

IDENTIFICATION: PRIME FACTOR SEARCH
Demonstration Routine

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ACCEPTED: 1 June 1961

PURPOSE: To determine the prime factors of a given integer and print these factors as an ascending product or, if no factors can be found, to indicate that the number is prime.

RESTRICTIONS: 1. All numbers entered must be positive integers.
2. No number may exceed 2,097,151.

STORAGE: All sectors of one long line are used by the program except 311, 315, 343, 344, 346, 347, 351-367, and 371-377. In addition, fast line channels F04, F05, and F07 are used for temporary storage.

TIMING: The program proceeds at a rate of one-thousand trial divisors per second. When a factor is found, printout is at Flexowriter speed of ten characters per second. The largest prime capable of being handled by this routine (2,097,143) requires approximately 650 milliseconds for completion.

USE: 1. Loading
The program is line relocatable and may be loaded into any long command line by means of the Octal Utility Package. To load, insert the tape in the reader and type LLF, where LL is the number of the line into which the program is to be loaded. Striking LL\$, will transfer to the beginning of the program.

2. Input
Numbers are entered through the keyboard and do not include a sign or decimal point. When the last digit has been entered, depress the TAB key and the routine

USE (cont.):

will print out the prime factors of the number just entered. If there are no prime factors, the word PRIME is printed instead. As soon as this is accomplished, the carriage returns and further operation is determined by the position of the BREAKPOINT switch.

With the BREAKPOINT switch raised, the carriage will return after printout is completed and keyboard control will be retained. This feature allows the operator to call for the factors of any number he desires.

With the BREAKPOINT lowered, the carriage will return after printout but control will not be transferred to the keyboard. Instead, the last number entered will be incremented by one, printed out, and its factors extracted and typed. The program will continue in this fashion until the BREAKPOINT switch is raised. In this mode, a table of prime factors may be generated starting with any number by typing that number and allowing the program to run continuously with the BREAKPOINT switch lowered.

METHOD:

Numbers are read in from the keyboard and converted to binary scaled at 21. When a TAB code is sensed, the program looks to see if the number entered is less than four. If it is, PRIME is printed out; if not, factors of two are extracted by inspecting for least significant zeros.

For each trailing zero, a 2 is printed and this process continues until no more trailing zeros are present. At this point, the remaining number is divided by all odd integers beginning at three, proceeding to five, seven, and so on. Whenever division produces a remainder of zero, the current value of the divisor is printed and the quotient becomes the new current dividend.

As soon as the value of the current divisor exceeds the value of the quotient after division, further division will be fruitless since the result will be less than one.

