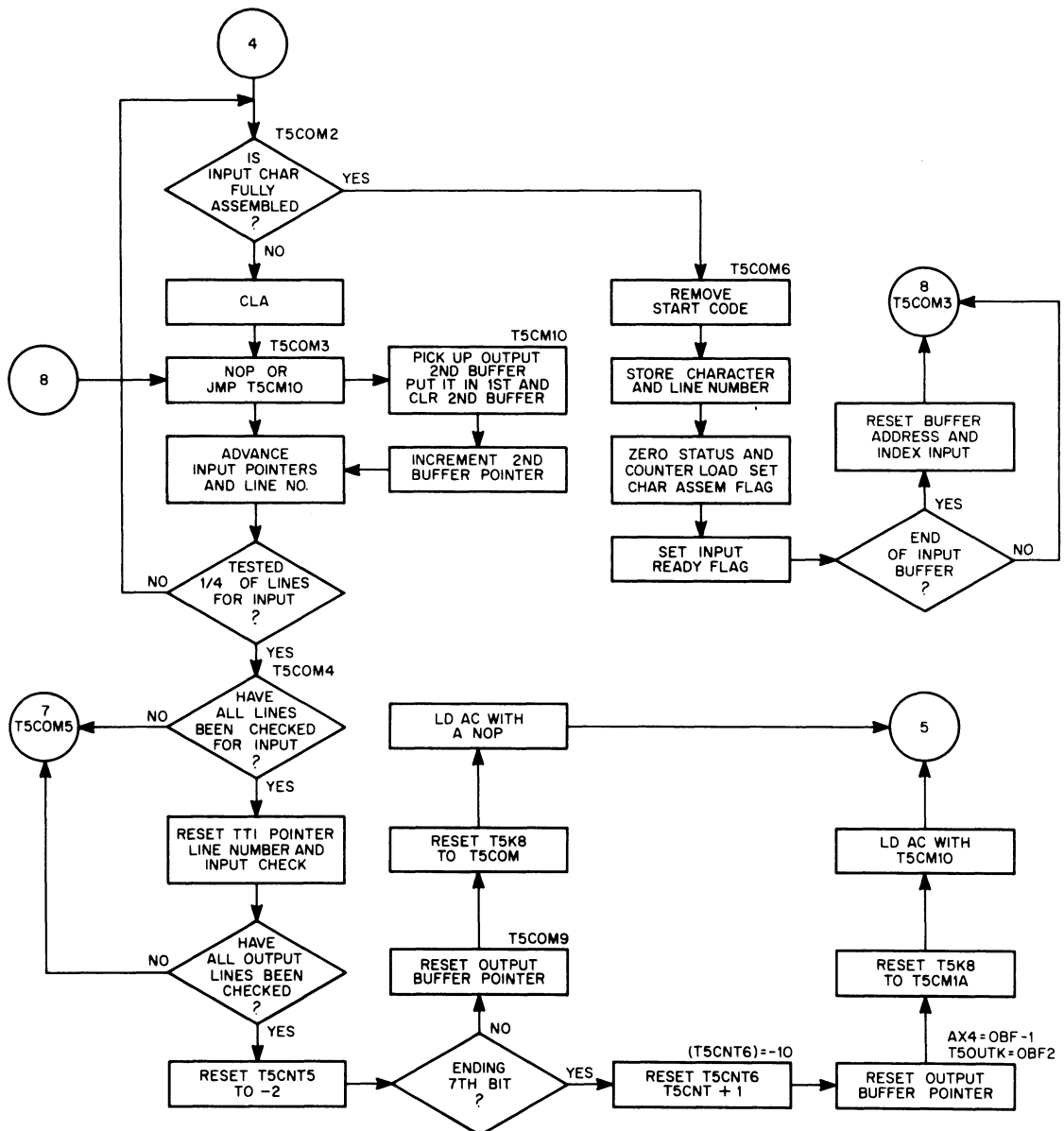
5351	6401	T5COM3,	ITINCR	/INCREMENT LINE NUMBER
5352	5232		JMP T5COM1	/CONTINUE
5353	1167	T5COM9,	TAD Z T5K7	/T50BF
5354	3153		DCA Z T5OUTK	/RESET OUTPUT POINTER
5355	1175		TAD Z T5K9D	/NORMAL ADDRESS, T5COM
5356	3170		DCA Z T5K8	/RESET ADDRESS
5357	1176		TAD Z T5K9E	/NOP
5360	5307		JMP T5COM5-1	/CONTINUE
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 T5OUTK	/CLEAR 2ND BUFFER
5364	2153		ISZ T5OUTK	/UPDATE POINTER
5365	5250		JMP T5COM3+1	/CONTINUE
/CONSTANTS				
5366	7777	T5LC,	-1	/INTERRUPT LEVEL COUNTER
5367	0000	T5SA,	0	/SAVE ACCUMULATOR
5370	0000	T5SVLK,	0	/SAVE LINK
5371	0000	T5SV0,	0	/SAVE PROGRAM COUNTER
5372	0000	T5SVLN,	0	/SAVE LINE NUMBER
5373	0000	T5MNC,	0	/-NO OF LINES/3
5374	0000	T5MNC2,	0	/-NO OF LINES/4
5375	0000	T5LN,	0	/LINE NUMBER FOR OUTPUT
5376	0000	T5LN2,	0	/LINE NUMBER FOR INPUT
5377	7774	T5K2A,	-4	/TO RESET MAJOR LOOP COUNTER
/PSEUDO-OPERATIONS				
*IT5BGN+200				
/SKIP IF OUTPUT IS FREE AND TRANSMIT CHARACTER AT TICHAR,				
/DON'T SKIP LINE NUMBER MUST BE IN AC. 24US MIN., 42US MAX.				
T5SOF=JMS I Z T5SOUT				
5400	0000	T5OUTS,	0	
5401	0157		AND Z T5K10	/177
5402	1217		TAD T5SL	/-STARTING LINE NUMBER
5403	1160		TAD Z T5K36	/OUTPUT BUFFER ADDRESS
5404	3220		DCA T5WA	/WORK AREA
5405	1620		TAD I T5WA	/OUTPUT CHARACTER
5406	7640		SZA CLA	/SKIP IF FREE
5407	5600		JMP I T5OUTS	/EXIT
5410	1177		TAD Z TICHAR	/PICK UP CHARACTER
5411	0221		AND T5K11	/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	2200		ISZ T5OUTS	/INDEX EXIT
5416	5600		JMP I T5OUTS	/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 IN				
/CHAR AT TICHAR. OTHERWISE DO NOT SKIP				
/15US MIN., 48US MAX., 37.5US NORMAL IF READY				
T5SIR=JMS I Z T5SIN				
5423	0000	T5INS,	0	
5424	6002		IOF	
5425	7240		CLA CMA	/ SET AC FOR TAD-1

