39 8225 G
For TI use only

PPX-59
professional
program exchange

TEXAS INSTRUMENTS
Calculator Products Division

# Submission Abstract

| Program Title | Rev. |
|---|---|
| Prime Factors of an Integer | B |

**Abstract of Program**

Computes prime factors of an integer N in order of increasing magnitude. Automatically senses whether a printer is used to determine whether to stop when each prime factor is determined, or to print the prime factor and continue.

**User Benefits:**

Fast. Eliminates dependence on tables. Handles numbers larger than those found in tables.

| Category Number | Required Progs. | Prog. Steps | PC-100A Needed Library Module ID |
|---|---|---|---|
| 39 | None | 196 | ☐ |

**Submittal Agreement**

All of the information forwarded herewith is contributed to Texas Instruments on a nonconfidential, nonobligatory basis; no relationship, confidential or otherwise express or implied, is established with Texas Instruments by this contribution. The submitter retains his or her copyright on this material and grants to Texas Instruments a non-exclusive, world-wide, royalty-free license to exercise any of the rights granted to an owner of copyright by law. To my knowledge, this is an original work, which does not infringe the copyright of another and contribution of this information to Texas Instruments by me does not breach any obligation to any other person or organization relating to proprietary or confidential information.

Signature Palmer O Hanson Jr Date 12 Oct 1980

Name Palmer O. Hanson, Jr. Mbr. No. 917659

Address 2149 14th Avenue SW Tel. No. 813-581-1850

City Largo State Florida Zip 33540

**Submission Checklist**

- ☒ Recorded Magnetic Cards
- ☒ Submission Abstract
- ☒ Program Description
- ☒ User Instructions
- ☒ Sample Problem
- ☒ Listing
- ☐ _____
- ☐ _____

For TI use only

PPX-59
professional
program exchange

TEXAS INSTRUMENTS
Calculator Products Division

# Program Description

| Program Title: Prime Factors of an Integer | Rev. B |
|---|---|

Method, Equations, Sketches, Limitations, References, Error Recovery:

This program finds prime factors in the same manner as PPX program number 398075 as originally submitted by Daniel Drucker of Royal Oak, Michigan on July 18, 1978 but includes the following corrections and additions:

1. An automatic printer sensing routine is provided such that the program simply prints out each prime factor as it is found and proceeds to test for additional prime factors if a printer is used, but stops with each prime factor in the display if a printer is not used.

2. The documentation for the original program indicated that scientific notation was used internally to obtain a speed increase of about three per cent. In practice, the original program provided the increased speed only for the calculation of the first prime factor since the CLR at location 26 returned the calculator to standard format at the time the first prime factor was displayed. In the revised program the CLR is maintained to provide a normal display and printout, but an EE is added later to return to scientific mode for subsequent calculations.

3. The original program could be used for eleven or twelve digit input values, but the EE which was used to set scientific mode at the start of the program had to be replaced with a Nop (code 68) to prevent the data in the guard digits from being discarded. That idiosyncrasy was corrected in the revision so that eleven or twelve digit numbers could be analyzed without altering the program.

The remaining description essentially quotes the documentation for the original version with changes only where where required to reflect the revisions described above.

This program tests positive numbers less than or equal to $\text{Int}(\sqrt{|N|})$ to determine whether they divide N. First 2, 3, 5, and 7 are tested. Numbers greater than 7 are used as test divisors only if they are not divisible by 2, 3, 5, or 7. Each group of 210 consecutive numbers contains 48 such

See Continuation Sheet

numbers to be used as test divisors. When a test divisor D divides N evenly (in which case D is necessarily prime) D is either printed or displayed and N is replaced by its unfactored portion U = N/D. The last prime divisor is flashed indicating that factorization is complete. N itself appears as a flashing divisor (the first divisor displayed) when N is prime. Approximately every sixth test divisor is compared with $\text{Int}(\sqrt{|U|})$ so that the program will terminate promptly when U is prime. (Note: A program which compares every test divisor with $\text{Int}(\sqrt{|U|})$ will run slightly faster for certain small primes, but will squander a great deal of time when the divisors are not all small).

The program uses scientific notation internally to increase its speed by about three per cent. The program can be applied for eleven or twelve digit numbers by synthesizing the values in scientific notation. For example, to enter the twelve digit number 111,111,111,111 press 1,111,111,111 x 100 + 11 = .

A rough estimate of running time for the program is given by the formula $T = \frac{1}{4}\,\text{minimum}\left(F_0, \text{Int}(\sqrt{|N|})\right)$

where $F_0$ is the smallest prime factor of N. Here running time is taken to mean only the time to the display or printout of the first factor. The estimate is too small when $F_0$ is small and too large when N is a large prime.

