IDENTIFICATION: PROBE I
Diagnostic Routine

AUTHOR: W. S. LaSor, PBC

ACCEPTED: July 1, 1961

PURPOSE:

1. To test the read-write circuitry of the PB250 memory under operator control.

2. To check all commands in the PB250 under marginal operation.

3. To check the punching and reading phases of the Flexowriter.

4. In addition, the program may link test routines for various peripheral equipment by changing one of the commands (See USE).

RESTRICTIONS:

1. Lines 00 through 07 must be in the machine. Line 00 must be a medium line.

2. If more than minimal operation is desired, an external switch bank must be connected to the computer.

STORAGE:

1. All sectors of lines 02 and 03 are used by the program.

2. Sectors 000 through 051, and sector 377 of line 01 are used by the bootstrap loader. The contents of these sectors may be destroyed once the program is loaded.

3. All line 00 channels are used for temporary storage.

TIMING:

1. When checking memory, the program requires approximately 3 seconds to write and read one line (optimized).

2. When checking commands, the program requires about 1 second to test all commands in one line.

TIMING(cont.):

3. When checking the punch-read phase of the Flexowriter, the program proceeds at the Flexowriter speed of 15 characters per second.

USE:

1. Loading

There are two tapes available; one has its own bootstrap loader, whereas the other may be loaded by means of the Octal Utility Package. The total time required to load the program is 3-1/2 - 4 minutes, depending on the tape used.

a. Bootstrap Loading

This tape may be loaded by bootstrap control through conventional use of the FILL switch on the console. Upon completion of loading, if there is no check-sum error, control is transferred to sector 000 of line 02. A TRU command to 00002 will be placed in sector 000 of line 01 by the bootstrap so that control may be returned to the beginning of the program at any time by using the ENABLE switch and I key. If there has been a check-sum error, the machine will halt and display a line number of $37)_8$ on the OPERAND lights.

b. Octal Utility Package Loading

This tape may be loaded by the Octal Utility Package by putting the tape in the mechanical reader and striking the F key. Be sure the BREAKPOINT switch is raised or loading will halt half way through. Should this happen, the remainder of the tape may be loaded by re-striking the F key. Upon completion of successful loading, the keyboard light will come back on and control may be transferred to the program by striking the T key. If there has been a check-sum error, the machine will halt and display a line number of $37)_8$.

Sector 000 of line 02 is the beginning of the program and contains a HALT with a line number of $30)_8$. The HALT instruction indicates the beginning of the program and allows the operator to set up the desired switch configuration. Once everything is in order, the program may be started by clearing parity and raising the ENABLE switch.

USE(cont.):

2. Modes of Operation

There are two basic modes of operation in the program; Memory and Command. The mode is determined by the position of the BREAKPOINT switch as follows: with BREAKPOINT in the raised position the program operates in the Memory mode (Write-Read II); with BREAKPOINT in the depressed position the program operates in the Command mode (Diagnostic 41). In the Memory mode all lines may be checked except lines 00, 01, 02, and 03. In the Command mode, all commands are checked but DVR, RTK, PTU, and BSO. With no external switch bank connected, the program will check lines 04 through 07 in the Memory mode and lines 03 through 07 in the Command mode. For more specific or extended uses, an external switch bank must be connected to the computer.

3. Switch Bank

For more effective operator control, the program has been set up to scan a switch bank and limit or extend its operation according to the switch settings. The switch bank should be so connected as to be addressable by TES commands on lines 10 through 17. The switches should be wired in such a way that transfer of control will be effected when a switch is in a raised position. Wiring instructions and lists may be found in the PB250 Technical Manual, Volume II, pages 46, and 58 through 60 of the Logic Layout section.

The switch bank is divided into two sections of four switches each. The four left-hand switches define an instruction, whereas the four right-hand switches define an address. All address designations are in octal.

a. Memory Mode

Table 1 shows the switch controls for operation in the Memory mode.

Table I

MEMORY MODE

Breakpoint Up.

Switch Line	Raised	Lowered
10	Program halts after checking specified lines.	Program continues after checking specified lines. Switches are rescanned for new instructions.
11	Program will only WRITE random numbers into specified lines.	Program write-reads continuously through all specified lines.
12	Program checks only that line indicated on address switches.	Program checks all lines from 04 up to line indicated on address switches.
13	Program write-reads lines 04 through 17.	Program write-reads lines 04 through 07.

USE(cont.): When the program is instructed to halt (switch 10), it will halt and display a line number of $30)_8$ which indicates the beginning of the program. Clearing parity at this point will resume computation. Where possible ambiguities occur, lower numbered switches have priority over higher numbered ones. Thus, if switches 12 and 13 are both raised, switch 13 is ignored. With switch 11 raised, random numbers are stored continuously throughout memory but no checking is done. When it is desired to return to Write-Read (by lowering switch 11), the ENABLE switch must be depressed and the I key struck to return control to the beginning.

USE(cont.):

Failure to do this will cause the program to go directly to the Read phase of the Write-Read program and an apparent error will occur due to the fact that the original random number is no longer correct. No complications will result other than the usual error punch-out which may be interrupted by depressing the ENABLE switch.

If an error is detected during a Write-Read phase, the Flexowriter will punch out the sector and line where the error occurred, followed by the number that should have been found and the number that was found. If the error is one of parity, the machine will halt and display an 05 code in the OPERATION lights and the line number where the error occurred in the OPERAND lights. Clearing parity will resume punch-out. Whenever five consecutive errors are noted, the entire line is assumed to be bad and the program will continue with no further punch-out for that line. Switches may be altered during any phase, but their states will not be determined until the current phase is complete. This is a cardinal rule for all operations in the program! NO NEW PHASE WILL BE INITIATED, REGARDLESS OF SWITCH POSITIONS, UNTIL THE CURRENT PHASE IS COMPLETE! In some cases, this may be as long as 30 or 40 seconds.

Switches 14 through 17 indicate a line address associated with the operation indicated in switches 10 through 13. Thus, 1001 on the switch bank specifies line $11)_8$ and all program operations will be referenced to this line. A line configuration of 0000 will indicate lines 04 through 07/17 are to be checked, depending upon the state of switch 13. In this case, switch 12 is ignored. Line configurations 0001, 0010, and 0011 are unused in this mode and will be rejected. In the event the unused codes are encountered, program will loop and rescan the switch bank until a legitimate combination is indicated. Sector 073 of line 02 contains a TAN command which notes if an illegal combination is present and returns control to rescan the switches. If so desired, these unused positions may be used to transfer out of

USE(cont.): PROBE I to other test programs by changing the TAN command to transfer to the desired location. When returning from an external test program, a transfer to sector 000 of line 02 will halt computation at the beginning of PROBE I. If it is desired to return to PROBE I without halting, transfer should be made to sector 001 of line 02.

b. Command Mode

Table 2 shows the switch controls for operation in the Command mode.

Table 2

COMMAND MODE

Breakpoint Down.

Switch Line	Raised	Lowered
10	Program halts after each block is checked.	Program continues after each block is checked.
11	Program repeats current block using same number only if error occurs.	Program halts if error in current block and displays block number in OPERAND lights.
12	Program repeats current block using different numbers unless error.	Program continues to next block in sequence with a different number unless error.
13	Program executes commands in all lines, 03 through 17.	Program executes commands in all lines, 03 through 07.

USE(cont.): There are $20)_8$ command blocks in this mode which operate with random numbers where applicable. Command blocks are numbered $01)_8$ through $20)_8$, consecutively and the commands checked in each block are listed below. When one block is complete, if no error is noted, the next block in sequence is checked, and so on. When the last block has been checked, the program is moved to the next higher line and the process repeats. When the last line has been checked, the program returns to scan the switches and proceeds from there. The time required to check the entire $16)_{10}$ blocks is about 1 second and the progress of the program through the lines may be noted by observing the K flip-flops on the computer console.

Whenever the program executes a halt in this mode, the block number where the halt occurred will be displayed on the OPERAND lights except when the last block is reached and the program returns to the beginning, at which time the line number displayed will be $30)_8$. If switch 10 is raised, the program will halt unconditionally after each block. Thus, if it is desired to repeat block 06 continuously, switch 10 should be raised and the program cycled by means of the ENABLE switch until 06 appears on the OPERAND lights. Then switch 12 should be raised, switch 10 lowered, and the program allowed to run. In this manner, block 06 will be checked continuously with different numbers until an error is detected or the switch configuration is changed.

