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Technical Document 738

TWO PROGRAMS FOR THE HP9836C COMPUTER TO ACQUIRE FREQUENCY OR VOLTAGE DATA FROM A SOURCE

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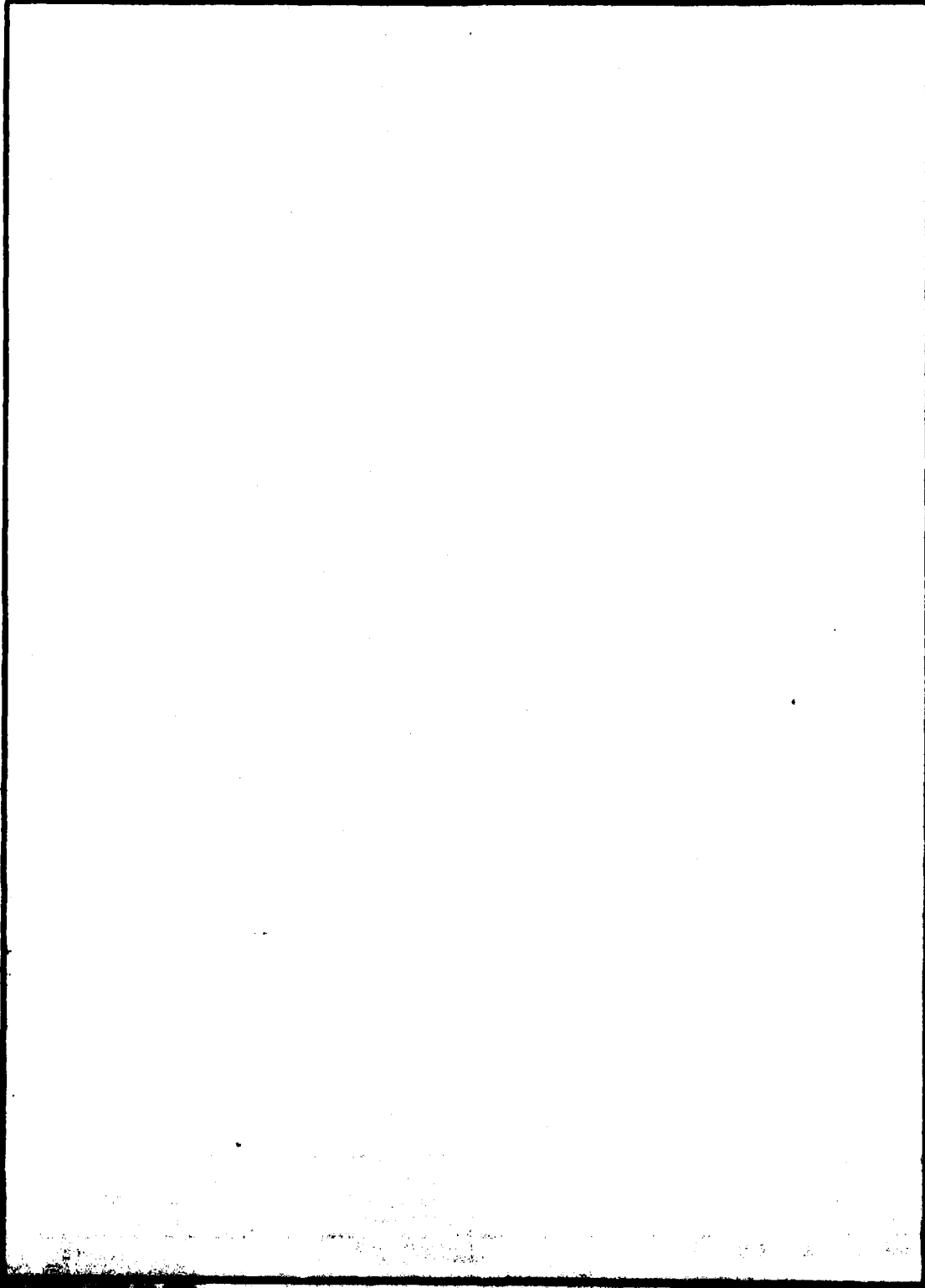
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OBJECTIVE

The objective of this work was to provide a computer program for the HP9836C which could read frequency data from the HP5345A Frequency Counter and plot these data on the computer screen, with the option of dumping the plots to the line printer. The data were also to be recorded on disk for further processing. While frequency was of primary interest here, the program should be useful for other types of data, such as phase locked loop error voltage or amplitude readings.

INTRODUCTION

Two programs have been written for the HP9836C computer in Basic to obtain frequency data from the HP5345A frequency counter. While the two programs are quite similar, the first one reads frequency, plots it, and stores it on the disk. The main difference in the second program is that it uses the interrupt technique, so that between frequency measurements it can do other things. The first program is listed in Appendix A and the second in Appendix B.

FIRST PROGRAM

DESCRIPTION

Since the two programs are quite similar, only the first one will be described in detail. The original program was written by R. L. Kellogg, but many changes and additions have since been made. It is probable that further improvements could be made to the program, but as it is it does a satisfactory job.

This program calculates frequency offset values from a "center frequency" identified in the program as C-band. This frequency, as seen in the program, is 100 kHz. Before running the program, it will have to be changed to the center frequency of whatever signal is of interest. The program then multiplies this offset frequency by 10 and converts it to INTEGER form before storing it. This has the advantage of allowing much more data to be stored on a single disk and at the same time provide a tenth Hertz frequency resolution. When the frequency is read from the disk it is divided by 10 before it is used. The disadvantage is that it limits useful frequency offset measurements to between +3276 Hz and -3276 Hz. Normally, if the frequency value is outside these limits, the computer quits and outputs the message that INTEGER limits have been exceeded. To avoid the problem of the computer quitting, if any value is outside the limit, it is set to the limit and that value stored. It is possible to store larger frequency offsets, with a corresponding reduction in frequency resolution, by changing the value of the constant, D-res1. Presently, it is set to 10 in the program. If it were changed to 1, frequency offsets between +32767 and -32767 could be recorded. In this case, the frequency resolution would be 1 Hertz.

The time of the frequency measurement is determined with the use of the computer's internal clock. This clock is read, to the nearest second, at the

beginning of each 256-sample data record and this value is subtracted from the time for subsequent measurements in the record. This value is then converted to INTEGER. After 256 frequency samples have been taken, the time array is added to the frequency array and stored as a 1024-byte record in the data file. The starting time for the record is stored in a corresponding record as a REAL number in a separate file. When the data are read from the disk, the process is reversed.

According to Kellogg, this method should allow about 18 hours of frequency measurements to be stored on a disk if measurements are made at 1-second intervals.

RUNNING THE PROGRAM

Before running the program, make sure that the address of the frequency counter is set to 12 (that is, A3 and A4 are set to 1 and A2 and A5 are set to 0). Also, make sure that the switch marked TALK ONLY and ADDRESSABLE is in the ADDRESSABLE position. These switches are located on the back of the frequency counter.

After the program is loaded and RUN is pressed, the computer asks for the scale desired for the plot that will be displayed on the screen. These four values are input at one time, separated by commas. The first value, called MAX. TIME, is the length of the time display on the horizontal axis. The second value is either an M or an H, depending on whether the first value is in minutes or in hours. The third and fourth values are the minimum and the maximum frequency, in Hertz, to be displayed on the vertical axis.

This program makes extensive use of what are referred to as soft keys. These are the keys in the upper left of the keyboard, labeled K0 through K9. The function of these keys can be changed by the program. At any given point in the program, the key function is shown in a corresponding box at the bottom of the screen. However, these keys are enabled only while the program is running.

Once the scale of the data plot has been entered, the computer comes up with the display DATA ACQUISITION and K0 shows COLLECT DATA, while K4 shows REVIEW DISK. If one wishes to collect data, K0 is pressed; if data have already been recorded on a disk and one wishes to see a plot of the data, the disk is put in the left drive and K4 is pressed.

DATA ACQUISITION

Assume that K0 has been pressed. The next thing displayed is

REAL-TIME COLLECTION
PUT DATA DISK IN LEFT DRIVE
INITIALIZE DISK IF REQUIRED

and K0 now reads CONT. PROGRAM and K4 reads INIT. DISK. Put a disk in the left drive, and if it has not been INITIALIZED, press K4; otherwise, press K0.

If K4 is pressed, the disk will be initialized. Once that is complete, press K0 to continue the program. The next thing displayed is

ready to collect

while K0 reads START COLLECT, K1 reads G-DUMP ON/OFF, K2 reads CHG. SCALE, and K4 reads STOP COLLECT. K0 is pressed to start the data collection.

The scale of the plot on the screen can be changed at any time while the program is running by pressing K2. The screen then displays

scale time/freq axes
Enter Screen Width Time (Minutes/Hours), (M/H)

A new time scale is entered, followed by a comma and an M or an H to indicate whether it is minutes or hours. The display then shows

Enter Screen Height Fain., Fmax. (Hz)

The graph is then re-drawn and plotting continues with the new scale. Data that were plotted on the old graph will not be shown; however, they will be stored on the disk. One point should be emphasized: during the time that the computer is waiting for input (e.g., for the new scale values), the frequency counter is not read and no data are obtained.

To terminate the data collection, K4, labeled STOP COLLECT, is pressed.

REVIEW PLOT DISK

If K4, labeled REVIEW DISK, was pressed, the computer will plot the data in a manner similar to what it does for the real time data, except it gets it from the disk. In this case, K0 now reads START PLOT, K1 reads G-DUMP Y/N, K2 reads CHG. SCALE, and K4 reads STOP PLOT. Here, K2 works the same way as has already been described. K4 terminates the plotting.

COPYING SCREEN PLOTS ON THE PRINTER

It is possible to copy, or dump, the screen plots to the HP2671G Printer. (The G indicates graphics capability.) Key 1 has been set up with an on/off toggle capability. The default condition is off. Push it once and it is on; push it again and it is off. The status of the key is displayed in the lower left corner of the screen during both data acquisition and disk plotting. When the dump routine is off, the computer plots across the graph until the right limit is reached; then the graph is erased and a new one started with the starting time equal to the ending time of the previous plot. This is repeated continuously as long as data are taken or disk data plotted.