The printer sensing routine (locations 074 through 078) uses a negative display value to trigger an error if the printer is connected, and Op 19 to set flag seven in response to the error. Printout or stopping with the prime factor in the display is then controlled by the IfFlg 7 at location 029 through 032.

The Op 69 command uses the callup of an illegal Op code to cause a flashing display without altering the value in the display. (Locations 055/056)

For TI use only

PPX-59
professional program exchange

# User Instructions

| Program Title | Prime Factors of An Integer | | | |
|---|---|---|---|---|
| | | | | |
| N | | | | |

Partition (OP 17): 479 .59
Parentheses Levels: 1
t Register: ☒
Angular Mode (if applicable): —
SBR Levels: 2
Absolute Addresses: ☒
Library Module ID: —
Disturbs Pending Operations: ☒

**USER DEFINED KEYS**

| | |
|---|---|
| A | Solve |
| B | |
| C | |
| D | Subroutine |
| E | Subroutine |
| A' | |
| B' | |
| C' | |
| D' | |
| E' | |

**DATA REGISTERS** (INV | [ ])

| | |
|---|---|
| 0 | N |
| 1 | U |
| 2 | Int $\sqrt{\text{U}}$ |
| 3 | D |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 0 | |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 0 | |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 0 | |
| 1 | |
| 2 | |
| 3 | |
| 4 | |

| FLAGS | 0 | 1 | 2 | 3 | 4 | 5 | 6 | Printer included 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |

| STEP | PROCEDURE | ENTER | PRESS | OUTPUT/MODE (see legend below) |
|---|---|---|---|---|
| | With Printer<br>Enter integer to be factored and find prime factors. | N | A | Print out N followed by prime factors in order of increasing magnitude. Stops with last factor flashing in display |
| 1 | Without Printer<br>Enter integer to be factored and find smallest prime factor. | N | A | Smallest prime factor in display. Display flashes N if N is prime or if $\lvert N \rvert < 2$. |
| 2 | Optional step | | $x \geq t$<br>$x \geq t$ | Unfactored part of N is displayed. This step is not required, but may be done if desired. |
| 3 | Find next factor | | R/S | Next factor in display. Display flashes if it is the largest prime factor. |
| 4 | Repeat 3 as necessary. | | | |

Modes: n* — Printed only (n) — Displayed briefly (Pause)
(n)* — Printed and displayed

☐ See Continuation Sheet

TEXAS INSTRUMENTS
Calculator Products Division

# Sample Problem

Prime Factors of an Integer Rev. B

Statement of Example

Examples are given for operation with and without a printer. In addition, an example is given to illustrate the three per cent slowdown which occurs if scientific mode is not used internally.

The problem used for the printer example and for the illustration of the speed effects of scientific notation is the value 987654321 which factors into 3, 3, 17, 17, 379721.

The problem used for the example without a printer is 8463839 which factors into 23, 71, 71, 73.

☐ See Continuation Sheet

| ENTER | PRESS | OUTPUT/MODE (see legend below) | COMMENT |
|---|---|---|---|
| Example with a printer: | | | |
| 987654321 | A | Calculator stops after about 2 minutes 19 seconds with 379721 flashing in the display. The printout which includes the input value is: | |
| | | 987654321.<br>3.<br>3.<br>17.<br>17.<br>379721. | |
| Example of effect of not using scientific mode internally: | | | |
| | GTO 035<br>LRN<br>2nd-Nop<br>LRN<br>GTO 079<br>LRN<br>2nd-Nop | 035 52 in the display<br>036 61 in display<br><br><br>079 52 in the display<br>080 24 in the display | |

Modes: n° — Printed only (n) — Displayed Briefly (Pause)
(n)° — Printed and displayed

Over

| ENTER | PRESS | OUTPUT/MODE (see legend below) | COMMENT |
|---|---|---|---|
| Example of effect of not using scientific mode internally (cont): | | | |
| 987654321 | LRN<br>A | Calculator stops after about 2 minutes 23 seconds with 379721 flashing in the display and the same printout as shown above. This indicates that scientific mode saves about four seconds for this problem. | |
| Example without a printer: | | | |
| 8463839 | A | Calculator stops with 23 in the display after about ten seconds. | 23 is the first prime factor. |
| | x⇄t | 367993 in the display. | 367993 is the unfactored part. |
| | x⇄t | 23 in the display. | |
| | R/S | Calculator stops with 71 in the display after about eleven seconds. | 71 is the second prime factor. |
| | x⇄t | 5183 in the display. | 5183 is the remaining unfactored part. |
| | x⇄t | 71 in the display. | |
| | R/S | Calculator stops with 71 in the display after about two seconds. (Note: It is not necessary to view the unfactored part--that step will be skipped this time.) | Another 71 is the third prime factor. |
| | R/S | Calculator stops with 73 flashing in the display after about two seconds. | 73 is the last prime factor. |
| | CLR | Stops flashing display. | |
| | RCL 00 | 8463839 in display. | This option permits viewing the original integer to be tested. |