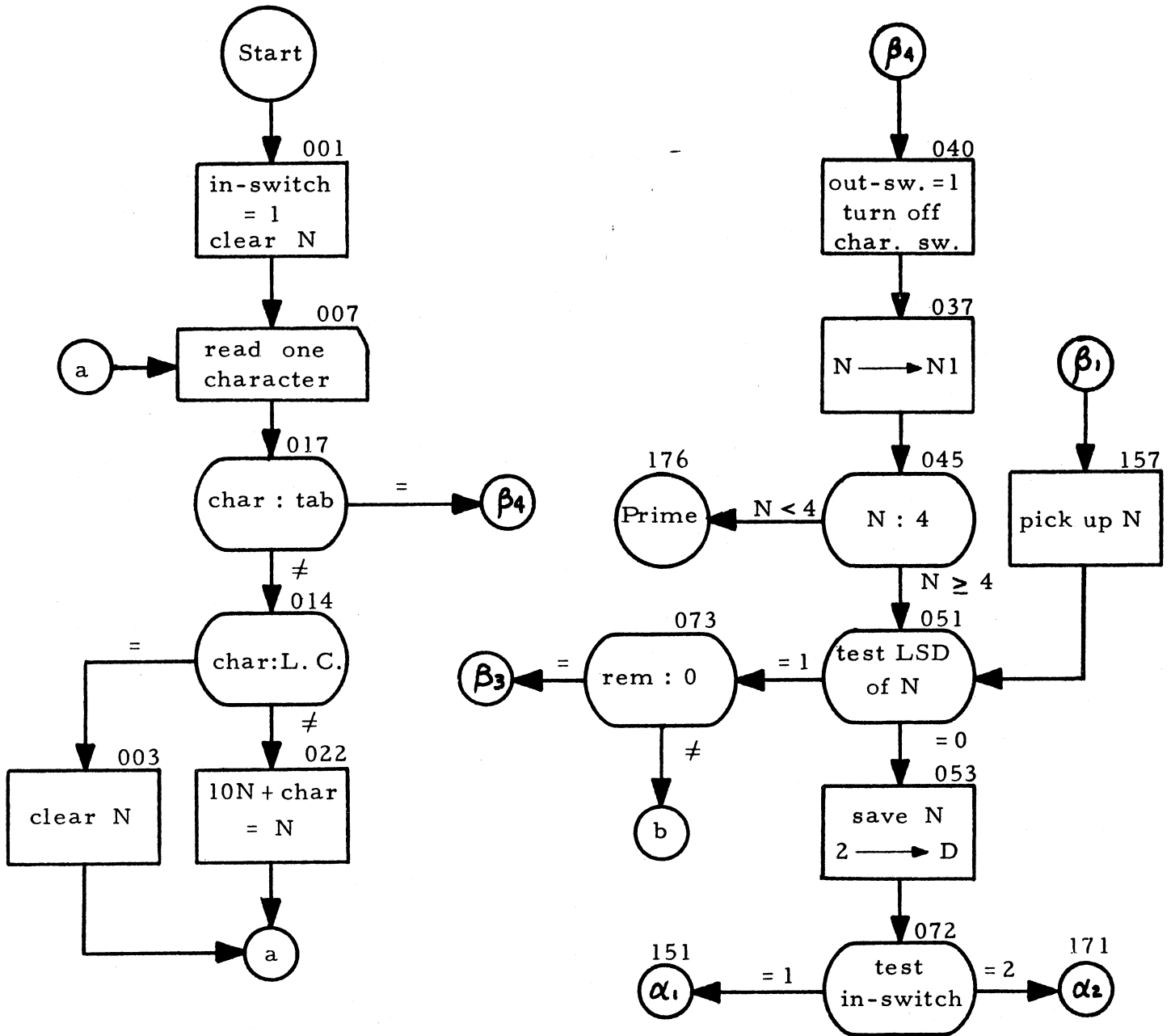
METHOD (cont.):

At this point, if no factors have been found, the number is prime and is so indicated. Otherwise, the last quotient found becomes the last factor unless its value is one. This factor will not be printed since it adds nothing to the result.