Switches 14 through 17 define an address to be used in reference to the other switches. A switch configuration of 0000 will automatically check lines 03 through 07/17 depending on the setting of switch 13. An address of 0010 will initiate a punch-read phase. In this phase, 5 inches of leader are punched, followed by a marker character of 8"ones" and 64 frames of random digits. When the last frame has been punched, another 5 inches of trailer is punched and the frames punched are read back into the machine and checked. During punch-out, there will be sufficient time for the operator to insert the tape in the mechanical reader so that read-

USE(cont.):

ing may be started immediately upon completion of punching. When an error is detected, the reader halts momentarily (about 3 seconds) and the light on the Flexowriter flashes. If the ENABLE switch is depressed while this light is on, the character just read may be viewed in the OPERATION and OPERAND lights on the console. By comparing the state of the lights against the frame just read, the operator may determine which read channel has failed. If the frame and display agree, then the error occurred during the punch phase. Raising the ENABLE switch will allow resumption of the test. When the test is complete, the program returns to the beginning and halts with a line display of $30)_8$.

All other configurations of the address switches indicate what line is to be tested. Only that line indicated will be tested. Line 01 may be tested but, if the Octal Utility Package is in this line, it will be destroyed. When the program is loaded by bootstrap, a TRU command to 00002 is stored in sector 000 of line 01 so that control may be returned to the beginning of the program at any time by use of the I key. This TRU command is also in sector 000 of line 03 and, when line 01 is tested, this command will be moved to 00001 so that the operator may still return to sector 000 of line 02 even after destroying the former contents of line 01 by checking that line.

Table 3 lists the command blocks by number (in octal) and the commands checked in that block. Commands which are not listed in Table 3 are considered to have been checked elsewhere, i.e., LAI, CIB, etc.

USE(cont.):

Table 3

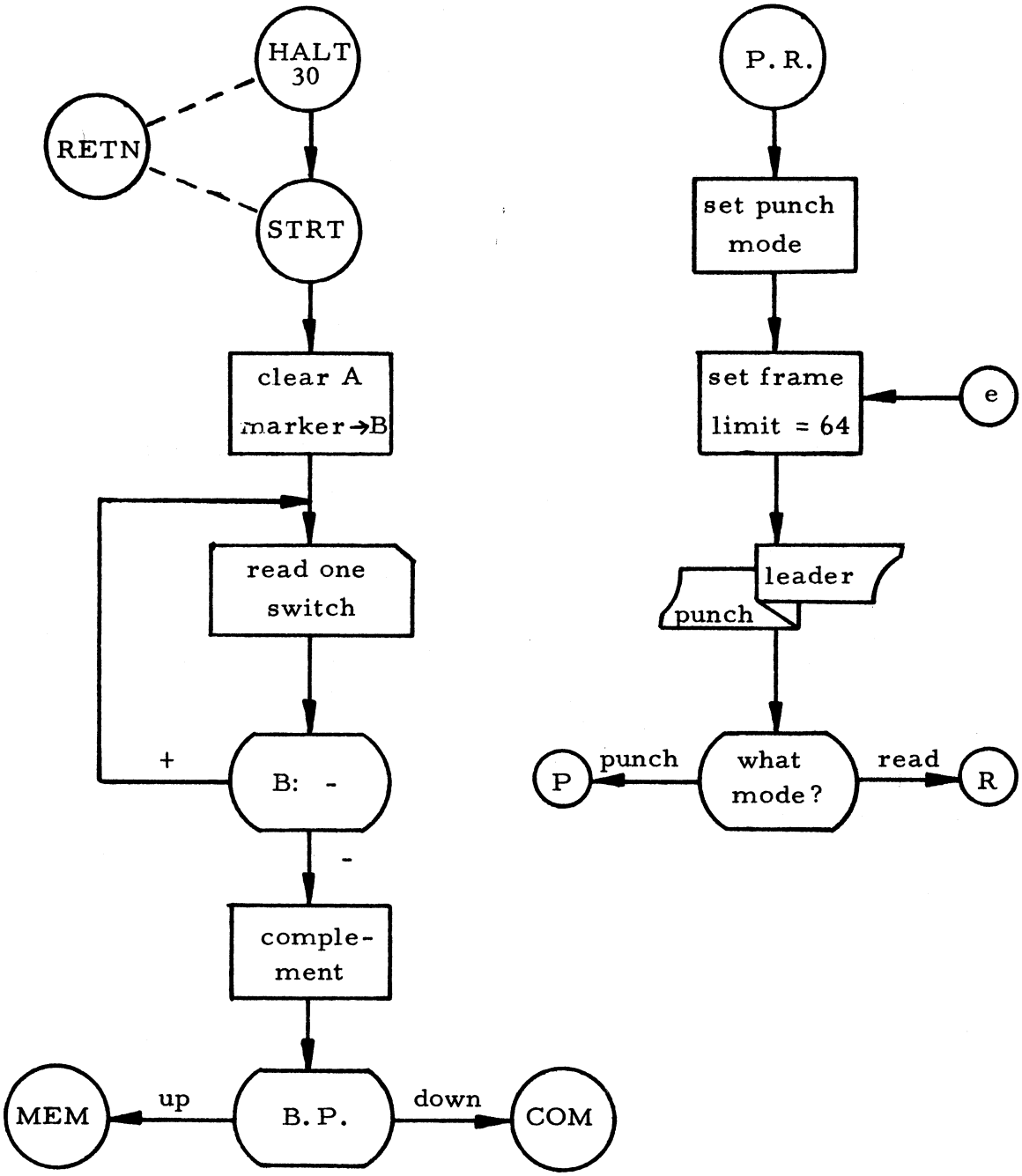
COMMAND BLOCK NUMBERS

Block Number	Commands Checked
01	IAC, IBC, ROT
02	LDC, CLA, ADD, SUB
03	MUP, DIV
04	MAC, AMC, EXF, AOC
05	LDP, STD, DPA, DPS, TOF
06	TAN, TBN, TCN, TRU, CLB
07	LDB, STB, EBP, IAM
10	LDA, CLC, STC, NAD, SAI
11	RSI, CAM
12	MLX, LST
13	RFU, DIU, TES (36)
14	LRS, GTB
15	NOP
16	SBR, LSD
17	BSI, STA
20	SQR