Modes: (n) — Printed only (n) — Displayed Briefly (Pause)
(n) — Printed and displayed

# PPX-59 Professional Program Exchange



For TI use only

| LOC | CODE | KEY | COMMENTS |
|---|---|---|---|
| 000 | 91 | R/S | |
| 001 | 76 | LBL | |
| 002 | 14 | D | Forms next test value D in R03 |
| 003 | 44 | SUM | |
| 004 | 03 | 03 | |
| 005 | 43 | RCL | |
| 006 | 01 | 01 | |
| 007 | 55 | ÷ | Calculate u/D |
| 008 | 43 | RCL | |
| 009 | 03 | 03 | |
| 010 | 75 | - | |
| 011 | 22 | INV | If fractional part ≠ 0, D is not prime to u. Go get a new divisor |
| 012 | 59 | INT | |
| 013 | 29 | CP | |
| 014 | 67 | EQ | |
| 015 | 00 | 00 | |
| 016 | 19 | 19 | |
| 017 | 54 | ) | |
| 018 | 92 | RTN | |
| 019 | 54 | ) | If D is prime, set u=u/D |
| 020 | 71 | SBR | |
| 021 | 00 | 00 | |
| 022 | 58 | 58 | |
| 023 | 43 | RCL | Print or Display D in normal mode |
| 024 | 01 | 01 | |
| 025 | 32 | X:T | |
| 026 | 25 | CLR | |
| 027 | 43 | RCL | |
| 028 | 03 | 03 | |
| 029 | 87 | IFF | |
| 030 | 07 | 07 | |
| 031 | 00 | 00 | |
| 032 | 34 | 34 | |
| 033 | 91 | R/S | |
| 034 | 99 | PRT | |
| 035 | 52 | EE | Scientific |
| 036 | 61 | GTO | |
| 037 | 00 | 00 | |
| 038 | 43 | 43 | |
| 039 | 76 | LBL | Entry to test whether u is prime |
| 040 | 15 | E | |
| 041 | 44 | SUM | |
| 042 | 03 | 03 | |
| 043 | 43 | RCL | |
| 044 | 03 | 03 | |
| 045 | 32 | X:T | |
| 046 | 43 | RCL | Get the new INT√u |
| 047 | 02 | 02 | |
| 048 | 77 | GE | |
| 049 | 00 | 00 | |
| 050 | 05 | 05 | |
| 051 | 25 | CLR | Exit if u is prime |
| 052 | 43 | RCL | |
| 053 | 01 | 01 | |
| 054 | 99 | PRT | |
| 055 | 69 | OP | Causes flashing Exit |
| 056 | 69 | 69 | |
| 057 | 81 | RST | |
| 058 | 42 | STO | |
| 059 | 01 | 01 | Store the new u and INT√u |
| 060 | 34 | FX | |
| 061 | 59 | INT | |
| 062 | 42 | STO | |
| 063 | 02 | 02 | |
| 064 | 92 | RTN | |
| 065 | 76 | LBL | |
| 066 | 11 | A | Enter and Print N |
| 067 | 98 | ADV | |
| 068 | 99 | PRT | |
| 069 | 42 | STO | |
| 070 | 00 | 00 | Store N in R00 |
| 071 | 71 | SBR | Set u=N in R01 |
| 072 | 00 | 00 | |
| 073 | 58 | 58 | |
| 074 | 94 | +/- | Sets Flag 7 if Printer is used & convert to Scientific |
| 075 | 69 | OP | |
| 076 | 07 | 07 | |
| 077 | 69 | OP | |
| 078 | 19 | 19 | |
| 079 | 52 | EE | |
| 080 | 24 | CE | |
| 081 | 02 | 2 | Use 2 as first Test Divisor |
| 082 | 42 | STO | |
| 083 | 03 | 03 | |
| 084 | 71 | SBR | Go to test of 2 |
| 085 | 00 | 00 | |
| 086 | 45 | 45 | |
| 087 | 01 | 1 | Test of 3 |
| 088 | 14 | D | |
| 089 | 02 | 2 | Test of 5 |
| 090 | 15 | E | |
| 091 | 02 | 2 | Test of 7 |
| 092 | 14 | D | |
| 093 | 04 | 4 | Test of 11 |
| 094 | 14 | D | |
| 095 | 02 | 2 | Add 2 and test |
| 096 | 14 | D | |
| 097 | 04 | 4 | Add 4 and test |
| 098 | 14 | D | |
| 099 | 02 | 2 | Add 2 and test |
| 100 | 14 | D | |
| 101 | 04 | 4 | Add 4, test |
| 102 | 15 | E | Is D too big |
| 103 | 06 | 6 | |
| 104 | 14 | D | etc |
| 105 | 02 | 2 | |
| 106 | 14 | D | |
| 107 | 06 | 6 | |
| 108 | 14 | D | |
| 109 | 04 | 4 | |
| 110 | 14 | D | |
| 111 | 02 | 2 | |
| 112 | 14 | D | |
| 113 | 04 | 4 | |
| 114 | 15 | E | |
| 115 | 06 | 6 | |
| 116 | 14 | D | |
| 117 | 06 | 6 | |
| 118 | 14 | D | |
| 119 | 02 | 2 | |
| 120 | 14 | D | |
| 121 | 06 | 6 | |
| 122 | 14 | D | |
| 123 | 04 | 4 | |
| 124 | 14 | D | |
| 125 | 02 | 2 | |
| 126 | 15 | E | |
| 127 | 06 | 6 | etc |
| 128 | 14 | D | |
| 129 | 04 | 4 | |
| 130 | 14 | D | |
| 131 | 06 | 6 | |
| 132 | 14 | D | |
| 133 | 08 | 8 | |
| 134 | 14 | D | |
| 135 | 04 | 4 | |
| 136 | 14 | D | |
| 137 | 02 | 2 | |
| 138 | 15 | E | |
| 139 | 04 | 4 | |
| 140 | 14 | D | |
| 141 | 02 | 2 | |
| 142 | 14 | D | |
| 143 | 04 | 4 | |
| 144 | 14 | D | |
| 145 | 08 | 8 | |
| 146 | 14 | D | |
| 147 | 06 | 6 | |
| 148 | 14 | D | |
| 149 | 04 | 4 | |
| 150 | 15 | E | |
| 151 | 06 | 6 | |
| 152 | 14 | D | |
| 153 | 02 | 2 | |
| 154 | 14 | D | |

