TI PPC NOTES

v7N10, 1982.

NEWSLETTER OF THE TI PERSONAL PROGRAMMABLE CALCULATOR CLUB.

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I should start here with the classical "I have some good news and some bad news. Now for the good news..." Well, let's reverse this order and get the bad news out of the way as soon as possible: Electronic News, September 27, 1982, page 57, carries an article with the title "TI Portable CPU Line May Dump Top Calculator." Then it goes on saying: "Texas Instruments has decided to withhold its top of the line TI-88 hand-held keystroke-programmable calculator, and will scrap it altogether as it shifts priorities to a family of hand-held computers it will unveil shortly. The article is far too long to be reproduced here in its entirety. But I learned from it that TI has opened up eight new facilities for the production of the TI-99/4A home computer or for making its components and that their total output is now 30,000 units per week. The real reasons for the demise of the 88 are probably a little more complex than TI explains in these simple terms of "shifting priorities", but the net result is that the 59 will be their top of the line machine. Requiescant in Pace TI-88.

The Digit Reversing puzzle generated so much interest that we dedicated several pages to it. In fact, the original number of pages I had for this issue totaled 31. By some judicious reducing and editting (hm,hm) we managed to get everything on 14 pages.

There are also several solutions to Myer Boland's Let Me Count the Ways puzzle.But the real star problem was the Pie Chart drawing contest. So far, and contrary to what I say on pages 6 & 7, I have received three solutions: The one published here and written by Robert Prins in the Netherlands, one by Lars Nilsson in Sweden and a third one by Michael Sperber in West Germany. Although slow all three, as expected, they neatly solve the problem and produce pie charts in Graphics Mode. My hat off to the three geniusses.

As I said in last issue, don't despair if you haven't seen your contribution appear in these pages yet. I am sending all as-yet-unpublished articles to Palmer Hanson for his consideration. But don't stop sending Palmer new ones. Let Palmer know that you support him, not by words, but by deeds. What he needs is programs, articles, neat tricks, in short publishable material.

Also, send in your dues early this year, so that Palmer will know what funds he can count on for 1983. You will find a subscription form with your address already on it. Correct it if necessary. I still have a few sets of back issues available on a first come first served basis. All those who received the Notes free, please send in your subscription form to Palmer Hanson with a note telling him of the arrangement and the reason why you want it to continue. Thank you.

Now, for the traditional (and expected of me) swan song: It has been lots of fun to get to know all of you, and especially the ones who repeatedly sent in good contributions which were subsequently puplished in these pages. My sincerest thanks and admiration for so much talent and dedication. I learned a lot from you.

I only hope now that we will not become strangers and that we will keep in contact.

Cordially,

[signature]

IN THIS ISSUE:

LET ME COUNT THE WAYS, by Myer Boland provoked a lot of reaction. I was unaware that there were so many puzzlers. The original programs Myer sent me were the following:
1) PAU + PI COS ABS = LBL A RAD CMs RST
2) PAU + CE DIV CE = LBL A CMs RST
3) PAU SUM+ RST LBL A CMs RST (this is the one I gave as a preview)
4) + OP E') PAU RST LBL A CMs CLR INV LNX PAU RST
5) INV LOG X (OP E' INV LOG) = LOG PAU RST LBL A CMs CLR INV LNX PAU RST
6) EE INV EE CP + X:T) + INV P/R = X=T RST PAU RST LBL A RAD FIX 0 RST

As you can see, some of them are long and among them you will find some of the fastest routines. As we just wanted other possible routines and didn't want this simple thing to degenerate into a speed contest, no rating is given neither for speed nor for briefness. Maybe elegance would be a good criterium. If that is accepted, my vote carries # 6, where Myer uses the device CP + X:T to get the number on both sides of X:T , so as to use to X=T to prevent repeating numbers. Nice!

Palmer Hanson says that Myer's sequence starts with zero, not with 1 as stated. What is more, if Myer's routine contains anything else than a zero, it will flash that number first and then flashes numbers incremented from it. Palmer sends three routines of his own:
1) SUM+ PAU RST LBL A CMs RST, which is the shortest of the three, but also the slowest: it counts only up to 44 in a minute.
2) OP 10 + PAU PLB A PI RST, which is longer but counts up to 88 in a minute.
3) LBL A CP X:T COS + PAU RST counts up to 75 in a minute.

Bill Buechner has two routines to offer. The first one duplicates exactly Palmer's # 1, but the second one goes like: = PAU + LBL A PI DIV PI RST.

Björn Gustavsson also has 3 routines:
1) OP 20 RCL 00 PAU RST LBL A CMs RST
2) LBL A PI OP 10 + PAU RST
3) PI OP 10 + PAU RST LBL A RST (faster than # 2)

Ralph Snyder, true to form, sent me a lot of solutions one day, to recant them the very next day. So, here go Ralph's two solutions:
1) PAU DIV LBL A + RST
2) PAU + LBL A DIV RST
Both solutions run continuously in error condition, so to stop them hold R/S down until the display winks. Then press CLR.

Erik Kempf in Denmark also put up a good show with these routines:
1) PAU SUM+ RST LBL A RST
2) PAU + CE DIV RST LBL A DIV CE + RST

Erik says that stopping the program results in flashing. But why stopping, he adds. My program is still running, so I will be forced to buy a new TI-59! He ends his letter with: Puzzling er sjovt! (puzzling is fun) to which I say to all of you: Ja, vi havde det vaeldig sjovt! (yes indeed, we have had lots of fun)

CALCULUS BY CALCULATOR.- Maurice Weir, Prentice-Hall, Inglewood Cliffs NJ, 07632, 387 pages, softcover, $ 15.95. Published Sept.22, 1982.

Maurice, as most of you are aware of by now, is a PPC member. He is also a mathematics professor at the Naval Postgraduate School in Monterey, California. He has written several books on the use of programmable calculators in mathematics education. This one again is superb.

The book contains six chapters:
1. Coordinates, Lines and Polynomial Functions.
2. Functions, Limits and Continuity.
3. Differentiation.
4. Integration.
5. Differential Equations.
6. Infinite Series.

Appendix A contains TI-59 programs and appendix B contains the answers to problems.

The book is intended for first-year calculus students. It makes a unique use of the TI-59 and its programs to do virtually all the aspects of computation of the calculus.

I cannot think of any better and easier way to be introduced to calculus. I am jaleous of the younger people having this wonderful and easy method to learn a rather involved sunject. By using the programmable calculator you can have it do all the computational drudgery, while you are able to concentrate on the "meat" of the matter, learning calculus.

I highly recommend it to anyone wanting to learn or simply refresh calculus.
(Maurice Swinnen)

DIGIT REVERSER PUZZLE.- I received numerous solutions to this one I had attributed to Harald M. Otto. I knew, of course, that Reinhold Patzer, a compatriot of Harald, had solved it in 52-Notes, v3n4p4. It was an improvement on one by Jared Weinberger (remember Jared from Bologna, Italy?) in v2n11p6. But I just hoped that nobody would remember it and those who did would not remember the source.

```
HARALD M. OTTO
REINHOLD PATZER
West Germany

000  76  LBL
001  11   A
002  53   (
003  24  CE
004  55   ÷
005  01   1
006  00   0
007  49  PRD
008  01   01
009  75   -
010  22  INV
011  59  INT
012  44  SUM
013  01   01
014  54   )
015  22  INV
016  67   EQ
017  11   A
018  53   (
019  48  EXC
020  01   01
021  65   ×
022  01   1
023  00   0
024  54   )
025  92  RTN
```

But you can always count on Patrick Acosta to have a mind as a steel trap. He remembered and reminded me of it. Patrick has a nice solution himself: LBL E CMs CP ÷ INV INT SUM 03 = DIV 10 PRD 03 = INV X=T 004 RCL 03 R/S.

Joseph P. Hanson's solution is unconventional in that it starts with the number in R10 and leaves the inverted version in R11. The EE at step 030 is necessary; without it, summing exponential and non-exponential formats into R11 produces rounding errors. Joe's version may be found among many others on the next two pages.

John R. Adams tells me that his solution has the following characteristics:

1. *Zero and single-digit numbers are reversed. (Hold onto that one, Jack. We can use it in our next April joke. Brilliant. Ed.)*
2. *Negative numbers are inverted and remain negative. (Some of the other solutions don't do that.Ed.)*
3. *For numbers greater than 1 X 10^{13}, all significant digits can be inverted if one ignores the exponent and is careful in how the 13 digits are retreived.*

From Nello Coda you will find several solutions. The first one reverses the order for any number up to 13 digits, by pressing A the first time, R/S all subsequent times. The second one reverses a number with trailing zeros and yields the zeros again when re-reversed. The third routine preserves both leading and lagging zeros, provided the number of digits is entered first. For example, consider the 6-digit number 012300. Enter 6 and press A. Enter 012300 or simply 12300, because a leading zero doesn't show up in the display, and press R/S repeatedly. The numbers 3210 and 12300 will alternate with each R/S.

Now for Ralph Snyder: That "fussy old boy" (his own words) is always panting along with some amendments to his submissions: three tries for the Dimension Operations last summer, three and a half for his famous Internal Rate of Return, two separate entries for the Digit Reverser and a pair of amendments for something he calls Digit Reverser by Alphas. Well, out of sheer fear of making an error in the transcription and incurring his holy wrath again, even after my retirement as editor, I am showing you here the last one of each version, LITTERALLY, reduced so they would fit. Any error you find is Ralph's. Look him up in the Indianapolis telephone guide.

By the way, Don O'Grady, the author of many modules and also of the Master Library for the TI-88, told me recently, at the occasion of my visit to Lubbock to be trained on the 88, that he used Ralph's equations for the financial programs. It permitted a much faster solution to financial problems with fewer itterations and higher accuracy. This coming from Don is a real complement. Ralph would also have had his name immortalized in the Manual, if the 88 had flown.

Please find a compilation of the many routines I received on the next two pages. My sincere thanks to everybody who participated. It was real fun.

Digit Reverser Puzzle

DIGIT REVERSER. Ralph W. Snyder, Indianapolis.

