



NUSC Technical Memorandum 851094
24 June 1985

REFERENCE ONLY

Automatic Aging Calculation for Transducer Piezoelectric Ceramic

Richard Lamprecht
Submarine Sonar Department



Naval Underwater Systems Center
Newport Rhode, Island/New London, Connecticut

Approved for public release; distribution unlimited.

Report Documentation Page

Form Approved
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE 24 JUN 1985		2. REPORT TYPE Technical Memo		3. DATES COVERED 24-06-1985 to 24-06-1985	
4. TITLE AND SUBTITLE Automatic Aging Calculation for Transducer Piezoelectric Ceramic				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Richard Lamprecht				5d. PROJECT NUMBER A11021	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Underwater Systems Center, New London, CT, 06320				8. PERFORMING ORGANIZATION REPORT NUMBER TM No. 851094	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Naval Sea Systems Command				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES NUWC2015					
14. ABSTRACT The "RING" computer program was developed to calculate the aging rate of piezoelectric ceramic materials. The program computes the percent aging rate for ceramic capacitance, resonant frequency, and coupling coefficient as a function of logarithmic time decades. Program options enable the user to store and edit data, perform statistical analyses, and display printed or plotted ceramic properties.					
15. SUBJECT TERMS piezoelectric ceramic; ceramic					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

REFERENCE ONLY

Naval Underwater Systems Center
New London Laboratory
New London, Connecticut 06320

Technical Memorandum

Automatic Aging Calculation
for Transducer Piezoelectric Ceramic

Date 24 June 1985

Prepared by: Richard Lamprecht
Richard Lamprecht

ABSTRACT

The "RING" computer program was developed to calculate the aging rate of piezoelectric ceramic materials. The program computes the percent aging rate for ceramic capacitance, resonant frequency, and coupling coefficient as a function of logarithmic time decades. Program options enable the user to store and edit data, perform statistical analyses, and display printed or plotted ceramic properties.

ADMINISTRATIVE INFORMATION

This technical memorandum was prepared under Project No. A11021, Principal Investigator, R.J. DeAngelis, Code 3234. The sponsoring activity is Naval Sea Systems Command, Program Manager, R. Heaney, NAVSEA 63X5B.

The author of this memorandum is located at the Naval Underwater System Center New London Laboratory, New London, CT 06320.

ACKNOWLEDGEMENT

The author would like to thank Mr. Kevin Farnham of Garrick Lockheed, Inc. for his support in developing the computer software.

INTRODUCTION

A computer program was developed to calculate the aging rate of piezoelectric ceramic materials. The program, called "RING", computes the percent aging rate for ceramic capacitance, resonant frequency, and coupling coefficient as a function of logarithmic time decades. The program is useful for predicting ceramic behavior over time.

Program applications include both circular ring and cylindrical tube ceramic shapes. The data to be entered includes the ceramic serial number, capacitance, dissipation factor, frequency data, and temperature for two different days since poling. Program options enable the user to store and edit data, perform statistical analyses, and display printed or plotted ceramic properties. A computer listing of the program is presented in the appendix of this technical memorandum.

PROGRAM INSTALLATION

The "RING" program operates on the Hewlett-Packard HP 9845 desktop computer. The tape cassette should be inserted into the right hand tape drive unit (from user perspective). The following executive commands are used to initialize, run, and terminate the program. Each example is divided into three parts. The first column lists the typed command. The second column shows the console key(s) to be pressed. The third column describes the action taken by the program.

COMMAND	CONSOLE KEY	COMMENT
GET "RING"	EXEC RUN	Executes the "RING" program
CAT	EXEC	Lists all data files
DUMP GRAPHICS	EXEC	Hard copy print of a plot
	STOP	Terminates the "RING" program
	STOP RUN	Terminates a session and restarts the program

PROGRAM OPTIONS

The program operates from a main options list. Each time the user selects an option, the program performs the requested function and returns to the main options list. The following paragraphs discuss the usage of each of the main options.

1. CREATE DATA FILE FOR RING STORAGE

This option creates a data file on tape on which ceramic ring data may be stored using Option 2. The user enters the file title (up to 6 characters in length) and the maximum number of rings for which storage is to be allocated. Up to 500 rings may be stored on a single file. The size of a data file should be specified greater than that used initially if subsequent ring data are added to the file.

The program then attempts to create the file on the tape or disk. If no tape or disk error occurs, the user enters an up to 80 character file title/information string indicating the contents of the file. The ring original poling data is then entered (up to 32 characters in length). This data is stored in the file, and the program returns to the main options list. See the Option 1 example in the Appendix of this report for creating a data file.

2. STORE RING DATA IN DATA FILE

Once a file has been created using Option 1, the user may store individual ring data in the file. First, the user selects the data file in which the ring data is to be stored. Then, provided that the file is not already filled, the user enters the ring serial number. The input data depends upon the types of measurements taken on the ceramic rings, which vary with transducer model. Currently the program is set up to accept data for the TR-317 or TR-155 transducers (ceramic ring or tube data). For the TR-317 transducer two sets of the following data are entered:

Days since poling
 CAP - Capacitance in picofarads at 1 KHz
 K - Coupling Coefficient (K_{31} , "Hoop Mode")
 DF - Dissipation Factor at 1 KHz
 FR - Ring Resonant Frequency, "Hoop Mode", KHz
 TEMP - Air Temperature in degrees Fahrenheit

For the TR-155 transducer two sets of the following data are entered:

Days since poling
 CAP - Capacitance in picofarads at 1 KHz
 DF - Dissipation Factor at 1 KHz
 FM - Frequency of Maximum Admittance KHz
 FN - Frequency of Minimum Admittance KHz
 TEMP - Air Temperature in degrees Celsius

The data is stored in the data file, and the program returns to the main options list. The Option 2 examples in the Appendix show data storage formats for both the TR-317 and TR-155 model transducers.

3. PRINT RING CATALOG FOR THE CURRENT DATA FILE

If the user wishes to print a catalog of the serial numbers of rings stored on the current data file, he selects Option 3. The catalog may be printed on the CRT or the printer. The file name, the title string, and the poling date string are printed, followed by a list of the ring serial numbers stored in the file (See the Appendix under the Option 3 example for displaying a ring catalog). The program then returns to the main options list.

