Program Description I

Program Title 67 - FAST FACTOR FINDER WITH AUTOMATIC ANSWER ACCUMULATION

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Program Description, Equations, Variables

This program is especially suitable for the unattended factoring of large integers on the HP-67. To increase factoring speed, after the initial 4 primes are tested, only 8 potential factors out of every 30 are tested (i.e., 1, 7, 11, 13, 17, 19, 23, and 29 Modulo 30). As factoring proceeds, the potential factors get larger, and the integer being factored gets smaller; when the square of the potential factor becomes greater than the integer, all factors have been found. The factor test routine and other short routines are repeated where needed instead of made into subroutines to increase the program speed.

To extend the range of integers that can be factored by five times, a "false factor" test is used, and false factors are ignored. False factors may occur when factoring integers between 2×10^9 and 10^{10} because there is no room in the register for a decimal remainder after the integer is divided by a potential factor.

Registers 1 through 10 are used to accumulate the factors that are found. When the last factor is found, the program stops, displaying it as a negative number. If a factor occurs more than once in the integer being factored, the power of that factor is accumulated in the same register with the factor as units of 0.01 to indicate the number of times that factor occurs. The display routine automatically adjusts the display to show these powers when they occur.

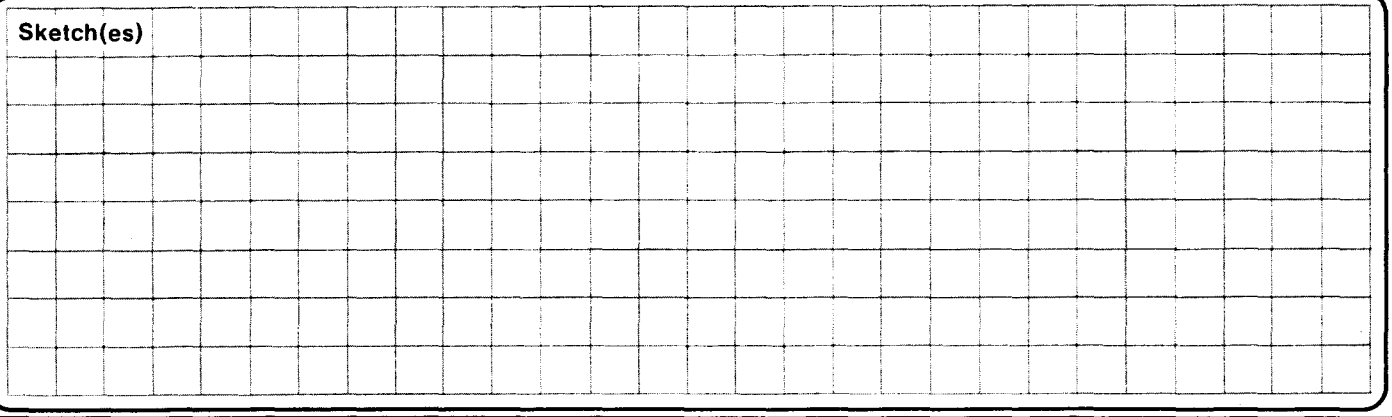
Operating Limits and Warnings

Illegal entries (negative, zero, non-integer, or greater than 9,999,999,999) cause the program to stop with an "Error" signal.

Large integers that are prime, or that contain large prime factors, may require up to several hours to factor.

01602D Program Description II

Sketch(es)



Sample Problem(s) Factor the following numbers:

1.	60,037	
2.	6,700,417	
3.	1,999,999,983	
4.	6,227,020,800	(13!)
5.	6,469,693,230	(Product of first 10 prime numbers)
6.	8,589,934,592	(2^{33})
7.	9,999,999,999	

Solution(s)

Problem	Factors	Time, seconds: This Program	Time, seconds: 00063D
1.	60,037 is prime	33	59
2.	6,700,417 is prime	336	604
3.	3 x 19 x 23 x 151 x 10,103	25	47
4.	$2^{10} \times 3^5 \times 5^2 \times 7 \times 11 \times 13$	28	Can't do it
5.	2 x 3 x 5 x 7 x 11 x 13 x 17 x 19 x 23 x 29	15	Can't do it
6.	2^{33}	45	Can't do it
7.	$3^2 \times 11 \times 41 \times 271 \times 9091$	42	Can't do it

Reference(s)

Eric Isaacson HP-65 Users' Library program No. 00253A

Mike Louder 65 Notes Vol. 3 No. 4 p. 14 (May 1976)

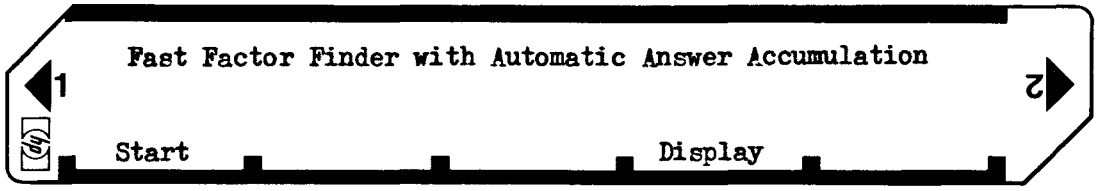
James J. Davidson 65 Notes Vol. 3 No. 9 pp. 9, 10 & 45 (Oct. - Nov. 1976)