MERGED CODES

| | | | | | |
|---|---|---|---|---|---|
| 62 | | 72 STO | | 83 GTO | |
| 63 | | 73 RCL | | 84 | |
| 64 | | 74 SUM | | 92 INV SBR | |

For TI use only

| LOC | CODE | KEY | COMMENTS |
|---|---|---|---|
| 155 | 04 | 4 | |
| 156 | 14 | D | |
| 157 | 06 | 6 | |
| 158 | 14 | D | |
| 159 | 02 | 2 | |
| 160 | 14 | D | |
| 161 | 06 | 6 | |
| 162 | 15 | E | |
| 163 | 06 | 6 | |
| 164 | 14 | D | |
| 165 | 04 | 4 | |
| 166 | 14 | D | |
| 167 | 02 | 2 | |
| 168 | 14 | D | |
| 169 | 04 | 4 | etc. |
| 170 | 14 | D | |
| 171 | 06 | 6 | |
| 172 | 14 | D | |
| 173 | 02 | 2 | |
| 174 | 15 | E | |
| 175 | 06 | 6 | |
| 176 | 14 | D | |
| 177 | 04 | 4 | |
| 178 | 14 | D | |
| 179 | 02 | 2 | |
| 180 | 14 | D | |
| 181 | 04 | 4 | |
| 182 | 14 | D | |
| 183 | 02 | 2 | |
| 184 | 14 | D | |
| 185 | 01 | 1 | |
| 186 | 00 | 0 | |
| 187 | 15 | E | |
| 188 | 02 | 2 | |
| 189 | 14 | D | |
| 190 | 01 | 1 | |
| 191 | 00 | 0 | |
| 192 | 14 | D | |
| 193 | 61 | GTO | Return to form test divisors from the next group of 210 consecutive numbers. 48 of the 210 are not divisible by 2, 3, 5, or 7 and will be used as test divisors. |
| 194 | 00 | 00 | |
| 195 | 95 | 95 | |

| LOC | CODE | KEY | COMMENTS |
|---|---|---|---|
| | | | |

| LOC | CODE | KEY | COMMENTS |
|---|---|---|---|
| | | | |

MERGED CODES

62 [FIX] [ ]  72 [STO] [ ]  83 [GTO] [ ]
63 [ ] [ ]  73 [RCL] [ ]  84 [ ] [ ]
64 [ ] [ ]  74 [SUM] [ ]  92 [INV] [SBR]