4. EDIT DATA STORED IN DATA FILE

Data that has been previously stored in a data file may be changed using Option 4. A list of data edit options is printed as follows:

EDIT OPTIONS:

1. Print serial number catalog for file
2. Edit ring
3. Purge ring
4. Enter new title string
5. Enter new poling date
6. Return to main options

Any changes made are stored in the data file. Thus, if a ring is purged using edit Option 3, that data is no longer accessible for any purpose, because it is deleted from the data file, not just from the statistical calculation (see main Option 6). When edit Option 6 is selected, data editing is completed, and the program returns to the main options list. The Option 4 example located in the Appendix gives a few examples of this option.

5. CALCULATE STATISTICS AND PRINT RING DATA TABLE

This option calculates statistics and prints the file data on the CRT or the printer. The user selects the file, and where the table is to be printed. The mean, standard deviation, and minimum and maximum of CAP, K, and FM are printed for both days since poling. If Option 6 has been exercised to delete a ring from the statistical calculations, an asterisk is placed next to the ring serial number. After the table has been printed, the program returns to the main options list (See Option 5 example in the Appendix).

6. DELETE A RING FROM THE STATISTICAL CALCULATIONS

Once a table has been printed using Option 5, the user may delete a ring from the statistical calculations. The user enters the ring serial number, and the program returns to the main options list (See Option 6 example in the Appendix).

7. RESTORE A RING TO THE STATISTICAL CALCULATIONS

A ring that has been deleted from the statistical calculations using Option 6 may be restored to the calculations using Option 7. The ring serial number is entered, and the program returns to the main options list. See the Option 7 example in the Appendix of this report.

8. PLOT INDIVIDUAL RING DATA

This option plots on the CRT, the CAP, FR, and K data for an individual ring on a logarithmic time scale. The user selects the file and ring serial number, and the plot is automatically scaled and drawn on the CRT. The actual CAP, FR, and K data points are denoted by an X. A line is drawn through the data points, and the slope of the line is printed, indicating the percent change per logarithmic decade for each data type (See Option 8 example in the Appendix). After the plot is drawn, the program pauses. The user presses CONT when he wishes to return to the main options list. A ring which was deleted from statistical calculations using Option 6 may be plotted under this option.

9. MAKE BAR PLOT OF COMPOSITE CAP, K, OR FR DATA

A bar graph of the CAP, K, or FR data for each data set is plotted on the CRT. Rings which have been deleted from the statistical calculations do not appear on the bar chart. When the plot for the first data set has been made, the program pauses. When CONT is pressed, the plot for the second data set is made, and the program pauses again. The user then presses CONT to return to the main options list. See the Appendix under the Option 9 example for a sample bar plot.

APPENDIX

"RING" PROGRAM OPTION EXAMPLES

The following computer listing is a sample session illustrating the use of options with the "RING" program. Each program option is demonstrated. User responses are denoted with a caret (>) preceding the response. Additional comments are inserted to clarify the input data.

OPTION 1 EXAMPLE:

```
ENTER OPTION NUMBER (1-9)
> 1
ENTER FILE TITLE AND MASS STORAGE DEVICE
> RING1
ENTER NUMBER OF RINGS TO ALLOCATE STORAGE FOR (1-500)
> 6
ATTEMPTING TO CREATE FILE RING1,8,128
ENTER FILE TITLE STRING (UP TO 80 CHARACTERS)
> TR155G-BQ SAMPLE DATA
ENTER POLING DATE (UP TO 32 CHARACTERS)
> 1-15-85
```

OPTION 2 EXAMPLE: TR-155

```

ENTER OPTION NUMBER (1-9)
> 2
PRESS CONT, OR ENTER NEW FILE NAME AND MASS STORAGE DEVICE
>
ENTER SERIAL NUMBER (NUMERIC ONLY, >0)
> 50830224
ENTER 1 FOR TR-317 DATA, 2 FOR TR-155 DATA
> 2
?
> 0      Days since poling
?
> 30549   CAP
?
> .002   DF
?
> 16901  FM
?
> 18822  FN
?
> 22     TEMP
?
> 22     DAYS SINCE POLING
?
> 29961  CAP
?
> .002   DF
?
> 16968  FN
?
> 18847  FN
?
> 22     TEMP
PRESS CONT TO ENTER DATA FOR ANOTHER RING; ENTER 0 TO RETURN TO OPTIONS LIST.

```

DATA SET 1

DATA SET 2

OPTION 2 EXAMPLE: TR-317

```

ENTER OPTION NUMBER (1-9)
> 1
ENTER FILE TITLE AND MASS STORAGE DEVICE
> RING2
ENTER NUMBER OF RINGS TO ALLOCATE STORAGE FOR (1-500)
> 50
ATTEMPTING TO CREATE FILE RING2,55,128
ENTER FILE TITLE STRING (UP TO 80 CHARACTERS)
> TR-317 SAMPLE DATA
ENTER POLING DATE (UP TO 32 CHARACTERS)
> 4-12-85
ENTER OPTION NUMBER (1-9)
> 2
PRESS CONT, OR ENTER NEW FILE NAME AND MASS STORAGE DEVICE
>
ENTER SERIAL NUMBER (NUMERIC ONLY, >0)
> 632148
ENTER 1 FOR TR-317 DATA, 2 FOR TR-155 DATA
> 1
?
> 129      Days since poling
?
> 1516     CAP
?
> .3291    K
?
> .0013    DF
?
> 14729    FR
?
> 75       TEMP
?
> 49       Days since poling
?
> 1536     CAP
?
> .3340    K
?
> .0013    DF
?
> 14695    FR
?
> 75       TEMP
?
DATA SET 1
DATA SET 2
PRESS CONT TO ENTER DATA FOR ANOTHER RING; ENTER 0 TO RETURN TO OPTIONS LIST.