When key 1 is in the ON position the same thing happens, but before starting a new graph on the screen when the plot reaches the right edge, the computer outputs, or dumps, the plot to the printer. Two sizes of plot are possible: the standard size shown in figure 1, and a double size plot shown in figure 2. To get the larger size plot, type DUMP DEVICE IS 701, EXPANDED

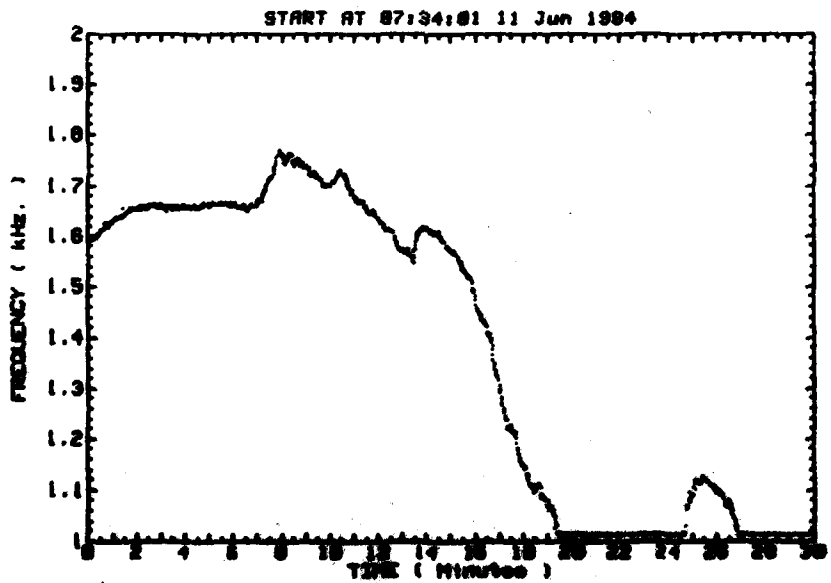
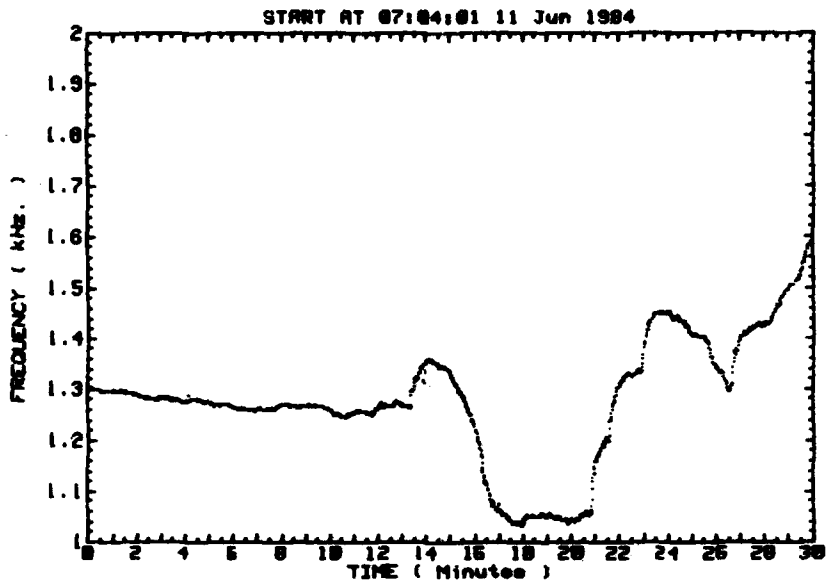


Figure 1. Examples of frequency versus time plots, small graph.

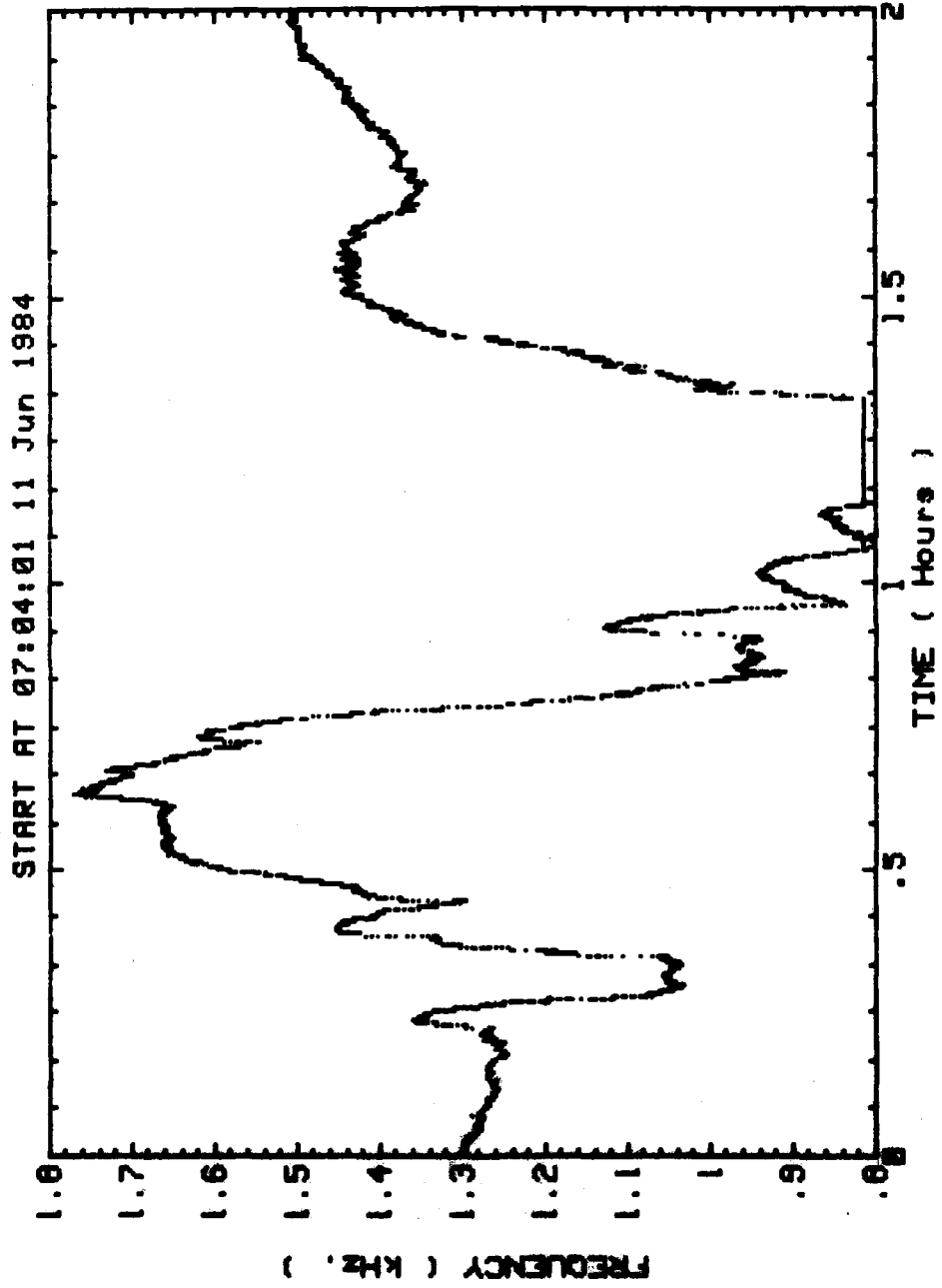


Figure 2. An example of frequency versus time plots, large graph.

and EXECUTE prior to running the program. To get back to the smaller size, type the same thing without the EXPANDED. This option has been programed on key 3. The default is for a small graph. Key 3 alternates between small and large graph.

One thing should be considered when dumping graphics to the printer. It takes about 30 seconds to dump the small graph and about 1 1/2 minutes to dump the large graph. No frequencies are being read during these times. If the time scale on the graph is made short, much data can be missed while the graphs are being dumped. It is recommended that, when dumping graphs to the printer while taking data, the time scale be made quite long, perhaps 4 to 6 hours, to minimize this problem. If greater time resolution is needed it can be obtained by plotting the data from the disk.

SCREEN DISPLAY AND PLOTS

Most of the information displayed on the screen, both for the data acquisition and the disk plots, is fairly self explanatory. The current frequency value is displayed in the upper left corner. To the right of it is shown its number position in the current record. To the right of that is the total number of data samples since recording began. In the upper right, current time is displayed in hours, minutes, and seconds if data are being acquired. If they are being plotted from the disk, it is the time when the measurement was made. In the lower right is displayed the number of the current record, and in the lower left the status of the graphics dump is shown. At the top center of the graph the center frequency is shown. None of these is part of the graph.

The border, scale, and labels of the graph on the screen are plotted in blue. The frequency data are plotted in yellow. If the frequency falls outside the current frequency limits of the graph, the data point is plotted at the limit of the frequency scale in red to indicate that a frequency measurement occurred at this time, but that it was off scale. A replot of the data with a sufficiently large frequency scale would permit these points to be plotted in their correct positions.

As stated earlier, any frequency data that exceed the INTEGER capability of the computer are set to the INTEGER limit before being stored. These values will be plotted at this limit if the frequency scale is large enough. The true frequency values of these points cannot be recovered. These points will, however, give an indication of how much frequency data are falling outside the capabilities of the recording system. If enough data are falling outside the limits and these data are considered to be of interest, it may be advisable to increase the frequency range capabilities of the system even though it will reduce the frequency resolution correspondingly. If most of the data are out of range on one side, it may only be necessary to change the center frequency.

