TI PPC NOTES

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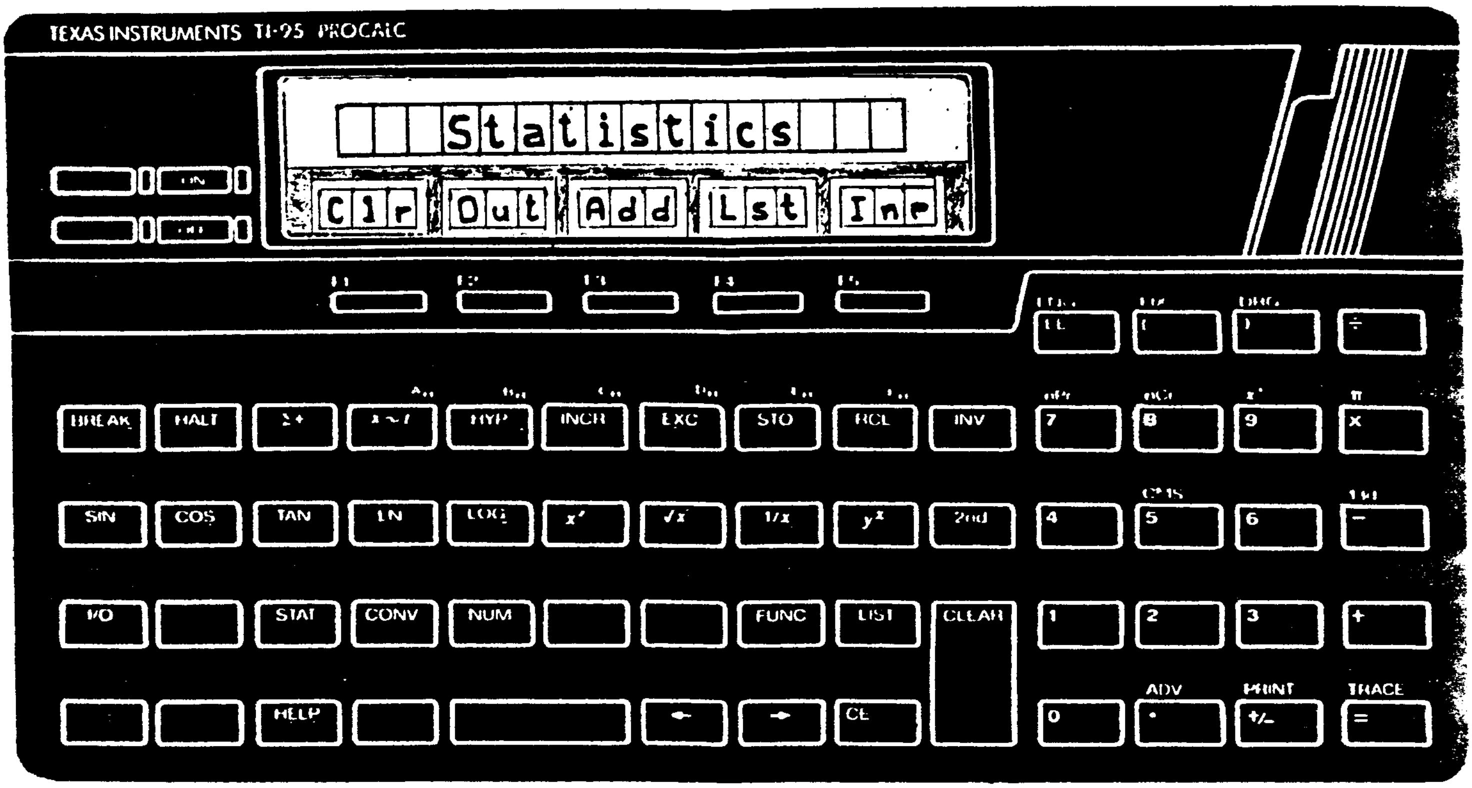
The TI-95 arrives - see page 14.



This approximate, full-size illustration was extracted from page iv of the TI-95 User's Guide. The key nomenclature is shown, but some of the second and third functions are not shown. The alphabet functions of the keys, not shown here, are pseudo-QWERTY, where the keys are not staggered from row to row. One exciting feature of the TI-95 is the group of "windows" immediately above the F1 to F5 function keys. User determined prompts can be provided for the function keys. The prompts shown here are for the statistics program on page 22.

ERRATA:

Combinatorial Analysis with Hex Codes on the TI-66 - V11N2P23

David Douglas, the author of this program, notes that there were typographical errors in the lists of keystrokes used to implant the hex codes: (1) the omission of the square root sign over the x before the equals sign in each line, and (2) STO 55 instead of STO 56 as the last step of the second line. The correct instructions are reproduced below:

Keystrokes	Hexcode	In Display
1 EE 50 / EE . 8 +/- 1 +/- $\sqrt{x}$ = STO 63 STO 60 STO 57	0D (13)	1. 0-
1 EE 50 / EE . 6 +/- 1 +/- $\sqrt{x}$ = STO 62 STO 59 STO 56	0E (14)	1. 0r
1 EE 50 / EE . 4 +/- 1 +/- $\sqrt{x}$ = STO 61 STO 58 STO 55	0F (15)	1. 0

More Subprograms in the Statistics Module - Line 40 in the program to demonstrate the IC subprogram call near the bottom of V11N2P21 should should read

```
40 CALL IC(A,B,N,Q)
```

Many Digits of Ln(3) - V11N2P25. The instructions for modifying the program on the preceding page to find Ln(3) instead of Ln(2) noted that line 160 should be changed to 9999999999 (ten nines) but failed to note that (1) the 2 in line 120 should be changed to a 3, and (2) the 9's in lines 620 and 630 should be changed to 4's.

Robert Prins writes that he has now completed an extended precision calculation of ln(3). He confirms that the first 998 digits on V11N2P25 are correct, but finds that the last two digits should be 23 not 43.

USED TI-59 MATERIAL - John Walker offers the following hardware and other TI-59 related material for sale:
TI-59 ($50.00), PC100C ($100.00), Applied Statistics Module ($20.00), and Math/Utilities Module ($20.00). He also has two boxes of magnetic cards and a manual CROM selector by American Microproducts which can be installed in the printer cradle. Books include four specialty pakettes (Printer Utility, Quality Assurance I, Quality Assurance II, and Statistical Testing), Engineering Statistics by William Volk, Statistics X Calculator by Peter Zehna, Calculator Clout by Maurice Weir, and Probability by Calculator by Peter Zehna. Make an offer.

He will sell the complete package for $190.00. Write to: John E. Walker, c/o Williams Industries, 2201 East Michigan Road, P.O. Box 212, Shelbyville, IN 46176.

USE OF THE AC-9201 WITH THE TI-74 AND PC-324 - V11N2P17 noted that the Educalc catalog listed the AC-9201 as TI-74 hardware, but that my TI-74 did not have an adapter socket. A statement on page 5 of the manual for the PC-324 provides an explanation:

> "You can use the optional AC9201 adapter to operate the printer on standard line voltage. When connected to the printer, the adapter provides power for both the printer and the calculator."

Tests also show that a TI-74 without batteries will run when connected to a PC-324 with batteries.

If you remove the batteries from a standalone TI-74 for about a minute, and then reinstall them you will receive the message "W30 Initialized" at turnon. Among other things, that message means that you lost any programs which may have been in memory. Page 1-5 of the TI-74 User's Guide warns against that condition with the statement:

> "The Constant Memory (TM) feature retains stored information for a short time after the batteries are removed. As a precaution, however, you may want to save any important progrms and data on a storage device (such as a cassette) before replacing batteries."

The availability of power for the TI-74 through the printer connection, whether from the batteries in the printer or the AC-9201, allows the user to circumvent the potential problem of loss of memory when changing batteries in the TI-74. All you need to do is have the printer connected, with batteries installed or the AC-9201 connected, during the battery change in the TI-74.

DEVICE CODE FOR THE PC-324 - The instructions for accessing the printer which appear in the manuals for the Statistics and Mathematics cartridges for the TI-74 state that you can find the identification number (device code) in the printer operating manual. I couldn't find the number in the manual for the PC-324. I experimented and found that the number 12 would work. Later, I found that page 3-19 of the TI-74 Programming Reference Guide indicates that the device code for the printer is indeed 12.

DISCUSSION OF THE TI-59 FIRMWARE - Page 7 of this issue discusses the firmware mechanization of the DMS function in the TI-59. Newcomers who are interested in more details on the firmware in the TI-59 should send four dollars for a twenty page discussion on subjects such as how to view the firmware from the keyboard, the mechanizations for all of the statistics and conversions functions, the HIR 20 function, and identification of the constants used in the log and trig functions.

TI- 74 AVAILABILITY - TI-74's became available at the local Service Merchandise outlets in October 1986. Only the computer was available at a price of $99.97 plus tax. No peripherals so far.

<u>Extra-precision Combinations on the TI-59</u> - L. Leeds. V11N1P4 compared the results from various devices for permutations and combinations. A method of calculating combinations was demonstrated which avoids the generation of non-integer values for combinations. In this program Laurance Leeds provides a fast mode program which has an option for the exact calculation of combinations of up to 37 digits.

<u>User Instructions</u>:

1. Enter N, press A.
2. Enter R, press B.
3. Press C and see a flashing "1. 12" in the display. Press 7 and then EE. The calculator stops with a thirteen digit solution in the display.
4. Look at the exponent of the answer. If it is less than 38 an extended precison answer can be obtained by pressing D. The calculator will stop with a flashing "1. 12" in the display. Press 7 and then EE and wait for completion of the solution indicated by display of a zero. Press E followed by as many R/S's as needed to display the anwawer. The output contains nine digits per display. Add leading zeroes to any number less than 9 digits. A display of 0.3333333333 indicates the end of the answer.