```

OPTION 3 EXAMPLE:

```

ENTER OPTION NUMBER (1-9)
> 3
HARDCOPY PRINTOUT (Y or N)?
> Y
FILE: RING1
TR155G-BQ SAMPLE DATA
POLING DATE: 1-15-85

FILE RING1 CONTAINS DATA FOR THE FOLLOWING RING SERIAL NUMBERS:

50830224      50830321      50880103      50880115
50880413      50900202

```

OPTION 4 EXAMPLE:

- a. Print ring serial number from RING 1 data file.

```

ENTER OPTION NUMBER (1-9)
> 4
ENTER FILE NAME WITH MASS STORAGE DEVICE
> RING1
ENTER EDIT OPTION NUMBER (1-6)
> 1
HARDCOPY PRINTOUT (Y or N)?
> Y
FILE: RING1
TR155G-BQ SAMPLE DATA
POLING DATE: 1-15-85

FILE RING1 CONTAINS DATA FOR THE FOLLOWING RING SERIAL NUMBERS:

50830224          50830321          50880103          50880115
50880413          50900202

```

- b. Create a new title string.

```

ENTER EDIT OPTION NUMBER (1-6)
> 4
ENTER NEW TITLE STRING (UP TO 80 CHARACTERS)
> TR-155G/BQ EDIT

```

- c. Make the following changes to the first data set of ring #50830224:

```

CAP = 30500
K   = .20
FM  = 17000
FN  = 19000

```

```

ENTER EDIT OPTION NUMBER (1-6)
> 2
ENTER RING SERIAL NUMBER (ENTER 0 FOR RING CATALOG)
> 50830224
ENTER Y or N
> Y
PRESS CONT, OR ENTER A NEW VALUE
>
PRESS CONT, OR ENTER A NEW VALUE
> 30500
PRESS CONT, OR ENTER A NEW VALUE
> .2
PRESS CONT, OR ENTER A NEW VALUE
>
PRESS CONT, OR ENTER A NEW VALUE
> 17000
PRESS CONT, OR ENTER A NEW VALUE
> 19000
PRESS CONT, OR ENTER A NEW VALUE
>
ENTER Y or N
> N
ARE VALUES CORRECT (Y or N)?
> Y

```

Change values for time 1?

Days since poling

CAP

K

DF

FM

FN

TEMP

Change values for time 2?

Updated values are listed on monitor.

OPTION 5 EXAMPLE:

```

ENTER OPTION NUMBER (1-9)
> 5
PRESS CONT, OR ENTER NEW FILE NAME AND MASS STORAGE DEVICE
>
PRINT HARD COPY (Y or N)?
> Y
    
```

```

FILE: RING1
TR-155G/BQ EDIT
POLING DATE: 1-15-85
    
```

RING	DAY	CAP	K	DF	FM	FN	T
50830224	008	30500	.2000	.0020	17000	19000	72
	022	29961	.1895	.0020	16968	18847	72
50830321	008	31259	.1920	.0020	16861	18758	72
	022	30546	.1877	.0020	16958	18816	72
50880103	008	30377	.1850	.0020	17011	18843	72
	022	29819	.1815	.0010	17088	18888	72
50880115	008	30503	.1902	.0020	16971	18859	72
	022	29919	.1851	.0010	17058	18896	72
50880413	008	30613	.1919	.0020	16971	18879	72
	022	30046	.1868	.0010	17058	18916	72
50900202	008	30612	.1910	.0020	16981	18880	72
	022	30022	.1867	.0010	17068	18926	72

CAP	MIN	MAX	MEAN	STD DEV
FIRST DATA SET	30377	31259	30644	313.72472
SECOND DATA SET	29819	30546	30052.167	255.0415

K	MIN	MAX	MEAN	STD DEV
FIRST DATA SET	.18439628	.2	.1916989	.0048303313
SECOND DATA SET	.18151538	.18945552	.18621573	.0027126622

FM	MIN	MAX	MEAN	STD DEV
FIRST DATA SET	16861	17011	16965.833	53.816039
SECOND DATA SET	16958	17088	17033	55.407581

```

ENTER OPTION NUMBER (1-9)
> 6
ENTER RING SERIAL NUMBER (ENTER 0 FOR RING CATALOG)
> 50830224
    
```

Verify ring # 50830224 deleted from ring statistical calculations

```

ENTER OPTION NUMBER (1-9)
> 5
PRESS CONT, OR ENTER NEW FILE NAME AND MASS STORAGE DEVICE
>
PRINT HARD COPY (Y or N)?
> Y
    
```

```

FILE: RING1
TR-155G/BQ EDIT
POLING DATE: 1-15-85
    
```

RING	DAY	CAP	K	DF	FM	FN	T
50830224*	008	30500	.2000	.0020	17000	19000	72
	022	29961	.1895	.0020	16968	18847	72
50830321	008	31259	.1920	.0020	16861	18758	72
	022	30546	.1877	.0020	16958	18816	72
50880103	008	30377	.1850	.0020	17011	18843	72
	022	29819	.1815	.0010	17088	18888	72
50880115	008	30503	.1902	.0020	16971	18859	72
	022	29419	.1851	.0010	17058	18896	72
50880413	008	30613	.1919	.0020	16971	18879	72
	022	30046	.1868	.0010	17058	18916	72
50900202	008	30612	.1910	.0020	16981	18880	72
	022	30022	.1867	.0010	17068	18926	72

CAP	MIN	MAX	MEAN	STD DEV
FIRST DATA SET	30377	31259	30672.8	341.77215
SECOND DATA SET	29819	30546	30070.4	280.73885
K	MIN	MAX	MEAN	STD DEV
FIRST DATA SET	.18439628	.19203305	.19003868	.0029142182
SECOND DATA SET	.18151538	.18774077	.18556777	.0024595313
FM	MIN	MAX	MEAN	STD DEV
FIRST DATA SET	16861	17011	16959	57.183914
SECOND DATA SET	16958	17088	17046	50.695167

Ring #50830224 was omitted from the ring statistics calculations via Option 6. Compare the results with those in the Option 5 example.