Flow Diagram

PROBE I

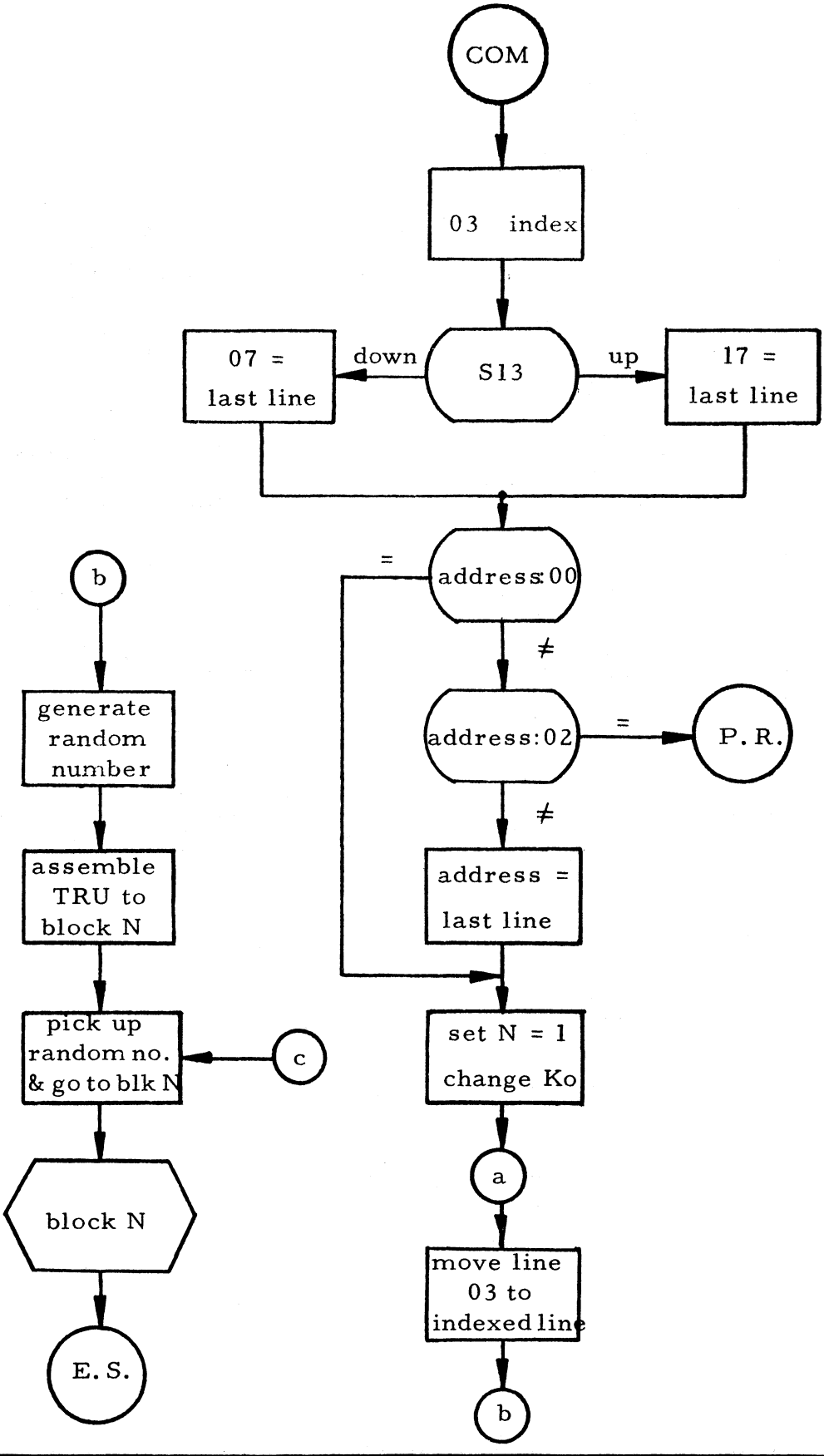
Catalog Number 9003



Flow Diagram

PROBE I

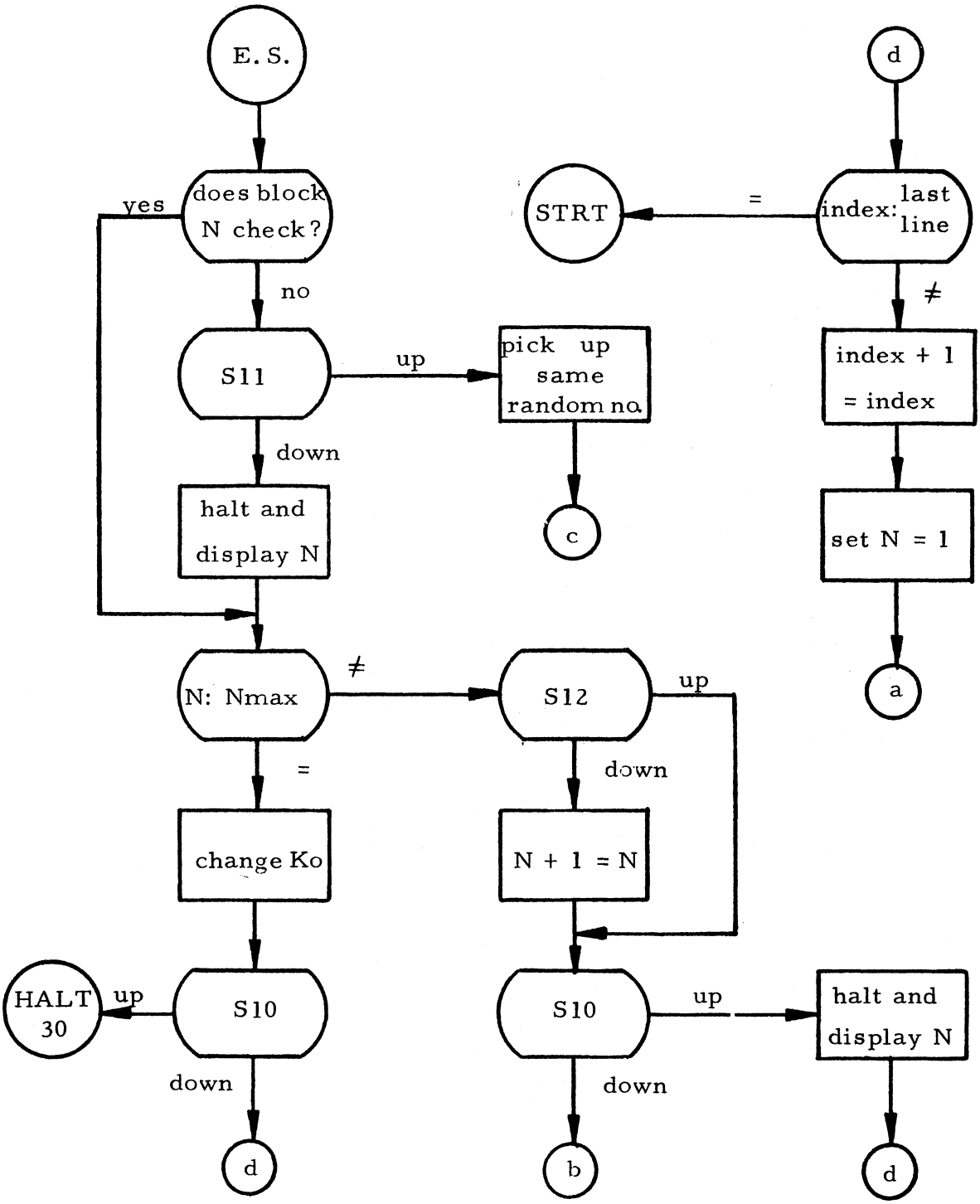
Catalog Number 9003



Flow Diagram

PROBE I

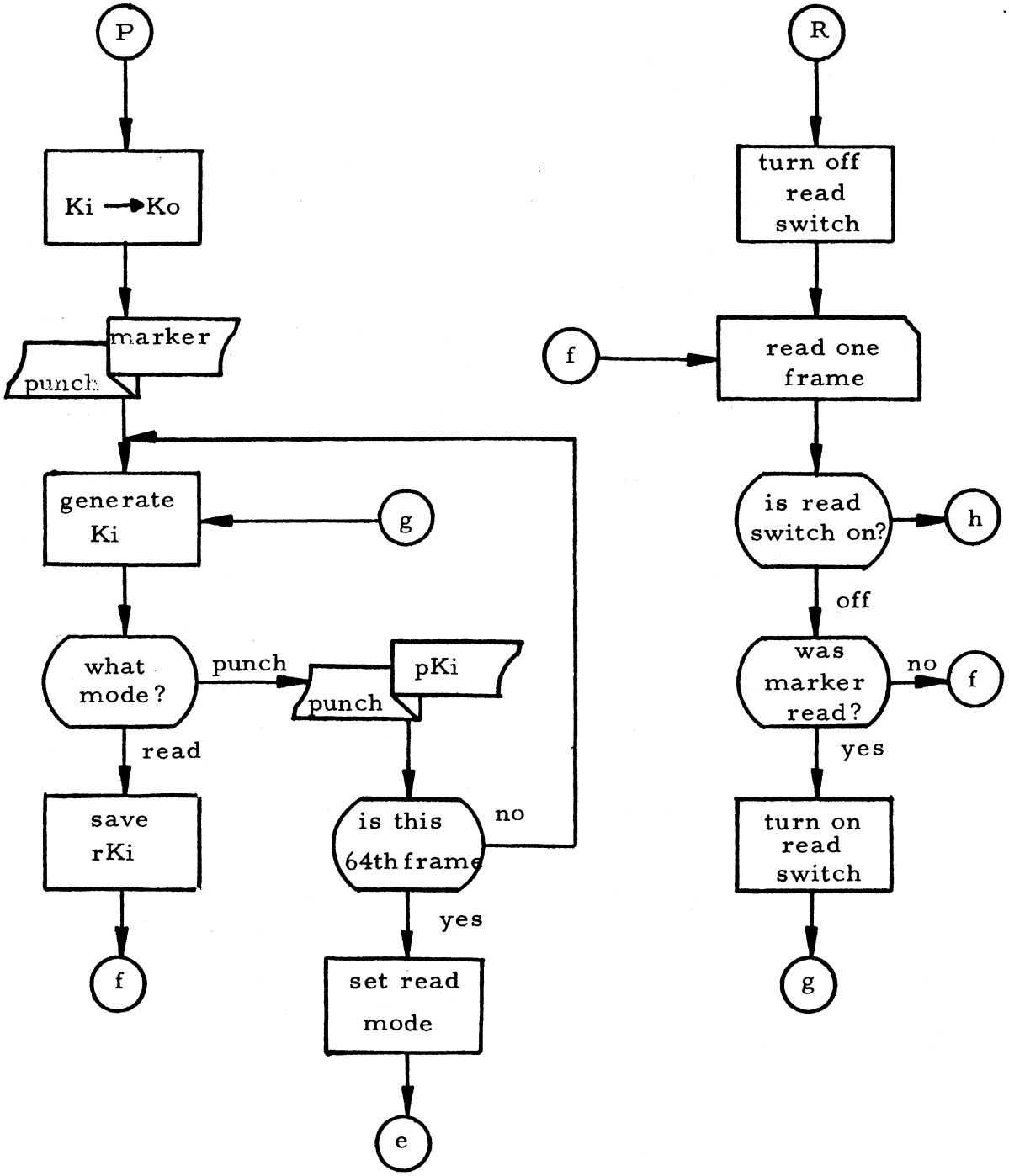
Catalog Number 9003



Flow Diagram

PROBE I

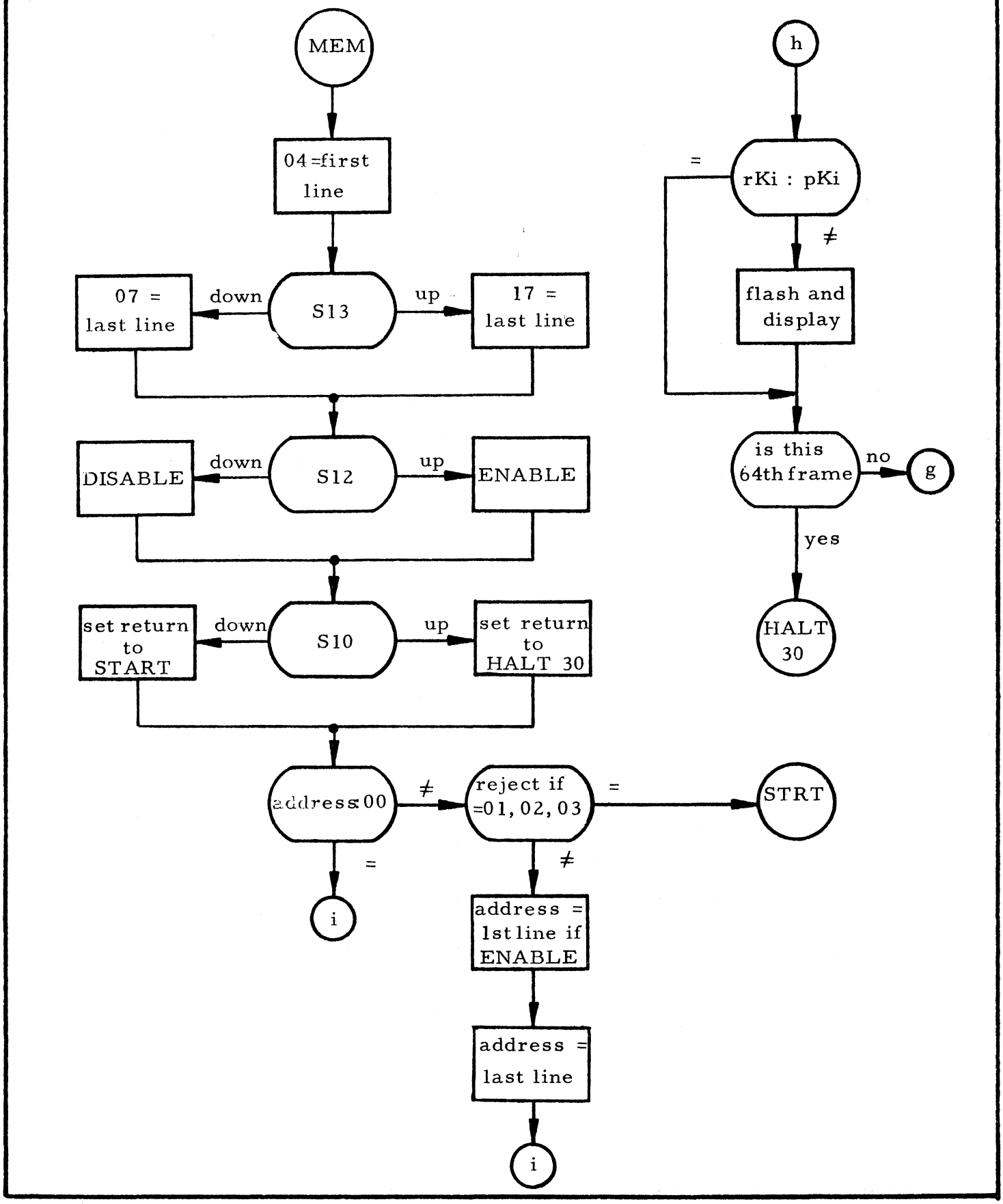
Catalog Number 9003



Flow Diagram

PROBE I

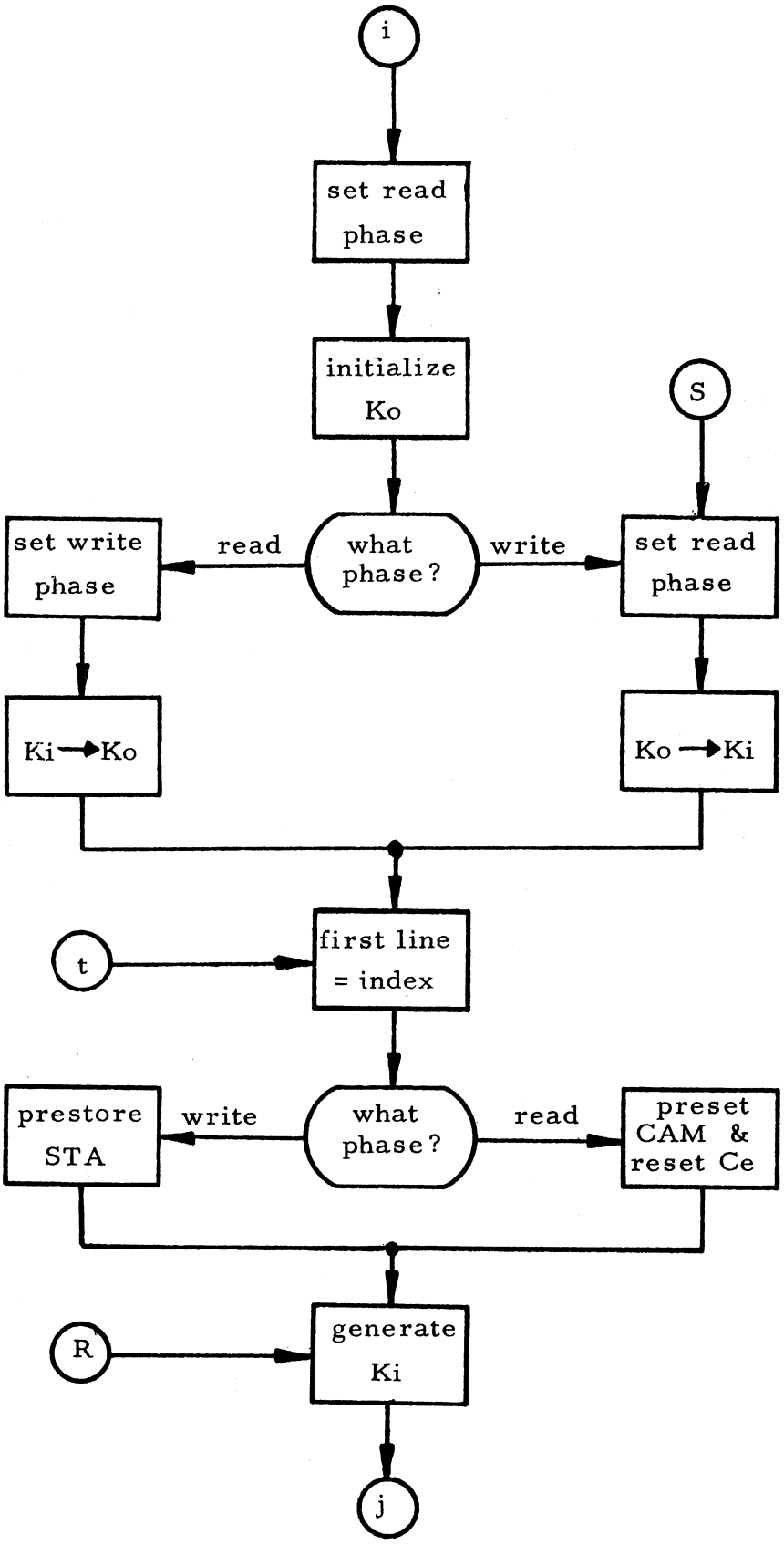
Catalog Number 9003



Flow Diagram

PROBE I

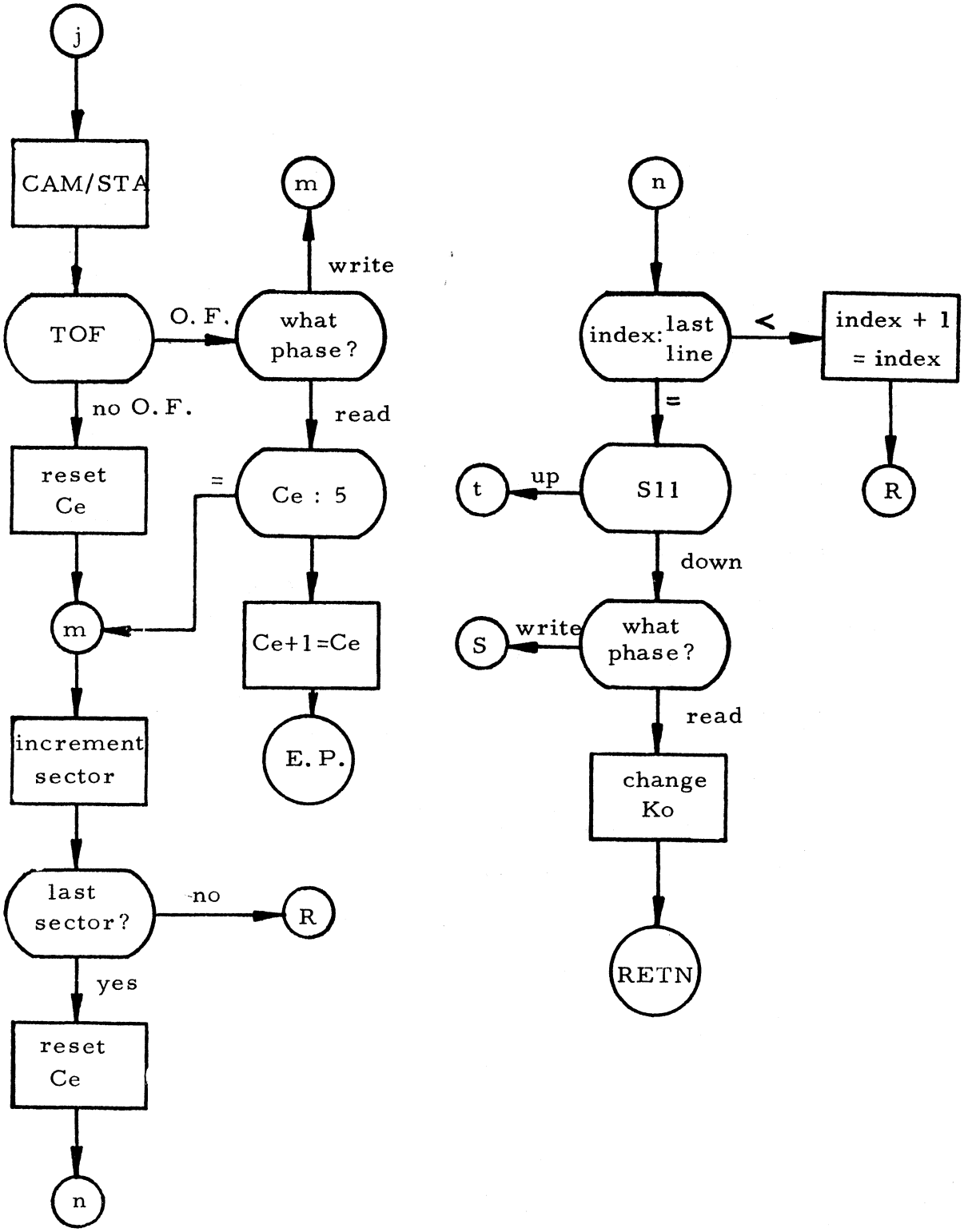
Catalog Number 9003



Flow Diagram

PROBE I

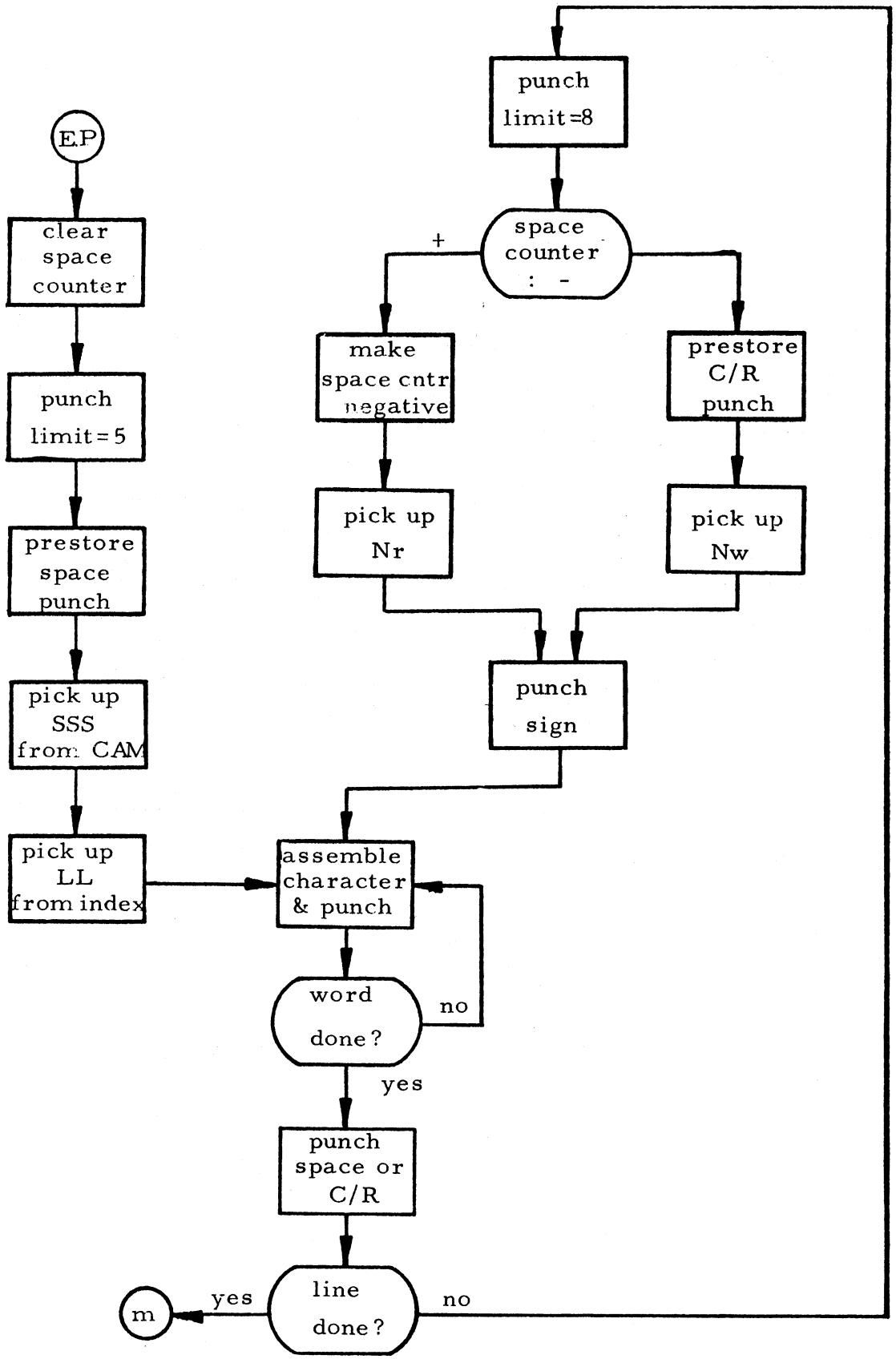
Catalog Number 9003



Flow Diagram

PROBE I

Catalog Number 9003 Sheet 8 of 8



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PB 250 PROGRAM LISTING

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PROGRAMMER W. S. LaSor DATE

LOCATION	INSTRUCTION	SYMBOLIC OP CODE	REMARKS
000	000 0030;	HLT	= Start of program
001	002S0702;	LDP	
002	000S0000;	CONST	Clear A and put marker bit in B
003	000 0000;	CONST	
004	020S7100;	MCL	Initialize
005	050 7710;	TES	
006	047S1400;	ADD	Add 1 if switch lowered
007	000 00001	CONST	
010	052 2110;	LST	1
011	047 3602;	TBN	Exit if B negative
012	112S0100;	IAC	
013	125 0500;	LDA	
014	135S1400;	ADD	Increment line
015	000 0001;	CONST	
016	145 1100;	STA	
017	044S0100;	IAC	Return to next switch
020	045S3700;	TRU	Read switches
021			
022	023S0402;	LDC	Begin memory mode
023	000 0002;	CONST	
024	015 1000;	STC	Set first line = 04
025	034 2210;	RST	6
026	032 3602;	TBN	Switch 13
027	030S0402;	LDC	
030	000 0043;	CONST	$\overline{S13}$; last line = 07
031	034S1000;	STC	
032	033S0402;	LDC	