<u>Program Listing</u>:

000	91	R/S	046	42	STO	092	03	03	138	73	RC*	184	95	=	230	73	RC*
001	25	CLR	047	06	06	093	00	00	139	04	04	185	59	INT	231	03	03
002	61	GTO	048	73	RC*	094	81	81	140	55	÷	186	72	ST*	232	72	ST*
003	00	00	049	06	06	095	01	1	141	43	RCL	187	03	03	233	04	04
004	60	60	050	91	R/S	096	95	=	142	09	09	188	65	×	234	69	OP
005	76	LBL	051	69	OP	097	42	STO	143	95	=	189	43	RCL	235	23	23
006	11	A	052	26	26	098	04	04	144	75	-	190	02	02	236	69	OP
007	32	X:T	053	97	DSZ	099	66	PAU	145	59	INT	191	95	=	237	24	24
008	47	CMS	054	05	05	100	81	RST	146	74	SM*	192	75	-	238	97	DSZ
009	01	1	055	00	00	101	01	1	147	03	03	193	43	RCL	239	05	05
010	52	EE	056	48	48	102	42	STO	148	95	=	194	08	08	240	02	02
011	09	9	057	03	3	103	14	14	149	65	×	195	95	=	241	30	30
012	42	STO	058	35	1/X	104	42	STO	150	43	RCL	196	94	+/-	242	97	DSZ
013	09	09	059	91	R/S	105	02	02	151	09	09	197	65	×	243	01	01
014	01	1	060	43	RCL	106	05	5	152	95	=	198	43	RCL	244	01	01
015	42	STO	061	01	01	107	42	STO	153	72	ST*	199	09	09	245	06	06
016	08	08	062	32	X:T	108	05	05	154	04	04	200	95	=	246	25	CLR
017	25	CLR	063	01	1	109	01	1	155	69	OP	201	85	+	247	66	PAU
018	32	X:T	064	42	STO	110	00	0	156	33	33	202	73	RC*	248	81	RST
019	42	STO	065	02	02	111	42	STO	157	69	OP	203	06	06	249	00	0
020	00	00	066	43	RCL	112	04	04	158	34	34	204	95	=	250	00	0
021	42	STO	067	00	00	113	73	RC*	159	97	DSZ	205	42	STO	251	00	0
022	07	07	068	75	-	114	04	04	160	05	05	206	08	08	252	00	0
023	91	R/S	069	43	RCL	115	65	×	161	01	01	207	69	OP	253	00	0
024	76	LBL	070	01	01	116	43	RCL	162	38	38	208	23	23	254	00	0
025	12	B	071	95	=	117	07	07	163	68	NOP	209	69	OP	[illegible]	00	0
026	42	STO	072	77	GE	118	95	=	164	01	1	210	26	26		[illegible]	0
027	01	01	073	00	00	119	72	ST*	165	01	1	211	97	DSZ			[illegible]
028	91	R/S	074	77	77	120	04	04	166	42	STO	212	05	05	462		
029	76	LBL	075	42	STO	121	69	OP	167	06	06	213	01	01	463	[illegible]	
030	13	C	076	01	01	122	24	24	168	02	2	214	79	79	464	00	[illegible]
031	61	GTO	077	43	RCL	123	97	DSZ	169	00	0	215	69	OP	465	00	0
032	04	04	078	01	01	124	05	05	170	42	STO	216	22	22	466	00	0
033	72	72	079	42	STO	125	01	01	171	03	03	217	69	OP	467	00	0
034	76	LBL	080	03	03	126	13	13	172	05	5	218	37	37	468	00	0
035	14	D	081	43	RCL	127	01	1	173	42	STO	219	05	5	469	01	1
036	61	GTO	082	00	00	128	04	4	174	05	05	220	42	STO	470	02	2
037	04	04	083	55	÷	129	42	STO	175	43	RCL	221	05	05	471	04	4
038	69	69	084	43	RCL	130	04	04	176	10	10	222	01	1	472	02	2
039	76	LBL	085	02	02	131	01	1	177	42	STO	223	00	0	473	85	+
040	15	E	086	65	×	132	03	3	178	08	08	224	42	STO	474	01	1
041	05	5	087	69	OP	133	42	STO	179	43	RCL	225	04	04	475	52	EE
042	42	STO	088	22	22	134	03	03	180	08	08	226	02	2	476	01	1
043	05	05	089	69	OP	135	04	4	181	55	÷	227	00	0	477	02	2
044	01	1	090	30	30	136	42	STO	182	43	RCL	228	42	STO	478	95	=
045	00	0	091	97	DSZ	137	05	05	183	02	02	229	03	03	479	86	STF

Extra-precision Combinations on the TI-59 - (cont)

Steps 5 through 29 provide for initialization and data entry. The GTO 472 at 031-033 picks a jump address for fast mode entry at step 001 for the 13 digit calculation. Steps 60 to 100 are the 13 digit calculation which determines if the answer is less than 38 digits long. The GTO 469 at 036-038 picks up a different jump address

8*(WXY) + Z + 1 = 8*12 + 4 + 1 = 101

where W through Z are the ninth through twelfth digits. Steps 101 through 248 are the extra-precision calculation. Steps 39 through 59 display the result of the precision calculation.

For N = 100 and R = 70 the 13 digit answer 2.937234e25 will be returned in about 13 seconds. The extra precision solution requires about 340 seconds, and is read out by Mode E as 0 0 29372339 821610944 823963760.

EXTRA-PRECISION COMBINATIONS IN BASIC - L. Leeds

Larry also provided a Model 100 BASIC language equivalent of the TI-59 program on the preceding page. The program at the right is the editor's conversion for use on the CC-40 or TI-74.

Line 110 presumes that a software module is installed so that the UP subprogram can be used to print a title, set a branching value (PN) to select use of a printer or the display for output, and open a file for access to the printer if needed.

Use of the ten digit IMAGE definition at line 120 provides right justification of the output for the extra-precision answer.

Lines 150 through 195 are the single-precision solution.

Lines 200 through 360 are the extended-precison solution.

Lines 370 through 410 provide output of the extra-precision solution.

The program capability is 41 digits. The printout illustrates the solution for two problems. The printout and listing were made with a CC-40/HX-1000 combination in the 36 character per line mode and magnified for readability.

A listing and printout using a TI-74 with a PC-324 appears on page 18. That program also illustrates the mechanization of an option between output to the printer or to the display with out using the Call UP idea.

```
100 Z=1.E+10
110 CALL UP("nCr = N!/(R!(N-R)!)",PN
)
120 IMAGE ##########
130 INPUT "Number of Things? ";N
135 PRINT #PN,"n = ";N
140 INPUT "How many at a time? ";R
145 PRINT #PN,"r = ";R
150 B=N:C=1
160 IF R>N/2 THEN R=N-R
170 FOR K=1 TO R
180 C=C*B/K:B=B-1:NEXT K
190 PRINT #PN,"nCr = ";C
195 IF PN=0 THEN PAUSE ELSE PRINT #P
N
200 INPUT "Need more precision (Y/N)
? ";A$
230 IF A$="n"OR A$="N"THEN 130
235 FOR I=0 TO 4:A(I)=0:NEXT I:A(4)=
1
240 FOR H=1 TO R
250 FOR J=0 TO 4
260 A(J)=A(J)*N:NEXT J
270 FOR J=4 TO 1 STEP -1
280 T=A(J)/Z:A(J-1)=A(J-1)+INT(T)
290 A(J)=(T-INT(T))*Z:NEXT J
300 FOR J=0 TO 4
310 B=A(J)/H:Q(J)=INT(B)
320 A(J+1)=A(J+1)+(A(J)-Q(J)*H)*Z
330 NEXT J
340 FOR J=0 TO 4
350 A(J)=Q(J):NEXT J
360 N=N-1:NEXT H
370 FOR I=0 TO 4
380 PRINT #PN,USING 120;Q(I)
390 IF PN=0 THEN PAUSE
400 NEXT I
410 PRINT #PN
420 GOTO 130
430 END
```

```
n =  100
r =  70
nCr =  2.937234E+25

         0
         0
    293723
3982161094
4823963760
```

```
n =  140
r =  70
nCr =  9.382097E+40

         9
3820969697
8400412047
8589458050
0297000000
```

LOAN SCHEDULE WITH THE FINANCE MODULE OF THE CC-40

Earlier issues have presented programs for loan schedules for the TI-59; for example, see V9N1P20 and V11N2P14. V10N1P9 also presented a loan schedule for the CC-40 used with the RS-232 interface and a full size printer. During search of the Finance module of the CC-40 for non-published subprograms I found that the Money Evaluator program can print out a loan schedule as well. A sample printer output appears at the right. To obtain this printout install the Finance module in the CC-40, connect the HX-1000 Printer/Plotter, enter RUN "MEVAL" in the display and press ENTER. The following sequence shows the displayed prompts followed by the responses in brackets:

1. Use Printer? <y>
2. Enter Device Name: <10.s=0>. The 36 character per line printer option is selected and the heading "MONEY EVALUATOR" is printed.
3. Nominal Interest? <y>. The heading "Nominal Interest is printed.
4. Enter Compounding Prds/Yr: <12> . The prompt and entry are printed.
5. Enter # Pmts/Yr: <12> . The prompt and entry are printed, followed by a menu of options.
6. Enter Compute Option: <1> , where we select the Payment option (1) to calculate the payment per period.
7. Enter # Payments: <9> . With Matteson's TI-59 program on V11N2P14 we had used 0.75 years. "# Payments= 9" is printed.
8. Enter %Interest: <12.5> , and "%Interest= 12.5" is printed.
9. Enter Pres Val: <1000> , and "Pres Val= 1000" is printed.
10. Enter Future Val: <0> , and "Future Val= 0" is printed.
11. End of Period Payments: <y> , and the prompt is printed. If the user response had been <n> then the prompt "Beginning of Period Payments" would have been displayed to permit use of an alternative method of payments.
12. Discount Backward? <y> , and the prompt is printed. I don't really understand this; perhaps some member with more background in accounting can enlighten me.
13. Edit? <n> , where if we had answered <y> we would have an opportunity to check and change if we desired all the responses since the menu. Since we had selected Option 1, the monthly payment of $116.98 is calculated and printed.
14. Amortize? <y> , and the message "Annual Debt Payment= 1403.76" is printed. That is the monthly payment multiplied by 12, which has very little to do with our nine month problem, but I don't know how to suppress it.
15. Subtotals? <n> , where the lower example at the right shows a printout for a response of <y>.
16. Cumulative Totals? <n> .
17. Enter First Payment #: <1> .
18. Enter Last Payment #: <9> , and the schedule is printed as shown at the right.

```
MONEY EVALUATOR

Nominal Interest
Compounding Prds/Yr= 12
# Pmts/Yr= 12

0=Menu 1=Payment 2=# Payments
3=Interest      4=Present Value
5=Future Value 6=Amortize


# Payments= 9
%Interest= 12.5
Pres Val= 1000
Future Val= 0

End of Period Payments

Discount Backward

Payment=         116.98
Annual Debt Payment=  1403.76

      **** Payment 1 ****
Principal Payment=          106.56
Interest Payment=            10.42
Balance=                    893.44

      **** Payment 2 ****
Principal Payment=          107.67
Interest Payment=             9.31
Balance=                    785.77

      **** Payment 3 ****
Principal Payment=          108.79
Interest Payment=             8.19
Balance=                    676.98

      **** Payment 4 ****
Principal Payment=          109.93
Interest Payment=             7.05
Balance=                    567.05

      **** Payment 5 ****
Principal Payment=          111.07
Interest Payment=             5.91
Balance=                    455.98

      **** Payment 6 ****
Principal Payment=          112.23
Interest Payment=             4.75
Balance=                    343.75

      **** Payment 7 ****
Principal Payment=          113.40
Interest Payment=             3.58
Balance=                    230.35

      **** Payment 8 ****
Principal Payment=          114.58
Interest Payment=             2.40
Balance=                    115.77

      **** Payment 9 ****
Final Payment=              116.98
Principal Payment=          115.77
Interest Payment=             1.21
Balance=                       .00


# Payments= 9
%Interest= 12.5
Pres Val= 1000
Future Val= 0

End of Period Payments

Discount Backward

Payment=         116.98
Annual Debt Payment=  1403.76

      **** Payment 5 ****
Subtotal Principal=         544.02
Subtotal Interest=           40.88
Total Principal=            544.02
Total Interest=              40.88
Balance=                    455.98

      **** Payment 9 ****
Final Payment=              116.98
Subtotal Principal=         455.98
Subtotal Interest=           11.94
Total Principal=           1000.00
Total Interest=              52.82
Balance=                       .00
```

Loan Schedule with the Finance Module of the CC-40 - (cont)

In step 2 it was necessary to respond with <10.s=0> to obtain the 36 character per line printer option and get the nicely formatted printout shown on page 6. If the simpler response <10> is used the default condition of this program sets the 18 character per line printer option. The printout at the right illustrates the effect of the 18 character option on the printout. Clearly, the programmer of the Money Evaluator assumed the 36 character per line option, but failed to provide for it as a default option.

```
End of Period Paym
ents

Discount Backward

Payment=       116
.98
Annual Debt Paymen
t=  1403.76

     **** Payment
1 ****
Principal Payment=
      106.56
Interest Payment=
        10.42
Balance=
      893.44
```

A different condition applies with the Prime Factors program (RUN "PRI") in the Mathematics module as discussed in V8N4P12. There the 36 character printer option is selected by the program, a the response to the prompt "Enter Device Name:" of <10.s=1> does not change the printer to the 36 character per line mode.

