TI PPC NOTES

NEWSLETTER OF THE TI PROGRAMMABLE CALCULATOR CLUB

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The dominant theme of this issue is fast mode, but more specifically fast mode using the STF IND sequence at the end of the current partition combined with Patrick Acosta's idea for selecting any desired program location for the jump at fast mode entry. The emphasis on that subject was triggered by Dejan Ristanovic's observation that he still sees many fast mode programs using the antiquated "load-and-go" method which is so sensitive to card reader problems.

The "star" article is not on fast mode however; it is Maurice Swinnen's translation of the text which accompanies the Science et Vie program which calculates 1287 digits of pi. See page 21. Not only is the program superbly crafted, but the text makes pertinent observations on programming style and on differences in calculators.

This issue carries additional information on the CC-40 including two graphics programs by Maurice Swinnen. Users of the CC-40 continue to be crippled by the unavailability of peripherals. For example, when analyzing the accuracy of the sine and cosine functions of the CC-40, I read the errors from the CC-40 display and entered the values into my TI-59 so that I could obtain a plot using Michael Sperber's classic Plot-60 program.

This issue also continues the coverage of precision started earlier this year with important inputs from George Thomson, Laurance Leeds, and Bob Fruit. Bob Fruit's input on the IBM PC was particularly interesting. The device performs very well on the interest problem that he proposed, but quite poorly on the problem of recovering a value for pi (see pages 4 and 14). For the first time I had a chance to look somewhat closely at the HP-75. Although I knew that both EDN and BYTE had reported that the HP-75's calculator mode was A.O.S., somehow I never really believed it. But it really is true! H-P also broke ranks with their traditional ten digits--the HP-75 has twelve. The real advantage of the HP-75 would seem to be the compatibility with the HP-IB interface bus so that several peripherals are already available. In contrast, we wait patiently (?) for the CC-40 related devices. No new information on the TI-66 has become available.

ERRATUM - 1188 Digits of Pi - Lars Hedlund of Sweden writes that there is an error in Program C on V8N1P22. The command at locations 104/105 should be RCL 08 not STO 08 as indicated in the listing. This error was not present in the original program submitted by Jovan Puzovic but was inadvertently introduced during an optimization by the editor.

CLARIFICATION - 1287 Digits of Pi - George Thomson writes that comment (2) on V8N3P8 is slightly misleading. Program steps 125 and 126 are used to define the number of registers used to store the answer. The user is not limited to the options indicated, but may set locations 125/126 to the number of places desired divided by 13 and rounded up.

HP-67 VS TI-59 WITH EE-INV-EE - Laurance Leeds writes "It has been asserted that using the EE INV EE routine with the TI-59 will give the same result as is given by the HP-67. This is not correct. Consider the problem involving the y^x function where x = 2.5 and y = 2.543210631 . Then

Exact solution	10.314 68158 50719 ...
Exact 10d rounded	10.314 68159
TI-59 solution	10.314 68158 506 including the guard digits.
TI-59 rounded	10.314 68159
HP-67 solution	10.314 68158

In this case and several others as well the TI-59 gives the exact 10 digit rounded answer, whereas the HP-67 is in error. "

Editor's Note: The discussion of the HP-67, the TI-59 and other calculators appeared in V8N3P13/14. I had compared the HP-67, the HP-41 and the HP-11 with the TI-59 for the case where five square roots were followed by five squares. Laurance asked whether the HP-41 makes the same mistakes for the y^x function above as the HP-67. I do not have an HP-41 readily available. My HP-11C gets the same correct ten digit answer as the rounded answer from the TI-59 for each of six problems posed by Laurance. Can one of our bi-linguals help us with an answer for the HP-41?

MU-17 CLARIFICATION - Don Graham reports that the documentation for the Romberg Integration program (MU-17) in the Math/Utilities module indicates that data registers R18 and beyond are used for data, the exact number being dependent on input parameters (and therefore accessed by indirect addressing). However, the listing for the program refers explicitly to R19 and R20 (see steps 047-048, 063,064, 071,072, 077-078, 086-087, and 173-174). It's not actually contradictory, but it could be a little misleading in certain cases.

<u>FAST MODE ENTRY</u> - Dejan Ristanovic writes: ...I still see many fast mode programs using "load-and-go" methods to initialize fast mode. I think that this method is very user unfriendly since:

* Memory is completely erased.
* Partitioning is returned to start-up condition.
* One cannot use a normal mode for data entry using labels and a fast mode for data processing without going through an intermediate step of writing magnetic cards which can be re-entered after fast mode initialization.
* Reading magnetic cards require extra steps, and includes the unpleasant possibility of card reading errors.

Dejan then recommends the use of the method which involves placement of a STF IND at the end of the current partition. This technique was discussed by Patrick Acosta in V6N8P3/4 and has been used in several programs in TI PPC Notes; for example, in

* Jovan Puzovic's program for 1188 digits of pi (V8N1P21).
* Laurance Leeds' speedy factor finder program (V8N2P27).
* Peter Messer's fast mode exact factorial program (page 5 of this issue).

All three of those programs share a common characteristic. The constant used in the fast mode entry sequence is chosen such that program execution after fast mode entry begins at location 001. The three programs also all use the 7 EE sequence after the flashing 1 has been obtained in the display after the STF IND at the end of the partition.

(Editor's Note: There is more versatility built into this method of fast mode entry. Patrick Acosta's discussion in V6N8P3/4 used 7 INV instead of 7 EE; and experimentation suggests that any number key can be used in place of the 7, and any command for which the second digit is a 2 can be used in place of the EE. Furthermore, V6N8P3/4 describes the use of the ninth through twelfth digits of the initialization constant to obtain a jump to a location other than 001 at fast mode entry. That technique is also illustrated in this issue on pages 15 and 25 of this issue.

<u>EVEN MORE ON NUMERICAL PRECISION</u> - The subject of the comparative numerical precision of various hand-held calculators was introduced in V8N2P3. Additional material was presented in V8N3 on pages 13 through 16. Several readers responded with their own observations:

<u>George W. Thomson</u>: "...The neophyte will never understand what all the shouting is about until he has a disaster. He routinely inverts a matrix or solves a set of simultaneous equations or a differential equation and he doesn't even get the right SIGN, much less the right magnitude. The literature on "ill-conditioning" goes back about 150 years. So, a long word length is good insurance, even although you never seem to need it. So, keep on shouting."

EVEN MORE ON NUMERICAL PRECISION (cont)

Bob Fruit: "...I think you are testing the wrong function to determine the precision of a computer. Not many people have need for high precision trigonometric functions. Maybe astronauts need them, but not many other people. From the people I know the lack of computer precision causes trouble most often when raising a number to a power. This shows up often when calculating amortization tables. Those of us accustomed to using the TI-59 don't even think about the precision of the raise to a power function since it often has more precision than the desired results. On a computer it often turns out that the result is only good to 4 or 5 significant digits. For a table covering 30 years that precision is nowhere near good enough. I would propose a test using the calculation of one dollar contributed to a savings account every month, with interest compounded every month for thirty years. The algebraic form for this test case (it is the solution to a geometric series) is:

$$S_{n} = \frac{(1 + i)^n - 1}{i}$$

To standardize the calculation an annual interest rate of 10% was used. The effective monthly interest rate is 10%/12. There are 360 monthly compounding periods in 30 years. I have calculated the results for this formula on the IBM PC in two ways. The first way is the straight forward application of the formula using the raise to the power function. and yields the answer

2260.487924796093

The second way is to avoid that function by squaring the value until the power is reached. Not only is this method faster than multiplying the number times itself 360 times (which would introduce a lot of rounding error), this is the least number of times a number can be multiplied to achieve the desired results:

$$X^{360} = X^{256}\ X^{64}\ X^{32}\ X^{8}$$

This method yields the answer

2260.487924796093 (identical with that above)

The IBM PC used double precision algebra to get those answers. Using a TRS-80 Model II at work for the same problem yielded:

2260.5 in single precision, and

2260.502243041992 in double precision, where

the built-in BASIC functions are single precision. FORTRAN for the Model II does have double precision functions--how many ways are we going to test? Straightforward mechanization of the problem on the TI-59 using the y^x function yields an answer of (including the guard digits):

2260.487924713

Editor's Note: For comparison the sinking fund option of ML-19 yields the identical answer if one removes the Fix 2 display mode from the output. Solutions on other computers include:

HP-11C	2260.487641
CC-40	2260.4879241984
Model 100	2260.4879247471

EXACT FACTORIALS IN FAST MODE - Peter Messer. V8N3 included two exact factorial programs, one for the TI-59 by Peter Messer and another for the TI-57 by Reginald van Genechten. The TI-57 program would find 34! in 2 minutes 30 seconds, while the TI-59 program required 3 minutes 15 seconds for the same calculations. Peter decided to rearrange his TI-59 program for increased speed, and then added fast mode using the Stflg-Ind-7-EE method. The fast mode version delivers 34! in just 1 minute 21 seconds, and delivers 100! in 10 minutes 30 seconds. The operating instructions are similar to those in V8N3P10, but with additional keystrokes for fast mode entry:

(1) Enter the program.

(2) Press A to initialize. See a zero in the display.

(3) To find n! :

(a) Enter the first factor and press B. You may use either a 1 or a 2.

(b) Enter the second factor and press C. You may use a 2 if you used a 1 in step 2.a., or a 3 if you used a 2 in step 2.a.

(c) Enter n and press D. See a flashing 1 in the display. Ignore the flashing and press 7 and then press EE. The calculator will be in fast mode. You will be unable to interrupt operation with either RST or R/S. A "-0" in the display signals the end of the calculations.

(d) Press E to display the highest order block. Press R/S to see each remaining block in order. The number of trailing zeroes is displayed as a negative integer.

(4) To find n!/m! , first initialize as in step 2 above.

(a) Enter m+1 and press B.

(b) Enter m+2 and press C.

(c) Enter n and press D. See a flashing 1 in the display. Proceed as in steps 3.c. and 3.d. above.

As with the program on V8N3P10:

* All blocks are ten digits.
* The highest factorial is 461!.

If you tire of all this speed and want to see how fast the program will run in normal mode simply proceed as above, but in response to the flashing 1, press CLR and see a steady zero. Press RST followed by two R/S's. The normal mode run time for 34! will be about 2 minutes 46 seconds. Tests of other factorials in normal and fast mode will show that the fast mode runs slightly better than two times faster than normal mode.

You might also want to experiment with other responses to the flashing 1 which signals readiness to enter fast mode. My tests show that you may use any number key (0 through 9) in place of the 7, and may use any function key which has a code which has a 2 in the second digit (STO, x t, INV or B) in place of the EE.

The program appears on the next page.