OPTION 9 EXAMPLE:

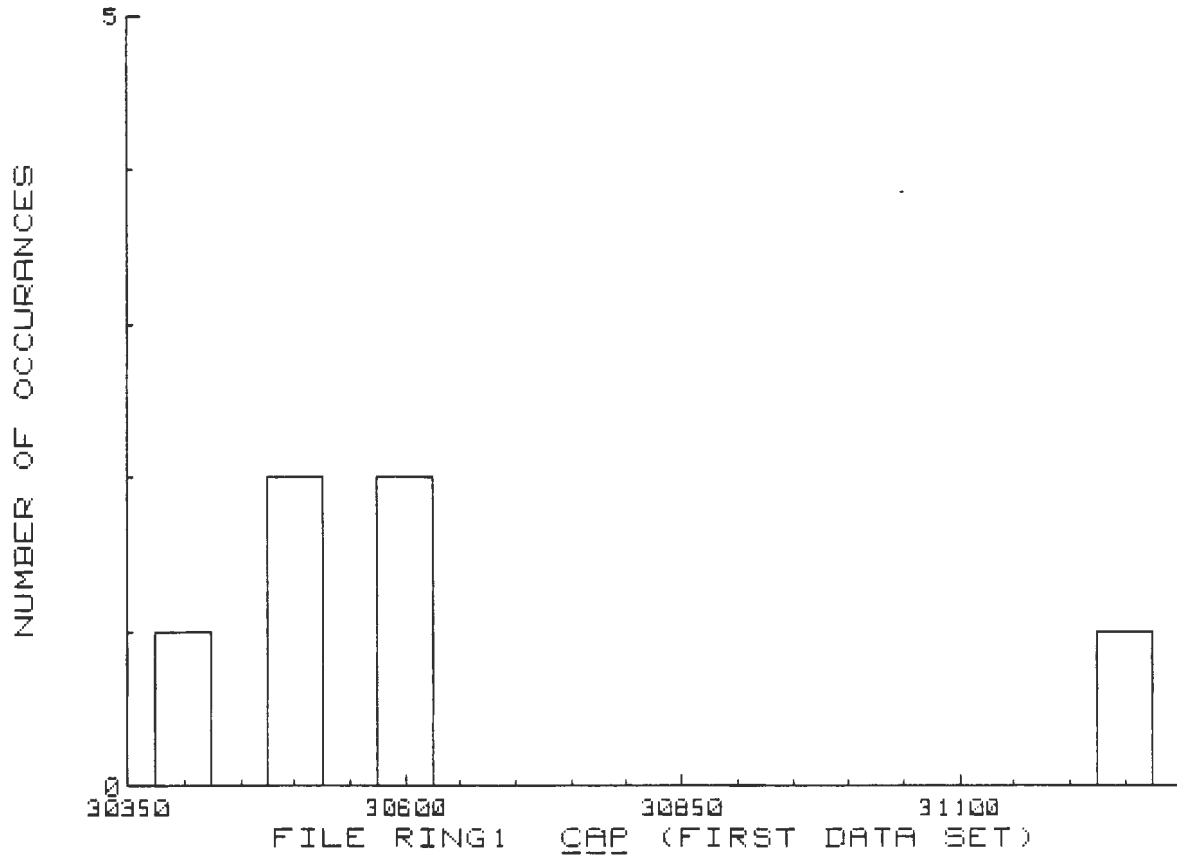
ENTER OPTION NUMBER (1-9)

9

ENTER 1 TO PLOT CAP; 2 TO PLOT K; 3 TO PLOT FR.

1

DUMP GRAPHICS



```

10  ! RING - 28 MAY 1985
20  OPTION BASE 1
30  DIM Ser(500),Dat(2,7),Dat$(7),Title#[80],Ckf(500,6),Stat(6,4),Nostat(500),Date#[32]
40  MAT READ Dat$
50  DATA DAYS SINCE POLING,CAP,K,DF,FM,FN,T
60  Opt:   Opt=0
70  PRINT LIN(3);"MAIN OPTIONS:"
80  PRINT "  1. CREATE DATA FILE FOR RING STORAGE;"
90  PRINT "  2. STORE RING DATA IN DATA FILE;"
100 PRINT "  3. PRINT RING CATALOG FOR THE CURRENT DATA FILE;"
110 PRINT "  4. EDIT DATA STORED IN DATA FILE;"
120 PRINT "  5. CALCULATE STATISTICS & PRINT RING DATA TABLE;"
130 PRINT "  6. DELETE A RING FROM THE STATISTICAL CALCULATIONS;"
140 PRINT "  7. RESTORE A RING TO THE STATISTICAL CALCULATIONS;"
150 PRINT "  8. PLOT INDIVIDUAL RING DATA;"
160 PRINT "  9. MAKE BAR PLOT OF COMPOSITE CAP, K, OR FR DATA."
170 INPUT "ENTER OPTION NUMBER (1-9)",Opt
180 IF (Opt<1) OR (Opt>9) THEN Opt
190 ON Opt GOSUB Createfile,Datastore,Rcat,Dataedit,Table,Statdelete,Statrestore,Plot,Call_barplot
200 GOTO Opt
210 Createfile: INPUT "ENTER FILE TITLE AND MASS STORAGE DEVICE",File$
220 Cf05: INPUT "ENTER NUMBER OF RINGS TO ALLOCATE STORAGE FOR (1-500)",Nring
230 IF Nring<1 THEN Cf99
240 IF Nring>500 THEN Cf05
250 Recplus=INT(Nring/16)+1+(Nring MOD 16>0)
255 Nrec=Nring+Recplus
260 DISP "ATTEMPTING TO CREATE FILE ";File$;",";VAL$(Nrec);",128"
270 ON ERROR GOTO Cf10
280 CREATE File$,Nrec,128
290 GOTO Cf15
300 Cf10: PRINT "ERROR";ERRN;"DURING ATTEMPT TO CREATE FILE ";File$
310 OFF ERROR
320 GOTO Cf99
330 Cf15: OFF ERROR
340 PRINT "FILE ";File$;" CREATED"
350 INPUT "ENTER FILE TITLE STRING (UP TO 80 CHARACTERS)",Title$
355 INPUT "ENTER POLING DATE (UP TO 32 CHARACTERS)",Date$
360 ASSIGN #1 TO File$
370 REDIM Ser(Nring)
380 MAT Ser=(-1)
390 PRINT #1,1;Nring,Title$,Date$
400 PRINT #1,2
410 PRINT #1;Ser(*)
420 PRINT "FILE ";File$;" READY FOR STORING CERAMIC RING DATA"
430 Cf99: RETURN
440 ! -----
450 Datastore: CALL Fileselect(File$,#1,Nring,Title$,Date$,Ser(*),Recplus,Nostat(*)
460 Ds12: FOR P=1 TO Nring
470 IF Ser(P)=-1 THEN Ds15
480 NEXT P
490 PRINT "FILE ";File$;" IS FILLED - NO ADDITIONAL DATA CAN BE STORED"
500 GOTO Ds99
510 Ds15: INPUT "ENTER SERIAL NUMBER (NUMERIC ONLY, >0)",Ser(P)
520 IF Ser(P)<=0 THEN Ds15
521 Ds20:   Kmode=0
522 INPUT "ENTER 1 FOR TR-317 DATA, 2 FOR TR-155 DATA",Kmode
523 ! "ENTER 1 IF K WILL BE DIRECTLY ENTERED, 2 TO CALCULATE K BASED ON FM & FN",Kmode
526 IF (Kmode<1) OR (Kmode>2) THEN Ds20
528 MAT Dat=(0)
530 FOR I=1 TO 2
540 PRINT LIN(2);"ENTER DATA SET";I;"FOR TRANSDUCER RING";Ser(P);LIN(1)
550 FOR J=1 TO 7