James J. Davidson 65 Notes Vol. 4 No. 6 pp. 20 & 61 (July - August 1977)

J. L. Horn 65 Notes Vol. 4 No. 10 p. 33 (December 1977)

HP Math Pac MA1 - 01A (Users' Library program No. 00063D)

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter Program, both sides			0.
2	Enter Integer to be factored:	N	A	$-F_n$
	(Last factor is displayed as a negative number)			
3	To see all factors:		D	1.
				F_1 ***
	(The display routine shows all factors in order,			2.
	from smallest to largest. There is first a			F_2 ***
	"pause" of the index number of the factor, then			3.
	a "print/pause" of the factor itself. If a			F_3 ***
	factor occurs more than once, it is shown in			⋮
	FIX 2 format, with the power as hundredths;			⋮
	i.e., a display of "2.05" means that the factor			n.
	"2" occurs 5 times in the integer being factored.			F_n ***
	The display routine halts showing the last			$-F_n$
	factor as a negative number.)			
4	To factor another integer, go to Step 2			
*	* * * * * * * * *	* *	* * *	* *
	Notes:			
	(1) Illegal entries will give an "Error" signal.			
	(2) Entries with very large, prime factors may			
	require several hours to run.			
	(3) To see all factors again, repeat Step 3.			

01602D Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	* LBL A	31 25 11	Start:
	EEX	43	
	1	01	
	0	00	
	x≤y?	32 71	Entry too large?
	GTO E	22 15	Yes, "Error"
	CLx	44	
	x≷y	35 52	
	x≤y?	32 71	Entry 0, negative?
010	GTO E	22 15	Yes, "Error"
	ENTER	41	
	INT	31 83	
	x≠y?	32 61	Entry non-integer?
	GTO E	22 15	Yes, "Error"
	CL REG	31 43	
	P≷S	31 42	
	CL REG	31 43	
	STO E	33 15	Store Entry, 1st N
	2	02	
020	STO 0	33 00	Store 2, 1st trial
	÷	81	divisor, D
	FRAC	32 83	
	x=0?	31 51	Is 2 a factor?
	GSB 1	31 22 01	Yes
	1	01	
	STO + 0	33 61 00	Increment D
	RCL E	34 15	
	RCL 0	34 00	
	÷	81	
030	FRAC	32 83	
	x=0?	31 51	Is 3 a factor?
	GSB 1	31 22 01	Yes
	2	02	
	STO + 0	33 61 00	Increment D
	RCL E	34 15	
	RCL 0	34 00	
	÷	81	
	FRAC	32 83	
	x=0?	31 51	Is 5 a factor?
040	GSB 1	31 22 01	Yes
	2	02	
	STO + 0	33 61 00	Increment D
	RCL E	34 15	
	RCL 0	34 00	
	÷	81	
	FRAC	32 83	
	x=0?	32 51	Is 7 a factor?
	GSB 1	31 22 01	Yes
	* LBL 0	31 25 00	Mod 30 Loop Reentry
050	4	04	
	STO + 0	33 61 00	Increment D
	RCL E	34 15	
	RCL 0	34 00	
	÷	81	
	FRAC	32 83	
	x=0?	31 51	Is 11 Mod 30 factor?
	GSB 1	31 22 01	Yes
	2	02	
	STO + 0	33 61 00	Increment D
060	RCL E	34 15	
	RCL 0	34 00	
	÷	81	
	FRAC	32 83	
	x=0?	31 51	Is 13 Mod 30 factor?
	GSB 1	31 22 01	Yes
	4	04	
	STO + 0	33 61 00	Increment D
	RCL E	34 15	
	RCL 0	34 00	
070	÷	81	
	FRAC	32 83	
	x=0?	31 51	Is 17 Mod 30 factor?
	GSB 1	31 22 01	Yes
	2	02	
	STO + 0	33 61 00	Increment D
	RCL E	34 15	
	RCL 0	34 00	
	÷	81	
	FRAC	32 83	
080	x=0?	31 51	Is 19 Mod 30 factor?
	GSB 1	31 22 01	Yes
	4	04	
	STO + 0	33 61 00	Increment D
	RCL E	34 15	
	RCL 0	34 00	
	÷	81	
	FRAC	32 83	
	x=0?	31 51	Is 23 Mod 30 factor?
	GSB 1	31 22 01	Yes
090	6	06	
	STO + 0	33 61 00	Increment D
	RCL E	34 15	
	RCL 0	34 00	
	÷	81	
	FRAC	32 83	
	x=0?	31 51	Is 29 Mod 30 factor?
	GSB 1	31 22 01	Yes
	2	02	
	STO + 0	33 61 00	Increment D
100	RCL E	34 15	
	RCL 0	34 00	
	÷	81	
	FRAC	32 83	
	x=0?	31 51	Is 1 Mod 30 factor?
	GSB 1	31 22 01	Yes
	6	06	
	STO + 0	33 61 00	Increment D
	RCL E	34 15	
	RCL 0	34 00	
110	÷	81	
	FRAC	32 83	
	x=0?	31 51	Is 7 a factor?