033	000 0047;	CONST	S13; last line = 17
034	014 1000;	STC	
035	037 2200;	RSI	1

LOCATION	INSTRUCTION	SYMBOLIC OP CODE	REMARKS
036	042 3602;	TBN	Switch 12
037	040S0402;	LDC	
040	076 3502;	TAN	$\overline{S12}$; Disable setting of last line
041	044S3702;	TRU	
042	043S0402;	LDC	
043	015 1100;	STA	S12; Enable setting of last line
044	075 1002;	STC	
045	050 2210;	RST	2
046	056S3702;	TRU	
047	000 1100;	STA	Save scanned word
050	051S0502;	LDA	
051	000 0377;	CONST	Take one's complement
052	000 1500;	SUB	
053	100 7735;	TES	B.P.
054	022S3702;	TRU	
055			
056	062 3602;	TBN	Switch 10
057	060S0402;	LDC	
060	001S3702;	TRU	$\overline{S10}$; Set return for no halt
061	064S3702;	TRU	
062	063S0402;	LDC	
063	000S3702;	TRU	S10; Set return for halt
064	264 1003;	STC	
065	072 2110;	LST	4
066	000 4500;	CLA	
067	075 2110;	LST	Save address only
070	003 5602;	CAM	If address = 0000, exit
071	077 7502;	TOF	to Write-Read II
072	023 1502;	SUB	Subtract 4,
073	001 3502;	TAN	If negative, return to rescan

LOCATION	INSTRUCTION	SYMBOLIC OP CODE	REMARKS
074	023 1402;	ADD	Not negative, restore address
075	015 1100;	STA TAN	Address = first line if S12
076	014 1100;	STA	Address = last line
077	124S4400;	CLC	Set read mode and exit
100	101S0402;	LDC	Begin command mode
101	000 0041;	CONST	Set index = 03
102	103 1037;	STC	
103	104S4002;	EBP	For switch 13
104	377S7720;	CONST	
105	110 3502;	TAN	
106	030 0402;	LDC	$\overline{S13}$; set last line = 07
107	111S3702;	TRU	
110	033 0402;	LDC	S13; set last line = 17
111	012 1000;	STC	
112	000 0100;	IAC	Extract off address
113	033 4202;	AMC	
114	000 0300;	ROT	
115	003 5602;	CAM	Exit if address = 0000
116	372 7503;	TOF	