Flow Diagram
PRIME FACTOR SEARCH

Catalog Number 5001

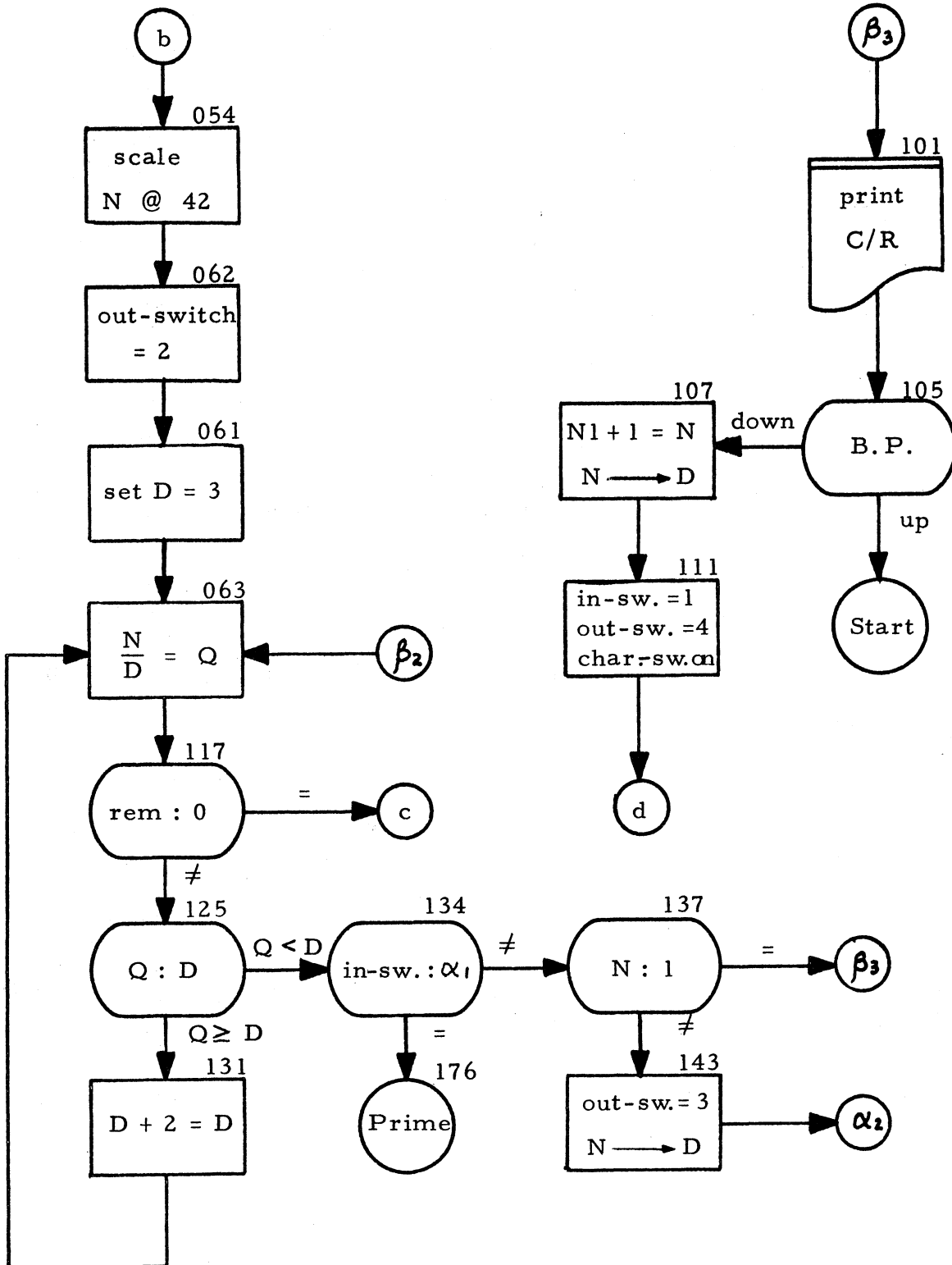
Sheet 1 of 3



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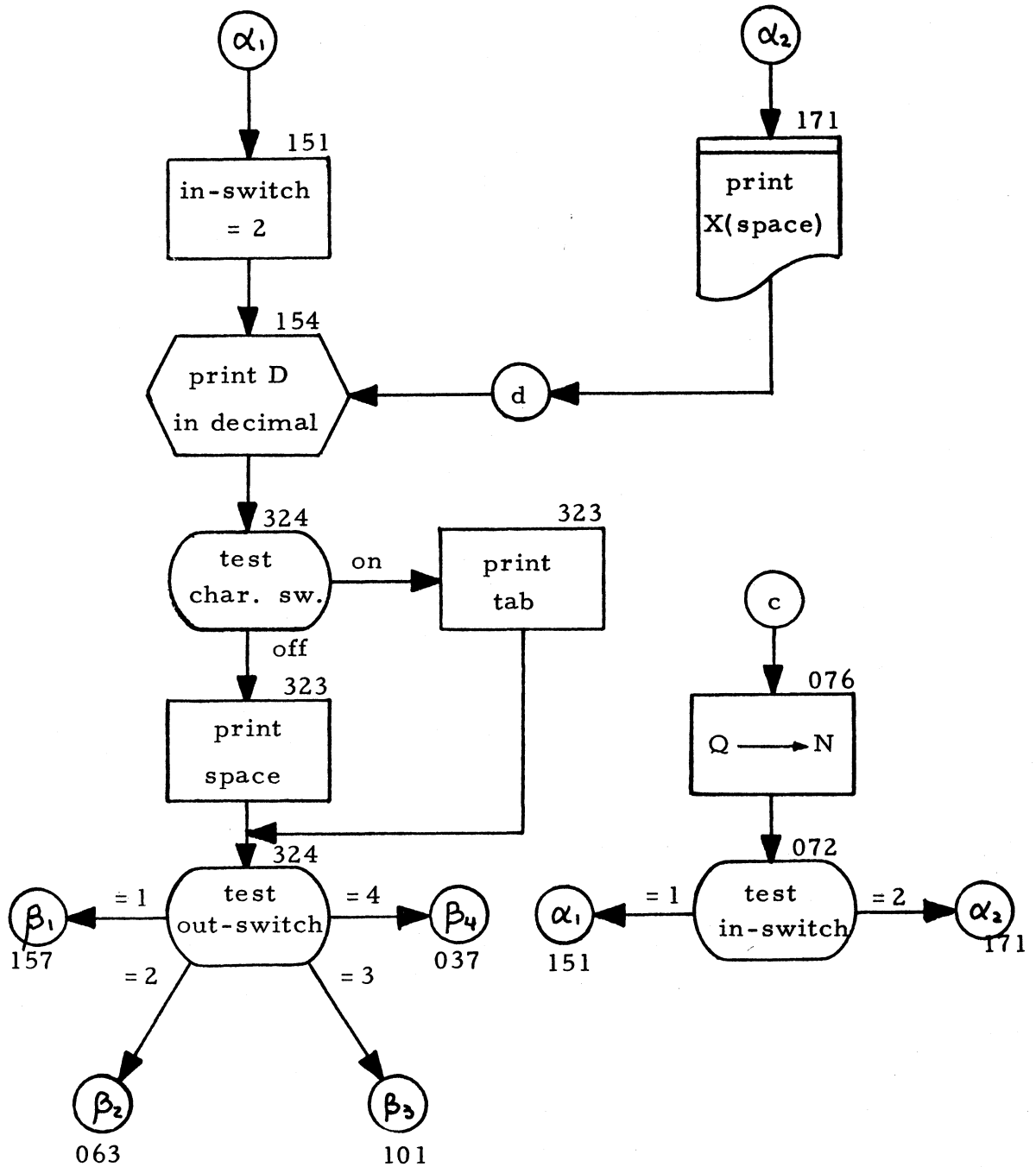
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LOCATION	INSTRUCTION	SYMBOLIC			REMARKS
		LOCATION	OP	ADDRESS	
000	001S0500I	START	LDA	⋄+1	Set in - switch = 1
001	151S3700I	J1	TRU	A1	
002	072 1100I		STA	A	
003	000 4300;	CLEAR	CLB		Clear N for input character
004	006S4500;	P2	CLA	P1	
005	013S5500I		LAI	MASK1	
006	004S5100;	P1	RTK	P2	Reject last character
007	010 5100;	P3	RTK		
010	007 7736;	P4	TES	36,P3	
011	006 7736		TES	36,P1	
012	010S5700;		CIB	P4	Wait for next character
013	+0000077	MASK1			
014	015S5600I		CAM	⋄+1	LAI mask
015	+0000074		OCT		
016	003 7500I		TOF	CLEAR	
017	020S5600I		CAM	⋄+1	Transfer to 003 if lower case
020	+0000076		OCT		
021	036 7500I		TOF	B4	
022	000 0300;		ROT		N → A, character → C
023	024S4200I		AMC	MASK2	
024	+0000017	MASK2			Extract parity bits and save
025	377 1200I		STB	T1	
026	000 0100;		IAC		
027	030S0600I		LDB	TEN	Compute 10 N
030	+5000000	TEN	DEC	10	
031	060 3200;		MUP	22	