REGISTERS

0 Trial Divisor	1 Factor	2 Factor or Zero	3 Factor or Zero	4 Factor or Zero	5 Factor or Zero	6 Factor or Zero	7 Factor or Zero	8 Factor or Zero	9 Factor or Zero
S0 Factor or Zero	S1 Zero	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E N_i, current No. being factored	I Factor Index

01602D Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
	GSB 1	31 22 01	Yes
	RCL 0	34 00	
	LST x	35 82	
	x>y?	32 81	Is $D^2 > N_i$?
	GTO 0	22 00	No, continue
	RCL E	34 15	Yes, factoring done
	ISZ	31 34	(Never skips)
120	STO (i)	33 24	Store last factor
	CHS	42	
	R/S	84	
	* LBL 1	31 25 01	Subroutine to handle
	RCL E	34 15	all factors
	RCL 0	34 00	
	LST x	35 82	
	X	71	
	x≠y?	32 61	False factor?
	RTN	35 22	Yes, ignore it
130	LST x	35 82	No, continue
	STO E	33 15	N/D becomes new N_i
	RCL 0	34 00	
	ISZ	31 34	(Never skips)
	STO (i)	33 24	Store factor
	x^2	32 54	
	SF 2	35 51 02	
	x>y?	32 81	Is $D^2 > N_i$?
	GTO 2	22 02	Yes, factoring done
	* LBL 3	31 25 03	No, continue
140	RCL E	34 15	
	RCL 0	34 00	
	÷	81	
	FRAC	32 83	
	x≠0?	31 61	Is D still factor?
	RTN	35 22	No, try next factor
	RCL E	34 15	Yes, continue
	RCL 0	34 00	
	LST x	35 82	
	X	71	
150	x≠y?	32 61	False factor?
	RTN	35 22	Yes, ignore it
	EEX	43	No, continue
	2	02	
	CHS	42	
	STO + (i)	33 61 24	Incr. factor power
	F? 2	35 71 02	First pass?
	STO + (i)	33 61 24	Yes, make 2nd power
	LST x	35 82	
	STO E	33 15	N/D becomes new N_i
160	RCL 0	34 00	
	x^2	32 54	
	x≤y?	32 71	Is $D^2 > N_i$?
	GTO 3	22 03	No, try D again
	* LBL 2	31 25 02	Yes, factoring done
	RCL 0	34 00	
	RCL E	34 15	
	x=y?	32 51	Does D equal N_i?
	GTO 4	22 04	Yes increment power

STEP	KEY ENTRY	KEY CODE	COMMENTS
	1	01	
170	x≠y	35 52	
	ISZ	31 34	(Never skips)
	x≠y?	32 61	Last factor is 1?
	STO (i)	33 24	No, store it
	x=y?	32 51	Last factor is 1?
	LST x	35 82	Yes, previous fact.
	CHS	42	
	R/S	84	Show last factor
	* LBL 4	31 25 04	Increment power of
	EEX	43	last factor
180	2	02	
	CHS	42	
	STO + (i)	33 61 24	
	F? 2	35 71 02	First pass?
	STO + (i)	33 61 24	Yes
	RCL E	34 15	
	CHS	42	
	R/S	84	Show last factor
	* LBL D	31 25 14	Display Routine:
	0	00	
190	ST I	35 33	
	CF 3	35 61 03	
	* LBL 5	31 25 05	Display Loop
	ISZ	31 34	(Never skips)
	RCL (i)	34 24	
	x=0?	31 51	All factors shown?
	GTO 6	22 06	Yes, end display
	FRAC	32 83	No, continue
	x≠0?	31 61	Factor has power?
	SF 3	35 51 03	Yes
200	RC I	35 34	
	PAUSE	35 72	Show factor index #
	LST x	35 82	
	F? 3	35 71 03	Factor has power?
	DSP 2	23 02	Yes, set display
	-x-	31 84	Show factor
	DSP 0	23 00	
	GTO 5	22 05	Loop, next factor
	* LBL 6	31 25 06	End display
	LST x	35 82	
210	CHS	42	
	RTN	35 22	Show last factor
220			

LABELS

A Start	B	C	D Display	E "Error"
a	b	c	d	e
0 Loop	1 Subroutine	2 Done	3 Try again	4 △ Power
5 Dspl Loop	6 End Dspl.	7	8	9

FLAGS

0	
1	
2	1st Pass
3	Set Dspl

SET STATUS

FLAGS	ON	OFF
0	☐	☐
1	☐	☐
2	☐	☒
3	☐	☒

TRIG	
DEG	☐
GRAD	☐
RAD	☐

DISP	
FIX	☒
SCI	☐
ENG	☐
n	0