This program has the option of displaying or not displaying the data and graphs. This is accomplished with the use of key 5 and the alpha and graphics keys. If the graph and data are being displayed, push key 5 once and only the graph will display. Push it again and the data display will return. Push the alpha key and the graph will disappear. Push the graphics key and it will

reappear. To completely blank the screen, first push key 5, then the alpha key. To recover the graphics, push the graphics key. To recover the data display, push key 5 again. Key 5 alternates between showing the data display and not showing it.

SECOND PROGRAM

Nearly everything about the first program applies to the second program, listed in Appendix B. However, while the program listed in Appendix A is limited to making frequency measurements, plotting them, and storing them on disk, the second program can be doing other calculations as well. This is because it uses the INTERRUPT capabilities of the system. When the frequency counter has completed a frequency measurement it lets the computer know. The computer accepts the measurement, plots it, and stores it. Between measurements, the computer can be doing other things.

As the program is currently written, the computer sits in an idle loop and displays time and the last frequency measurement, among other things, while waiting for a new measurement. This is redundant information and is used only to show where the computer is between frequency measurements. This idle loop can be replaced with whatever program calculations are of interest.

It should be noted that, even though this program uses an interrupt technique, no data are taken while the program is waiting for input from the keyboard, receiving input from disk, or while outputting to the disk or to the printer. This it has in common with the first program.

Also, this second program has the option of displaying or not displaying data during acquisition. This is accomplished with key 5 and the alpha and graphics keys, as was described for the first program.

SUMMARY

Two programs to acquire frequency data with the use of the HP5345A Frequency Counter have been described. These programs have been written in Basic for the HP9836C computer. The two programs are quite similar, except that the second program uses the interrupt method so that other calculations can be performed between frequency measurements. Both programs read frequency data, plot them on the computer screen, and store them on disk for future processing.

Screen plots of the frequency data can be dumped to the printer, if desired, both when data are being plotted as they are being read and when they are being plotted from the disk. These plots can be either of two sizes.

APPENDIX A

DATA ACQUISITION PROGRAM ONE

```

10 ! *****
20 ! *****
30 ! *
40 ! *          SIGNAL COLLECTION PROGRAM ONE          *
50 ! *
60 ! * Written by:   R.L. KELLOGG           10 February 1984 *
70 ! *
80 ! *          MODIFIED   MRP           19 March 1984   *
90 ! *
100 ! *****
110 !
120 ! SIGNAL COLLECTION is the acquisition program
130 ! for fetching frequency and time data and
140 ! storing it onto a FLOPPY disk.
150 !   Freq data from HP-5345a digital freq counter
160 !   Time data from HP-9836c internal clock
170 !   Stored on left Floppy disk in BDAT format
180 !
190 ! options: (1) screen display and record in real-time
200 !           (2) screen display from Floppy disk record
210 !
220 ! Freq      Frequency data      HP-Freq Counter=702
230 !           Resolution is .1Hz
240 ! Time      Time data           Time from internal clock
250 !           Resolution is 1 second
260 !
270 ! Disk      Freq & Time data are transferred to the disk
280 !            in blocks. It takes about 1 second each 256
290 !            data points for the file transfer. Expect
300 !            I/O to the disk file with minimum data loss.
310 !
320 !            To maximize the disk storage capacity, both
330 !            Time and Frequency are stored as 2-byte
340 !            integer numbers. Frequency is scaled to allow
350 !            .1 Hz resolution. Time storage is more
360 !            problematic. The julian time of the first data
370 !            word of each 256-block is stored in a separate
380 !            file called "time". The actual time stored in
390 !            the 256-block is the number of seconds (+one)
400 !            since the filed julian time. This allows
410 !            any 256-block to range up to 32,766 seconds, or
420 !            about half a day (or about one time/frequency
430 !            intercept every 15 minutes).
440 ! *****
450 OPTION BASE 1
460 DEG
470 DIM Logo$(30)           ! Title string
480 DIM Filename$(30)      ! File name string
490 INTEGER F_data(1:256)  ! Frequency data block
500 INTEGER T_data(1:256) ! Time data block
510 REAL Colors(15,3)      ! Color Map
520 ! *****
530 OUTPUT KBD USING "#,B":255,75 ! Clear screen of alpha
540 CONTROL CRT,5:140       ! Alpha in blue vice green
550 ASSIGN @Hp_freq TO 712 ! HP-FREQUENCY COUNTER
560 REMOTE @Hp_freq
570 ! Bus 700 (select code)
580 ! Add 012 (device address)
590 OUTPUT @Hp_freq:"E8"."E"."G0" ! Enables Remote & Addresses
600 ! to Talk.

```

```

610 ! *****
620 Sys_disk$=":INTERNAL,4,0" ! Right disk for programs
630 Sys_data$=":INTERNAL,4,1" ! Left disk for data
640 Filem$="raw_data"&Sys_data$ ! Raw data file
650 Filet$="time"&Sys_data$ ! Start time file
660 Max_rec=250 ! Raw data file record length
670 ! Disk holds max 270,336 bytes
680 ! IMPORTANT POINT: > ! Utilization as follows:
690 ! > ! 256x(2+2)=1024 bytes/record
700 ! ONE DISK > ! 1024x250 =256,000 bytes/disk
710 ! >
720 ! 18 HRS COLLECTION > ! If the data rate is one
730 ! > ! measurement per second, then
740 ! TIME > ! 256x250 =64000 time/freq pts
750 ! > ! 64000/86400=.74 days=18 hrs
760 !
770 X_edge=9 ! Clip edge of screen
780 Y_edge=8 ! Clip height of screen
790 T_width=5 ! Time width default=5 minutes
800 F_width=200 ! Freq width default=+/- 200 Hz
810 C_band=100000 ! Freq center default=100000 Hz
820 L_pos=1 ! Logo position default
830 D_resl=10 ! 10 gives 1 decimal point
840 ! resolution. This allows an
850 ! INTEGER range of +/- 3.276 kHz.
860 Flimit=32767
870 Dump$="OFF" ! Default, no graphics dump to
880 ! the printer
890 Plt$="N" ! Default, no plot to HP 7470A
900 DUMP DEVICE IS 701
910 Gsize$="SMALL GRAPH"
920 Dsply$="DN"
930 ! *****
940 ! *****
950 !
960 ! BEGIN PROGRAM
970 ! *****
980 Start_screen: !
990 ! INPUT "CENTER FREQUENCY (Hz)".C_band
1000 INPUT "MAX. TIME, (M/H), MIN.,MAX. FREQ. (For plotting)",T_width,Tm$,Fmin,F
max
1010 F_width=(Fmax-Fmin)
1020 ! *****
1030 GOSUB Set_up
1040 ! *****
1050 Begin:!
1060 ! *****
1070 Logo$="DATA ACQUISITION" ! Let operator choose option
1080 GOSUB Background
1090 GOSUB Logo
1100 GOSUB Clr_keys
1110 GOSUB Rt0_keys
1120 GOTO Wait_loop
1130 Kys:////////// Key Assignments //////////
1140 Rt0_keys:!
1150 ON KEY 0 LABEL "COLLECT DATA" GOTO Real_time
1160 ON KEY 4 LABEL "REVIEW DISK" GOTO Plot_disk
1170 RETURN
1180 Rt1_keys:!
1190 ON KEY 0 LABEL "CONT. PROGRAM" GOTO Rt_1b
1200 ON KEY 4 LABEL "INIT. DISK" GOSUB Rt_1a

```

```

1210 RETURN
1220 Rt2_keys: !
1230 ON KEY 0 LABEL "START COLLECT" GOTO Rt_2a
1240 ON KEY 1 LABEL "G_DUMP ON/OFF" GOSUB G_dmp
1250 ON KEY 2 LABEL " CHG. SCALE" GOSUB T_scale
1260 ON KEY 3 LABEL "GRAPH SIZE" GOSUB G_size
1270 ON KEY 4 LABEL "STOP COLLECT" GOTO Rt_2b
1280 ON KEY 5 LABEL "DISPLAY OFF/ON" GOSUB Dsply
1290 RETURN
1300 Rt3_keys: !
1310 ON KEY 0 LABEL "START PLOT" GOTO Rt_3a
1320 ON KEY 1 LABEL "G_DUMP ON/OFF" GOSUB G_dmp
1330 ON KEY 2 LABEL "CHG.SCALE" GOSUB T_scale
1340 ON KEY 3 LABEL "GRAPH SIZE" GOSUB G_size
1350 ON KEY 4 LABEL "STOP PLDT" GOTO Rt_3b
1360 ON KEY 5 LABEL "DISPLAY OFF/ON" GOSUB Dsply
1370 RETURN
1380 Clr_keys: !
1390 ON KEY 0 LABEL "" GOSUB No_opt
1400 ON KEY 1 LABEL "" GOSUB No_opt
1410 ON KEY 2 LABEL "" GOSUB No_opt
1420 ON KEY 3 LABEL "" GOSUB No_opt
1430 ON KEY 4 LABEL "" GOSUB No_opt
1440 ON KEY 5 LABEL "" GOSUB No_opt
1450 ON KEY 6 LABEL "" GOSUB No_opt
1460 ON KEY 7 LABEL "" GOSUB No_opt
1470 ON KEY 8 LABEL "" GOSUB No_opt
1480 ON KEY 9 LABEL "" GOSUB No_opt
1490 RETURN
1500! *****
1510 G_dmp: IF Dump$="OFF" THEN
1520   Dump$="ON"
1530   IF Dsply$="ON" THEN
1540     PRINT TABXY(9,17):"GRAPHICS DUMP IS ON "
1550     PRINT TABXY(30,17):Gsize$
1560   END IF
1570 ELSE
1580   Dump$="OFF"
1590   IF Dsply$="ON" THEN
1600     PRINT TABXY(9,17):"GRAPHICS DUMP IS OFF"
1610     PRINT TABXY(30,17):Gsize$
1620   END IF
1630 END IF
1640 RETURN
1650 !
1660 G_size: !
1670 IF Gsize$="LARGE GRAPH" THEN
1680   DUMP DEVICE IS 701
1690   Gsize$="SMALL GRAPH"
1700   PRINT TABXY(30,17):Gsize$
1710 ELSE
1720   DUMP DEVICE IS 701,EXPANDED
1730   Gsize$="LARGE GRAPH"
1740   PRINT TABXY(30,17):Gsize$
1750 END IF
1760 RETURN
1770 Dsply: !
1780 IF Dsply$="ON" THEN
1790   Dsply$="OFF"
1800   PRINT CHR$(12)