5426	1145	TAD Z T5INFL	INPUT FLAG COUNTER-1
5427	7510	SPA	/SOMETHING AVAILABLE
5430	5244	JMP T5INON	/EXIT
5431	3145	DCA Z T5INFL	/RESTORE FLAG COUNTER
5432	2246	ISZ T5CNT4	/END OF BUFFER? START AT -N
5433	5240	JMP .+5	/GET CHARACTER
5434	1147	TAD Z T5NL	/-NUMBER OF LINES
5435	3246	DCA T5CNT4	/RESET COUNTER
5436	1146	TAD Z T5BFL	/BUFFER ADDRESS-1
5437	3012	DCA Z T5AX3	/RESET ADDRESS
5440	1412	TAD I Z T5AX3	/PICK UP CHARACTER
5441	3177	DCA Z T1CHAR	/STORE CHARACTER
5442	1412	TAD I Z T5AX3	/PICK UP LINE NO.
5443	2223	ISZ T5INS	/INDEX EXIT
5444	6001	T5INON, I ON	
5445	5623	JMP I T5INS	/EXIT
5446	0000	T5CNT4, 0	/-NUMBER OF LINES
		/INITIALIZATION ROUTINE	
		/ENTER WITH NUMBER OF LINES IN AC	
		/FORMAT T5INIT	
		/ 1ST LINE NO.	
		T5INIT=JMS I Z T5G0	
5447	0000	T5G0S, 0	
5450	0355	AND T5K14	/377
5451	3147	DCA Z T5NL	/NO. OF LINES
5452	1147	TAD Z T5NL	/NO. OF LINES
5453	0356	AND T5K15	/7
5454	7040	SZA CLA	/MULTIPLE OF 8
5455	1357	TAD T5K16	/10
5456	1147	TAD Z T5NL	/NO. OF LINES
5457	0360	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	/-N
5463	3156	DCA Z T5CNT3	COUNTER
5464	1361	TAD T5K20	/T5IN-1
5465	3010	DCA Z T5AX1	/TO STORE TTI TABLE
5466	1362	TAD T5K21	/T50BF-1
5467	3011	DCA Z T5AX2	/TO CLEAR OUTPUT AREA
5470	1373	TAD T5K37	/T50BF2-1
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	/TTI+INCR
5475	3410	DCA I Z T5AX1	/STORE TTI
5476	3410	DCA I Z T5AX1	/CLEAR STATUS WORD
5477	1166	TAD Z T5K6	/ASSEMBLY RESET WORD
5500	3410	DCA I Z T5AX1	/RESET ASSEMBLY WORD
5501	3411	DCA I Z T5AX2	/ZERO OUTPUT WORD
5502	3412	DCA I Z T5AX3	/CLEAR DOUBLE BUFFER
5503	2246	ISZ T5CNT4	/COUNTER
5504	5274	JMP T5G02	/DO NEXT LINE
5505	1364	TAD T5K24	/JMP I Z T5K8
5506	3410	DCA I Z T5AX1	/STORE FINAL JUMP
5507	1147	TAD Z T5NL	/-N
5510	7012	RTR	/-N/4