```

```

551 IF (J=3) AND (Kmode=2) OR (J=6) AND (Kmode=1) THEN Ds30
560 PRINT "ENTER DATA SET";I;Dat$(J)
570 INPUT Dat(I,J)
580 Ds30: NEXT J
581 IF Kmode=1 THEN Ds40
582 Dat(I,3)=(Dat(I,6)^2-Dat(I,5)^2)/Dat(I,6)^2
583 PRINT "CALCULATED K VALUE FOR DATA SET";I;"=";Dat(I,3)
584 Dat(I,7)=Dat(I,7)*9/5+32
585 PRINT "TEMPERATURE CONVERTED TO";Dat(I,7);"deg F"
590 Ds40: NEXT I
600 PRINT #1,P+Recplus;Dat(*)
610 PRINT #1,2
620 PRINT #1;Ser(*)
630 READ #1,1;X
640 PRINT "DATA FOR RING";Ser(P);"HAS BEEN STORED IN FILE ";File$
650 Ds90: X=1
660 INPUT "PRESS CONT TO ENTER DATA FOR ANOTHER RING; ENTER 0 TO RETURN TO OPTI
ONS LIST.",X
670 IF X=1 THEN Ds12
680 IF X THEN Ds90
681 ASSIGN #1 TO *
682 ASSIGN #1 TO File$
690 Ds99: RETURN
700 ! -----
710 Dataedit: CALL Fileselect(File$,#1,Nring,Title$,Date$,Ser(*),Recplus,Nostat(
*))
720 De02: PRINT LIN(2);"EDIT OPTIONS:"
730 PRINT LIN(1);" 1. PRINT SERIAL NUMBER CATALOG FOR FILE ";File$
740 PRINT " 2. EDIT RING"
750 PRINT " 3. PURGE RING"
753 PRINT " 4. ENTER NEW TITLE STRING"
757 PRINT " 5. ENTER NEW POLING DATE"
760 PRINT " 6. RETURN TO MAIN OPTIONS"
770 De05: Edopt=0
780 INPUT "ENTER EDIT OPTION NUMBER (1-6)",Edopt
790 IF (Edopt<1) OR (Edopt>6) THEN De05
800 ON Edopt GOTO De10,De20,De60,De70,De80,De99
810 De10: CALL Ringcat(File$,Nring,Title$,Date$,Ser(*),Nostat(*))
820 GOTO De02
830 De20: CALL Ringselect(Nring,Ser(*),Ring,File$,Title$,Date$,Nostat(*))
840 IF Ring=0 THEN De02
850 READ #1, Ring+Recplus;Dat(*)
860 PRINT LIN(1);"CURRENT DATA FOR RING";Ser(Ring)
870 GOSUB De50
880 De28: FOR I=1 TO 2
890 De30: X$=""
900 PRINT "CHANGE VALUES FOR TIME";I;"(Y or N)?"
910 INPUT "ENTER Y or N",X$
920 IF X$="N" THEN De35
930 IF X$<>"Y" THEN De30
940 PRINT LIN(1);"PRESS CONT TO MAINTAIN DISPLAYED VALUE, OR ENTER A NEW VALUE"
;LIN(1)
950 FOR J=1 TO 7
960 PRINT "TIME";I;Dat$(J);"=";Dat(I,J)
970 INPUT "PRESS CONT, OR ENTER A NEW VALUE",Dat(I,J)
980 NEXT J
990 De35: NEXT I
1000 PRINT LIN(2);"REVISED VALUES FOR RING";Ser(Ring)
1010 GOSUB De50
1020 De40: X$=""
1030 INPUT "ARE VALUES CORRECT (Y or N)?",X$
1040 IF X$="Y" THEN De45
1050 IF X$<>"N" THEN De40
1060 GOTO De28
1070 De45: PRINT #1, Ring+Recplus;Dat(*)
1080 MAT Dat=(0)