Similarly, the UP subprogram in the various modules will set the printer to the 36 character per line option whether or not you add the s=0 part to the device name.

THE USE OF DMS TO TRUNCATE THE DISPLAY REGISTER TO THE DISPLAY - P. Hanson.

Step 4 of the instructions for the loan schedule program on V11N2P14 noted that fractional years could be entered. An example was given using 0.75 years. It is not surprising that when the program multiplies that value by 12 to yield the number of months that the answer is acceptable. But what about other fractions. If you wanted seven months you might enter 7 divided by 12. When the program multiplies that result by 12 the display is "7.", but the display register contains 7 - 1e-12. The use of an integer function as at step 336 on V11N2P15 will yield 6 instead of the desired 7. An EE-INV-EE sequence before the integer function would place the display value in the display register as noted on page C-1 of Personal Programming, but examination of the program doesn't reveal such a sequence. The equivalent result is obtained with the DMS at step 323, where page V-30 of Personal Programming notes that the DMS conversion acts only on the displayed value.

We know that the DMS function is mechanized as shown at the right. The curious feature of the mechanization is that the truncation to the display feature of the DMS function is cannot be determined from the listing. There is no EE-INV-EE sequence to be found. If you place 7 - 1e-12 (7 / 12 x 12 =) in the display register and run the routine at the right from user memory the displayed answer will be 7.677777778 which is derived as follows:

```
000  76 LBL      020  00   0
001  11   A      021  54   )
002  53   (      022  82 HIR
003  53   (      023  08  08
004  53   (      024  59 INT
005  82 HIR      025  54   )
006  08  08      026  65   ×
007  59 INT      027  93   .
008  65   ×      028  06   6
009  06   6      029  85   +
010  00   0      030  82 HIR
011  85   +      031  18  18
012  53   (      032  22 INV
013  82 HIR      033  59 INT
014  18  18      034  54   )
015  22 INV      035  55   ÷
016  59 INT      036  03   3
017  65   ×      037  06   6
018  01   1      038  54   )
019  00   0      039  92 RTN
```

6.	degrees converts to	6.
99	minutes converts to	1.65
99	seconds converts to	.0275
.99999999	seconds converts to	.000277777775
	which sums to	7.677777777775
	for a display of	7.777777778

FINAL VALUE OF AN EXPONENTIAL PROCESS - Page 98 of the July 19, 1986 issue of Machine Design presents an HP-15 program which allows the user to predict the final temperature of a system in a steady state thermal environment. The author, Michael Kugelman, starts with the well-known equation

$$T = (T_f - T_o)(1 - e^{-At}) + T_o$$

where T = the temperature at any time, t = time, T_o = initial temperature, T_f = final temperature, and A = the reciprocal of the thermal time constant for the system. Kugelman then derives the following equation for the final temperature as a function of two temperature measurements performed early in the process:

$$(T_f - T_o)\left[1 - \left(\frac{T_f - T_1}{T_f - T_o}\right)^{t_2/t_1}\right] - (T2 - T_o) = 0$$

where T_1 = the temperature at time t_1 and T_2 = the temperature at time t_2. The author gives a program for determining T_f using the SOLVE function of the HP-15C. The solution can also be obtained using the Zeroes of Functions program in the Master Library module of the TI-59. The program below provides a solution, including annotation of the input and output values when using the PC-100.

000	76	LBL	030	54	)	060	42	STO	090	95	=	120	06	6	150	98	ADV
001	16	A'	031	45	Y^x	061	12	12	091	42	STO	121	00	0	151	36	PGM
002	53	(	032	53	(	062	91	R/S	092	03	03	122	03	3	152	08	08
003	53	(	033	43	RCL	063	76	LBL	093	01	1	123	69	OP	153	15	E
004	42	STO	034	14	14	064	14	D	094	42	STO	124	04	04	154	32	X:T
005	09	09	035	55	÷	065	42	STO	095	08	08	125	43	RCL	155	01	1
006	75	-	036	43	RCL	066	13	13	096	69	OP	126	12	12	156	06	6
007	43	RCL	037	13	13	067	91	R/S	097	00	00	127	69	OP	157	02	2
008	10	10	038	54	)	068	76	LBL	098	98	ADV	128	06	06	158	01	1
009	54	)	039	54	)	069	15	E	099	01	1	129	98	ADV	159	69	OP
010	65	×	040	75	-	070	42	STO	100	06	6	130	03	3	160	04	04
011	53	(	041	43	RCL	071	14	14	101	00	0	131	07	7	161	32	X:T
012	01	1	042	12	12	072	91	R/S	102	01	1	132	00	0	162	69	OP
013	75	-	043	85	+	073	76	LBL	103	69	OP	133	02	2	163	06	06
014	53	(	044	43	RCL	074	17	B'	104	04	04	134	69	OP	164	98	ADV
015	53	(	045	10	10	075	42	STO	105	43	RCL	135	04	04	165	91	R/S
016	43	RCL	046	54	)	076	01	01	106	10	10	136	43	RCL	166	00	0
017	09	09	047	92	RTN	077	91	R/S	107	69	OP	137	13	13	167	00	0
018	75	-	048	76	LBL	078	76	LBL	108	06	06	138	69	OP	168	00	0
019	43	RCL	049	11	A	079	18	C'	109	01	1	139	06	06	169	00	0
020	11	11	050	42	STO	080	42	STO	110	06	6	140	03	3	170	00	0
021	54	)	051	10	10	081	02	02	111	00	0	141	07	7	171	00	0
022	55	÷	052	91	R/S	082	91	R/S	112	02	2	142	00	0	172	00	0
023	53	(	053	76	LBL	083	76	LBL	113	69	OP	143	03	3	173	00	0
024	43	RCL	054	12	B	084	19	D'	114	04	04	144	69	OP	174	00	0
025	09	09	055	42	STO	085	43	RCL	115	43	RCL	145	04	04	175	00	0
026	75	-	056	11	11	086	02	02	116	11	11	146	43	RCL	176	00	0
027	43	RCL	057	91	R/S	087	75	-	117	69	OP	147	14	14	177	00	0
028	10	10	058	76	LBL	088	43	RCL	118	06	06	148	69	OP	178	00	0
029	54	)	059	13	C	089	01	01	119	01	1	149	06	06	179	00	0

User Instructions:

1. Enter T_o and press A.
2. Enter T_1 and press B.
3. Enter T_2 and press C.
4. Enter t_1 and press D.
5. Enter t_2 and press E.
6. Enter the lower limit and press 2nd B'.
7. Enter the upper limit and press 2nd C'.
8. Press 2nd D' to solve. The printouts at the right are for the sample problem in the article in Machine Design. Note that the printout uses D's to indicate temperatures and T's to indicate time.

```
         25.    D0
       51.17    D1
       89.37    D2

          3.    T1
          8.    T2

 299.609375     DF
```

```
         25.    D0
       51.17    D1
       89.37    D2

          3.    T1
          8.    T2

 299.9511719    DF
```

Final Value of an Exponential Process - (cont)

The "1" at step 093 of the program sets the maximum error at 1 degree. With that setting, and starting the solution with the lower limit at 200 degrees and the upper limit at 400 degrees, the program yields the first solution, 299.609375, in about 40 seconds. If the maximum error is set at 0.1 the execution time time is extended to about 55 seconds to yield the second solution of 299.9511719. If the maximum error is set at 0.01 with the TI-59 program the solution 299.9786377 is obtained in about 70 seconds. The HP-15C, where it is not necessary to enter a maximum error when using the SOLVE mode, obtains the solution 299.98 in 19 seconds. We will see that a maximum error setting of 1 degree will be adequate unless the temperature and time measurements are very accurate.

Analysis of accuracy:

The input temperatures defined for the sample problem in Machine Design were listed to two decimal places, 51.17 °C at 3 minutes and 89.37 °C at 8 minutes. I wondered at that level of accuracy. The leadin to the sample problem states:

> "A piece of electrical equipment operates at a current level that is expected to result in a final temperature of about 300 °C. Ambient temperature is 25 °C and the thermal time constant of the equipment is about 30 minutes."

If you enter those values into the first formula and solve for T at 3 and 8 minutes you will obtain values of 51.16971004 °C and 89.36970695 °C. Thus, the input values in the sample problem are within 0.0003 °C of those values. To examine the effect of errors in the input values on the estimate of the final value I reran the sample problem with variations in the input temperatures of either 0.1 or 0.5 °C, and variations in the input times of one and five seconds. The results are in the following tables.

Sensitivity to errors in temperature measurements (delta in °C):

	T - 0.5	T - 0.1	T + 0.1	T + 0.5
T_0	271.5	293.4	306.6	339.5
T_1	377.7	312.1	288.7	252.7
T_2	276.2	294.9	305.1	328.5

Sensitivity to errors in time measurements (delta in seconds):

	t - 5	t - 1	t + 1	t + 5
t_1	239.5	284.8	317.6	420.7
t_2	334.8	305.9	294.2	273.0

Thus, errors in the input temperatures of as little as 0.1 °C, or errors in the input times of as little as one second, can generate errors in the solution of 5 °C or more. Unless you can achieve at least those accuracies in measurement there is no need to use a maximum error smaller than 1 in the TI-59 solution.