```

```

1810 ELSE
1820   Dpaly$="ON"
1830   GOSUB Rerite
1840 END IF
1850 RETURN
1860! *****
1870 Background:!
1880 CLIP OFF
1890! *****
1900 GCLEAR
1910 AREA PEN Grey ! Grey background
1920 OUTPUT KBD USING "#,B";255,75 ! Erase alphanumeric writing
1930 CLIP ON
1940 RETURN
1950! *****
1960 Logo:!
1970! *****
1980 LORG 4 ! Center logo
1990 PEN Yellow ! Always yellow
2000 CSIZE Large ! Always large letters
2010 FOR I=0 TO .1 STEP .04
2020   MOVE L1_pos+I,L_pos
2030   LABEL Logo$ ! Bold characters
2040 NEXT I
2050 L_pos=1 ! Re-estab logo default position
2060 RETURN
2070! *****
2080 Graf: !!!!!!!!!!!!!!!!! Graphics Routine !!!!!!!!!!!!!!!!!!!!!!!!!!!!!
2090 Screen_grid:
2100! *****
2110 IF Plt$<>"Y" THEN GOSUB Background ! Set up grey background
2120 IF Tm$="M" THEN Tme$=" Minutes "
2130 IF Tm$="H" THEN Tme$=" Hours "
2140 GOSUB Rerite
2150 IF Plt$<>"Y" THEN PEN Ltgrey
2160 IF Plt$="Y" THEN PEN 1
2170 CLIP -X_edge,X_edge,-Y_edge,Y_edge ! Clip graph area to 9x6
2180 IF Plt$<>"Y" THEN PEN Blue
2190 !
2200 !***** SCALE TIME AXIS *****
2210 IF T_width<=10 THEN Xtic=X_edge/(T_width*6)
2220 IF T_width>10 AND T_width<=20 THEN Xtic=X_edge/(T_width*3)
2230 IF T_width>20 THEN Xmaj=2
2240 IF T_width<=20 THEN Xmaj=6
2250 IF T_width>20 THEN Xtic=X_edge/(T_width)
2260 !
2270 !***** SCALE FREQUENCY AXIS *****
2280 Ytic=Y_edge/25
2290 Ymaj=5
2300 Ystep=Ytic*Ymaj
2310 Fstep=F_width*Ystep/(2*Y_edge)
2320 !*****
2330 IF Plt$<>"Y" THEN PEN Ltgrey
2340 IF Plt$="Y" THEN
2350   INPUT "DO YOU WANT TO DRAW A GRID (Y/N)".Grds
2360   IF Grds="Y" THEN
2370     PEN 2
2380     ! GRID Xtic,Ytic
2390     END IF
2400 END IF

```

```

2410 !IF Plt$<>"Y" THEN GRID Xtic,Ytic           ! Draw black grid
2420 IF Plt$<>"Y" THEN PEN Blue
2430 IF Plt$="Y" THEN PEN !
2440 AXES Xtic,Ytic,9,8,Xmaj,Ymaj             ! Draw blue axes
2450 AXES Xtic,Ytic,-9,-8,Xmaj,Ymaj         ! Draw blue axes
2460 CLIP OFF
2470 !+++++++
2480 Xaxis: !+                               ! Label Time Axis
2490 !+++++++
2500 IF T_width<6 THEN Tstep=Xtic*Xmaj
2510 IF T_width>=6 THEN Tstep=2*Xtic*Xmaj
2520 FOR I=0 TO 2*(X_edge+.1) STEP Tstep
2530   CSIZE 3
2540   LORG 6
2550   MOVE -X_edge+I,-8.02
2560   T_x=T_width*I/(2*X_edge)
2570   LABEL USING "K";T_x
2580 NEXT I
2590 MOVE 0,-8.6
2600 LABEL USING "K";"TIME (";Tme$;")"
2610 !+++++++
2620 Yaxis: !+                               ! Label Frequency Axis
2630 !+++++++
2640 F_y=Fmin
2650 FOR J=0 TO 2*Y_edge+.1 STEP Ystep
2660   LORG 8
2670   IF Fmax>=1000 OR Fmin<=(-1000) THEN
2680     Fval=F_y/1000
2690     IF ABS(Fval)<1.E-6 THEN Fval=0
2700   ELSE
2710     Fval=F_y
2720     IF ABS(Fval)<1.E-6 THEN Fval=0
2730   END IF
2740   MOVE -9.1,-Y_edge+J
2750   LABEL USING "K";Fval
2760   F_y=F_y+Fstep
2770 NEXT J
2780 LDIR 90
2790 MOVE -10.47,0
2800 LORG 4
2810 IF Fmax>=1000 OR Fmin<=(-1000) THEN
2820   Fr$="kHz."
2830 ELSE
2840   Fr$="Hz."
2850 END IF
2860 LABEL USING "K";"FREQUENCY (";Fr$;")"
2870 LDIR 0
2880 CLIP ON
2890 RETURN
2900 !
2910 Dd: !////////// Data Display Routine //////////
2920 ! *****
2930 Display_data: !
2940 ! *****
2950 WHILE Grid>=X_edge           ! Check for screen edge
2960   GOSUB Screen_grid
2970   Time_zero=Time           ! Set time ordinate
2980   LORG 4
2990   LDIR 0
3000   CSIZE 3

```

```

3010 MOVE 0.8.15
3020 CLIP OFF
3030 PEN Blue
3040 LABEL USING "K";"START AT ":TIMES(Time_zero);" ":DATES(Time_zero)
3050 CLIP ON
3060 Grid=0
3070 END WHILE
3080 IF Dsply$="ON" THEN
3090 PRINT TABXY(9.5);"                " ! CLEAR DATA
3100 PRINT TABXY(9.5);Freq                ! Display FREQ resolution to "D_resl"
3110 PRINT TABXY(21.5);Icount
3120 PRINT TABXY(26.5);Pcount
3130 PRINT TABXY(65.5);TIMES(Time)        ! DisplayHR:MIN:SEC
3140 PRINT TABXY(68,18);Record_nr
3150 ELSE
3160 PRINT CHR$(12)
3170 END IF
3180 Tpos=Time-Time_zero                    ! Scale Time axis
3190 IF Tm$="M" THEN Xpos=Tpos/30*(X_edge/T_width)
3200 IF Tm$="H" THEN Xpos=Tpos/1800*(X_edge/T_width)
3210 Xpos=Xpos-X_edge
3220 Fpos=Freq-Fmin
3230 Ypos=Fpos*2*Y_edge/(Fmax-Fmin)-Y_edge
3240 Grid=Xpos
3250 IF Grid>X_edge AND Dump$="ON" THEN GOSUB Gdump
3260 IF Grid>X_edge THEN Display_data      ! Oops...right edge run off
3270 IF ABS(Fdata)<Flimit THEN
3280 IF Plt$<>"Y" THEN PEN Yellow
3290 IF Plt$="Y" THEN PEN 1
3300 MOVE Xpos,Ypos                        ! Plot data to screen
3310 RPLLOT 0.0,-1                          ! PEN UP
3320 END IF
3330 IF Freq>Fmax OR Fdata>-Flimit THEN
3340 IF Plt$<>"Y" THEN PEN Red
3350 IF Plt$="Y" THEN PEN 2
3360 MOVE Xpos,Y_edge*.97
3370 RPLLOT 0.0,-1
3380 END IF
3390 IF Freq<-Fmin OR Fdata<-Flimit THEN
3400 IF Plt$<>"Y" THEN PEN Red
3410 IF Plt$="Y" THEN PEN 2
3420 MOVE Xpos,-Y_edge*.97
3430 RPLLOT 0.0,-1
3440 END IF
3450 RETURN
3460 ! *****
3470 T_scale: ! //////////////// Change Graphics Scale ////////////////
3480 ! *****
3490 Logo$="scale time/freq axes"
3500 GOSUB Background
3510 GOSUB Logo
3520 PRINT TABXY(25,15);"Enter Screen Width Time (minutes/hours),(M/H)"
3530 INPUT "Time ",T_width,Tm$
3540 PRINT TABXY(25,16);"Enter Screen Height Fmin., Fmax. Hz)"
3550 INPUT "Freq ",Fmin,Fmax
3560 F_width=Fmax-Fmin
3570 Logo$="continue"
3580 GOSUB Background
3590 L_pos=-.5
3600 GOSUB Set_up