```

```

1090 READ #1, Ring+Recplus; Dat(*)
1100 PRINT "EDITED VALUES HAVE BEEN STORED IN FILE "; File$
1110 GOTO De02
1120 De50: PRINT LIN(1); "    TIME 1",, "    TIME 2"
1130 FOR I=1 TO 7
1140 PRINT Dat(1, I), Dat$(I), Dat(2, I)
1150 NEXT I
1160 PRINT
1170 RETURN
1180 De60: CALL Ringselect(Nring, Ser(*), Ring, File$, Title$, Date$, Nostat(*))
1190 IF Ring=0 THEN De02
1195 PRINT "RING"; Ser(Ring); "PURGED"
1200 Ser(Ring)=-1
1210 PRINT #1, 2; Ser(*)
1220 READ #1, 1; Nring
1232 GOTO De02
1234 De70: PRINT "CURRENT TITLE STRING:"
1235 PRINT Title$
1236 INPUT "ENTER NEW TITLE STRING (UP TO 80 CHARACTERS)", Title$
1237 PRINT #1, 1; Nring, Title$, Date$
1238 READ #1, 1
1239 GOTO De02
1240 De80: PRINT "CURRENT POLING DATE: "; Date$
1242 INPUT "ENTER NEW POLING DATE (UP TO 32 CHARACTERS)", Date$
1244 PRINT #1, 1; Nring, Title$, Date$
1245 READ #1, 1
1247 GOTO De02
1250 De99: ASSIGN #1 TO *
1251 ASSIGN #1 TO File$
1256 RETURN
1260 ! -----
1270 Table: IF Opt=9 THEN Ta11
1275 CALL Fileselect(File$, #1, Nring, Title$, Date$, Ser(*), Recplus, Nostat(*))
1280 Ta10: X$=""
1290 INPUT "PRINT HARD COPY (Y or N)?", X$
1300 IF (X$<>"Y") AND (X$<>"N") THEN Ta10
1310 PRINTER IS 16*(X$="N")
1320 PRINT LIN(2); "FILE: "; File$
1322 PRINT Title$
1325 PRINT "POLING DATE: "; Date$
1340 PRINT LIN(1); "    RING    DAY    CAP    K    DF    FM
      FN    T "
1350 Ta11: X=-1
1360 MAT Ckf=(0)
1370 Ckf=0
1380 FOR I=1 TO 6
1390 Stat(I, 1)=1E35
1400 Stat(I, 2)=-1E35
1410 Stat(I, 3)=Stat(I, 4)=0
1420 NEXT I
1430 Ta12: Y=1E35
1440 FOR J=1 TO Nring
1450 IF (Ser(J)<=X) OR (Ser(J)>Y) THEN Ta13
1460 I=J
1470 Y=Ser(J)
1480 Ta13: NEXT J
1490 IF Y=1E35 THEN Ta20
1500 X=Y
1510 READ #1, I+Recplus; Dat(*)
1520 IF Nostat(I) THEN Ta14
1530 Ckf=Ckf+1
1540 Ckf(Ckf, 1)=Dat(1, 2)
1550 Ckf(Ckf, 2)=Dat(1, 3)
1560 Ckf(Ckf, 3)=Dat(1, 5)
1570 Ckf(Ckf, 4)=Dat(2, 2)
1580 Ckf(Ckf, 5)=Dat(2, 3)

```

```

1590 Ckf(Ckf,6)=Dat(2,5)
1600 FOR K=1 TO 6
1610 IF Ckf(Ckf,K)<Stat(K,1) THEN Stat(K,1)=Ckf(Ckf,K)
1620 IF Ckf(Ckf,K)>Stat(K,2) THEN Stat(K,2)=Ckf(Ckf,K)
1630 Stat(K,3)=Stat(K,3)+Ckf(Ckf,K)
1640 Stat(K,4)=Stat(K,4)+Ckf(Ckf,K)^2
1650 NEXT K
1660 Ta14: IF Opt=9 THEN Ta12
1665 PRINT USING "#,10D";Ser(I)
1670 PRINT USING Ta15;CHR$(32+10*Nostat(I))&" ",Dat(1,1),Dat(1,2),Dat(1,3),Dat(
1,4),Dat(1,5),Dat(1,6),Dat(1,7)
1680 PRINT USING Ta15;"          ",Dat(2,1),Dat(2,2),Dat(2,3),Dat(2,4),Dat(2,
5),Dat(2,6),Dat(1,7)
1690 PRINT
1700 GOTO Ta12
1710 Ta15: IMAGE K,32,4X,5D,4X,D.4D,4X,D.4D,5X,5D,5X,5D,5X,3D
1720 Ta20: IF Opt=5 THEN PRINT LIN(2)
1725 IF Ckf=0 THEN Ta95
1730 FOR I=1 TO 6
1740 IF Ckf<>1 THEN Stat(I,4)=SQRT((Stat(I,4)-Stat(I,3)^2/Ckf)/(Ckf-1))
1750 IF Ckf=1 THEN Stat(I,4)=0
1760 Stat(I,3)=Stat(I,3)/Ckf
1770 NEXT I
1771 IF Opt=9 THEN Ta99
1780 FOR I=1 TO 3
1790 PRINT
1800 IF I=1 THEN PRINT USING "#,K";"   CAP"
1810 IF I=2 THEN PRINT USING "#,K";"   K"
1820 IF I=3 THEN PRINT USING "#,K";"   FM"
1830 PRINT TAB(24);"MIN";TAB(36);"MAX";TAB(51);"MEAN";TAB(66);"STD DEV"
1840 FOR J=0 TO 3 STEP 3
1850 IF J=0 THEN PRINT USING "#,K";"FIRST DATA SET "
1860 IF J=3 THEN PRINT USING "#,K";"SECOND DATA SET"
1870 PRINT TAB(18);DROUND(Stat(I+J,1),8);TAB(30);DROUND(Stat(I+J,2),8);TAB(45);
DROUND(Stat(I+J,3),8);TAB(60);DROUND(Stat(I+J,4),8)
1880 NEXT J
1890 NEXT I
1900 Ta95: PRINTER IS 16
1901 PAUSE
1910 Ta99: RETURN
1920 ! -----
1930 Call_barplot: IF Ckf THEN Cb10
1940 PRINT "THERE IS NO DATA BASE FOR MAKING A BAR PLOT AT THIS TIME."
1950 PRINT "ACCESS OPTION 5 TO CREATE A DATA BASE AND CALCULATE STATISTICS."
1960 GOTO Cb99
1970 Cb10: GOSUB Table
1975 CALL Barplot(Ckf,Ckf(*),Stat(*),File$)
1980 Cb99: RETURN
1990 ! -----
2000 Rcat: IF File$<>" THEN Rca10
2010 PRINT "NO FILE HAS BEEN SELECTED."
2020 GOTO Rca99
2030 Rca10: CALL Ringcat(File$,Nring,Title$,Date$,Ser(*),Nostat(*))
2040 Rca99: RETURN
2050 ! -----
2060 Statdelete: IF File$<>" THEN Sd10
2070 PRINT "NO FILE HAS BEEN SELECTED FOR PRINTING AND STATISTICAL ANALYSIS."
2080 GOTO Sd99
2090 Sd10: CALL Ringselect(Nring,Ser(*),Ring,File$,Title$,Date$,Nostat(*))
2100 IF Ring=0 THEN Sd99
2110 Nostat(Ring)=1
2120 PRINT "RING";Ser(Ring);"DELETED FROM STATISTICAL CALCULATIONS."
2130 Sd99: RETURN
2140 ! -----
2150 Statrestore: IF File$<>" THEN Sr10
2160 PRINT "NO FILE HAS BEEN SELECTED FOR PRINTING AND STATISTICAL ANALYSIS."