Final Value of an Exponential Process - (cont)

Solution on the Casio fx-7000G

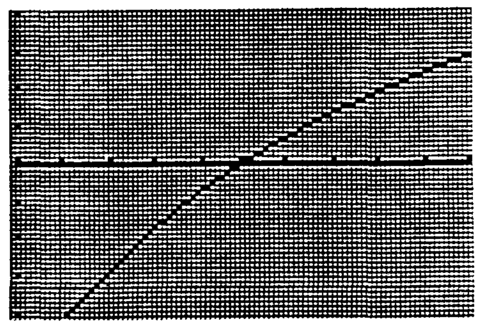
This sort of problem can be solved very nicely using the Graph, Trace, Factor and Range functions on the fx-7000G. Enter the program shown at the right, say in the Program 0 location. Then, to run the sample problem from Machine Design:

```
1   Cls:0→F
2   "1=INPUT"?→F
3   F=0⇒Goto 2
4   "T0"?→A
5   "T1"?→B
6   "T2"?-C
7   "TIME1"?→D
8   "TIME2"?→E
9   Lbl 2
10  Graph Y=(X-A)(1-
    ((X-B)÷(X-A))x^y(
    E÷D))-C+A
11  Graph Y=0
```

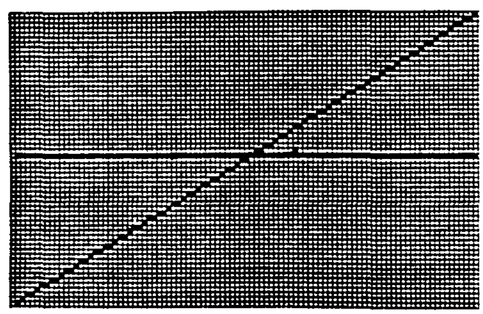
1. Press Range and enter the following values:

Xmin:200	Ymin:-2
max:400	max:2
scl:20	scl:0.5

2. Press Prog 0 EXE and see "1=INPUT?" in the display. To enter the temperatures and times press 1 EXE, and see the prompt "T0?" in the display. Enter the value for T_0 (25 for the sample problem), press EXE, and see the prompt "T1?". Continue to respond to the prompts. When EXE is pressed after entering the value for t_2 in response to the prompt "TIME2?" the plot of the function will be generated in about fifteen second. For the sample problem the plot will look like the upper figure at the right.



3. Press SHIFT Trace, and then press the right arrow until the flashing cursor is at the intersection of the plot and the x axis. The displayed x value nearest to that condition is the solution for T_f. (Note that the flashing cursor moves along the x axis, not along the function curve. That is due to the Graph Y = 0 at line 11 of the program. If you would rather have the cursor move along the function curve, simply eliminate line 11.) For the sample problem the values 300 and 302.1276596 seem to bracket the solution.



4. Expand the plot in the neighborhood of the solution to obtain increased resolution of the value for T_f. Place the flashing cursor near the intersection at one of the bracketing values, press SHIFT Factor, and see the prompt "Factor ". Enter the factor, or factors, by which you wish to expand the plot and press EXE. Then, press Prog 0 EXE and see the prompt "1=INPUT?". Respond with 0 EXE to skip the data entry steps. A new plot will appear. For the sample problem, and a response to "Factor " of 100 the new display will look like the lower figure at the right.

5. Go to step 3 above to read out the solution. For the sample problem and a factor of 100 the best solution seems to be 299.9787234. Repeat steps 3, 4, and 5 as many times as necessary to obtain the desired readout resolution.

YEARLY LOAN SCHEDULE - Hewlett Ladd. V9N1P20 and V11N2P24 presented earlier loan schedules for the TI-59 and PC-100. Those programs are time-consuming since they print monthly schedules with year-end summaries, while many users are only interested in the annual summaries. Hewlett's program prints only the annual summaries to yield a substantial savings in execution time and in printer paper. His program also provides a worksheet mode to permit examination of the effect of alternative loan parameters. A sample printout appears at the right. The Master Library module must be installed.

User Instructions:

1. Enter the date of the loan as YYYY.MM for the year and the month and press 2nd A'. The heading "LOAN TABLE DATA" and the year and month with the annotation "DATE" are printed. The display shows the year and month. The program assumes that the first monthly payment becomes due in the ensuing month.

2. Enter the remaining loan factors in sequence with an R/S:

(a) Amount of loan. The amount is printed with the annotation "AM'T". The display shows "0.00."

(b) Balloon payment. If not applicable do not skip this step, but press R/S. The balloon payment is printed with the annotation "B/PM". The display shows "4045653536".

(c) Number of years of the loan. Enter fractional years as a decimal to the nearest quarter. The years are printed with the annotation "Y'RS". The display shows "4061336313".

(d) Annual interest rate in per cent. The rate is printed with the annotation "%P/A". The program continues with the calculations and prints the following parameters:

P/MO	-	Monthly payment.
PMTS	-	Total monthly payments.
+BLN	-	Additional payment due at end of term
INT	-	Total interest for term.

and ends the table with a line of asterisks. The display shows "0.00".

3. To print the annual loan schedule press 2nd B'. The heading "ANNUAL RESULTS" and the loan date and amount are printed, followed by annual summaries which include the date (YYYY.12), the payment on principal for the year (annotation "P-PD"), the interest payments for the year (annotation "I-PD"), and the balance at the end of the year (annotation "BAL"). The final year's payments are identified as YYYY.MM where MM will be the month in which the final payment is due. This year will normally end with a zero balance, unless a balloon payment applies when that amount will be shown as the final balance. The schedule ends with a line of asterisks. Printout of a five year schedule takes about 32 seconds.

```
LOAN DATA TABLE
     1986.08      DATE
     6500.00      AM'T
        0.00      B/PM
        2.00      Y'RS
        9.75      %P/A
      299.19      P/MO
     7180.56      PMTS
        0.00      +BLN
      680.56      ΣINT
*******************

WORKSHEET:

      200.00      P/MO
 3.157476983      Y'RS

      175.00      P/MO
 3.699349992      Y'RS

        10.5      %P/A
      177.33      P/MO

        3.75      Y'RS
      175.37      P/MO
*******************

LOAN DATA TABLE
     1986.08      DATE
     6500.00      AM'T
        0.00      B/PM
        3.75      Y'RS
        10.5      %P/A
      175.37      P/MO
     7891.65      PMTS
        0.00      +BLN
     1391.65      ΣINT
*******************

ANNUAL RESULTS:
     1986.08      DATE
     6500.00       BAL

     1986.12      DATE
      480.22      P-PD
      221.26      I-PD
     6019.78       BAL

     1987.12      DATE
     1545.28      P-PD
      559.16      I-PD
     4474.50       BAL

     1988.12      DATE
     1715.58      P-PD
      388.86      I-PD
     2758.92       BAL

     1989.12      DATE
     1904.64      P-PD
      199.80      I-PD
      854.28       BAL

     1990.05      DATE
      854.28      P-PD
       22.57      I-PD
        0.00       BAL
*******************
```

Yearly Loan Schedule - (cont)

4. Worksheet - with a tentative loan schedule entered you may use this routine to test the effect of alternative loan factors before running a final table. Enter the factor to be changed and press the appropriate key to see the effect. The keys and the instructions for their use are:

- D′ To print the worksheet heading.
- A To change the principal and find a new payment
- B To change the balloon payment and find a new payment.
- C To change the term and find a new payament.
- D To change the interest rate and find a new payment.
- E To change the payment and find a new term.
- E′ To print a concluding line of asterisks.

You may continue to test changes in this way unitl you have attained your desired goal. To erase a previously entered balloon payment enter a zero and press B. Remember to return to steps 2 and 3 with your final data before attempting to print the loan schedule.

You may use the workaheet program after a loan schedule has been printed, but your first entry must be a new principal since the previous starting value for the principal will have been changed to the balance at the beginning of the final year.

```
LOAN DATA TABLE
     1986.08    DATE
     6500.00    AM'T
        0.00    B/PM
        2.00    Y'RS
        9.75    %P/A
      299.19    P/MO
     7180.56    PMTS
        0.00    +BLN
      680.56    ΣINT
********************

WORKSHEET:

      200.00    P/MO
 3.157476983    Y'RS

      175.00    P/MO
 3.699349992    Y'RS

        10.5    %P/A
      177.33    P/MO

        3.75    Y'RS
      175.37    P/MO
********************
```

Program Listing:

Bank 1

000	76	LBL	040	25	CLR	080	43	RCL	120	36	PGM	160	65	×	200	42	STO
001	11	A	041	36	PGM	081	41	41	121	19	19	161	01	1	201	20	20
002	98	ADV	042	19	19	082	69	OP	122	11	A	162	00	0	202	01	1
003	32	X:T	043	13	C	083	04	04	123	55	÷	163	00	0	203	44	SUM
004	43	RCL	044	69	OP	084	25	CLR	124	01	1	164	54	)	204	21	21
005	38	38	045	06	06	085	32	X:T	125	02	2	165	95	=	205	43	RCL
006	69	OP	046	92	RTN	086	69	OP	126	95	=	166	49	PRD	206	37	37
007	04	04	047	42	STO	087	06	06	127	69	OP	167	17	17	207	69	OP
008	25	CLR	048	05	05	088	55	÷	128	06	06	168	22	INV	208	04	04
009	32	X:T	049	61	GTO	089	01	1	129	92	RTN	169	44	SUM	209	43	RCL
010	36	PGM	050	00	00	090	02	2	130	76	LBL	170	01	01	210	23	23
011	19	19	051	34	34	091	95	=	131	17	B'	171	43	RCL	211	69	OP
012	14	D	052	76	LBL	092	36	PGM	132	69	OP	172	01	01	212	06	06
013	69	OP	053	13	C	093	19	19	133	00	00	173	75	-	213	59	INT
014	06	06	054	98	ADV	094	12	B	134	43	RCL	174	53	(	214	85	+
015	61	GTO	055	32	X:T	095	58	FIX	135	34	34	175	53	(	215	93	.
016	00	00	056	43	RCL	096	02	02	136	69	OP	176	24	CE	216	01	1
017	36	36	057	40	40	097	61	GTO	137	01	01	177	55	÷	217	02	2
018	76	LBL	058	69	OP	098	00	00	138	43	RCL	178	01	1	218	95	=
019	12	B	059	04	04	099	36	36	139	35	35	179	02	2	219	42	STO
020	98	ADV	060	25	CLR	100	76	LBL	140	69	OP	180	54	)	220	00	00
021	32	X:T	061	32	X:T	101	15	E	141	02	02	181	59	INT	221	43	RCL
022	43	RCL	062	69	OP	102	98	ADV	142	43	RCL	182	42	STO	222	46	46
023	39	39	063	06	06	103	32	X:T	143	36	36	183	21	21	223	69	OP
024	69	OP	064	65	×	104	43	RCL	144	69	OP	184	65	×	224	04	04
025	04	04	065	01	1	105	42	42	145	03	03	185	01	1	225	43	RCL
026	25	CLR	066	02	2	106	69	OP	146	69	OP	186	02	2	226	04	04
027	32	X:T	067	95	=	107	04	04	147	05	05	187	54	)	227	69	OP
028	67	EQ	068	36	PGM	108	25	CLR	148	69	OP	188	95	=	228	06	06
029	00	00	069	19	19	109	32	X:T	149	00	00	189	49	PRD	229	42	STO
030	47	47	070	11	A	110	36	PGM	150	01	1	190	19	19	230	15	15
031	36	PGM	071	61	GTO	111	19	19	151	02	2	191	55	÷	231	98	ADV
032	19	19	072	00	00	112	13	C	152	49	PRD	192	01	1	232	43	RCL
033	15	E	073	36	36	113	69	OP	153	18	18	193	00	0	233	37	37
034	69	OP	074	76	LBL	114	06	06	154	75	-	194	00	0	234	69	OP
035	06	06	075	14	D	115	43	RCL	155	53	(	195	95	=	235	04	04
036	43	RCL	076	22	INV	116	40	40	156	43	RCL	196	42	STO	236	43	RCL
037	42	42	077	58	FIX	117	69	OP	157	23	23	197	22	22	237	00	00
038	69	OP	078	98	ADV	118	04	04	158	22	INV	198	01	1	238	69	OP
039	04	04	079	32	X:T	119	25	CLR	159	59	INT	199	07	7	239	06	06