117	120S5602;	CAM	Exit to punch-read if address = 0010
120	000 0001;	CONST	
121	265 7503;	TOF	
122	123 1137;	STA	Otherwise address to index
123	012 1100;	STA	And last line
124	372S3703;	TRU	Exit to command mode
125	160 1002;	STC	Store phase constant
126	127S0502;	LDA	Prestore first random number
127	047 2646;	CONST	
130	004 1100;	STA	
131	005 1100;	STA	

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PROGRAMMER W. S. LaSor DATE

LOCATION	INSTRUCTION	SYMBOLIC OP CODE	REMARKS
132	141 3402;	TCN	Test phase constant
133	135 2100;	LSD	Was read, set write
134	160 1002;	STC	
135	005 0500;	LDA	Ki ⟶ Ko
136	004 1100;	STA	
137	155 0600;	LDB	First line to index
140	143S1237;	STB	
141	143 2200;	RSI	Was write, set read
142	160 1002;	STC	
143	171S3702;	TRU	
144	152 3402;	TCN	Test phase constant
145	146S0702;	LDP	= read
146	000 0000;	CONST	Reset error counter (Ce) and prestore CAM
147	200 56001	CAM	
150	007 1200;	STB	
151	154S3702;	TRU	
152	153S0502;	LDA	Prestore STA
153	200 11001	STA	
154	156 1102;	STA	
155	164S7100;	MCL	Put store-check sequence in line 00
156	200 11001	CAM STA	Store and check sequence
157	240S0400;	LDC	
160	377S77771	CONST	
161	244 7502;	TOF	
162	250 3402;	TCN	
163	266S3702;	TRU	
164	165S0600;	LDB	With Ki
165	355S65671	CONST	
166	167S0402;	LDC	
167	046 22331	CONST	= +2304555

LOCATION	INSTRUCTION	SYMBOLIC OP CODE	REMARKS
170	220S3200;	MUP	Generate Ki + 1
171	004 0500;	LDA	
172	005 1100;	STA	Ko → Ki
173	137S3702;	TRU	
174	007 1000;	STC	(From 276) Ce + 1 = Ce
175	176S1102;	STA	Save Nr = read phase number
176		CONST	
177	016 0500;	LDA	
200	201S1502;	SUB	Prepare to pick up
201	000 5100;	CONST	Nw = write phase number