	PRESS		PRESS		
9.	A	13.	A	76655.	
123456789.	B	1122334455.	TRACE +	766554.	
9.		0.667	=	7665544.	
98.		1122334456.		76655443.	
987.		1122334456.	×	766554433.	
9876.		1000.	=	7665544332.	
98765.		1.1223345 12	TRACE	7.6655443 10	
987654.		1.1223345 12	B	7.6655443 11	
9876543.		7.		7.6655443 12	TRACE
98765432.		76.		7.6655443 12	÷
987654321.		766.		1000.	=
		7665.		7665544332.	
				7665544332.	INV INT TRACE
				0.211	

000	91	R/S	013	02	02	026	00	00
001	76	LBL	014	95	=	027	00	00
002	12	B	015	32	X:T	028	05	05
003	99	PRT	016	43	RCL	029	91	R/S
004	32	X:T	017	02	02	030	76	LBL
005	32	X:T	018	65	×	031	11	A
006	65	×	019	01	1	032	47	CMS
007	93	.	020	00	0	033	42	STO
008	01	1	021	95	=	034	00	00
009	75	-	022	99	PRT	035	99	PRT
010	22	INV	023	42	STO	036	98	ADV
011	59	INT	024	02	02	037	81	RST
012	44	SUM	025	97	DSZ			

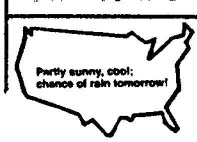
Instructions:

Numbers up to 10 digits: (1) Enter number of digits, press A. (2) Enter the number, press B. Reversal is printed by cumulative digits (for no printout delete PRT at Step 022; insert at Step 029 for printed answer).

Numbers exceeding 10 digits: (3) Enter number of digits, press A. (4) Enter first 10 digits, press + ; enter remaining digits as a decimal, press = x ; then, depending on whether the number has 11, 12 or 13 digits, enter a multiplier of 10, 100 or 1000, press = B . (For printout of this, press TRACE before entering digits, and again before pressing B .) (5) For an answer exceeding 10 digits, press TRACE + , then enter a divisor of 10, 100 or 1000 (matching the multiplier in operation (4)), and press = INV INT TRACE. The answer will be printed as 10 digits as an integer, and the remaining digits as a decimal. (See second example, showing printouts by operations (4) and (5).)

LEM MATTESON
Kansas City, MO

000	76	LBL
001	11	A
002	47	CMS
003	42	STO
004	11	11
005	42	STO
006	12	12
007	99	PRT
008	28	LOG
009	59	INT
010	42	STO
011	00	00
012	69	OP
013	20	20
014	76	LBL
015	16	A'
016	43	RCL
017	11	11
018	55	÷
019	01	1
020	00	0
021	75	-
022	59	INT
023	42	STO
024	11	11
025	95	=
026	42	STO
027	10	10
028	01	1
029	00	0
030	49	PRD
031	13	13
032	43	RCL
033	10	10
034	44	SUM
035	13	13
036	97	DSZ
037	00	00
038	16	A'
039	01	1
040	00	0
041	49	PRD
042	13	13
043	43	RCL
044	13	13
045	99	PRT
046	98	ADV
047	91	R/S



JOSEPH P. HANSON
Lexingtom MA

000	43	RCL
001	10	10
002	28	LOG
003	85	+
004	01	1
005	54	)
006	59	INT
007	42	STO
008	01	01
009	25	CLR
010	42	STO
011	11	11
012	76	LBL
013	29	CP
014	43	RCL
015	10	10
016	55	÷
017	01	1
018	00	0
019	54	)
020	42	STO
021	02	02
022	22	INV
023	59	INT
024	65	×
025	43	RCL
026	01	01
027	22	INV
028	28	LOG
029	54	)
030	52	EE
031	44	SUM
032	11	11
033	43	RCL
034	02	02
035	59	INT
036	42	STO
037	10	10
038	97	DSZ
039	01	01
040	29	CP
041	92	RTN

NELLO CODA
Erie, PA

000	76	LBL
001	13	C
002	55	÷
003	01	1
004	00	0
005	95	=
006	42	STO
007	00	00
008	22	INV
009	59	INT
010	22	INV
011	44	SUM
012	00	00
013	44	SUM
014	01	01
015	01	1
016	00	0
017	49	PRD
018	01	01
019	43	RCL
020	00	00
021	69	OP
022	22	22
023	22	INV
024	67	EQ
025	13	C
026	43	RCL
027	01	01
028	91	R/S
029	32	X:T
030	43	RCL
031	02	02
032	47	CMS
033	42	STO
034	02	02
035	32	X:T
036	76	LBL
037	14	D
038	55	÷
039	01	1
040	00	0
041	95	=
042	42	STO
043	00	00
044	22	INV
045	59	INT
046	22	INV
047	44	SUM
048	00	00
049	44	SUM
050	01	01
051	01	1
052	00	0
053	49	PRD
054	01	01
055	43	RCL
056	00	00
057	97	DSZ
058	02	02
059	14	D
060	43	RCL
061	01	01
062	91	R/S
063	76	LBL
064	11	A
065	47	CMS
066	29	CP
067	81	RST

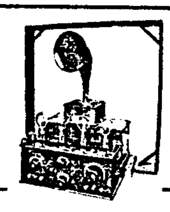
000	76	LBL
001	13	C
002	55	÷
003	01	1
004	00	0
005	95	=
006	42	STO
007	00	00
008	22	INV
009	59	INT
010	22	INV
011	44	SUM
012	00	00
013	44	SUM
014	01	01
015	01	1
016	00	0
017	49	PRD
018	01	01
019	43	RCL
020	00	00
021	97	DSZ
022	02	02
023	13	C
024	43	RCL
025	03	03
026	42	STO
027	02	02
028	25	CLR
029	48	EXC
030	01	01
031	91	R/S
032	81	RST
033	76	LBL
034	11	A
035	47	CMS
036	29	CP
037	42	STO
038	02	02
039	42	STO
040	03	03
041	91	R/S

000	76	LBL
001	13	C
002	55	÷
003	01	1
004	00	0
005	95	=
006	42	STO
007	00	00
008	22	INV
009	59	INT
010	22	INV
011	44	SUM
012	00	00
013	44	SUM
014	01	01
015	01	1
016	00	0
017	49	PRD
018	01	01
019	43	RCL
020	00	00
021	87	IFF
022	01	01
023	14	D
024	69	OP
025	22	22
026	22	INV
027	67	EQ
028	13	C
029	43	RCL
030	01	01
031	91	R/S
032	86	STF
033	01	01
034	32	X:T
035	43	RCL
036	02	02
037	47	CMS
038	42	STO
039	02	02
040	32	X:T
041	61	GTO
042	13	C
043	76	LBL
044	14	D
045	97	DSZ
046	02	02
047	13	C
048	43	RCL
049	01	01
050	91	R/S
051	76	LBL
052	11	A
053	47	CMS
054	29	CP
055	81	RST

000	76	LBL
001	13	C
002	55	÷
003	01	1
004	00	0
005	95	=
006	42	STO
007	00	00
008	22	INV
009	59	INT
010	22	INV
011	44	SUM
012	00	00
013	44	SUM
014	01	01
015	01	1
016	00	0
017	49	PRD
018	01	01
019	43	RCL
020	00	00
021	22	INV
022	67	EQ
023	13	C
024	43	RCL
025	01	01
026	91	R/S
027	76	LBL
028	11	A
029	47	CMS
030	29	CP
031	81	RST

JOHN ADAMS
Pittsburg PA

000	76	LBL
001	11	A
002	32	X:T
003	00	0
004	42	STO
005	02	02
006	32	X:T
007	59	INT
008	76	LBL
009	12	B
010	55	÷
011	01	1
012	00	0
013	95	=
014	75	-
015	53	(
016	22	INV
017	59	INT
018	75	-
019	53	(
020	24	CE
021	85	+
022	01	1
023	00	0
024	65	×
025	43	RCL
026	02	02
027	54	)
028	42	STO
029	02	02
030	00	0
031	95	=
032	22	INV
033	67	EQ
034	12	B
035	01	1
036	00	0
037	49	PRD
038	02	02
039	43	RCL
040	02	02
041	92	RTN



DIGIT REVERSER BY ALPHAS. Ralph W. Snyder, Indianapolis.

5.	000 91 R/S	018 03 03	036 09 09	054 69 OP	072 69 OP	090 00 00
203040506.	001 69 OP	019 99 PRT	037 95 =	055 29 29	073 02 02	091 24 24
708091200.	002 00 00	020 69 OP	038 65 ×	056 87 IFF	074 22 INV	092 91 R/S
0.	003 42 STO	021 05 05	039 01 1	057 01 01	075 86 STF	093 76 LBL
123456789	004 01 01	022 69 OP	040 00 0	058 00 00	076 01 01	094 11 A
987654321	005 69 OP	023 00 00	041 00 0	059 72 72	077 86 STF	095 47 CMS
	006 01 01	024 73 RC*	042 95 =	060 87 IFF	078 02 02	096 05 5
	007 99 PRT	025 08 08	043 72 ST*	061 02 02	079 87 IFF	097 99 PRT
	008 91 R/S	026 65 ×	044 09 09	062 00 00	080 02 02	098 42 STO
5.	009 42 STO	027 93 .	045 97 DSZ	063 83 83	081 00 00	099 00 00
202030304.	010 02 02	028 00 0	046 00 00	064 69 OP	082 87 87	100 03 3
405050606.	011 69 OP	029 01 1	047 00 00	065 01 01	083 69 OP	101 42 STO
707080909.	012 02 02	030 75 -	048 24 24	066 86 STF	084 03 03	102 08 08
112233445566778	013 99 PRT	031 59 INT	049 05 5	067 01 01	085 69 OP	103 04 4
877665544332211	014 91 R/S	032 72 ST*	050 42 STO	068 87 IFF	086 05 05	104 42 STO
	015 42 STO	033 08 08	051 00 00	069 01 01	087 25 CLR	105 09 09
	016 03 03	034 85 +	052 73 RC*	070 00 00	088 97 DSZ	106 25 CLR
	017 69 OP	035 73 RC*	053 09 09	071 87 87	089 08 08	107 91 RST

Instructions.

(1) Press A. This sets two DSZ controls, one for the Digit Reversal "short loop" ending at Step 048, and the other for the "long loop" ending at Step 091 controlling the looping for the three alpha banks.

(2)(a) Enter the 1st alpha bank double-digits for the 1st 5 actual digits of the actual number. Press R/S.