Yearly Loan Schedule - (cont)

Bank 2

240	43	RCL	280	44	SUM	320	15	15	360	69	OP	400	43	RCL	440	19	19
241	47	47	281	01	01	321	75	-	361	17	17	401	39	39	441	12	B
242	69	OP	282	01	1	322	43	RCL	362	69	OP	402	69	OP	442	43	RCL
243	04	04	283	08	8	323	05	05	363	00	00	403	04	04	443	42	42
244	25	CLR	284	42	STO	324	95	=	364	43	RCL	404	25	CLR	444	69	OP
245	36	PGM	285	20	20	325	69	OP	365	30	30	405	92	RTN	445	04	04
246	19	19	286	43	RCL	326	06	06	366	69	OP	406	67	EQ	446	25	CLR
247	14	D	287	37	37	327	75	-	367	01	01	407	04	04	447	36	PGM
248	75	-	288	69	OP	328	43	RCL	368	43	RCL	408	12	12	448	19	19
249	48	EXC	289	04	04	329	48	48	369	31	31	409	36	PGM	449	13	C
250	15	15	290	22	INV	330	69	OP	370	69	OP	410	19	19	450	52	EE
251	95	=	291	97	DSZ	331	04	04	371	02	02	411	15	E	451	22	INV
252	50	I×I	292	21	21	332	43	RCL	372	43	RCL	412	69	OP	452	52	EE
253	69	OP	293	03	03	333	19	19	373	32	32	413	06	06	453	42	STO
254	06	06	294	02	02	334	95	=	374	69	OP	414	43	RCL	454	17	17
255	75	-	295	43	RCL	335	50	I×I	375	03	03	415	40	40	455	42	STO
256	43	RCL	296	00	00	336	69	OP	376	69	OP	416	69	OP	456	18	18
257	48	48	297	69	OP	337	06	06	377	05	05	417	04	04	457	42	STO
258	69	OP	298	06	06	338	43	RCL	378	43	RCL	418	92	RTN	458	19	19
259	04	04	299	61	GTO	339	46	46	379	37	37	419	69	OP	459	69	OP
260	73	RC*	300	02	02	340	69	OP	380	69	OP	420	06	06	460	06	06
261	20	20	301	40	40	341	04	04	381	04	04	421	65	×	461	43	RCL
262	95	=	302	29	CP	342	43	RCL	382	43	RCL	422	01	1	462	43	43
263	50	I×I	303	43	RCL	343	05	05	383	23	23	423	02	2	463	69	OP
264	69	OP	304	22	22	344	69	OP	384	69	OP	424	95	=	464	04	04
265	06	06	305	67	EQ	345	06	06	385	06	06	425	36	PGM	465	43	RCL
266	43	RCL	306	04	04	346	61	GTO	386	43	RCL	426	19	19	466	17	17
267	46	46	307	98	98	347	04	04	387	38	38	427	11	A	467	65	×
268	69	OP	308	85	+	348	98	98	388	69	OP	428	43	RCL	468	43	RCL
269	04	04	309	43	RCL	349	76	LBL	389	04	04	429	41	41	469	11	11
270	43	RCL	310	00	00	350	16	A'	390	43	RCL	430	69	OP	470	95	=
271	15	15	311	59	INT	351	42	STO	391	23	23	431	04	04	471	50	I×I
272	69	OP	312	95	=	352	23	23	392	92	RTN	432	92	RTN	472	69	OP
273	06	06	313	69	OP	353	36	PGM	393	42	STO	433	69	OP	473	06	06
274	98	ADV	314	06	06	354	19	19	394	15	15	434	06	06	474	75	-
275	69	OP	315	43	RCL	355	10	E'	395	36	PGM	435	55	÷	475	43	RCL
276	20	20	316	47	47	356	36	PGM	396	19	19	436	01	1	476	44	44
277	01	1	317	69	OP	357	19	19	397	14	D	437	02	2	477	69	OP
278	02	2	318	04	04	358	18	C'	398	69	OP	438	95	=	478	04	04
279	22	INV	319	43	RCL	359	05	5	399	06	06	439	36	PGM	479	43	RCL

Bank 3

480	04	04	500	69	OP	520	49	49
481	85	+	501	01	01	521	69	OP
482	43	RCL	502	69	OP	522	01	01
483	05	05	503	02	02	523	02	2
484	69	OP	504	69	OP	524	03	3
485	06	06	505	03	03	525	01	1
486	95	=	506	69	OP	526	07	7
487	32	X:T	507	04	04	527	01	1
488	43	RCL	508	69	OP	528	07	7
489	45	45	509	05	05	529	03	3
490	69	OP	510	69	OP	530	07	7
491	04	04	511	00	00	531	06	6
492	25	CLR	512	25	CLR	532	02	2
493	32	X:T	513	98	ADV	533	69	OP
494	69	OP	514	92	RTN	534	02	02
495	06	06	515	76	LBL	535	69	OP
496	76	LBL	516	19	D'	536	05	05
497	10	E'	517	69	OP	537	69	OP
498	43	RCL	518	00	00	538	00	00
499	33	33	519	43	RCL	539	92	RTN

LOAN	2732133100.	30
DATA	1613371300.	31
TABLE	3713142717.	32
*****	5151515151.	33
ANNUA	1331314113.	34
L RES	2700351736.	35
ULTS:	4127373662.	36
.DATE	4016133717.	37
.AM'T	4013286537.	38
.B/PM	4014633328.	39
.Y'RS	4045653536.	40
.%P/A	4061336313.	41
.P/MO	4033632832.	42
.PMTS	4033283736.	43
.+BLN	4047142731.	44
.ΣINT	4077243137.	45
. BAL	4000141327.	46
.P-PD	4033203316.	47
.I-PD	4024203316.	48
WORKS	4332352636.	49

TI-95 AVAILABILITY - Page 57 of Issue #33 of the EduCALC catalog describes the the TI-74 BASICALC and the TI-95 PROCALC. The following prices are listed for the TI-95 and its peripherals:

TI-95	Procalc	$149.95
95-771	Math Cartridge	39.95
95-772	Statistics Cartridge	39.95
TI-695	8K RAM Cartridge (Also used with the TI-74)	39.95
PC-324	Portable Printer (Also used with the TI-74)	89.95
CI-7	Cassette Interface (Used with the TI-74)	26.95

You can order with a credit card by calling (714)-582-2637.

<u>THE</u> <u>TI-95</u> - Palmer Hanson. In early December the TI-95 became available from Educalc. The price list appears at the bottom of page 13 of this issue. Members report that the TI-95 is also available from Elek-Tek, but I have not yet received a catalog. You can call Elek-Tek toll-free at 800-621-1269 and order by credit card if you like. There is a shipping charge of $4.00 for the first item and an additional $1.00 for each additional item. The TI-95 has not yet appeared on the shelves of local stores.

A full size illustration of the TI-95 appears on the front page. At first glance it looks a lot like the TI-74, and it is. The TI-95 will fit in the carrying case for the TI-74 and vice versa. Both devices work with the PC-324 printer, the CI-7 Cassette Interface, and the 8K RAM cartridge, but there the similarity ends. The Educalc catalog calls the TI-74 a BASIC-language programmable calculator, and V11N2P4 noted that the operation is very similar to the CC-40. The Educalc catalog describes the TI-95 as TI's top-of-the-line scientific programmable which now includes "menu windows". We will see that the TI-95 has many features similar to the TI-59, but that it also has some commonality in command structure with the TI-57, the TI-55II, and the TI-57LCD.

The menu windows and the associated function keys directly below the menu windows provide a major extension in flexibility. As an example consider the operation of the NUM key. When the key is pressed, the legends INT, FRC, R#, RND, and --> appear in the windows above the function keys F1 through F5. Pressing one of the function keys results in the following response:

F1 INT The integer function is performed on the value in the display register.

F2 FRC The fraction function (INV INT on the TI-59) is performed on the value in the display register.

F3 R# A pseudo-random number between 0 and 1 is placed in the display register.

F4 RND The mantissa of the number in the display register is rounded to the mantissa of the number in the display (the equivalent of the EE-INV-EE sequence on the TI-59).

F5 --> A new set of legends appears in the menu windows: SGN, LCM, PF, ABS and -->. Pressing one of the function keys now yields a different response:

F1 SGN The signum function is performed on the number in the display register (the Op 10 function in the TI-59).

F2 LCM The lowest common multiple for a pair of numbers in the t and display registers is returned to the display register. The lowest common factor is returned to the t register.

F3 PF The lowest prime factor of the number in the display register is returned to the display register. The remaining factor is in the t register.

F4 ABS Finds the absolute value of a number in the display register.

F5 --> Returns to the original set of options.

The TI-95 - (cont)

Each of these functions can be used from the keyboard or in a user program. A demonstration factor finder program which uses the PF function, and which will also illustrate other aspects of programming the TI-95 is listed at the right together with some sample solutions. Note that the LIST function prints more than one keystroke on each line; old-timers will recall that programs were listed in a similar manner in 52 Notes.

```
0000 ADV PRT x~t 1 STO A
0006 LBL PF PRT ` ` PAU
0012 x~t PF INV IF= A
0017 GTL PF x~t PRT ADV
0023 HLT
```

```
987654321.
        1.
        3.
        3.
       17.
       17.
   379721.
```

```
1.111111 11
         1.
         3.
         7.
        11.
        13.
        37.
       101.
      9901.
```

```
     1. 13
        1.
        2.
        2.
        2.
      929.
1345532831.
```

Line 0000 - The value to be factored is printed, stored temporarily in the t register, and a one is stored in data register A. In the TI-95 the first 26 data registers (000 through 025) can also be identified by the letters A through Z.

Line 0006 - All labels consist of two alphanumeric characters, and require three program steps. You can use a space for one of the characters, but the program assembly still assigns three steps to the label. The PRT at step 0009 prints the factors, or displays them if the PC-324 printer is not connected. The PRT ` ` PAU sequence acts to provide a flashing display of each factor similar to that we are used to with the TI-59 and TI-66. Without the ` ` to clear the display it would not be possible to identify repeated factors from the display.