202	203 1102;	STA	
203	204 0500;	LDA	Pick up Nw
204	165 1102;	STA	
205	016 0600;	LDB	With CAM in check sequence
206	000 4500;	CLA	
207	221 2110;	LST	
210	000 0100;	IAC	Save SSS in C
211	212 0637;	LDB	With index for LL
212	233 2110;	LST	16
213	000 0100;	IAC	Merge with SSS
214	227 2210;	RST	10
215	006 1200;	STB	Save for punch out
216	376 0706;	LDP	Save 37606 and 37706
217	220S4400;	CLC	
220	225S1200;	STB	Save B for next random number
221	010 1300;	STD	
222	012 1000;	STC	To reset space counter
223	306 0702;	LDP	Set space punch mode and
224	263 1302;	STD	limit = 5
225	226S0600;	LDB	

LOCATION	INSTRUCTION	SYMBOLIC OP CODE	REMARKS
226	236S3700;	TRU	Exit to store-check sequence
227	000 4500;	CLA	
230	234 2110;	LST	3, to extract one digit
231	006 1200;	STB	Save rest for later punching
232	000 4300;	CLB	
233	000 4400;	CLC	Copy digit to C
234	235 0000;	MAC	
235	003 5602;	CAM	Is digit = 0?
236	000 4100;	GTB	To check parity
237	000 0100;	IAC	Return original digit to A
240	243 3402;	TCN	Parity odd or even?
241	245 1402;	ADD	Was even, add 1 At 17
242	241 7502;	TOF	Digit was zero, add again
243	251S1402;	ADD	Add into WOC
244	245S4500;	CLA	No error, reset Ce
245	000 0004;	CONST	= 1 at 17
246	247S1100;	STA	In Ce
247	313S3702;	TRU	Punch return
250	256S0500;	LDA	With CAM/STA
251	000 1400;	CONST	WOC skeleton and delay number
252	277 2210;	RST	Put command in B
253	247 0502;	LDA	With punch return
254	376 1306;	STD	To line 06 for punch-out
255	251 0402;	LDC	
256	376S3706;	TRU	
257	260S1402;	ADD	Increment sector
260	001 0000;	CONST	
261	276S1100;	STA	
262	000 6116;	WOC	Carriage return
263	000 0000;	CONST	For punch limit