(b) Same for 2nd alpha bank. Press R/S.

(c) Same for 3rd alpha bank (if there are no actual digits for any bank, enter 0). Press R/S.

Execution time from last R/S, about 23 seconds (about 21 seconds if no digits in 3rd bank).

Notes: Be sure to complete the full 10 alpha double-digits, using sufficient double zeros (00) to fill each bank; and remember that when entering say 02 for the actual digit 1 as the leading digits in any bank, the 0 is "silent" and need not be entered (if a leading 02 is keyed in, only 2 appears in the display and in the printout).

Remember that the digits 0 to 8 are entered in alpha by a zero followed by the actual digit-plus 1 (e.g., 0 is 01, 1 is 02, etc., and 8 is 09). The actual digit 9 is entered as 12.

JAMES BAUER
Kenosha WI

```
000  76 LBL
001  11  A
002  47 CMS
003  42 STO
004  00  00
005  32 X:T
006  01  1
007  03  3
008  42 STO
009  01  01
010  32 X:T
011  55  ÷
012  01  1
013  00  0
014  95  =
015  42 STO
016  02  02
017  22 INV
018  59 INT
019  29 CP
020  22 INV
021  67  EQ
022  00  00
023  31  31
024  65  ×
025  01  1
026  44 SUM
027  04  04
028  61 GTO
029  00  00
030  35  35
031  85  +
032  00  0
033  49 PRD
034  04  04
035  95  =
036  65  ×
037  01  1
038  00  0
039  49 PRD
040  03  03
041  95  =
042  44 SUM
043  03  03
044  43 RCL
045  02  02
046  59 INT
047  97 DSZ
048  01  01
049  00  00
050  11  11
051  43 RCL
052  03  03
053  55  ÷
054  01  1
055  00  0
056  45 YX
057  43 RCL
058  04  04
059  95  =
060  91 R/S
```

CH.WILLIAMSON
Sacramento CA

```
000  76 LBL
001  11  A
002  29 CP
003  32 X:T
004  85  +
005  53  (
006  32 X:T
007  55  ÷
008  01  1
009  00  0
010  75  -
011  59 INT
012  53  (
013  29 CP
014  05  +
015  32 X:T
016  95  =
017  65  ×
018  01  1
019  00  0
020  85  +
021  00  0
022  22 INV
023  67  EQ
024  00  00
025  04  04
026  95  =
027  92 RTN
```

JOHN HAMLIN
Beaverton OR

```
000  76 LBL
001  11  A
002  42 STO
003  15  15
004  28 LOG
005  59 INT
006  85  +
007  01  1
008  95  =
009  42 STO
010  00  00
011  42 STO
012  16  16
013  43 RCL
014  15  15
015  55  ÷
016  43 RCL
017  00  00
018  22 INV
019  28 LOG
020  52 EE
021  22 INV
022  52 EE
023  95  =
024  76 LBL
025  42 STO
026  65  ×
027  01  1
028  00  0
029  95  =
030  72 ST*
031  00  00
032  59 INT
033  22 INV
034  74 SM*
035  00  00
036  63 EX*
037  00  00
038  97 DSZ
039  00  00
040  42 STO
041  01  1
042  42 STO
043  00  00
044  76 LBL
045  43 RCL
046  73 RC*
047  00  00
048  95  =
049  65  ×
050  01  1
051  00  0
052  85  +
053  69 OP
054  20  20
055  43 RCL
056  16  16
057  32 X:T
058  43 RCL
059  00  00
060  22 INV
061  77  GE
062  43 RCL
063  73 RC*
064  00  00
065  95  =
066  92 RTN
```

ERIK KEMPF
Denmark

```
000  76 LBL
001  11  A
002  29 CP
003  75  -
004  22 INV
005  59 INT
006  44 SUM
007  00  00
008  95  =
009  55  ÷
010  01  1
011  00  0
012  49 PRD
013  00  00
014  95  =
015  22 INV
016  67  EQ
017  11  A
018  48 EXC
019  00  00
020  92 RTN
```

```
000  76 LBL
001  11  A
002  29 CP
003  55  ÷
004  53  (
005  28 LOG
006  59 INT
007  65  +
008  01  1
009  54  )
010  22 INV
011  28 LOG
012  52 EE
013  22 INV
014  52 EE
015  42 STO
016  00  00
017  75  -
018  59 INT
019  44 SUM
020  01  01
021  95  =
022  65  ×
023  01  1
024  00  0
025  22 INV
026  49 PRD
027  01  01
028  95  =
029  22 INV
030  67  EQ
031  00  00
032  17  17
033  48 EXC
034  00  00
035  49 PRD
036  01  01
037  25 CLR
038  48 EXC
039  01  01
040  92 RTN
```

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

D.RISTANOVIC
Yugoslavia

```
000  76 LBL
001  11  A
002  42 STO
003  00  00
004  55  ÷
005  01  1
006  00  0
007  49 PRD
008  01  01
009  75  -
010  59 INT
011  42 STO
012  00  00
013  95  =
014  65  ×
015  01  1
016  00  0
017  95  =
018  44 SUM
019  01  01
020  43 RCL
021  00  00
022  22 INV
023  67  EQ
024  00  00
025  04  04
026  48 EXC
027  01  01
028  91 R/S
```

ERIK SORENSEN
Denmark

```
000  76 LBL
001  11  A
002  47 CMS
003  29 CP
004  55  ÷
005  01  1
006  00  0
007  75  -
008  59 INT
009  42 STO
010  00  00
011  95  =
012  44 SUM
013  01  01
```

```
014  01  1
015  00  0
016  49 PRD
017  01  01
018  43 RCL
019  00  00
020  59 INT
021  22 INV
022  67  EQ
023  00  00
024  04  04
025  43 RCL
026  01  01
027  91 R/S
```

HENRIK KLEIN
Denmark

```
000  76 LBL
001  11  A
002  42 STO
003  01  01
004  76 LBL
005  16  A'
006  22 INV
007  59 INT
008  22 INV
009  44 SUM
010  01  01
011  95  =
012  55  ÷
013  93  .
014  01  1
015  49 PRD
016  01  01
017  85  +
018  43 RCL
019  01  01
020  22 INV
021  67  EQ
022  16  A'
023  95  =
024  92 RTN
```

PIE CHARTS.- I once called Robert Prins from De Bilt,in the Netherlands, a master programmmer. This was in a letter to the organizer of Procal meetings, a get-together of calculator fanatics in that country, Dr. Frans Van den Bogaard. Frans got that message back to Robert and ever since they have noticed a light swelling of young Robert's head accompanied by a a noticeable elevating of the nose. And rightly so: In my eyes this young student at the Delft Technical University is one of the practicioners of the art of computing on small machines that has shown a rare insight into how these machines really work and has consistently come up with ingenious and practical programs. So, again he rose to the challenge I put up in one of the former issues and he sends me a program that will produce pie charts in double mode: Graphics and Fast modes. The Graphics part is a slight modification of Michael Sperber's Plot 60 using the STF h12 Fast mode entry with a smartly chosen initialization constant of " 1 $\sqrt{x}$ x^2 1/x ", which sets only flag 4, so that you can start Fast mode by calling B and "pop" out into Normal mode by a RTN, without going into Trace mode after the RTN. This method was described by Patrick Acosta in v6n8p4.

The program is divided into 4 sections:

Section 1: steps 000 through 239, the main section, needed for initialization, both Graphics and Fast mode.
Section2: steps 240 through 476, the "rotate and print" descriptor section.
Section 3: steps 240 through 479, the first part of the actual pie printer.
Section 4: steps 480 through 623, the rest of the pie printer.

Keying in the program:

1) Repartition to 4 OP 17 and key in listing 1, steps 000 through 239, followed by steps 240 through 479, and lastly steps 480 through 623. Record only bank 2 in this partitioning, i.e. 4 OP 17. Mark this track" 2.1".Then repartition to 6 OP 17 and record banks 1 and 3 on a separate card.
2) Repartition again to 4 OP 17 and key in steps 240 through 476. Record this also as bank 2 on the remaining track of the very first card. Mark this track however "2.2".

You now must have two mag cards: one with a bank 2 recorded on each track, marked 2.1 and 2.2 respectively and recorded in 4 OP 17 and a second mag card with banks 1 and 3 on it, recorded in 6 OP 17.

USING THE SYSTEM:

1. Make sure the Master Library module is in place.
2. Enter banks 1 and 3 in the calculator. (the 6 OP 17 card).
3. Create the two necessary hex codes: press from the keyboard: 10 OP 17 CLR GTO 016 PGM 19 SBR 045 P/R LRN INS (this creates h25) SST sixteeen times, INS (this creates the h12) LRN RST CLR.
4. Enter the number of tapes wanted. I would start modestly with 1 or 2, and press A. The display will show a zero.
5. Enter the number of pie sectors you want. It has to be equal to or smaller than 20. Press R/S.
6. Enter the print code for the first sector of the pie chart and press the X:T key.
7. Enter the percentage for that first pie sector and press R/S.
8. Repeat steps 6 and 7 for all the pie sectors you want.

NOTE that percentages will be rounded to the nearest .5% and that they are stored, together with their print codes in R20, R20+n-1....where n is the numner of slices. The percentage of each slice is added to all the previous ones. For matters of convenience the program works in GRAD moe (finally somebody outside France has found a use for the GRAD mode) because multiplying by 4 is easier than by 3.6 or pi/50.

After all the percentages have been entered, the display will show 2.1, meaning it wants the bank marked "2.1". DON'T TOUCH ANY KEY, just slide in the requested card, correct bank. However, if you happen to slide in bank 2.2, no harm is done. Eacg bank has its own ID number, and sliding in the wrong one will only cause the program to jump back to the entry point. That means 2.1 will appear again in the display. After entering 2.1, the program will still continue automatically, as it still is in Fast mode.

If you entered bank 2.2 correctly, it will check all entered angles i.e. percentages, for "legallity." Angles from 90 through 110 and from 290 through 310 are considered "illegal", as the would cause Plot 60 to print nearly horizontal lines! When such an angle is encountered, all angles are rotated by 2% and tested again. If after 50 rotations, that is a 100% rotation, there are still illegal angles, the program will halt with a flashing 1/0.

If you want to alter this feature: steps 258-260 contain 050 (the max # of rotations) and steps 276-277, both of bank 2.1, contain 08, the rotation in grads.