Line 0012 - the x~t command brings the number to be factored to the display register. The PF command places the factor which was found in the display register and stores the remaining value in the t register. If the solution is complete, that is, the number being tested is prime, then a 1 appears in the display register. The INV IF= A compares the factor found with the value of 1 in data register A to determine if the solution is complete. Note that comparisons are not made against the contents of the t register, but may be made against the contents of any data register.

Line 0017 - GTL PF means goto label PF. We could have also used GTO 0009. The x~t brings the last prime factor to the display for printing.

The first two solutions are for benchmarks that we have used to evaluate factor finder programs. The second solution actually used an input of 111,111,111,111 and demonstrates that the PF algorithm can handle twelve digit inputs. The third solution is incorrect. The thirteen digit input value was 9,999,999,999,990 which is 90 times the input value for the second solution; therefore, we would expect to find the same factors, plus additional factors of 2, 3, 3 and 5. The erroneous solution is the result of the algorithm used in the factor finding, which probably tests whether the quotient of the input value divided by the factor being tested has a fractional part. Note that eleven, twelve, and thirteen digit values can be entered directly into the display.

The PF algorithm requires about 1 hour 45 minutes to declare that 9999999967 is prime. That is about ten minutes less than reported for the CC-40 in V9N6P4.

BENCHMARK TESTS OF THE TI-95 - Palmer Hanson. I tested the TI-95 arithmetic with some of the same benchmarks which we have discussed in earlier issues. The results were better than the TI-59 in nearly every case.

1. e x π was equal to π x e indicating that multiplication was commutative. The non-commutative multiply on the TI-59 was discussed in V9N2P15.

2. sin(45) was equal to cos(45). Use of a short program showed that sin(X) was equal to cos(90 - X) for 0.01 degree increments over at least the range from 0 to 90 degrees. For arguments less than one radian the value of the calculated sine was no more than 1e-13 from the rounded value from the tables in AMS 55. For arguments above one radian the accuracy was degraded, with errors as large as 4e-13.

3. The square root-squared test: V8N3P13/14 described this test which is a derivative of the $(\sqrt{2})^2$ test by Brian Hayes on page 136 of the January 1981 issue of BYTE. For our test we start with an integer, take the square root five times, take the square five times and compare the result to the original number. I tested selected integers from 2 through 17. The display returned the starting integer in each case. The actual values before truncation to the display were:

2	1.99999 99999 83	12	12.00000 00001 3
3	3.00000 00000 04	13	12.99999 99998 1
5	4.99999 99999 70	15	15.00000 00002 9
7	7.00000 00000 71	17	17.00000 00000 7

where all of the answers are better than those from the TI-59.

4. 1.0000001 squared 27 times: V9N2P11 described this test from the "Computer Recreations" column of the April 1984 issue of Scientific American, where there are different methods of calculation:

Exact	674530.47074 10845 59 ...
Mode A (Repeated A^2)	674530.31804 26
Mode B (Repeated A*A)	674530.31804 26
Mode C (A^134217728)	674530.47074 01

All solutions are much better the answers from the TI-59. The Mode C solution is nearly identical to that from the TI-74 and TI-66, within 1 in the last place. In tests of other devices only the Model 100 and Casio fx-7000G yielded better answers for the Mode C solution from the TI-95.

5. The Bob Fruit Benchmark: Bob proposed a compound interest problem as another benchmark (see V8N4P4). The appropriate equation is that for the sum of a geometric series S = [(1 + i)^n -1]/i . An annual interest rate of ten per cent (i = .10/12) and compounding monthly for thirty years (n = 360) yields:

Exact	2260.48792 47960 86067 ...
TI-95 using the y^x function	2260.48792 4513

where that answer is equivalent to that obtained with the TI-74 or TI-66, but not quite as good as from the TI-59.

Benchmark Tests of the TI-95 - (cont)

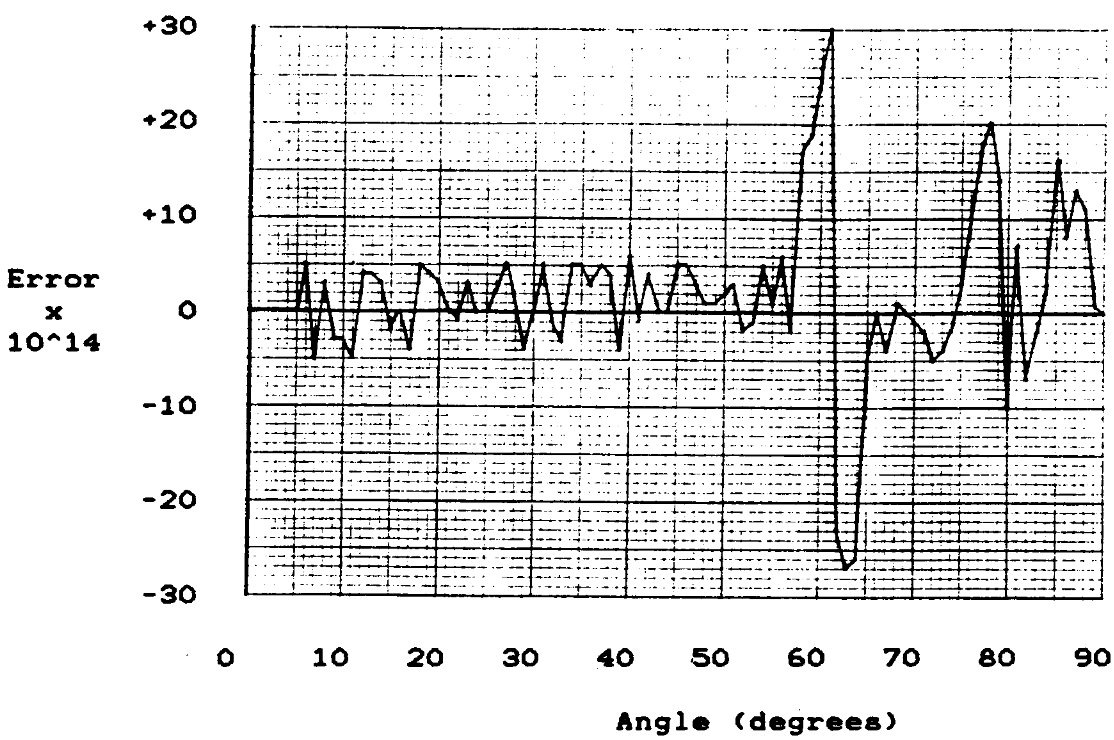
Radix	10.
Prec	13.
FPw	1. 13
UlP1	1.-13
Has G.D.	

6. The "Itsy-bit of Paranoia" test from the February 1985 issue of BYTE is another method for examining the internal arithmetic of a device. V10N2P18 presented a 383 step listing which would run on the TI-59. A "brute-force" conversion for the TI-95 required 470 steps, where the major portion of the increase was associated with use of three steps for a STO nnn or RCL nnn versus the two steps required for equivalent commands on the TI-59. The program lengths would have been very similar if I had used alphabetic addressing. The printout from the program appears at the right. The pleasant surprise is the existence of a guard digit. That can be verified by another test from the BYTE article, comparing the results from the two expressions:

1 - (9 / 27 x 3) = and 1 / 2 - (9 / 27 x 3) + 1 / 2 =

The TI-95 yields 1.-13 for both expressions. The TI-59 and TI-66 yield 1.-12 for the first expression and 1.-13 for the second.

7. More on Accuracy of the sine function: The errors in the output of the sine function from the TI-95 are actually very similar to those from the TI-74. To illustrate the similarity I plotted the difference between the thirteen digit output of the TI-95 versus the fourteen digit values obtained from AMS 55:



Note the similarity to the plot for errors in the sine function from the TI-74 on V11N2P6. For input angles less than one radian the error is never greater than 5e-14. These results are substantially better than those from the TI-59, the TI-66, or the CC-40, and are only slightly worse than those from the Radio Shack Model 100. The results are slightly worse than those from the TI-74, but only because the output is limited to thirteen digits, not fourteen digits.

EXTRA-PRECISION COMBINATIONS ON THE TI-74 & PC-324

Page 5 presented a conversion of a BASIC program by Larry Leeds for use with the CC-40. The program assumed that a software module was installed so that the UP subprogram could be used to print a title, to set a branching value to select use of either the printer or the display for output, and to open a file for access to the printer when needed. That program would also run on a TI-74 if one of the software modules was installed.

The program at the right does not assume that a software module is installed. Thus the functions which might have been provided by the UP subprogram must be provided in the user's program. The changes required are in lines 110 through 117 where:

Line 110 provides a prompt for selection of the printer or the display for output.

Line 113 processes the user response to set the PN flag as required.

Line 115 provides a prompt for entry of the device number if the printer option was selected. For the TI-74 operating with the PC-324 the user response is 12. For the CC-40 operating with the HX-1000 the response may be either a 10 or a 11 depending upon the setting of the switch in the HX-1000.

Line 117 opens a file for access to the printer if the printer option was selected.

The program listing was made using the normal printing mode of the PC-324, or 24 characters per line. Note the substantially improved legibility relative to the listing on page 5 which was made using the 36 character per line mode of the HX-1000 and then magnified.

Sample printouts appear below. Again, note the improved legibility over that on page 5.

```
100 Z=1.E+10
110 INPUT "Use Printer <
Y/N>? ";A$
113 IF A$="Y"OR A$="y"TH
EN PN=1
115 IF PN=1 THEN INPUT "
Enter device name: ";F$
117 IF PN=1 THEN OPEN #P
N,F$,OUTPUT
120 IMAGE ##########
130 INPUT "Number of Thi
ngs? ";N
135 PRINT #PN,"n = ";N
140 INPUT "How many at a
 time? ";R
145 PRINT #PN,"r = ";R
150 B=N:C=1
160 IF R>N/2 THEN R=N-R
170 FOR K=1 TO R
180 C=C*B/K:B=B-1:NEXT K
190 PRINT #PN,"nCr = ";C
195 IF PN=0 THEN PAUSE E
LSE PRINT #PN
200 INPUT "Need more pre
cision <Y/N>? ";A$
230 IF A$="n"OR A$="N"TH
EN 130
235 FOR I=0 TO 4:A(I)=0:
NEXT I:A(4)=1
240 FOR H=1 TO R
250 FOR J=0 TO 4
260 A(J)=A(J)*N:NEXT J
270 FOR J=4 TO 1 STEP -1
280 T=A(J)/Z:A(J-1)=A(J-
1)+INT(T)
290 A(J)=(T-INT(T))*Z:NE
XT J
300 FOR J=0 TO 4
310 B=A(J)/H:Q(J)=INT(B)
320 A(J+1)=A(J+1)+(A(J)-
Q(J)*H)*Z
330 NEXT J
340 FOR J=0 TO 4
350 A(J)=Q(J):NEXT J
360 N=N-1:NEXT H
370 FOR I=0 TO 4
380 PRINT #PN,USING 120:
Q(I)
390 IF PN=0 THEN PAUSE
400 NEXT I
410 PRINT #PN
420 GOTO 130
430 END
```

```
n =  140
r =  70
nCr =  9.382097E+40

         9
3820969697
8400412047
8589458050
6297666600
```

```
n =  100
r =  70
nCr =  2.937234E+25

         0
         0
    293723
3982161094
4823963760
```

ALPHA-NUMERIC INV LST - Hewlett Ladd found that the existing alphanumeric listing programs were painfully slow. Lem Matteson's program from V7N6P5 takes about 47 seconds per line. The earlier Bill Skillman program from V5N3P11 required about 22 seconds per line in normal mode, or about 13 seconds per line when converted to fast mode. Hewlett's program as listed below requires only eight seconds per line. The user instructions are:

For R01 through R89: See a sample listing on page 13.