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LOCATION	INSTRUCTION	SYMBOLIC			REMARKS
		LOCATION	OP	ADDRESS	
032	037 2110;		SI	4	To adjust scaling
033	377 14001		ADD	T1	Add character and save in B @ 21
034	063 2210;		SRT	22	
035	006S4500;		CLA	P1	
036	067 12001	B4	STB	N1	Save N → N1
037	040S07001	R10	LDP	\$+1	Pick up out-switch = 1 and character-switch off
040	157S37001		TRU	B1	
041	000 6020;		WOC	SPACE	
042	323 11001		STA	OUT	
043	324 12001		STB	B	Store in char-switch
044	067 05001		LDA	N1	
045	046S15001		SUB	\$+1	Compare N and 4
046	+0000004	FOUR	DEC	4	
047	176 35001		TAN	PRIME	If N < 4, print PRIME
050	046 14001		ADD	FOUR	
051	053 2210;	P10	SRT	1	Otherwise test LSD
052	073 36001		TBN	NEG	
053	070S1100;		STA	N2	LSD = 0, save in N2
071	132 04001		LDC	TWO	2 → D
132	+0000002	TWO	DEC	2	
072	XXXS37001	A	TRU	A1-A2	Transfer to α_1 / α_2
073	120 56001	NEG	CAM	ZERO	LSD = 1, compare remaining for zero
120	+0000000	ZERO	DEC	0	
074	101 75001		TOF	B3	Transfer to C/R print if zero
075	054S37001		TRU	P5	Otherwise scale N @ 42
054	101 2210;	P5	SRT	20	