```

```

3610 GOSUB Graf
3620 !GOSUB Logo
3630 LORG 4
3640 LDIR 0
3650 CSIZE 3
3660 MOVE 0,8.15
3670 CLIP OFF
3680 PEN Blue
3690 LABEL USING "K";"START AT ";TIMES(Time_zero);" ";DATES(Time_zero)
3700 CLIP ON
3710 RETURN
3720 ! *****
3730 Color_map:!!!!!!!!!!!!!! Color Map !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
3740 ! *****
3750 DATA 0,0,0, 1,1,1, .2,.2,.2, 1,0,0, 0,1,0, 0,0,1, 1,1,0
3760 DATA .1,.1,.1, 0,1,0, 0,0,1,1,1,0, 0,1,0, 0,1,1, 0,0,1, 1,0,1
3770 ! pen 0 black pen 6 blue pen 11 yellow
3780 ! pen 1 white pen 7 yellow pen 12 green
3790 ! pen 3 grey pen 8 lt grey pen 13 cyan
3800 ! pen 4 red pen 9 green pen 14 blue
3810 ! pen 5 green pen 10 blue pen 15 magenta
3820 ! *****
3830 No_opt:RETURN ! Dummy routine
3840 ! *****
3850 Wait_loop:BEEP 160..! ! Wait Loop
3860 Loop:GOTO Loop
3870 ! !!!!!!!!!!!!!!!!!!!!!/Real-time Data Collection!!!!!!!!!!!!!!!!!!!!
3880 ! *****
3890 Real_time: ! Begin real-time program
3900 ! *****
3910 Logo$="REAL-TIME COLLECTION" ! Set up screen
3920 GOSUB Background
3930 GOSUB Logo
3940 GOSUB Clr_keys
3950 GOSUB Rtl_keys
3960 CSIZE Medium
3970 LORG 4
3980 LABEL "*PUT DATA DISK IN LEFT DRIVE"
3990 LABEL "*INITIALIZE DISK IF REQUIRED"
4000 CSIZE Small
4010 PEN Green ! Change Color
4020 LABEL ""
4030 LABEL "(COLLECTION REPLACES PREVIOUS DATA ON THIS DISK, Record by Record)"
4040 GOTO Wait_loop
4050 ! !!!!!!!!!!!!!!!!!!!!! Initialize Data Disk !!!!!!!!!!!!!!!!!!!!!
4060 ! *****
4070 Rt_la: ! Request initialization
4080 ! *****
4090 CSIZE Medium
4100 LORG 4
4110 LABEL ""
4120 LABEL ""
4130 LABEL "INITIALIZATION STARTED"
4140 INITIALIZE Sys_data$ ! Initialize left data disk
4150 Logo$="continue"
4160 GOSUB Background
4170 GOSUB Logo
4180 BEEP 160..!
4190 RETURN
4200 ! *****

```

```

4210 Rt_lb:                                     ! Establish data & time file
4220 ! *****
4230 ON ERROR GOTO Rt_lc                         ! If error in file name, create it
4240 CREATE BDAT Filemme$,Max_rec,1024         ! If file exists, don't create
4250 CREATE BDAT Filetme$,Max_rec,10          ! Start time file
4260 Rt_lc:OFF ERROR
4270 ASSIGN @D_write TO Filemme$              ! Open path to data file
4280 ASSIGN @T_write TO Filetme$              ! Open path to start time file
4290 Pcount=1                                   ! Total Nr Points
4300 Logo$="ready to collect"
4310 GOSUB Background
4320 GOSUB Logo
4330 GOSUB Clr_keys
4340 GOSUB Rt2_keys
4350 Record_nr=1                               ! Initialize collect parameters
4360 Icount=1
4370 Grid=X_edge                               ! Used by Display Data
4380 GOSUB Wait_loop                           ! Wait for operator to start
4390 ! *****
4400 Rt_2a:                                     ! Start collection
4410 ! *****
4420 !!!!!!!!!!!!!!!!!!!!!!! Get Data from Freq. Counter !!!!!!!!!!!!!!!!!!!!!!!
4430 Collect: !
4440 WHILE Record_nr<=Max_rec                 ! Collect while disk space
4450   WHILE Icount<=256                       ! Collect 256 data points
4460     ENTER @Hp_freq:Frequency              ! Enter data from counter
4470     Time=TIMEDATE                          ! Get time
4480     IF Icount=1 THEN S_time=Time          ! Start time of 256 block
4490     T_data(Icount)=Time-S_time+1         ! Save integer time to seconds
4500     Fdata=INT(D_resl*(Frequency-C_band))
4510     IF Fdata>=Flimit THEN Fdata=Flimit
4520     IF Fdata<=-Flimit THEN Fdata=-Flimit
4530     Freq=Fdata/D_resl
4540     F_data(Icount)=Freq                   ! Save freq to "D_resl" resolution
4550     GOSUB Display_data                    ! Data to screen
4560     Icount=Icount+1                       ! Up data counter
4570     Pcount=Pcount+1
4580   END WHILE                               ! Datum array now full
4590                                           ! Now have 256 data points...
4600                                           ! Put out to disk
4610   OUTPUT @D_write,Record_nr;T_data(*),F_data(*)
4620   OUTPUT @T_write,Record_nr;S_time
4630   Record_nr=Record_nr+1
4640   Icount=1                               ! Set data counter
4650 END WHILE                                 ! Done--filled disk file
4660 ! *****
4670 Rt_2b:                                     ! Terminate collection
4680 ! *****
4690 Logo$="collection terminated"
4700 L_pos=-7                                  ! Position logo at bottom
4710 GOSUB Logo                                ! not to obscure data
4720 IF Record_nr>Max_rec THEN Rt_2c
4730 FOR I=Icount TO 256
4740   T_data(I)=0                               ! Null Time
4750   F_data(I)=0                               ! Null Frequency
4760 NEXT I
4770                                           ! Now have 256 data points
4780                                           ! Final out to disk
4790 OUTPUT @D_write,Record_nr;T_data(*),F_data(*)
4800 OUTPUT @T_write,Record_nr;S_time

```

```

4810 Rt_2c: !
4820 ASSIGN @D_write TO *           ! Close Files
4830 ASSIGN @T_write TO *
4840 GOSUB Clr_keys                 ! Loop back to screen options
4850 GOSUB Rt0_keys
4860 GOTO Wait_loop
4870 !
4880 Pd:!!!!!!!!!!!!!!!!!!!! Plot Data from Disk !!!!!!!!!!!!!!!!!!!!!!!
4890 ! *****
4900 Plot_disk: !
4910 ! *****
4920 INPUT "OUTPUT TO PLOTTER (Y/N)",Plt$
4930 Logo$="PLOT DISK DATA"       ! time & freq scaling before
4940 GOSUB Clr_keys
4950 IF Plt$="Y" THEN GOSUB Hp_g1
4960 IF Plt$<>"Y" THEN GOSUB Set_up
4970 IF Plt$<>"Y" THEN GOSUB Logo   ! displaying data from disk
4980 GOSUB Rt3_keys
4990 GOTO Wait_loop
5000 ! *****
5010 Rt_3a: !
5020 ! *****
5030 ASSIGN @D_path TO Filem$      ! Open Raw-data File
5040 ASSIGN @T_path TO Filet$      ! Open Time file
5050 Pcount=1                      ! Total # points counter
5060 Grid=X_edge
5070 FOR Record_nr=1 TO Max_rec
5080                                     ! Read block of data from disk
5090   ENTER @D_path,Record_nr;T_data(=),F_data(=)
5100   IF Record_nr=1 THEN
5110     ENTER @T_path,Record_nr;T_first
5120   END IF
5130   ENTER @T_path,Record_nr;S_time
5140   IF T_first>S_time THEN Rt_3b
5150   Icount=1                      ! Set data in block counter
5160   WHILE Icount<=256
5170     IF T_data(Icount)=0 THEN Rt_3b ! End if zero (no data)
5180     Time=T_data(Icount)+S_time-1 ! Reconstruct Julian Time
5190     Fdata=F_data(Icount)
5200     Freq=Fdata/D_res1
5210     GOSUB Display_data          ! Display data to screen
5220     Icount=Icount+1            ! Up data counter
5230     Pcount=Pcount+1
5240   END WHILE
5250 NEXT Record_nr                ! Loop until done
5260 ! *****
5270 Rt_3b: !
5280 ! *****
5290 Logo$="plot completed"
5300 L_pos=0                       ! Put logo at side of screen
5310 LT_pos=10.1
5320 LDIR 90
5330 CLIP OFF
5340 IF Plt$<>"Y" THEN GOSUB Logo   ! not to obscure data
5350 L1_pos=0
5360 LDIR 0
5370 CLIP ON
5380 ASSIGN @D_path TO *
5390 ASSIGN @T_path TO *           ! Close files
5400 GOSUB Clr_keys

```

```

5410 GOSUB Rt0_keys
5420 GOTO Wait_loop                ! Loop back and await operator
5430                                ! command
5440 Set_up: !!!!!!!!!!!!! Initial Setup !!!!!!!!!!!!!
5450 GINIT                          ! Initialize graphics
5460 GCLEAR                          ! Clear screen of graphics
5470 PLOTTER IS CRT,"INTERNAL";COLOR MAP ! Use screen as plotter
5480 RESTORE Color_map              ! Data pointer for read colors
5490 READ Colors(*)                 ! Enter new color map
5500 SET PEN 1 INTENSITY Colors(*) ! Establish new colors
5510 Large=6                         ! Large letters
5520 Medium=4                       ! Medium letters
5530 Small=3                        ! Small letters
5540 Yellow=7                       ! Yellow Pen
5550 Ltgrey=8                       ! Ltgrey Pen
5560 Green=9                        ! Green Pen
5570 Blue=13                        ! Blue Pen
5580 Grey=3                         ! Grey Area Pen
5590 Red=4                          ! Red Pen
5600 GRAPHICS ON
5610 Xrange=100*MAX(1,RATIO)
5620 Yrange=100*MAX(1,1/RATIO)
5630 VIEWPORT .05*Xrange,.95*Xrange,.08*Yrange,.98*Yrange
5640 WINDOW -10.5,10.5,-10,10      ! Set initial screen window
5650 RETURN
5660                                !
5670 Hp_gl:PLOTTER IS 705,"HPGL"
5680 RETURN
5690 Gdump: !!!!!!!!!!!!! Dump Graphics to Printer !!!!!!!!!!!!!
5700 DUMP GRAPHICS #701
5710 RETURN
5720 Rerite: !
5730 IF Daply$="ON" THEN
5740 PRINT TABXY(25,1):"Center Frequency is ";C_band/1000;" kHz"
5750 PRINT TABXY(9,4):"FREQUENCY Icount Dcount"! Label screen
5760 PRINT TABXY(67,4):"TIME"
5770 IF Dump$="OFF" THEN
5780 PRINT TABXY(9,17):"GRAPHICS DUMP IS OFF"
5790 PRINT TABXY(30,17):Gsize$
5800 ELSE
5810 PRINT TABXY(9,17):"GRAPHICS DUMP IS ON "
5820 PRINT TABXY(30,17):Gsize$
5830 END IF
5840 PRINT TABXY(67,17):"RECORD"
5850 END IF
5860 RETURN
5870 END