EXACT FACTORIALS IN FAST MODE (cont)

Program Listing:

```
000  91 R/S
001  01   1
002  44 SUM
003  98  98
004  42 STO
005  00  00
006  73 RC*
007  00  00
008  65   ×
009  43 RCL
010  98  98
011  85   +
012  43 RCL
013  94  94
014  59 INT
015  95   =
016  67  EQ
017  01  01
018  09  09
019  55   ÷
020  43 RCL
021  99  99
022  95   =
023  42 STO
024  94  94
025  22 INV
026  59 INT
027  65   ×
028  43 RCL
029  99  99
030  95   =
031  63 EX*
032  00  00
033  69 OP
034  20  20
035  61 GTO
036  00  00
037  06  06
038  68 NOP
039  76 LBL
040  14   D
041  75   -
042  43 RCL
043  98  98
044  85   +
045  01   1
046  22 INV
047  44 SUM
048  98  98
049  95   =
050  42 STO
051  95  95
052  61 GTO
053  01  01
054  45  45
055  76 LBL
056  11   A
057  47 CMS
058  01   1
059  00   0
060  69 OP
061  17  17
062  01   1
063  52 EE
064  01   1
065  00   0
066  42 STO
067  99  99
068  25 CLR
069  91 R/S
070  76 LBL
071  12   B
072  69 OP
073  20  20
074  72 ST*
075  00  00
076  91 R/S
077  61 GTO
078  00  00
079  72  72
080  76 LBL
081  13   C
082  42 STO
083  98  98
084  91 R/S
085  76 LBL
086  15   E
087  43 RCL
088  97  97
089  42 STO
090  00  00
091  73 RC*
092  00  00
093  91 R/S
094  97 DSZ
095  00  00
096  00  00
097  91  91
098  43 RCL
099  96  96
100  65   ×
101  01   1
102  00   0
103  95   =
104  94 +/-
105  91 R/S
106  61 GTO
107  00  00
108  87  87
109  69 OP
110  30  30
111  43 RCL
112  00  00
113  67  EQ
114  01  01
115  25  25
116  42 STO
117  97  97
118  97 DSZ
119  95  95
120  00  00
121  01  01
122  25 CLR
123  94 +/-
124  81 RST
125  43 RCL
126  97  97
127  42 STO
128  00  00
129  00   0
130  63 EX*
131  00  00
132  97 DSZ
133  00  00
134  01  01
135  30  30
136  01   1
137  44 SUM
138  96  96
139  61 GTO
140  00  00
141  04  04
142  00   0
143  00   0
144  00   0
145  02   2
146  52  EE
147  01   1
148  02   2
149  94 +/-
150  85   +
151  01   1
152  95   =
153  22 INV
154  52  EE
155  58 FIX
156  00  00
157  60 DEG
158  86 STF
159  40 IND
```

ZERO AS A CALLABLE LABEL - Myer Boland. Myer suggests adding the availability of zero as an additional label to the list of quirks in V8N3P3. He notes that you can address LBL Ø by hand or from a program by using IND A (or any other user defined key A through E'). For example with the following routines in user memory:

LBL C 100 RTN

LBL Ø 200 RTN

LBL A x IND A = RTN

LBL B x C = RTN

If you put a 5 in the display and press A you will get 1000. With a 5 in the display, pressing B will return 500. If you have a soft 5 (no decimal point) in the display, pressing C will yield 5100; but with a hard 5. (with a decimal point) pressing C will yield 100. With a soft 5 in the display, pressing IND A will yield 5200; but with a hard 5. in the display, pressing IND A (or IND E' or IND followed by any other user defined key) will yield 200.

The effect is as if there is one more user defined label.

Editor's Note: Myer didn't recall where he had seen this technique. My research shows that the effect was reported in V4N3P4 of 52 Notes by Maurice Swinnen, who stated that he had found the technique in the newsletter DISPLAY. Maurice reported that zero was the only numeral that worked this way, and that somehow data register 00 gets into the act. For example, if you had the number 123.55 in data register 00 and press the keys 5 2nd IND A with the routines above in the calculator and in TRACE mode then the integer portion of the contents of R00, or 123 will be printed at the right hand side on the line before 5200. RTN is printed. If you try the technique with no data registers (Ø Op 17) you get a flashing display.

EDUCALC MAIL STORE - Educalc sells software, accessories, books and supplies for portable computing. Devices covered range from the TI-59 and HP-41 to the CC-40 and the HP-75. The shipping and handling charge is only $1.00 no matter how large the order. Order from

Free Catalog

EduCALC Mail Store
27953 Cabot Road
Laguna Niguel CA 92677

That is a slightly different address than has been listed previously. If you order, mention TI PPC Notes. Items of interest to TI-59 users:

Stock No. A-514 - Leather Calculator Case for the TI-58/59. These hard leather cases are made of high quality, 7 to 8 ounce cowhide. They are perfect for outdoor applications such as surveying, construction or a machine shop environment. A belt loop is available on the back of each case. Light tan in color. $29.95.

Stock No. P-150 - Designed to fill a very real gap in TI's manual documentation. Also, appendices give useful information on Registers versus Program Memory and Pseudo-Instruction Codes. Gives procedures for interfacing CROM programs in user memory. $12.00. (Editor's Note: This is listed as the User Survival Guide for the TI-58/59 Master Library, but old timer's will recognize it as Fred Fish's book which has been previously mentioned in V6N6/7P1. Maurice is no longer providing these books for members.)

Stock No. I-159 - Problem Solving with the Programmable Calculator by Dunlop and Sigmund. This unique approach to problem-solving will develop your programming skills. Here are dozens of puzzles, games and simulations for a wide variety of applications in math and science. Each activity comes complete with detailed user instructions, flowcharts and/or keystroke listings, and solutions. 227 pages, soft bound. $10.95. (Editor's Note: This book was reviewed by Maurice Swinnen on V8N1P16).

Stock No. M-135 - Curve Fitting for Programmable Calculators (Second Edition) by William Kolb. Formulas, graphs, and sample problems for a huge assortment--38 in all--of different curves to be fitted to your data. Most of these are for one independent variable, but multiple linear regression is also covered, along with exotics like Hoerl Functions and Logistic Curves. The equations are designed for any programmable calculator; however, you may need to change register assignments if you have fewer than 100 data registers. HP-41 programs and barcodes are included for half of these curves. In addition some program listings are given for the HP-75 and the TI-59. 148 pages. Spiral bound. $13.95. (Editor's Note: I reviewed this book on V8N2P20).

Stock No. B-81 - Programmable Calculators: Business Applications by Aronofsky, Frame and Greynolds. For the manager, analyst, or student who wants a more business-like and understandable treatment than the TI-58/59 manuals offer, this comprehensive introduction is a spin-off of an MBA course at SMU. 203 pages, softbound. $11.95.

Stock No. P-141 - Calculator Programming for Chemistry and the Life Sciences by Frank Clarke. This book gives students and lab scientists new approaches to experimental design and data interpretation with specific detailed examples. The four main topics are Molecular Formulas, Coordinate Transformations (for X-ray crystallography), Potentiometric Titrations, and Correlation Analysis (up to 5 variables). Programs are given for the TI-59 with printer. 226 pages. $26.50.

<u>MODULE SELECTOR</u> - V5N8P3 and V7N1/2P25 described module selectors which permit selection, either from the keyboard or under program control, of up to four modules. The devices are available from American Microproducts Inc., 705 North Bowser, Richardson TX 75080 or call them at (214)-238-1815. Joseph Thomas who has one of the devices writes:

A word of caution to those fellow programmers who use the automatic module selector. One sleepless night I decided to put my ams through its paces and found some interesting results. The instructions for accessing a module are

X 77 Op 04 Op 06

where X is the module port and ranges from zero through three. This is not the only way to access the modules. It seems that if the alphanumeric code for Σ (77 from the print code table) occurs anywhere in the program the ams senses it and transfers (switches) to the appropriate (or depending on the situation, inappropriate) module. That is, a legal command is

X 77 Op Y Op Z

where X is the module port, Y is 1 through 4, and Z is 5. This might enable the user to print prompt statements such as

ACCESSING MODULE XΣ

with an Op 05 command. But at the same time the user must be careful not to inadvertently transfer module connections during a critical point in his program. Consider some examples:

13 77 Op 04 Op 06

prints an AΣ and selects port 3, while

19 77 Op 01 0 77 Op 03 Op 05

prints 8Σ   Σ and selects port 1 as controlled by the Op 01 command. Furthermore, suppose that some part of a user program contains a Σ+ command. While listing a program the module selector will switch to port 1 no matter where it is originally located. It is not the key code 78 which initiates the switching process, but seems to be the Σ character which has a print code 77.

Editor's Note: I do not have a module selector, so I am unable to verify these effects. Readers who use the ams are invited to comment.

<u>OTHER TI-59 PERIPHERALS</u> - The following page describes two other peripherals which are available for use with the TI-59. I do not own, nor have I used, either of these devices. Contact the manufacturers for more information. Readers with experience with either device are invited to comment.

<u>SNYDER's CHALLENGE</u> - Ralph Snyder's Challenge (V8N1P18) must have been too hard. Ralph agrees that it may have been a little cryptic, and he should have provided a definition of the symbol v in his formula (5). It's a standard symbol for $(1+i)^{-1}$. The single response chose to tackle the problem from an entirely different aspect, not consistent with Ralph's guidelines. The bottom line is that all bets are off, and no prize money was paid. Case closed.

HUGE STORACE CAPACITY- PROGRAM OR DATA

*****SAVE UP TO $1000.00*****

This coupon is good until May 30, 1983 for a five percent discount on Hand Held Products, Inc. EPROM Memory Storage Units ordered through Educalc and is limited to a maximum value of $1,000.00 on a single purchase of hardware. Limit of one coupon per company or person per purchase during the discount period.

***** MAIL BEFORE MAY 30, 1983*****

FOR HP-41C/CV USERS AND NOW AVAILABLE FOR TI 58C/59 USERS

Storage capacities of 4K, 8K, 16K, and even 32K bytes are possible for the HP-41 and up to 10K bytes for the TI 58/59.

This added memory is accomplished through the use of EPROM (Eraseable Programmable Read Only Memory) technology and emulates the ROM (Read Only Memory) capability of your hand held computer. The advantages are the following:

1. Significantly larger memory capacity than is available through a custom ROM module!
2. The speed of delivery and programming time, typically 2 weeks delivery versus months for a custom ROM!
3. EPROM's are eraseable (with ultra-violet light) and therefore can be updated or changed to foil murphy's law at a relatively low cost.
4. Complete system support for in-house design.
5. Low power circuit technique, no battery required.

This expanded storage space can be used to maintain large reference tables or program libraries or both. It's ideal for field sales and service, in-house engineering or professional software development organizations. Relatively low volume projects become cost effective. EPROM modules plug directly into the HP-41 (any port) or the TI 58/59 (using an adapter) with no modification. All RAM space remains available for your use.

HP-41 APPLICATION

Two memory units are available, 16K and 32K bytes. Physically they are the same size (3.6" x 5.8") about the size of your HP-41. Since its introduction in November 1981 by Hand Held Products, Inc., the system support has grown to include the following:

1. A User Code Compiler (UCC) which is a full function cross-compiler for the HP-41. Working with a text editor, the programmer develops source user code with all desired comments/notes/definitions embeded as simply as drafting a letter on a word processor. When ready to compile, the programmer directs UCC to cross-compile the program and produce (A) a fully documented source code listing; (B) complete cross reference index of register, flag and label utilization and optionally; (C) a printer bar code image file.
2. A ROM Development System (RDS) handles all of the functions necessary to build, interlink, catalog and burn the EPROM chips with minimum technical input. All software tools are designed for the CP/M operating system and are fully operational on the Osborn I and IBM-PC with baby blue.