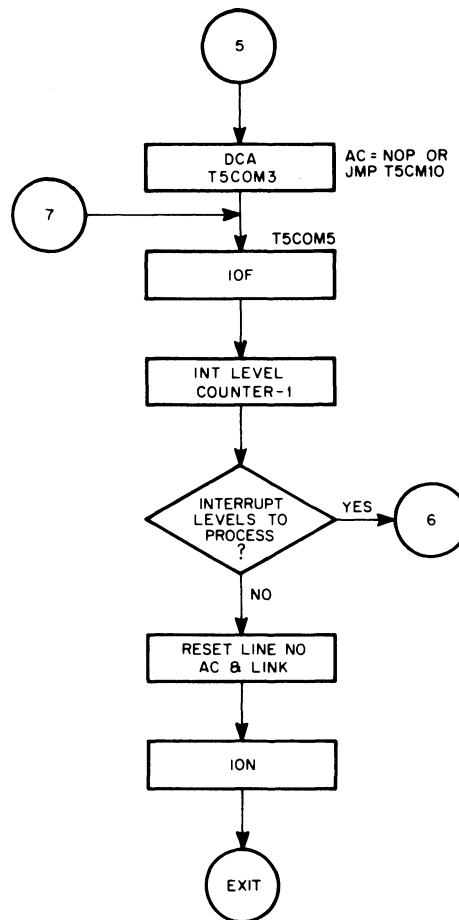
5511	7010	RAR	/-N/8
5512	0365	AND I5K25	/17
5513	1366	IAD I5K26	/7760, MAKE NUMBER NEGATIVE
5514	3767	DCA I I5K27	/T5MNC
5515	1767	IAD I I5K27	/T5MNC
5516	1767	IAD I I5K27	/T5MNC -N/4
5517	3774	DCA I I5K33	/T5MNC2
5520	7240	STA	/-1
5521	3246	DCA T5CNT4	/SET CNTR TO SKIP 1ST TIME
5522	1146	IAD Z T5BFK	/T5IBF-1
5523	3011	DCA Z T5AX2	/SET INPUT BUFFER POINTER
5524	1370	IAD I5K28	/-4
5525	3154	DCA Z T5CNT1	/MAJOR LOOP COUNTER
5526	1165	IAD Z I5K5	/-2
5527	3161	DCA Z T5CNT5	/OUTPUT COUNTER
5530	1164	IAD Z I5K3	/T5IN+1
5531	3010	DCA Z I5AX1	/SET I11 POINTER
5532	1167	IAD I5K7	/T50BF
5533	3153	DCA Z T5OUTK	/SET OUTPUT BUFFER POINTER
5534	7240	STA	/-1
5535	1647	IAD I T5G0S	/STARTING LINE NUMBER
5536	3171	DCA Z I5K9	/STARTING LINE NO-1
5537	1171	IAD Z I5K9	/STARTING LINE -1
5540	7240	CMA	/MAKE NEGATIVE
5541	3217	DCA T5SL	/-STARTING LINE NUMBER
5542	3145	DCA Z T5INFL	/CLEAR INPUT FLAG COUNTER
5543	7240	STA	/-1
5544	3771	DCA I I5K35	/T5LC, RESET INTERRUPT LEVEL
5545	2247	ISZ T5G0S	/INDEX EXIT
5546	1372	IAD I5K35A	/-7
5547	3162	DCA Z T5CNT6	/SET SPECIAL 5-BIT COUNTER
5550	1175	IAD Z I5K9D	/T5COM
5551	3170	DCA Z I5K8	/I11 RETURN
5552	1176	IAD Z I5K9E	/NOP
5553	3775	DCA I I5K40	/T5COM3
5554	5647	JMP I T5G0S	/EXIT
/CONSTANTS			
5555	0377	I5K14, 377	/FOR ANDING
5556	0007	I5K15, 7	/FOR EVEN MULTIPLE OF 8
5557	0010	I5K16, 10	/FOR EVEN MULTIPLE OF 8
5560	0370	I5K17, 370	/FOR EVEN MULTIPLE OF 8
5561	5577	I5K20, T5IN-1	/FOR STORING I11'S
5562	6577	I5K21, T50BF-1	/FOR OUTPUT AREA
5563	6403	I5K22, I11+1	/ I11
5564	5570	I5K24, JMP I Z I5K8	/FOR FINAL JUMP
5565	0017	I5K25, 17	/FOR -N/8
5566	7762	I5K26, 7760	/FOR MAKING NEGATIVE
5567	5373	I5K27, T5MNC	/FOR -N/8
5570	7774	I5K28, -4	/FOR MAJOR LOOP COUNTER
5571	5366	I5K35, T5LC	/FOR INTERRUPT LEVEL COUNTER
5572	7771	I5K35A, -7	/FOR 5-BIT COUNTER
5573	6777	I5K37, T50BF2-1	/FOR DOUBLE BUFFER
5574	5374	I5K33, T5MNC2	/FOR -N/4
5575	5247	I5K40, T5COM3	/FOR SWITCH

11 DIAGRAMS  
11.1 Flow Charts









## 12. REFERENCES

### 12.1 Other Library Programs

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