1. Load bank 1 below with banks 2, 3, and 4 of the data registers.
2. Enter the lowest register to be listed and press A.
3. Enter the highest register < 90 and press R/S. See a flashing "1." and press 7 and then EE to begin listing.

For R90 through R99:

1. Load banks 1 and 2 of the program and force the bank 1 with the data registers to be listed into bank 3.
2. Enter the lowest register to be listed > 89 and press B.
3. Enter the highest register < <00 and press R/S. See a flashing "1.12" and press 7 and then EE to begin listing.

000	91	R/S	040	00	00	080	82	HIR	120	82	HIR	160	01	01	200	22	INV
001	25	CLR	041	45	45	081	36	36	121	36	36	161	61	GTO	201	67	EQ
002	82	HIR	042	02	2	082	25	CLR	122	01	1	162	00	00	202	00	00
003	13	13	043	82	HIR	083	82	HIR	123	00	0	163	90	90	203	02	02
004	42	STO	044	36	36	084	16	16	124	00	0	164	22	INV	204	06	6
005	00	00	045	73	RC*	085	69	OP	125	82	HIR	165	86	STF	205	69	OP
006	55	÷	046	00	00	086	04	04	126	66	66	166	01	01	206	17	17
007	01	1	047	69	OP	087	04	4	127	97	DSZ	167	93	.	207	25	CLR
008	00	0	048	01	01	088	42	STO	128	00	00	168	00	0	208	81	RST
009	75	-	049	22	INV	089	00	00	129	01	01	169	01	1	209	00	0
010	59	INT	050	67	EQ	090	82	HIR	130	06	06	170	00	0	210	00	0
011	82	HIR	051	00	00	091	12	12	131	87	IFF	171	01	1	211	00	0
012	02	02	052	63	63	092	55	÷	132	01	01	172	00	0	212	00	0
013	95	=	053	82	HIR	093	01	1	133	01	01	173	01	1	213	00	0
014	65	×	054	16	16	094	00	0	134	64	64	174	00	0	214	00	0
015	01	1	055	69	OP	095	75	-	135	93	.	175	01	1	215	00	0
016	00	0	056	04	04	096	59	INT	136	00	0	176	85	+	216	00	0
017	95	=	057	00	0	097	82	HIR	137	01	1	177	01	1	217	00	0
018	85	+	058	82	HIR	098	02	02	138	00	0	178	00	0	218	00	0
019	82	HIR	059	06	06	099	95	=	139	01	1	179	00	0	219	76	LBL
020	12	12	060	61	GTO	100	55	÷	140	00	0	180	00	0	220	11	A
021	65	×	061	01	01	101	01	1	141	01	1	181	00	0	221	82	HIR
022	01	1	062	85	85	102	00	0	142	00	0	182	95	=	222	03	03
023	00	0	063	55	÷	103	95	=	143	01	1	183	82	HIR	223	91	R/S
024	00	0	064	01	1	104	82	HIR	144	00	0	184	36	36	224	85	+
025	85	+	065	00	0	105	06	06	145	01	1	185	69	OP	225	01	1
026	01	1	066	75	-	106	82	HIR	146	85	+	186	05	05	226	75	-
027	00	0	067	59	INT	107	12	12	147	01	1	187	69	OP	227	82	HIR
028	01	1	068	82	HIR	108	55	÷	148	00	0	188	00	00	228	13	13
029	95	=	069	02	02	109	01	1	149	00	0	189	01	1	229	95	=
030	82	HIR	070	85	+	110	00	0	150	85	+	190	82	HIR	230	82	HIR
031	06	06	071	93	.	111	75	-	151	82	HIR	191	33	33	231	04	04
032	55	÷	072	01	1	112	59	INT	152	16	16	192	87	IFF	232	09	9
033	01	1	073	04	4	113	82	HIR	153	95	=	193	02	02	233	69	OP
034	00	0	074	95	=	114	02	02	154	82	HIR	194	02	02	234	17	17
035	95	=	075	65	×	115	95	=	155	07	07	195	41	41	235	04	4
036	22	INV	076	01	1	116	65	×	156	03	3	196	82	HIR	236	05	5
037	59	INT	077	52	EE	117	01	1	157	42	STO	197	54	54	237	30	TAN
038	22	INV	078	09	9	118	00	0	158	00	00	198	82	HIR	238	33	X²
039	67	EQ	079	95	=	119	95	=	159	86	STF	199	14	14	239	86	STF

240	00	00	254	25	CLR	268	85	+	282	76	LBL	296	05	5	310	02	2
241	82	HIR	255	82	HIR	269	01	1	283	12	B	297	09	9	311	85	+
242	54	54	256	13	13	270	02	2	284	75	-	298	75	-	312	01	1
243	82	HIR	257	42	STO	271	00	0	285	06	6	299	82	HIR	313	52	EE
244	14	14	258	00	00	272	01	1	286	00	0	300	13	13	314	01	1
245	22	INV	259	55	÷	273	61	GTO	287	95	=	301	95	=	315	02	2
246	67	EQ	260	01	1	274	00	00	288	82	HIR	302	82	HIR	316	95	=
247	02	02	261	00	0	275	29	29	289	03	03	303	04	04	317	22	INV
248	55	55	262	95	=	276	00	0	290	85	+	304	08	8	318	52	EE
249	61	GTO	263	22	INV	277	00	0	291	06	6	305	69	OP	319	86	STF
250	02	02	264	59	INT	278	00	0	292	00	0	306	17	17			
251	04	04	265	65	×	279	00	0	293	95	=	307	03	3			
252	86	STF	266	01	1	280	00	0	294	91	R/S	308	01	1			
253	02	02	267	00	0	281	00	0	295	75	-	309	03	3			

COMBINATORIAL ANALYSIS ON THE TI-95 - Built-in functions are provided for factorials, permutations, and combinations. The solutions are relatively fast, but not as fast as with the TI-74. Some representative times are:

	TI-59 (ML-16)	TI-74	TI-95
69!	14 sec	<1 sec	1 sec
100p50	43 sec	1 sec	2 sec
328c164	165 sec	3 sec	10 sec

The TI-95 does not seem to have the TI-59 ML-16 problem with non-integer solutions for combinations as described in V11N1P5; thus, 20c12 and 20c8 both yield the integer 12570. The TI-74 yields the non-integer value 12570.00000007 for both of those problems.

In the EE mode the TI-95 displays only a seven digit mantissa, while the TI-59 displays an eight digit mantissa and the TI-74 displays a ten digit mantissa. The 13d function of the TI-95 provides an easy method for viewing the entire mantissa.

RANDOM NUMBERS FROM THE TI-95 - The R# function provides a series of uniformly distributed pseudo-random numbers with values in the range from 0 to 1. A different sequence of values will be returned each time the routine is used. This is in contrast to the TI-74 and CC-40 where the RND function delivers the same sequence each time the computer is used. A method is provided for controlling the starting seed number so that a user can obtain a repeatable set of pseudo-random numbers if he so desires. Sorting the R# output into ten equal width buckets yields the following distributions for different quantities of numbers:

	1000	10,000	100,000
R000	95	975	9,828
R001	94	1044	10,096
R002	102	1000	10,093
R003	100	961	9,993
R004	107	1015	9,953
R005	104	1007	10,001
R006	100	950	9,987
R007	114	1030	9,985
R008	90	1023	9,941
R009	94	995	10,113

```
0000 CMS STO 011
0004 LBL AA R# *10=
0012 STO 010 INC IND 010
0019 DSZ 011 GTL AA
0025 LBL  B RCL IND 011
0032 PRT INC 011 10 INV
0039 IF= 011 GTL  B HLT
```

The tallying program at the right uses the indirect address sorting technique deswcribed in V10N1P4 and V10N3P13. Steps 0007 through 0014 rely in the characteristic of the TI-95 which selects the indirect address for a non-integer subscript by truncating to the integer value. That feature was also present in the TI-59 and TI-66. V11N2P7 noted that the CC-40 and TI-74 select the indirect address by rounding to the nearest integer. Line 0025 illustrates the use of a label where one character is a space.

ELEMENTARY STATISTICS ON THE TI-59 - Palmer Hanson.

Since this is one of the first programs I wrote for my TI-59 I thought it might be an appropriate program for comparing the capability of the TI-59 with the TI-95. The program assembles a list of input values in memory which can then be operated on to yield some of the elementary statistics. When used with a printer the program provides titles for the input and output, prints the input and output values, and provides annotation for the output. A sample printout appears at the right. The program listing appears below. User instructions follow.

1. Press A to initialize. The heading "INPUT" is printed.

2. Enter each input value and press R/S or 2nd A'. The input values will be printed. The calculator will stop with the number of items entered so far in the display.

3. To compute the statistics press B. The calculator wil stop with the number of input values in the display.

4. To print the statistics summary press C. The heading "STATISTICS" is printed followed by the annotated output values.

5. To add values to the list after modes B or C have been run, enter the first additional value and press 2nd-A'. The input value will be printed. You may use R/S to enter any further values.

6. To make corrections press 10 INV List to see each input value with the corresponding data register. Use STO nn to enter corrections.