TI 58/59 APPLICATION

The most recent development by Hand Held Products has been an EPROM package for the TI 58/59. It consists of an interface adapter (HHP-IA) which plugs into the back of the TI 58/59 and a plug-in program module (HHP-PM). It offers twice as much storage (10K bytes) as a custom ROM and is small enough to fit into the PC-100 printer storage compartment (2.5" x 2.25"). No calculator or printer modification is required. Private or Non-private mode may be used. System support for the TI 58/59 includes the following:

1. 10K RAM/ROM emulator board for the IBM-PC to support program testing of application libraries without the necessity of burning EPROM's.
2. Source programs can be created using the User Language Translator (ULT) software system. ULT accepts source code created by the programmer using a standard word processing editor and cross compiles it into native TI 58/59 binary code while producing a detailed source listing with user comments for evaluation. The binary program modules are linked, down loaded to RAM/ROM for testing and formulated for EPROM storage using the ROM Build System (RBS). Several other methods are available to create EPROMS for the HP-41. For example, programs stored on magnetic cards or HP Development system disc may be converted to EPROM storage through Hand Held Products. OEM application support services include EPROM production, custom labeling, and application development assistance.

For additional information, Call Hand Held Products. (704)377-3841

PRICE LIST	HP-41
HHP-16K (HP EPROM)	$241.00
HHP-32K (HP EPROM)	495.00
HHP-IA (TIAdapter)	199.00
HHP-PM (TI EPROM)	55.00
HHP-EB (TI Emulator BD)	1495.00
One Time Charge	
HHP-ULT (TI User Language Trans)	995.00(Lease)
HHP-RBS (TI ROM Build System)	395.00(Lease)
HHP-UCC (HP User Code Comp)	395.00(Lease)
HHP-RDS (HP ROM Develop Syst)	295.00(Lease)

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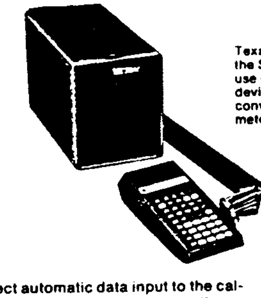
TECHNICAL BULLETIN

59 12 ?1

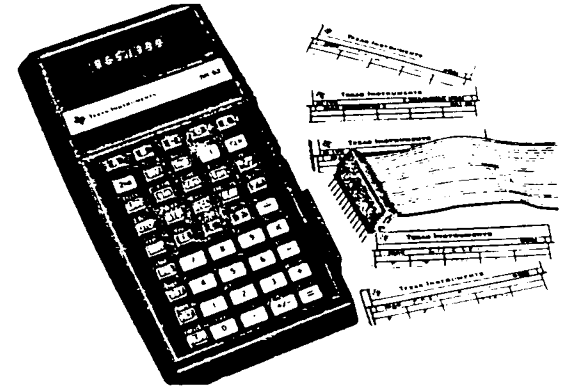
DC-59 Texas Instruments Programmable Calculator Interface

SAC DC-59 free-standing Model 59 or 52 interfaces consist of two printed circuit boards and a power supply, housed in a small, attractive cabinet, for use with a Texas Instruments' SR-59 or SR-52 hand-held programmable calculator. One cable is supplied which connects the interface to the calculator. The user's calculator is modified by SAC to accept this cable.

Input from the user's device to the interface is via a 50 pin connector. A 50 pin cable transition card is supplied for the user to construct a cable between the device to be monitored and the DC-59. This innovative approach expands the use of the calculator by providing a means of simulating keyboard closures on the calculator. The interface is designed to connect any standard output devices such as digital voltmeters, A/D convertors, event counters, frequency meters, and strain gauges to the programmable calculators. The combination of TI's vast library of programs and the speed and convenience of direct automatic data input to the calculator can significantly increase the utility of these electronic tools. SAC's free standing interfaces represent the first non-keyboard entry devices for use with hand-held programmable calculators. The DC-59 allows the user to create his own solutions to problems by programming the TI calculator.



Providing a non-keyboard entry for Texas Instruments' hand-held calculators, the SAC Model DC-59 Interface allows the use of the calculator with standard output devices such as digital volt meters, A/D converters, event counters, frequency meters, and strain gauges.



Each Texas Instrument SR-59 or SR-52 programmable calculator is modified for use in the SAC system by the addition of a simple, plug-in connector. The addition of the connector does not affect the functioning of the calculator in any way. The interface simulates key closings on the calculator to allow the rapid input of graphic data.

Specifications*

Components:	Cabinet Interface Electronics Power Supply Calculator Cable Calculator Modification Interface Input Connector
Physical Dimensions:	Height: 5" Width: 4" Depth: 6" Weight: 3 lbs.
Controls:	Power (On/Off).
Data Input:	Standard TTL/7400 series (Logic 1 equals high)
35 Input lines including:	32 Data Input lines 1 Data Ready line 1 Inhibit Data line 1 Signal Ground Input may be 8 BCD digits or 5 octal digits or used as 24 simple contact closures
Connector:	Input: 50 pin. Cable transition card supplied
Data Input Rate:	Dependent upon calculator and particular program being run
Power Required:	100-120 VAC 50-60 Hz 200-240 VAC 50-60 Hz
Ambient Temperature Range:	18°-50°C
Ambient Humidity Range:	0-90% non-condensing

*Specifications for sonic digitizer only. Refer to applicable Texas Instruments literature for programmable calculator specifications and list of available programs. Specifications subject to change without notice.

Printed in U.S.A.

<u>CC-40</u> <u>GRAPHICS</u> - Maurice Swinnen. These whimsical little programs illustrate the use of the CHAR command (page 5-15 of the <u>CC-40</u> <u>User's</u> <u>Guide</u> to generate user defined characters. The characters are then called in sequence to provide an illusion of motion. The first program moves a character across the screen while performing the old "jumping jack" exercise. The second program uses seven characters (all that are allowed) to generate a "soccer" figure which moves the ball back and forth across the screen.

JUMPING JACK

```
100 CALL CHAR(0,"0E0E150E04040A11"):CALL CHAR(1,"0E0E040E15040404")
110 FOR I=1 TO 31:FOR J=0 TO 1:DISPLAY AT(I),CHR$(J):PAUSE .3
120 NEXT J:NEXT I
130 FOR K=31 TO 1 STEP -1:FOR L=0 TO 1:DISPLAY AT(K),CHR$(L)
140 NEXT L:NEXT K
150 GOTO 110
```

SOCCER

```
100 CALL CHAR(0,"0E0E150E04040A11"):CALL CHAR(1,"001A1A1B06020509")
110 CALL CHAR(2,"0001050305191919"):CALL CHAR(3,"000105031D191901")
120 CALL CHAR(4,"150E04040A110E0E"):CALL CHAR(5,"0010141814131313")
130 CALL CHAR(6,"000B081B0C081412")
140 FOR A=10 TO 21:FOR B=0 TO 6:DISPLAY AT(A),CHR$(B):PAUSE .1
150 NEXT B:NEXT A:PAUSE .5
160 FOR A=21 TO 10 STEP -1:FOR B=6 TO 0 STEP -1
170 DISPLAY AT(A),CHR$(B):PAUSE .1
180 NEXT B:NEXT A:PAUSE .5:GOTO 140
```

<u>TI-99/4A</u> <u>SOFTWARE</u> <u>DIRECTORY</u> - This directory listing over 1200 software packages for the TI-99/4A contains both programs available from Texas Instruments and those developed by and available from third party authors. The directory can be purchased directly from TI at a cost of $5.95 plus $2.00 for shipping and handling. The directory is currently being updated for release in the fourth quarter of 1983 and will then include listings for more than 2000 software packaged.

Former <u>PPX</u> <u>Exchange</u> members will recognize the format of the index which includes cross-references by category, author and keyword with individual listings including a short abstract.

To obtain a copy send a check or money order to: Texas Instruments
Consumer Relations
P.O. Box 53
Lubbock, Texas 79408

Copies may also be obtained by calling 1-800-858-4565.

ACCURACY OF THE CC-40 SINE AND COSINE FUNCTIONS - Palmer Hanson

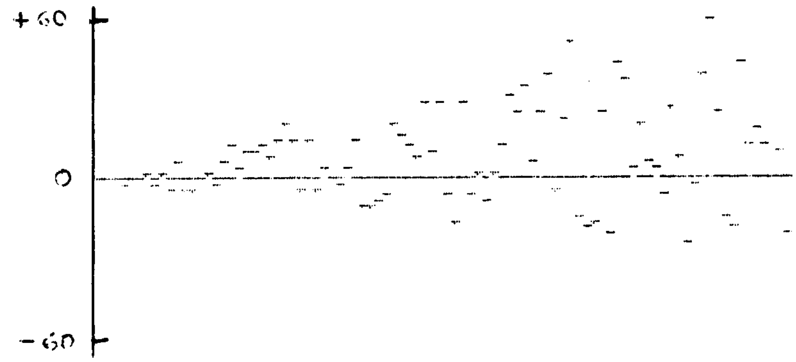
V8N3P18/19 presented George Thomson's analysis of the accuracy of the sine and cosine functions of the TI-58/59. The CC-40 calculates the trigonometric functions to fourteen places and might be expected to yield more accurate results than the TI-59. Examination of the CC-40 sine function for one degree increments from 0 through 90 degrees shows the following errors:

CC-40 Sine Errors

Mean Error = 8.2E-14

RMS Error = 18.3E-14

Peak Error = 59E-14



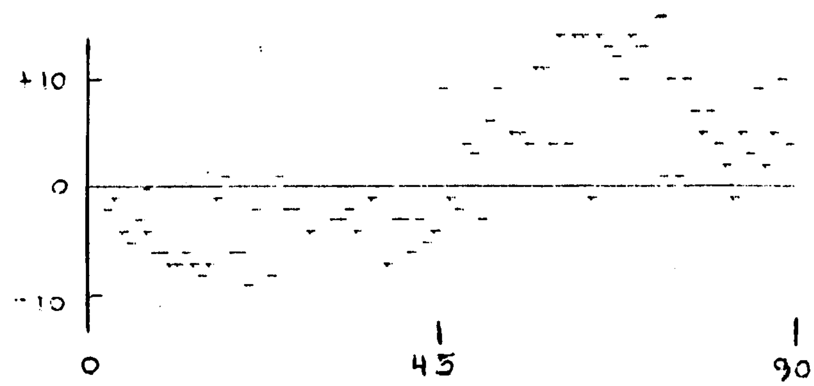
The peak error of 59E-14 occurs at 79 degrees. For a graphic comparison with the TI-59 results the following plots show the TI-59 errors without compensation (same as the top plot on V8N3P19) and the CC-40 errors using the same scale for both plots:

TI-59 Errors without any compensation

Mean Error = 1.6E-13

RMS Error = 6.8E-13

Peak Error = 17E-13

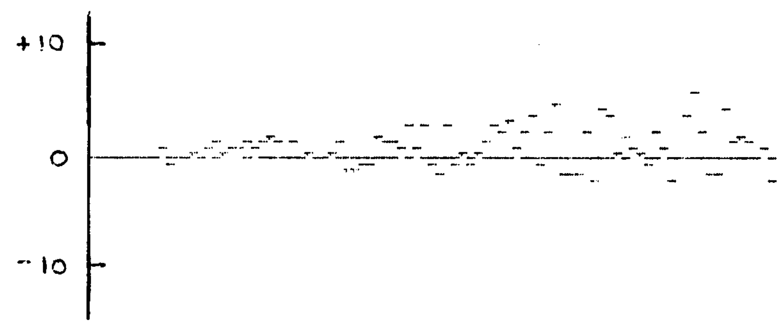


CC-40 Errors

Mean Error = 0.8E-13

RMS Error = 1.8E-13

Peak Error = 5.9E-13



Over the examined range the CC-40 results are nearly four times more accurate than the TI-59. As with the TI-59 the cosine function is less accurate over the same range. The mean cosine error is 5.8E-14, but the RMS cosine error is 37.1E-14, nearly twice that of the sine.