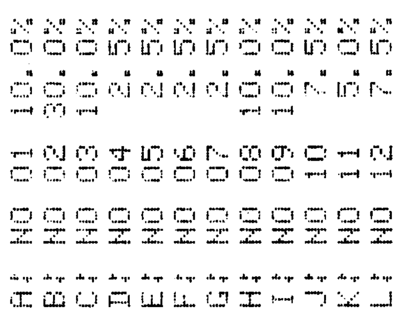
After checking all rotations, the program prints out a list of names, percentages and identifiers, A through T.

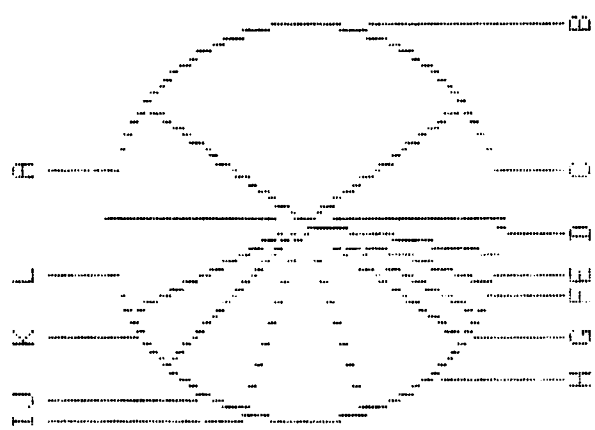
After completion of this list, the display shows 2.2; enter bank 2.2 and sit back and enjoy; you will have about an hour to, according to Harald M.Otto, "drink a cup of the strong brew, smoke'm if you have'm and maybe you suddenly discover again you have been married for some time now..."

Now, suppose the printing is ready and you observe that it is either too large or too small to your taste. A Scottsman would say here:"Nay bodder at all." Just enter a new number of tapes and press A. The display will show 2.1, for you to slide in card-bank 2.1. And, here shows the true genious of the programmer, the program will now simply skip the rotation part and start right away with the print part. After printing of the list, the display will show again 2.2, indicating to slide in bank 2.2; do it and again you may sit back and continue doing whatever you were, before you were so rudily interrupted by this the halting of this insolent program!!!

To print a brand new pie chart, always press RST before entering the number of tapes and pressing A.

At this point Robert gives a detailed explanation as to how the program exactly works. And in spite of his rather stern admonition to publish EVERYTHING or nothing at all, lest the user will not understand at all what is going on, I am going to risk incurring his wrath and leaving the explanation in its original form, written on paper. If some of the fanatics want a copy of it, though, one can be had of this 22-page epistle (small wonder Swinnen left it out of the Notes) for $ 4.00 US. By means of a yellow filter it should be possible to render a legible Xerox(TM) copy of this blue roll ball pen writing.





See programs on next two pages.

CIRKELDIAGRAM,- As you might have guessed, that is Swedish for Pie Chart.(why not?)
------------- Lars Nilsson, who obviously hails from that country, has also written a Fast Mode program to solve the Pie Chart problem. It works just fine but, unfortunately, there is not enough space in this issue to put in both solutions I received so far. I am sending Lars' program to Palmer Hanson, so that he may publish it eventually in one of the future issues.

Pie Chart, Robert Prins.

000	92	RTN
001	76	LBL
002	11	A
003	61	GTO
004	00	00
005	40	40
006	76	LBL
007	12	B
008	61	GTO
009	00	00
010	18	18
011	76	LBL
012	13	C
013	25	CLR
014	69	OP
015	05	05
016	74	SM*
017	90	90
018	12	B
019	20	CLR
020	30	TAN
021	30	TAN
022	61	GTO
023	53	(
024	32	X:T
025	93	.
026	01	1
027	34	√X
028	33	X²
029	35	1/X
030	86	STF
031	71	71
032	35	1/X
033	43	RCL
034	03	03
035	97	DSZ
036	74	74
037	72	ST*
038	00	0
039	04	4
040	69	OP
041	17	17
042	87	IFF
043	04	04
044	00	00
045	49	49
046	47	CMS
047	01	1
048	93	.
049	00	0
050	05	5
051	94	+/-
052	42	STO
053	01	01
054	02	2
055	93	.
056	01	1
057	42	STO
058	02	02
059	03	3
060	00	0
061	35	1/X
062	42	STO
063	04	04
064	06	6
065	00	0
066	42	STO
067	06	06
068	32	X:T
069	42	STO
070	08	08
071	49	PRD
072	06	06
073	69	OP
074	26	26
075	35	1/X

076	49	PRD
077	02	02
078	49	PRD
079	04	04
080	01	1
081	05	5
082	06	6
083	42	STO
084	14	14
085	87	IFF
086	04	04
087	01	01
088	46	46
089	00	0
090	92	RTN
091	42	STO
092	16	16
093	42	STO
094	18	18
095	01	1
096	09	9
097	42	STO
098	00	00
099	53	(
100	43	RCL
101	00	00
102	75	-
103	01	1
104	09	9
105	54	)
106	29	CP
107	92	RTN
108	53	(
109	46	INS
110	65	×
111	02	2
112	85	+
113	93	.
114	05	5
115	54	)
116	53	(
117	59	INT
118	65	×
119	02	2
120	85	+
121	73	RC*
122	00	00
123	59	INT
124	85	+
125	32	X:T
126	55	÷
127	01	1
128	00	0
129	22	INV
130	28	LOG
131	54	)
132	69	OP
133	20	20
134	72	ST*
135	00	00
136	97	DSZ
137	18	18
138	01	01
139	01	01
140	02	2
141	05	5
142	08	8
143	93	.
144	02	2
145	06	6
146	07	7
147	93	.
148	02	2
149	06	6
150	12	B
151	61	GTO

152	02	02
153	40	40
154	02	2
155	93	.
156	01	1
157	91	R/S
158	56	DEL
159	56	DEL
160	92	RTN
161	02	2
162	93	.
163	02	2
164	91	R/S
165	92	RTN
166	12	B
167	61	GTO
168	02	02
169	40	40
170	02	2
171	05	5
172	01	1
173	42	STO
174	14	14
175	09	9
176	94	+/-
177	42	STO
178	05	05
179	01	1
180	12	B
181	69	OP
182	05	05
183	02	2
184	12	B
185	13	C
186	97	DSZ
187	05	05
188	01	01
189	85	85
190	69	OP
191	35	35
192	43	RCL
193	06	06
194	42	STO
195	00	00
196	00	0
197	12	B
198	13	C
199	43	RCL
200	04	04
201	44	SUM
202	05	05
203	97	DSZ
204	00	00
205	01	01
206	96	96
207	09	9
208	42	STO
209	05	05
210	02	2
211	12	B
212	13	C
213	97	DSZ
214	05	05
215	02	02
216	12	12
217	69	OP
218	00	00
219	13	C
220	02	2
221	42	STO
222	05	05
223	01	1
224	12	B
225	69	OP
226	05	05
227	43	RCL

228	02	02
229	44	SUM
230	01	01
231	98	ADV
232	97	DSZ
233	08	08
234	01	01
235	75	75
236	00	0
237	98	ADV
238	98	ADV
239	92	RTN
240	89	π
241	32	X:T
242	43	RCL
243	07	07
244	22	INV
245	67	EQ
246	01	01
247	52	52
248	61	GTO
249	01	01
250	70	70
251	86	STF
252	40	IND
253	07	07
254	87	IFF
255	01	01
256	03	03
257	53	53
258	87	IFF
259	02	02
260	03	03
261	53	53
262	02	2
263	08	8
264	00	0
265	42	STO
266	15	15
267	53	(
268	01	1
269	75	-
270	43	RCL
271	05	05
272	33	X²
273	54	)
274	34	√X
275	42	STO
276	17	17
277	61	GTO
278	04	04
279	72	72
280	01	1
281	00	0
282	44	SUM
283	15	15
284	43	RCL
285	17	17
286	94	+/-
287	61	GTO
288	04	04
289	72	72
290	05	5
291	07	7
292	44	SUM
293	15	15
294	43	RCL
295	16	16
296	42	STO
297	18	18
298	01	1
299	09	9
300	42	STO
301	03	03
302	80	GRD
303	69	OP

304	23	23
305	29	CP
306	53	(
307	43	RCL
308	05	05
309	65	×
310	73	RC*
311	03	03
312	59	INT
313	39	COS
314	54	)
315	77	GE
316	40	IND
317	15	15
318	53	(
319	43	RCL
320	05	05
321	65	×
322	73	RC*
323	03	03
324	59	INT
325	30	TAN
326	54	)
327	94	+/-
328	53	(
329	42	STO
330	17	17
331	33	X²
332	85	+
333	43	RCL
334	05	05
335	33	X²
336	75	-
337	01	1
338	54	)
339	77	GE
340	40	IND
341	15	15
342	43	RCL
343	17	17
344	61	GTO
345	04	04
346	72	72
347	97	DSZ
348	18	18
349	03	03
350	03	03
351	86	STF
352	02	02
353	04	4
354	04	4
355	07	7
356	42	STO
357	15	15
358	43	RCL
359	16	16
360	42	STO
361	18	18
362	01	1
363	09	9
364	42	STO
365	03	03
366	80	GRD
367	53	(
368	93	.
369	05	5
370	65	×
371	53	(
372	73	RC*
373	03	03
374	75	-
375	69	OP
376	23	23
377	73	RC*
378	03	03
379	54	)

380	85	+
381	73	RC*
382	03	03
383	54	)
384	42	STO
385	17	17
386	39	COS
387	67	EQ
388	04	04
389	00	00
390	53	(
391	46	INS
392	65	×
393	43	RCL
394	05	05
395	54	)
396	77	GE
397	40	IND
398	15	15
399	22	INV
400	86	STF
401	03	03
402	53	(
403	01	1
404	75	-
405	43	RCL
406	05	05
407	33	X²
408	75	-
409	43	RCL
410	17	17
411	38	SIN
412	42	STO
413	17	17
414	33	X²
415	54	)
416	77	GE
417	40	IND
418	15	15
419	22	INV
420	87	IFF
421	03	03
422	04	04
423	39	39
424	53	(
425	43	RCL
426	17	17
427	69	OP
428	10	10
429	75	-
430	43	RCL
431	05	05
432	69	OP
433	10	10
434	54	)
435	22	INV
436	67	EQ
437	40	IND
438	15	15
439	05	5
440	04	4
441	07	7
442	48	EXC
443	17	17
444	61	GTO
445	04	04
446	72	72
447	97	DSZ
448	18	18
449	03	03
450	67	67
451	00	0
452	48	EXC
453	09	09
454	69	OP
455	01	01