```

```

2170 GOTO Sr99
2180 Sr10: CALL Ringselect(Nring,Ser(*),Ring,File$,Title$,Date$,Nostat(*))
2190 Nostat(Ring)=0
2200 PRINT "RING";Ser(Ring);"RESTORED TO STATISTICAL CALCULATIONS."
2210 Sr99: RETURN
2220 ! -----
2230 Plot: CALL Fileselect(File$,#1,Nring,Title$,Date$,Ser(*),Recplus,Nostat(*))
2240 CALL Ringselect(Nring,Ser(*),Ring,File$,Title$,Date$,Nostat(*))
2241 PRINT PAGE
2250 IF Ring=0 THEN P199
2260 PLOTTER IS 13,"GRAPHICS"
2270 GRAPHICS
2280 LOCATE 18,118,8,98
2290 SCALE 0,3,0,7
2300 AXES 1,1,0,0
2310 LORG 2
2320 CSIZE 3.3
2330 MOVE -.48,1.5
2340 LABEL USING "K";"K"
2350 MOVE -.48,3.5
2360 LABEL USING "K";"FR (Hz)"
2370 MOVE -.48,5.5
2380 LABEL USING "K";"CAP (pF)"
2390 LORG 6
2400 FOR I=0 TO 3
2410 MOVE I,-.05
2420 LABEL USING "K";"1"&RPT$("0",I)
2430 NEXT I
2440 MOVE 1.5,-.3
2450 LABEL USING "K";"DAYS"
2460 LORG 3
2470 MOVE 0,-.4
2480 LABEL USING "K,K";"FILE: ",File$
2490 LORG 9
2500 MOVE 3,-.4
2510 LABEL USING "K,10D";"RING: ",Ser(Ring)
2520 FOR I=20 TO 90 STEP 10
2530 FOR J=-1 TO 1
2540 X=LGT(I)+J
2550 MOVE X,0
2560 DRAW X,.05
2570 NEXT J
2580 NEXT I
2581 READ #1,Ring+Recplus;Dat(*)
2590 X0=LGT(Dat(1,1))
2600 X1=LGT(Dat(2,1))
2610 D0=X0/(X1-X0)
2620 D1=(3-X1)/(X1-X0)
2630 FOR I=1 TO 3
2640 ON I GOTO P120,P125,P130
2650 P120: J=3
2651 P=-2
2670 GOTO P135
2680 P125: J=5
2681 P=3
2700 GOTO P135
2710 P130: J=P=2
2720 P135: D=Dat(2,J)-Dat(1,J)
2721 ! P=INT(LGT(ABS(D)))+1
2730 Y0=Dat(1,J)-D0*D
2740 Y1=Dat(2,J)+D1*D
2741 P=INT(LGT(ABS(Y0-Y1)*.4))+1
2750 ! Y=(Y0+Y1)/2
2751 Y=(Dat(1,J)+Dat(2,J))/2
2760 Y=10^P*INT(Y/10^P)
2770 SCALE 0,3,Y-(2*I-1)*10^P,Y+(8-2*I)*10^P

```

```

2780  LORG 8
2790  MOVE -.03,Y
2800  LABEL USING "K";Y
2810  MOVE -.03,Y+10^P
2820  LABEL USING "K";Y+10^P
2830  LORG 5
2840  FOR K=1 TO 2
2850  MOVE LGT(Dat(K,1)),Dat(K,J)
2860  LABEL USING "K";"X"
2870  NEXT K
2880  MOVE 0,Y0
2890  DRAW 3,Y1
2900  IF Y1+Y0<>0 THEN Perdecade=(Y1-Y0)/3/((Y1+Y0)/2)*100      ! CHANGE PER DECADE
E CALCULATION
2905  IF Y1+Y0=0 THEN Perdecade=0
2930  MOVE 2,(Y0+Y1)/2+.4*10^P
2940  CSIZE 2.5
2950  LABEL USING "K,K";PROUND(Perdecade,-1)," PERCENT PER DECADE"
2960  CSIZE 3.3
2970  NEXT I
2980  PAUSE
2990  EXIT GRAPHICS
3000 P199:  RETURN
3010  ! -----
3020 Fileselect: SUB Fileselect(File$,#1,Nring,Title$,Date$,Ser(*),Recplus,Nostat
t(*))
3030 OPTION BASE 1
3040 X=1+(File$<>"")
3050  IF X=2 THEN Fs20
3060 Fs10: INPUT "ENTER FILE NAME WITH MASS STORAGE DEVICE",F$
3070  GOTO Fs30
3080 Fs20:  PRINT PAGE;"CURRENT FILE: ";File$
3090  F$=File$
3100  INPUT "PRESS CONT, OR ENTER NEW FILE NAME AND MASS STORAGE DEVICE",F$
3110  IF F$=File$ THEN Fs99
3120 Fs30:  PRINT "ATTEMPTING TO OPEN FILE ";F$
3130  ON ERROR GOTO Fs40
3140  ASSIGN #1 TO F$
3150  OFF ERROR
3160  READ #1,1;Nring,Title$,Date$
3170  REDIM Ser(Nring)
3180  READ #1,2
3190  READ #1;Ser(*)
3200  Recplus=1+INT(Nring/16)+(Nring MOD 16>0)
3210  MAT Nostat=(0)
3220  GOTO Fs50
3230 Fs40: OFF ERROR
3240  PRINT LIN(1);"ERROR";ERRN;"DURING ATTEMPT TO OPEN FILE ";F$
3250  ON X GOTO Fs10,Fs20
3260 Fs50: File$=F$
3270 Fs99: Recplus=1+INT(Nring/16)+(Nring MOD 16>0)
3275  SUBEND
3280  ! -----
3290 Ringcat: SUB Ringcat(File$,Nring,Title$,Date$,Ser(*),Nostat(*))
3300 OPTION BASE 1
3310 Rc10:X$=""
3320 INPUT "HARDCOPY PRINTOUT (Y or N)?",X$
3330 IF (X$<>"Y") AND (X$<>"N") THEN Rc10
3340  PRINTER IS 16*(X$="N")
3341  PRINT LIN(2);"FILE: ";File$
3342  PRINT Title$
3343  PRINT "POLING DATE: ";Date$
3350  PRINT LIN(1);"FILE ";File$;" CONTAINS DATA FOR THE FOLLOWING RING SERIAL N
UMBERS: ";LIN(1)
3353  X=-1
3357 Rc20:  Y=1E35