LOCATION	INSTRUCTION	SYMBOLIC OP CODE	REMARKS
264	000 6116;	WOC	Space or carriage return
265	321S3702;	TRU	Return
266	267S0400;	LDC	With Ce
267	377S77361	CONST	Limit = 8
270	271S0100;	IAC	Save A in C
271	010 0000;	CONST	N = 1, for command mode
272	273S5602;	CAM	
273	000 0042;	CONST	If Ce = 5, no further punching
274	250 7502;	TOF	
275	337 1402;	ADD	Ce ≠ 5, exit to
276	173S0100;	IAC	punch-out sequence
277	301 7502;	TOF	(From 261) overflow if last sector
300	165S0600;	LDB	Not last sector, return to begin
301	302S4500;	CLA	To reset Ce
302	303S1137;	STA	(From 377) restore index
303	304S0437;	LDC	With index
304	004S37001	TRU	Return to begin of command mode
305	307S1100;	STA	In Ce
306	377S77761	CONST	Limit = 5,
307	000 6020;	WOC	Space punch
310	311S4202;	AMC	Extract off line number
311	000 0047;	CONST	From index register
312	331S0300;	ROT	
313	263 0402;	LDC	
314	316 2200;	RSI	Increment digit counter
315	263 1002;	STC	
316	225 3402;	TCN	Return to punch if not through
317	264 0702;	LDP	Word done; punch space or
320	254S3702;	TRU	carriage return and go to 321
321	264 0502;	LDA	With termination character

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PROGRAMMER W. S. LaSor DATE

LOCATION	INSTRUCTION	SYMBOLIC OP CODE	REMARKS
322	262 5602;	CAM	If carriage return, line done
323	360 7502;	TOF	
324	267 0602;	LDB	Line not done, set punch
325	263 1202;	STB	Limit = 8
326	012 0500;	LDA	Test space counter
327	365 3502;	TAN	
330	267 1402;	ADD	Space counter +; make -
331	012 1100;	STA	
332	341S3702;	TRU	
333	334S5600;	CAM	(From 312) compare index with last line
334			
335	357 7502;	TOF	
336	337S1402;	ADD	Not last line, increment index and return to begin
337	000 0040;	CONST	
340	163S1137;	STA	
341	165 0602;	LDB	Since space counter +, Pick up Nw
342	165 0402;	LDC	
343	345 2110;	LST	Extract sign
344	006 1200;	STB	
345	352 3402;	TCN	Check sign of Nw/Nr
346	347S0702;	LDP	Sign positive, punch +
347	000 6036;	[WOC]	
350	225S3702;	[TRU]	
351	254S3702;	TRU	
352	353S0702;	LDP	Sign negative, punch -
353	000 6037;	[WOC]	
354	225S3702;	[TRU]	
355	254S3702;	TRU	
356			
357	360S0400;	LDC	Pick up phase constant

LOCATION	INSTRUCTION	SYMBOLIC OP CODE	REMARKS
360	370S0700;	LDP	(From 323) restore 37606 & 37706
361	137 7711;	TES	Stay in write phase & return if S11
362	363S3702;	TRU	Proceed if $\overline{S11}$
363	141 3402;	TCN	Test phase constant
364	262S3703;	TRU	Exit from memory mode
365	262 0502;	LDA	(From 327) space counter
366	264 1102;	STA	-, prestore C/R punch
367	176 0602;	LDB	
370	176 0402;	LDC	Pick up Nr
371	343S3702;	TRU	
372	376 1306;	STD	Restore 37606 & 37706
373	250S3702;	TRU	
374	011 0500;	LDA	(Command mode) pick up N
375	016 2210;	RST	
376	000 2537;	IAM	N → index, save index
377	302S00001	HLT	Halt & display N

LOCATION	INSTRUCTION	SYMBOLIC OP CODE	REMARKS
00003$	000S3702;	TRU	Return to beginning
001	011 1100;	STA	(From 37303) set first block (N = 1)
002	127 0502;	LDA	Prestore first random number
003	006 1100;	STA	
004	005S71001	MCL	Move test to indexed line and transfer there
005	006S37001	TRU	
006	167 0602;	LDB	Generate random number
007	006 0400;	LDC	
010	040 3200;	MUP	
011	006 1200;	STB	
012	010 1100;	STA	
013	011 0500;	LDA	Assemble jump command for transferring to block N
014	15S14001	ADD	
015	051S37001	TRU	
016	020 11001	STA	
017	010 0500;	LDA	Pick up random number
020	251S37001	TRU	Transfer to block N
021	010 5600;	CAM	Transfer to 032 ERROR SEQUENCE if no error
022	032 75001	TOF	
023	017 7711;	TES	Switch 11: repeat if error; halt & display N if error
024	025S37001	TRU	
025	011 0500;	LDA	Pick up block number
026	047 2210;	RST	
027	031 2537;	IAM	Save index
030	000 00001	HLT	Halt and display N
031	033 2537;	IAM	Restore index
032	011 0500;	LDA	Pick up N
033	034S56001	CAM	Test for maximum N
034	200 0000;	CONST	
035	254 75001	TOF	Transfer to 254 if through

LOCATION	INSTRUCTION	SYMBOLIC OP CODE	REMARKS
036	041 7712;	TES	S12: Do not increment N
037	271 1402;	ADD	$\overline{S12}$: Increment N
040	011 1100;	STA	
041	043 7710;	TES	S10: Halt and display N
042	004S3703;	TRU	$\overline{S10}$: Continue in Sequence
043	374S3702;	TRU	
044	045 0437;	LDC	Pick up index
045	033 4202;	AMC	Extract off line number
046	000 0300;	ROT	
047	012 5600;	CAM	Is this last line?
050	001 7502;	TOF	Transfer to 00102 if last line
051	337 1402;	ADD	Not last line; increment index
052	053 1137;	STA	
053	271 0502;	LDA	Set N = 1
054	011 1100;	STA	
055	041S3703;	TRU	Return to test S10
056	060 7710;	TES	(From 256LL)
057	044S3700l	TRU	Halt and display N if S10
060	056S0030;	HLT	

LOCATION	INSTRUCTION	SYMBOLIC OP CODE	REMARKS
254	006 0500;	LDA	(From 035LL) Change original random number
255	127 1102;	STA	
256	056S37001	TRU	
257	253S6000;	WOC	(From 371LL) Flash light and display Input character
260	174 0402;	LDC	
261	256S5100;	RTK	
262	005 0500;	LDA	Change random number and return to scan switches
263	127 1102;	STA	
264	000S3702;	TRU	
265	127 0502;	LDA	Begin punch-read: initialize First random number
266	007 1100;	STA	
267	000 4500;	CLA	Set punch phase
270	010 1100;	STA	
271	104 0602;	LDB	Set limit = 64
272	006 1200;	STB	
273	274S0703;	LDP	To punch leader
274	000 6000;	[WOC]	
275	301S3703;	[TRU]	
276	074 0402;	LDC	With large delay number
277	376 1306;	STD	
300	376S3706;	TRU	Punch 5 inches of leader
301	010 0400;	LDC	Transfer to 31303 if read phase
302	313 3403;	TCN	
303	007 0500;	LDA	Pick up first random number
304	011 1100;	STA	
305	306S0703;	LDP	Punch 8-channel marker and go to 33603
306	000 6737;	[WOC]	
307	336S3703;	[TRU]	
310	311S0403;	LDC	Delay = +0004000
311	000 2000;	CONST	