Pie Chart, Robert Prins.

```
456 00 0
457 48 EXC
458 10 10
459 69 OP
460 02 02
461 00 0
462 48 EXC
463 11 11
464 69 OP
465 03 03
466 00 0
467 48 EXC
468 12 12
469 69 OP
470 04 04
471 92 RTN
472 53 (
473 53 (
474 46 INS
475 75 -
476 43 RCL
477 01 01
478 54 )
479 55 ÷
480 01 1
481 32 X:T
482 43 RCL
483 02 02
484 54 )
485 77 GE
486 40 IND
487 15 15
488 29 CP
489 22 INV
490 77 GE
491 40 IND
492 15 15
493 53 (
494 53 (
495 53 (
496 46 INS
497 65 ×
498 04 4
499 85 +
500 09 9
501 75 -
502 59 INT
503 42 STO
504 13 13
505 54 )
506 65 ×
507 05 5
508 42 STO
509 07 07
510 85 +
511 59 INT
512 94 +/-
513 44 SUM
514 07 07
515 54 )
516 65 ×
517 03 3
518 54 )
519 52 EE
520 59 INT
521 87 IFF
522 01 01
523 05 05
524 93 93
525 87 IFF
526 02 02
527 05 05
528 44 44
529 67 EQ
530 05 05
531 41 41
```

```
532 32 X:T
533 02 2
534 22 INV
535 67 EQ
536 05 05
537 44 44
538 02 2
539 05 5
540 93 .
541 02 2
542 07 7
543 93 .
544 04 4
545 07 7
546 59 INT
547 52 EE
548 94 +/-
549 44 SUM
550 13 13
551 53 (
552 73 RC*
553 13 13
554 55 ÷
555 43 RCL
556 07 07
557 22 INV
558 28 LOG
559 33 X²
560 52 EE
561 22 INV
562 57 ENG
563 42 STO
564 07 07
565 54 )
566 53 (
567 22 INV
568 59 INT
569 65 ×
570 01 1
571 00 0
572 00 0
573 54 )
574 59 INT
575 29 CP
576 22 INV
577 67 EQ
578 40 IND
579 15 15
580 53 (
581 43 RCL
582 07 07
583 65 ×
584 43 RCL
585 13 13
586 22 INV
587 59 INT
588 54 )
589 74 SM*
590 13 13
591 83 GO*
592 15 15
593 53 (
594 43 RCL
595 03 03
596 75 -
597 07 7
598 54 )
599 53 (
600 46 INS
601 85 +
602 53 (
603 46 INS
604 55 ÷
605 01 1
606 08 8
607 54 )
```

```
608 59 INT
609 65 ×
610 03 3
611 85 +
612 53 (
613 46 INS
614 55 ÷
615 03 3
616 00 0
617 54 )
618 59 INT
619 65 ×
620 02 2
621 54 )
622 83 GO*
623 17 17
```

BANK 2.1

```
240 43 RCL
241 07 07
242 22 INV
243 59 INT
244 82 HIR
245 31 31
246 59 INT
247 32 X:T
248 02 2
249 06 6
250 67 EQ
251 40 IND
252 07 07
253 43 RCL
254 07 07
255 61 GTO
256 01 01
257 66 66
258 00 0
259 05 5
260 00 0
261 42 STO
262 17 17
263 02 2
264 09 9
265 04 4
266 93 .
267 03 3
268 02 2
269 09 9
270 42 STO
271 14 14
272 12 B
273 61 GTO
274 01 01
275 66 66
276 00 0
277 08 8
278 74 SM*
279 07 07
280 69 OP
281 27 27
282 97 DSZ
283 03 03
284 02 02
285 78 78
286 97 DSZ
287 17 17
288 02 02
289 99 99
290 00 0
291 35 1/X
292 66 PAU
293 81 RST
294 93 .
295 09 9
296 09 9
297 32 X:T
298 80 GRD
299 01 1
300 09 9
301 42 STO
302 00 00
303 42 STO
304 07 07
305 53 (
306 43 RCL
307 16 16
308 85 +
309 01 1
310 54 )
311 42 STO
312 05 05
313 42 STO
314 03 03
315 73 RC*
316 00 00
317 59 INT
318 38 SIN
319 50 I×I
320 77 GE
321 02 02
322 76 76
323 69 OP
324 20 20
325 97 DSZ
326 05 05
```

```
327 03 03
328 15 15
329 43 RCL
330 16 16
331 42 STO
332 18 18
333 01 1
334 09 9
335 42 STO
336 03 03
337 00 0
338 42 STO
339 05 05
340 53 (
341 53 (
342 53 (
343 73 RC*
344 03 03
345 59 INT
346 94 +/-
347 85 +
348 69 OP
349 23 23
350 73 RC*
351 03 03
352 59 INT
353 85 +
354 93 .
355 04 4
356 54 )
357 55 ÷
358 04 4
359 54 )
360 52 EE
361 55 ÷
362 52 EE
363 00 0
364 01 1
365 94 +/-
366 42 STO
367 17 17
368 54 )
369 28 LOG
370 48 EXC
371 17 17
372 53 (
373 53 (
374 53 (
375 46 INS
376 65 ×
377 01 1
378 00 0
379 00 0
380 49 PRD
381 05 05
382 34 ΓX
383 85 +
384 01 1
385 85 +
386 28 LOG
387 59 INT
388 65 ×
389 02 2
390 75 -
391 59 INT
392 44 SUM
393 05 05
394 54 )
395 97 DSZ
396 17 17
397 03 03
398 74 74
399 52 EE
400 00 0
401 04 4
402 22 INV
```

```
403 57 ENG
404 85 +
405 93 .
406 04 4
407 85 +
408 00 0
409 48 EXC
410 05 05
411 54 )
412 65 ×
413 04 4
414 22 INV
415 28 LOG
416 54 )
417 69 OP
418 03 03
419 01 1
420 01 1
421 09 9
422 33 X²
423 82 HIR
424 08 08
425 53 (
426 73 RC*
427 03 03
428 85 +
429 01 1
430 00 0
431 00 0
432 54 )
433 82 HIR
434 06 06
435 04 4
436 05 5
437 03 3
438 42 STO
439 17 17
440 53 (
441 43 RCL
442 03 03
443 75 -
444 06 6
445 93 .
446 03 3
447 08 8
448 54 )
449 53 (
450 61 GTO
451 05 05
452 99 99
453 65 ×
454 04 4
455 22 INV
456 28 LOG
457 54 )
458 69 OP
459 01 01
460 69 OP
461 05 05
462 97 DSZ
463 18 18
464 03 03
465 40 40
466 69 OP
467 00 00
468 69 OP
469 05 05
470 01 1
471 06 6
472 01 1
473 42 STO
474 14 14
475 89 π
476 92 RTN
```

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TI 59 INTEGRATION

This is a packet of programs designed to solve most problems encountered in numerical integration. It consist of a main program which can handle most functions, supplemented with two secondary programs used in special cases.

THEORY

When the following is true for an integrale with the exact value I:

$$I = T(h) + Ah^q + Bh^{q+r} + \ldots \qquad (1.1)$$

where T(h) is an approximation to I and h is the width of the intervals used $(h = (b-a)/n)$, then h amy be chosen so small that Bh^{q+r} is much smaller than Ah^q which means that the following approximation can be done:

$$I \approx T(h) + Ah^q \qquad (1.2)$$

If there in addition is another value based on 2h:

$$I \approx T(2h) + A(2h)^q \qquad (1.3)$$

then A may be eliminated from (1.2) and (1.3):

$$I \approx \frac{(2h)^q T(h) - h^q T(2h)}{(2h)^q - h^q} = T(h) + \frac{T(h) - T(2h)}{2^q - 1} = T(2h,h) \qquad (1.4)$$

Used in (1.1) this yields:

$$I = T(2h,h) + Bh^{q+r} + \ldots \qquad (1.5)$$

which means that the fault now is in the order of h^{q+r}, i.e. smaller than before. These calculations is on the assumption that q is known. If this is not the case another approximate value of I, based on 4h, is needed. This yields:

$$2^q \approx \frac{T(4h) - T(2h)}{T(2h) - T(h)} \Leftrightarrow q \approx \frac{1}{\ln 2} \ln\left|\frac{T(4h) - T(2h)}{T(2h) - T(h)}\right| \Rightarrow \qquad (1.6)$$

$$I \approx \frac{T(h)T(4h) - (T(2h))^2}{T(4h) - 2T(2h) + T(h)} = T(h) - \frac{(T(2h) - T(h))^2}{T(4h) - 2T(2h) + T(h)} \qquad (1.7)$$

The above is called Aitken-extrapolation while (1.4) is called Richardson-extrapolation.