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		LOCATION	OP	ADDRESS	
055	004 1300;		STD	N3	And save in N3
056	057S0700I		LDP	⋄+1	Pick up D = 3 and out-switch = 1
057	+0000003		DEC	3	
060	063S3700I		TRU	B2	
061	007 1200;		STB	D	
062	324 1100I		STA	B	Store in out-switch
063	064S0700;	B2	LDP	N3	Pick up N
066	067S0400;		LDC	D	Pick up D
070	117S3100;		DIV	22	and divide
117	120S5600I		CAM	⋄+1	Remainder = 0 ?
120	+0000000		DEC	0	
121	076 7500I		TOF	P6	
122	123S0300;		ROT		Remainder ≠ 0
125	127S1500;		SUB	D	Subtract D
130	134 3500I		TAN	THRU	and transfer to 134 if neg
131	132S0500I		LDA	⋄+1	Otherwise add 2 to D
132	+0000002		DEC	2	
133	147S1400;		ADD	D	
150	162S0100;		IAC		Save in C
163	164S0700;		LDP	N3	Pick up N
166	167S1000;		STC	D	Store new value of D
170	217S3100;		DIV	22	Repeat same sequence two more times in one line cycle for speed
217	220S5600I		CAM	⋄+1	
220	+0000000		DEC	0	
221	076 7500I		TOF	P6	
222	223S0300;		ROT		

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LOCATION	INSTRUCTION	SYMBOLIC			REMARKS
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225	227S1500;		SUB	D	
230	134 3500I		TAN	THRU	
231	232S0500I		LDA	\$+1	
232	+0000002		DEC	2	
233	247S1400;		ADD	D	
250	262S0100;		IAC		
263	264S0700;		LDP	N3	
266	267S1000;		STC	D	
270	317S3100;		DIV	22	
317	320S5600I		CAM	\$+1	
320	+0000000		DEC	0	
321	076 7500I		TOF	P6	
322	323S0300;		ROT		
325	327S1500;		SUB	D	
330	134 3500I		TAN	THRU	
331	332S0500I		LDA	\$+1	
332	+0000002		DEC	2	
333	347S1400;		ADD	D	
350	367S1100;		STA	D	
370	063S3700I		TRU	B2	
076	100 2110;	P6	SLT	1	
077	004 1200;		STB	N3	
100	072S3700I		TRU	A	
151	152S0500I	A1	LDA	\$+1	
152	171S3700I		TRU	A2	
153	072 1100I		STA	A	

Remainder = 0, prepare to print D
 Q → N
 Transfer to in-switch
 In-switch = 1; set in-switch
 = 2

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		LOCATION	OP	ADDRESS	
154	155S0100;	PRINT	IAC		Begin decimal print out
156	156S4300;	P9	CLB		
160	161S0400I		LDC	\$+1	
161	+7502200		DEC	2000000	Divide by 2×10^6 to reduce to complete fraction
162	211S3100;		DIV	22	
211	212S1600I		DPA	\$+1	
212	+0000001		DEC	1Q43	Add roundoff
213	+0000000				
214	215S0400I		LDC	\$+1	Set print limit (L) = 7
215	+0000007		DEC	7	
216	233S4500;		CLA		Set Zs = 0
234	241 1100I		STA	ZS	
235	277 1000I		STC	LIMIT	
236	241 2110;		SLT	2	Multiply by 2 for first digit
237	307 1200I	P8	STB	PF	
240	241S5600I		CAM	ZS	Save fractional remainder
241	+0000000	ZS			
242	276 7500I		TOF	REJ	
243	266S4300;		CLB		Reject character if leading zero
267	243S4400;		CLC		
244	245 0000;		MAC		Otherwise prepare for print
245	120 5600I		CAM	ZERO	
246	000 4100;		GTB		Save digit in C
247	250S0100;		IAC		
251	255 3400I		TCN	OMIT	Compare for zero to obtain parity
252	253S1400I	P7	ADD	\$+1	

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		LOCATION	OP	ADDRESS	
253	+0000020		DEC	1Q17	
254	252 7500I		TOF	P7	Add again if zero
255	256S1400I	OMIT	ADD	DELAY	Merge with WOC command
256	+0003000	DELAY	DEC	3Q12	
257	304 2210;		SRT	20	Scale in B
260	261S0500I		LDA	\$/+1	Load return into A
261	275S3700I		TRU	R1	
262	271S3700I		TRU	CHAR	
271	376 1305;	CHAR	STD	37605	Store in line 05 for execution
272	256 0400I		LDC	DELAY	Load C and wait for flex
273	273 7737;		TES	37,\$	
274	376S3705;		TRU	37605	Transfer to execution
275	241 1000I	R1	STC	ZS	Return from digit print; make Zs ≠ 0, check to see if last digit.
276	277S0500I	REJ	LDA	\$/+1	
277	+0000007	LIMIT			
300	301S1500I		SUB	\$/+1	Decrement L
301	+0000001	ONE	DEC	1	
302	277 1100I		STA	LIMIT	
303	304S5600I		CAM	\$/+1	Transfer to finish if last digit
304	+0000000		DEC	0	
305	334 7500I		TOF	FIN	
306	307S0600I		LDB	PF	Pick up fraction remainder
307	+0000000	PF			
310	311S4500;		CLA		
312	313S0400I		LDC	\$/+1	Set multiplier = 10
313	+0000012		DEC	10	