```

APPENDIX B
DATA ACQUISITION PROGRAM TWO

```

10 ! .....
20 ! .....
30 ! .....
40 ! .....
50 ! .....
60 ! .....
70 ! .....
80 ! .....
90 ! .....
100 ! .....
110 ! .....
120 ! SIGNAL COLLECTION is the acquisition program
130 ! for fetching frequency and time data and
140 ! storing it onto a FLOPPY disk.
150 !   Freq data from HP-5345a digital freq counter
160 !   Time data from HP-9836c internal clock
170 !   Stored on left Floppy disk in BDAT format
180 ! .....
190 ! options: (1) screen display and record in real-time
200 !           (2) screen display from Floppy disk record
210 ! .....
220 ! Freq   Frequency data   HP-Freq Counter-702
230 !                               Resolution is .1Hz
240 ! Time   Time data       Time from internal clock
250 !                               Resolution is 1 second
260 ! .....
270 ! Disk   Freq & Time data are transferred to the disk
280 !         in blocks. It takes about 1 second each 256
290 !         data points for the file transfer. Expect
300 !         I/O to the disk file with minimum data loss.
310 ! .....
320 !         To maximize the disk storage capacity, both
330 !         Time and Frequency are stored as 2-byte
340 !         integer numbers. Frequency is scaled to allow
350 !         .1 Hz resolution. Time storage is more
360 !         problematic. The julian time of the first data
370 !         word of each 256-block is stored in a separate
380 !         file called "time". The actual time stored in
390 !         the 256-block is the number of seconds (+one)
400 !         since the filed julian time. This allows
410 !         any 256-block to range up to 32,766 seconds, or
420 !         about half a day (or about one time/frequency
430 !         intercept every 15 minutes).
440 ! .....
450 !         Can output graphs to either the printer or
460 !         the HP 7470A Plotter.
470 ! .....
480 OPTION BASE 1
490 DEG
500 DIM Logo$(30) ! Title string
510 DIM Filem$(30) ! File name string
520 INTEGER F_data(1:256) ! Frequency data block
530 INTEGER T_data(1:256) ! Time data block
540 REAL Colors(15,3) ! Color Map
550 ! .....
560 OUTPUT KBD USING "#,B";255.75 ! Clear screen of alpha
570 CONTROL CRT,5;140 ! Alpha in blue vice green
580 RESET 7
590 ASSIGN @hp_freq TO 712 ! HP-FREQUENCY COUNTER
600 REMOTE @hp_freq ! Bus 700 (select code)

```

```

610 ON INTR 7,14 GOSUB Dread          ! Add 012 (device address)
620                                  ! Frequency counter works on an
630                                  ! interrupt basis.
640 ! *****
650 Sys_disks=":INTERNAL,4,0"        ! Right disk for programs
660 Sys_data$=":INTERNAL,4,1"        ! Left disk for data
670 Filemme$="raw_data"&Sys_data$    ! Raw data file
680 Filetme$="time"&Sys_data$        ! Start time file
690 Max_rec=250                      ! Raw data file record length
700                                  ! Disk holds max 270,336 bytes
710                                  ! Utilization as follows:
720 ! IMPORTANT POINT: >            ! 256x(2+2)=1024 bytes/record
730 ! ONE DISK >                    ! 1024x250 =256,000 bytes/disk
740 ! >
750 ! 18 HRS COLLECTION >         ! If the data rate is one
760 ! >                               ! measurement per second, then
770 ! TIME >                         ! 256x250 =64000 time/freq pts
780                                  ! 64000/86400=.74 days=18 hrs
790 !
800 X_edge=9                          ! Clip edge of screen
810 Y_edge=8                          ! Clip height of screen
820 T_width=5                         ! Time width default=5 minutes
830 F_width=200                       ! Freq width default+/- 200 Hz
840 C_band=100000                    ! Freq center default=100000 Hz
850 L_pos=1                           ! Logo position default
860 D_resl=10                         ! 10 gives 1 decimal point
870                                  ! resolution. This allows an
880                                  ! INTEGER range of +/- 3.276 kHz.
890 Flimit=32767                     ! Prevents error stop if freq.
900                                  ! exceeds integer limit.
910 Dump$="OFF"                       ! Default No printer dump of Graph
920 Plt$="N"                          ! Default No plot to HP 7470A
930 Gsize$="SMALL GRAPH"
940 DUMP DEVICE IS 701
950 Dsply$="ON"
960 ! *****
970 ! *****
980 !
990 !!!!!!!!!!!!!!!!!!!!!!! BEGIN PROGRAM !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
1000 ! *****
1010 Start_screen:
1020 INPUT "MAX. TIME.(M/H), MIN.,MAX. FREQ. (For plotting)",Tm$,Fmin,F
max
1030 F_width=(Fmax-Fmin)
1040 ! *****
1050 GOSUB Set_up
1060 ! *****
1070 Begin:
1080 ! *****
1090 Logo$="DATA ACQUISITION"          ! Let operator choose option
1100 GOSUB Background
1110 GOSUB Logo
1120 GOSUB Clr_keys
1130 GOSUB Rto_keys
1140 GOTO Wait_loop
1150 Kys:!!!!!!!!!!!!!!!!!!!!!!Key Assignments !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
1160 Rto_keys:
1170 ON KEY 0 LABEL "COLLECT DATA" GOTO Real_time
1180 ON KEY 4 LABEL "REVIEW DISK" GOTO Plot_disk
1190 RETURN
1200 Rtl_keys:

```

```

1210 ON KEY 0 LABEL "CONT. PROGRAM" GOTO Rt_1b
1220 ON KEY 4 LABEL "INIT. DISK" GOSUB Rt_1a
1230 RETURN
1240 Rt2_keys:
1250 ON KEY 0 LABEL "START COLLECT" GOTO Rt_2a
1260 ON KEY 1 LABEL "G_DUMP ON/OFF" GOSUB G_dmp
1270 ON KEY 2 LABEL "CHG. SCALE" GOSUB T_scale
1280 ON KEY 3 LABEL "GRAPH SIZE" GOSUB G_size
1290 ON KEY 4 LABEL "STOP COLLECT" GOTO Rt_2b
1300 ON KEY 5 LABEL "DISPLAY OFF/ON" GOSUB Dsply
1310 RETURN
1320 Rt3_keys:
1330 ON KEY 0 LABEL "START PLOT" GOTO Rt_3a
1340 ON KEY 1 LABEL "G_DUMP ON/OFF" GOSUB G_dmp
1350 ON KEY 2 LABEL "CHG. SCALE" GOSUB T_scale
1360 ON KEY 3 LABEL "GRAPH SIZE" GOSUB G_size
1370 ON KEY 4 LABEL "STOP PLOT" GOTO Rt_3b
1380 ON KEY 5 LABEL "DISPLAY OFF/ON" GOSUB Dsply
1390 RETURN
1400 Clr_keys:
1410 ON KEY 0 LABEL "" GOSUB No_opt
1420 ON KEY 1 LABEL "" GOSUB No_opt
1430 ON KEY 2 LABEL "" GOSUB No_opt
1440 ON KEY 3 LABEL "" GOSUB No_opt
1450 ON KEY 4 LABEL "" GOSUB No_opt
1460 ON KEY 5 LABEL "" GOSUB No_opt
1470 ON KEY 6 LABEL "" GOSUB No_opt
1480 ON KEY 7 LABEL "" GOSUB No_opt
1490 ON KEY 8 LABEL "" GOSUB No_opt
1500 ON KEY 9 LABEL "" GOSUB No_opt
1510 RETURN
1520! .....
1530 G_dmp:IF Dmp$="ON" THEN
1540     IF Dsply$="ON" THEN PRINT TABXY(9,17):"GRAPHICS DUMP IS OFF"
1550     Dmp$="OFF"
1560     IF Dsply$="ON" THEN PRINT TABXY(30,17):Gsize$
1570     ELSE
1580     IF Dsply$="ON" THEN PRINT TABXY(9,17):"GRAPHICS DUMP IS ON "
1590     Dmp$="ON"
1600     IF Dsply$="ON" THEN PRINT TABXY(30,17):Gsize$
1610     END IF
1620     RETURN
1630     !
1640     G_size:
1650     IF Gsize$="LARGE GRAPH" THEN
1660     DUMP DEVICE IS 701
1670     Gsize$="SMALL GRAPH"
1680     IF Dsply$="ON" THEN PRINT TABXY(30,17):Gsize$
1690     ELSE
1700     DUMP DEVICE IS 701,EXPANDED
1710     Gsize$="LARGE GRAPH"
1720     IF Dsply$="ON" THEN PRINT TABXY(30,17):Gsize$
1730     END IF
1740     RETURN
1750     Dsply:
1760     IF Dsply$="ON" THEN
1770     Dsply$="OFF"
1780     PRINT CHR$(12)
1790     ELSE
1800     Dsply$="ON"