ROMBERG-INTEGRATION

When f(x) and all of it's derivatives are continuous in the whole integration-interval a simple case of (1.1) results (if either the trapez-formula or the center-formula is used to calculate approximate I-values):

$$I = T(h) + A_1h^2 + A_2h^4 + \ldots\ldots + A_kh^{2k} + \ldots \qquad (1.8)$$

Now the idea with Romberg-integration is that some T(h) values are calculated, while h is bisected for each new value. On the basis of these, new values are calculated with the use of (1.4), which means that the term with h^2 is eliminated. These new values are used to remove the term with h^4. A general outline of this procedure is shown in fig 1. The first vertical column is calculated by using the trapez-formula, as mentioned earlier:

$$T_1^0 = \tfrac{1}{2}(f(a) + f(b))$$

$$T_n^0 = \frac{h}{2}(f(a) + f(b)) + h\sum_{s=1}^{n-1} f(a+sh)\ ;\ h = \frac{b-a}{n},\ n = (2,4,8,16,32,\ldots)$$

The next columns are derived from the first by the use of (1.4). For example is T_4^1 derived from T_2^0 and T_4^0. Instead of the trapez-formula the center-formula (I do not know the english name, this is a direct translation of the danish name) may be used:

$$M_n^0 = h\sum_{s=1}^{n} f(a + h(s - \tfrac{1}{2}))\ ,\quad h = \frac{b-a}{n}\ ,\quad n = (1,2,4,8,16,\ldots)$$

Note: a and b refer respectively to the lower and upper limits of the integrationinterval, i.e. $I = \int_a^b f(x)dx$.

number of intervals	size of fault: h^2	h^4	h^6	h^8	h^{10}	h
1	T_1^0					
2	T_2^0	T_2^1				
4	T_4^0	T_4^1	T_4^2			
8	T_8^0	T_8^1	T_8^2	T_8^3		
16	T_{16}^0	T_{16}^1	T_{16}^2	T_{16}^3	T_{16}^4	
32	-	-	-	-	-	-
-	-	-	-	-	-	-

Fig 1 showing structure of Romberg-integration

no. of intervals	no. of extrapolations: 0	1	2	3
1	T_1^0			
2	T_2^0			
4	T_4^0	T_4^1		
8	T_8^0	T_8^1		
16	T_{16}^0	T_{16}^1	T_{16}^2	
32	T_{32}^0	T_{32}^1	T_{32}^2	
-	-	-	-	-

Fig 2 Aitken-integration

FOX-ROMBERG & AITKEN-INTEGRATION

When f(x) and/or one of it's derivatives have one or more points where the function is not defined the ordinary Romberg method does not work

$$\int_0^2 \sqrt{x}\, dx$$

is an example. Here is $f'(x) = 1/\sqrt{x}$ and therefore not defined for x = 0. Now (1.1) looks like this:

$$I = T(h) + A_0h^{1.5} + A_1h^2 + A_2h^4 + \ldots + A_kh^{2k} + \ldots$$

When using ordinary Romberg, the term with $h^{1.5}$ is not eliminated, and the convergence towards I goes very slow. The term with $h^{1.5}$ can however be eliminated with Richardson-extrapolation, using q = 1.5.
The value of q must be dertermined on the basis of approximate values calculated with the use of (1.6). The method of using modified Romberg-integration is called Fox-Romberg.
Another possibility is to use Aitken-extrapolation, i.e. (1.7). Then there is no need for dertermining q-values, but on the other hand more T(h) values are needed, and the convergence is consequently slower. Fig 2 shows the structure of Aitken-integration.

RECORDING INSTRUCTIONS

Using the turn-on partitioning, 6 Op 17, read in the main program consisting of programsteps 000-239 and registers 35-44. Record bank 1 and 3 on one mag card. Then read in the Aid Program, programsteps 360-479, and record bank 2 on a new mag card.

OUTPUT WITHOUT PRINTER

If you do not have a printer, you may, though it is not necessary, replace the print-instructions with [R/S] or [Pause]. There is print-instructions at step 075,103 and 120.
The Aid Program must be modified by changing the print-instruction at step 418 or you will not get an output of the approximate q-values.

USER-DEFINED KEYS

LBL A	Enter the lower limit of the integrale $\int_a^b f(x)\,dx$.
LBL B	Enter the upper " "
LBL C	Enter ε, that is the limit of error. If nothing is entered $\varepsilon = 10^{-10}$ is used, which means that the output will have at least 10 correct digits.
LBL D	Initialize for entering of extra q-values. These values are entered with the use of [R/S].
LBL E	Start the numerical integration using either Romberg or Fox-Romberg.
LBL A'	"Enter" f(x). Press [A'], and the calculator will automatic shift to programming-status.
LBL B'	The trapez-formula is used.
LBL C'	The center-formula is used.
LBL E'	As LBL E, but in addition approximate q-values are calculated with the use of the Aid Program.

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THE TRAPEZ- AND CENTER-FORMULA

As basis for the extrapolations you may choose between two methods: The center-formula and the trapez-formula. The last one is the fastest and is for that reson preferable, but at times it is neccesary to use the center-formula.

When flag 0 is set, the center-formula is used. If not the trapez-formula is used. [C'] sets flag 0, while [B'] clears flag 0.

USER INSTRUCTIONS FOR ROMBERG INTEGRATION

Only bank 1 and 3 is needed when using ordinary Romberg. The function is entered from step 240 anf forward. Simply press [A'] and start to program the function. When the function is called the program is in the middle of a summation, *so do not use any terminating operations*. Finish with [INV] [SBR]. x is in the display (x-register) when f(x) is called. Registers 45 through 59 may be used for the evaluation of the function.

The limit of error is entered by pressing [C]. If convenient [x:t]. When nothing is entered, i.e the t-register is zero, then $\varepsilon = 10^{-10}$ is used, and the result will normally be with 10 correct digits. If the result is found with 3 correct digits and more correct digits is wanted, you may press [R/S] and the program will continue from where it stopped and make an extra serie of extrapolations. This may be repeated, but another possibility is to enter a new ε value, though this *must* take place with the use of [x:t].

As an example is used $\int_0^1 \frac{1}{x+1}\,dx = \ln 2 = 0.6931471806$ (10 correct digits)

Procedure: [A'] → 240 00, [(] [CE] [+] 1 [)] [1/x] [INV] [SBR] [LRN]

0 [A] → 0, 1 [B] → 1, .001 [C], [E] → 0.6931746032 (14 sec)

10 [+/-] [INV] [Log] [x:t] [R/S] → 0.6931471806 (44 sec)

OUTPUT ON PRINTER

When a printer is attached when running the above example, the result will be as shown in fig 3. All the T-values shown in fig 1 is printed, one row at a time. This can be very useful when dealing with functions which doesn't behave normally.

ROMBERG INTEGRATION FAILS

As mentioned earlier the Romberg method sometimes fails. An example was

$\int_0^{\frac{1}{2}} \sqrt{x}\,dx = \frac{2}{3}x^{3/2} = 0.2357022604$ (10 correct digits)

Try with ordinary Romberg:

[A'] [√x] [INV] [SBR] [LRN] 0 [A] .5 [B] [E] → 0.2347001681 (7½ minute)

That is only 5 correct digits, where there is supposed to be 10. When ordinary Romberg takes exceptional long time† to compute an integrale, change to one of the secondary methods.

†See EXAMPLES for further explanation.

FOX-ROMBERG INTEGRATION

The problem when using Fox-Romberg is to determine the theoretical q-values on the basis of the approximate q-values.

Continuing the above example, read in the aid program. This clears the entered function, which was in bank 2. If you forget to reenter the function, the program will automatical shift to programming status

You won't need to reenter the upper and lower limits, simply press [E'] in order to get q-values. With printer attached you will get a printout as shown in fig 4. The upper index refer to the order (no. of extrapolations), while the lower refer to the highest number of intervals used to calculate the T-values. q_4^0 is calculated by inserting T_1^0, T_2^0 and T_4^0 in (1.4), while q_8^1 is based on T_2^1, T_4^1 and T_8^1.

If f(x) and it's deriatives are continous in the integration interval, then $q_n^0 = 2$, $q_n^1 = 4$, $q_n^2 = 6$ etc. (See theory). This is obviously not the case in fig 4, where all q-values approximately are equal to 1.5, which must be prsumed being the theoretical q-value. This value is entered using the following procedure:

[D] → 34, 1.5 [R/S] → 1.828427125 (eller $2^{1.5} - 1$)

Now the program is ready to do the actual Fox-Romberg integration, which may be started using either [E] or [E']. Note: The aid program is only used for calculating approximate q-values together with T-values. If you know the q-value of a function, you naturally don't need the aid program.

In fig 5 is the printout using [E'] shown. Now the q-values are as expected, i.e 1.5, 2, 4, 6 etc. Notice that the extra q-value is represented. This will only take place when the q-value is smaller than 2; when the q-value is larger than 2, 2 will appear twice.

Sometimes it is neccesary to use more than one extra q-value, as here:

$\int_0^{.5} \sqrt{x} + 1/\sqrt{x}\,dx = 1.649915823$ (10 correct digits)

Now f(x) is not defined for x = 0, as f(x) → ∞ when x → 0. Therefore it is a neccesity to use Fox-Romberg. For the same reason it is impossible to use the trapez-formula as this uses the boundaries in the evaluation of T (try!). Instead the center-formula is used:

[A'] [(] [√x] [+] [1/x] [)] [INV] [SBR] [LRN] 0 [A] .5 [B] [C'] [E']

The theoretical q-value is determined to q = ½, which is entered:

[D] → 34, .5 [R/S] → .4142135624, [E']

Now we can determine the q-value to q = 1.5. We now have two theoretical q-values which both have to be entered; the entered q-value from before is *not* preserved. The order in which the two values are entered is unimportant, but in order to get the most influential extrapolation done first, you may as a matter of form enter the largest first. When running the program you'll get 10 correct digits. The execution time is quite long now, which especially is caused by the use of the center-formula, which is almost twice as slow as the trapez-formula.

IMPORTANT NOTES

Remember to clear entered q-values before starting to compute another integrale. This can be done by pressing [D], or better still [RST] which clears all flags, and actually initialize the program.

You can enter a maximum of three extra q-values.

Both Romberg and Fox-Romberg have limited running time, as they can't go higher than T_{256}^{10}.

Suggestion for card-marking:

		ROMBERG		RST=INIT
f(x)	TRAPEZ	CENTER		→ I,q
a	b	ε	↕q R/S	→ I

PROBLEMS!

If you have got the impression that these programs always works, you're wrong! The following integrale seems to be a simple problem:

$\int_0^{10} 1/x\,dx = \ln 10 = 2.302585093$

[A'] [1/x] [INV] [SBR] [LRN] 1 [A] 10 [B] [E] → 2.302585096 (2½ minute)

That is only 9 correct digits, where there is supposed to be 10. All deriatives of f(x) is continous, so there is no extra q-value missing. I can't tell why the program fails, only point out how to overcome it.

The program compares T_n^i with T_n^{i-1} in order to determine the size of the fault. The most correct method would be to compare T_n^i with T_{2n}^{i+1}, but this would in most cases prolong the execution-time unneccesarily.

Now, the program uses normally about 60 sec to compute an integrale. If the execution-time is much longer than this, you should compare T_n^i with T_{2n}^{i+1}, in the above example that is T_{64}^6 and T_{128}^7. Look at the two or three last digits

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and subtract one from the other. If the result is greater than about 50, you should press [R/S] in order to get an extra series of extrapolations. In this particular case the result is 463, which is far too much, so simply press [R/S] and the correct result will appear in a little while.