PROMPTING ON THE CC-40 - In V7N7/8P24 Maurice Swinnen described a multi-language capability built into the TI-88 such that prompting could be in English, German or French. The CC-40 provides an extended multi-language prompting capability through the use of the CALL SETLANG(n) command. The assigned language codes are:

0	English
1	German
2	French
3	Italian
4	Dutch
5	Swedish
6	Spanish

For n = 1 the system messages and error messages are in German. For example, the response to the incorrect entry sequence ATN(ENTER is "ungleiche Klammern". For any other value of n the system messages and error messages are in English. In response to the incorrect sequence ATN(ENTER the English response is "Unmatched parenthesis". This output of error messages in text is one of the attractive features of the CC-40. The user need not memorize error codes or translation tables to avoid frequent reference to the manual. The manual does provide extended discussion of each error message.

For programs from a Solid State Software™ module the prompts and messages from the module may be in any of the languages if supported by the particular module. My Mathematics module supports English, German and French. For the Prime Factors program the various messages are:

English	German	French
PRIME FACTORS	PRIMZAHLEN	FACTEURS PREMIERS
Use Printer?	Drucker benutzen?	Utilisation d'une Imprimante?
Enter # To Be Factored:	-> Zahl:	-> Nb a Decomposer:
Exit Program?	Programm verlassen?	Fin du Programme?

The responses to the questions asking for yes/no answers are Y or N in English, J or N in German, and O or N in French. I have not found any information in the manual for the Mathematics module which would tell me which languages are supported. Language codes 3 through 6 result in English messages for that module.

PRIME FACTORS WITH THE CC-40 MATHEMATICS MODULE - The speed of the prime factors program in the CC-40 Mathematics module is disappointing, about ten to forty percent faster than the fastest program for the TI-59, but substantially slower than some programs for the HP-41. Representative speeds for some of the standard problems are:

Program/machine	111111111111	103569859	987654321	9999999967
CC-40	11 sec	32 sec	41 sec	1 hr 55 min
Fast Mode Modulo 210		45 sec	58 sec	2 hr 8 min
Leeds FM (V8N2P26)	17 sec	46 sec	61 sec	2 hr 31 min
Acosta FM 58C	27 sec	61 sec	79 sec	3 hr 6 min
M/U Module - 59	43 sec	163 sec	215 sec	

PRIME FACTORS ON THE CC-40 (cont)

For large primes such as 9999999967 the execution speed of the CC-40 Mathematics module program is about $0.069\sqrt{N}$. Page 19 of the July 1981 issue of the PPC Calculator Journal reported a speed of $0.035\sqrt{N}$ for the HP-41C; but the HP-41C cannot maintain that speed for input integers of more than ten digits.

The CC-40 Mathematics module program has other deficiencies:

* The program stops as each factor is found. A better technique is to store the factors as they are found and continue the search until all factors are found. This minimizes operator attention. A simple additional routine provides for recall of the factors. The technique was illustrated in Laurance Leeds' Speedy Factor Finder in V8N2P26.
* Multiplicity of factors is not indicated. Indication of the multiplicity using a technique such as that devised by George Vogel in his prime factor program in the article "It Pays to Analyze Your Problem" in the January/February 1981 issue of PPX Exchange would be preferred. As George said in that article "Piecemeal presentation of results is slow and inconvenient (try factoring 7,247,757,312). Yet it is not difficult to make the program count the number of times each prime factor occurs, and output the count." George used a decimal point notation where the number after the decimal point indicated the multiplicity. For the number mentioned the output would be 2.28 and 3.03 meaning $2^{28}x3^3$.
* Although the CC-40 program can factor input integers of up to twelve digits, it does not provide an ability to recall the input integer correctly for more than ten digits. For example, factor the number 111,111,111,111. You will obtain the correct solution on the first pass, and an "N" in response to the prompt "Exit Program?" will bring the input value back to the display but in exponential notation 1.1111111E+11 . If you run with that value you will get the factors for 111,111,100,000 !

We will have to wait until someone finds out how to download the programs in the modules before we can know if there will be ways to use segments of the module programs, say in the manner in which we can enter the library modules of the TI-59 with the sequence Pgm-XX-SBR-nnn .

CC-40 PERIPHERALS - Peripherals for the CC-40 include a Printer/Plotter a Wafertape™ Digital Tape Drive, and an RS-232 interface. Currently, none of these are available in the Tampa Bay area. The devices are listed in the Sears Fall/Winter 1983 catalog (page 869), in the Educalc Mail Store catalog issue 16 (page 34), and in the Elek-Tek catalog Volume VI (page 17). Inquiries indicate the peripherals will be available in early fall.

Although the Manufacturer's Suggested Retail Price for the CC-40 is $249.95, catalog prices range from $199.99 (Sears) through $189.95 (Educalc) to $189.00 (Elek-Tek). I have seen the CC-40 at local discount houses for as low as $179.95. The CC-40 packs a lot of "bang for the buck" at those prices.

NEWCOMER'S SPECIALS - These are additional copies of old issues that Maurice Swinnen forwarded for disposition. As with V6N9/10 which was described in V8N3P23, these are single issues which are not parts of complete one year sets

V7N4/5, 1982 - This is another of Maurice's double issues which includes thirty pages. There are eleven complete programs; two, Bill Carpenter's Loan Repayment and Ralph Snyder's Rate of Return are of interest to those who work in business and finance. Bob Fruit"s pi program runs in fast mode and finds 460 digits in six hours eighteen minutes--the best for the TI-59 until the programs from Yugoslavia and France were published this year. My article on Powers of -1 examined that exercise from nearly every aspect. Charlie Williamson's 13 Digit Printer and Sidney Hack's 100 Random Integer programs were responses to earlier challenges. A copy of the index is at the right. Send two dollars (no checks, please) for a copy.

V7N6, 1982 - This single issue contains eighteen pages, with four programs and thirteen (count them) solutions to a puzzle proposed in V7N4/5. Dejan Ristanovic examines the responses of the TI-59 to twelve different hexadecimal codes and describes a way to place a TI-57 in a mode that minimizes energy use, effectively converting it to a TI-57C. George Thomson makes the observation that the correlation coefficient is a poor measure of the quality of a fit, and proposes a concise method for finding the standard error for a straight line fit using values already accumulated with the linear regression functions. A copy of the index is at the right. Send one dollar for a copy.

MORE PI FROM BASIC - V8N3P25/26 discussed finding pi in BASIC and gave several examples. More examples include:

	From 4*ATN(1)	From 2*ATN(N)
AMS-55 Reference	3.1415 92653 58979	3.1415 92653 58979
IBM PC Single Precision	3.1415 93	3.1415 93
Double Precision	3.1415 92979 43115 2	3.1415 92741 01257 3
HP-75	3.1415 92653 59	3.1415 92653 59

__13 DIGIT MODULO 30 SPEEDY FACTOR FINDER__ - Palmer Hanson. The original version of this program used the h-12 method for fast mode entry, with all of the attendant button pushing (PPX 398278). This revised version uses the STF IND at the end of the current partition technique (see page 3 of this issue). Previously published programs using the technique have all had a jump to location 001 at fast mode entry, a necessary feature associated with the initialization constant used. Use of the same technique with this programming would have caused substantial reprogramming effort. Reprogramming was minimized by using a jump to another location through use of another initialization constant. The selection of the appropriate constant was defined by Patrick Acosta in V6N8P3: when accessing fast mode the calculator will jump to address 8*(WXY) + Z + 1 where W, X, Y, and Z are the ninth through the twelfth digits. To use large segments of the existing h-12 type program as is I needed to jump to program location 230. Therefore, the ninth through twelfth digits needed to be 0235 yielding an address of (28*8 + 5 + 1 = 230 . A 2 is needed in the thirteenth digit for fast mode entry, and a one in the first digit avoids any flag setting problems. Therefore, the initialization constant selected was 1.000000002852 which is generated at locations 462 through 474 of the program.

The typical algorithm used for factor finding has been of the form

RCL 01 DIV RCL 02 = INV INT

The integer to be factored is in R01. The factor to be tested **is** in in R02. If the result is zero then the value in R02 is a factor of the value in R01. This algorithm permits factoring input integers of up to 12 digits. The truncation characteristics of the guard digits can be used to obtain a thirteen digit capability. While the ten digit display is obtained by rounding from the three guard digits as described on pages C-1 and V-5 of __Personal Programming__, the thirteen digits in the display register seem to be obtained in a truncated, not a rounded format. If we fill the display register with a thirteen digit integer and divide by a small integer such that the integer part of the quotient is still a thirteen digit number then a "built-in" integer function has been performed. We can use this characteristic to do modulo arithmetic to find prime factors with the program sequence

RCL 01 - (CE DIV RCL 02) x RCL 02 =

Again, if the result is zero the value in R02 is a factor of the value in R01. To cover the cases where the division yields a quotient with less than thirteen digits to the left of the decimal point we add an integer function to the sequence, yielding

RCL 01 - (CE DIV RCL 02)INT x RCL 02 =

where the double integer function which occurs when the quotient has thirteen digits to the left of the decimal point is an idiosyncrasy of the algorithm which does no harm.

The PRT command prints what is in the display, not what is in the display register. Thus, if the integer 111,111,111,111 had been synthesized in the display register, say with a key sequence such as 1111111111 x 100 + 11 = then the display will show 1.1111111 11, and that is what would be printed with a PRT command. The actual number could be recovered by the reverse of the entry process. An example appears in the Leeds Factor Finder program on V8N2P26/27.

13 DIGIT FACTOR FINDER - (cont)

This program prints all the digits of the input integer on one line by using a conversion algorithm similar to that originally developed by Robert Snow (V5N1P2). Integers of ten digits or less are printed using the PRT command. Integers of 11, 12, or 13 digits are printed using the routine from locations 250 through 315. That routine is used both for the input integer and for a final factor which is greater than ten digits. The use of indirect addresses is required to permit the converter to work in fast mode where subroutines are not allowed. The return addresses are set up before the converter routine is called.

The particular sequence of test integers in locations 001 through 167 was selected to provide an easy calculation of the return addresses from the multiplicity routine in locations 340 through 403.

Other features of the program include:

* Multiplicity of factors is indicated using the Vogel technique which has been discussed on page 13 of this issue.
* Factors are stored for later recall. Thus, when operating without a printer the program need not stop each time a fa tor is found.

Operating Instructions:

(1) Enter the program.

(2) Place the integer to be factored in the display register and press A. After a short time a flashing "1" will appear in the display. Do not clear it, but press 7 and then EE . The input integer will be printed followed by the factors with their multiplicity as illustrated at the right. A flashing "1" indicates that the solution is complete.

(3) To recall the input integer and the factors with their multiplicities, press B. The input integer will appear in the display. Press R/S as many times as needed to see the factors. A flashing "1" indicates that there are no more factors. This mode does not provide a printout since it is provided primarily for use without a printer.