```

```

3360 FOR I=1 TO Nring
3370 IF (Ser(I)<=X) OR (Ser(I)>Y) THEN Rc30
3371 J=I
3372 Y=Ser(I)
3380 Rc30: NEXT I
3381 IF Y=1E35 THEN Rc90
3382 X=Y
3383 Z$=" "&VAL$(Ser(J))
3384 IF Nostat(J) THEN Z#[1,1]="*"
3387 PRINT Z$,
3388 GOTO Rc20
3390 Rc90: PRINT
3400 PRINTER IS 16
3410 Rc99: SUBEND
3420 ! -----
3430 Ringselect: SUB Ringselect(Nring,Ser(*),Ring,File$,Title$,Date$,Nostat(*))
3440 OPTION BASE 1
3450 PRINT
3460 Rs10: Ser=-1
3470 INPUT "ENTER RING SERIAL NUMBER (ENTER 0 FOR RING CATALOG)",Ser
3480 ON SGN(Ser)+2 GOTO Rs10,Rs15,Rs20
3490 Rs15: CALL Ringcat(File$,Nring,Title$,Date$,Ser(*),Nostat(*))
3500 GOTO Rs10
3510 Rs20: FOR Ring=1 TO Nring
3520 IF Ser(Ring)=Ser THEN Rs99
3530 NEXT Ring
3540 Ring=0
3550 PRINT LIN(1);"SERIAL NUMBER";Ser;"NOT FOUND IN FILE ";File$
3560 Rs99: SUBEND
3570 ! -----
3580 Barplot: SUB Barplot(Ckf,Ckf(*),Stat(*),File$)
3590 DEG
3600 OPTION BASE 1
3610 DIM Bins(25)
3611 PRINT PAGE
3620 Bp10: K=0
3630 INPUT "ENTER 1 TO PLOT CAP; 2 TO PLOT K; 3 TO PLOT FR",K
3640 IF (K<1) OR (K>3) THEN Bp10
3650 FOR Dataset=1 TO 2
3660 D=Dataset*3-3
3670 Dx=Stat(K+D,2)-Stat(K+D,1)
3680 Dtic=10^INT(LGT(Dx)-1)
3690 IF Dx/Dtic<20 THEN Bp20
3700 Dtic=Dtic*2
3710 IF Dx/Dtic>=20 THEN Dtic=Dtic*2.5
3720 Bp20: Bmin=PROUND(Stat(K+D,1)/Dtic,0)
3730 Bmax=PROUND(Stat(K+D,2)/Dtic,0)
3740 REDIM Bins(1+Bmax-Bmin)
3750 MAT Bins=(0)
3760 Ymax=0
3770 FOR I=1 TO Ckf
3780 B=PROUND(Ckf(I,K+D)/Dtic,0)+1-Bmin
3790 Bins(B)=Bins(B)+1
3800 IF Bins(B)>Ymax THEN Ymax=Bins(B)
3810 NEXT I
3820 Ymax=MAX(5,Ymax)
3830 PLOTTER IS 13,"GRAPHICS"
3840 GRAPHICS
3850 LOCATE 15,110,25,95
3860 Xmin=Dtic*(Bmin-1)
3870 Xmax=Dtic*(Bmax+1)
3880 SCALE Xmin,Xmax,0,Ymax
3890 Ytic=1+(Ymax>50)
3900 AXES Dtic,Ytic,Xmin,0,5,5
3910 CSIZE 2.5
3920 LOG 5

```

```

3930 MOVE (Bmin-1)*Dtic,-.028*Ymax
3940 LABEL USING "K";(Bmin-1)*Dtic
3950 FOR I=Bmin TO Bmax
3960 CLIP (I-.5)*Dtic,(I+.5)*Dtic,0,Bins(I-Bmin+1)
3970 FRAME
3980 IF (I-Bmin+1) MOD 5 THEN Gr20
3990 MOVE I*Dtic,-.028*Ymax
4000 LABEL USING "K";I*Dtic
4010 Gr20: NEXT I
4020 MOVE Dtic*(Bmin+Bmax)/2,-.0654*Ymax
4030 CSIZE 2.7,.8
4040 Y$="FIRST"
4050 IF Dataset=2 THEN Y$="SECOND"
4060 X$="CAP"
4070 IF K=2 THEN X$="K"
4080 IF K=3 THEN X$="FR"
4090 LABEL USING "K";"FILE "&File$&" "&X$&" ("&Y$&" DATA SET)"
4100 CSIZE 2.5
4110 LORG 8
4120 FOR I=0 TO Ymax STEP 5*Ytic
4130 MOVE Dtic*(Bmin-1)-.01*Dtic*(Bmax-Bmin+2),I
4140 LABEL USING "K";I
4150 NEXT I
4160 LORG 5
4170 MOVE Dtic*(Bmin-1)-.11*Dtic*(Bmax-Bmin),Ymax/2
4180 LDIR 90
4190 CSIZE 2.7,.8
4200 LABEL USING "K";"NUMBER OF OCCURANCES"
4210 LDIR 0
4220 PRINT "PRESS CONT WHEN READY"
4230 PAUSE
4240 NEXT Dataset
4250 EXIT GRAPHICS
4260 SUBEND

```