There are functions which the programs completely fail to handle. The classica: example is the integrale of sin(1/x) from 0 to 1. Another example is the integrale of cos(x^3) from 0 to 10. In both cases the function is so complicated that it is a matter of chance what the result is, as the intervals simply can't get small enough.

EXAMPLES

Try the following examples:

$\int_0^1 1 - \ln x \, dx = 2$, q = 1   f(x): [(] [lnx] [+/-] [+] 1 [)]

$\int_0^1 x^{3/2} \, dx = 0.4$, q = 2½   f(x): [(] [CE] [×] [√x] [)]

– SURVEY OF MAIN PROGRAM

000-013	Entering of a, b and ε.
014-022	The adress for indirect call of 2^q-1 values is loaded in R01 and flac 2 is set.
023-039	Enter extra q-values, while adjusting the adress in R01.
040-047	If flag 0 is set, the center-formula is used.
048-054	If flag 1 is set, the aid program is used.
055-059	If R01 is not made ready, this is done now.
060-070	If the t-register is zero, then $\varepsilon = 10^{-10}$ is entered.
071-079	R04 is cleared. The first T is calculated, while initializing both th trapez- and the center-formula.
080-083	If flag 1 is set: shift to aid program.
084-102	Init for a series of extrapolations. A new T is calculated.
103-123	Extrapolation using (1.4)
124-146	The last T is loaded into the correct register, while determining the size of the fault.
147-178	Init of trapez/center-formula. In the case of the trapez-formula the first T is calculated.
179-187	If the trapez-formula is used: return to 076, otherwise R10 is cleared to init the center-formula. The reason for CE in step 184 is to stop possible flashing display.
188-205	The width of the intervals is bisected, the number of intervals is doubled and the first x-value is determined.
206-217	The evaluation of f(x), which is summed in R10.
218-236	The numerical integration is finished. R10 is cleared if the center-formula is used. Notice the difference between the two methods: The trapez-formula uses the earlier found f(x)-values, while the center-formula starts all over each time.

The aid program replaces 084-146 in the main program, and is generally similar to these, except the additional capability of calculating approximate q-values.

SURVEY OF REGISTERS

R00	DSZ counter for extra-polations				
R01	The adress for call of the first 2^q-1 value.				
R02	Adress for indirect call of 2^q-1 values. Starting value equal to R01.				
R03	Adress for indirect storing of T-values.				
R04	Counter for number of possible extrapolations. Used in R00				
R05	DSZ-counter for trapez/center integration. Index in aid program				
R06-R07	a, b.				
R08	Trapez-formula: n/2, center-formula: n (n number of intervals)				
R09	Trapez-formula: 2h , center-formula: h (h width of intervals)				
R10	$\sum f(x)$			R32-34	For extra 2^q-1
R11	T_n^1	R23	$T_n^1 - T_n^0$ (only aidprg)	R35-44	2^q-1, q = 2,4,6..
⋮		⋮			
R22	T_n^{10}	R31	$T_n^{10} - T_n^9$ (only aidprg)		

AITKEN INTEGRATION

This program is an alternativ to Fox-Romberg. The program is as simple as ordinary Romberg, and you won't have to mess about with extra q-values. On the other hand the program is proportionally slow.

Record bank 1 on one mag card. There is no registers to record. The user defined keys are as before, except Lbl D and Lbl E' which both are omitted. The printout resembles that of Romberg, except for an extra T-value every other time as shown in fig 2.

Fig 3		Fig 4		Fig 5
0.75	T_1^0	.1767766953	T_1^0	.1767766953
.7083333333	T_2^0			
.6944444444	T_1^1	.2133883476	T_2^0	.2133883476
		.2255922318	T_1^1	.2334119252
.6970238095	T_4^0			
.6932539683	↓	1.382	q_2^0	1.382
.6931746032	T_1^2			
		.2274349021	T_4^0	.2274349021
.6941218504	T_8^0	.2321170869		.2351172178
.6931545307	↓	.2325520773	T_1^2	.2356856487
.6931479015				
.6931474776	T_1^3	1.420	q_4^0	1.420
		1.494	q_2^1	1.961
.6933912022	T_{16}^0			
.6931476528	↓	.3326841713	T_8^0	.2326841713
.6931471943		.2344339277	↓	0.235555092
.6931471831		.2345883838		0.23570105
.6931471819	T_1^4	.2346207061	T_1^3	.2357020768
.6932082083	T_{32}^0	1.446	q_8^0	1.446
.6931472103		1.499	↓	1.989
.6931471808	↓	1.500	q_2^2	3.768
.6931471806				
.6931471806		.2346113821	T_{16}^0	.2346113821
.6931471806	T_1^5	.2352537857		.2356654087
		.2353084429	↓	.2357021809
		.2353198724		.2357022563
		.2353226142	T_1^4	.2357022591

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ROMBERG

```
000 76 LBL    065 01 1      131 23 23     196 08 08     381 01 1      446 03 03
001 11 A      066 00 0      132 72 ST*    197 42 STO    382 48 EXC    447 54 )
002 42 STO    067 94 +/-    133 03 03     198 05 05     383 05 05     448 42 STO
003 06 06     068 22 INV    134 75 -      199 43 RCL    384 98 ADV    449 00 00
004 92 RTN    069 28 LOG    135 01 1      200 06 06     385 58 FIX    450 53 (
005 76 LBL    070 32 X:T    136 54 )      201 85 +      386 03 03     451 69 OP
006 12 B      071 42 STO    137 50 I×I    202 43 RCL    387 53 (      452 23 23
007 42 STO    072 04 04     138 77 GE     203 09 09     388 69 OP     453 73 RC*
008 07 07     073 71 SBR    139 00 00     204 55 ÷      389 25 25     454 03 03
009 92 RTN    074 01 01     140 84 84     205 02 2      390 69 OP     455 99 PRT
010 76 LBL    075 47 47     141 73 RC*    206 85 +      391 22 22     456 97 DSZ
011 13 C      076 98 ADV    142 03 03     207 71 SBR    392 69 OP     457 00 00
012 32 X:T    077 99 PRT    143 91 R/S    208 02 02     393 23 23     458 04 04
013 92 RTN    078 42 STO    144 61 GTO    209 40 40     394 85 +      459 51 51
014 76 LBL    079 11 11     145 00 00     210 44 SUM    395 53 (      460 55 ÷
015 14 D      080 87 IFF    146 84 84     211 10 10     396 53 (      461 69 OP
016 03 3      081 01 01     147 53 (      212 43 RCL    397 53 (      462 33 33
017 04 4      082 03 03     148 53 (      213 09 09     398 24 CE     463 73 RC*
018 42 STO    083 61 61     149 43 RCL    214 97 DSZ    399 75 -      464 03 03
019 01 01     084 69 OP     150 07 07     215 05 05     400 63 EX*    465 75 -
020 86 STF    085 24 24     151 42 STO    216 02 02     401 03 03     466 01 1
021 02 02     086 43 RCL    152 09 09     217 06 06     402 54 )      467 54 )
022 92 RTN    087 04 04     153 71 SBR    218 54 )      403 55 ÷      468 50 I×I
023 53 (      088 42 STO    154 02 02     219 00 0      404 63 EX*    469 77 GE
024 42 STO    089 00 00     155 40 40     220 53 (      405 05 05     470 03 03
025 03 03     090 01 1      156 85 +      221 87 IFF    406 54 )      471 61 61
026 02 2      091 00 0      157 43 RCL    222 00 00     407 23 LNX    472 69 OP
027 45 Y^X    092 42 STO    158 06 06     223 02 02     408 55 ÷      473 23 23
028 43 RCL    093 03 03     159 22 INV    224 30 30     409 02 2      474 73 RC*
029 03 03     094 43 RCL    160 44 SUM    225 93 .      410 23 LNX    475 03 03
030 75 -      095 01 01     161 09 09     226 05 5      411 54 )      476 91 R/S
031 01 1      096 42 STO    162 71 SBR    227 65 ×      412 22 INV    477 61 GTO
032 54 )      097 02 02     163 02 02     228 43 RCL    413 97 DSZ    478 03 03
033 72 ST*    098 71 SBR    164 40 40     229 10 10     414 00 00     479 61 61
034 01 01     099 01 01     165 54 )      230 48 EXC    415 04 04
035 69 OP     100 88 88     166 65 ×      231 10 10     416 19 19
036 31 31     101 98 ADV    167 93 .      232 65 ×      417 94 +/-
037 61 GTO    102 99 PRT    168 05 5      233 43 RCL    418 99 PRT
038 00 00     103 53 (      169 42 STO    234 09 09     419 69 OP
039 22 22     104 69 OP     170 08 08     235 54 )      420 20 20
040 76 LBL    105 22 22     171 65 ×      236 92 RTN    421 24 CE
041 17 B'     106 69 OP     172 42 STO    237 76 LBL    422 73 RC*
042 22 INV    107 23 23     173 10 10     238 16 A'     423 05 05
043 76 LBL    108 85 +      174 43 RCL    239 31 LRN    424 55 ÷
044 18 C'     109 53 (      175 09 09                   425 73 RC*
045 86 STF    110 24 CE     176 44 SUM    360 16 A'     426 02 02
046 00 00     111 75 -      177 09 09     361 69 OP     427 54 )
047 92 RTN    112 63 EX*    178 54 )      362 24 24     428 97 DSZ
048 76 LBL    113 03 03     179 87 IFF    363 43 RCL    429 00 00
049 15 E      114 54 )      180 00 00     364 04 04     430 03 03
050 22 INV    115 55 ÷      181 01 01     365 42 STO    431 87 87
051 76 LBL    116 73 RC*    182 84 84     366 00 00     432 98 ADV
052 10 E'     117 02 02     183 92 RTN    367 01 1      433 22 INV
053 86 STF    118 54 )      184 24 CE     368 00 0      434 58 FIX
054 01 01     119 99 PRT    185 00 0      369 42 STO    435 69 OP
055 87 IFF    120 97 DSZ    186 42 STO    370 03 03     436 23 23
056 02 02     121 00 00     187 10 10     371 43 RCL    437 72 ST*
057 00 00     122 01 01     188 53 (      372 01 01     438 03 03
058 60 60     123 03 03     189 02 2      373 42 STO    439 53 (
059 14 D      124 53 (      190 22 INV    374 02 02     440 43 RCL
060 00 0      125 63 EX*    191 49 PRD    375 71 SBR    441 03 03
061 22 INV    126 03 03     192 09 09     376 01 01     442 75 -
062 67 EQ     127 55 ÷      193 49 PRD    377 88 88     443 01 1
063 00 00     128 63 EX*    194 08 08     378 48 EXC    444 00 0
064 71 71     129 03 03     195 43 RCL    379 05 05     445 42 STO
              130 69 OP                   380 02 2
```

3.	35.
15.	36.
63.	37.
255.	38.
1023.	39.
4095.	40.
16383.	41.
65535.	42.
262143.	43.
1048575.	44.