(4) To test additional input integers, return to step (2) above.

```
1111111111111.
         3.01
         7.01
        11.01
        13.01
        37.01
       101.01
      9901.01


   7247757312.
         2.28
         3.03


 8074195354368.
         2.08
         3.06
        11.01
        13.02
        17.01
        37.02


    987654321.
         3.02
        17.02
    379721.01
```

Execution Times:

Execution times are somewhat longer than for the twelve digit factor finders due to the more complex test algorithm. The factors of 987654321 are found in about one minute thirty-three seconds. For large input integers the execution time is about $0.137\sqrt{N}$. After somewhat over 120 hours the program will declare 9,999,999,999,971 to be prime. Until the advent of the Science et Vie pi programs that was a long period.

13 DIGIT FACTOR FINDER - (cont)

Program Listing:

```
000 91 R/S
001 06 6
002 44 SUM
003 02 02
004 43 RCL
005 01 01
006 75 -
007 53 (
008 24 CE
009 55 ÷
010 43 RCL
011 02 02
012 54 )
013 59 INT
014 65 ×
015 43 RCL
016 02 02
017 95 =
018 67 EQ
019 03 03
020 40 40
021 04 4
022 44 SUM
023 02 02
024 43 RCL
025 01 01
026 75 -
027 53 (
028 24 CE
029 55 ÷
030 43 RCL
031 02 02
032 54 )
033 59 INT
034 65 ×
035 43 RCL
036 02 02
037 95 =
038 67 EQ
039 03 03
040 40 40
041 02 2
042 44 SUM
043 02 02
044 43 RCL
045 01 01
046 75 -
047 53 (
048 24 CE
049 55 ÷
050 43 RCL
051 02 02
052 54 )
053 59 INT
054 65 ×
055 43 RCL
056 02 02
057 95 =
058 67 EQ
059 03 03
060 40 40
061 04 4
062 44 SUM
063 02 02
064 43 RCL
065 01 01
066 75 -
067 53 (
068 24 CE
069 55 ÷
070 43 RCL
071 02 02
072 54 )
073 59 INT
074 65 ×
075 43 RCL
076 02 02
077 95 =
078 67 EQ
079 03 03
080 40 40
081 02 2
082 44 SUM
083 02 02
084 43 RCL
085 01 01
086 75 -
087 53 (
088 24 CE
089 55 ÷
090 43 RCL
091 02 02
092 54 )
093 59 INT
094 65 ×
095 43 RCL
096 02 02
097 95 =
098 67 EQ
099 03 03
100 40 40
101 04 4
102 44 SUM
103 02 02
104 43 RCL
105 01 01
106 75 -
107 53 (
108 24 CE
109 55 ÷
110 43 RCL
111 02 02
112 54 )
113 59 INT
114 65 ×
115 43 RCL
116 02 02
117 95 =
118 67 EQ
119 03 03
120 40 40
121 06 6
122 44 SUM
123 02 02
124 43 RCL
125 01 01
126 75 -
127 53 (
128 24 CE
129 55 ÷
130 43 RCL
131 02 02
132 54 )
133 59 INT
134 65 ×
135 43 RCL
136 02 02
137 95 =
138 67 EQ
139 03 03
140 40 40
141 02 2
142 44 SUM
143 02 02
144 43 RCL
145 01 01
146 75 -
147 53 (
148 24 CE
149 55 ÷
150 34 ΓX
151 32 X:T
152 43 RCL
153 02 02
154 54 )
155 22 INV
156 77 GE
157 01 01
158 71 71
159 29 CP
160 59 INT
161 65 ×
162 43 RCL
163 02 02
164 95 =
165 67 EQ
166 03 03
167 40 40
168 61 GTO
169 00 00
170 01 01
171 01 1
172 32 X:T
173 00 0
174 42 STO
175 03 03
176 95 =
177 67 EQ
178 02 02
179 03 03
180 85 +
181 93 .
182 00 0
183 01 1
184 95 =
185 72 ST*
186 08 08
187 42 STO
188 28 28
189 02 2
190 00 0
191 02 2
192 42 STO
193 27 27
194 02 2
195 00 0
196 03 3
197 42 STO
198 29 29
199 61 GTO
200 02 02
201 30 30
202 99 PRT
203 98 ADV
204 01 1
205 69 OP
206 41 41
207 66 PAU
208 81 RST
209 76 LBL
210 12 B
211 25 CLR
212 29 CP
213 09 9
214 42 STO
215 00 00
216 73 RC*
217 00 00
218 67 EQ
219 02 02
220 03 03
221 91 R/S
222 69 OP
223 20 20
224 61 GTO
225 02 02
226 16 16
227 68 NOP
228 68 NOP
229 68 NOP
230 25 CLR
231 22 INV
232 58 FIX
233 01 1
234 42 STO
235 06 06
236 52 EE
237 01 1
238 00 0
239 32 X:T
240 25 CLR
241 03 3
242 42 STO
243 05 05
244 43 RCL
245 28 28
246 22 INV
247 77 GE
248 40 IND
249 27 27
250 55 ÷
251 32 X:T
252 55 ÷
253 28 LOG
254 59 INT
255 42 STO
256 07 07
257 69 OP
258 27 27
259 22 INV
260 28 LOG
261 85 +
262 22 INV
263 59 INT
264 32 X:T
265 01 1
266 85 +
267 28 LOG
268 59 INT
269 65 ×
270 01 1
271 00 0
272 00 0
273 49 PRD
274 03 03
275 02 2
276 95 =
277 59 INT
278 44 SUM
279 03 03
280 32 X:T
281 65 ×
282 01 1
283 00 0
284 95 =
285 97 DSZ
286 07 07
287 02 02
288 61 61
289 48 EXC
290 03 03
291 84 OP*
292 06 06
293 69 OP
294 26 26
295 05 5
296 42 STO
297 07 07
298 25 CLR
299 48 EXC
300 03 03
301 97 DSZ
302 05 05
303 02 02
304 61 61
305 04 4
306 52 EE
307 09 9
308 22 INV
309 52 EE
310 69 OP
311 04 04
312 69 OP
313 05 05
314 83 GO*
315 29 29
316 68 NOP
317 99 PRT
318 01 1
319 00 0
320 42 STO
321 08 08
322 04 4
323 01 1
324 00 0
325 42 STO
326 03 03
327 04 4
328 03 3
329 05 5
330 42 STO
331 04 04
332 04 4
333 42 STO
334 00 00
335 29 CP
336 83 GO*
337 03 03
338 68 NOP
339 68 NOP
340 43 RCL
341 02 02
342 55 ÷
343 03 3
344 00 0
345 95 =
346 22 INV
347 59 INT
348 65 ×
349 08 8
350 95 =
351 59 INT
352 65 ×
353 02 2
354 00 0
355 85 +
356 01 1
357 95 =
358 42 STO
359 04 04
360 00 0
361 42 STO
362 07 07
363 43 RCL
364 02 02
365 22 INV
366 49 PRD
367 01 01
368 69 OP
369 27 27
370 43 RCL
371 01 01
372 75 -
373 53 (
374 24 CE
375 55 ÷
376 43 RCL
377 02 02
378 54 )
379 59 INT
380 65 ×
381 43 RCL
382 02 02
383 95 =
384 67 EQ
385 03 03
386 63 63
387 43 RCL
388 02 02
389 85 +
390 93 .
391 00 0
392 01 1
393 65 ×
394 43 RCL
395 07 07
396 95 =
397 72 ST*
398 08 08
399 69 OP
400 28 28
401 99 PRT
402 83 GO*
403 04 04
404 02 2
405 85 +
406 02 2
407 85 +
408 01 1
409 85 +
410 02 2
411 95 =
412 42 STO
413 02 02
414 02 2
415 22 INV
416 44 SUM
417 03 03
418 43 RCL
419 01 01
420 75 -
421 53 (
422 24 CE
423 55 ÷
424 43 RCL
425 02 02
426 54 )
427 59 INT
428 65 ×
429 43 RCL
430 02 02
431 95 =
432 67 EQ
433 03 03
434 60 60
435 97 DSZ
436 00 00
437 40 IND
438 03 03
439 61 GTO
440 00 00
441 21 21
442 76 LBL
443 11 A
444 98 ADV
445 47 CMS
446 42 STO
447 01 01
448 42 STO
449 09 09
450 42 STO
451 28 28
452 03 3
453 01 1
454 07 7
455 42 STO
456 27 27
457 03 3
458 01 1
459 08 8
460 42 STO
461 29 29
462 02 2
463 08 8
464 05 5
465 02 2
466 52 EE
467 01 1
468 02 2
469 94 +/-
470 85 +
471 01 1
472 95 =
473 22 INV
474 52 EE
475 58 FIX
476 00 00
477 60 DEG
478 86 STF
479 40 IND
```

IMPEDANCE MATCHING, ATTENUATING T-PAD CIRCUIT.- Maurice Swinnen. This program allows you to compute the three resistors necessary to form the t-pad circuit, with as inputs the input and output impedances and the attenuation in dB. As an added bonus, the program also computes the minimum attenuation in dB necessary to assure positive values for all three resistors and thus provide a realizable t-pad attenuator. To my knowledge, this is the first program to do that. Other programs, although computing the three values correctly, require you arrive at realistic values by a time-consuming "trial and error" method.

αmin (the minimum attenuation in dB) is determined as follows: since $R_1 = Z_1\left[\frac{N+1}{N-1}\right] - R_3$ and $R_2 = Z_2\left[\frac{N+1}{N-1}\right] - R_3$ for certain values of $R_3 = \frac{2\sqrt{NZ_1Z_2}}{N-1}$ $N = 10^{**}$, R_1 and R_2 can be negative. That is, for a given Zin and Zout there is a minimum , i.e. αmin, below which R_1 and/or R_2 are negative.

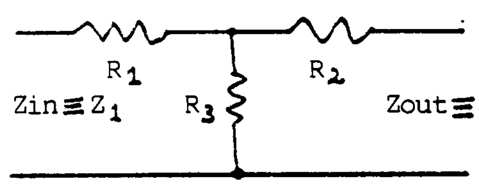
αmin is determined by solving the above equation for $R_1 = 0$, $R_2 = 0$, using the equation for R_3 which yields:

$$\alpha \text{ min} = 10\log_{10}\left[2Z-1 + \sqrt{4Z(Z-1)}\right] \text{ dB for } Z>1, \text{ where } Z = Z_1/Z_2 \text{ or } Z_2/Z_1.$$

USER INSTRUCTIONS: 1. To draw the circuit of a t-pad attenuator, press 2nd E'. For calculator use only, LBL E' may be omitted from the listing altogether without affecting the computation part of the program.

2. Enter attenuation required in dB and press A.
3. Enter the input impedance required, Zin, and press B.
4. Enter the output impedance required, Zout, and press C.
5. Compute the three resistance values in ohms: press D. When the printer is attached, values are printed with suitable descriptors. When the calculator only is used, the first value appearing in the display is R_3 . Press R/S to obtain R_2. Press R/S again to obtain R_1.
6. To obtain the minumum attenuation possible in dB, press E.
7. It is now possible to obtain new values for the three resistors, without re-entering Zin and Zout, by simply entering a new attenuation value, using either the minimum value computed in 6, or any other value you enter.

NOTE: If you are curious about the derivations of the above equation of αmin, just send me SASE and I will send you a copy of that two-page hand-written "opus". Typing it all out would have constituted an enormous chore and I am not even sure the editor would have wanted it in this article.



REF.: Reference Data for Radio Engineers, Howard W. Sams & Co. Inc. Indianapolis, 6th Edition, 1977, pp 11-3 to 11-9.