INPUT	
4.	
5.	
6.	
0.	
-5.	
STATISTICS	
5.	N
-5.	MIN
6.	MAX
2.	x̄
4.527692569	e
4.516635916	RMS
10.09950494	RSS
6.	
7.	
-7.	
STATISTICS	
8.	N
-7.	MIN
7.	MAX
2.	x̄
5.398412465	e
5.431390246	RMS
15.3622915	RSS

000	76	LBL	040	91	R/S	080	77	GE	120	03	3	160	03	3	200	02	02
001	11	A	041	61	GTO	081	00	00	121	07	7	161	04	4	201	55	÷
002	29	CP	042	16	A'	082	86	86	122	02	2	162	04	4	202	43	RCL
003	47	CMS	043	76	LBL	083	32	X:T	123	04	4	163	69	OP	203	03	03
004	01	1	044	12	B	084	42	STO	124	01	1	164	04	04	204	95	=
005	01	1	045	36	PGM	085	09	09	125	05	5	165	43	RCL	205	34	√X
006	42	STO	046	01	01	086	69	OP	126	03	3	166	10	10	206	69	OP
007	07	07	047	71	SBR	087	28	28	127	06	6	167	69	OP	207	06	06
008	98	ADV	048	25	CLR	088	43	RCL	128	69	OP	168	06	06	208	98	ADV
009	69	OP	049	01	1	089	07	07	129	03	03	169	98	ADV	209	03	3
010	00	00	050	01	1	090	32	X:T	130	69	OP	170	79	x̄	210	05	5
011	02	2	051	42	STO	091	43	RCL	131	05	05	171	32	X:T	211	03	3
012	04	4	052	08	08	092	08	08	132	69	OP	172	06	6	212	06	6
013	03	3	053	43	RCL	093	22	INV	133	00	00	173	07	7	213	03	3
014	01	1	054	11	11	094	67	EQ	134	98	ADV	174	69	OP	214	06	6
015	03	3	055	42	STO	095	78	Σ+	135	03	3	175	04	04	215	69	OP
016	03	3	056	09	09	096	75	-	136	01	1	176	32	X:T	216	04	04
017	04	4	057	42	STO	097	01	1	137	69	OP	177	69	OP	217	43	RCL
018	01	1	058	10	10	098	01	1	138	04	04	178	06	06	218	02	02
019	03	3	059	76	LBL	099	95	=	139	43	RCL	179	98	ADV	219	34	√X
020	07	7	060	78	Σ+	100	91	R/S	140	03	03	180	22	INV	220	69	OP
021	69	OP	061	73	RC*	101	76	LBL	141	69	OP	181	79	x̄	221	06	06
022	02	02	062	08	08	102	13	C	142	06	06	182	32	X:T	222	69	OP
023	69	OP	063	42	STO	103	98	ADV	143	98	ADV	183	05	5	223	00	00
024	05	05	064	00	00	104	69	OP	144	03	3	184	04	4	224	98	ADV
025	98	ADV	065	78	Σ+	105	00	00	145	00	0	185	69	OP	225	91	R/S
026	91	R/S	066	43	RCL	106	03	3	146	02	2	186	04	04	226	00	0
027	76	LBL	067	00	00	107	06	6	147	04	4	187	32	X:T	227	00	0
028	16	A'	068	32	X:T	108	03	3	148	03	3	188	69	OP	228	00	0
029	72	ST*	069	43	RCL	109	07	7	149	01	1	189	06	06	229	00	0
030	07	07	070	10	10	110	01	1	150	69	OP	190	98	ADV	230	00	0
031	69	OP	071	77	GE	111	03	3	151	04	04	191	03	3	231	00	0
032	27	27	072	00	00	112	03	3	152	43	RCL	192	05	5	232	00	0
033	99	PRT	073	77	77	113	07	7	153	09	09	193	03	3	233	00	0
034	43	RCL	074	32	X:T	114	02	2	154	69	OP	194	00	0	234	00	0
035	07	07	075	42	STO	115	04	4	155	06	06	195	03	3	235	00	0
036	75	-	076	10	10	116	69	OP	156	98	ADV	196	06	6	236	00	0
037	01	1	077	43	RCL	117	02	02	157	03	3	197	69	OP	237	00	0
038	01	1	078	09	09	118	03	3	158	00	0	198	04	04	238	00	0
039	95	=	079	22	INV	119	06	6	159	01	1	199	43	RCL	239	00	0

ELEMENTARY STATISTICS ON THE TI-95 - P. Hanson

This program was written to provide a capability equivalent to that of the TI-59 program on page 21. The program also demonstrates unique capabilities of the TI-95 such as the use of the windows for prompting, and the merging of alphanumerics and display register values to obtain printout with annotation. A sample printout appears at the right for the same conditions as in the TI-59 example on page 21. The program listing appears on page 23.

```
        Data

              4.
              5.
              6.
              0.
             -5.

     Statistics

N                 5.

Min              -5.

Max               6.

Mean              2.

S.D.     4.527692569

RMS      4.516635916

RSS      10.09950494

     More Data

              6.
              7.
             -7.

     Statistics

N                 8.

Min              -7.

Max               7.

Mean              2.

S.D.     5.398412465

RMS      5.431390246

RSS       15.3622915

        Data

              4.
              5.
              6.
              0.
             -5.
              6.
              7.
             -7.
```

User Instructions:

1. At program entry the windows above keys F1 through F5 will contain the legends Clr, Out, Add, Lst and Inp. Press F1 (Clr) to initialize. The prompt "Data" will appear in the display. If a printer is connected the heading "Data" wil be printed.

2. To enter each input value place the value in the display and press F5 (Inp). If a PC-324 is connected the input value will be printed. The calculator will stop with the number of values entered so far in the display.

3. To calculate the statistics and print the output values press F2 (Out). If a printer is connected the heading "Statistics" will be printed followed by the values for the number of input values, the maximum and minimum input values, the mean, the standard deviation, the RMS and the RSS, all with appropriate annotation. If a printer is not connected the output values and the annotation will be flashed in the display. The calculator stops with a zero in the display.

4. If you would like a printed heading to indicate that input values are being added to the array press F3 (Add) and the heading "More Data" will be printed. You may add values to the input array by repeating step 2. You may add values without pressing F3 to obtain the heading.

5. To obtain a combined printout of all the input data to date press F4 (Lst). The heading "Data" will be printed followed by a list of the input values. If a printer is not installed the input values will be flashed in the display.

Comments on the Program:

Lines 0000 through 0028 define the functions to be associated with keys F1 through F5.

Lines 0036 through 0054 provide initialization, and print the heading "Data".

Elementary Statistics on the TI-95 - (cont)

Lines 0057 through 0068 store the input values in data registers starting at 003.

Lines 0072 through 0081 place the prompt "Use Printer" in the display and the legends "Yes" and "No" below keys F1 and F2. If the answer is yes, flag 1 is set.

Line 0091 - the SBR 0000 re-defines the F1 through F5 functions which had been replaced by the Y/N command at step 0088.

Line 0096 prints the heading "Statistics".

Lines 0110 and 0115 select the one variable statistics option and clear the statistics registers (CS1), and initialize the minimum and maximum values in data registers B (001) and C (002) to the first input value.

Lines 0119 through 0137 retrieve the input values in reverse order, determine the maximum and minimum values of the array, and obtain the sums necessary for statistics calculations. The SG+ command is equivalent to the Σ+ command in the TI-59. The STO A at steps 0145/0146 and the 2 ST+ A at steps 0151-0153 restore the location of the last input value into data register A (000). The St+ command is the equivalent of the SUM command in the TI-59.

Lines 0132 through 0202 bring each of the output parameters and the appropriate annotation alphanumeric to the display in order. The SHW 2 and SHW 4 functions are obtained from the SHW option of the STAT key, where SHW 2 retrieves the number of input values, and SHW 4 retrieves the sum of the squares of the input values.

Lines 0205 through 0217 provide the equivalent of the Op 06 function in the TI-59. A test of flag 1 (condition controlled in lines 0072 through 0081 above) is used to select column 16 for the last digit of output value in the display when a printer is not used, or to select column 20 for the last digit of the output value if a printer is used.

Lines 0220 through 0238 print the heading "More Data" in response to function key F3.

Lines 0239 through 0274 print the heading "Data" followed by a list of all the input values in response to function key F4. This portion of the program is a good example of the rule that a new line is started for each label in the program listing.

```
0000 DFN F1:Clr@CL
0007 DFN F2:Out@OU
0014 DFN F3:Add@AD
0021 DFN F4:Lst@LT
0028 DFN F5:Inp@IN RTN
0036 LBL CL CLR ADV CMS
0042 2 STO A `    Data `
0054 PRT ADV HLT
0057 LBL IN INC A
0062 STO IND A PRT RCL A
0068 -2= HLT
0072 LBL OU RF 01 `Use `
0081 `Printer` Y/N SF 01
0091 SBR 0000 ADV CLR
0096 `   Statistics` PRT
0110 ADV CS1 RCL IND A
0115 STO B STO C
0119 LBL SG RCL IND A
0125 IF< B STO B IF> C
0131 STO C SG+ INV INC A
0137 2 IF< A GTL SG
0143 SHW 2 STO A `N`
0148 SBL PR 2 ST+ A
0154 RCL B `Min` SBL PR
0162 RCL C `Max` SBL PR
0170 MN `Mean` SBL PR s
0179 `S.D.` SBL PR SHW 4
0188 / SHW 2 = SQR `RMS`
0196 SBL PR SHW 4 SQR
0202 `RSS`
0205 LBL PR COL 16 TF 01
0212 COL 20 MRG = PRT
0217 ADV CLR RTN
0220 LBL AD CLR ADV `  `
0227 `More Data` PRT ADV
0238 HLT
0239 LBL LT ADV CLR `  `
0246 `  Data` PRT ADV 2
0255 STO B
0257 LBL LL INC B
0262 RCL IND B PRT RCL B
0268 IF< A GTL LL ADV
0274 CLR HLT
```

<u>FROM THE EDITOR</u> - Of course the big news in this issue is the TI-95. The CI-7 Cassette Interface for use with both the TI-74 and the TI-95 also became available. I haven't had time to even try it. I will report on it next month.

Several correspondents have asked me to comment on the TI-74 versus the TI-95. At this point I see the real advantage of the TI-74 as the BASIC language with a built-in subscript capability. If you do a lot of work with arrays as I do that is important. While the windows and other new features of the TI-95 are attractions, I think that the real advantage is that we have a faster machine which should be able to accept our library of TI-59 programs with a minimum amount of editing. (By the way, have you noticed that 95 is 59 reversed?). For TI-59 programs written with all label addressing the conversion will be particularly easy; even the printout commands (Op 00 through Op 06) can be readily converted as indicated in the example on page 23. Op 07 is a different matter--there does not seem to be any equivalent built-in plot capability in the TI-95, but I may simply have missed it. I didn't find that there was a more direct way of determining if the printer is connected than with a Y/N prompt until today. I also found the CHR IND nnnn or CHR IND X command too late to incorporate it in the program on page 23 to provide sequence numbers for the list option. For TI-59 programs which use absolute addressing the conversion will not be so simple. The problem arises because many of the equivalent TI-95 commands require more program steps; for example, even a Label requires three steps instead of two. At the moment I see no alternative but to enter the TI-59 program in sequence, and then adjust the addresses as required through examination of the branch points.

A card which came with the TI-95 indicates that there will be a <u>free</u> newsletter supporting the device. I sent in the card, but have not yet received any response. The card does not indicate whether or not there will be a program exchange. What I suggest that members who purchase TI-95's do is notify me when they have converted TI-59 programs. I will list them in coming issues in a manner similar to that used to indicate availability of PPX programs for the TI-59. We also need to develop a method for transferring programs on magnetic media. That may seem self-evident once we get the cassette interfaces working; however, experience with the magnetic cards for the TI-59 and with cassette tapes for the Radio Shack Model 100 suggests that there may be some incompatibility problems lurking out there. Time will tell. The other alternative would be to use the TI-695 8K RAM cartridges to exchange data.

TABLE OF CONTENTS

Magnetic card service will continue to be available for TI-59 programs in this issue, and for programs in the 1983, 1984 and 1985 issues. One dollar per card plus a stamped and self addressed enveloope, please.