Aitken

```
000 76 LBL    065 98 ADV    130 03 03     132 43 RCL
001 11 A      066 99 PRT    131 75 -      133 08 08
002 42 STO    067 53 (      132 01 1      134 42 STO
003 06 06     068 69 OP     133 54 )      135 05 05
004 92 RTN    069 23 23     134 50 I×I    136 43 RCL
005 76 LBL    070 69 OP     135 77 GE     137 06 06
006 12 B      071 23 23     136 00 00     138 85 +
007 42 STO    072 75 -      137 55 55     139 43 RCL
008 07 07     073 53 (      138 69 OP     140 09 09
009 92 RTN    074 24 CE     139 23 23     141 55 ÷
010 76 LBL    075 75 -      140 73 RC*    142 02 2
011 13 C      076 69 OP     141 03 03     143 85 +
012 32 X:T    077 23 23     142 91 R/S    144 71 SBR
013 92 RTN    078 63 EX*    143 61 GTO    145 01 01
014 76 LBL    079 03 03     144 00 00     146 68 68
015 17 B'     080 42 STO    145 55 55     147 44 SUM
016 22 INV    081 02 02     146 00 0      148 10 10
017 76 LBL    082 54 )      147 53 (      149 43 RCL
018 18 C'     083 33 X²     148 53 (      150 09 09
019 86 STF    084 55 ÷      149 43 RCL    151 97 DSZ
020 00 00     085 53 (      150 07 07     152 05 05
021 92 RTN    086 73 RC*    151 42 STO    153 01 01
022 76 LBL    087 03 03     152 09 09     154 43 43
023 15 E      088 75 -      153 71 SBR    155 54 )
024 00 0      089 02 2      154 02 02     156 43 RCL
025 22 INV    090 65 ×      155 40 40     157 10 10
026 67 EQ     091 43 RCL    156 85 +      158 55 ÷
027 00 00     092 02 02     157 43 RCL    159 02 2
028 35 35     093 85 +      158 06 06     160 65 ×
029 01 1      094 43 RCL    159 22 INV    161 43 RCL
030 00 0      095 02 02     160 44 SUM    162 09 09
031 94 +/-    096 69 OP     161 09 09     163 54 )
032 22 INV    097 33 33     162 71 SBR    164 92 RTN
033 28 LOG    098 63 EX*    163 02 02     165 76 LBL
034 32 X:T    099 03 03     164 40 40     166 16 A'
035 71 SBR    100 54 )      165 54 )      167 31 LRN
036 01 01     101 54 )      166 65 ×
037 47 47     102 99 PRT    167 93 .
038 98 ADV    103 97 DSZ    168 05 5
039 99 PRT    104 00 00     169 42 STO
040 42 STO    105 00 00     170 08 08
041 11 11     106 67 67     171 65 ×
042 71 SBR    107 22 INV    172 42 STO
043 01 01     108 87 IFF    173 10 10
044 88 88     109 01 01     174 43 RCL
045 98 ADV    110 01 01     175 09 09
046 99 PRT    111 17 17     176 44 SUM
047 42 STO    112 69 OP     177 09 09
048 12 12     113 24 24     178 54 )
049 01 1      114 69 OP     179 87 IFF
050 42 STO    115 23 23     180 00 00
051 04 04     116 22 INV    181 01 01
052 22 INV    117 86 STF    182 84 84
053 86 STF    118 01 01     183 92 RTN
054 01 01     119 53 (      184 24 CE
055 43 RCL    120 69 OP     185 00 0
056 04 04     121 23 23     186 42 STO
057 42 STO    122 63 EX*    187 10 10
058 00 00     123 03 03     188 53 (
059 09 9      124 55 ÷      189 02 2
060 42 STO    125 63 EX*    190 22 INV
061 03 03     126 03 03     191 49 PRD
062 71 SBR    127 69 OP     192 09 09
063 01 01     128 23 23     193 49 PRD
064 88 88     129 72 ST*    194 08 08
```

ARRIVAL OF THE STORM.-(v7n7/8p27) Michael Sperber is the only one so far who sent me a solution to that one. To use it: Press E' for a new storm. Enter the time in D.MS format and press A. Enter delay time between lightning and thunder in seconds and press B. Repeat of often as necessary. At least two sets are required. To compute the time of arrival press C. As an example:

```
E'   22.3020 A 28 B ; 22.3102 A 25 B  C  see 22.3652
                      22.3118 A 24 B  C  see 22.3703
                      22.3210 A 20 B  C  see 22.3646
```

```
LBL A X:T R/S  LBL B  X:T DMS  SUM+ R/S  LBL C  OP 12 INV DMS  FIX 4  CP  R/S
LBL E' CMs   R/S
```

DIGIT REVERSER II.- At the very last moment I received two more solutions. They come from Herman Stevens in Wilsele, Belgium. Wilsele is very close to Leuven (better known outside Belgium as "Louvain") the seat of famous Catholic University, my old Alma Mater. So, I suppose Herman is a student there. Herman uses a TI-58C. One program is in Normal Mode. The second one requires Fast Mode. A 58C refuses to go into Fast mode by the sequence PGM 02 SBR 239... so Herman says to place an hl2 at step 024 per his instructions below. He also used quite a lot of EE INV EE and INT and INV INT. This is absolutely necessary, as he used the method n=log(sum of n-1). This would introduce large errors in large numbers.

I am aware of the fact that the fast-mode program could be optimized, but I have no time left for the moment. The Hexcode at step 024 should be entered as follows : enter the first 23 steps, then in keybordmode press GTO 24 LRN GTO BST LRN Pgm 12 SBR 999 R/S D.MS LRN Ins LRN RST GTO 25. Now you can enter the rest of the program.
To use the program : give the number to be reversed, press A.

Herman Stevens

```
000 76 Lbl      023 82 HIR      047 52 EE
001 11 A        024 06 6        048 05 5
002 22 INV      025 22 INV      049 32 x⇄t
003 58 Fix      026 59 Int      050 77 GE
004 57 Eng      027 65 X        051 00 0
005 82 HIR      028 53 (        052 56 56
006 06 6        029 53 (        053 82 HIR
007 25 CLR      030 82 HIR      054 38 38
008 82 HIR      031 16 16       055 25 CLR
009 07 7        032 28 LOG      056 82 HIR
010 82 HIR      033 85 +        057 37 37
011 08 8        034 02 2        058 61 GTO
012 82 HIR      035 54 )        059 00 0
013 16 16       036 59 Int      060 12 12
014 59 Int      037 22 INV      061 82 HIR
015 29 CP       038 28 LOG      062 17 17
016 67 EQ       039 85 +        063 52 EE
017 00 0        040 93 .        064 22 INV
018 61 61       041 05 5        065 57 Eng
019 55 ÷        042 54 )        066 85 +
020 01 1        043 59 Int      067 82 HIR
021 00 0        044 95 =        068 18 18
022 95 =        045 32 x⇄t      069 95 =
                046 01 1        070 92 RTN
```

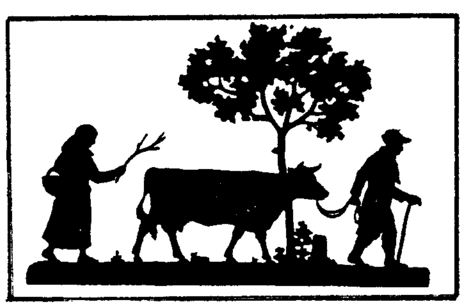
```
000 68 NOP      031 25 CLR      063 85 +
001 85 +        032 82 HIR      064 93 .
002 82 HIR      033 07 7        065 05 5
003 18 18       034 82 HIR      066 54 )
004 95 =        035 08 8        067 59 Int
005 92 RTN      036 82 HIR      068 95 =
006 76 Lbl      037 16 16       069 32 x⇄t
007 11 A        038 59 Int      070 01 1
008 82 HIR      039 29 CP       071 52 EE
009 06 6        040 67 x= t     072 05 5
010 02 2        041 00 0        073 32 x⇄t
011 85 +        042 35 35       074 77 GE
012 02 2        043 55 ÷        075 00 0
013 52 EE       044 01 1        076 80 80
014 01 1        045 00 0        077 82 HIR
015 02 2        046 95 =        078 38 38
016 94 +/-      047 82 HIR      079 25 CLR
017 95 =        048 06 6        080 82 HIR
018 22 INV      049 22 INV      081 37 37
019 52 EE       050 59 Int      082 61 GTO
020 60 DEG      051 65 X        083 00 0
021 58 FIX      052 53 (        084 36 36
022 00 0        053 53 (        085 82 HIR
023 86 St flg   054 82 HIR      086 17 17
024 12 12 H     055 16 16       087 22 INV
025 68 NOP      056 28 log      088 57 Eng
026 68 NOP      057 85 +        089 52 EE
027 61 GTO      058 02 2        090 22 INV
028 00 0        059 54 )        091 52 EE
029 30 30       060 59 Int      092 81 RST
030 57 Eng      061 22 INV
                062 28 log
```

WANTED: James A. Girola, 1101 New Hampshire Ave. NW # 606, Washington DC 20037, Tel.: 202-566-5243, is interested in older TI and HP calculators, and would like to buy some. Members, here is your chance to make some money from those old SR-56, SR-52, and PC-100 printers lying around. PLease contact Jim at the above address and phone.

DEAR MEMBERS, FRIENDS, here then comes the dreaded moment where I finally have to stop writing. So I leave you with a couple of pictures.

I will surely keep on

And for diversion, Martha and I will do some



I love you all,