EXAMPLE: Design a t-pad circuit with 10 Kohm input impedance and 250,000 ohm output impedance. Is an attenuation of 10 dB possible? If not, what is the lowest attenuation possible. Design for that attenuation.

Press 2nd E'. See drawing.

```
--000----+-----000--
 R1      :      R2
       R 0
 ZIN   3 0     ZOUT
         :
---------+----------
```

Enter attenuation 10 and press A.	10.	A
Enter input impedance 10000 and press B.	10000.	ZIN
Enter output impedance 250000 and press C.	250000.	ZOUT
To compute R1, R2 and R3, press D.	35136.42	R3
	270419.14	R2
Note negative resistance for R3.	-22914.20	R1
Obtain minimum attenuation, press E.	19.9118	AMIN
Enter new attenuation 20 and press A	20.	A
Compute R1, R2 and R3 again, press D.	10101.01	R3
	244949.49	R2
	101.01	R1

IMPEDANCE MATCHING - ATTENUATING T-PAD CIRCUIT - (cont)

Program Listing:

000	76	LBL	065	03	3	130	76	LBL	195	02	02	260	69	OP	325	01	01	390	69	OP
001	11	A	066	07	7	131	42	STO	196	69	OP	261	06	06	326	06	6	391	05	05
002	42	STO	067	69	OP	132	43	RCL	197	06	06	262	22	INV	327	02	2	392	25	CLR
003	05	05	068	04	04	133	04	04	198	22	INV	263	58	FIX	328	69	OP	393	69	OP
004	65	×	069	43	RCL	134	55	÷	199	58	FIX	264	98	ADV	329	02	02	394	01	01
005	93	.	070	02	02	135	43	RCL	200	98	ADV	265	91	R/S	330	25	CLR	395	03	3
006	01	1	071	69	OP	136	05	05	201	91	R/S	266	76	LBL	331	69	OP	396	02	2
007	95	=	072	06	06	137	95	=	202	76	LBL	267	10	E'	332	03	03	397	69	OP
008	32	X:T	073	91	R/S	138	42	STO	203	15	E	268	02	2	333	03	3	398	02	02
009	01	1	074	76	LBL	139	06	06	204	43	RCL	269	00	0	334	05	5	399	25	CLR
010	00	0	075	14	D	140	65	×	205	01	01	270	02	2	335	00	0	400	69	OP
011	45	Y^X	076	02	2	141	43	RCL	206	55	÷	271	00	0	336	03	3	401	04	04
012	32	X:T	077	00	0	142	02	02	207	43	RCL	272	03	3	337	00	0	402	06	6
013	95	=	078	69	OP	143	95	=	208	02	02	273	02	2	338	00	0	403	02	2
014	42	STO	079	07	07	144	75	-	209	95	=	274	03	3	339	00	0	404	69	OP
015	00	00	080	69	OP	145	43	RCL	210	42	STO	275	02	2	340	00	0	405	02	02
016	85	+	081	19	19	146	03	03	211	07	07	276	03	3	341	69	OP	406	69	OP
017	01	1	082	25	CLR	147	95	=	212	32	X:T	277	02	2	342	04	04	407	05	05
018	95	=	083	43	RCL	148	32	X:T	213	43	RCL	278	69	OP	343	69	OP	408	02	2
019	42	STO	084	00	00	149	03	3	214	07	07	279	01	01	344	05	05	409	00	0
020	04	04	085	65	×	150	05	5	215	35	1/X	280	02	2	345	25	CLR	410	02	2
021	01	1	086	43	RCL	151	00	0	216	77	GE	281	00	0	346	69	OP	411	00	0
022	03	3	087	01	01	152	03	3	217	38	SIN	282	02	2	347	01	01	412	02	2
023	00	0	088	65	×	153	00	0	218	35	1/X	283	00	0	348	03	3	413	00	0
024	00	0	089	43	RCL	154	00	0	219	76	LBL	284	02	2	349	05	5	414	02	2
025	00	0	090	02	02	155	00	0	220	38	SIN	285	00	0	350	00	0	415	00	0
026	00	0	091	95	=	156	00	0	221	42	STO	286	02	2	351	00	0	416	02	2
027	00	0	092	34	√X	157	69	OP	222	07	07	287	00	0	352	03	3	417	00	0
028	00	0	093	65	×	158	04	04	223	75	-	288	04	4	353	02	2	418	69	OP
029	69	OP	094	02	2	159	32	X:T	224	01	1	289	07	7	354	69	OP	419	01	01
030	04	04	095	55	÷	160	58	FIX	225	95	=	290	69	OP	355	02	02	420	02	2
031	43	RCL	096	53	(	161	02	02	226	65	×	291	02	02	356	25	CLR	421	00	0
032	05	05	097	53	(	162	69	OP	227	04	4	292	02	2	357	69	OP	422	02	2
033	69	OP	098	43	RCL	163	06	06	228	65	×	293	00	0	358	04	04	423	00	0
034	06	06	099	00	00	164	22	INV	229	43	RCL	294	02	2	359	69	OP	424	02	2
035	91	R/S	100	75	-	165	58	FIX	230	07	07	295	00	0	360	05	05	425	00	0
036	76	LBL	101	01	1	166	87	IFF	231	95	=	296	02	2	361	04	4	426	02	2
037	12	B	102	54	)	167	07	07	232	34	√X	297	00	0	362	06	6	427	00	0
038	42	STO	103	42	STO	168	43	RCL	233	75	-	298	02	2	363	02	2	428	04	4
039	01	01	104	05	05	169	91	R/S	234	01	1	299	00	0	364	04	4	429	07	7
040	04	4	105	95	=	170	76	LBL	235	85	+	300	02	2	365	02	2	430	69	OP
041	06	6	106	42	STO	171	43	RCL	236	02	2	301	00	0	366	09	9	431	02	02
042	02	2	107	03	03	172	43	RCL	237	65	×	302	69	OP	367	00	0	432	02	2
043	04	4	108	03	3	173	06	06	238	43	RCL	303	03	03	368	00	0	433	00	0
044	03	3	109	05	5	174	65	×	239	07	07	304	03	3	369	69	OP	434	02	2
045	01	1	110	00	0	175	43	RCL	240	95	=	305	02	2	370	01	01	435	00	0
046	00	0	111	04	4	176	01	01	241	28	LOG	306	03	3	371	04	4	436	02	2
047	00	0	112	00	0	177	95	=	242	65	×	307	02	2	372	00	0	437	00	0
048	69	OP	113	00	0	178	75	-	243	01	1	308	03	3	373	00	0	438	02	2
049	04	04	114	00	0	179	43	RCL	244	00	0	309	02	2	374	03	3	439	00	0
050	43	RCL	115	00	0	180	03	03	245	95	=	310	02	2	375	02	2	440	02	2
051	01	01	116	69	OP	181	95	=	246	32	X:T	311	00	0	376	69	OP	441	00	0
052	69	OP	117	04	04	182	32	X:T	247	01	1	312	02	2	377	02	02	442	69	OP
053	06	06	118	43	RCL	183	03	3	248	03	3	313	00	0	378	04	4	443	03	03
054	91	R/S	119	03	03	184	05	5	249	03	3	314	69	OP	379	06	6	444	69	OP
055	76	LBL	120	58	FIX	185	00	0	250	00	0	315	04	04	380	00	0	445	04	04
056	13	C	121	02	02	186	02	2	251	02	2	316	69	OP	381	01	1	446	69	OP
057	42	STO	122	69	OP	187	00	0	252	04	4	317	05	05	382	04	4	447	05	05
058	02	02	123	06	06	188	00	0	253	03	3	318	03	3	383	01	1	448	69	OP
059	04	4	124	22	INV	189	00	0	254	01	1	319	05	5	384	03	3	449	00	00
060	06	6	125	58	FIX	190	00	0	255	69	OP	320	00	0	385	07	7	450	98	ADV
061	03	3	126	87	IFF	191	69	OP	256	04	04	321	02	2	386	00	0	451	98	ADV
062	02	2	127	07	07	192	04	04	257	32	X:T	322	00	0	387	00	0	452	98	ADV
063	04	4	128	42	STO	193	32	X:T	258	58	FIX	323	00	0	388	69	OP	453	25	CLR
064	01	1	129	91	R/S	194	58	FIX	259	04	04	324	69	OP	389	04	04	454	92	RTN

BOOK REVIEW - A Data Reduction Package for US Army Topographic Computers: Hand-Held Programmable Calculators. by Walter Blackmer. 14 May 1982. National Technical Information Service (NTIS), Springfield, VA, 22161. 103 pages. Paperback, $12.00 shipping included.

A number of subscribers have indicated an interest in surveying. This book may be of interest. The abstract in Government Reports Announcements (GRA) states:

> This study was done to provide the US Army with the basis for a standardized program package for use with hand-held programmable calculators. The programs are written and published in a format which is immediately useable with the Texas Instruments Programmable 59 Calculator, but which can easily be adapted for use with other programmable calculators. Other Department of Defense agencies mzy also find them valuable in training and operational efforts. The study includes a general overview of the history of the Topographical Engineers.

The accession number for the book is AD-A118 854/9. The listing appears on page 5405 of GRA dated December 17, 1982.

COMPLEX NUMBER ARITHMETIC - Maurice Swinnen called my attention to this article which appeared in the June 1983 issue of Microwaves & RF. The article "TI-59 Program Simplifies Complex-Number Arithmetic" is by Professor Darko Kajfez of the Unversity of Missippi. The article states:

> The program described in this article is an alternative to the EE module. The routine enables users of the TI-59 calculator to perform the four basic arithmetic operations on complex numbers without the need for any additional modules. The program hzs 114 steps and requires only four registers (26 through 29) and four flags (1 through 4).
>
> One of the benefits of the new program is that the instructions are easy to memorize, since the standard keys are used. For example, the "+" key is used for addition and the "1/X" key is used for inversion. Memory storage and recall are accomplished by means of the standard keys for these operations ("STO" and "RCL"). Thus, rules for operating the program are fairly simple, eliminating the "search-the-manual" syndrome that can occur with the EE module.

LIST PROCESSOR --- George Thomson's response to the list processor problem in V8N3P16 appears at the right. The top of the list is at R02. Enter the number of items in the list and press A. As you enter each item for the list press E. The program requires about 38 seconds to process a 60 item list.

```
000  76 LBL    015  42 STO    030  69 OP
001  15  E     016  00  00    031  31  31
002  82 HIR    017  73 RC*    032  82 HIR
003  08  08    018  01  01    033  18  18
004  03  3     019  69 OP     034  72 ST*
005  42 STO    020  31  31    035  01  01
006  01  01    021  72 ST*    036  32 X:T
007  43 RCL    022  01  01    037  92 RTN
008  02  02    023  02  2     038  76 LBL
009  32 X:T    024  44 SUM    039  11  A
010  82 HIR    025  01  01    040  47 CMS
011  17  17    026  97 DSZ    041  82 HIR
012  75  -     027  00  00    042  07  07
013  01  1     028  00  00    043  92 RTN
014  95  =     029  17  17
```

1287 DIGITS OF PI - translation by Maurice Swinnen. V8N3P8/9 presented a program from the French scientific journal "Science et Vie" which would calculate up to 1287 digits of pi. Pierre Flener had obtained permission for us to reprint the program. Maurice Swinnen has provided a translation of portions of the text, which has been reviewed and edited with the help of George Thomson and Bob Fruit. Palmer Hanson performed the final typing and editing, and hence must bear responsibility for any residual inaccuracy:

Large Numbers and Calculators: The Limits
by
Renaud de la Taille

(From "Science et Vie", 12/80, pages 54-57)

With the entry of the Japanese into the programmable calculator market, it has become difficult for amateurs to make a choice among the available calcuators. Since we have used several models to handle the difficult art of calculating large numbers, we have formed more accurate opinions about the performance and capacity of these astonishing machines.