```

```

1810 GOSUB Rerite
1820 END IF
1830 RETURN
1840! *****
1850 Background:!
1860 CLIP OFF
1870! *****
1880 GCLEAR
1890 AREA PEN Grey ! Grey background
1900 OUTPUT KBD USING "#.B":255,75 ! Erase alphanumeric writing
1910 MOVE -10.5,-10
1920 CLIP ON
1930 RETURN
1940! *****
1950 Logo:!
1960! *****
1970 LORG 4 ! Center logo
1980 PEN Yellow ! Always yellow
1990 CSIZE Large ! Always large letters
2000 FOR I=0 TO .1 STEP .04
2010 MOVE L_pos+I,L_pos
2020 LABEL Logo$ ! Bold characters
2030 NEXT I
2040 L_pos=! ! Re-estab logo default position
2050 RETURN
2060! *****
2070 Graf:!!!!!!!!!!!!!!!!!!!! Graphics Routine !!!!!!!!!!!!!!!!!!!!!!!!!!!!!
2080 Screen_grid:!
2090! *****
2100 IF P1ts<>"Y" THEN GOSUB Background ! Set up grey background
2110 IF Tms="M" THEN Tms=" Minutes "
2120 IF Tms="H" THEN Tms=" Hours "
2130 IF Dp1ys="ON" THEN GOSUB Rerite
2140 IF P1ts<>"Y" THEN PEN Ltgrey
2150 IF P1ts="Y" THEN PEN 1
2160 CLIP -X_edge,X_edge,-Y_edge,Y_edge ! Clip graph area to 9x8
2170 IF P1ts<>"Y" THEN PEN Blue
2180 !
2190 !***** SCALE TIME AXIS *****
2200 IF T_width<=10 THEN Xtic=X_edge/(T_width*6)
2210 IF T_width>10 AND T_width<=20 THEN Xtic=X_edge/(T_width*3)
2220 IF T_width>20 THEN Xmaj=2
2230 IF T_width<=20 THEN Xmaj=6
2240 IF T_width>20 THEN Xtic=X_edge/(T_width)
2250 !
2260 !***** SCALE FREQUENCY AXIS *****
2270 Ytic=Y_edge/25
2280 Ymaj=5
2290 Ystep=Ytic*Ymaj
2300 Fstep=F_width*Ystep/(2*Y_edge)
2310 !*****
2320 IF P1ts="Y" THEN
2330 INPUT "DO YOU WANT TO DRAW A GRID (Y/N)",Grd$
2340 IF Grd$="Y" THEN
2350 PEN 2
2360 GRID Xtic,Ytic ! Draw Grid
2370 END IF
2380 END IF
2390 IF P1ts<>"Y" THEN PEN Blue
2400 IF P1ts="Y" THEN PEN 1