LOCATION	INSTRUCTION	SYMBOLIC OP CODE	REMARKS
312	277S3703;	TRU	
313	011 0500;	LDA	Initiate read phase
314	007 1100;	STA	
315	316S0503;	LDA	Turn read switch off
316	327S5503;	[LAI]	(To remain off until marker is read)
317	321 1103;	STA	
320	322S4500;	CLA	Enter read sequence
321	364S5503;	LAI	
322	320S5200;	RPT	
323	324 5200;	RPT	Read one frame
324	323 7736;	TES	
325	322 7736;	TES	
326	324S5700;	CIB	
327	000 01771	CONST	LAI mask
330	327 5603;	CAM	Transfer to 33303 when
331	333 7503;	TOF	marker frame is read
332	322S4500;	CLA	Return to read sequence
333	334S0503;	LDA	Marker has been read;
334	364S5503;	[LAI]	Turn read switch on
335	321 1103;	STA	
336	007 0600;	LDB	
337	167 0402;	LDC	Generate next random digit
340	370 3200;	MUP	
341	007 1200;	STB	Save LSH for next number
342	000 0100;	IAC	Extract off eight bits
343	327 4203;	AMC	
344	010 0400;	LDC	Transfer to 36203 if read phase
345	362 3403;	TCN	
346	375 2110;	LST	Assemble into WOC command
347	251 1402;	ADD	

LOCATION	INSTRUCTION	SYMBOLIC OP CODE	REMARKS
350	375 2210;	RST	
351	352S0503;	LDA	Set return address
352	355S3703;	TRU	
353	251 0402;	LDC	With delay
354	277S3703;	TRU	Out to punch digit
355	006 0500;	LDA	Return from digit punchout
356	007 1402;	ADD	
357	006 1100;	STA	Increment frame counter
360	336 3503;	TAN	Return to 33603 if not done
361	270S1000;	STC	Through; restore counter
362	012 1200;	STB	(From 34405) Save random
363	322S4500;	CLA	digit and return to read
364	000 01771	CONST	LAI mask
365	012 5600;	CAM	Enter here after marker frame
366	374 7503;	TOF	read; go to 37403 if no error
367	372 2110;	LST	
370	250 1403;	ADD	Error: assemble input character into WOC command & go to 26003
371	257S1103;	STA	
372	271 0502;	LDA	(From 12402) pick up N = 1
373	001S3703;	TRU	Go to beginning of command mode
374	006 0500;	LDA	Pick up frame counter
375	007 1402;	ADD	Increment
376	006 1100;	STA	Restore counter
377	336 3503;	TAN	Return if not last frame

LOCATION	INSTRUCTION	SYMBOLIC OP CODE	REMARKS
06103	062S0100;	IAC	BLOCK 01
063	064S0200;	IBC	
065	017S0300;	ROT	
07103	010 0400;	LDC	BLOCK 02 Put number in C
072	073S4500;	CLA	Zeros to C
074	075S0100;	IAC	Number to A
076	023 34001	TCN	If C negative, error
077	020 14001	ADD	Test ADD and SUB
100	020S15001	SUB	
10103	074S0100;	IAC	BLOCK 03
075	102S42001	AMC	Number to C, copy to B
102	-7777777	CONST	
103	132 3200;	MUP	Check MUP, DIV
104	133 3100;	DIV	
105	107 36001	TBN	If negative, correct quotient
106	017S0300;	ROT	Return to check
107	030 16001	DPA	DIV correction
110	017S0300;	ROT	Return to check
030	+0000001	CONST	
11103	000 4400;	CLC	BLOCK 04
112	113 0000;	MAC	Copy number to C
113	114S42001	AMC	Copy number to B
114	-7776000	CONST	
115	000 0200;	IBC	
116	114 47001	EXF	Check AMC, EXF, AOC
117	114 46001	AOC	
120	017S0300;	ROT	Return to check

LOCATION	INSTRUCTION	SYMBOLIC OP CODE	REMARKS
12103	114 06001	LDB	Negative number to B — BLOCK 05
122	124 36001	TBN	
123	023S37001	TRU	If TBN fails, error
124	017 16001	DPA	Check DPA, STD
125	000 1300;	STD	
126	061S4500;	CLA	
062	063S4300;	CLB	
064	066S56001	CAM	Check for zero after CLA
066	+0000000	CONST	
067	127 75001	TOF	
070	023S37001	TRU	Error if TOF fails
127	000 0700;	LDP	Check LDP, DPS
130	017S17001	DPS	
13103	072S4300;	CLB	Zero to C — BLOCK 06
073	131S0200;	IBC	
132	133 0000;	MAC	Copy A to C
133	102 42001	AMC	Copy C to B
134	157 35001	TAN	If A positive then
135	023 36001	TBN	B and C must be also
136	023 34001	TCN	If not, error
137	032S37001	TRU	Continue to next block
157	167 36001	TBN	A was negative, B must
160	023S37001	TRU	be or else error
167	032 34001	TCN	A and B negative, C must
170	023S37001	TRU	be or else error

LOCATION	INSTRUCTION	SYMBOLIC OP CODE	REMARKS
14103	127 06001	LDB	With 7 at 14 — BLOCK 07
142	004 1200;	STB	Save in F04
143	145 2500;	IAM	Interchange random number & F04
144	114 40001	EBP	Extend bit 12 to sign bit
145	147 35001	TAN	A must now be negative,
146	023S37001	TRU	other wise error
147	004 0500;	LDA	Pick up original number
150	021S37001	TRU	and return to check
15103	000 4400;	CLC	BLOCK 10 — Set C = 0
152	226 2000;	NAD	Normalize then rescale
153	227 2300;	SAI	(C) should = 0
154	000 0100;	IAC	Number to C, then to F00
155	000 1000;	STC	
156	020S0500;	LDA	Pick up number & return to check
16103	000 4400;	CLC	BLOCK 11 — Set C = 0
162	203 2200;	RSI	Right shift 16 places
163	000 0100;	IAC	(C) should now be +0000020
164	245 5602;	CAM	Check to see if it is
165	032 75001	TOF	
166	023S37001	TRU	To error sequence
24502	+0000020	CONST	
20103	000 5300;	RFU	BLOCK 13 — sRf, sTf
202	023 7736;	TES	Should not transfer
203	000 5000;	DIU	rRf, rTf
204	032 7736;	TES	Should now transfer

LOCATION	INSTRUCTION	SYMBOLIC OP CODE	REMARKS
17103	177S26001	MLX	BLOCK 12
177	172S3707;	TRU	Move block to 07
172	010 0400;	LDC	With random number
173	245 0602;	LDB	With 1 at 17
174	223 3200;	MUP	Should shift right 17 places
175	217 2110;	LST	Back 17 places
176	021S37001	TRU	Out to check
21103	200 05001	LDA	BLOCK 14
200	+0222222	CONST	Constant to A
212	215 3320;	LRS	Parity is even therefore
213	023 35001	TAN	A should be positive
214	000 4100;	GTB	
215	216S56001	CAM	Check GTB
216	-7707070	CONST	
217	022S37001	TRU	
22103	140S2400;	NOP	BLOCK 15
140	220S2400;	NOP	Check NOP and Oc
220	021S2400;	NOP	
23103	221S4400;	CLC	BLOCK 16
222	226 3300;	SBR	Set C = 0
223	066 56001	CAM	Should clear A
224	226 75001	TOF	Check for A = 0
225	023S37001	TRU	A not equal to zero; error
226	233 2100;	LSD	See if C decrements; since
227	032 34001	TCN	C was zero, should now be neg.
230	023S37001	TRU	Error exit if C not negative
066	+0000000	CONST	

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LOCATION	INSTRUCTION	SYMBOLIC OP CODE	REMARKS
24103	245 11001	STA	Put number in 245 — BLOCK 17
242	102 04001	LDC	Put all 1's in F05
243	005 1000;	STC	
244	246S7300;	BSI	If no external buffer, 245 → F05
245	+0000000	CONST	BSI mask
246	005 0500;	LDA	Pick up BSI'ed word
247	021S37001	TRU	Out to error cheçk
102	-7777777	CONST	
25103	032 35001	TAN	Reject if number neg. — BLOCK 20
252	204S0100;	IAC	
205	010 0600;	LDB	Square number
206	235 3200;	MUP	
207	235 3000;	SQR	Take square root
210	230S1700;	DPS	Subtract original number
232	000 0300;	ROT	→A: difference should be no more than 2^{-21}
233	030 56001	CAM	Check for + 2^{-21}
234	032 75001	TOF	
235	066 56001	CAM	Check for zero
236	032 75001	TOF	
237	102 56001	CAM	Check for - 2^{-21}
240	022S37001	TRU	