Presenting the calculation of large numbers on small machines in our past issue, we thought to have reached the limits of these machines. We had also showed their possibilities to be well superior to what one had believed up to then. In response to that article, our readers have proven to us that we were rather far off the mark, and that the mathematical limits of these programmable calculators were, on the average, at least two times greater than we had thought.

This leads us to discuss this subject again in order to complete the study started in the last issue, and to answer the numerous questions posed to us. It behooves us to note that calculators have seemingly three uses, often rather distinct from each other:

* The resolution of scientific or technical problems such as the computation of the profile of the teeth in gears, or the determination of the positions of the planets for a given date.

* Mathematical games: the calculator acts as a game partner which may ask questions, give responses, and win the game.

* The science of numbers: the machine handles a multitude of arithmetic problems such as the determination of prime factors of integers, the determination of the limit of a series, the evaluation term by term of a series, etc.

Our former article was primarily concerned with this last field, the computation of large numbers, that is, obtaining numeric values with the largest possible number of digits (that is, significant figures). This kind of calculation can be useful for all sorts of values: mathematical constants, logarithms, exponentials, roots, quotients, sums of series, and so on.

The entire art consists of finding the right formula in order to design a short and simple program, and to use the largest possible number of memory registers. As an example, we have previously discussed the calculation of the two most important mathematical constants, e and pi. We had arrived at more than 600 digits with a TI-59 and thought it to be rather difficult, even impossible, to go any further.

1287 DIGITS OF PI (cont)

Well, we were mistaken by a factor of two: on a TI-59 one can evaluate pi to 1287 digits, which exceeds by far the record announced at the round table conference at the Palais de la Decouverte (The Palace of Discovery) at Paris. But we must admit that we would have never arrived at this result without the help of our readers.

Especially, we have to mention M. Labat of Paris, M. Brombeck of Marckolsheim, M. Colmont of Brive-la-Gaillarde and M. Molinaro of Nantes. Thanks to their contributions we have been able to redesign the programs we presented in our last article and go a large step farther in the calculation of pi. The records are:

* 250 digits on the HP-67 by M. Molinaro.

* 576 digits on a TI-58 by M. Brombeck.

* 1287 digits on a TI-59 by M. Colmont.

On the other hand, the programs we have reworked for the HP-41C have allowed us to obtain 3600 digits; but the calcuation requires the enormous time of four months.

In order to reach these large numbers of digits one has to start with the series

pi/2 = 1 + 1/3 + 1*2/3*5 + 1*2*3/3*5*7 + 1*2*3*4/3*5*7*9 + ...

Thus pi/2 is equal to the sum of the series k!/1*3*...(2k + 1) from k = 0 to k = x. This series can easily be factored by Horner's method, which gives

pi = ((...((2n/(2n+1) + 2)(n-1)/(2n-1) + 2)(n-2)/(2n-3) + 2)(n-3)/...) 1/3 + 2.

This method avoids the addition of terms of the series to the preceding sums. The resulting program contains only a multiplication and a division.

One will easily recognize the multiplication and division loops in the programs presented. In the other parts, which were much shorter, n went to 2n+1, then to n-1 for the next cycle after having added the 2.

Some of our correspondents redesigned the programs based on the same principle, but in a more subtle way, which permits reduction of execution time. The chief prize for it goes to M. Molinaro who succeeeded in halving the execution time on the HP-67 by replacing the returns with labels with returns with GSB, and in this way increasing the number of available memory registers.

There are others who made the multiplication and division within the same loop further reducing execution time. Finally, one gains a lot of execution time using the HIR's on the TI calculators. Let us remind you that these codes give access to internal registers reserved for the levels of parentheses, but are not accessible from the keyboard. A little trick is all that is needed: in order to code, say HIR 46, of which the machine code is 82 46, one simply keys in SUM 82 SUM 46, after which by means of BST and DEL one removes the two 44 codes from the SUM commands, and what remains is 82 46.

1287 DIGITS OF PI (cont)

The first digit of the second part of the HIR command indicates the operation to be performed. The second digit indicates which of 8 registers will be used. As an example, for register 6 HIR 06 = STO 6, HIR 16 = RCL 6, HIR 46 = PRD 6, HIR 56 = INV SUM 6, and HIR 66 = INV PRD 6.

While the program does have one level of parenthesis, we still have registers 3, 4, 5, 6, 7, and 8 available. It is through the use of these registers that M. Brombeck was able to arrive at 576 digits with a TI-58.

It should be well understood that the same procedures could be used in any arithmetic computation; the number pi, the most important of all mathematical constants, has simply served as an example. But one could as well calculate e which is still easier (there is no division whatsoever), a fifth root, the prime factors of a large number, etc.

What one looks for in such a problem is a short program and a large number of memory registers. Let us note that the ideal consists of writing a complete program, which has a data entry system without any superfluous manipulation, and an output of the results which is simple and direct. In this sense, in the programs which we publish, the only complete one is that for the HP-67; one has only to enter the number of digits one requires, from 10 to 250 in increments of 10. Key D provides an output of all the decimals without the possibility of forgetting any of them.

One could have made similar programs for the HP-41C, for the TI-58/59, and for the Sharp, which have selectable partitioning between program memory and data memory, but at the expense of some of the digits in the solution. We should also add that the large numbers obtained are not always easy to manipulate, and that one shouldn't forget the leading or trailing zeros.

Only the HP-67 program collects the decimals of pi in the form 0.abcde where one retains only the five digits following the decimal point, even for numbers such as 00357 or 23040. ... On the TI-58/59 the numbers are in the form uvwxyz.abcdefg and one reads 6 digits in front of and 7 digits beyond the decimal point. If necessary, one should add leading zeros or trailing zeros as needed to make up the proper number of digits.

Editor's Note: The remainder of the article has not been completely translated to date. It is primarily concerned with more detailed discussion of each calculator in terms of capabilty, price, etc. Only the portions that discuss the TI-58/59 are printed below.

The TI-58: For its price it is the one that offers the greatest possibilities. It has a very large number of registers, the memory can be partitioned, it has all the useful mathematical functions, and it has superb precision thanks to the 13 digits in each register. It also is very complete with respect to programming having all the tests needed, the control of loops, subroutines, symbolic addressing and direct addressing, user-defined keys, etc. It is also a subtle machine in which the capabilities surpass the instructions in the manual: it is thus possible to create loops (Dsz) with any register, not only registers 0 through 9, and one may use the registers reserved for parenthesis by using the HIR commands.

1287 DIGITS OF PI (cont)

TI-58/59 Program Description: We made a program as short as possible in order to keep the largest number of data registers available for the digits. One can obtain 507 digits in 87 hours with the TI-58 and 1287 digits in 24 days with the TI-59. 1000 digits are reached in 15 days. (Editor's Note: One must reduce the number of registers which will be used to support only the number of digits desired if one wishes to minimize execution time. The number of registers to use must be entered at program locations 125/126 in the LRN mode prior to running the program.) And, one has to calculate the number of terms to be used as a function of the number of digits desired, and enter that value at the start of the program. The number of terms must be greater than the number of digits divided by log 2.

The TI calculators are more delicate to program than the HP calculators, and one should pay careful attention to the order of the operations.

Editor's Note: In another section you will see that I have been able to optimize the TI-59 program in two areas:

* Fast mode has been added using the STF IND technique such that execution time is reduced by about a factor of 0.56 .

* A data entry system has been added using the portion of bank 1 from program locations 160 through 239. The number of digits desired is entered (from 1 to 1287 in increments of 1) and user defined key A is pressed. The program calculates and stores both the number of memory registers and the number of terms.

1287 DIGITS OF PI IN FAST MODE - Program Listing

000	91	R/S	040	01	1	080	55	÷	120	00	00	160	00	0	200	02	2
001	81	RST	041	52	EE	081	82	HIR	121	43	RCL	161	00	0	201	28	LOG
002	69	OP	042	06	6	082	16	16	122	00	00	162	00	0	202	54	)
003	20	20	043	75	-	083	54	)	123	32	X:T	163	00	0	203	85	+
004	25	CLR	044	59	INT	084	59	INT	124	85	+	164	00	0	204	01	1
005	29	CP	045	65	×	085	65	×	125	82	HIR	165	00	0	205	54	)
006	82	HIR	046	32	X:T	086	32	X:T	126	18	18	166	00	0	206	59	INT
007	16	16	047	01	1	087	82	HIR	127	67	EQ	167	00	0	207	82	HIR
008	66	PAU	048	95	=	088	16	16	128	01	01	168	00	0	208	06	06
009	67	EQ	049	65	×	089	85	+	129	36	36	169	00	0	209	43	RCL
010	00	00	050	01	1	090	32	X:T	130	65	×	170	00	0	210	00	00
011	01	01	051	52	EE	091	63	EX*	131	00	0	171	00	0	211	85	+
012	73	RC*	052	06	6	092	00	00	132	95	=	172	00	0	212	01	1
013	00	00	053	95	=	093	22	INV	133	61	GTO	173	00	0	213	02	2
014	32	X:T	054	74	SM*	094	59	INT	134	00	00	174	00	0	214	95	=
015	55	÷	055	00	00	095	95	=	135	67	67	175	00	0	215	55	÷
016	01	1	056	97	DSZ	096	65	×	136	03	3	176	00	0	216	01	1
017	52	EE	057	00	00	097	01	1	137	82	HIR	177	00	0	217	03	3
018	07	7	058	00	00	098	52	EE	138	56	56	178	00	0	218	95	=
019	85	+	059	12	12	099	07	7	139	02	2	179	00	0	219	59	INT
020	73	RC*	060	02	2	100	75	-	140	82	HIR	180	00	0	220	82	HIR
021	00	00	061	82	HIR	101	53	(	141	66	66	181	00	0	221	08	08
022	22	INV	062	46	46	102	24	CE	142	52	EE	182	00	0	222	01	1
023	59	INT	063	01	1	103	55	÷	143	05	5	183	00	0	223	08	8
024	65	×	064	82	HIR	104	82	HIR	144	44	SUM	184	00	0	224	07	7
025	82	HIR	065	36	36	105	16	16	145	01	01	185	00	0	225	02	2
026	16	16	066	32	X:T	106	54	)	146	61	GTO	186	00	0	226	52	EE
027	75	-	067	69	OP	107	59	INT	147	00	00	187	00	0	227	01	1
028	22	INV	068	20	20	108	65	×	148	04	04	188	76	LBL	228	02	2
029	59	INT	069	65	×	109	32	X:T	149	68	NOP	189	11	A	229	94	+/-
030	72	ST*	070	01	1	110	82	HIR	150	68	NOP	190	42	STO	230	85	+
031	00	00	071	52	EE	111	16	16	151	68	NOP	191	00	00	231	01	1
032	85	+	072	06	6	112	95	=	152	01	1	192	09	9	232	95	=
033	32	X:T	073	85	+	113	32	X:T	153	00	0	193	69	OP	233	22	INV
034	59	INT	074	73	RC*	114	55	÷	154	69	OP	194	17	17	234	52	EE
035	65	×	075	00	00	115	01	1	155	17	17	195	53	(	235	58	FIX
036	82	HIR	076	59	INT	116	52	EE	156	47	CMS	196	53	(	236	00	00
037	16	16	077	75	-	117	07	7	157	61	GTO	197	43	RCL	237	60	DEG
038	95	=	078	53	(	118	95	=	158	00	00	198	00	00	238	86	STF
039	55	÷	079	24	CE	119	74	SM*	159	02	02	199	55	÷	239	40	IND

1287 DIGITS OF PI IN FAST MODE - Palmer Hanson. I started the conversion of the Science et Vie program to fast mode as a demonstration of the ease of conversion when using the STF IND technique combined with Patrick Acosta's method for jumping to program locations other than 001. I soon found that there was adequate space to provide a data entry system which only requires that the number of digits be entered, and which also automatically selects the minimum number of registers as suggested by George Thomson on page 2 of this issue. Two penalties result:

* The output routine at locations 149 through 159 of the original program is eliminated. It is necessary to key in an output routine at the completion of the calculations.
* It is necessary to return to the start-up partitioning and reenter the program for each new solution.