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		LOCATION	OP	ADDRESS	
314	316S2210;		SRT	1	To set sign of fraction positive compute next digit and return to process
316	345S3200;		MUP	22	
345	237S3700I		TRU	P8	
171	167 1000I	A2	STC	DTEMP	in-switch = 2, save D
172	126 0700I		LDP	X	
126	000 6127;	X	WOC	X	Print X
127	174S3700I		TRU	R2	
173	271S3700I		TRU	CHAR	
174	164 0700I	R2	LDP	SPACE	Print space
164	000 6020;	SPACE	WOC	SPACE	
165	155S3700I		TRU	R3	
175	271S3700I		TRU	CHAR	Pick up D & go to decimal print
155	167 0500I	R3	LDA	DTEMP	
156	157S4300;	156	EQU	P9	Q less than D, terminate divide
134	072 0500I	THRU	LDA	A	
135	001 5600I		CAM	J1	If in-switch still = 1, N is prime
136	176 7500I		TOF	PRIME	
137	004 0500;		LDA	N3	If not, check to see if last factor = 1 Exit via C/R if N = 1
140	142 2210;		SRT	1	
141	301 5600I		CAM	ONE	
142	101 7500I		TOF	B3	Otherwise set out-switch = 3
143	000 0100;		IAC		
144	145S0500I		LDA	\$/+1	
145	101S3700I		TRU	B3	
146	324 1100I		STA	B	And print N as last factor
147	171S3700I		TRU	A2	

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		LOCATION	OP	ADDRESS	
176	223 0700I	PRIME	LDP	P	Print P
223	000 6027;	P	WOC		
224	200S3700I		TRU	R4	
177	271S3700I		TRU	CHAR	Print R
200	226 0700I	R4	LDP	R	
226	000 6011;	R	WOC	R	
227	202S3700I		TRU	R5	Print I
201	271S3700I		TRU	CHAR	
202	264 0700I	R5	LDP	I	
264	000 6131;	I	WOC	I	Print M
265	204S3700I		TRU	R6	
203	271S3700I		TRU	CHAR	
204	326 0700I	R6	LDP	M	Print E
326	000 6024;	M	WOC	M	
327	206S3700I		TRU	R7	
205	271S3700I		TRU	CHAR	Out-switch = 2; pick up N and return to DIV sequence
06	336 0700I	R7	LDP	E	
336	000 6125;	E	WOC	E	
337	101S3700I		TRU	B3	Out-switch = 3; print C/R
207	271S3700I		TRU	CHAR	
157	050S0500;	B1	LDA	N2	
051	053 2210;	051	EQU	P10	Out-switch = 3; print C/R
101	064 0700I	B3	LDP	C/R	
064	000 6116;	C/R	WOC	C/R	
065	103S3700I		TRU	R8	
102	271S3700I		TRU	CHAR	

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		LOCATION	OP	ADDRESS	
103	123 0700I	R8	LDP	DUMMY	Print dummy character before returning to read sequence
123	000 6000;	DUMMY	WOC	00	
124	105S3700I		TRU	R9	
104	271S3700I		TRU	CHAR	
105	107 7735;	R9	TES	BP, \$+2	Test breakpoint
106	000S3700I		TRU	START	Up : return to start
107	067 0400I		LDC	N1	Down : N + 1 = N
110	112 2200;		RSI	1	
111	112S0700I		LDP	\$+1	Turn on character-switch
112	000 6136;		WOC	TAB	
113	037S3700I		TRU	R10	
114	3231300I		STD	OUT	
115	067 1000I		STC	N1	Restore N
116	340S0500I		LDA	P11	Set in-switch = 1
340	151S3700I	P11	TRU	A1	
341	154S3700I		TRU	PRINT	Go to print N & tab
334	3230700I	FIN	LDP	OUT	Test character-switch: print tab or space
323	000 6XXX;	OUT	WOC	XX	
324	XXXS3700I		TRU	B1-B4	
335	271S3700I		TRU	CHAR	