```

```

2410 AXES Xtic,Ytic,9,8,Xmaj,Ymaj           ! Draw blue axes
2420 AXES Xtic,Ytic,-9,-8,Xmaj,Ymaj       ! Draw blue axes
2430 CLIP OFF
2440 !+++++++
2450 Xaxis: !+                               ! Label Time Axis
2460 !+++++++
2470 PEN Blue
2480 IF T_width<6 THEN Tstep=Xtic*Xmaj
2490 IF T_width>=6 THEN Tstep=2*Xtic*Xmaj
2500 FOR I=0 TO 2*(X_edge+.1) STEP Tstep
2510   CSIZE 3
2520   LORG 6
2530   MOVE -X_edge+I,-8.02
2540   T_x=T_width*I/(2*X_edge)
2550   LABEL USING "K":T_x
2560 NEXT I
2570 MOVE 0,-8.6
2580 LABEL USING "K": "TIME (":Tme$:" )"
2590 !+++++++
2600 Yaxis: !+                               ! Label Frequency Axis
2610 !+++++++
2620 PEN Blue
2630 F_y=Fmin
2640 FOR J=0 TO 2*Y_edge+.1 STEP Ystep
2650   LORG 8
2660   IF Fmax>=1000 OR Fmin<=(-1000) THEN
2670     Fval=F_y/1000
2680     IF ABS(Fval)<1.E-6 THEN Fval=0
2690     ELSE
2700       Fval=F_y
2710       IF ABS(Fval)<1.E-6 THEN Fval=0
2720     END IF
2730     MOVE -9.1,-Y_edge+J
2740     LABEL USING "K":Fval
2750     F_y=F_y+Fstep
2760 NEXT J
2770 LDIR 90
2780 MOVE -10.47,0
2790 LORG 4
2800 IF Fmax>=1000 OR Fmin<=(-1000) THEN
2810   Fr$="kHz."
2820   !SE
2830   Fr$="Hz."
2840 END IF
2850 LABEL USING "K": "FREQUENCY ( ":Fr$:" )"
2860 LDIR 0
2870 CLIP ON
2880 RETURN
2890 Dd: !////////// Display Data //////////
2900 ! *****
2910 Display_data: !
2920 ! *****
2930 WHILE Grid>=X_edge           ! Check for screen edge
2940   GOSUB Screen_grid
2950   Time_zero=Time             ! Set time ordinate
2960   CLIP OFF
2970   PEN Blue
2980   LORG 4
2990   MOVE 0,0.15
3000   LABEL USING "K": "START AT ":TIME$(Time_zero):" ":DATE$(Time_zero)

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3010 CLIP ON
3020 Grid=0
3030 END WHILE
3040 IF Dsply$="ON" THEN PRINT TABXY(9,5);" " ! CLEAR DATA
3050 IF Dsply$="ON" THEN PRINT TABXY(9,5);Freq ! Display FREQ resolution
3060 ! to 'D_resl'
3070 IF Dsply$="ON" THEN PRINT TABXY(21,5);Icount
3080 IF Dsply$="ON" THEN PRINT TABXY(26,5);Pcount
3090 IF Dsply$="ON" THEN PRINT TABXY(65,5);TIMES(Time) ! Display HR:MIN:SEC
3100 IF Dsply$="ON" THEN PRINT TABXY(68,18);Record_nr
3110 Tpos=Time-Time_zero ! Scale Time axis
3120 IF Ts$="M" THEN Xpos=Tpos/30*(X_edge/T_width)
3130 IF Ts$="H" THEN Xpos=Tpos/1800*(X_edge/T_width)
3140 Xpos=Xpos-X_edge
3150 Fpos=Freq-Fmin
3160 Ypos=Fpos*2*Y_edge/(Fmax-Fmin)-Y_edge
3170 Grid=Xpos
3180 IF Grid>X_edge AND Dumps="ON" THEN GOSUB Gdump ! Output plot to printer
3190 IF Grid>X_edge THEN Display_data ! Oops...right edge run off
3200 IF ABS(Fdata)<Flimit THEN
3210 IF Plt$<"Y" THEN PEN Yellow
3220 IF Plt$="Y" THEN PEN 1
3230 MOVE Xpos,Ypos ! Plot data to screen
3240 RPLLOT 0,0,-1 ! PEN UP
3250 END IF
3260 IF Freq>Fmax OR Fdata>Flimit THEN
3270 IF Plt$<"Y" THEN PEN Red
3280 IF Plt$="Y" THEN PEN 2
3290 MOVE Xpos,Y_edge*.97
3300 RPLLOT 0,0,-1
3310 END IF
3320 IF Freq<Fmin OR Fdata<-Flimit THEN
3330 IF Plt$<"Y" THEN PEN Red
3340 IF Plt$="Y" THEN PEN 2
3350 MOVE Xpos,-Y_edge*.97
3360 RPLLOT 0,0,-1
3370 END IF
3380 RETURN
3390 !!!!!!!!!!!!!!!!!!!!! Change Graph Scale !!!!!!!!!!!!!!!!!!!!!!!!!!!!!
3400 ! *****
3410 T_scale: ! ! Change screen scale factors
3420 ! ***** for graphics.
3430 DISABLE INTR 7
3440 Logo$="scale time/freq axes"
3450 GOSUB Background
3460 GOSUB Logo
3470 PRINT TABXY(25,15);"Enter Screen Width Time (minutes/hours).(M/H)"
3480 INPUT "Time ",T_width,Ts
3490 PRINT TABXY(25,16);"Enter Screen Height Fmin., Fmax. Hz)"
3500 INPUT "Freq ",Fmin,Fmax
3510 F_width=Fmax-Fmin
3520 Logo$="continue"
3530 GOSUB Background
3540 L_pos=-.5
3550 GOSUB Set_up
3560 PEN Blue
3570 GOSUB Graf
3580 CLIP OFF
3590 LORG 4
3600 MOVE 0,8.15

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3610 LABEL USING "K": "START AT ":TIMES(Time_zero):" ":DATES(Time_zero)
3620 CLIP ON
3630 ENABLE INTR 7
3640 RETURN
3650 !!!!!!!!!!!!!!!!!!!!!!!!!!!!! Color Map !!!!!!!!!!!!!!!!!!!!!!!!!!!!!
3660 ! *****
3670 Color_map: !
3680 ! *****
3690 DATA 0,0,0, 1,1,1, .2,.2,.2, 1,0,0, 0,1,0, 0,0,1, 1,1,0
3700 DATA .1,.1,.1, 0,1,0, 0,0,1,1,1,0, 0,1,0, 0,1,1, 0,0,1, 1,0,1
3710 ! pen 0 black pen 6 blue pen 11 yellow
3720 ! pen 1 white pen 7 yellow pen 12 green
3730 ! pen 3 grey pen 8 lt grey pen 13 cyan
3740 ! pen 4 red pen 9 green pen 14 blue
3750 ! pen 5 green pen 10 blue pen 15 magenta
3760 ! *****
3770 No_opt:RETURN ! Dummy routine
3780 ! *****
3790 Wait_loop:BEEP 160,.05 ! Wait Loop
3800 Loop:DISABLE INTR 7
3810 GOTO Loop
3820 ! *****
3830 Real_time: !!!!!!!!!!!!!!! Begin real-time program !!!!!!!!!!!!!!!
3840 ! *****
3850 Logo$="REAL-TIME COLLECTION" ! Set up screen
3860 GOSUB Background
3870 GOSUB Logo
3880 GOSUB Clr_keys
3890 GOSUB Rtl_keys
3900 CSIZE Medium
3910 LORG 4
3920 LABEL "+PUT DATA DISK IN LEFT DRIVE"
3930 LABEL "+INITIALIZE DISK IF REQUIRED"
3940 CSIZE Small
3950 PEN Green ! Change Color
3960 LABEL ""
3970 LABEL "(COLLECTION replaces previous DATA on this DISK: Record by Record)"
3980 GOTO Wait_loop
3990 !!!!!!!!!!!!!!! Initialize Data Disk !!!!!!!!!!!!!!!
4000 ! *****
4010 Rt_1a: ! Request initialization
4020 ! *****
4030 CSIZE Medium
4040 LORG 4
4050 LABEL ""
4060 LABEL ""
4070 LABEL "INITIALIZATION STARTED"
4080 INITIALIZE Sys_data$ ! Initialize left data disk
4090 Logo$="continue"
4100 GOSUB Background
4110 GOSUB Logo
4120 BEEP 160,.05
4130 RETURN
4140 ! *****
4150 Rt_1b: ! Establish data & time file
4160 ! *****
4170 ON ERROR GOTO Rt_1c ! If error in file name, create it
4180 CREATE BDAT Filename$,Max_rec,1024 ! If file exists, don't create
4190 CREATE BDAT Filename$,Max_rec,10 ! Start time file
4200 Rt_1c:OFF ERROR

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4210 ASSIGN @D_write TO Filemes$           ! Open path to data file
4220 ASSIGN @T_write TO Filetmes$        ! Open path to start time file
4230 Pcount=0                             ! Total Nr Points
4240 Logo$="ready to collect"
4250 GOSUB Background
4260 GOSUB Logo
4270 GOSUB Clr_keys
4280 GOSUB Rt2_keys
4290 Record_nr=1                          ! Initialize collect parameters
4300 Icount=0
4310 Grid=X_edge                          ! Used by Display Data
4320 GOSUB Wait_loop                      ! Wait for operator to start
4330 ! *****
4340 Rt_2a:                               ! Start collection
4350 ! *****
4360 Collect: !
4370 OUTPUT @Hp_freq:"E8","E:","G0" ! Remote Enable & Addresses Counter to talk
4380 ENABLE INTR 7:2
4390 Idler: !!!!!!!!!!!!!!! Waiting for Frequency Counter Interrupt !!!!!!!!!!!!!!!
4400 !
4410 IF Dsply$="ON" THEN
4420   DISP USING Fmta:DATE$(TIMEDATE)," ",TIME$(TIMEDATE),Freq,Icount,Pcount,R
ecord_nr
4430 ELSE
4440   DISP ""
4450 END IF
4460 GOTO Idler
4470 Fmta:IMAGE 7X,K,K,K,X,MDDDD.D,3X,DDD,3X,DDDDD.3X,DDD
4480 !
4490 !!!!!!!!!!!!!!! Terminate Data Collection !!!!!!!!!!!!!!!
4500 ! *****
4510 Rt_2b: !
4520 ! *****
4530 Logo$="collection terminated"
4540 L_pos=-7                             ! Position logo at bottom
4550 GOSUB Logo                          ! not to obscure data
4560 IF Record_nr>Max_rec THEN Rt_2c
4570 FOR I=Icount TO 256
4580   T_data(I)=0                       ! Null Time
4590   F_data(I)=0                       ! Null Frequency
4600 NEXT I
4610                                     ! Now have 256 data points
4620                                     ! Final out to disk
4630 OUTPUT @D_write,Record_nr:T_data(*),F_data(*)
4640 OUTPUT @T_write,Record_nr:S_time
4650 Rt_2c: !
4660 ASSIGN @D_write TO *                ! Close Files
4670 ASSIGN @T_write TO *
4680 GOSUB Clr_keys                      ! Loop back to screen options
4690 GOSUB Rt0_keys
4700 GOTO Wait_loop
4710 Pd:!!!!!!!!!!!!!! Plot disk data !!!!!!!!!!!!!!!
4720 ! *****
4730 Plot_disk: !
4740 ! *****
4750 INPUT "OUTPUT TO PLOTTER (Y/N)",P1ts ! Plot on 7470A Plotter?
4760 Logo$="PLOT DISK DATA"             ! time&freq scaling before
4770 GOSUB Clr_keys
4780 IF P1ts="Y" THEN GOSUB Hp_gl
4790 IF P1ts<>"Y" THEN GOSUB Set_up
4800 IF P1ts<>"Y" THEN GOSUB Logo        ! displaying data from disk

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4810 GOSUB Rt3_keys
4820 GOTO Wait_loop
4830 ! *****
4840 Rt_3a: !
4850 ! *****
4860 ASSIGN @D_path TO Filem$          ! Open Raw-data File
4870 ASSIGN @T_path TO Filetme$      ! Open Time file
4880 Pcount=0                          ! Total # points counter
4890 Grid=X_edge
4900 FOR Record_nr=1 TO Max_rec
4910                                     ! Read block of data from disk
4920   ENTER @D_path,Record_nr:T_data(*),F_data(*)
4930   IF Record_nr=1 THEN
4940     ENTER @T_path,Record_nr:T_first
4950   END IF
4960   ENTER @T_path,Record_nr:S_time
4970   IF T_first>S_time THEN Rt_3b
4980   Icount=0                          ! Set data in block counter
4990   WHILE Icount<256
5000     Icount=Icount+1                ! Up data counter
5010     Pcount=Pcount+1
5020     IF T_data(Icount)=0 THEN Rt_3b ! End if zero (no data)
5030     Time=T_data(Icount)+S_time-1 ! Reconstruct Julian Time
5040     Fdata=F_data(Icount)
5050     Freq=Fdata/D_resi
5060     GOSUB Display_data            ! Display data to screen
5070   END WHILE
5080   NEXT Record_nr                 ! Loop until done
5090 ! *****
5100 Rt_3b: !
5110 ! *****
5120 Logo$="plot completed"
5130 L_pos=0                          ! Put logo at side of screen
5140 L1_pos=10.1                       ! so as not to obscure data
5150 LDIR 90
5160 CLIP OFF
5170 IF Plt$("<>")="Y" THEN GOSUB Logo
5180 L1_pos=0
5190 LDIR 0
5200 CLIP ON
5210 ASSIGN @D_path TO *
5220 ASSIGN @T_path TO *              ! Close files
5230 GOSUB Clr_keys
5240 GOSUB Rt0_keys
5250 GOTO Wait_loop
5260                                     ! Loop back and await operator
5270 Set_up: !!!!!!!!!!!!!!!!!!!!! Initial Setup !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
5280 GINIT                             ! Initialize graphics
5290 GCLEAR                             ! Clear screen of graphics
5300 PLOTTER IS CRT,"INTERNAL";COLOR MAP ! Use screen as plotter
5310 RESTORE Color_map                 ! Data pointer for read colors
5320 READ Colors(*)                   ! Enter new color map
5330 SET PEN 1 INTENSITY Colors(*)    ! Establish new colors
5340 Large=6                          ! Large letters
5350 Medium=4                          ! Medium letters
5360 Small=3                          ! Small letters
5370 Yellow=7                          ! Yellow Pen
5380 Ltgrey=8                          ! Ltgrey Pen
5390 Green=9                          ! Green Pen
5400 Blue=13                          ! Blue Pen

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5410 Grey=3 ! Grey Area Pen
5420 Red=4 ! Red Pen
5430 GRAPHICS ON
5440 Xrange=100*MAX(1,RATIO)
5450 Yrange=100*MAX(1,1/RATIO)
5460 VIEWPORT .05*Xrange,.95*Xrange,.08*Yrange,.98*Yrange
5470 WINDOW -10.5,10.5,-10,10 ! Set initial screen window
5480 RETURN
5490 ! ////////////////////////////////// Assign Graphics to HP 7470A Plotter //////////////////////////////////
5500 Hp_gl:PLOTTER IS 705."HPGL"
5510 RETURN
5520 Dread: !//////////////////////////////// Read frequency counter //////////////////////////////////
5530 Icount=Icount+1
5540 Pcount=Pcount+1
5550 ENTER @Hp_freq;Frequency ! Enter data from counter
5560 Time=TIMEDATE ! Get time
5570 IF Icount=1 THEN S_time=Time ! Start time of 256 block
5580 T_data(Icount)=Time-S_time+1 ! Save integer time to seconds
5590 Fdata=INT(D_resl*(Frequency-C_band))
5600 IF Fdata>Flimit THEN Fdata=Flimit
5610 IF Fdata<=-Flimit THEN Fdata=-Flimit
5620 Freq=Fdata/D_resl
5630 F_data(Icount)=Fdata ! Save freq to "D_resl" resolution
5640 GOSUB Display_data ! Data to screen
5650 IF Icount>=256 THEN GOSUB Dstore ! Ub data counter
5660 ENABLE INTR 7
5670 TRIGGER @Hp_freq
5680 RETURN
5690 ! Now have 256 data points...
5700 ! Put out to disk
5710 Dstore: !//////////////////////////////// Output Data to Disk //////////////////////////////////
5720 !
5730 OUTPUT @D_write,Record_nr:T_data(*),F_data(*)
5740 OUTPUT @T_write,Record_nr:S_time
5750 Record_nr=Record_nr+1
5760 Icount=0 ! Set data counter
5770 IF Record_nr>Max_rec THEN STOP ! Done--filled disk file
5780 RETURN
5790 !
5800 Gdump: !//////////////////////////////// Output graph to printer //////////////////////////////////
5810 DUMP GRAPHICS #701 ! For double size plots EXECUTE 'DUMP DEVICE IS #701,EX
PANDED' once. before running the program.
5820 RETURN
5830 Rerite: !
5840 PRINT TABXY(25,1);"Center Frequency is ";C_band/1000;" kHz"
5850 PRINT TABXY(9,4);"FREQUENCY Icount Dcount" ! Label screen and
5860 PRINT TABXY(67,4);"TIME" ! Create black grid with
5870 PRINT TABXY(67,17);"RECORD" ! blue axes
5880 PRINT TABXY(9,17);"GRAPHICS DUMP IS ON "
5890 IF Dump$<"ON" THEN PRINT TABXY(9,17);"GRAPHICS DUMP IS OFF"
5900 IF Gsize$="SMALL GRAPH" THEN PRINT TABXY(30,17);"SMALL GRAPH"
5910 IF Gsize$="LARGE GRAPH" THEN PRINT TABXY(30,17);"LARGE GRAPH"
5920 RETURN
5930 END

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