The program revision concept is to begin execution in that part of bank 1 which includes program steps 160 through 239, set partitioning 9-Op-17 for use by the STF IND fast mode entry at locations 238/239, calculate the number of terms (iterations) and the minimum number of data registers from the number of digits desired and store the values in the appropriate locations, and set up for fast mode entry. At fast mode entry the program jumps to program location 152, changes the partitioning to 10-Op-17, clears the data registers with a Cms, and jumps to location 002 to begin the normal Science et Vie calculations, but in fast mode. The changes required to the original program as listed on V8N3P9 are:

1. Place a R/S RST sequence at program locations 001/002. These commands provide the transparent fast mode exit as defined in V7N1/2P23.
2. Change the address for the EQ command at program locations 010/011 from 149 to 002. The transfer at the completion of the calculations is changed from going to the start of the output routine at location 149 (which will no longer exist) to going to the transparent fast mode exit sequence.
3. Change the 39 at locations 125/126 to HIR 18. The minimum number of registers needed will have been previously stored in hierarchy register 8 by the input routine.
4. Replace the output routine which had been at locations 149 to 159 with a routine which sets partitioning to 10-Op-17, clears the data memories, and transfers the program to location 002.
5. Add the input routine and fast mode initialization sequence at locations 188 through 239. Locations 195 through 208 calculate the number of terms using the formula defined in V8N3P8, and store the result in hierarchy register 6. Locations 209 through 221 calculate the minimum number of data registers required, and store the result in hierarchy register 8. Locations 222 through 239 set up for fast mode entry. The 187 at locations 222/223/224 provide the transfer address of 18*8 + 7 + 1 = 152 as defined by Patrick Acosta in V6N8P3.

The revised program listing, which should be recorded with partitioning 6-Op-17 (the turn-on partitioning), appears on the facing page at the end of the Science et Vie article translation (page 24).

1287 DIGITS OF PI IN FAST MODE - (cont)

Operating Instructions:

(1) Enter the program.

(2) Enter the number of digits desired and press A. After a short period a flashing "1" will appear in the dispaly. Do not reset it, but press 7 and then EE. At the end of the calculations the calculator will stop with a zero in the display.

(3) The solution appears in data registers R01 through R99 as required. You may simply read these values out with sequential RCL statements from the keyboard, thirteen digits at a time, in the format with six digits to the left of the decimal point and seven to the left. You must add leading or trailing zeros to make up that many digits.

As one alternate method of readout you may key in the short seventeen step program at the right. The sample printout is for an input asking for thirty digits.

A second alternative is to record banks 1 through 4 as required and use one of the thirteen digit print routines to print the results.

(4) To run an additional solution, return to the startup partition, re-enter the program card, and go to step (2) above.

```
000  76 LBL
001  12  B
002  01  1
003  42 STO
004  00  00
005  73 RC*
006  00  00
007  75  -
008  59 INT
009  99 PRT
010  95  =
011  99 PRT
012  69 OP
013  20  20
014  61 GTO
015  00  00
016  05  05
```

```
   314159.
0.2653589
   793238.
0.4626433
   832792.
0.2563632
        0.
        0.
        0.
        0.
        0.
```

Sample Execution Times:

Number of Places Wanted	Normal Mode from V8N3P9	Fast Mode
20	52.5 minutes	7.3 minutes
100	4 h 33 m	2 h 10 m
500	3d 18h 12m	2d 1h 16m
1287	24.55 days	13.39 days

The great improvement in speed for the 20 digit case is due to the use of only two data registers with the automatic calculation, where in the test with the original program I had used a Nop at location 125 yielding the use of nine data register. The execution time listed for 1287 digits for the fast mode program is an extrapolation based on the number of iterations completed after five days. One of my TI-59's is still running as of this writing, and will not finish the 1287 digit problem until after V8N4 is published.

STEREO GRAPHICS WITH BALL-STICK OPTION - Don Graham.

This is a highly comprehensive modular system of programs designed to place at the disposal of TI-59/PC-100 users a relatively simple means of generating accurate professional-quality drawings of three-dimensional objects. Although other programs are available that will do this (see, for example, the 3D Graphics Pakette, or Lester Tibbetts' program in V7N3P9), this system has numerous special features that make it,so far as I know, unique. The principal unique feature, but by no means the only one, is that it contains special routines to make it easy to draw ball-stick molecular-type models.

The system consists of 21 semi-independent programs in four groups: data entry, data manipulation, special ball-stick programs, and output. Since all the programs operate on a common database, additional special-purpose routines could be added by those who need them.

The data entry programs permit entry of up to 216 coordinates at a time, either point-by-point, or automatically from user-written subroutines in any of a variety of coordinate systmes.

The data manipulation programs permit an almost unlimited range of transformations of the coordinates in memory. Besides provision for all the usual transformations such as translations, rotations, scaling, etc. It is also possible to perform almost any other transformation imaginable by means of user-written subroutines.

The output programs can print lists of coordinates in memory, or generate coordinates for perspective drawings. All output is fully labeled, as is most input.

This is NOT a graphics mode program. All it does is provide coordinates for hand-plotting. It is a "straight" program that doesn't use any unpublished quirks, but does use HIR and two-digit Dsz. It is not a demonstration program. It is intended as a workhorse system for persons who wish to make accurate professional-quality drawings of 3D objects without the expense of a computer graphics system. The Math/Utilities module is required.

Some examples of stereo pairs of drawings, generated with the aid of the system, are shown on the next page. The drawings are placed for crossed, rather than parallel, viewing. That is, the image intended for the left eye is on the right, and vice versa. They are easily viewed by crossing the eyes, then uncrossing them until the images fuse. Most persons seem to find that this gives a better stereo effect than the more conventional parallel method.

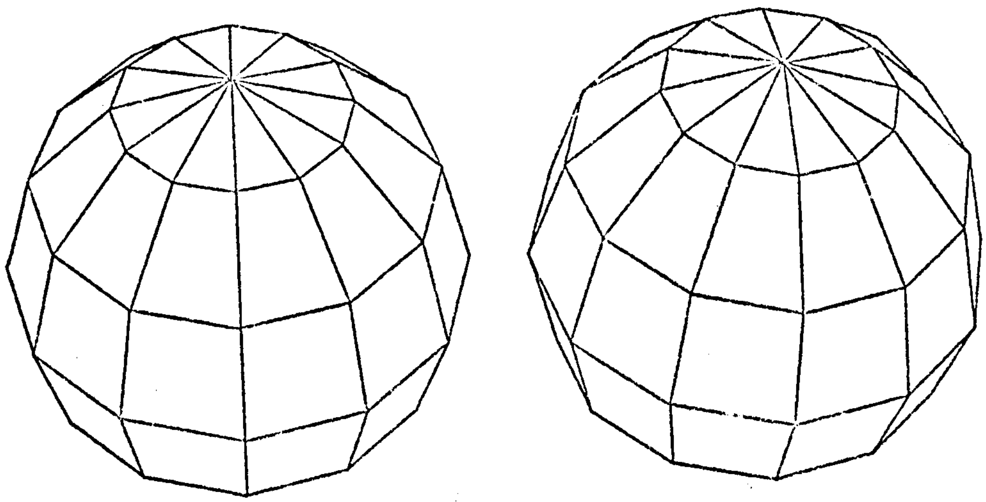
The total system contains over 7300 lines of code, requiring 39 card sides. There are 239 pages of documentation, including algorithm derivations, listings, instructions and examples. You can order a copy of the program by sending $20.00 Canadian, plus postage and packing. Postage and packing charges are as follows:

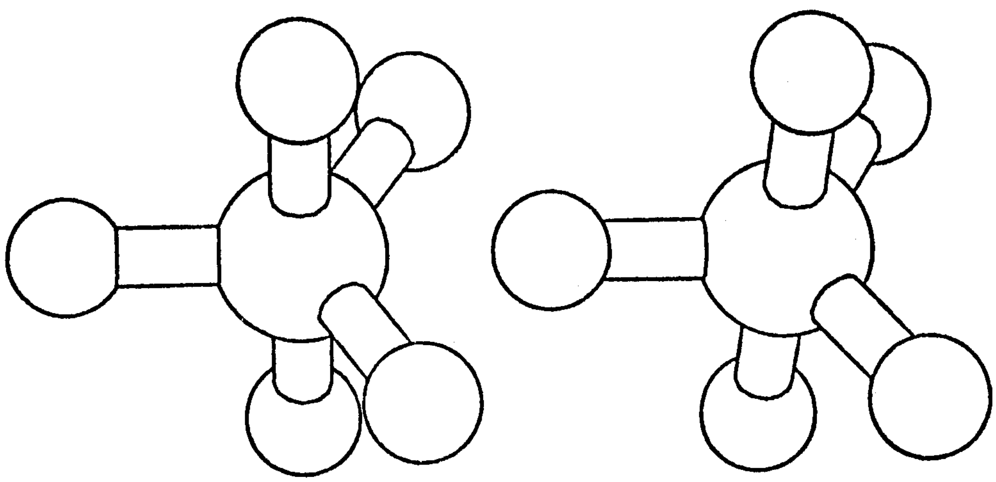
Destination	Surface Mail	Air Mail
Canada	$2.50	$3.50
US	$5.00	$7.00
Other	$6.00	$10.50

A complete set of 24 pre-recorded cards, 15 of which are recorded on both sides, is available for an additional $20.00 (although I can't guarantee compatibility between the card-reading mechanism on your TI-59 and mine. International money orders only, please - cash is too risky, and checks take forever to clear.

STEREO GRAPHICS WITH BALL-STICK OPTION - (cont)

Editor's Note: This is a monumental effort which I simply haven't had time to review. The documentation seems thorough and the printing is legible. Two sample outputs follow:





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MAGNETIC CARD SERVICE

See V8N1P32 for details. One dollar per card plus a stamped and self-addressed envelope. No checks please. For programs in this issue:

FM Exact Factorials	$1.00
13 Digit SFF	$1.00
Impedance Matching	$1.00
FM 1287 Digits of Pi	$1.00

Others:

Superplot II (V5N8P9)	$1.00